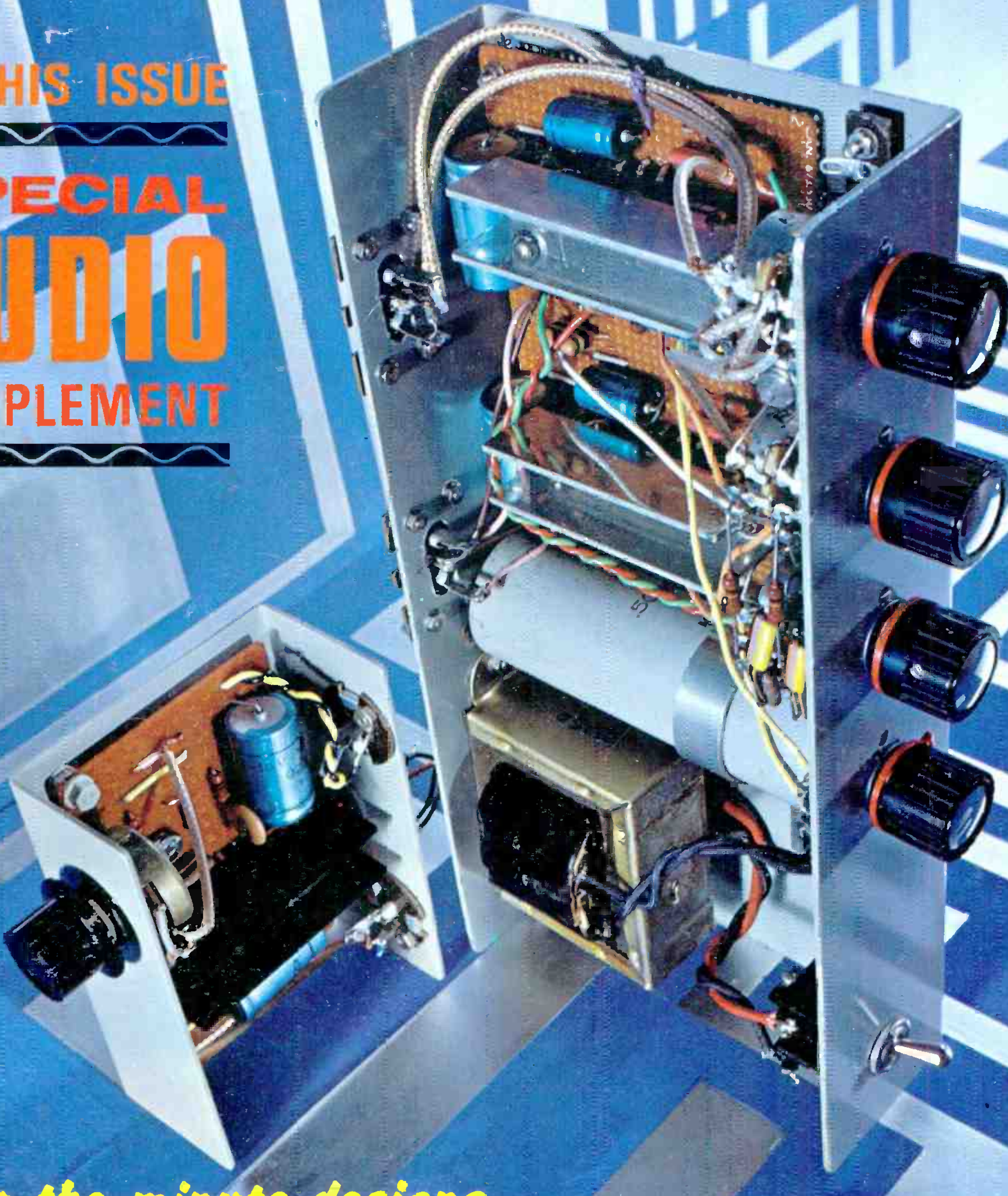
PRACTICAL ELECTRONICS

NOVEMBER 1969

THREE SHILLINGS

IN THIS ISSUE

SPECIAL AUDIO SUPPLEMENT



Up-to-the-minute designs

INTEGRATED CIRCUIT AUDIO AMPLIFIERS

ADCOLA

PRODUCTS LIMITED
(Regd Trade Mark)

THE RELIABLE SOLDERING INSTRUMENT!

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ELECTROVALUE

RAPID MAIL ORDER SERVICE

EVERYTHING BRAND NEW AND TO EXACT SPECIFICATION • NO SURPLUS GOODS

AMPLIFIER KITS

PEAK SOUND P.W. DOUBLE 12

Complete stereo kit including cabinet, but less panel and other metalwork. **£23** net. Available in separate packages as follows: Main amplifier kit **£3.19.6** per channel, net. Accessories **19/-** mono, **36/-** stereo.
Pre-amplifier kit **£1.7.0** per channel, net. Accessories **13/6** mono, **27/3** stereo.
Tone control kit **19/-** per channel, net. Accessories **8/9** mono, **22/6** stereo.
Power supply kit **£4.10.0** mono or stereo, net.
Cabinet kit **£2.12.6** net. Metalwork available separately from other sources, details on request.

30 WATT (designed by Dr. A. R. Bailey). Published May 1968 W.W., modified November 1968 W.W.
Full kit for main amplifier **£9.9.6** (less power supply). Transistors only for main amplifier **£7.9.6.** PC board supplied free with above kit. Heat sinks for output transistors **8/6** extra.
Power supply kit, unregulated, November 1969 circuit **£4.14.0.** Regulated version, 60V 1·6A or 0·8A, current limiting, re-entrant characteristic: does not need re-set button **£8.10.0.** Transformer only: 0–25–45–50V 2A **58/-.**
8 x 8 watt Stereo only. Peak Sound SA 8 x 8 kit. Sensitivity 50mV into 1MΩ, output into 5Ω. Complete with cabinet and power supply. Kit complete **£16.10.0** net. Built and tested **£21** net.

BARGAINS IN BRAND NEW ELECTRONIC COMPONENTS

Ultra low-noise resistors (under 0·1μV/V) Electrosil TR5: Metal oxide, 2% tolerance, range 10Ω to 1MΩ. All values in E24 series available. ½W rating. 1–24 **10d.** each; 25–99 **9d.** each; 100 up **8d.** each. (Ohmic values may be mixed to obtain quantity price.)
Potentiometers, carbon track, long plastic spindles: Single gang linear 220Ω to 2·2MΩ **2/6** each; log 4·7KΩ to 2·2MΩ **2/6** each. Dual gang stereo-matched lin or log 10K to 1MΩ **8/6** each. Stereo balance log/anti-log 10K, 47K, 1MΩ only, **8/6** each. All types available with ½A D.P. switch **2/3** extra.

TRANSISTORS, etc.

2N696	5/6	2N3704	3/9	BC107	3/6	BFY51	4/3
2N697	6/–	2N3705	3/5	BC108	3/–	MC140	6/3
2N706	3/5	2N3707	4/–	BC109	3/6	MJ480	21/–
2N1302	4/–	2N3794	2/11	BC125	12/–	MJ481	27/–
2N1303	4/–	2N4286	2/11	BC126	12/–	MJ491	31/–
2N1304	4/–	2N4289	2/11	BC148	3/3	MPF103	11/6
2N1305	4/–	2N4291	2/11	BC149	4/3	MPF105	7/6
2N2147	18/9	cheapest FET:		BC169	2/3	OA47	1/9
2N2926yellow	1/9	2N5163	5/–	BC183L	2/–	OA90	1/3
2N2926green	2/3	40361	12/6	BC184L	2/3	OA91	1/3
2N3053	5/3	40362	16/9	BD124	16/–	OA202	2/–
2N3054	15/6	AD149	17/6	BFX85	8/3	P346A	5/9
2N3055	16/6	AD161	14/–	BFX88	7/9	TPMD	
2N3702	3/6	AD162	pr.	BFY50	4/9	(= ORP12)	6/–
2N3703	3/3						

Large capacitors, high ripple current types. 2000μF 25V **7/–**; 2000μF 50V **9/3**; 5000μF 25V **10/3**; 5000μF 50V **17/6**. S-DeC **30/6**; 2-DeC DeCstore **69/6**; 4-DeC **119/6**.

- DISCOUNTS (on all but net items): 10% for *total* order value of £3 or over. 15% for *total* order value of £10 or over.
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- CATALOGUE gives further details of above products and much information on semiconductor characteristics etc. **1/6** post free.

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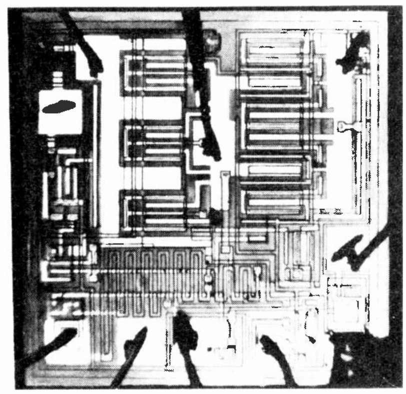
(Dept. P.E.11)

28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY.
Tel: Egham 5533

10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output power of 10 watts. It contains 13 transistors (including two power types), 2 diodes, 1 zenor 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 the usual tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required for producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. It also enables us to give a 5 year guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

■ SPECIFICATIONS

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

■ CIRCUIT DESCRIPTION

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

■ APPLICATIONS

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

SINCLAIR

IC.10 *with IC.10 manual and 5 year guar-antee* **59/6**

POST FREE

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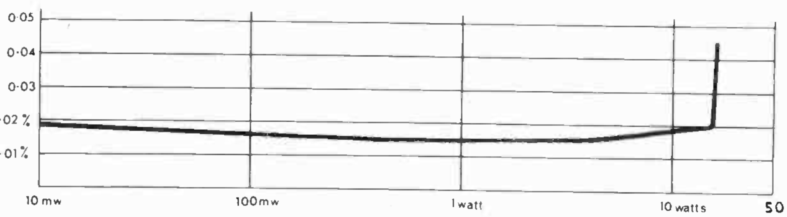
SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD · CAMBRIDGE
Tel. 0233-52731

Z.30

THE WORLD'S LOWEST DISTORTION HIGH FIDELITY AMPLIFIER.

For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual boot-strapping. 9 silicon epitaxial planar transistors are used to provide enormous power; up to 25 watts RMS sine wave (50 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection. At all output levels, distortion is only 0.02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. It can also be used entirely on its own as an amplifier for an efficient economy record player.



Ready built and tested, with Z.30 Manual, post free (except air mail)

89/6

SPECIFICATIONS

Power output—15 watts R.M.S. sine wave (30w peak) into 8 ohms using 35 volts supply; 25 watts R.M.S. sine wave (50w. peak) into 3 ohms using 30 volts supply.

Frequency Response—30 to 300,000 Hz ± 1dB.

Input sensitivity—250mV into 100K ohms.

Distortion—0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.

Signal-to-noise ratio—better than 70dB unweighted.

Power requirements—from 8 to 35 V.d.c.

Output stage—Class AB.

Size—$3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ ins.

Damping factor—better than 500.

APPLICATIONS—Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; intercom; electronic music and instruments; P.A.; laboratory work, etc. Full details for these and many other applications are given in the manual supplied with the Z.30.

Loudspeaker Impedances—3 to 15 ohms.

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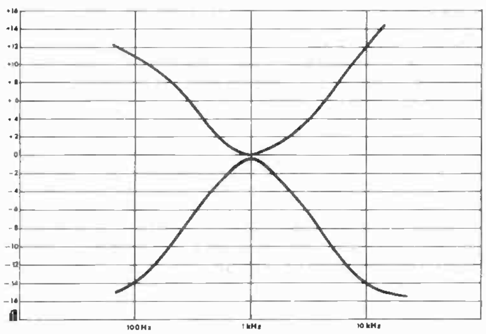
SINCLAIR RADIONICS LIMITED
22 NEWMARKET RD., CAMBRIDGE Tel: 0223 52731

STEREO SIXTY

PRE-AMP & TONE CONTROL UNIT



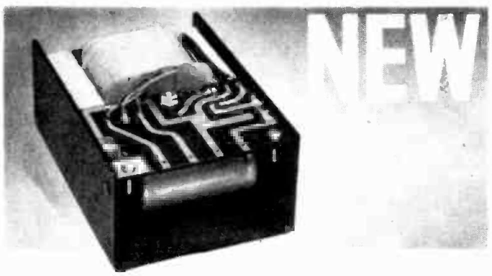
Ready built and tested, with instructions, post free

£9.19.6

This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

Frequency range:	Radio & Aux. 20-25,000 Hz ± 1dB Pick-up corrected to within ± 1dB for R.I.A.A. equalisation.
Inputs:	Radio, pick-up (magnetic, ceramic or crystal), Auxiliary.
Overload factor:	>20dB per channel on all inputs
Distortion:	0.03%
Signal to noise ratio:	Better than 70dB unweighted
Controls:	press buttons for on-off, P.U, radio and aux. Treble +15dB to —15dB at 10kHz. Bass +15dB to —15dB at 100Hz. Volume. Stereo Balance.
Size:	$8\frac{1}{4}$" x $1\frac{1}{2}$" x 4" from front to back, plus knobs.
Finish:	Brushed aluminium with black titling, knobs and press buttons.



PZ.5 POWER SUPPLY UNIT

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design.
For AC Mains, 200-240V/50Hz. **£4.19.6.**

USE THIS COUPON FOR Z.30, STEREO 60 AND P.Z.5

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SINCLAIR MICROMATIC

the world's most successful miniature radio

Considerably smaller than an ordinary box of matches, this is a multi-stage A.M. receiver meticulously designed to provide remarkable standards of selectivity, power and quality. Powerful A.G.C. is incorporated to counteract fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy at all times. Vernier type tuning plus the directional properties of the self-contained special ferrite rod aerial makes station separation much easier than with many larger sets. The plug-in magnetic earpiece which matches exactly with the output provides wonderful standards of reproduction.
Everything including the batteries is contained within the attractively designed case. Whether you build your Micromatic or buy it ready built and tested, you will find it as easy to take with you as your wristwatch, and dependable under the severest listening conditions.

Specifications
Size:
$1\frac{13}{16}'' \times 1\frac{7}{16}'' \times \frac{1}{2}''$ (46 × 33 × 13mm).
Weight incl. batteries:
1 oz. (28·35gm) approx.
Tuning:
Medium wave band with bandspread at higher frequency end.
Earpiece.
Magnetic type.
Case:
Black plastic with anodized aluminium front panel, spun aluminium dial.

Complete kit incl. earpiece, case, solder and instructions in fitted pack. **49/6**
Plus 11d. P.T. surcharge

Ready built, tested and guaranteed, with earpiece. **59/6**
Plus 1/1d. P.T. surcharge

Mallory Mercury Cell RM675 (2 required) each 2/9d.

USE THIS COUPON FOR MICROMATIC AND Q.16 ORDERS

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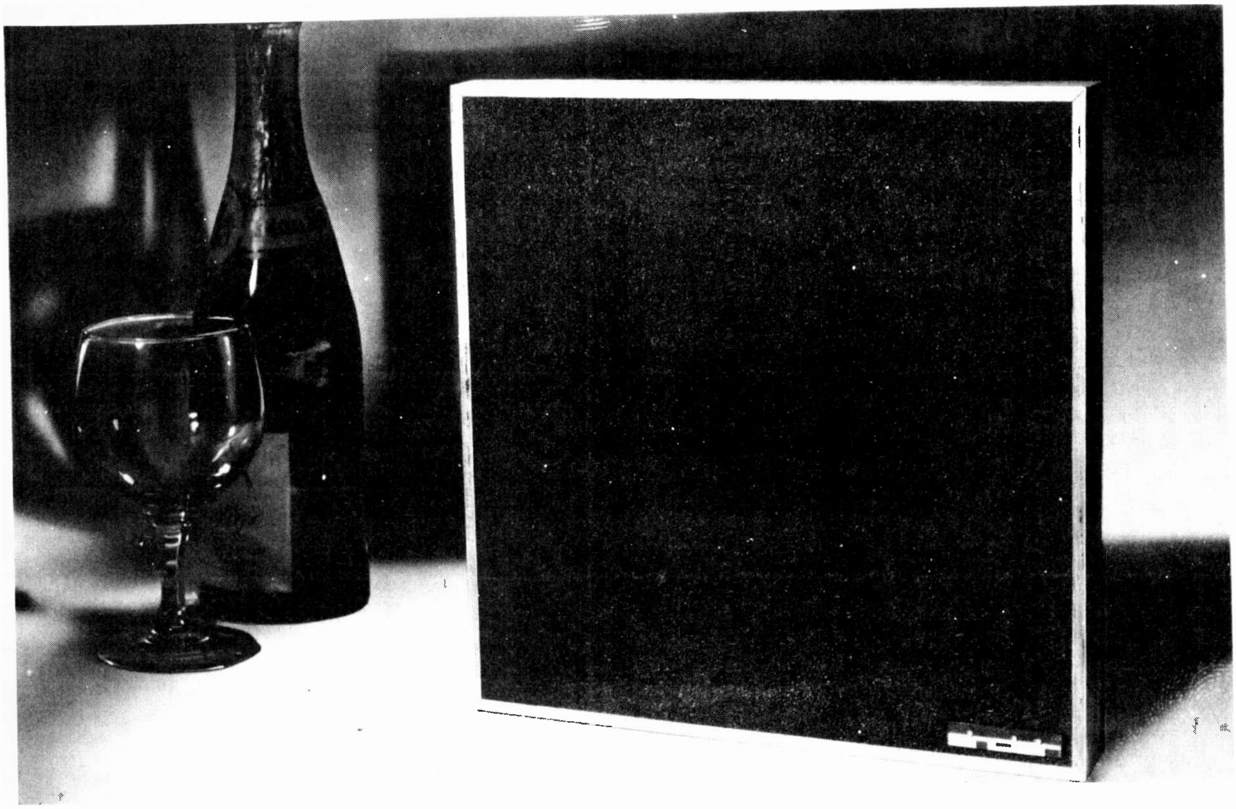


Lasky's

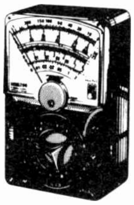
TMK METER KITS

ANOTHER LASKY'S EXCLUSIVE

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 Model 200 also has the range selector in position. The highest quality in components and 1% tolerance resistors are used throughout. Both offer professional standards of accuracy. 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: 0-0·6-6-60-600mA. ● Resistance: 0-10K-100K-1M-10M/ohms (58-580-5·8K-58K at mid-scale). ● Capacitance: 0·002-0·2uf (AC 6V range). ● Decibels −20 to +63dB. ● Output: 0·05uf blocking capacitor. Uses two 1·5V (U.7 type) batteries. Black bakelite cabinet—Size 5½ × 3⅞ × 1⅞in. Complete with test leads.

LASKY'S PRICE 85/- 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 clearly indicated on the actual meter face. High speed rotary range selection knob; also features polarity reversal switch, shielded meter movement with overload protection circuit; Special uA 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. DCuA: 0-25uA at 125mA: 0-50uA 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 (0·1uF, 400Vw) in series with ACV ranges. Decibels: −20 to +81·5db. Operates on two 1·5V batts. Black bakelite cabinet, size 5¾ × 6¾ × 2¾in. Complete with test leads.

LASKY'S PRICE £10.10.0 Post 5/-

ALSO AVAILABLE READY BUILT AND TESTED £13.10.0. Post 5/-

Garrard

SP.25 Mk II

4-speed single player—less cartridge

LASKY'S PRICE £11.19.6 Post 5/-

AUTOCHANGERS

1025 less cartridge	£6 9 6
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SL55 with J2006 stereo cartridge	£11 19 6
SL65 less cartridge	£14 15 0
AT60 Mk. II less cartridge	£13 5 0
SL75 less cartridge	£28 10 0
SL95 less cartridge	£35 0 0
A70 Mk. II less cartridge	£13 19 6
B.S.R.UA-47 less cartridge	£5 9 6

SINGLE PLAYERS

AP75 with AD76K magnetic cartridge	£21 0 0
AP75 less cartridge	£18 10 0
SRP22 Mains model less cartridge	£6 12 10
SRP22 Battery model less cartridge	£7 15 3
TRANSCRIPTION DECKS 401	£28 10 0

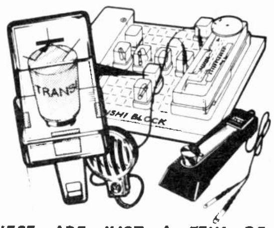
GARRARD BASES:
WB1 £3. 6. 11; WB4 Mk. II £5. 8. 11; WB5 £5. 8. 11.

CLEARVIEW PERSPEX COVERS:
SPC1 £3. 5. 0 SPC4 Mk. II £4. 6. 6.

Postage on all above 5/- extra

DENSHI BOARD KITS

NEW EXPERIMENTAL AND EDUCATIONAL CIRCUIT SYSTEM



The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are encapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. In addition each **DENSHI BOARD KIT comes complete with an 80 page manual of circuits and data.**

THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES: VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, CONTINUITY TESTER, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE, ETC., ETC.

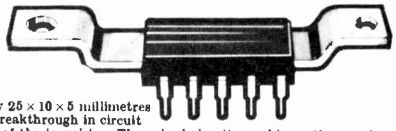
DENSHI BOARD KIT SR-1A *comprises:*
Base board; tuner block; 4 resistors; choke coil; transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces and 80 page manual. **This kit permits the building of 16 basic circuits.**

LASKY'S PRICE £4.19.6 Post 3/6

DENSHI KIT SR-2A *as SR-1A with these additional parts:*
2SB transistor for AF; 2 resistors; 1 capacitor; crystal microphone; test probes; electrode; additional connecting pieces; 9V battery. **This kit permits the building of 30 circuits**

LASKY'S PRICE £7.2.6 Post 3/6

EXCLUSIVE FIRST THE IC-403 INTEGRATED CIRCUIT AMPLIFIER MODULE AVAILABLE NOW!



These tiny modules—size only 25 × 10 × 5 millimetres represent the most amazing breakthrough in circuit design since the introduction of the transistor. The actual circuit—no bigger than a pinhead—is encapsulated in solid plastic fused with the heatsink and connecting pins to make an almost indestructible unit. The IC-403 is an integrated power and pre-amplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output. Originally developed for computer and space projects—there are many applications for these unique devices, wherever high efficiency and ultra compact size is required, i.e. miniature P.A. and audio amplifiers, intercoms, electronic organs, tape recorders, etc., etc.

SPECIFICATION (ratings at 20°C): Output power typically 3W from 250mV input. Frequency response 20 Hz to 80KHz ± 3dB. Power amp. distortion 0·3% (at 1W, 400Hz). Pre-amp. gain 24dB. Power amp. gain 26dB. Max operating voltage 21V. Min. operating load 7·5. Noise level −75dB. Pre-amp. input imp. 2m/ohms. Pre-amp and power amp. D.C. input current 50N.A.

THE IC-403 IS AVAILABLE FROM STOCK EXCLUSIVELY FROM LASKY'S—COMP. WITH INS. DATA AND SUGGESTED CIRCUIT APPLICATIONS

LASKY'S PRICE 49/6 Post 1/6. 2 for 95/- Post free
Also available SINCLAIR IC10 59/6 Post free.

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Complete stereo system – 28 gns.

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

Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6"×4" speaker and 2¼" tweeter. Teak finish 12"×6¾"×5¾". **4 guineas each.** 7/6d. p. & p.
Type 2 as type 1. Size 17¾"×10¾"×6¾". Incorporating Elac 10½"×6½" 10,000 lines and 2½" tweeter. 3 ohms impedance 5½ guineas plus 7/6d. p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto **Integrated Transistor Stereo Amplifier** **9GNS.** plus 7/6d. p. & p.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.
SPECIFICATION:–
R.M.S. power output: 3 watts per channel into 10 ohms speakers
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on off switch. A preset balance control.

These 5 items can be purchased together for 28 gns. +£1.10 P.&P.

The Classic

Teak finished case

8½ GNS.
Plus P. & P. 7/6

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2 mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range: Bass:* 13dB at 60Hz. *Treble:* ±14dB at 15KHz. *Total Distortion:* (for 10 watt output) < 1·5%. Signal Noise: < −60dB. A.C. Mains 200–250V. Size 12½in long, 4¼in deep, 2¾in high. **Built and tested.**

The Viscount

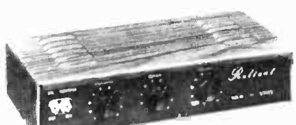
INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFER

13½ GNS.
Plus P. & P. 7/6

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

THE RELIANT Mk. II

SOLID STATE GENERAL PURPOSE AMPLIFIER



6½ GNS. Plus P. & P. 7/6
In teak finished case

SPECIFICATION: *Output:* 10 watts into a 3 ohms speaker. *Inputs:* (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors:* 4 silicon and three germanium. *Mains input:* 220/250 volts. *Size:* 10½ × 4¾ × 2½in. *Mike to suit (crystal):* 12/6 plus 1/6 P. & P. 8 × 5in speaker 14/6 plus 3/– P. & P. Mk. I 5½ gns. plus 7/6 P. & P. Less teak finished case.

SPECIAL OFFER

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 DUO speaker systems size 12 × 6¾ × 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

19 GNS. Plus P. & P. 20/–

B.S.R. TD2 TAPE DECK

This tape deck takes 5¾in spools complete with two-track heads. Size 13½ in long by 8¾in wide.

Price £8.19.6 Plus P. & P. 7/6

THE ELEGANT SEVEN Mk. III (350mW Output)

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

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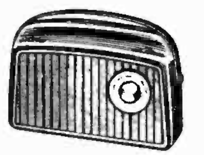
Circuit 2/6. Free with parts.

THE DORSET (600mW Output)

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



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Circuit 2/6. Free with parts.

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R.TV
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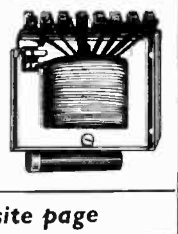
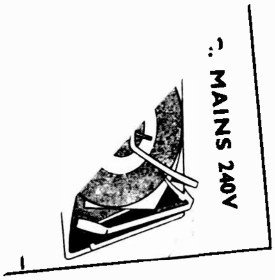
QUALITY MAINS TRANSFORMER

Input 250V OUTPUT (All RMS values) 4 windings of 11·5V connected in series total 46V at 4·5 amps (conservatively rated). The following combinations may be used. 1. 23—0—23V; 2. 46V. Both of these above voltages are commonly used in medium to high powered transistor amplifiers, power supplies, etc.



Price 35/- Plus P. & P. 7/6

Also see opposite page



Diamond manu- . Acos npatible cturers'

OFF
ft. 30/-
ft. 39/-
ft. 57/-

E
KERS

er to ... heavy duty cast chassis, twin cone construction, smooth extended range, with very low level of distortion.—Response 35–17,500Hz.—impedance 15 ohms—flux, 11,000 gauss.

WALDON PRICE 97/6 each plus 6/6 P. & P.

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SET 450: 13 × 8 with two built-in tweeters and cross-over unit. **Our Price 69/6.** 3 or 15 ohm, 10W, 40-13,000Hz.

SET 850: 6½in bass plus 3¾in tweeter and cross-over unit. 8 ohm, 10W, 65-20,000Hz. **79/6.**

SET 250: 5in heavy duty bass plus 3in tweeter and cross-over unit. 8 ohm, 6W, 80-20,000Hz. **65/-**

Add 5/6 p/p for each speaker set.

TRIO Stereo Moving Magnet Cartridge Model AD76K. Diamond Stereo LP Stylus. Frequency response 20-20,000c/s output. 7mV tracking pressure 2 grammes ± 0·5 grm. Fully guaranteed. Price 85/- p/p free.

GARRARD UNITS

	Retail £	s	d	Our Price £	s	d
SP25 Mk. II	15	11	11	**11**	**9**	**6**
AP75	23	16	7	**17**	**19**	**6**
SL65	18	8	4	**14**	**9**	**6**
***3500**	16	0	10	**11**	**9**	**6**

***Denotes** including Sonotone 9TA-Stereo/Diamond Cartridge. Elegantly styled plinth and cover to suit the above units. From **5 gns.** Please add 10/- p/p each on all above items.

SPEAKER ENCLOSURES

Designed to accept the full range of E.M.I. loudspeakers. Beautifully styled in teak.

Prices from 89/6 each.

25 WATT GROUP SPEAKERS

Guitar group 25. 12in round, heavy duty cone, with solid aluminium chassis, 15 ohms imp. 12,000 gauss. Response 30-10,000c/s. OUR SPECIAL PRICE, **£.5.9.6** plus 6/6 P. & P.

The greatest budget system available today—can't be beaten—price or quality anywhere—look at these great features—then compare:

	£	s	d
Teleton FZ000 Mk. II. Tuner amp. Latest version with all the new features. Tuning indicator—fused circuit protection, AM-FM fitted multiplex, A.F.C. 2 × 5 watts per channel. A truly outstanding unit.	43	1	8
Garrard 3500 (Auto/single). Latest in the great new Garrard range, provides facilities and controls that are usually found only on much more expensive units	13	11	0
Teleton SA1003 matching speaker systems	10	0	0
Sonotone 9TA stereo cartridge with diamond styli—a perfect match	4	2	0
Plinth/Cover elegantly styled	7	0	0
Plugs and Leads all supplied	1	5	0
Normal Retail Price	£78	19	8

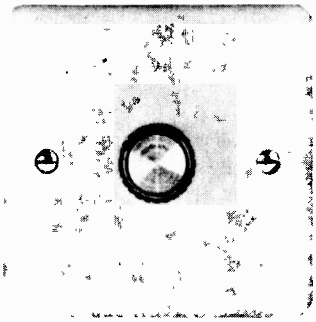
Exclusively offered by WALDON at the remarkably low price of 63 gns +25/- Carrg.

All items may be purchased separately.

WALDON ELECTRONICS, 707 Blackburn Road, Bolton, Lancs. Bolton 54280

PLEASE ENCLOSE 1/0 IN STAMPS WITH ENQUIRIES

DIMMASWITCH



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

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

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

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Chester 25883

Buy with confidence and get results. Refund if not delighted.

RHYTHM GENERATOR. 29 silicon transistors and 119 diodes. Finger tip selection of seven instruments in nine basic rhythms in any sequence. Self contained in an attractive case 14 × 13 × 7½in. Retails at over £74. Our price only **£66.9.6.** + 10/6 P. & P. & Ins. S.A.E. for illustrated leaflet.

REVERBERATION AMPLIFIER. Self contained transistorised battery operated. An entirely different approach to sound reproduction. Normally sound reproduction from a single course has a flat one dimensional effect. With this, proper sound delay through reverberation, tones are created with a truly third dimension for concert hall originality. Two controls adjust volume and reverberation. Simply plug microphone, guitar, etc., in and the output into your amplifier. Supplied in a beautiful walnut cabinet 7½ × 3 × 4½in. **£10.4.0.** P. & P. & Ins. 6/-.

POWER CONTROLLER. Power at your finger tips. Not just half wave control but full wave. One variable control gives zero to full power. Uses latest 15amp 3kw triac and special triggering device. Complete with box, power socket, etc. Ideal for flood lights, fires motors, etc. In kit form **£6.9.6.**, ready built **£9.4.6.** + 5/6 P. & P.

VOX SWITCH KIT. This sound operated switch is ideal for mobile T.X. work tape recorder switching, etc., etc., you speak it switches. High & med. imp. inputs. A.F. take off point. Drives your 12 volt relay. **42/6,** P. & P. 2/6.

METRONOME KIT. Variable beat, listen whilst you play and keep in the groove. Easy to build, pocket size with personal mini earphone. **25/-** P. & P. 2/6.

MORSE OSCILLATOR KIT. P.C. board, transistors, high stab. components battery carrier, ear piece. Adj. tone. Just attach your key. Drives phones or speaker. **15/6.** P. & P. 2/-.

Free lists with every order. For lists only send 1/- P.O. (deductable from first order).

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5 SHAW LANE, HALIFAX

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(electronic component specialists)
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Assorted Components mounted on boards all with long tags. Ideal for breaking down and experimenting with. Take advantage of bulk purchase

1 Board	2/- each
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8 × 6 inch One Sided Board	2/- each

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Small Motors for the Model Maker, etc.

12 volt 9,000 RPM	4/6 each
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2½" 80 Ω Loudspeaker	5/6 each
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Transistor Pots 5K Ω D.P. Switch	2/6 each
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4BA Screw Terminals	6d each
Transistor Earpieces	1/6 each
Mains Neon Indicators	2/- each
3 Section Tank Aerial 12ft long	6/- each
D.P. Rotary Mains Switch	2/9 each
68,000 PF. Mullard Capacitors	6d each, 4/- per doz
OC19/AD149 Power Transistor	5/- each

CONTINENTAL CONVERSION KIT

Three mains adaptors will convert any continental socket into 5 amp. 2 pin English. Presented in a handy box. Few left only at 7/6 each.

With our new premises in Mayes Road we can now offer an even wider selection of components for the home constructor and enthusiast.

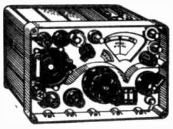
POSTAGE WITH ORDER PLEASE; P.S. Our new catalogue is now available at 1/6 per copy

CAR LIGHT FLASHERS

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

R209 MK II COMMUNICATION RECEIVER

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



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Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES

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

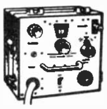
MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts. £20. Carr. 20/-.

SOLARTRON CD. 1016 OSCILLOSCOPE

Double beam. d.c. To 5 Mc/s. Excellent condition. £55 each. Carr. 20/-.

CLASS D WAVEMETERS

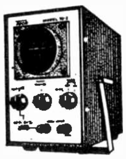


A crystal controlled heterodyne frequency meter covering 1·7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6, or brand new with accessories. £7.19.6. Carr. 7/6.

CLASS D WAVEMETERS No. 2

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

TO-2 PORTABLE OSCILLOSCOPE

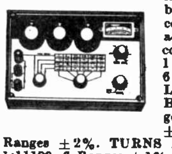


A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 meg Ω 25 P.F. Illuminated scale. 2in tube. 115 × 180 × 230mm. Weight 8lb. 220/240V a.c. Supplied brand new with handbook £22.10.0. Carr. 10/-.

SOLARTRON CD. 711S.2 OSCILLOSCOPES

Double beam. D.C. to 9 Mc/s. Perfect order. £65. Carr. 50/-.

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

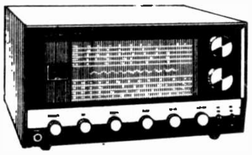


A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 meg Ω 6 Ranges ±1%. L.1 μH - 1 1 1 HENRYS 6 Ranges -2%. C. 10pF ±1 1 1 0 m F d. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

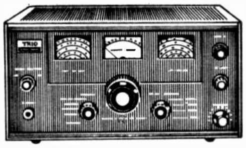
Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s-400 kc/s and 550 kc/s-30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in × 9½in × 8½in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. £42 Carriage paid.
TRIO COMMUNICATION TYPE HEADPHONES Normally £5.19.6.
OUR PRICE £3.15.0 if purchased with above receiver.

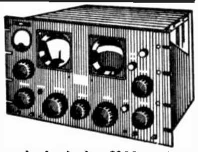
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER

TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212. IN STOCK!

Covers all the amateur bands in 7 separate ranges between 3·5 and 29·7Mc/s, 7 valves, 2 transistors and 5 diodes plus 8 crystals: output 8 and 500 ohm and 5,000 ohm phone jack, Crystal controlled oscillator. Variable BFO, VFO, AVC, ANL. S meter. SSB-CW. Stand-by switch. Special double gear dial drive with direct reading down to 1kHz. Remote control socket for connection to a transmitter. Audio output 1W 115/250V a.c. mains. Superb modern styling. Size 7 × 13 × 10in. with instruction manual and service data. £69.10.0. Carr. paid.

SPECIAL BONUS OFFER! **TRIO SP5D Matching Speaker Mate and TRIO HS4 Communication Headphones, Normal Value £10.7.0, FREE OF CHARGE with every JR.500SE purchased.**

HAMMARLUND SP600JX COMMUNICATION RECEIVER



High quality professional dual conversion communication receivers. Few available again in this country at a reasonable price. Frequency range 540 Kc/s-54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2·5 watt output into 600 ohms. Input 110/230V a.c. 20 valve circuit incorporating: Xtal filter, B.F.O., A.N.L., Xtal calibrator, S meter etc. Size 19 × 12 × 22in. (List £520.) Offered in excellent condition fully tested and checked. £100 each.

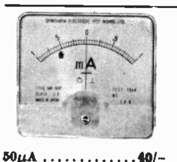
RCA COMMUNICATION RECEIVER AR88D

Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 535Kc/s-32Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £97.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

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

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. $1^{21}/_{32}$in square fronts.

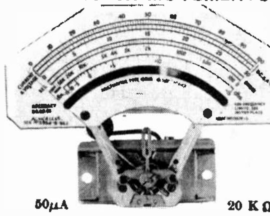
50μA	40/-	500-0-500μA	27/6	150V. D.C.	27/6
50-0-50μA	27/6	1mA	27/6	300V. D.C.	27/6
100μA	37/6	1-0-1mA	27/6	500V. D.C.	27/6
100-0-100μA	35/-	2mA	27/6	750V. D.C.	27/6
200μA	35/-	5mA	27/6	15V. A.C.	27/6
500μA	40/-	10mA	27/6	50V. A.C.	27/6
		50mA	27/6	150V. A.C.	27/6
		100mA	27/6	300V. A.C.	27/6
		150mA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

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

Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230 V 50-60 cycles.
Output full variable from 0-260 V. Bulk quantities available.
1 amp.—£5.10.0; 2·5 amp.—£6.15.0; 5 amp.—£9.15.0;
8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21.0.0;
20 amp.—£37.0.0.

AVOMETER MOVEMENTS



50μA 20 KΩ/V.

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

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

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

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

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

TE-65 VALVE VOLTMETER

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

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

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

AM/FM SIGNAL GENERATORS

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

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Paralux type SD19 230/250V a.c. Reversible. 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3⅛. Complete with instructions and leads. £7.19.6. P.&P. 4/-.

FIELD TELEPHONES TYPE L

Generator ringing, metal cases. Operates from two 1·5v. batteries (not supplied). Excellent condition. £4.10.0 per pair. Carr. 10/-.

AUTO TRANSFORMERS

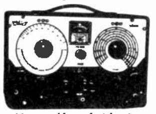
0/115/230v. Step up or step down. Fully shrouded.

150 W.	£1.12.6,	P. & P. 3/6
300 W.	£2.7.6,	P. & P. 4/6
500 W.	£4.10.0,	P. & P. 6/6
1,000 W.	£6.10.0,	P. & P. 7/6
1,500 W.	£7.19.6,	P. & P. 8/6
7,500 W.	£15.10.0,	P. & P. 20/-

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

Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



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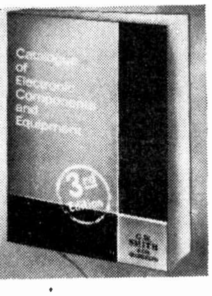

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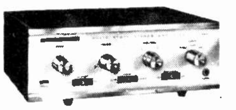

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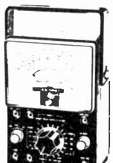

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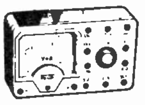

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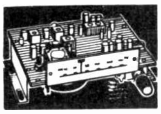

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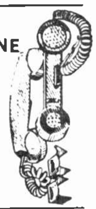

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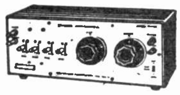

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VOL. 5 No. 11
November 1969

PRACTICAL ELECTRONICS

A SUBSTITUTE FOR STEREO?

STEREOPHONIC reproduction from records is well established, and home performance of orchestral works can attain a state of near-perfection, assuming the various pieces of equipment that make up the complete audio system are selected with care and installed properly.

This much is known, and generally appreciated. However, despite these merits, it is open to question whether stereo in its present form is the definitive method for high quality reproduction in domestic settings. The realism of instrument placing is of limited significance in the absence of actual concert going experience. As the home audience continues to grow, so it must include an ever increasing proportion of listeners whose musical experience is confined to broadcast and recorded works. And, in any case, why assume that the concert hall style of presentation is the most appropriate for the intimate character of a domestic room?

At present electronics is being used to help synthesise a traditional style of performance originated under totally different circumstances to those under which it is later reproduced. True, there are certain exceptions, and experimental works have been performed and recorded, but mainly in the field of popular music.

If all this sounds like heresy to the classical music devotee, let him be assured that this is not some whimsy conjured up by electronics-obsessed eccentrics. Such progressive thoughts have already occurred to some members of the musical world. And the subject was given fresh airing a few weeks ago by Leopold Stokowski. During an interview on BBC Television, this eminent conductor and authority on recorded music re-stated his opinion that stereo is not the ultimate solution.

As one possible advance, Stokowski envisages the home audience seated in the centre of the room with music emanating from loudspeakers situated in the four corners. The intention is to place the audience, in effect, right among the performers. It is a fascinating concept for home listening in the electronic age.

How such an idea could be achieved artistically and technically is not clear at this stage. Certainly difficult problems would have to be solved to make this a practical proposition. The mind boggles at the complexity of a four-channel system. At anyrate, it is worthwhile remembering that such a futuristic idea based upon an awareness of electronic processes and potentialities should have come from a musician. Also, it is encouraging to learn there need be no ideological conflict between art and science where music is concerned.

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

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GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

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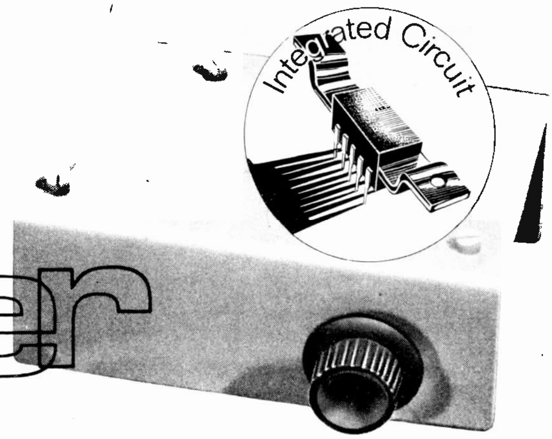
basic amplifier



By M. J. Gay **Chief Circuit Engineer (Linear), Plessey Microelectronics**

BASIC operation theory was given last month for the SL402 and SL403 integrated circuit audio amplifiers. However it is not essential to have read the previous article before constructing the amplifier described here. This article will describe a complete amplifier using the Plessey SL402 or SL403 integrated circuit audio amplifiers. This is a simple arrangement providing a straightforward amplifier without tone controls.

SIMPLE AMPLIFIER

The simplest circuit using the SL402 or 403 is shown in Fig. 1. Here the pre-amplifier section is used solely to provide the bias voltage for the main amplifier. The bias voltage is generated by connecting together the pre-amplifier input and output (pins 6 and 5 respectively), and it is applied to the main amplifier input (pin 4) via the volume control. The use of the pre-amplifier to generate the bias voltage eliminates temperature effects (as explained last month).

The output is taken from pin 10 via the 1,000μF coupling capacitor C5 and the output voltage is fed back to the "bootstrap" connection (pin 8) via C3 (20μF). C2 is a supply decoupling capacitor and C4 is the compensation capacitor necessary to ensure stability of the negative feedback loop.

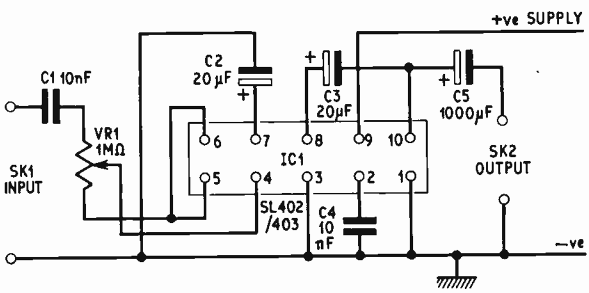


Fig. 1. The simplest amplifier possible using the SL402 or 403

While the circuit of Fig. 1 will work satisfactorily with the great majority of SL402 and SL403 amplifiers, some modifications are necessary to ensure optimum performance with all devices. The recommended circuit is given in Fig. 2.

RECOMMENDED CIRCUIT

The major modification from Fig. 1 is the addition of a bias trimming potentiometer enabling the output quiescent voltage to be precisely centred on all units, thus assuring maximum possible output before overload occurs. Bias trimming is obtained in effect by varying the pre-amplifier section current by means of VR2. The 10 kilohm series resistor R1 prevents the bias point being moved excessively negative, which can in some cases cause damage to the integrated circuit.

The bias voltage is applied to the circuit via a fixed resistor R2 (1 megohm) rather than via the volume control, so that any bias errors due to the main amplifier input current flowing through this impedance will be fixed, and can be trimmed out by means of VR2.

Additional stabilising components R4 and C5 have been added; this is simply a precaution to reduce the risk of oscillation due to h.f. feedback via stray capacitances, etc. when unscreened speaker leads are used. One must always bear in mind that the SL402 and SL403 are capable of operating (and hence of oscillating) at several megahertz. The single compensation capacitor in Fig. 1 has been replaced in Fig. 2 by a resistor-capacitor combination R3 C4. This alternative compensation system preserves the loop gain to higher frequencies and thus gives lower distortion towards the top of the audio band.

The supply decoupling capacitor C7 can be the reservoir capacitor for the power supply unit. It is placed on the board close to the integrated circuit so that it provides effective decoupling of the supply line at high frequencies. For this reason it must be used even if a battery or stabilised power supply provides power to the circuit.

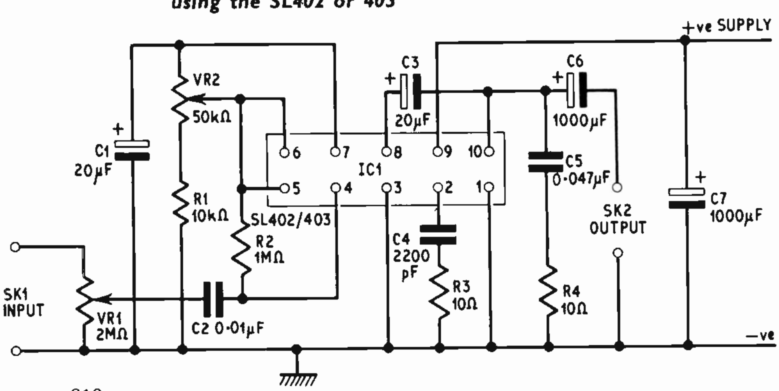


Fig. 2. Recommended simple mono amplifier

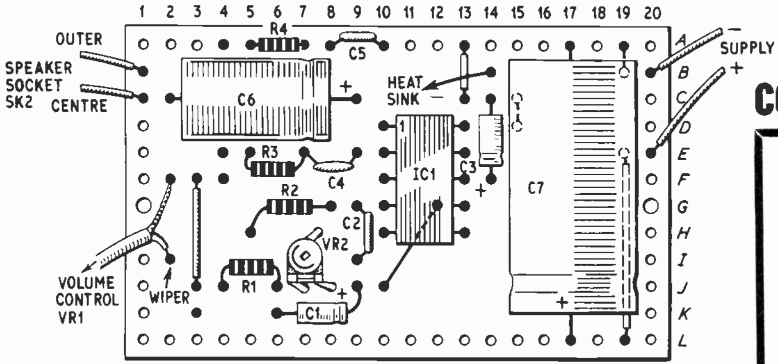


Fig. 3. Layout and wiring of the components for the simple amplifier (Fig. 2)

COMPONENTS . . .

SIMPLE AMPLIFIER

Resistors
R1 10kΩ R3 10Ω
R2 1MΩ R4 10Ω
All ¼W, 10% carbon

Potentiometers
VR1 2MΩ log. carbon
VR2 50kΩ linear skeleton preset

Capacitors
C1 20μF elect. 16V C5 0·047μF polyester
C2 0·01μF polyester C6 1,000μF elect. 16V
C3 20μF elect. 16V C7 1,000μF elect. 25V
C4 2,200pF ceramic

Integrated Circuit
IC1 SL402 or SL403

Miscellaneous
SK1, 2 phono sockets (2 off), control knob
18 s.w.g. aluminium 6½in × 4½in and 2½in × 2in
Screened lead, 6B.A. fixings, grommet

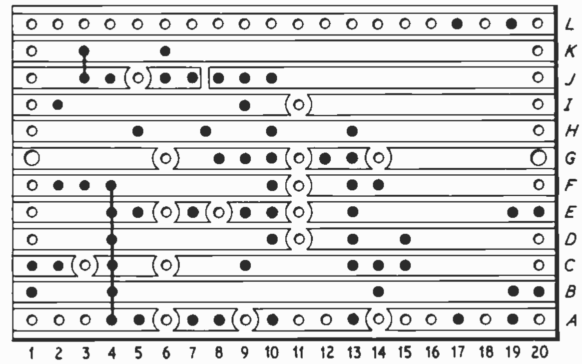


Fig. 4. Underside of Veroboard for the amplifier, showing breaks in copper strip and link wires

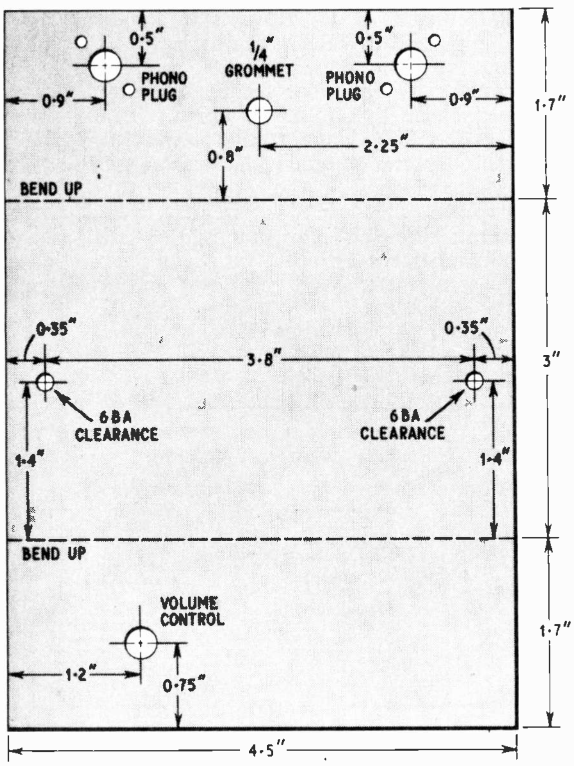
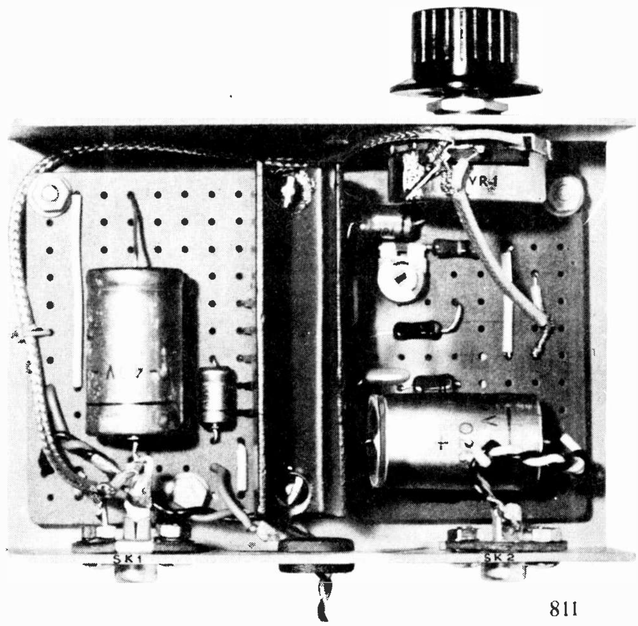


Fig. 5. Chassis details for the simple amplifier

CONSTRUCTIONAL DETAILS

Figs. 3, 4, and 5 show constructional details of the amplifier which was built up on a 2·6in × 4·2in Veroboard mounted in a simple chassis. Note that, as the i.c. has 0·2in pin spacing, 0·2in matrix Veroboard was used. Obviously 0·1in spaced board may be used as an alternative but care must be taken with this size to avoid excess solder shorting adjacent conductors together. If the common 0·15in matrix board is used, then insert pins into the board and solder the i.c. to these. Do not attempt to bend the leads sideways to force them into 0·15in spaced holes.

This unit may be operated from a battery, stabilised power supply, or from a mains power supply consisting simply of a transformer and bridge rectifier as detailed for the stereo amplifier in the following article. The integrated circuit is provided with a heat radiator, see Fig. 9 in the following article. Note that the metal bar of the package, to which the radiator is attached, must be earthed to the negative side of the supply. The completed amplifier measures 4·5in × 3in × 1·7in.



PERFORMANCE OF SIMPLE AMPLIFIER

All the characteristics given were measured with an SL403 in the circuit operating on an 18 volt supply line and a 7·5 ohm load. The performance with an SL402 and a 14V supply will be similar except, of course, that the maximum power will be 2 watts instead of 3 watts. The main characteristics for the simple amplifier are given in Table 1.

Table 1: SPECIFICATION OF SIMPLE AMPLIFIER

Sensitivity (for 3W output)	270mV r.m.s.
Input impedance: Volume control at max.	700kΩ
Volume control at min.	2MΩ
Frequency response (see Fig. 6)	30Hz–90kHz
Distortion (see Fig. 7)	0·5 per cent
Noise level (referred to 3W output)	−84dB
Hum level (see text)	−63dB
Quiescent current	60mA
Current consumption at 3W output	350mA

The noise level quoted is the worst case, measured with the volume contol at maximum and the input open circuit. It is furthermore the absolute level, not weighted for the ear's frequency response. This weighting would yield an even better figure (which is why weighted figures are often quoted).

For hum measurements the circuit was fed directly from a transformer and bridge rectifier. This gave a supply line ripple of 550mV peak-to-peak, which produced the quoted hum level of 63dB below full output. This can be improved proportionately if desired by increasing the value of the reservoir capacitor (C7 in Fig. 2); raising this to 5,000μF will give a hum level of 77dB below full output.

Fig. 7 shows total harmonic distortion against output level. In fact the distortion is predominantly second harmonic.

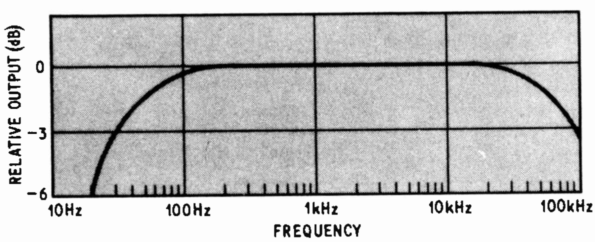


Fig. 6. Frequency response at 0·5 watt output—simple amplifier

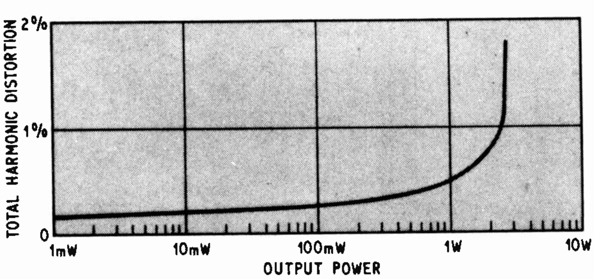


Fig. 7. Distortion curve at 400Hz—simple amplifier

stereo

THE amplifier to be described uses two SL403 integrated circuits in a stereo system which can be driven by a radio tuner, or crystal or ceramic pick-ups. The design includes comprehensive tone controls and a balance control, and also incorporates the mains power supply.

TONE CONTROL CIRCUITS

There are various methods of adding tone control circuits to the SL403, for example, placing them in a feedback loop around the pre-amplifier. The method adopted here however is simply to connect a conventional tone control network between the pre-amplifier and main amplifier. This has the advantages of using normal logarithmic potentiometers and of leaving the amplifier's input impedance unaffected by tone control settings. The basic system is shown in Fig. 1

The input signal is applied to the pre-amplifier which provides the gain necessary to offset the tone control network attenuation (six times with controls set level). The tone control output is then fed directly to the main amplifier section of the SL403 which, having a very high input impedance, presents no significant loading to the network.

It will be remembered that the pre-amplifier serves not only as an amplifier but also as the generator of the temperature compensated bias voltage for the main amplifier. These functions are combined by connecting it as in Fig. 2.

Shunt feedback via R1 R2 and R3 establishes the collector potential of TR3 at approximately 6·5 volts; this allows the pre-amplifier sufficient swing to drive the tone control network. The feedback is decoupled at audio frequencies by C7, across which is established a d.c. potential sensibly equal to that at the base of TR1. This potential is the necessary bias voltage for the main amplifier, to which it is applied via the tone control network. Bias adjustment is essential in this circuit since, by raising the collector potential of TR3 we have reduced its quiescent current; it is accomplished by the pre-set potentiometer VR3 connected across the pre-

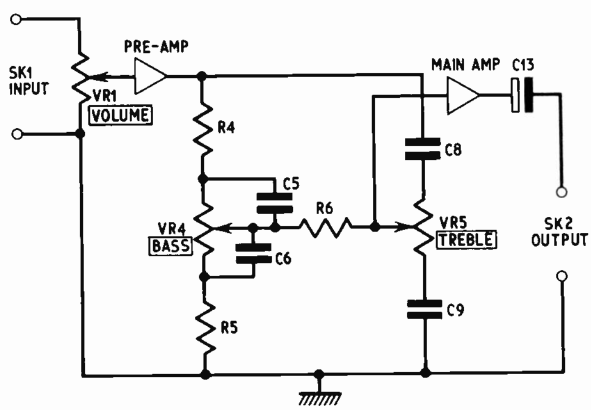
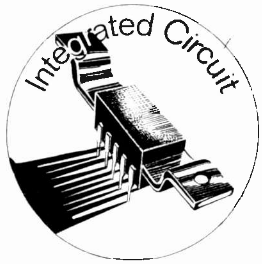


Fig. 1. Basic tone control arrangement

Integrated Circuit amplifier



By M. J. Gay Chief Circuit Engineer (Linear), Plessey Microelectronics

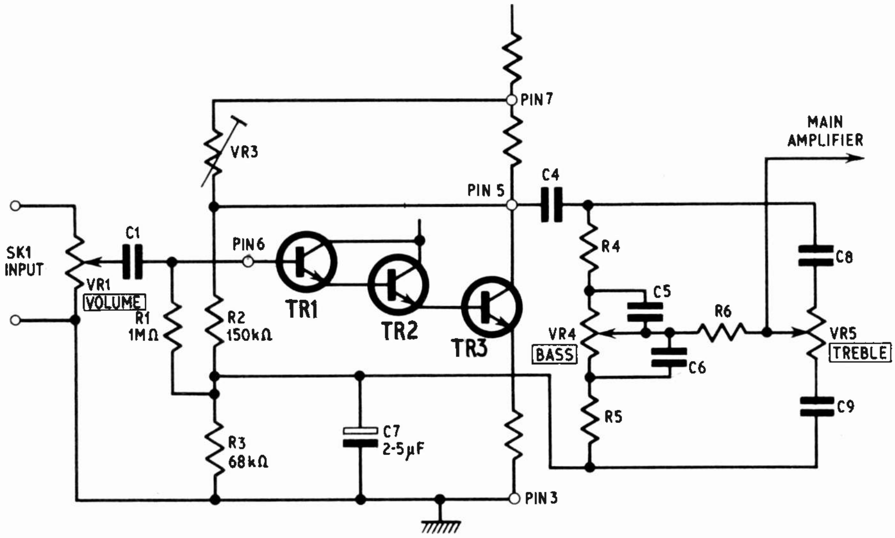


Fig. 2. Bias arrangements for the SL402 and SL403

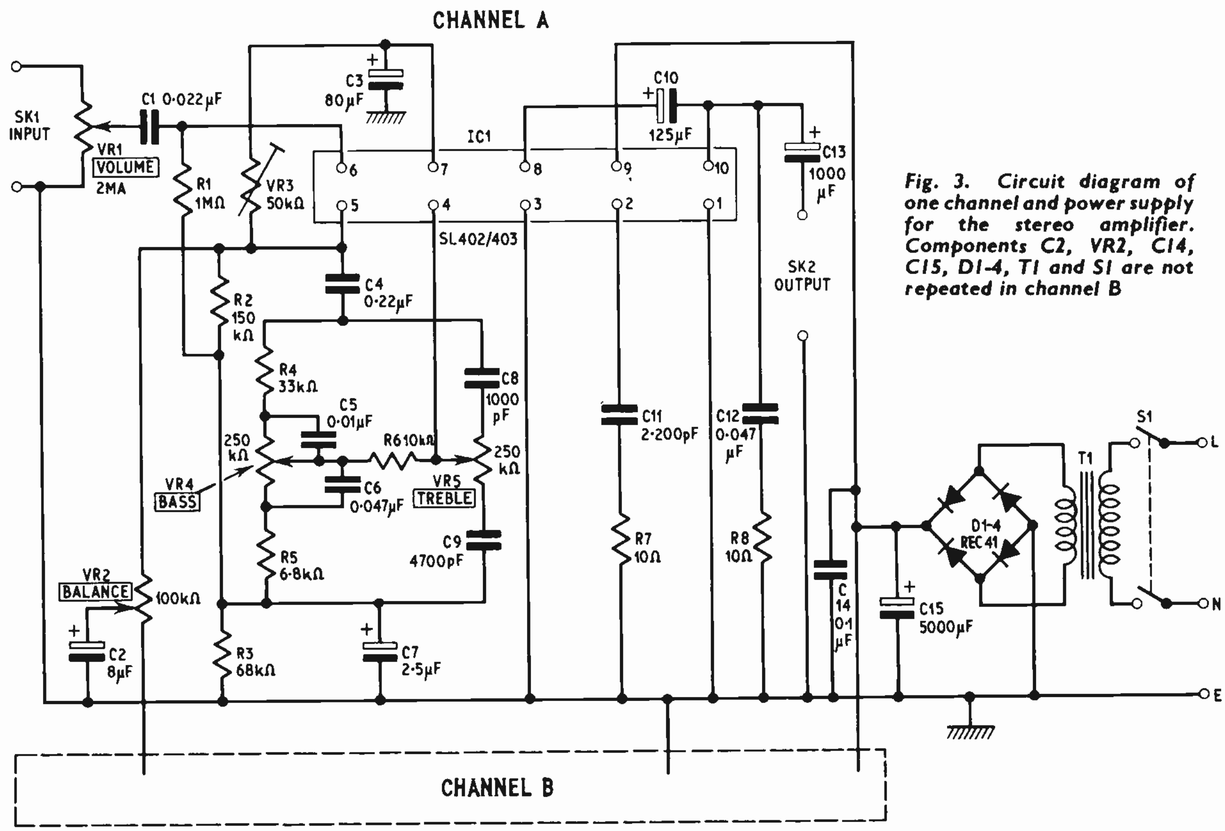


Fig. 3. Circuit diagram of one channel and power supply for the stereo amplifier. Components C2, VR2, C14, C15, D1-4, T1 and S1 are not repeated in channel B

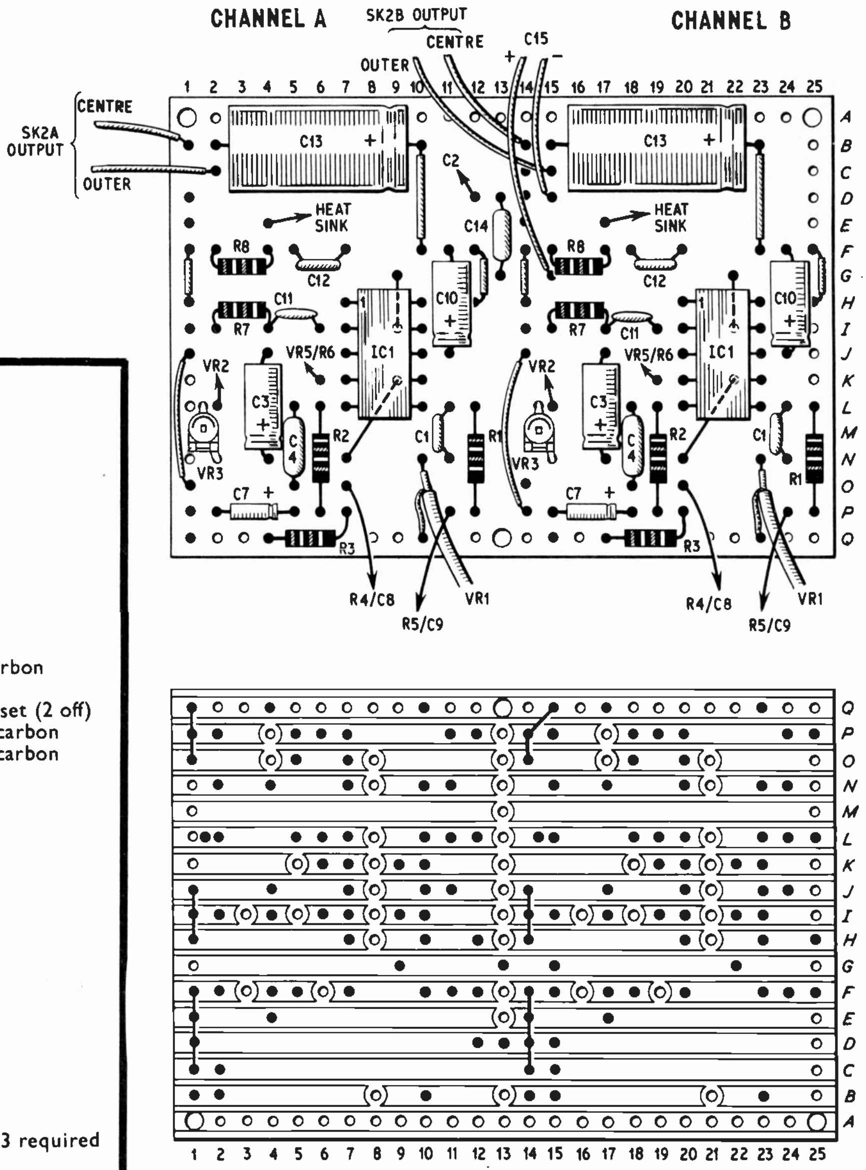


Fig. 4. Veroboard layout and underside wiring and breaks for both channels of the stereo amplifier

COMPONENTS . . .

STEREO AMPLIFIER

Resistors

- R1 1MΩ
- R2 150kΩ
- R3 68kΩ
- R4 33kΩ
- R5 6·8kΩ
- R6 10kΩ
- R7 10Ω
- R8 10Ω
- All $\frac{1}{4}$W, 10% carbon (2 each)

Potentiometers

- VR1 2MΩ log. twin-ganged carbon
- VR2 100kΩ linear carbon
- VR3 50kΩ linear skeleton preset (2 off)
- VR4 250kΩ log. twin-ganged carbon
- VR5 250kΩ log. twin-ganged carbon

Capacitors

- C1 0·022μF polyester (2 off)
- C2 8μF elect. 12V
- C3 80μF elect. 16V
- C4 0·22μF polyester
- C5 0·01μF polyester
- C6 0·047μF polyester
- C7 2·5μF elect. 3V
- C8 1,000pF polystyrene
- C9 4,700pF polystyrene
- C10 125μF elect. 16V
- C11 2,200pF ceramic
- C12 0·047μF polyester
- C13 1,000μF elect. 16V
- C14 0·1μF polyester
- C15 5,000μF elect. 25V
- Two of each value for C3 to C13 required

Integrated Circuit

- IC1 SL402 *or* SL403

Miscellaneous

- D1-4 REC 41 bridge rectifier (Radiospares)
- T1 Filament transformer 240V primary 2 × 6·3V, 1·8A secondary (Radiospares)
- SK1, 2 twin phono sockets (2 off)
- S1 SPST toggle switch
- Control knobs (4 off)
- Capacitor clamp for C15
- 18 s.w.g. aluminium $10\frac{1}{4}$in × $9\frac{3}{4}$in and $2\frac{1}{2}$in × 2in (2 off)
- 6B.A. fixings
- Grommet

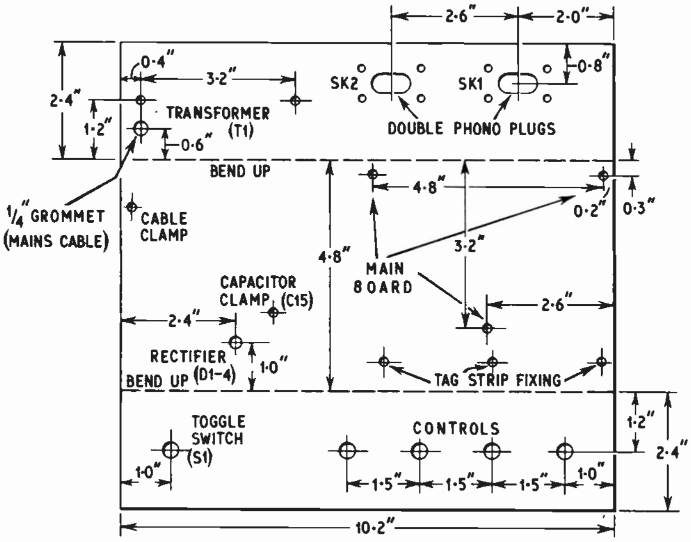


Fig. 5. Chassis details for the stereo amplifier

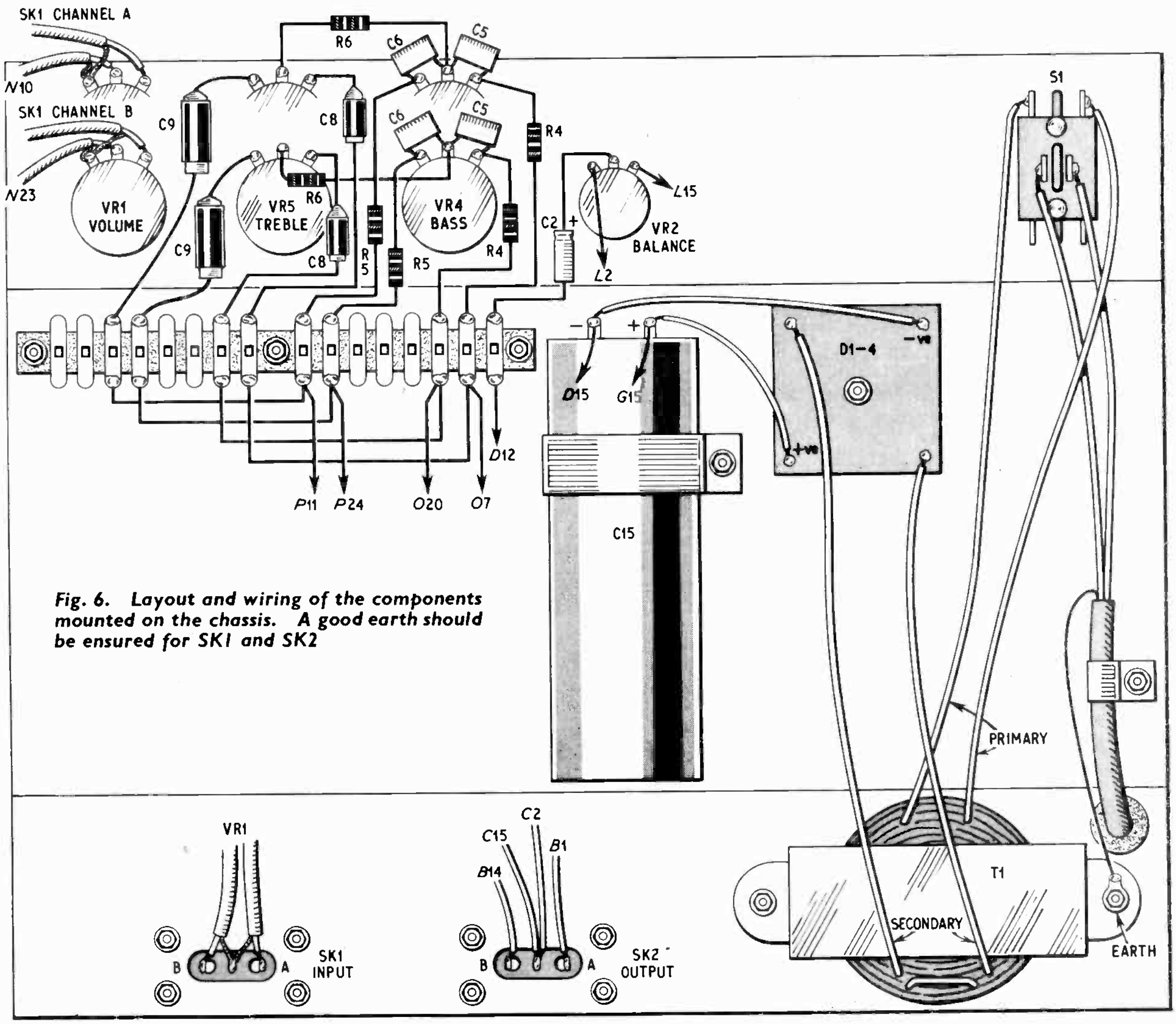


Fig. 6. Layout and wiring of the components mounted on the chassis. A good earth should be ensured for SK1 and SK2

amplifier load. This potentiometer is adjusted as before to set the quiescent output voltage to half the supply voltage.

Balance adjustment is obtained by connecting a 100 kilohm potentiometer between the pre-amplifier outputs of the two channels with the wiper earthed via a capacitor. By adjusting this control the gain of either channel may be reduced to achieve balance.

The complete circuit of the stereo amplifier is shown in Fig. 3. It will be seen that the main amplifier section is connected essentially as in the simple amplifier described earlier.

CONSTRUCTIONAL DETAILS

Figs. 4, 5 and 6 show the constructional details of the unit. The power supply components are mounted directly on the chassis, as are the controls, while the main circuitry of the amplifiers is mounted on the 3·6in × 5·2in piece of 0·2in matrix Veroboard. The tone control network components are wired directly to the potentiometers or between the potentiometers and a tagstrip fixed to the chassis beneath them (see Fig. 6). Screened leads are used for the input connections. The arrangement gives a very compact design without needing a shoehorn to fit the components in. This complete unit measures 10·2in × 4·9in × 2·4in. The recommended construction order is as follows.

1. Build up tone control networks on chassis.
2. Build main board with flying leads attached for connection to tone, volume and balance controls, speaker sockets and power supply. Do not forget to earth the heat sinks.
3. Affix main board to chassis after thorough checking (it is very trying taking it out again) and wire up to controls.
4. Attach and connect up power supply components.

Because, in this layout, the supply reservoir capacitor is connected via leads of about six inches in length, it is necessary to provide supply decoupling directly on the main board; hence the additional 0·1μF capacitor (C14 in Fig. 3) across the supply.

PERFORMANCE OF STEREO AMPLIFIER

The characteristics were measured with a 7·5 ohm load on the output of each channel. The power supply generated a quiescent supply line voltage of 17·4V. With one amplifier driven to full output this dropped to

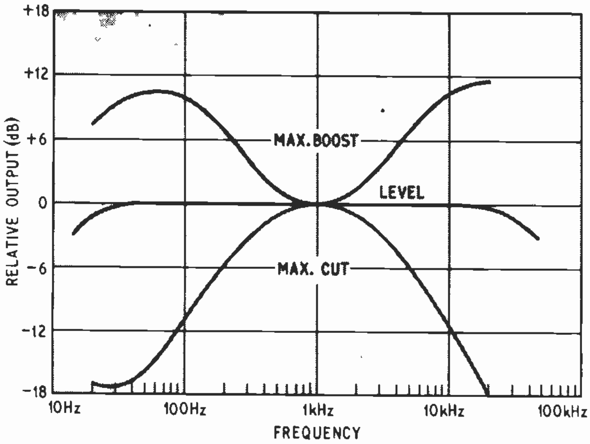


Fig. 7. Frequency response and tone control characteristics—stereo amplifier

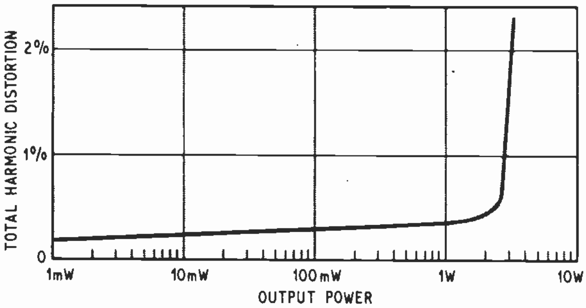


Fig. 8. Distortion curve at 400Hz—stereo amplifier

16·5V, while with both driven to full output it dropped to 15·8V. There are thus three maximum output power figures that can be quoted:

1. Music power, which assumes that full power is demanded for only very short periods so that the supply remains at 17·4V.
2. Continuous sine wave output power with one channel driven only.
3. Continuous sine wave output power with both channels driven.

In this case measurements were made with one channel driven, giving 2·7 watts r.m.s. continuous sine wave output at the onset of clipping. The music rating corresponding to this will be 3W r.m.s. per channel, while the maximum continuous sine wave output per channel with both channels driven is 2·5W r.m.s. per channel. The remaining major characteristics are listed in Table 1.

Table 1: SPECIFICATION FOR STEREO AMPLIFIER

Sensitivity (for 2·7W r.m.s. output)	160mV r.m.s.
Input impedance: Volume control at max.	700kΩ
Volume control at min.	2MΩ
Frequency response (see Fig. 7)	15Hz–50kHz
Tone control range: Bass (40Hz) (see Fig. 7)	−17dB, +10dB
Treble (15kHz)	−15dB, +11·5dB
Distortion (see Fig. 8)	less than 1 per cent
Noise level (ref. 2·7W output, controls level)	−80dB
Hum level (ref. 2·7W output, controls level)	−72dB
Crosstalk level	−40dB

As for the simple amplifier the noise level quoted is worst case and is unweighted. The distortion curve Fig. 8 shows higher distortion than for the simple amplifier due to the additional contribution from the pre-amplifier. Again the distortion is predominantly second harmonic. Crosstalk was measured with one channel driven to 2W r.m.s. output.

SUPERIOR PERFORMANCE

This and the previous article have shown how the SL402 and 403 can be used in amplifier systems. These i.c. devices enable the home constructor to produce complete amplifiers of high reliability in a very small size without recourse to elaborate constructional techniques.

The performance of the designs given will be adequate for many applications (being superior to that of many programme sources and loudspeakers), but it is not claimed however that it reaches real high fidelity standards, although many so-called hi fi amplifiers fall sadly short of a −84dB noise level.

Next month's article will show how advantage may be taken of the low cost and simplicity of use of these units to produce an unconventional stereo system which really does merit the title high fidelity.

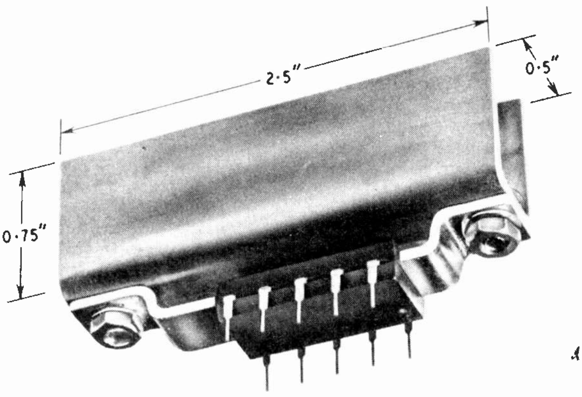
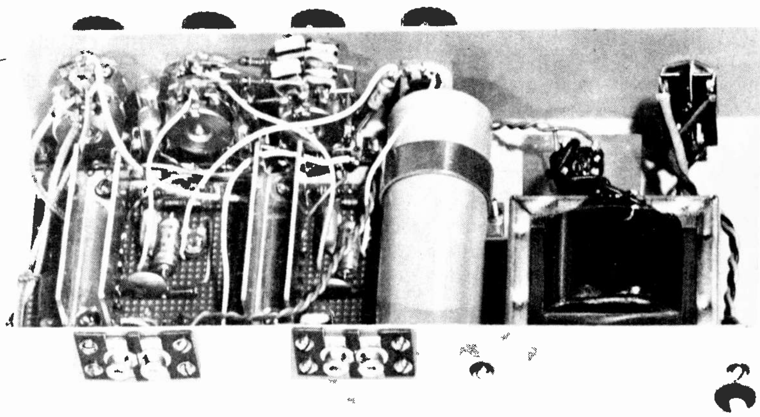


Fig. 9. Heat sink, made of 18 s.w.g. aluminium, attached to the i.c. package



MARKET PLACE

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

F.M. TUNER KIT

A new f.m. tuner kit from **General Avionic Associates Ltd.**, 9 Wimpole Street, London, W.1., is believed to be the first kit to be made available using integrated circuits in a pulse-counting design.

The tuner is capacitively tuned and incorporates automatic frequency control. A voltage tuned version is available as an alternative.

The use of integrated circuits in the tuner is claimed to be equivalent to 44 transistors and also eliminates the need for discriminator and i.f. transformers. The use of i.c.'s also makes alignment much simpler.

The kit price is £9 19s 6d plus 5s postage and packing. No technical specification was given but an illustrated instruction booklet is included with the kit.

WORK BENCH AID

When working on the test bench, the wish for a third hand before becoming entangled in wire, fumbling with components and the work piece, and trying to juggle with a hot soldering iron at the same time, is quite a common scene.

The vice is a useful "third hand" for holding items but is limited in the number of angles that the work can be held. The Pana Vise system from **Special Products Distributors** is a base and vice head arrangement that allows the work piece to be pivoted 360 degrees in any tangent to a half sphere to achieve any compound angle, i.e. tilted 180 degrees and rotated 360 degrees.

There are four types of bases and seven work holder attachments available. The holders are easily locked into position by a single patented lock screw.

Further details and price list is obtainable from Special Products Distributors Ltd., 81 Piccadilly, London, W.1.

SOLDER PINS

Solder pins that can be soldered onto component leads so that they can be readily plugged into printed circuit and 0·050in matrix perforated boards are the latest product from **Oxley Development Co. Ltd.**

These tapered, splined and barbed pins are particularly useful for enabling components to be removed and replaced without damage to the board, mounting transistor and integrated circuits, and for connecting wires between boards.

Further information is available from Oxley Developments Co. Ltd., Priory Park, Ulverston, North Lancashire.

LITERATURE

A designer's guide to mercury and alkaline primary cell power systems has been published by **Mallory Batteries Ltd.**

The guide, in addition to describing the two primary cell systems, explains their advantage under widely differing conditions.

One of the guide's objectives is to assist design engineers of battery powered equipment to make the best possible choice when specifying a particular battery. The technical specifications of 126 different mercury and alkaline manganese cells and batteries are included in the guide.

Further information and copies of the guide can be obtained from Mallory Batteries Ltd., Gatwick Road, Crawley, Sussex.

Another guide of particular interes to electronics firms is the new edition of the Guide to Northern Engineering, price 5s, now available from the **North East Engineering Bureau,** 15, Walker Terrace, Prince Consort Road, Gateshead-on-Tyne, 8.

The guide contains the names and addresses, with a description of capacity and products of most engineering and allied trades in the Northern Region. There is also a classified index to all products.

Featured in this issue are articles from most of the development organisations in the region, giving valuable information and contacts for expansion in the North.

COMPONENT ORDERING SCHEME

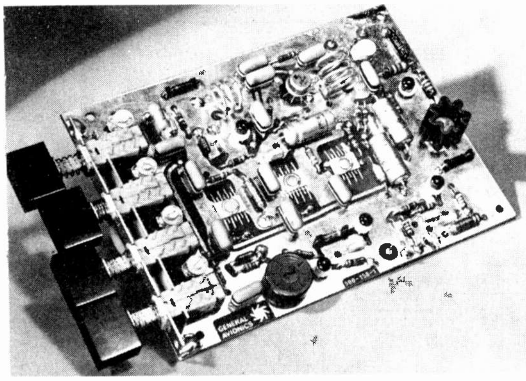
It is always frustrating that just as a project is nearing completion, components are urgently required, and being a spare time hobby or private enterprise it invariably occurs in the evenings or weekends when components shops are closed.

To eliminate the unnecessary delays involved when posting orders to dealers and the time taken for dealers to dispatch orders, **Home Radio (Components)** are running a special deposit credit account scheme to individuals. They have installed a special telephone answering machine for customers wishing to place orders outside normal business hours and the scheme is claimed to cover over 8,000 components.

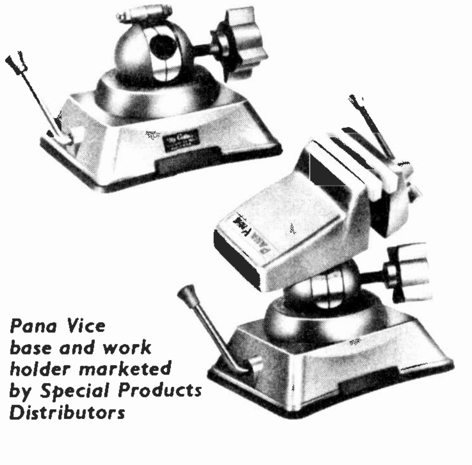
The Credit Deposit Account is similar to a scheme that has been available for several years to industry, government departments and education authorities. Complete details can be obtained from Home Radio (Components) Ltd., 234–240 London Road, Mitcham, Surrey.

NOTICE

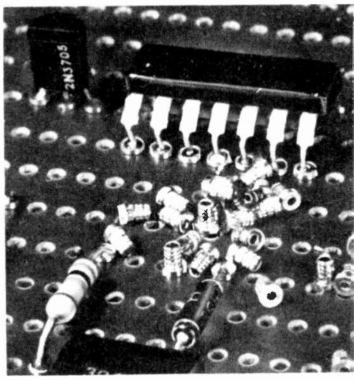
It should be noted that the Peak Sound advertisement on page 740 of the October issue should read "Cir-Kit" is supplied in spools, $\frac{1}{16}$in wide × 5ft long" (not 50ft).



Completed tuner kit from General Avionic Associates

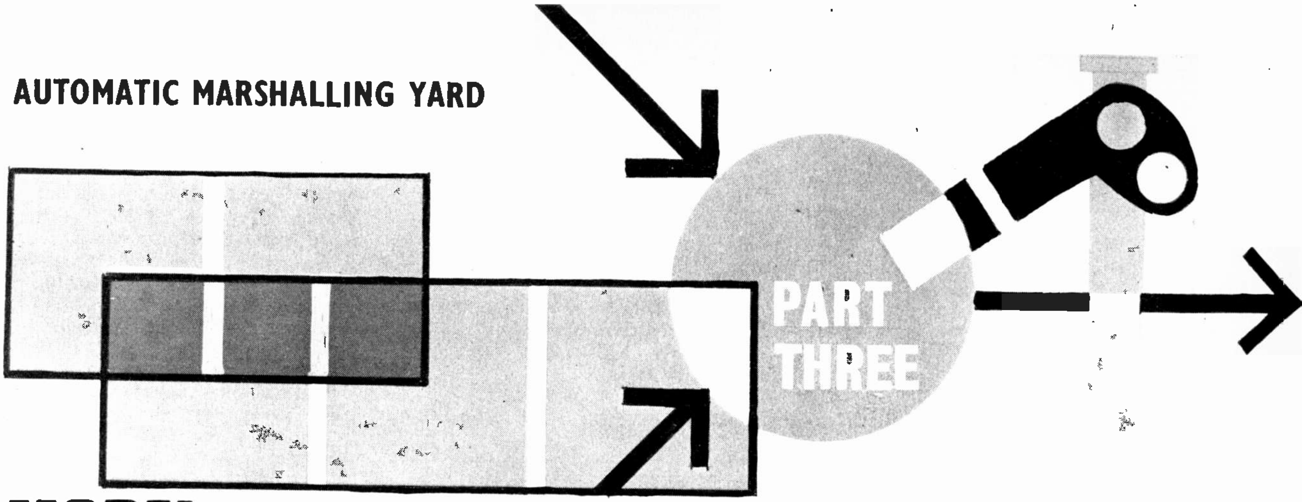


Pana Vice base and work holder marketed by Special Products Distributors



Solder pins manufactured by Oxley Development Co.

AUTOMATIC MARSHALLING YARD



MODEL RAILWAY LOGIC SYSTEMS

By P. GOODES

THIS is a fairly complex circuit for an automatic marshalling yard and should not be attempted by anyone who has not some knowledge of electronics. No printed circuit layouts are given since it is assumed that those building this circuit are capable of laying out the components for themselves. The object of this circuit is as follows (refer to the block diagram Fig. 3.1 and track layout Fig. 3.2).

SHUNTING

Suppose a train of five trucks and an engine enters the initial section of the yard. The engine is uncoupled conventionally and is removed.

When the circuit supply is switched on and the start button pressed, the control unit operates points P5 to its b position and allows the shunting engine to come out of the siding (Fig. 3.2). This engine pushes the five trucks up the slope where each is uncoupled in turn and allowed to roll down the other side under gravity.

As the first truck runs down it passes over switch block S1 and trips one or a combination of the switches in this block. The resulting pulse is fed into a switch decoder and operates a particular combination of points; the truck is routed into the associated siding.

The rest of the trucks are still being pushed slowly up the ramp and each is in turn uncoupled and routed into its respective siding.

At any point during this sequence, the number store may be programmed. This is achieved by dialling pulses from an ordinary telephone dial into the store, whose input is fed by gates biased from master control.

When the shunting engine reaches switch S2 (which it cannot do until all the trucks have been dispersed), a pulse is fed to master control which primes the gates on the number store read out, and also a pulse to the engine control amplifier.

The first output from the store represents the first digit dialled during programming, and this output is fed to the relay which operates the points combination required to reach this truck.

Suppose that truck number 4 was required as the first truck (i.e. 4 was the first digit dialled). During the uncoupling sequence, truck 4 was directed into a particular siding. Then the first read-out operates the points giving access to this siding and the engine proceeds to collect this truck.

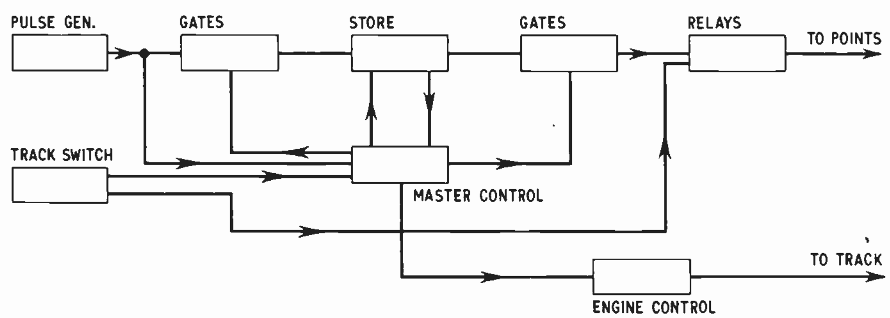


Fig. 3.1. Typical system of control for a marshalling yard

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2G303	4/-	2N3054	11/6	2S005	15/-	BC113	6/6	BFY76	6/-	NKT241	6/6
2G306	8/6	2N3055	15/-	2S020	37/6	BC115	6/6	BFY77	11/6	NKT10419	6/-
2G308	6/-	2N3133	6/-	2S102	6/6	BC116	12/6	BFY90	12/6		
2G309	6/-	2N3134	6/-	2S103	6/6	BC118	6/6	BFW58	7/6	NKT10439	6/-
2G371	3/-	2N3135	6/-	2S104	6/6	BC121	4/-	BFW59	6/6		
2G374	5/6	2N3136	6/-	2S501	5/6	BC122	4/-	BFW60	6/6	NKT10519	6/-
2G381	4/6	2N3390	10/6	2S502	5/6	BC125	13/6	BSX19	5/6		
2N404	6/6	2N3391	7/6	2S503	5/6	BC126	13/6	BSX20	5/6	NKT20329	8/6
2N696	5/-	2N3391A	6/-	3N83	37/6	BC140	11/-	BSX21	8/6		
2N697	5/-	2N3392	6/6	3N128	18/6	BC147	5/-	BSX26	10/6	NKT20339	10/6
2N698	4/6	2N3393	6/6	3N140	19/6	BC148	4/6	BSX27	10/6		
2N706	2/6	2N3394	5/6	3N141	21/6	BC149	5/-	BSX28	6/-	NKT80111	15/6
2N706A	2/6	2N3402	7/6	3N142	16/6	BC157	4/-	BSX60	19/6		
2N708	4/-	2N3403	7/6	3N143	19/6	BC158	3/6	BSX61	12/6	NKT80112	19/6
2N709	12/6	2N3404	8/6	3N152	24/-	BC159	4/-	BSX76	4/6		
2N718	6/-	2N3405	12/6	R.C.A.:—		BC160	12/6	BSX77	6/6	NKT80113	22/6
2N726	5/-	2N3414	5/6	40250	16/6	BC167	3/6	BSX78	6/6		
2N727	5/-	2N3415	6/6	40251	17/6	BC168	3/6	BSY10	5/6	NKT80211	18/6
2N743	4/6	2N3416	9/6	40253	8/6	BC169	3/6	BSY11	5/6		
2N744	4/6	2N3417	11/6	40254	10/6	BC170	3/6	BSY24	4/-	NKT80212	18/6
2N753	5/6	2N3570	12/6	40309	10/6	BC171	3/6	BSY25	4/-		
2N914	3/6	2N3572	12/6	40310	13/-	BC172	3/6	BSY26	4/-	NKT80213	18/6
2N916	3/6	2N3605	5/6	40311	10/6	BC182	4/6	BSY27	4/-		
2N918	6/-	2N3606	5/6	40312	13/6	BC183	4/6	BSY28	4/-	NKT80214	18/6
2N929	5/6	2N3607	4/6	40314	11/-	BC184	4/6	BSY29	4/-		
2N930	6/6	2N3662	9/6	40315	11/-	BC212L	5/-	BSY32	5/-	NKT80215	18/6
2N987	10/6	2N3663	10/-	40316	12/6	BCY10	5/6	BSY36	5/-		
2N1090	6/6	2N3702	4/-	40317	11/-	BCY12	5/6	BSY37	5/-	NKT80216	18/6
2N1091	6/6	2N3703	4/6	40319	14/-	BCY30	7/6	BSY38	4/6		
2N1131	8/6	2N3704	5/6	40320	11/-	BCY31	4/6	BSY39	4/6	OC20	21/6
2N1132	8/6	2N3705	4/6	40323	10/6	BCY32	7/6	BSY40	6/6	OC22	8/-
2N1302	4/-	2N3706	4/6	40324	12/6	BCY33	5/6	BSY51	10/6	OC23	8/-
2N1303	4/-	2N3707	4/-	40326	10/6	BCY34	5/6	BSY52	6/-	OC24	7/6
2N1304	4/6	2N3708	4/-	40329	7/6	BCY38	5/6	BSY53	9/-	OC25	8/-
2N1305	4/6	2N3709	4/-	40344	8/-	BCY39	6/6	BSY54	6/-	OC26	6/6
2N1306	5/-	2N3710	4/-	40347	10/-	BCY40	7/6	BSY56	6/-	OC28	8/6
2N1307	5/-	2N3711	4/-	40348	11/-	BCY42	3/-	BSY78	9/6	OC30	8/-
2N1308	6/-	2N3819	9/-	40360	12/6	BCY43	3/-	BSY79	9/6	OC35	6/6
2N1309	6/-	2N3820	21/6	40361	12/6	BCY54	7/6	BSY82	10/6	OC36	6/6
2N1420	7/6	2N3823	17/6	40362	14/6	BCY58	4/6	BSY83	11/6	OC38	10/6
2N1507	5/6	2N3854	5/6	40370	8/6	BCY59	4/6	BSY84	12/6	OC41	4/6
2N1525	7/6	2N3854A	5/6	40467	16/6	BCY60	19/6	BSY85	13/6	OC42	4/-
2N1526	7/6	2N3855	5/6	40468A	16/6	BCY70	5/6	BSY87	10/6	OC44	4/-
2N1527	7/6	2N3855A	6/-	AC107	6/-	BCY71	9/6	BSY90	11/6	OC45	2/6
2N1605	9/6	2N3856	6/-	AC126	4/-	BCY72	5/-	BSY95A	3/6	OC46	3/-
2N1613	6/6	2N3856A	6/-	AC127	5/-	BCZ10	4/6	BSW41	8/6	OC70	3/-
2N1631	8/6	2N3858	5/-	AC128	4/-	BCZ11	4/6	BSW70	5/6	OC71	2/6
2N1632	8/6	2N3858A	6/-	AC176	6/-	BD121	19/6	D16P1	7/6	OC72	2/6
2N1637	8/6	2N3859	5/6	AC187	12/-	BD123	23/6	D16P2	8/-	OC74	4/6
2N1638	8/6	2N3859A	6/6	AC188	12/-	BD124	12/-	D16P3	7/6	OC75	4/6
2N1639	8/6	2N3860	6/-	ACY17	5/-	BF115	5/6	D16P4	8/-	OC76	3/-
2N1711	6/6	2N3877	9/-	ACY18	5/-	BF117	10/6	GET102	6/-	OC77	4/-
2N1889	8/-	2N3877A	9/6	ACY19	5/-	BF167	6/6	GET113	4/-	OC78	3/-
2N1893	8/-	2N3900	10/6	ACY20	5/-	BF173	7/6	GET114	4/-	OC78D	3/-
2N2147	17/6	2N3900A	11/6	ACY21	5/-	BF177	11/6	GET116	6/-	OC81	3/-
2N2148	12/6	2N3901	19/6	ACY22	4/-	BF178	10/6	GET118	4/-	OC81D	3/-
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2N2193	5/6	2N3904	8/6	ACY40	4/-	BF180	7/6	GET120	6/6	OC82D	3/-
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2N2194A	4/6	2N3906	8/6	ACY44	8/-	BF184	7/6	GET880	6/-	OC84	5/-
2N2217	6/-	2N4058	6/6	AD140	8/-	BF185	5/6	GET887	4/-	OC123	4/6
2N2218	6/-	2N4059	5/-	AD149	8/-	BF194	6/6	GET889	4/6	OC139	6/6
2N2219	6/-	2N4060	5/-	AD150	15/6	BF195	5/6	GET890	4/6	OC140	6/6
2N2220	5/-	2N4061	5/-	AD161	7/6	BF196	5/6	GET896	4/6	OC170	6/-
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2N2222	5/-	2N4244	9/6	AF106	11/6	BF198	5/6	GET898	4/6	OC200	5/6
2N2287	21/6	2N4255	8/6	AF114	5/-	BF200	10/6	MAT100	6/-	OC201	5/6
2N2297	6/-	2N4255	7/6	AF115	5/-	BF224	6/6	MAT101	6/-	OC202	8/6
2N2302	12/6	2N4285	3/6	AF116	5/-	BF225	6/6	MAT120	6/-	OC203	5/6
2N2303	7/6	2N4286	3/6	AF117	5/-	BF237	6/6	MAT121	6/-	OC204	5/6
2N2368	6/6	2N4287	3/6	AF118	12/6	BF238	6/6	MJ400	21/6	OC205	7/6
2N2369	7/6	2N4288	3/6	AF119	4/-	BFX12	5/6	MJ420	22/6	OC207	7/6
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The engine, meantime, has been slowing down (due to the pulse from S2 to the engine control amplifier). The engine couples with the truck and continues to slow down, stop and reverse out of the siding with the truck. As it reverses out and once more trips S2 switch, it starts slowing down again and starts going forward again. As it trips S2, a pulse is fed to master control to read out the second digit in the store. The engine then proceeds to collect this truck also.

When all trucks have been collected in this manner, master control operates uncoupler number 2 and the trucks are left where they were initially. The shunting engine returns to its siding, trips switch S3, and resets the circuit. The main engine may now return and collect the newly formed train.

TRACK SWITCH DECODER

The main requirement for this section was simplicity and reliability. The object of the decoder is to be able to distinguish any one truck from any other truck (Fig. 3.3). The idea of reflecting light from coloured patches on the trucks was unnecessarily complex and would require some very careful setting up.

Consequently trip switches were used. These were made from off-cuts of old relay contacts and mounted in a bank of three (Fig. 3.4) which for the purpose of the circuit description will be called S1a, S1b, and S1c.

In the quiescent state of all three switches being open, inverters I1, I3, I5, are giving a 0 output and hence I2, I4, I6 are giving a 1 output. When S1a operates, I1 gives a 1, I2 a 0 and similarly for S1b and S1c.

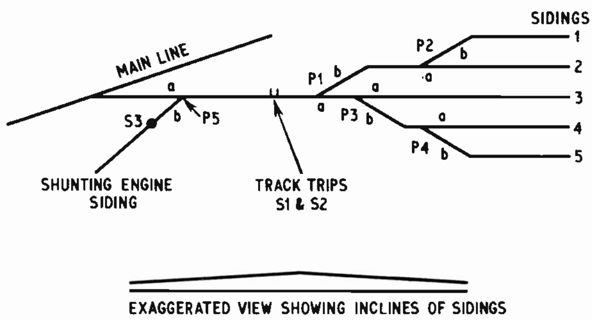
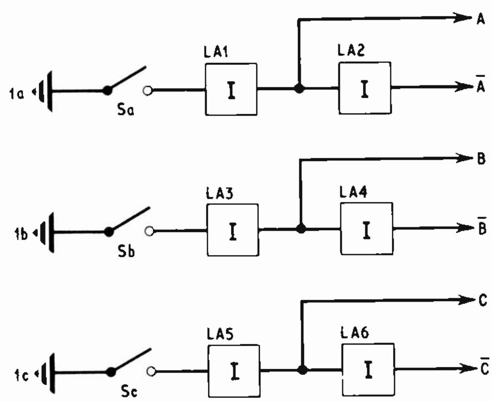


Fig. 3.2. Coding system for control at sidings. Points P1 to P5—"a" is straight on, "b" is fork



Resistor R1 on each inverter (see Fig 1.11 in Part 1) LA1, LA3, LA5, to be connected between TR1 base and −12V. Switches Sa, Sb, and Sc connected between base and earth (see Fig 1.12)

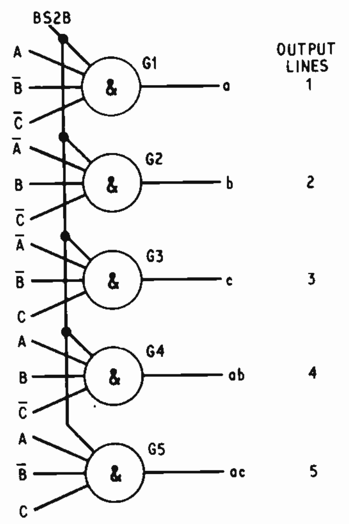


Fig. 3.3. Track switch decoder using inverters (top) and gates

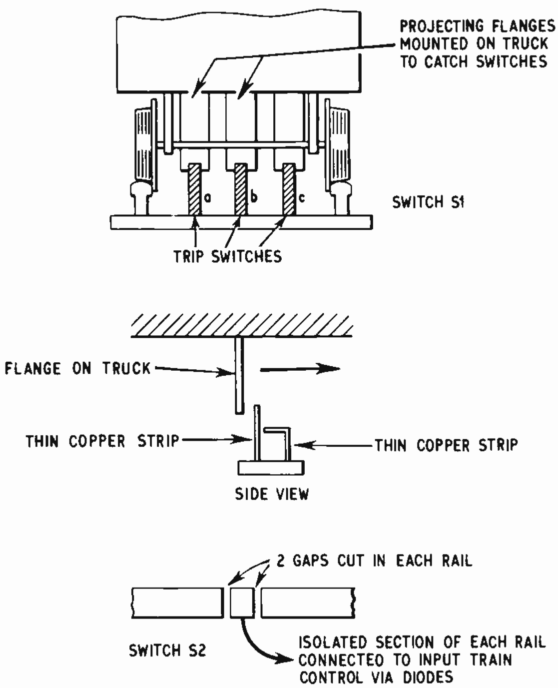


Fig. 3.4. Trip switches on track are actuated by projecting flanges on truck underside

Combinations of the six inverter outputs are fed to AND-gates controlled by master control. Thus for any one switch or combination of switches operating, one gate will give an output.

Considering a few codes:

S1a operates alone

A	B	$\bar{A}$	$\bar{B}$	C	$\bar{C}$
1	0	0	1	0	1

The only gate with this input combination is G1, therefore G1 gives a 1 output (assuming that master control gives the O.K.).

Considering S1a and S1b operating together:

A	B	$\bar{A}$	$\bar{B}$	C	$\bar{C}$
1	1	0	0	0	1

Gate G4 will then give an output.

Thus each truck may be coded by fitting small projections to the underside to trip combinations of these switches (Fig. 3.4).

MASTER CONTROL UNIT

This section, as the name implies, controls all the switching sequences required to build up the train. When the start button is depressed, BS1 is triggered. This means that BS1b gives a 1 output which operates points P5 to allow the shunting engine to leave its siding. Fig. 3.5 shows the master control system.

The depression of this switch also gives BS2b a 1 output which primes the store input gates and also the decoder gates. The pulse feeding the slow down amplifier causes the engine to speed up, and it proceeds to disperse the trucks as they pass over uncoupler number 1 operated via relay RLA (see Fig. 3.6 points actuators).

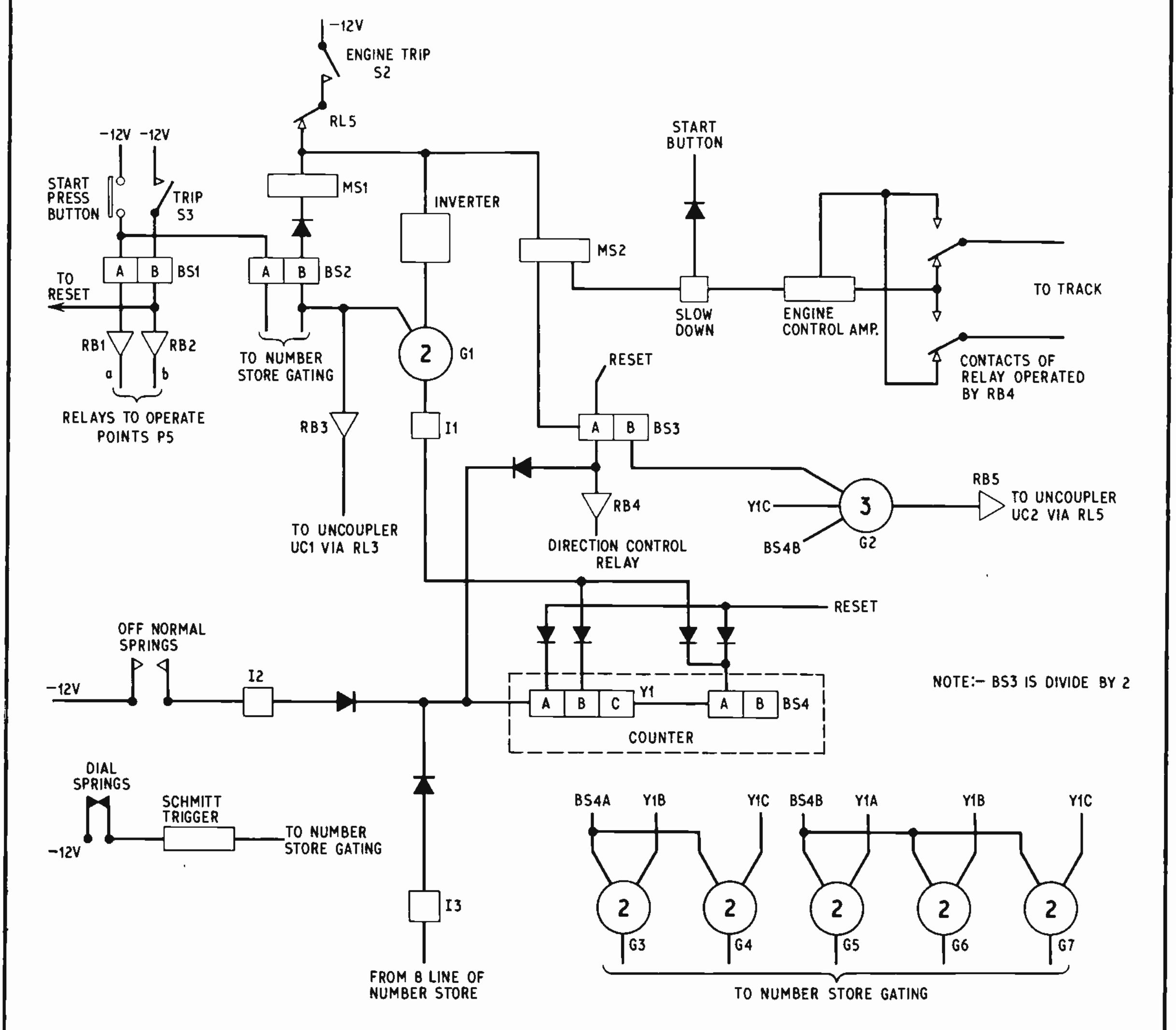


Fig. 3.5. Block diagram of the master control unit

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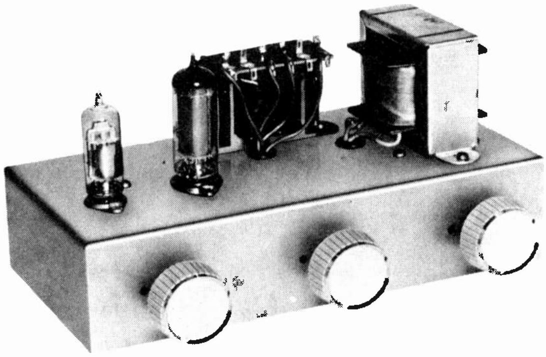

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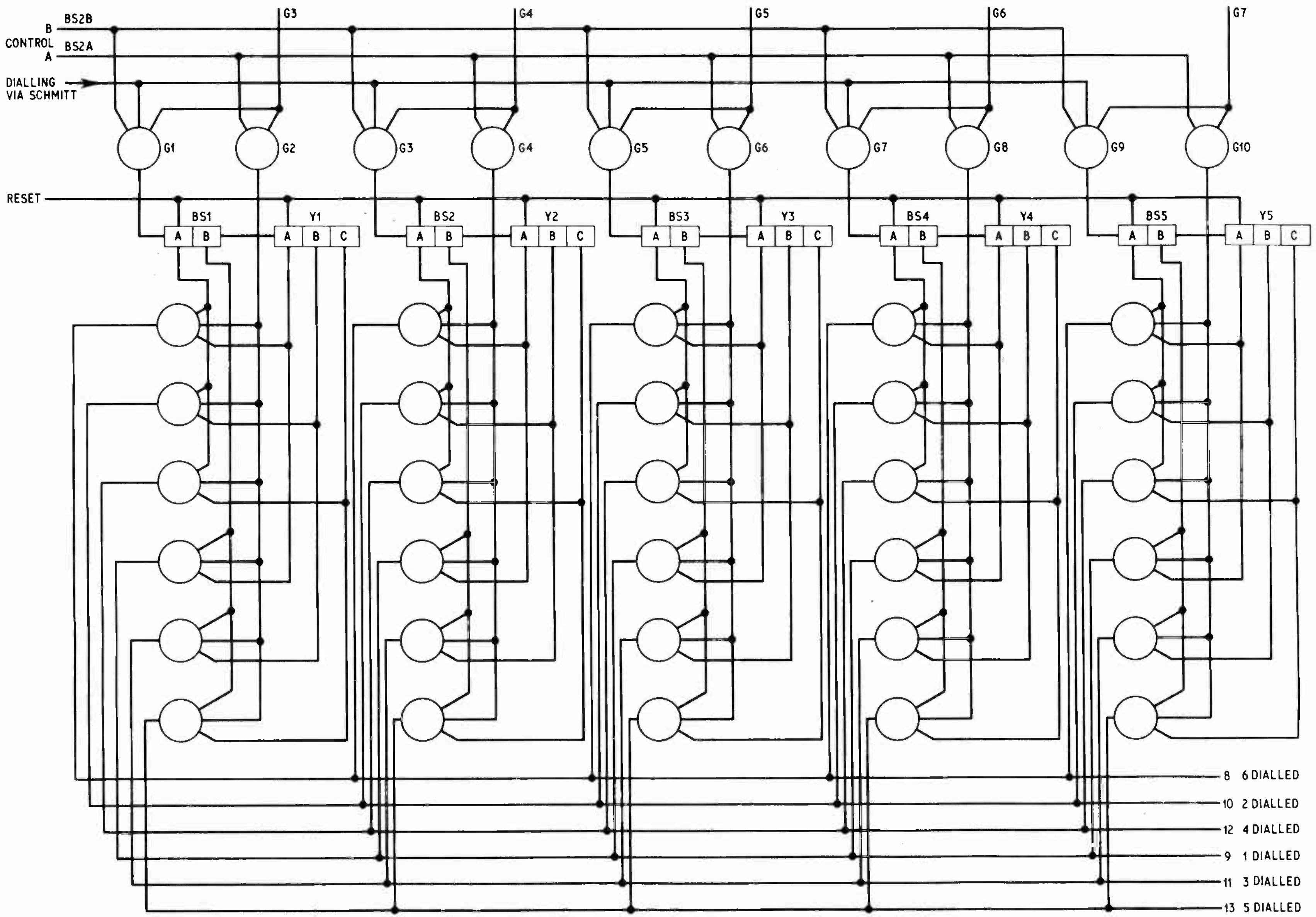


Fig. 3.7. ***Programmed numbers store for marshalling yard***

During programming, the normally off springs of the dial are used to shift the ring counter Y1 which primes the associated store input gates. Thus every time a digit is commenced, the 1 in the counter moves along one section and opens gates to another part of the store.

REQUIRED ORDER MOVEMENT

Assuming now that the required order of the train has been dialled into the store (which is dealt with later), and that the engine has routed all the trucks into the required sidings, switch S2 is now tripped by the engine. This sends a 1 pulse into MS2 (which controls the slowing down of the engine) and a 1 pulse into gate G1 which, being already primed by BS2b, gives in turn a 1 output. This is fed via I1 to set ring counter Y1 to its "1" position.

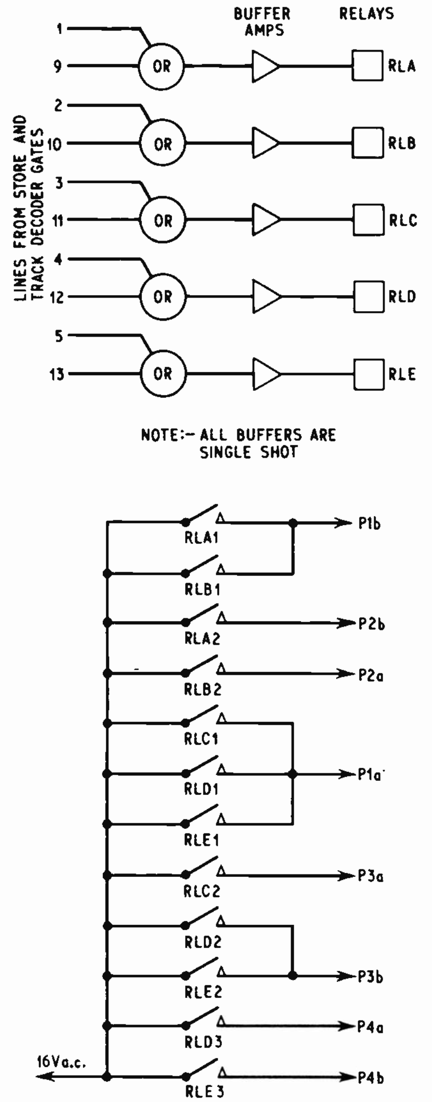


Fig. 3.6. Siding selector relays. Points "a" to straight on, "b" to fork. Other side of 16V a.c. wired to common coil tags of points motors

Monostable MS1 was also triggered by S2 and after about four milliseconds, triggers bistable BS2 so that BS2a gives an output. This primes the store read-out gates and the points corresponding to the first required truck operation.

The engine proceeds to this siding, still slowing down, and couples with the truck there. When MS2 reverts to its quiescent state, it feeds a pulse to BS3 which is a divide-by-two circuit. This operates a relay via buffer RB4, which reverses the polarity of the supply to the track. Thus, the engine reverses out of the siding with the truck, gradually building up speed.

As it passes over switch S2 again, it starts slowing, reverses, and speeds up again. A pulse is also fed to BS3 which in turn shifts the ring counter to its C position. This reads out the second digit dialled and operates the associated points; the engine continues on its way to collect this truck. On the way it trips S2 again, starts slowing down and removes the truck from the siding.

This procedure continues until all trucks are collected by which time Y1 has reached the end position. This means that gate G2 is primed.

As the engine reverses out for the last time with a 1 on BS3B, RB5 operates relay RLE which disconnects switch S2 and operates uncoupler number 2. The train thus leaves the trucks as it passes over the uncoupler and the engine proceeds back to its siding where it trips S3, changing points P5 back to "straight on" and resetting the ring counter, the memory, and the bistable BS3 with a 0 pulse.

POINTS ACTUATORS

A line from the track switch decoder and corresponding line from the store are fed via an OR gate to a relay buffer. The associated relay then operates the required points. The system is shown in Fig. 3.6.

PROGRAMMED NUMBER STORE

This is a straightforward circuit using 3-ring counters and bistables. Pulses are dialled in from the telephone dial via a Schmitt trigger circuit.

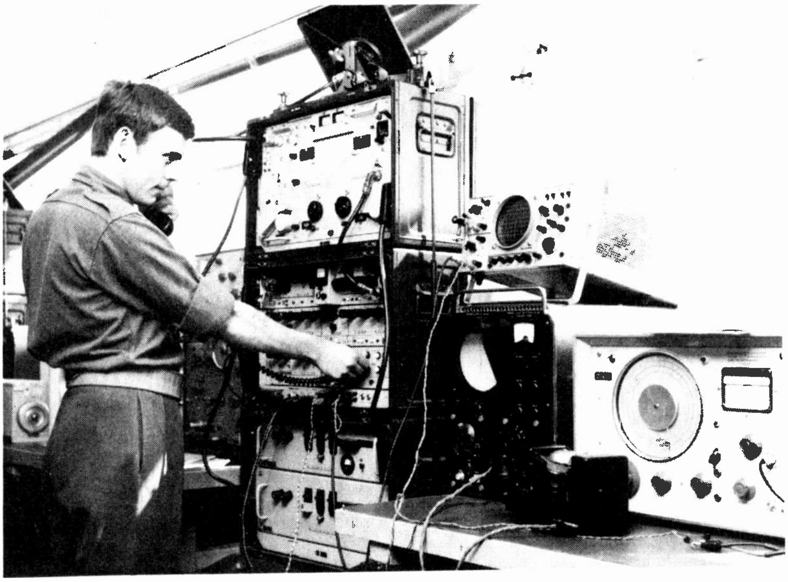
Consider the first digit to be dialled. During dispersal of the trucks BS2b is at 1 and before dialling Y1 is at position 1. When this train of pulses starts, the normally off springs of the dial close, allowing a pulse into the ring counter Y1 shifting the 1 to position Y1b. This then primes gate G1 and pulses may be fed into section 1 of the store and so on until all required digits have been dialled.

When BS2 changes state, BS2a gives a 1 output thus priming gates G2, G4, G6, G8, G10; Y1 again selects the required section of the store. An output is obtained on the appropriate line and this feeds the required combination of points. The action of the engine shifts Y1 along and the second section may then be read.

The gates associated with line 8 of the store are included to allow for the fact that fewer than five trucks may be required. Then with no digit in that section of the store the 8 line will have a 1 pulse on it. This is fed to the input of Y1 so that it scans on until a section is found with a digit in it.

Section 5 of the store must always have a digit in it, and earlier positions filled up by blanks if necessary. Thus if only three trucks are required in the order, say, 3, 5, 2, the dialled code should be 6, 6, 3, 5, 2.

Next month: Conclusion of the automatic marshalling yard and an automatic turntable



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INTEGRATED CIRCUIT F.M. TUNER KIT

Dart Electronics has been appointed by General Avionics Limited as their U.K. distributor for their FM Tuner kit, the first to use integrated circuits with pulse counting techniques developed by Marconi-Elliott Microelectronics.

The circuit has built-in automatic frequency control, and with the inherent stability of the integrated circuits, a reliable and easily set up circuit is offered to the home constructor in kit form. A resistively tuned version is in widespread use as an industrial radio system and is noted for its extreme reliability under continuous, unattended operation. The circuit employed effectively contains 44 transistors and, although the quantity of discrete components is fairly high, the entire unit is built on a double-sided board measuring 133 × 98·5mm (3·875 × 5·25in). The Tuner can be run off a 12V d.c. power supply or a combination of 6 and 12V batteries.

All components are available BY POST ONLY from Dart Electronics at a special kit price of **£9 19s 6d** plus 5/- post and packaging (U.K. & N. Ireland) which includes selector switch and double-sided p.c. board ready drilled and tinned. The kit is complete with all necessary circuits and instructions.

Full assembly details, circuit diagram and parts list are also available separately from Dart Electronics at **2/6** per copy and an article appeared in the June issue of the WIRELESS WORLD magazine.

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A 4 Germ. R.F. PNP T0-1	=OC44-45, NKT72/125, ASY54	£1.10	£4.10	£7.10	£60
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A 9 Sil. Alloy PNP T0-5	=2S301-5, BCY17-29, BCY30-34	£2	£7.10	£12.10	£100
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BFY51	2N708	2N2904	2S102	2N2906
BFX84	2N929	2N2905	2S103	2N2907
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AC128	ACY29	NKT212	OC44	2G302	
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Report from AUSTRALIA

BY D. F. MOODY

THERE is an old Chinese proverb—"he who works with a machine must think like a machine". This saying pre-dates, probably by a few thousand years, much of the so-called modern science fiction which uses this concept as the basis for so many stories, and it causes one to wonder whether to pay any heed or not to the warnings so common these days of the impending computer-run society of tomorrow.

However, it is interesting to observe the ways in which we are being led, slowly and subtly, to accept and depend upon modern automation and give up our freedom in little bits and pieces.

SPEEDING THE POST

The distribution of mail in the huge outback areas of Australia has always held a fascination whether by the one-man and pack horse, or by the 2,000 miles round trip "milk runs" carried out by the Royal Mail aircraft today.

There is one thing that the postman on these rounds can be sure of, and that is to receive a hearty and friendly welcome from the bush-folk who are so very glad to get their mail when they do, and not just to accept the daily postal delivery as we do in the city (and grumble when the daily deliveries were cut from two to one).

However, although personalised service for the mail is desirable, due to the explosion in the quantity of mail handled (the Australian Post Office handled over 2½ billion articles of mail last year), it would be impossible to cope with this without mechanical and electronic help. This is not only an Australian problem, and the Universal Postal Union has been active for some time in trying to achieve a higher standard of service in those areas where the mail situation is rapidly reaching a state of chaos.

In Sydney we have one of the most modern electronic mail sorting machines in the world, with a capability of handling a quarter of a million letters an hour. In order to achieve high sorting rates the public have to co-operate by using a four figure post-code which was introduced in 1967 and covers all areas in Australia.

LUMINESCENT CODING

At the moment in the Redfern mail exchange, the destination information is stamped on the reverse side of the envelope in the form of a set of luminescent spots. This is done by a trained operator who sits in front of a display screen, and according to the marked destination or post code and a pre-fixed code the appropriate dots are punched onto the back of the envelope. These dots are practically invisible under normal lighting conditions, but when exposed to ultra-violet light, they glow with sufficient intensity to be detected by photoelectric devices. Hence in this way, the "brain" in the exchange can be told the address on the letter, and automatically arrange for the correct chutes to open up at the right time so that the mail is selectively filtered in a manageable fashion.

Further research is aimed at attempting to handle all stages of the actual transmission using electronic techniques, and may well affect the whole concept of mail as we know it today. It has been said that the mail of the future will be of a similar form to Telex—Heaven forbid! Surely this step would be even too cold hearted for the most ardent "systems" man to contemplate. However, for business correspondence, I will be most surprised if such a system is not eventually employed with a Big Brother computer keeping its steely eyes on "who from", "to whom" and "how much".

UFO's OVER ALICE SPRINGS

With so much interest and activity in the American Apollo project, the continuing work at Woomera tends to get more or less forgotten, at least on the international scene. Although the recent failure in attempting to hurl a test satellite load into orbit from the *Europa I* rocket did manage to get a mention in the papers, it appears that this news is not considered so glamorous as that emanating from Cape Kennedy—at least to terrestrial eyes.

It is rewarding however to note that sightings of mysterious flying objects in Central Australian skies have followed the recent setting up of space research facilities at Pine Gap near Alice Springs. This at least seems to indicate that "someone" is interested in what goes on in Australia. After all, Woomera is one of the oldest rocket sites in the world.

COPPER PROSPECTING

When you are hard at work soldering COPPER wire to your COPPER deposited printed wiring board and probably using a COPPER soldering iron bit, perhaps you may care to think of the romance behind a recent copper strike in Papua, New Guinea, particularly when you also bear in mind that the known world land supplies of copper are doomed to be worked out within the next sixty years.

About a year ago an Australian Company sent an American Explorer into the jungle in the far north-western corner of Papua. He found villages and people who had never before seen a white man, unknown streams, and more significantly, he found copper. Now there is a base camp there (known as Oregalore), with a team of 25 men from Canada, USA, Australia, New Zealand, South Africa and Northern Ireland.

The team exist under extreme conditions and the work is very tough, and their sole contact with the outside world is vested in a helicopter.

The next question to be answered is whether or not there is sufficient copper there to warrant the immense cost of extraction and transport.

I wonder what the electronics industry would do without copper?

AUDIO SUPPLEMENT

To coincide with the International Audio Festival and Fair at Olympia, this issue contains an extra 16-page Supplement (bound in the centre) aimed to help readers sort out the jungle of specifications and terms found in audio equipment brochures, and to guide the potential buyer on how to buy wisely.

PE ORGAN — PART 7

By Alan Douglas, Sen. Mem. I.E.E.E.

In this article we will complete the remaining accompaniment tone forming elements and also the post amplifiers which are fed from the passive voicing networks.

ACCOMPANIMENT PRE-AMPLIFIERS

As there are only two pitch busbars used for the accompaniment voicing, two pre-amplifiers are required. These, of course, are identical to the solo pre-amplifiers, a circuit diagram of which is given in Fig. 6.2. As before the function of these pre-amplifiers is to provide both a high impedance to the busbar input and an increase in signal level prior to feeding the voicing filters.

ACCOMPANIMENT FILTERS

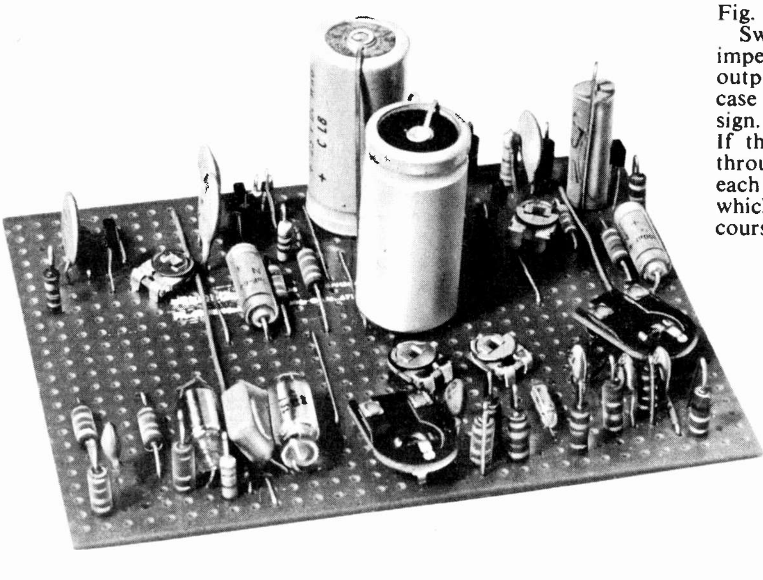
The circuit diagram of the accompaniment tone filters following the 8ft and 4ft pre-amplifiers is given in Fig. 7.1. Here, as in the solo filters, low pass, high pass, and resonant types are in evidence. The two flutes are low pass circuits, with somewhat differing characteristics, because we do not want the 4ft to sound just like the octave of the 8ft.

The string stops—Viole Acute and Violina—are high pass circuits and again the values are chosen to produce a difference in character.

The clarinet is a parallel tuned circuit with the filter coil wound on a ferrite core. The potentiometer VR3 combines in varying the response and broadening the resonance peak necessary to accommodate the formant band.

In practice the correct adjustment of this potentiometer encompasses a band of two octaves which correspond fairly well with the actual instrument.

The Trumpet stop is another parallel resonant circuit with different characteristic which is very useful as a solo voice.



The addition of the Dolce stop provides a reduced flute tone by shunting the 8ft flute capacitor C2 when the stop key is depressed.

Inclusion of preset potentiometers in some of the filter outputs enable volume adjustment.

PRE-AMPLIFIERS AND FILTER BOARD

Since only two pitches are used in the accompaniment manual, both the pre-amplifiers and tone networks can easily be assembled on one 3¾in × 5in Veroboard as given in Fig. 7.2. The wiring and cutouts for the underside are given in Fig. 7.3.

In Fig. 7.2 the 4ft and 8ft pre-amplifiers are shown contained within a dashed box. For the components of this section refer to the components list for the solo pre-amplifiers given last month as the annotation is identical.

FUNCTIONAL CHECK

The checking of this board follows the same lines as that carried out in the solo pre-amplifiers detailed last month.

First we take off a +15V tap and earth return from the oscillator shelf, making the connections as shown. A 30,000pF capacitor connected across one of the oscillators will generate the test signal with subsequent division through its related divider. The note sign of the divider will indicate, of course, the key to be depressed when testing.

Since we need to pick up square waves from the 8ft and 4ft lower manual busbar, we must connect two 1yd lengths of single miniature microphone cable to the lower tagstrip which is attached to the lower keyframe. The busbar wires to this are coloured yellow for 4ft and grey for 8ft.

The coaxial screens are earthed at the tagstrip in common with the solo manual cables and their free ends connected to the Veroboard as indicated in Fig. 7.3 by the identifying colours.

Switch on the supply, then connect a pair of high impedance headphones at each of the pre-amplifier output capacitors C3 in turn; the return line in each case being earth. Depress a key of the divider note sign. This should produce a clear, unsullied tone. If there is nothing or a distorted product, check through from the input and then at the collectors of each stage to pinpoint the offending component which will probably be a transistor. Here, of course, replacement will be necessary.

This organ will be demonstrated at The International Audio Festival and Fair, Olympia, London, October 16 to 22

ACCOMPANIMENT TONE NETWORKS

Resistors
R1 100kΩ
R2 51kΩ
R3 56kΩ
R4 680Ω
R5 47kΩ
R6 51kΩ
R7 3·3kΩ
R8 33kΩ
R9 22kΩ
R10 27kΩ
R11 68kΩ
R12 47kΩ
All 10%, ½ watt carbon

Capacitors
C1 0·01μF polyester
C2 0·01μF polyester
C3 0·01μF polyester
C4 220pF polystyrene
C5 0·022μF polyester
C6 4,700pF polystyrene
C7 0·01μF polyester
C8 4,700pF polystyrene
C9 0·01μF polyester

Potentiometers
VR1 500kΩ
VR2 100kΩ
VR3 500kΩ
VR4 100kΩ
VR5 100kΩ
All horizontal presets

Inductors
L1 1H
L2 1·5H
All Mullard pot cores types LA2. For winding details see text

Miscellaneous
Veroboard 3¾in × 5in

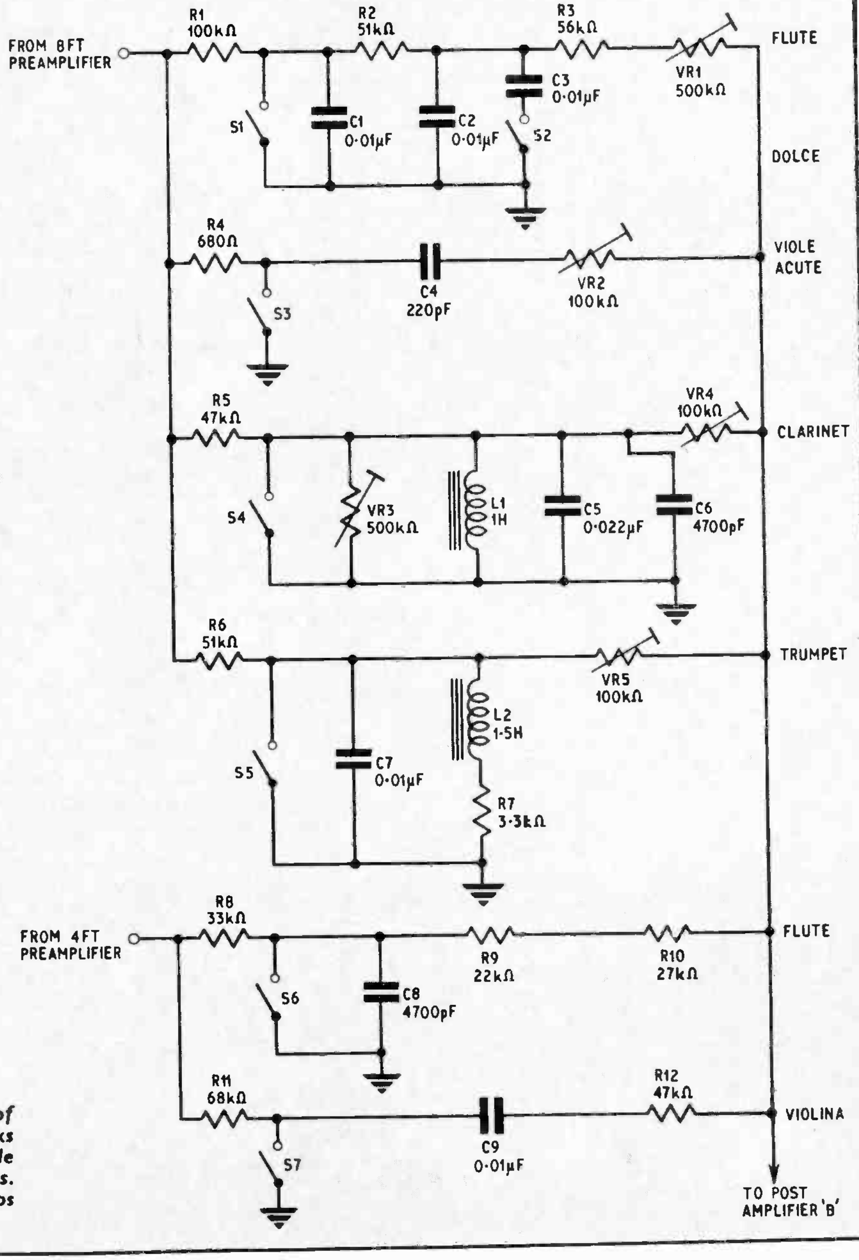


Fig. 7.1. Circuit diagram of accompaniment tone networks with the flutes and strings made up from low and high pass filters. The clarinet and trumpet stops are both resonant circuits

ACCOMPANIMENT PRE-AMPLIFIER AND FILTER BOARD

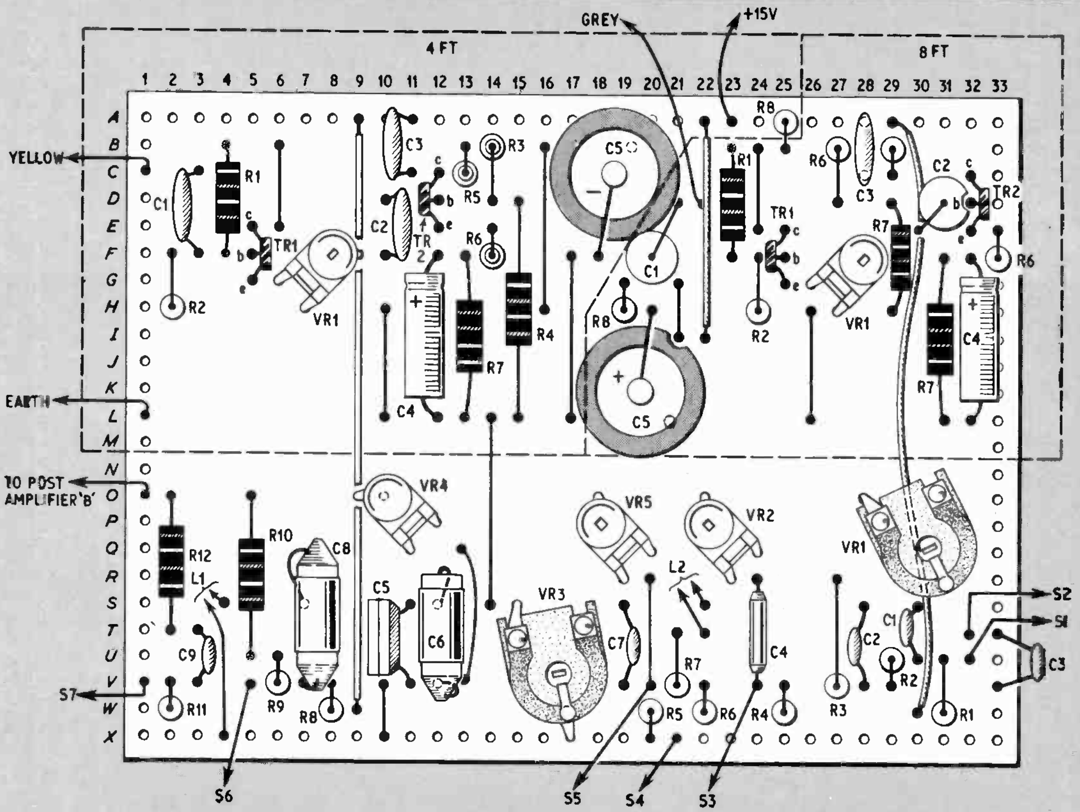


Fig. 7.2. Component layout of the accompaniment pre-amplifiers and associated tone networks

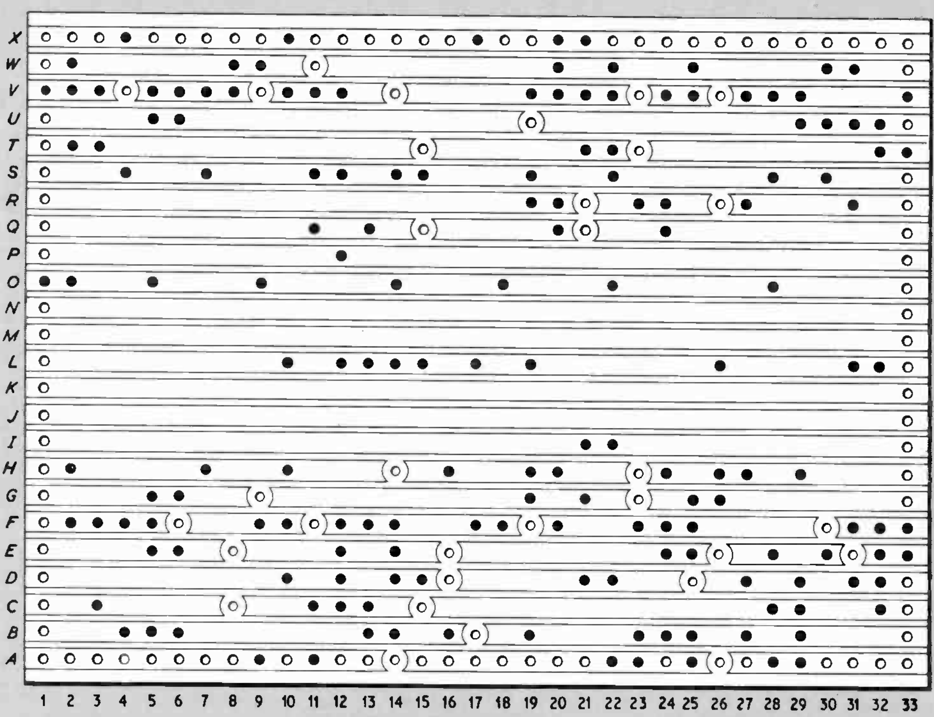


Fig. 7.3. Wiring and copper cutouts for Veroboard underside

PEDAL PRE-AMPLIFIERS

Resistors
R1 68kΩ
R2 33kΩ
R3 2·7kΩ
R4 470Ω
R5 470Ω
R6 68kΩ
R7 33kΩ
R8 2·7kΩ
R9 470Ω
R10 470Ω
R11 390Ω
All 10%, ½ watt carbon

Capacitors
C1 0·22μF
C2 100μF elect. 12V
C3 0·1μF
C4 0·33μF
C5 100μF elect. 12V
C6 0.1μF
C7 500μF elect. 25V
All polyester except where marked

Transistors
TR1, TR2 ZTX300
(Ferranti) 2 off

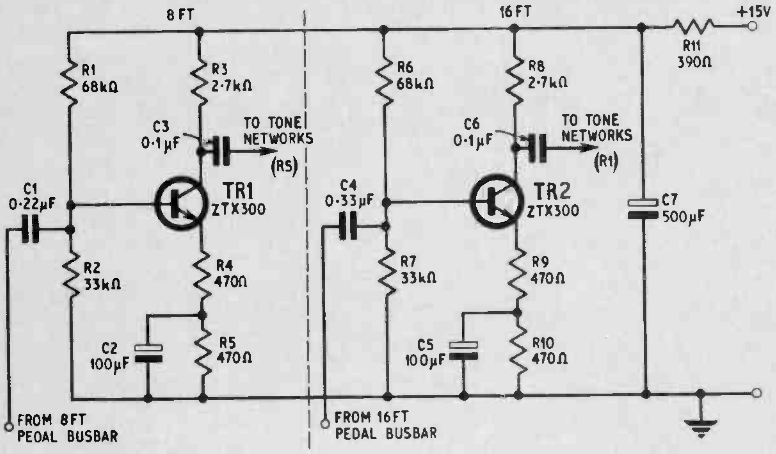


Fig. 7.4. Circuit diagram of pedal pre-amplifiers for 8ft and 16ft pitches

ACCOMPANIMENT FILTER ASSEMBLY

The accompaniment filter networks, with the exception of the coils, occupy the lower half of the board shown in Fig. 7.3. The winding data for the two coils L1 and L2—both LA2 Ferroxcubes—follows from the formula given last month. Using 44s.w.g. enamelled copper wire the approximate number of turns required for each coil are:

L1—2,000 turns
L2—2,500 turns

With these coils wound they should be placed to one side prior to mounting in the voice screening box.

PEDAL PRE-AMPLIFIERS

Since only one note is played at a time on the pedals, we can dispense with the emitter followers as used in the manuals and employ only the pre-amplifiers as shown in Fig. 7.4. Here capacitors C1 and C4 are fed directly from the 8ft and 16ft pedal busbars.

PEDAL FILTERS

The outputs from the pre-amplifier feed two low pass filters, a 16ft Major Bass and an 8ft Bass Flute as shown in Fig. 7.5.

S2 provides a Sub Bass stop as the depression of this key removes the additional filtering of the capacitors C4 and C5. The filter outputs are not routed to post amplifiers as in the manuals, but go directly to the pedal power amplifier P.A.1. Not only does this allow the setting of a volume level independent of the manuals, but it reduces the risk of intermodulation and prevents the tremulant getting onto the pedal tones. Of course, it is more expensive, but once again if the pedal section is altered or enlarged in the future, the advantages of an independent channel will be considerable.

PEDAL TONE NETWORKS

Resistors
R1 27kΩ
R2 27kΩ
R3 27kΩ
R4 27kΩ
R5 39kΩ
R6 39kΩ
R7 39kΩ
All 10%, ½ watt carbon

Capacitors
C1 0·047μF
C2 0·047μF
C3 0·047μF
C4 0·1μF
C5 0·047μF
C6 0·01μF
C7 0·1μF
C8 0·047μF
All polyester

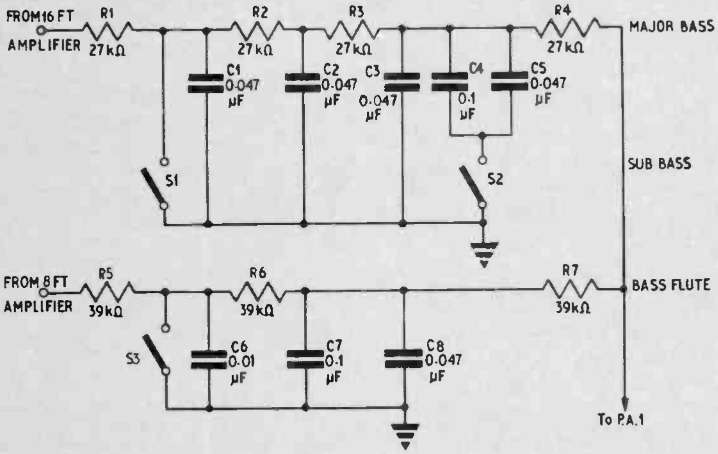


Fig. 7.5. Circuit diagram of the 8ft and 16ft low pass filters of the pedal department

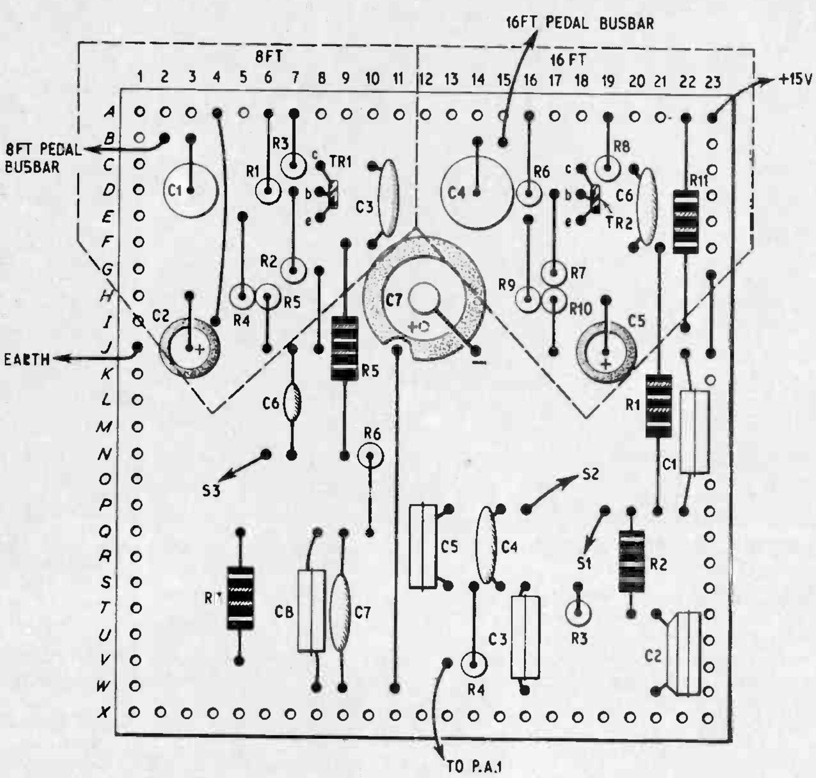


Fig. 7.6. *Component layout of the pedal pre-amplifiers and tone networks*

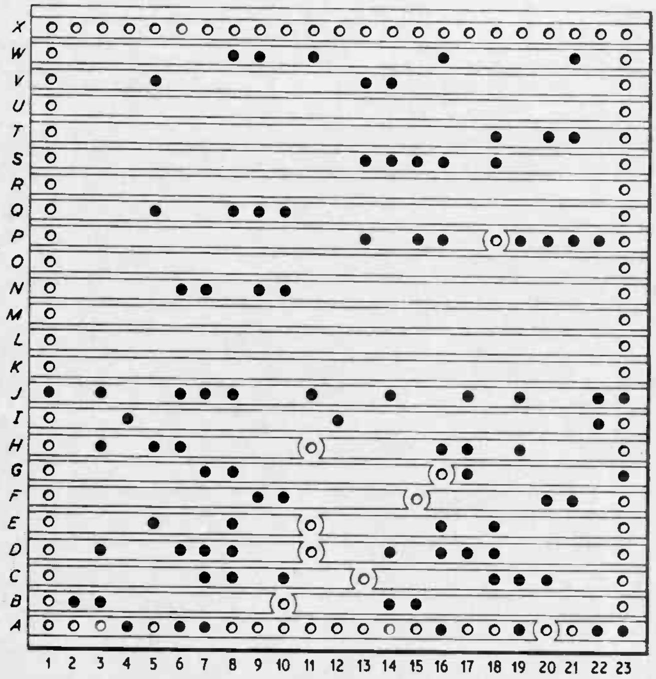


Fig. 7.7. Underboard wiring of pedal circuitry

POST AMPLIFIERS "A" AND "B"

Resistors
- R1 68kΩ
- R2 330kΩ
- R3 8·2kΩ
- R4 47Ω
- R5 100Ω
- All 10%, ½ watt carbon

Capacitors
- C1 4μF elect. 15V
- C2 0·1μF polyester
- C3 500μF elect. 25V

Potentiometers
- VR1 4·7kΩ
- VR2 47kΩ

Transistors
- TR1, TR2 ZTX300 (Ferranti) 2 off

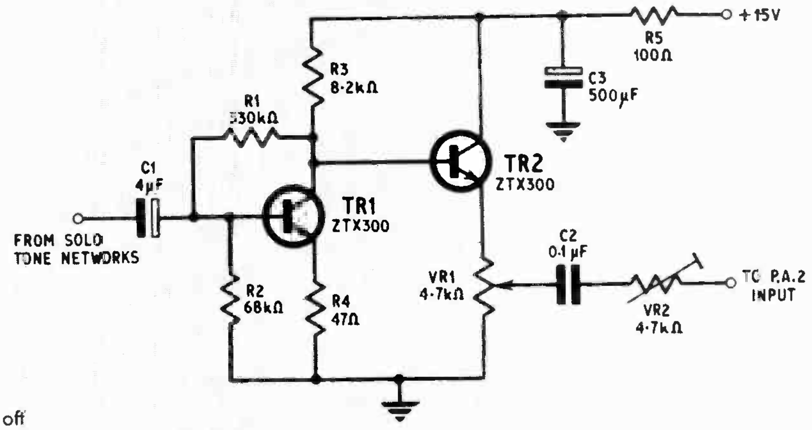
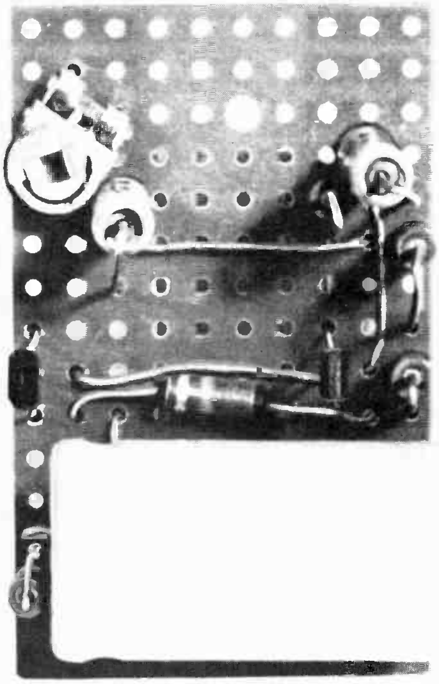


Fig. 7.8. Circuit diagram of a post amplifier. Two of these are required



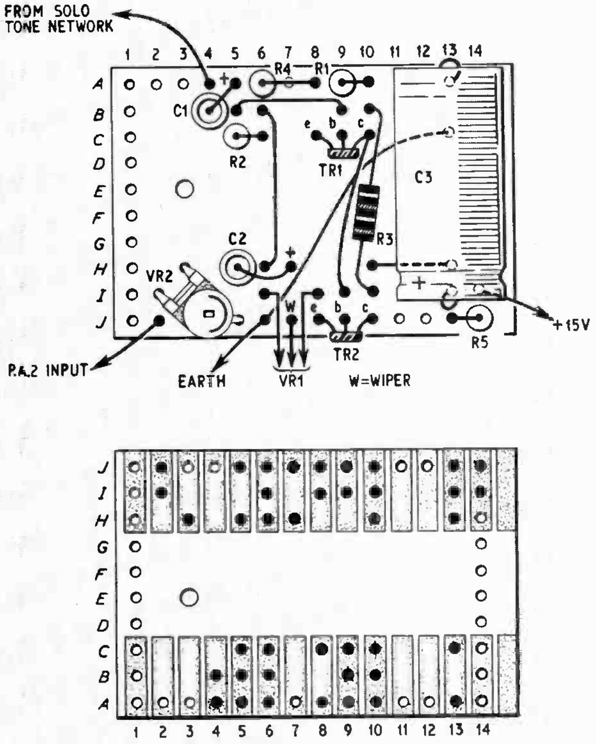
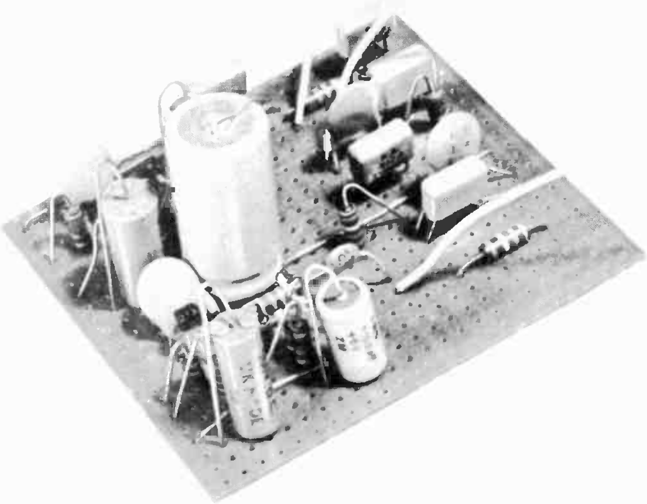


Fig. 7.10. Component layout and underside connections of post amplifier assembly



PEDAL CIRCUIT ASSEMBLY

The components making up the pedal pre-amplifiers and tone nets are mounted on Veroboard as shown in Fig. 7.6. Underboard wiring and copper strip cutouts required can be seen in Fig. 7.7.

TESTING

The testing of the pre-amplifiers follows that given for the manual pre-amplifiers. However, since we have no pedals as yet, we can use the 8ft and 16ft coaxial cables from the solo manual busbars for test purposes. These should be connected as shown in Fig. 7.6. With the supply lines connected, headphone checks can now be carried out.

POST AMPLIFIER

With the exception of the pedal department, the filter outputs, both solo and accompaniment, are routed via intermediary post amplifiers. These recover any signal losses due to the voice nets.

The manual amplifier P.A.2 requires only 20 millivolts for full power output and this is easily provided by a d.c. coupled pair, the circuit of which is given in Fig. 7.8.

Two post amplifiers are required for the two manuals; these have been designated "A" for solo and "B" for accompaniment in the filter circuit diagrams. Before the signals from the post amplifiers are applied to P.A.2, they are mixed after going through the output potentiometers VR2.

These allow relative manual balance to be achieved both in loudness and total input setting to the main amplifier. As with the pre-amplifiers the +15V supply for the post amplifiers derives from P.S.U.1. Decoupling from the line is the simple CR filter seen in Fig. 7.8.

POST AMPLIFIER CONSTRUCTIONS

The post amplifiers are assembled individually on Veroboard strips as shown in Fig. 7.9. Underside connections are given in Fig. 7.10.

In common with the guidelines provided previously in checking the pre-amplifiers, the post amplifier can be functionally vetted. As before, the test requirements are a signal source and a headset.

CONCERT ORGAN VOICES

For the benefit of the experimenter a number of conventional church or concert organ voices are given in Fig. 7.11.

ADDENDUM

The output from the 8ft tibia, shown in Fig. 6.5 of last month, should be attenuated by a 100 kilohm preset potentiometer. This is connected between C7 and the common post amplifier line.

CONCERT ORGAN VOICES

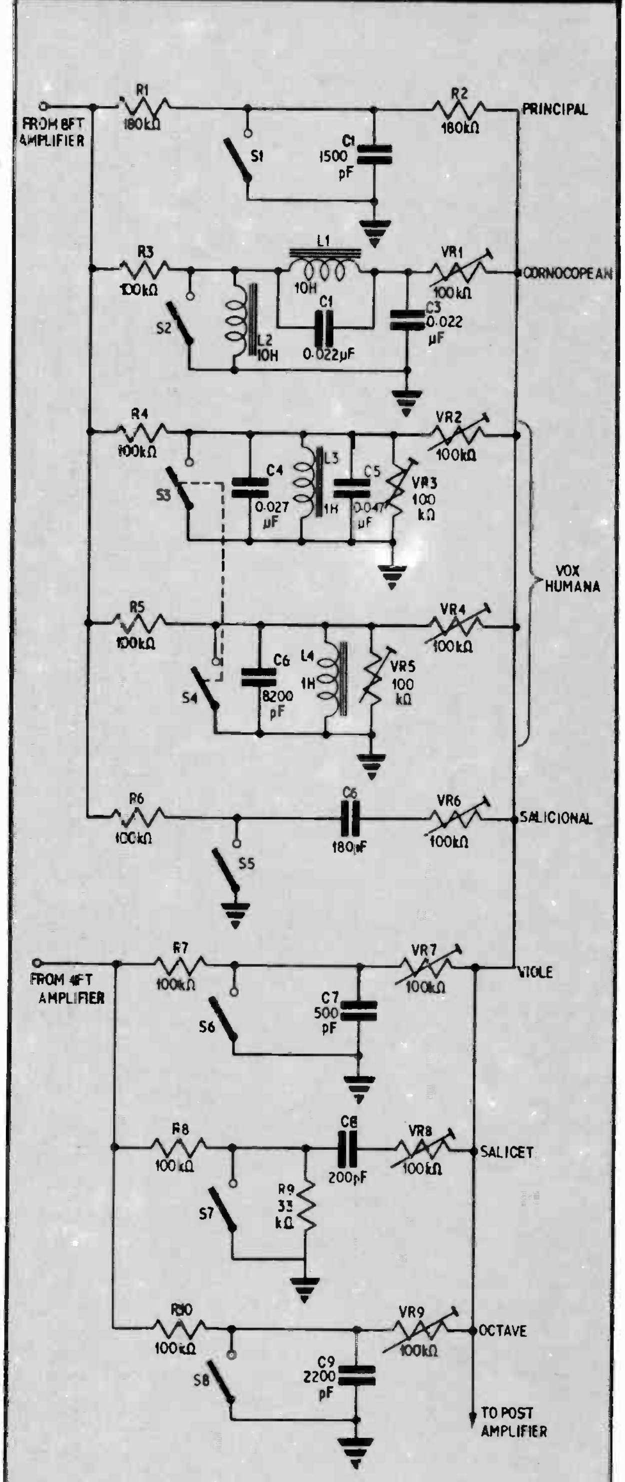


Fig. 7.11. Additional concert organ voices which are included purely for experimentation. Note the ganging of the vox humana stop switches

AT HOME WITH AUDIO

Special Supplement PRACTICAL ELECTRONICS November 1969

IN about ten years from now we shall be able to celebrate the centenary of sound recording for it will then be 100 years since Edison produced the first talking machine, the "Phonograph". Since that time engineers have constantly strived for perfection in sound recording and reproduction, working always to maintain a standard which even as early as the 1930's became known as "high fidelity".

Today "high fidelity" means more than just good quality gramophone records and equipment for playing them. It sets a standard for the whole field of sound recording, broadcasting and the reproduction of sound from these sources.

UNFORTUNATELY the specifications for the electrical and mechanical performance of domestic high fidelity sound reproducing equipment are somewhat elastic and lacking in specific terms of reference.

Some manufacturers have taken unfair advantage of this and exploit the public at large who may have little or no idea as to what "hi fi" really means.

OBJECTIVE REQUIREMENTS

Although the object of hi fi is to reproduce as closely as possible that which might have been heard in the concert hall or the broadcasting or recording studio, there are certain limitations. For example, it is not normally practicable or even desirable to reproduce the sound of a symphony orchestra life size in the living room since this would require peak power approaching 70 to 80 watts (Fig. 1).

The "dynamic range" or degree of relative loudness must therefore be compressed somewhat for technical as well as aesthetic reasons. Much the same applies to the spatial effect obtainable with stereo, for one cannot normally hope to produce the original sound width of a large orchestra within the confined space of a living room.

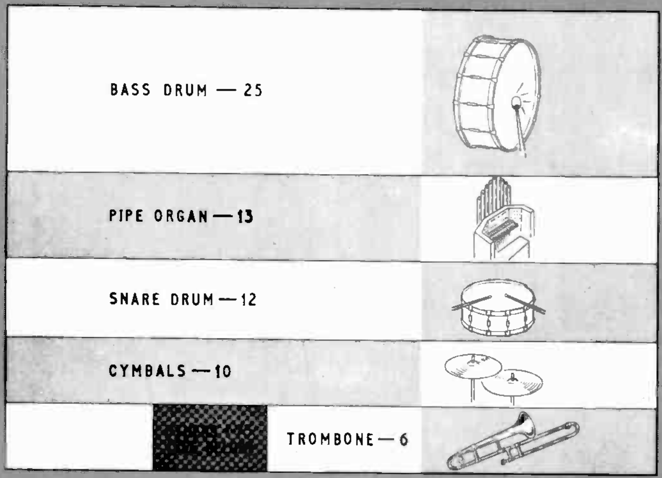
On the other hand a wide frequency response, low distortion, and an absolute minimum of unwanted noise is essential. Frequency variation, caused by the mechanical parts of recording or replay systems, must also be so low as to be virtually undetectable by ear.

SPECIFICATIONS FOR HI FI

The *Consise Oxford Dictionary* defines "fidelity" as "an exact correspondence of the original". When applied to sound recording, broadcasting and especially to sound reproduction in the home, the term "high fidelity" infers a faithful re-creation of the original sound. To achieve this the whole chain of equipment, from microphone to loudspeaker must perform to a very high standard, which involves laying down separate electrical and mechanical performance specifications for each piece of equipment in the chain.

Many of the terms quoted in the specification for any one piece of equipment are directly related to each other. For example, the frequency response of an amplifier is, or should be, relative to a given power output with negligible distortion. Equally, the power rating of an amplifier is, or should be, relative to a given amount of distortion as well as to frequency response.

The signal level from any hi fi signal source (for example, a tape recorder or radio tuner) is relative not only to frequency response but also to the noise level produced within the equipment. Such information is not always given and without it a specification can be almost meaningless or even give a false impression.



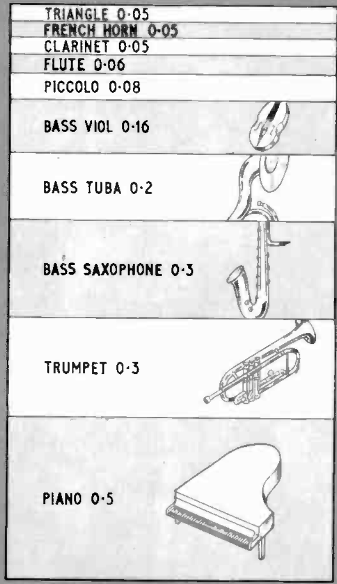


Fig. 1a. Approximate peak power of musical instruments (fortissimo playing) in watts based on measurements of sound pressure. The large outer rectangle represents 70 watts for a large orchestra
Other instruments shown as 1·75 watts total are divided into groups of related peak power in the panel on the right

Power output (continuous sine wave rating)	25 watts per channel into an 8 ohm load
Power bandwidth	20–25,000Hz (ref. 1,000Hz)
Frequency response	20–20,000±1dB (ref. 1,000Hz)
Harmonic distortion	Less than 0·5% at 1,000Hz at rated power output
Loudspeaker impedance	4 to 16 ohms
Crosstalk	Better than −40dB
Channel matching	±1dB
Bass control	±10dB at 70Hz
Treble control	±10dB at 10,000Hz
*Loudness Control	70Hz +10dB, 10,000Hz +5dB (ref. 1,000Hz −20dB)
Tape recording output	400mV (low impedance)

Inputs	*Sensitivity*	*Hum and Noise (reference 25W output)*
Tape	400mV	−70dB
Radio	100mV	−60dB
Pick-up 1 (ceramic)	60mV	−55dB
Pick-up 2 (magnetic)	3·5mV	−55dB

* Loudness controls are not always found in British equipment.

Fig. 2. Typical example of a well presented specification for a hi fi amplifier showing acceptable terms and definitions

A specified noise level given without reference to an output signal or power level is just as meaningless as a frequency response given without a reference frequency, or a distortion level without reference to a specified output power.

Specifications for hi fi equipment should be read very carefully. The sample specification shown in Fig. 2 is of a well known maker's amplifier and is a good example of how the technical performance should be stated. Note, for example, that hum and noise is quoted with reference to the rated r.m.s. power output. The distortion factor is given with reference to a signal of 1kHz at the rated output power. The specification is typical of a good hi fi amplifier.

TECHNICAL REQUIREMENTS

Let us deal now with the general technical requirements for domestic hi fi and some of the facts and figures concerned with performance.

POWER OUTPUT

Here we are concerned only with hi fi amplifiers and some confusion can arise because of the different ways in which output power is quoted, one being the r.m.s. (root mean square) rating the other being so-called "music power" rating. Provided they are relative to themselves and to other performance factors, both may well amount to the same thing in the end although apparent differences may occur.

However, the r.m.s. power rating does not take into account the very short power peaks from music and is the average power developed by a continuous sine wave signal. Music power rating does take into account the peaks of power required for music which may be as much as twice the r.m.s. power. Many manufacturers have adopted the music power rating in their specifications simply because it looks more impressive. (Needless to say it originates from the U.S.A.)

Unfortunately music power ratings can be quoted in such a way as to give an unrealistic impression. For example, let's take a stereo amplifier for which the specification simply reads "50 watts output". Now the manufacturer may have deliberately failed to mention that this 50 watts is a music power rating and is also the combined output of both channels. This could therefore be 25 watts music power per channel, and may well turn out to be only 8 to 10 watts r.m.s. per channel (a more familiar rating).

With modern transistor amplifiers the so-called music power output depends very much on the d.c. power supply regulation and the efficiency of the heatsinks of the output transistors. The power supply should provide the required voltage for instantaneous large current demands, and the heatsinks should be large

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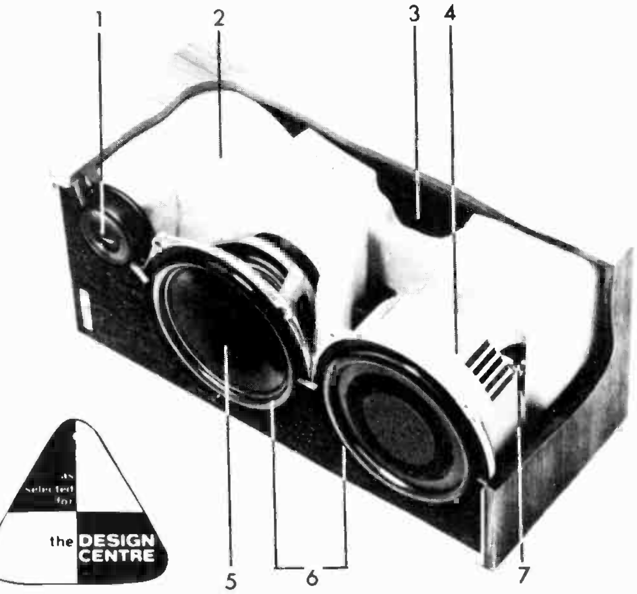

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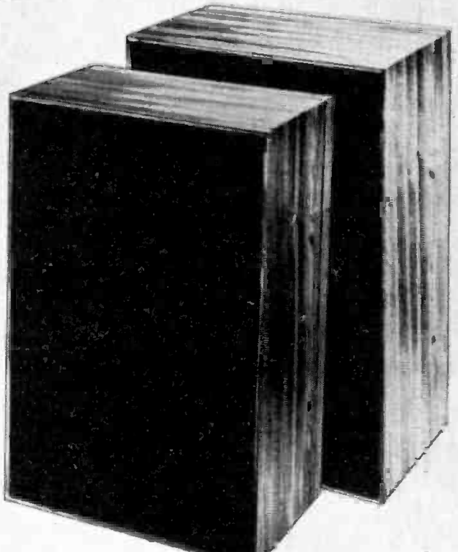

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enough to prevent the start of thermal runaway in the output transistors during prolonged peaks.

With a well regulated power supply and large heatsinks, the available r.m.s. power might well be equal to the music power. A poorly regulated power supply and small heatsinks may well allow short peaks of power just long enough for the music rating to be adequate, but severely limit the available r.m.s. or continuous power.

It is always best to think in terms of r.m.s. power and unless one has an exceptionally large living room and very tolerant neighbours, 8 to 10 watts r.m.s. (per channel for stereo) is ample for a domestic hi fi system, and should be capable of handling transient peaks.

FREQUENCY RESPONSE

To say that an amplifier (or any other piece of hi fi equipment for that matter) has a wide frequency response does not mean very much. A reference frequency, usually 1,000Hz, should be given together with a reference power output or signal output at that frequency. The output level at all other frequencies can now be compared with the reference.

It is not unusual for a manufacturer to quote the overall frequency response of a hi fi amplifier relative to about half the rated r.m.s. power, although some do give a "power response", i.e. the frequency response at the full rated r.m.s. power. It would be as well to look for this in the specification because transistorised amplifiers especially will not always maintain the rated power output at the extreme upper and lower frequencies.

Some manufacturers deliberately quote a "frequency range" which can make the performance look very impressive. However, the "frequency range" is merely an extension of the uniform frequency response to the lower and higher frequencies, where the equipment may develop far too little power or signal output to be of any value. This applies equally to tape recorders, pick-up cartridges and even microphones and loudspeakers.

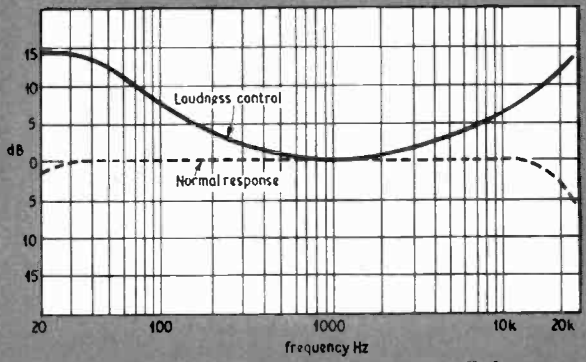

Fig. 3. Loudness control modifies the overall frequency response to match natural average hearing losses at low volume level

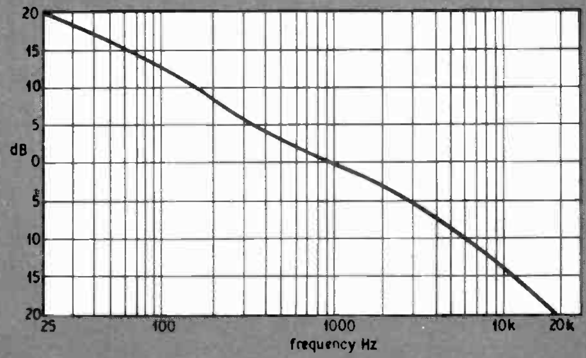

Fig. 4. Typical R.I.A.A./B.S. frequency response characteristic for the replay of fine groove discs

With hi fi amplifiers we are also concerned with the frequency responses provided by the tone controls, the loudness control (if this is incorporated) and also the special responses for signal sources such as direct replay from a tape head and pick-up. The tone controls should provide approximately 10 to 12 dB lift or cut for both the bass and treble at around 100 and 10,000Hz respectively, and with reference to 1,000Hz.

The "loudness" control, which is sometimes incorporated in some of the more expensive amplifiers from the U.S.A. and elsewhere, is designed to compensate for certain natural hearing losses when the amplifier is operating at low volume. The control automatically provides a predetermined degree of lift to the bass and treble resulting in an overall response like that shown in Fig. 3. However, some British pundits believe that this creates an unnatural phenomenon to hearing.

For reasons too complex to go into here, disc records have a special frequency characteristic. To ensure replay with a linear frequency response, it becomes necessary to emphasise the lower frequencies and de-emphasise the higher frequencies and to do this the amplifier must have a special frequency response like that shown in Fig. 4. This frequency response correction (or equalisation) is normally carried out in the pre-amplifier stages and, to comply with the requirements for hi fi, must not introduce unnecessary distortion or excessive hum and noise.

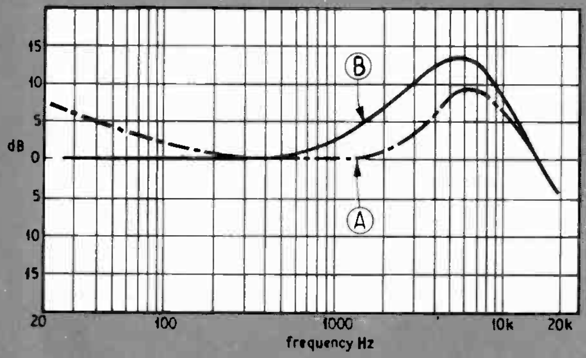

Fig. 5. Curve B is the C.C.I.R. frequency response characteristic for a magnetic tape recording at $7\frac{1}{2}$ inches per second. In practice, and for improved signal to noise ratio, a response like that shown by curve A would be acceptable for modern tape recorders

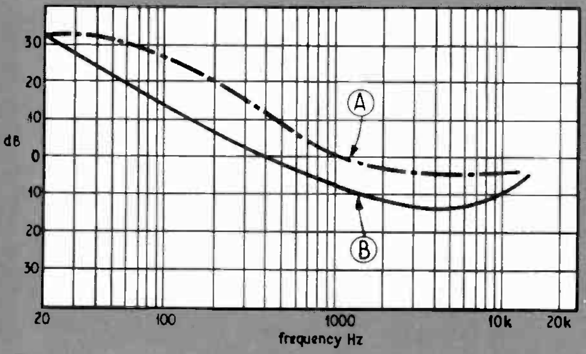

Fig. 6. Frequency response required for direct replay from a tape head. Curve B is the C.C.I.R. response for a tape speed of $7\frac{1}{2}$ inches per second. Curve A is more likely practical characteristic, particularly with modern fine gap tape heads

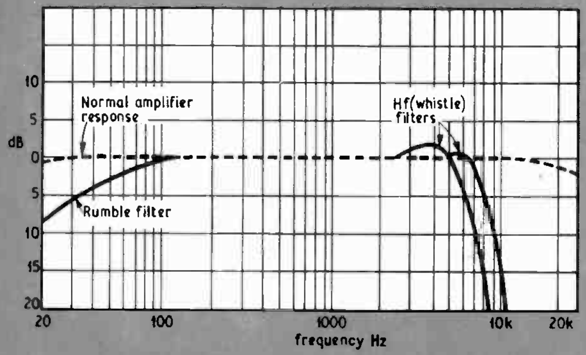

Fig. 7. Typical responses for a rumble filter and whistle filter

Much the same applies to magnetic tape replay directly from a replay tape head which also requires a special frequency response. Tape is recorded with a frequency response characteristic like that shown in Fig. 5 which necessitates bass emphasis during replay as in Fig. 6. Tape replay from a tape recorder or record/replay unit, where the signals are taken from the head pre-amplifier, does not require special frequency response correction.

Some of the more expensive hi fi amplifiers have built-in filters for reducing rumble (low frequency noise) from record turntables and for reducing heterodyne whistles from a.m. radio. Such filters simply alter the frequency response of the amplifier by providing sharp cut off at the appropriate frequencies. Typical responses for rumble and whistle filters are shown in Fig. 7.

SIGNAL LEVEL AND NOISE

In this day and age of transistors, the hum and noise level in hi fi amplifiers has been very considerably reduced and performance in this respect is now generally better than that hitherto obtainable with valves.

It is not unusual to find hum and noise levels (for radio and tape recorder inputs) of 60 to 70dB below the rated output, or a ratio of −60 to −70dB, and for pick-up of −50 to −55dB. Again figures can be made to look impressive so a reference, such as the rated r.m.s. output power, should be looked for in the specification.

Much the same applies to harmonic distortion which is usually quoted as a percentage with reference to one or more fixed frequencies and the full rated output. Harmonic distortion should be less than one per cent at full rated output and preferably less than 0·5 per cent in the more expensive amplifiers.

Specifications for hi fi equipment and especially amplifiers, can be difficult to interpret and unless one is in a position to carry out a full set of performance tests there is no way of proving, other than by objective listening, whether or not the equipment really does perform as the manufacturer claims. Test reports published in the technical press can be relied upon to give a pretty clear indication as to performance for the price of the equipment, otherwise one must rely entirely upon the integrity of the manufacturer and dealer.

THE HI FI SYSTEM

So far this supplement has dealt mainly with the general technical requirements for hi fi and especially those concerned with the amplifier. Although the amplifier is the nucleus of a hi fi system, and all other units depend on its performance, even the very best of amplifiers cannot improve the performance of poor quality auxiliary equipment.

This is well worth remembering because one of the advantages of the hi fi system is, that it can be built up gradually and one need not be faced with a large initial outlay in order to get the best equipment. You can still buy the best as and when you can afford it, which immediately raises the question of what to start with and what will ultimately be worth adding.

For those who can afford the outlay for a complete ready to use system, many manufacturers are now marketing hi fi systems in matching style and performance, although even these can often be purchased piece by piece. Prices for complete outfits vary from around £80 to well over £300 with performance accordingly.

A popular system is the integrated stereo amplifier/f.m. tuner plus a disc transcription unit complete with pick-up arm and cartridge and two loudspeakers. It should be mentioned here that very few manufacturers are now making hi fi mono amplifiers except for special requirements; almost all domestic hi fi amplifiers, tuners and tape recorders are transistorised. Nearly all tape recorders in the hi fi category now being sold are also for stereo record and replay.

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LETTERS FROM ABROAD

Feb 1969

Extract of letter from Mr. Wendell G. Ward, of Texas, U.S.A., Sept. 1968.

I have recently read through Mr. Briggs' book "A to Z in Audio" and found it most interesting. It's refreshing to find a man who can write about what could be a dry subject with enthusiasm and humor.

Extract of letter from Mr. R. G. Bernaldez, of Madrid, Spain.

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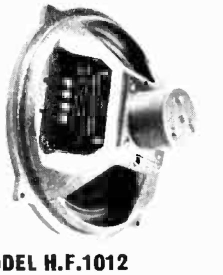

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THE first part of this supplement dealt mainly with the objective requirements of hi fi and some of the facts and figures associated with the specification for hi fi amplifiers and ancillary equipment. One of the major problems is the choice and price bracket of the various items of equipment that constitute a hi fi system, i.e. amplifiers, tuners, turntables, pick-up arms and cartridges, tape recorders and loudspeakers.

A hi fi system can of course be made up from separate items of equipment by different manufacturers, or of units matched in design and finish made by one manufacturer. Most of the units that go to make a hi fi system, with the exception of the loudspeakers, can be installed in one large cabinet or neatly arranged on bookshelves; in fact bookshelf sized loudspeakers and amplifiers are becoming popular and greatly favoured by those who have little room space to spare.

WHAT TO LOOK FOR WHEN BUYING

LOUDSPEAKERS

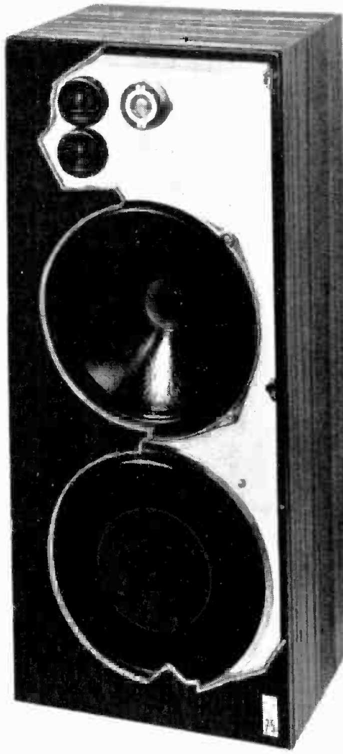
Whilst compact amplifiers, tuners, and even tape recorders intended for bookshelf mounting, are quite efficient, the same cannot always be said of miniature loudspeakers, often with enclosures no more than 12 inches or so high. These are usually single speaker systems that often require a fairly large driving power, and lack the extended and smooth low frequency response of larger multiple speaker systems.

A good loudspeaker, capable of handling 10 to 15 watts r.m.s. power and which has a uniform and wide frequency response will invariably have two, if not three, internal speaker units plus an appropriate frequency dividing network.

The frequency range covered by the speaker system as a whole is divided between the individual speaker units, i.e. bass and treble, or bass mid-range and treble as the case may be. For such systems either corner reflex or completely closed cabinets are popular although there is frequent argument among hi fi enthusiasts as to which type of enclosure offers the best performance. Listen to any of the different makes and designs and they will probably all sound slightly different anyway, but only by listening to loudspeakers in the same room setting can the hi fi enthusiast make his choice.

Generally speaking, the greater the cost the better the performance and really good speaker systems are not cheap, especially when two are required for stereo. The prices of speaker systems that could be labelled "hi fi" range from about £10 upwards per channel. The average price for a good 15 to 20 watt loudspeaker with three units, crossover network and a well designed enclosure is around £30 to £40.

Of course, loudspeaker systems are not difficult to construct and some of the large manufacturers of speaker units may supply working plans for building enclosures to suit their particular units. Complete kits for building speaker units are also available. The saving can be quite considerable.



Ditton 25 speaker unit by Rola Celestion Ltd. Power rating is 25 watts r.m.s. using a 12in auxiliary bass radiator, 12in long throw bass speaker

LOUDSPEAKER IMPEDANCE

One final point which concerns the loudspeaker impedance, and this is a very important one, has arisen with the popularity of transistor amplifiers. The common impedance of hi fi speakers has hitherto been 15 ohms to match the common output impedance of valve amplifiers, also 15 ohms.

Nearly all present day transistor amplifiers will only develop full rated power at an impedance of 8 ohms. The power output decreases as the impedance of the output load (the speaker) increases. Some transistor amplifiers will develop a little more power as the load impedance is reduced but are then inclined to go unstable, or at worst the output transistors can become overheated and may even destroy themselves.

The graph (Fig. 8) shows the power output against load impedance of a typical transistor amplifier.

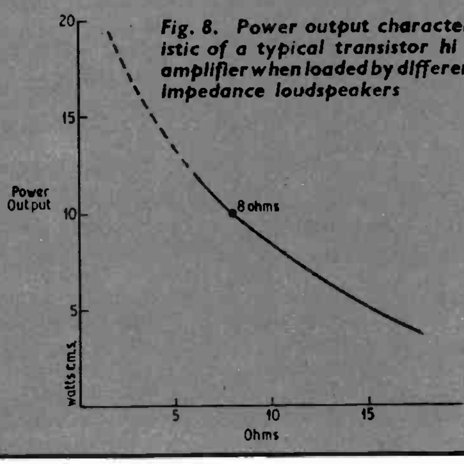


Fig. 8. Power output characteristic of a typical transistor hi fi amplifier when loaded by different impedance loudspeakers

AMPLIFIERS

Part 1 of this supplement dealt fairly extensively with the technical requirements and specifications for hi fi amplifiers. The earlier arrangement of a separate pre-amplifier and power amplifier that was popular for valve amplifiers is gradually disappearing, and almost all transistorised amplifiers are integrated, i.e. the pre-amplifier and power amplifier is made in one complete unit.

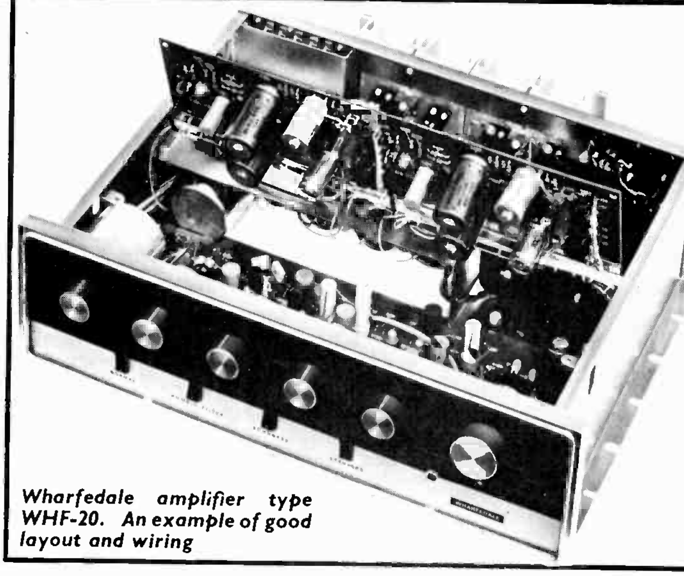
There is now a trend toward integrated tuner/amplifiers, i.e. an a.m. and f.m. tuner with a built-in amplifier having the necessary inputs for disc and tape reproduction. Some tape recorder manufacturers are also including hi fi power amplifiers within the tape recorder so that one can buy what is literally an integrated tape recorder/amplifier having inputs for disc and radio reproduction.

So the choice in this respect is quite wide and useful. For instance, for those who are inclined toward tape recording, especially for its creative aspects, may find it cheaper to buy a tape recorder with built-in power amplifiers. Those whose chief interest is radio programmes at high quality, may of course find the integrated tuner/amplifier a better proposition.

The prices of these combination systems vary very little as far as different makes of repute are concerned and the outlay would be in the region of £80 to £120 for a top performance tuner/amplifier and certainly over £100 for a hi fi stereo tape recorder with built-in power amplifiers.

The now more conventional integrated hi fi pre-amplifier/power amplifier systems range in price from about £40 (budget class and limited flexibility and performance) to over £100 for top performance and fairly large power rating.

One in this latter category, oringinating from Japan, is rated at 60 watts music power per channel. Its r.m.s. power performance is also very good as is the general overall performance. This retails at £90 and caters for mono or stereo, tape, disc, radio and microphone and includes such refinements as overload meters, loudness control, filters for treble and bass, separate tone controls for each channel, and so on.



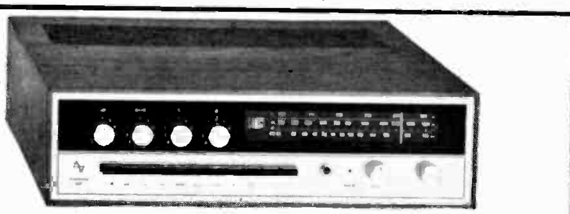
Wharfedale amplifier type WHF-20. An example of good layout and wiring

AMPLIFIER PERFORMANCE

Unfortunately the buyer of hi fi equipment often has no way of assessing the quality and performance of items like an amplifier or tuner except by listening, and even this will convey very little unless a direct comparison can be made with other equipment of known performance.

The ears can become quite satisfied with the reproduction from a radio set or record player of moderate performance; even a very cheap so-called hi fi system (and there are plenty on the market) can sound quite pleasing to those who have heard nothing better.

When buying any hi fi equipment it's not a bad idea to have one or two of the most expensive items demonstrated first and then hear how cheaper versions compare with them. The dealer might be offended but it's your money that's being spent. It is also worthwhile studying the reviews and test reports that appear in the "hi fi" technical magazines.



Armstrong 526 f.m./a.m. mono/stereo tuner

TUNERS

The radio side of hi fi is, of course, mainly concerned with v.h.f./f.m. mono and stereo broadcasting, which should but does not always reach the strictly hi fi level. However, the tuner and/or tuner/amplifier, employ much about the same kind of circuitry, so there is little choice from this point of view, and most available now are transistorised. A good signal to noise performance is important especially for the reception of stereo broadcasts.

Tuners are available for mono reception only, in which case they will not include a stereo decoder unit, but since stereo/mono transmissions are compatible, a mono tuner will receive stereo transmissions and provide the audio signal output in mono. Tuners are available for f.m. reception only and, unless one really wants medium and long-wave reception, there is little point in spending the extra money for it.

There are few if any technical problems with tuners except perhaps with reception in fringe areas, i.e. on the edge of the expected good reception zone, or in low lying pockets with intervening hills. An a.f.c. control is valuable if frequency drift is likely to occur.

A good aerial is essential for proper reception of f.m. stereo broadcasts in which the noise level is around 3dB greater than that of mono transmissions. A poor aerial will increase the noise level even more. You should consult your local dealer to find out if a specially large array is needed.

Most manufacturers can supply stereo decoders that can be fitted later to mono only tuners, but be sure to verify that the mono tuner can be adapted for stereo, and allow for the possibility of having to increase the number of elements on the aerial for stereo if perhaps only one or two elements were adequate for mono.

RECORD TRANSCRIPTION UNITS

The hi fi enthusiast recognises that the turntable unit must be of a high quality, especially if he respects his records and cares for them. He does not like the "record player" which often denotes an automatic record changer that are often more clumsy than the human hand.

The transcription unit, however, does imply a heavy turntable, precision pick-up arm and cartridge and all three items can be purchased as completely separate items from two or more manufacturers or as one complete unit by one manufacturer, ready to install and use. The choice is wide and prices range from around £15 for a complete but modest form of unit to over £40 for a top quality turntable alone.

Pick-up arms and cartridges also have a very wide price range, making choice somewhat difficult; they can cost as little as £8 or up to over £30. The variations in design are so complex and so varied that a whole article could be devoted to any one type and its technical performance.

Pick-up cartridges that can be classified as hi fi also vary in price from around £4 to £5 to nearly £50! Again the variations in design and performance are too numerous to deal with here.

The average ear, especially one unaccustomed to hi fi reproduction, would find it difficult to detect audibly any great difference in performance between all but the very cheapest and most expensive of the pick-up cartridges. Price is the best guide and the average price for a good cartridge is around £12 to £15.

Goldring GL69 transcription unit mounted on its own plinth

Beware of very cheap or even so-called "budget priced" equipment. A complete transcription unit comprising turntable, pick-up arm and cartridge that would stand up to exacting tests for hi fi performance would cost in the region of £30 to £40 minimum.

TURNTABLE

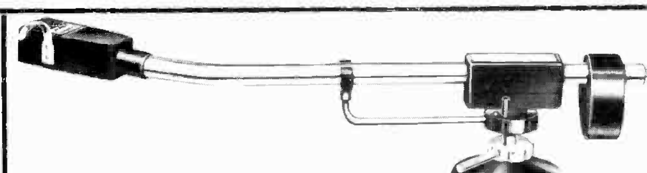
What should one look for technically? Well as far as turntables are concerned the platter itself should be heavy and turn with a speed accuracy of less than ± 1 per cent. Wow and flutter (or variations of nominal running speed) should be less than 0·1 per cent, and few except very cheap turntables are any worse than this.

PICK-UPS

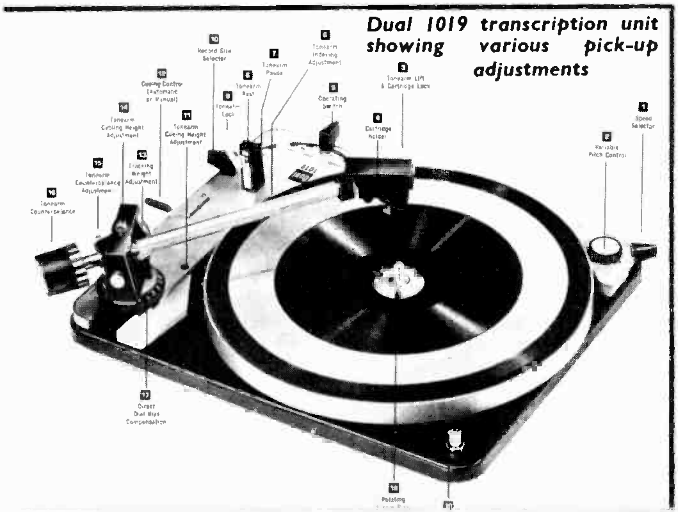
The best pick-up arms often incorporate a number of devices to ensure correct tracking, balance and stylus pressure. They are usually fairly expensive but one is at least assured of a really high performance with minimum disc wear. Such pick-up arms do, of course, warrant the use of an equally expensive cartridge and there would be little point in doing otherwise.

Whatever the other performance factors may be and whether they are adjustable or not, a good hi fi pick-up arm must have provision for setting the tracking pressure to between a ¼ and 5 grammes. The exact pressure depends on the pick-up, so the manufacturer's recommendation should be followed.

The performance of a pick-up cartridge is almost impossible to estimate just by listening and the technical specification will convey little to the layman. However, a low tracking force (sideways movement restriction) is essential, although this may be anything between ¼ and 5 grammes, hence the necessity for adjustment on the pick-up arm.



Connoisseur pick-up arm



Dual 1019 transcription unit showing various pick-up adjustments

The frequency response of a good cartridge should be in the region of 20–20,000Hz ± 2dB and for stereo cartridges the channel separation should be better than 25dB. Deviation in the output signal from each channel should be not more than ± 1dB over its working frequency range.

Most modern magnetic cartridges have an output of around 5mV at 50 kilohms or so impedance, so remember that the amplifier must have appropriate input facilities if a magnetic cartridge is to be used. Average price for a good cartridge is about £15, but one at £20 to £25 will sound just that bit better.

Brenell 2 or 4 track mono/stereo tape recorder with its own 6 watt amplifiers

TAPE RECORDERS

The tape recorder is now very much considered as part of a hi fi system and for this reason many hi fi tape units have made their appearance recently. The tape unit has full provision for recording, with inputs for radio and microphone, sometimes with provision for mixing, and suitable recording level meters.

They also have playback pre-amplifiers that provide a linear output signal suitable for direct connection to a hi fi amplifier system. For this reason they seldom have built-in power amplifiers and loudspeakers.

A more recent arrangement is to incorporate hi fi power amplifiers but not loudspeakers. This enables one to use the recorder with appropriate hi fi speakers as a hi fi system.

The majority of tape recorders rated as hi fi are also stereo machines; in fact few mono only recorders are now being made. Aside from such functions as stereo or mono recording, or replay, many of the higher priced recorders include the track-to-track or multi-play facility, dual channel mixing, provision for introducing echo, and so on.

The choice of a tape recorder as a hi fi signal source warrants a little thought since tape recording itself can be quite creative as one may soon discover when using a tape recorder. The machine should not be too limited for really creative purposes.

If the recording activity is to be strictly for hi fi listening, then a good quality stereo tape replay unit (or one with output stages) may suffice. However, tape recorders that could be classified as having a hi fi performance do not come cheaply.

Trio TT-10 4-track stereo tape deck

Tape units range from about £50 to £60 upwards; it is very unlikely that lower priced machines will have provision for mixing and track-to-track recording. Tape recorders with power output stages and with extra facilities like track-to-track dubbing will be over £150 for something strictly hi fi and can cost as much as £300.

TAPE PERFORMANCE

The technical performance of tape recorders that come within the hi fi category is fairly standard and has improved quite considerably with the introduction of extra low noise transistors. Few, if any, tape recorders of good quality now employ valves.

One can expect a good frequency response from 30 to 18,000Hz even for a tape speed of $3\frac{3}{4}$ inches per second with modern tapes and ferrite heads. Signal to noise ratio of better than 50dB is possible on quarter-track recording. As far as quarter-track or half-track is concerned, there is little difference these days in actual performance and if one requires to make long recordings with a minimum amount of tape then quarter-track is recommended.

The mechanical performance of modern tape recorders of good quality can also be relied upon. Wow and flutter and nominal speed variation is usually so low as to be undetectable by ear even at the lower popular tape speeds of $1\frac{7}{8}$ and $3\frac{3}{4}$ inches per second. As with most transistor audio equipment made now, printed circuit assembly is employed and some manufacturers even fit exchangeable circuit boards, thus simplifying service and repair.

CONCLUSION

Readers who have read this supplement through from Part 1 will realise that the technical performance, specifications and choice of hi fi equipment could not possibly be covered to its fullest extent nor in any great detail here. The choice of equipment is enormous and the variations may at first cause confusion.

The first step to making a choice is best taken by collecting as many leaflets and brochures as possible on different makes and types of equipment and by these compare specifications and prices. Make a short list and then try to find a dealer willing to demonstrate various combinations of the different items you have chosen. Try not to be put off by sales talk that may confuse you even more. The price tag can give a pretty good idea as to quality and performance but is not in itself conclusive evidence of true hi fi standards throughout.

Hi fi is a very broad term, so far without laid down minimum performance figures. It has developed over several years from the experience and desire of enthusiasts, who wish to reproduce in their own homes as near a faithful acoustic quality as was heard at the performance. The two parts of this supplement has attempted to illustrate how one can achieve this measure of fidelity within the limitations of currently available equipment.

A later article will be published describing installation and maintenance of hi fi equipment.

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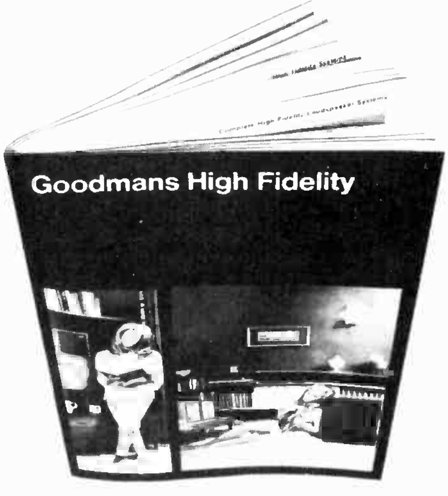

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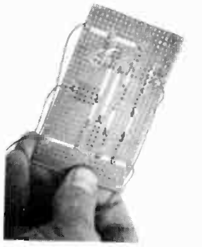

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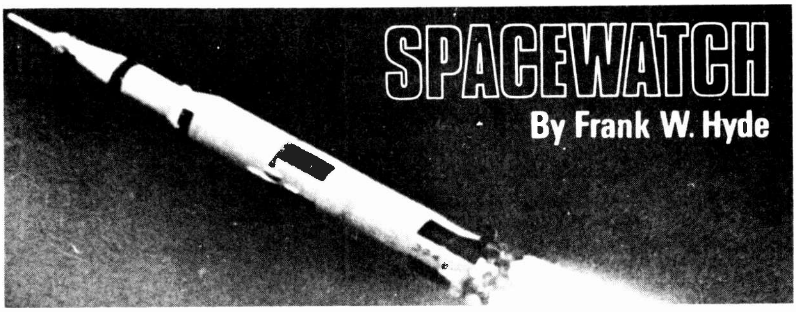


MOON ROCK RESULTS

In the first reports of the biological examination of the lunar rock samples collected by Armstrong and Aldrin, Dr W. Schopf of the University of California finds no evidence of lunar organisms "living, dead, or fossilised". It seems that earlier reports are now discounted and the apparent organisms the result of earth contamination. The carbon content so far established is less than ten parts per million. This can be the level that could result from the handling of the materials using rubber gloves and tools.

Mice injected with lunar material have not exhibited any unusual behaviour. Six cell culture samples have been examined and some of the cultures of human embryo lungs and kidneys have shown no signs of the growth of bacteria. The experiments in this field will go on with special observation of the effects on reproduction of animal and plant species.

Radiation checks on lunar rocks have shown the presence of thorium, uranium, potassium, sodium-22, cobalt-56, strontium-46 and manganese-54. The level of the thorium content of both the rocks and the dust is higher than that found in meteorites but lower than that found in terrestrial basalt.

This part of the work carried out by Dr D. O'Kelly of the Oak Ridge National Laboratory has also disclosed that the moon rocks contain less uranium and potassium than earth rocks. He states that the sodium-22 is formed by cosmic ray bombardment.

SOLAR-WIND GASES

At New York State University, Dr O. Schaeffer has detected a large amount of solar-wind gases, more than anyone has suspected. The gases are mainly hydrogen and helium but he has also detected argon, neon, krypton and xenon. The blackish colour of the surface dust is thought to be the result of bombardment by the solar gas. It is claimed that some 20 to 30 per cent of the moon dust comes from molten particles.

In the second box of rocks which was opened on August 4 there were 30 rocks of various sizes. Some of these are quite different from anything on earth and may offer some interesting minerological facts. There were about 40lb weight of rocks of a medium grey colour and more angular and fractured than those in the first box opened. In these latest rocks to be examined there are signs of crystalline and opaque metallic clusters.

MARINERS 6 and 7

The results that are now being released from the two Mars probes, which were so successful in the Mars flypast in July and August, are causing a considerable amount of speculation and quite a number of new questions are posed when the data is examined. The *Mariners* have shown that Mars is anything but a hospitable planet by earth standards, it would seem that it is more like the moon than the earth. One thing is certain and that is that there are many questions to be answered and that we know somewhat less than was thought as far as this red planet is concerned.

Photographs taken with filters attached to the cameras show no signs of the blue haze consistently reported by earth based astronomers. Again the close-up shots with provision for seeing in ultra-violet and blue light, do not confirm the haze at the poles which appears on the distant shots.

SPECTROSCOPIC STUDIES

Dr G. C. Pimentel of Berkley, California, who is concerned with the spectroscopic studies, asks why is it that the absorption lines which indicate the presence of methane and ammonia appear just above the dark rim which surrounds the receding polar cap. Why is it that these gases appear there and only there. Could it be that life of a sort could exist in this marginal area where there is possibly melting hoar-frost.

The spectrometer experiment set up by Dr C. A. Barth of the University of Colorado has revealed that although there are features on the surface of Mars which suggest volcanic conditions, there is no sign of molecular or atomic nitrogen in the upper atmosphere of the planet. These findings differ from those that occur on earth.

One explanation from Dr D. N. Horowitz of California Institute of Technology, suggests that the Martian nitrogen may have been oxidised by carbon dioxide in the atmosphere and is now in the soil as nitrate. Some experiments carried out at Caltech support this view.

POLAR CAPS

Meanwhile a controversy arises from the differing views of Dr R. R. Leighton of Caltech and Dr C. Hord of the University of Colorado regarding the nature of the polar caps. Dr Leighton, basing his statements on radiometer and ultra-violet spectrometry, argues that the polar caps are solid carbon dioxide some three or four feet thick and deposited by conditions of the Martian winter as snow. He maintains that water vapour is only present in very small amounts in the atmosphere and could not be transported to the poles with enough speed to form more than a very thin layer of hoar-frost.

As further support for Dr Leighton's view is the presence of what appear to be configurations of the caps resembling snow drifts. As against this the infra-red spectrometer gives a temperature which is too high for the presence of solid carbon dioxide.

While Dr Hord is prepared to accept thin water ice with carbon dioxide superimposed, his ultra-violet spectrometer measurements do not support the presence of carbon dioxide clouds, because the atmosphere above the polar caps is highly transparent.

PLAIN OF HELLAS

Another puzzling observation by the *Mariners* shows the plain of Hellas, which is about one million square miles in extent, to be quite different from all other areas on Mars in that there are no craters within the boundary escarpments.

Interest has also been aroused by the observations from the spacecraft of bright streaks curling across the high plateau known as Tharsis, and earth based observers have reported similar recurring features, thought to be cloud formation. At Goldstone, Dr R. Goldstein has used the large space tracking telescope in the radar mode and finds that this area is very high above the surrounding terrain.

Photographs from *Mariners 6* and *7* spaced several revolutions of Mars apart, do not confirm the recurrence of markings which change in character. It is suggested by this that rather than cloud formations these are variations which appear on the surface due to the changing of the incident light in the Martian afternoon.

P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD.

PART TWO R.F. MODULE

LAST month an overall description of the complete receiver was given. Now each module has to be considered in detail. This present article deals with, firstly, the construction of a standard housing for the modules; and secondly, the assembly and testing of the first module—the R.F. Unit.

MECHANICAL CONSTRUCTION OF MODULE CONTAINERS

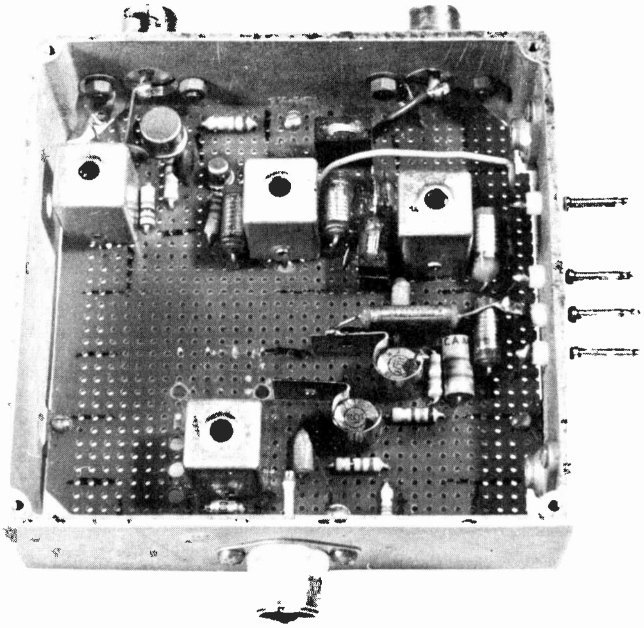
As it is difficult to locate suitable boxes for this type of construction it was decided to manufacture a set of identical containers from sheet aluminium. These boxes have to be reasonably accurate if the final mechanical assembly is to go together with ease.

The first step is to accurately cut a piece of wood, preferably a very hard wood, into the shape indicated in Fig. 2.1. This is now the master template for all the boxes (seven will be needed). The 16 s.w.g. aluminium should be cut into strips 14⅝ inches long and 1$\frac{3}{16}$ inches wide and two holes should be drilled in one end as shown in Fig. 2.1. This end of the strip should be fixed to the wooden template, exactly on the marker, with two screws. Now proceeding to the first corner, bend the aluminium strip firmly at this point and after bending tap both sides of the corner with a hide or wooden mallet. Having ensured that the corner is a good fit proceed to the next corner and so on until all the corners have been made.

If the job has been carried out correctly there should be a ¼in overlap. Temporarily easing the strip to one side, remove the two pilot screws and trim the last quarter of an inch at each end. The assembly should now be squared up and two further holes drilled in the other end of the strip to line up with the joining strip. When the container is bolted up, the box should be rigid.

The round rod should be cut into the required length and drilled and tapped accordingly. These rods are Araldited into the corners of the container as shown in Fig. 2.1. The corner blocks should be allowed to set for 24 hours in a reasonably warm room. Two 6B.A. hank bushes should be fitted into the base of the box and the lead through connectors can also be fitted in this final stage. Fig. 2.1. also shows an alternative method of making the corner fixings.

It is wise to take considerable care in the manufacture of the boxes as it will save endless filing and cutting at some later stage, possibly with detriment to the circuitry. For the constructor who does not wish to go to the bother of making the mechanical assemblies it is possible to use the diecast box type 46RCS00043A00, stock number 268X0075F supplied by Electroniques at 6s 11d each. It will mean that a slightly larger cabinet will have to be purchased to house the receiver.



R.F. UNIT CONSTRUCTION

The complete circuit of the r.f. unit (module 1) appears in Fig. 2.2. This should be studied in conjunction with the description given in Part 1 last month. Reference should also be made to the block diagram of the complete receiver, Fig. 1.4.

The inductors L1, L3, L4, L5, and the transformers T1, T2 have to be constructed according to information given in Fig. 2.5. All winding details, as well as the various purchased items needed, are included in this drawing.

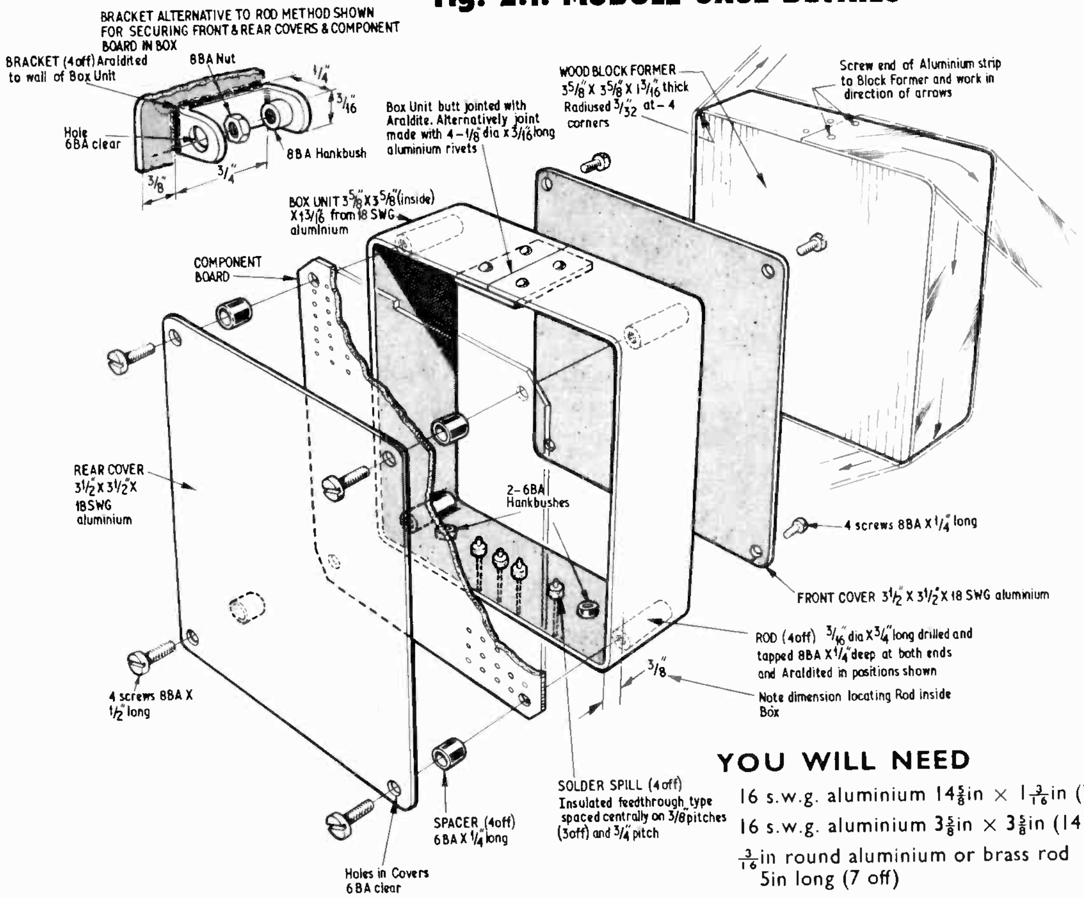
When these components are completed, work can commence on the circuit board assembly. A piece of s.r.b.p. board 3½in by 3½in with perforations on a 0.1in grid (plain Veroboard) is required. Components are mounted as shown in Fig. 2.3 and the wiring completed on the underside as in Fig. 2.4. Note that four capacitors are also mounted on the underside.

The completed circuit board is screwed into the module container and the three coaxial sockets SK1, 2, 3, and the four pins of PL4 wired up as shown in the diagrams.

SETTING UP INSTRUCTIONS

The following instructions are for the constructor who has sufficient resources at his command to enable the setting up of the units to be carried out individually.

Fig. 2.1. MODULE CASE DETAILS



YOU WILL NEED

16 s.w.g. aluminium $14\frac{5}{8}$in × $1\frac{3}{16}$in (7 off)

16 s.w.g. aluminium $3\frac{5}{8}$in × $3\frac{5}{8}$in (14 off)

$\frac{3}{16}$in round aluminium or brass rod 5in long (7 off)

Araldite

Hard wood block $3\frac{5}{8}$in × $3\frac{5}{8}$in × $1\frac{3}{16}$in (1 off)

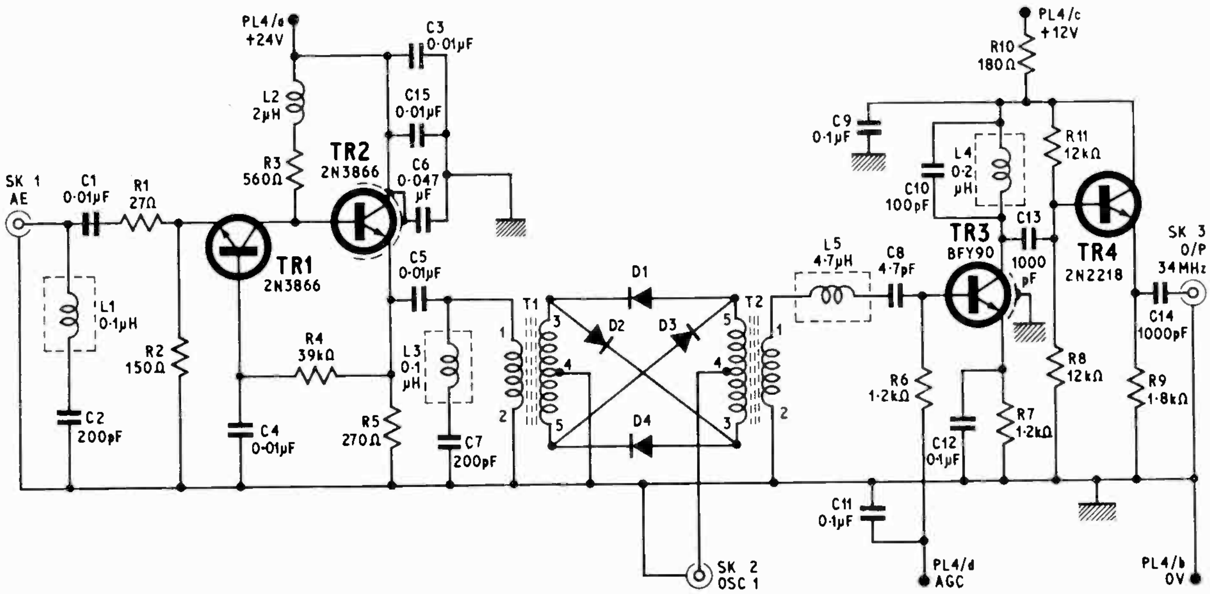
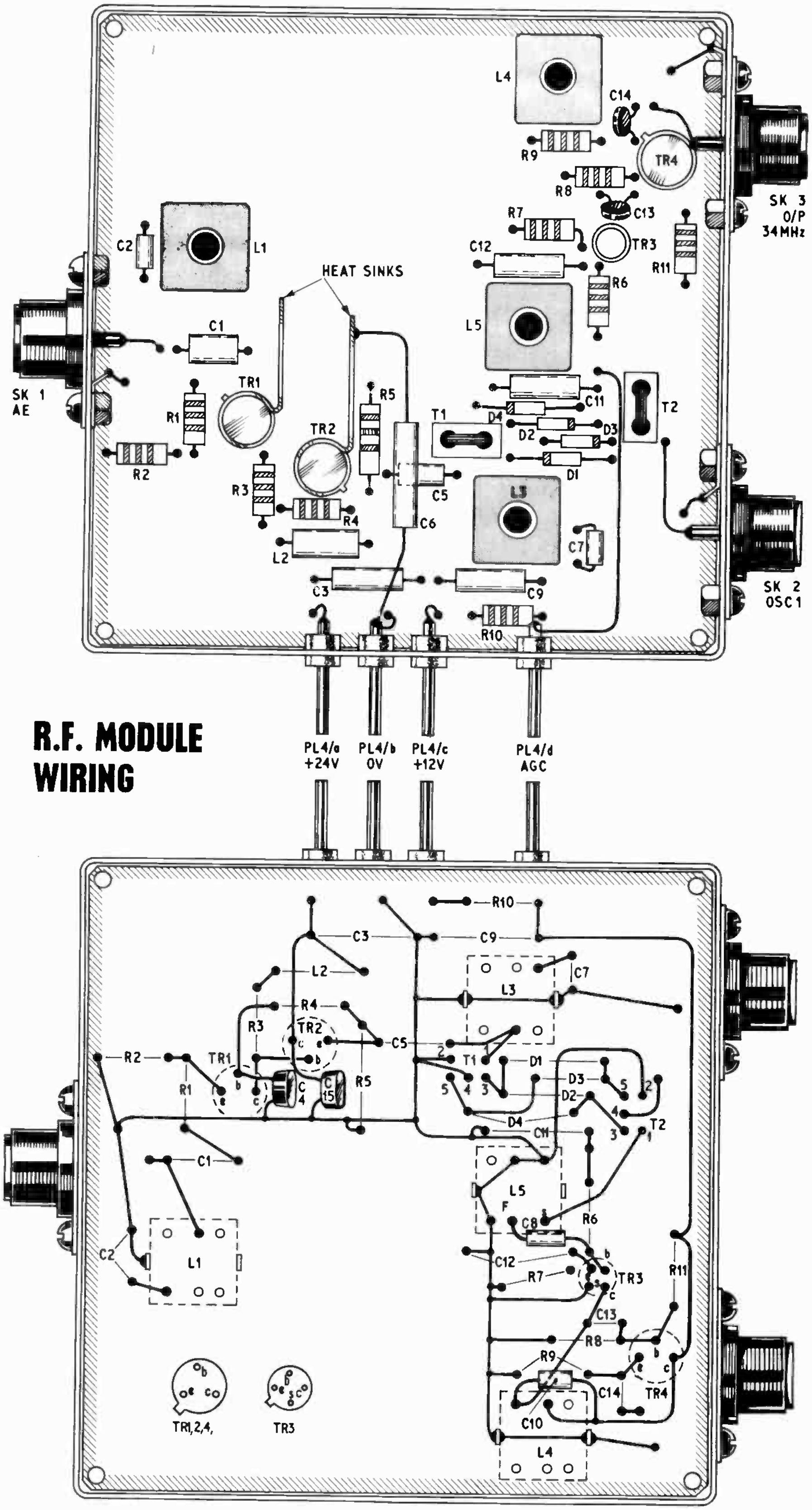


Fig. 2.2 The complete circuit diagram of the r.f. module

R.F. MODULE WIRING



COMPONENTS . . .

Resistors

R1	27Ω	R7	1·2kΩ
R2	150Ω	R8	12kΩ
R3	560Ω	R9	1·5kΩ
R4	39kΩ	R10	180Ω
R5	270Ω	R11	12kΩ
R6	1·2kΩ		

All $\frac{1}{4}$W to $\frac{1}{3}$W high stability carbon film

Capacitors

C1	0·01μF	paper foil (Hunts Metalmite)
C2	200pF	polystyrene, 5%
C3	0·1μF	polyester
C4	0·01μF	ceramic
C5	0·01μF	paper foil
C6	0·047μF	polyester
C7	200pF	polystyrene, 5%
C8	4·7pF	polystyrene, 5%
C9	0·1μF	polyester
C10	100pF	polystyrene, 5%
C11	0·1μF	polyester
C12	0·1μF	polyester
C13	1,000pF	ceramic
C14	1,000pF	ceramic
C15	0·01μF	ceramic

Transistors

TR1	2N3866	R.C.A. or Motorola
TR2	2N3866	R.C.A. or Motorola
TR3	BFY90	Mullard
TR4	2N2218	Mullard, Texas or Newmarket

Inductors

L1	0·1μH	
L2	2μH	Choke (Painton or Cambion)
L3	0·1μH	see Fig. 2.5
L4	0·2μH	see Fig. 2.5
L5	4·7μH	see Fig. 2.5

Diodes

D1	OA47	D3	OA47
D2	OA47	D4	OA47

Transformers

T1 Wideband Transformer
T2 Wideband Transformer
see Fig. 2.5

Sockets and Plugs

SK1–3	Sub-miniature coaxial chassis mounted sockets (3 off)
PL1–3	Plugs for above (3 off)
PL4	Four Hellerman insulated lead-through connectors

Miscellaneous

Plain Veroboard (perforated s.r.b.p.), 0·1in grid, $3\frac{1}{2}$in × $3\frac{1}{2}$in

Fig. 2.3 and 2.4 Component layout and wiring of the complete r.f. module

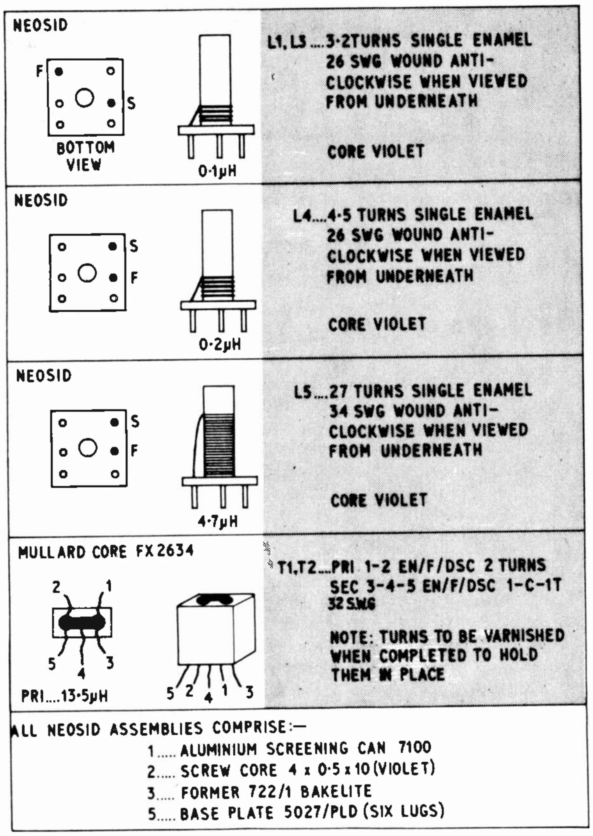


Fig. 2.5 Coil winding details

(Similar instructions will be given for all seven modules, as they are dealt with in turn.)

Equipment required

(a) **Power supplies,** 24V 100mA, 12V 20mA and 2·5V 5mA.

(b) **High frequency generator.** Capable of delivering 100 millivolts into 50 ohms at 2MHz to 34MHz.

(c) **High frequency generator.** Capable of delivering 500 millivolts into 50 ohms at 32MHz to 64MHz.

(d) **Valve voltmeter.** Capable of measuring 2MHz to 34MHz from 100 microvolts to 1 volt.

PROCEDURE

Apply the two h.t. potentials and set the incoming a.g.c. voltage at the terminal to read 2·5 volts. Check all the d.c. potentials at the base collector and emitter of each of the transistors to ensure that they coincide with the levels indicated in the D.C. Voltage Chart (Table 2.1). If the potential at the emitter of TR2 is not within 2 volts of the specified value R4 may be increased or decreased until the voltage level at the point in question is approximately 17·3 volts. Once this level has been achieved check the other d.c. levels again.

Having ensured that the circuit is working from a d.c. point of view apply a 100 microvolt signal to the input Socket SK1 and measure with a low capacity, high impedance, high frequency valve voltmeter across pins 1 and 2 of T1. The frequency of the input signal should be 2MHz. Approximately 500 microvolts of signal should be measured upon the valve voltmeter.

Change the frequency at the input Socket SK1 to 34MHz and increase the level of the input signal to 100 millivolts. Tune L1 and L3 for minimum output on the meter. (Core sealer should have been applied to the cores of both these coils before this adjustment is made).

With a.g.c. voltage set at 2·5 volts the input signal should be removed from Socket SK1 and transferred to Pins 1 and 2 of T2, the level being set at 10 millivolts at 34MHz. The valve voltmeter should be placed across Socket SK3 and L4 and L5 should be tuned to give maximum reading on the valve voltmeter.

Now remove the input signal from T2 and apply it once again to Socket SK1 with the frequency set at 2MHz at a level of 10 millivolts. Leave the valve-voltmeter connected across Socket SK3 and then apply a 500 millivolt signal at 36MHz to Socket SK2 (this level measured after connection). Retune L4 and L5 for maximum output. (Core sealer should have been applied to these cores prior to adjustment.)

The r.f. unit can now be considered to be set up. *Note:* it was incorrectly stated last month that the dynamic range of the r.f. amplifier was 54db, it is in fact 114db.

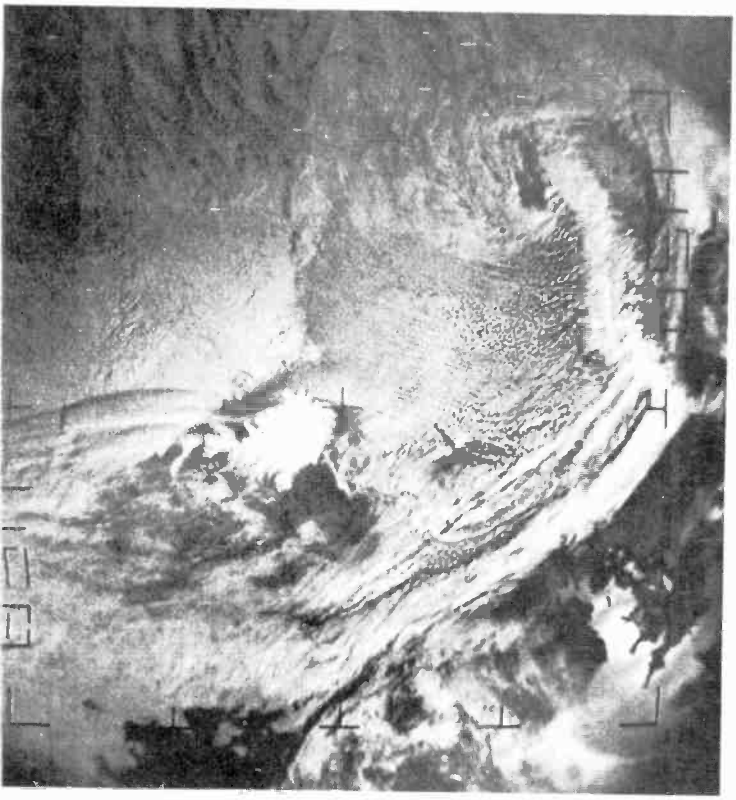
Table 2.1. R.F. UNIT D.C. VOLTAGES

Stage		Voltage
TR1	Vc	18V
	Ve	1·25V
TR2	Vc	24V
	Ve	17·3V
TR3	Vc	11V
	Ve	1·75V
	Vb	2·4V
TR4	Vc	11·1V
	Ve	4·5V
	Vb	5V

*set for 2·5V at a.g.c. terminal. All above readings taken with a 20 kilohm/volt meter

Next month: constructional details of the i.f. unit

ELECTRONORAMA

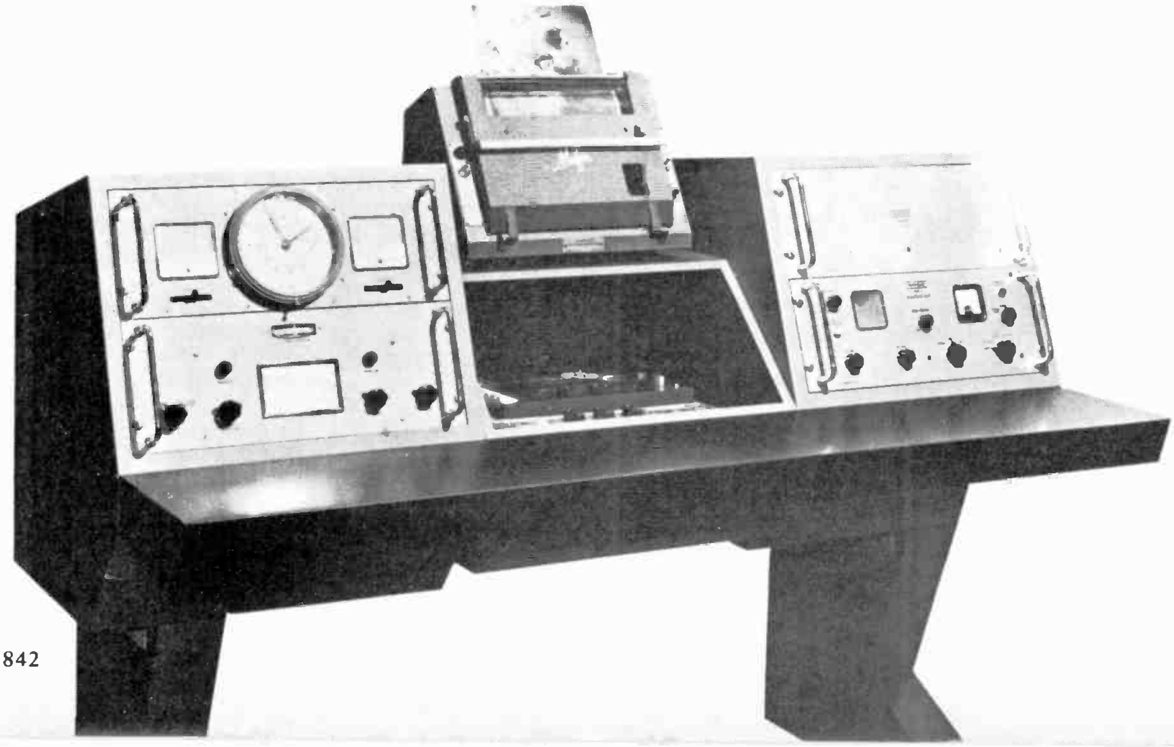


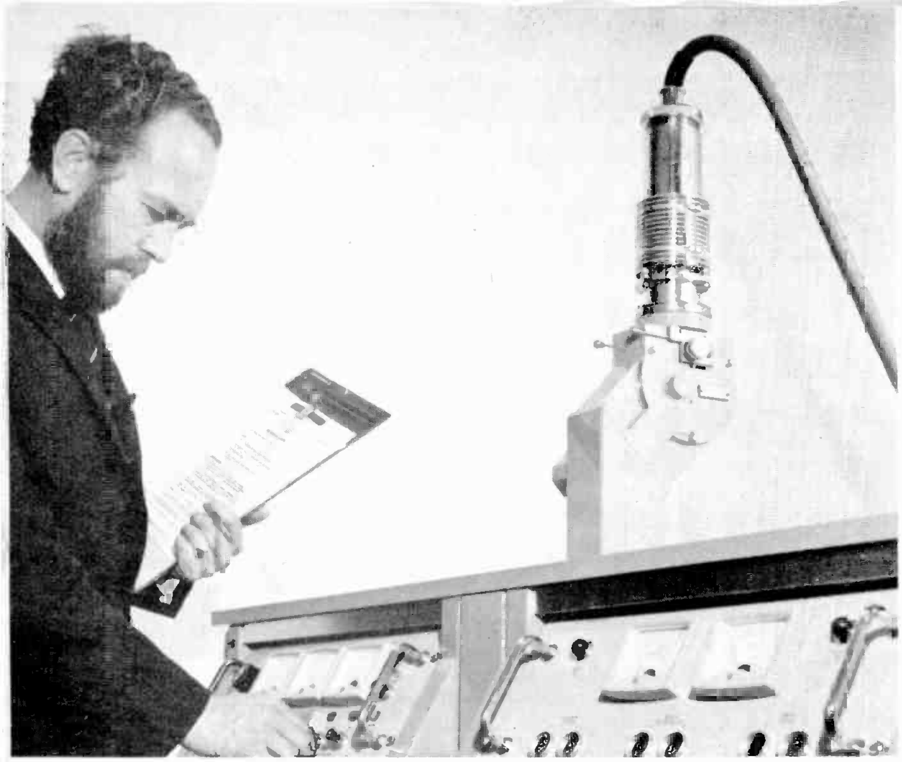
Five New Picture Receiving Stations

THE British Meteorological Office has ordered five automatic picture transmission receiving stations to improve short and long term weather forecasts. The receiving stations will be installed overseas in Europe, Africa and the Middle East by Meteorological Office engineers. Each receiving station consists of four principle units; an antenna assembly, a receiver, a facsimile recorder and a tape recorder. With the exception of the antenna, all units are situated on the control console shown below. Pictures, such as that on the left, covering an area of about 2·5 million square miles and showing cloud cover over the earth, can be received direct from weather satellites while they are above the stations' horizon.

The picture transmitted from an ESSA 8 satellite (left) shows cloud cover over Iceland, Greenland, Norway and Sweden. A ridge of high pressure over the United Kingdom (bottom right) is forcing the weather front to the north-east, giving fine weather

The basic console of the receiving station (below) manufactured by Hawker Siddeley and incorporating a Muirhead picture recorder. The picture can be seen at the top centre of the console





X-ray Equipment Helps Search for Life's Secrets

SPECIAL x-ray defraction equipment that allows scientists to examine protein molecules, which are a central component of living matter, has been developed by Elliott-Automation in collaboration with the Medical Research Council's Molecular Biology Laboratory at Cambridge.

The device, called a fine focus, rotating-anode x-ray diffraction equipment, is to be used to help determine the three-dimensional chemical architecture of protein molecules, an essential step in understanding the basic processes of life and therefore of abnormalities such as cancer.

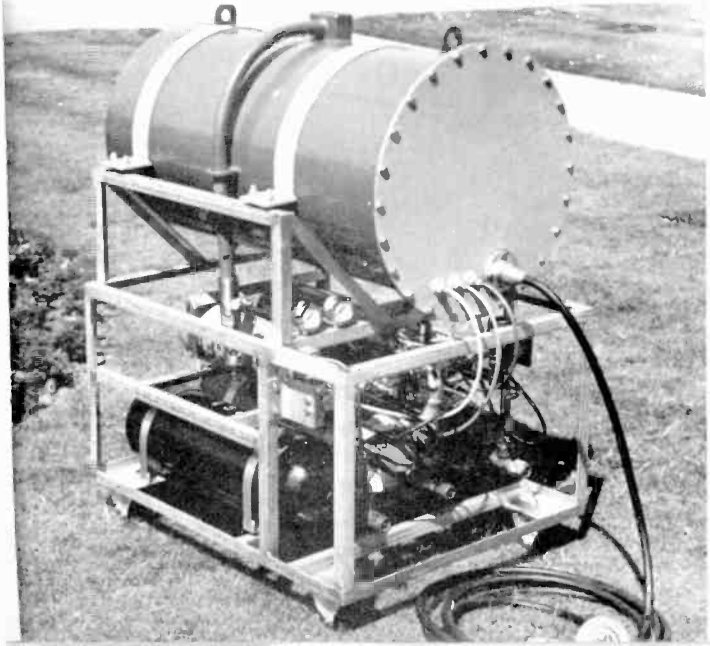
The x-ray equipment has become an important export; sales have already reached £250,000. The equipment, shown in use on the left, is the only system with this capability available anywhere in the world.

Fuel-cell Battery for Undersea House

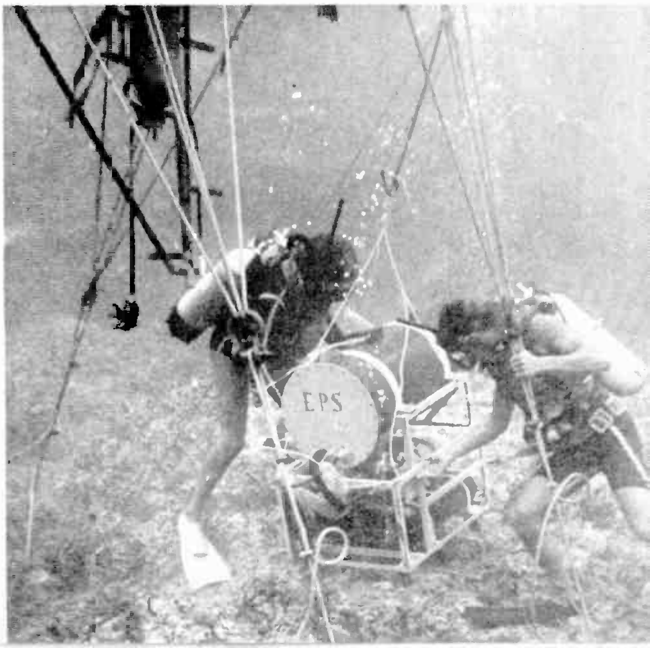
A TEAM of British scientists and engineers from Imperial College and Enfield College has recently successfully completed a series of experiments with a new "undersea house" submerged off the Maltese Coast. Relays of divers used the house and lived in it continuously for up to six days, during which time the structure and systems needed to operate the house above and beneath the water were tested.

The new type of house needs no "umbilical cord" to the surface as food, air and water are provided by a life-support module powered by a fuel-cell battery designed and manufactured by Electric Power Storage Ltd. This is the first time that such a cell has been operated at the surrounding pressures involved; the metal drum which houses the cell is filled with nitrogen to balance the pressure inside the drum to that of the sea water.

The battery produces 12 volts from 16 hydrogen–oxygen cells and the supply cylinders contain enough gas to produce 50 watts of power for seven days' continuous operation. The battery can operate continuously for one month and, apart from replenishing the supply cylinders, needs no attention for this period; the design on which the cell is based has been in operation for up to three years under laboratory conditions.



The complete fuel cell pictured before its installation. Supply cylinders can be clearly seen under the drum which houses the cell



Two divers working on the fuel cell during its installation. The entrance to the house can be seen in the background

TIME LAPSE CINE

By
D. Burn Ph.D.
and
E. W. Summers B.Sc.

Anyone who has seen films which apparently speed up movement, like the miraculous unfolding of a flower in a matter of seconds, will no doubt have been intrigued at the results of time-lapse cinephotography. Although widely used as a scientific tool, this branch of the camera-man's art can also provide interest and some amusement by enabling one to compress into half a minute a continuous event which may have taken hours or even days to complete.

A simple and inexpensive device is described which will allow cine-camera owners to photograph their own time-lapse sequences. In essence, a relay is energised at pre-determined intervals, actuating the camera shutter and exposing a single frame of film at a time.

As the normal running speed of a cine camera is 16 or 18 frames per second, this means that for a "shooting" interval of one second, the action is speeded up nearly twenty times; the result is that pedestrians appear to rush about at 40 m.p.h. to dodge cars hurtling along at 600 m.p.h.

It is essential that the cine camera should have provision for single frame operation. Less essential, but none the less desirable features include electric drive, for extended runs, and automatic exposure control to compensate for varying light conditions.

TIMED PULSE GENERATOR

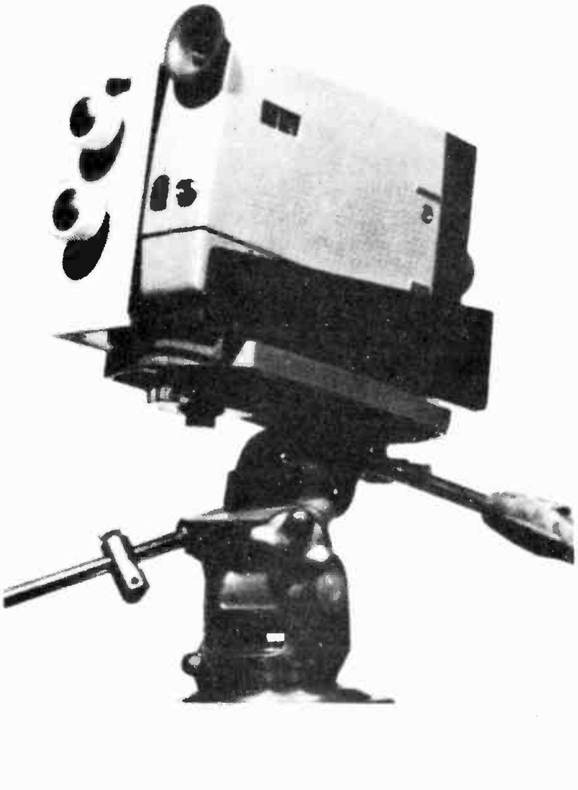
The circuit was designed around a P.O.3000 type relay. Preliminary tests had shown that this relay, in a suitably modified form, had sufficient power to operate the shutter. Timing pulses are produced by the relaxation oscillator TR1 (Fig. 1).

Three ranges are provided, selected by switch S1, continuous control within each range being provided by the variable resistance VR1. The frame rates with the capacitors shown are roughly 1-10 seconds (C1), 6-70 seconds (C2), and 35 seconds to 7 minutes (C3).

The pulses obtained at base-2 of the unijunction transistor are much too short to operate the relay and are therefore "stretched" to about 0·5 second, determined by R7 and C5, by the monostable formed by TR2 and TR3. The fastest practical pulse rate is therefore about 1 frame per second, and is set by the smallest timing capacitor C1 and resistor R1, with VR1 at minimum value.

The negative-going 0·5 second pulses at TR3 collector are passed via R9 and R10 to the output stage consisting of TR4 and TR5 arranged as a Darlington pair.

Although the power requirements of the relay are quite modest, a power transistor has been selected for TR5 to ensure that no overheating occurs, particularly during long runs at high pulse rates. R11 is included to keep down the leakage current of TR5, whilst D2 protects it from transient back e.m.f. when the relay turns off.



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5	3µF	25	4d		
6	64µF	9	4d		
7	20µF	6	4d		
8	20µF	50	6d		
9	30µF	15	6d		
10	8µF	12	4d		
11	8µF	6	4d		
12	1µF	350	6d		
13	8/8/8	350	1/-		
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15	100/200	275	6/-		
16	32	150	9d		
17	64	2·5	3d		
18	100/200/200/50	275	7/6		
19	50/80	300	3/-		
20	150/200	275	6/-		
21	24	275	1/-		
22	10	25	3d		
23	125	2·5	3d		
24	2	150	3d		
25	16/32	350	2/6		
26	32	275	1/6		
27	350	12	6d		
28	75/75/75/75	150	2/6		
29	1	20	3d		
30	12·5	40	9d		
31	640	2·5	3d		
32	3,000	35	7/6		
33	3,000	15	3/-		
34	3,000	30	7/-		
35	250	70	2/-		
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38	750	12	1/9		
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44	16	275	1/-		
45	350	12	9d		
46	20/4	275	1/-		
47	250	50	2/-		
48	500	25	1/6		
49	400	15	1/-		
50	400	2·5	3d		
51	64	275	1/9		
52	32/32	350	2/6		
53	8/8/8	275	1/9		
54	500	6	6d		
55	64	275	1/3		
56	25	6	3d		
57	100	9	6d		
58	400	50	2/-		
59	400	30	1/6		
60	500	4	3d		
61	150	30	1/6		
62	64/32/8	275	2/6		
63	200	275	2/6		
64	40	6·4	3d		
65	50	25	6d		
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67	30	6	3d		
68	100/100/50	275	5/-		
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73	32/32 · 25	275 / 25	2/6		

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RESISTORS. 5% EXCELLENT QUALITY. 7/6 per 100 or **2/-** per doz.
Tick the values required.

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

or our selection (mixed) **6/6** per 100

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS 10/- per 100, **3/-** per doz.
Available in following values. Tick those required.

2pF	5pF	12pF	25pF	50pF	80pF	135pF	180pF	250pF	680pF	1,000pF	2,500pF
3·9pF	6pF	15pF	27pF	58pF	82pF	140pF	190pF	330pF	800pF	1,100pF	2,700pF
4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	420pF	820pF	1,500pF	3,000pF
4·7pF	10pF	22pF	39pF	72pF	125pF	170pF	240pF	600pF	900pF	2,200pF	6,200pF

Total:

COMPARE THESE PRICES

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1 µF **1/-** ea. 125V		

Total:

25% discount lots of 100 per type.
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GANGED STEREO POTS. 250K Ω, **2/6** ea.

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TELEVISION REMOTE CONTROLS. Philips, contain 11 7-way cable, 1 double pot., 5 resistors, two condensers, **10/-** ea. (cost £3/3/-).

THIN CONNECTING WIRE
10yd **1/-** 100yd **7/6.** 1,000yd **50/-**

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POWER OUTPUT (Similar OC35) ALL TESTED. **4/-** ea; **£2** doz.
SILICON PLANAR TRANSISTORS. ALL TESTED. NO LEAKS OR SHORTS
Gain of 20/50, **6d** ea.; 50/100, **9d** ea.; 100/200, **1/-** ea.
Transistors similar to OCP71 (Light sensitive) **2/-** ea.

THYRISTORS 400V BTY79, **7/6** ea. 5CR51 (10A), **£1** ea.

RECTIFIERS Latest type. All marked. 800V peak, 1A mean current type IN4006
2/6 ea., **24/-** doz, **£7/10/-** 100.
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ALL BRITISH MADE, BEST QUALITY. 5in, 600ft, **7/3**; 5¾in, 900ft, **9/-**; 7in, 1,200ft, **12/-**.
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2½ x 1 x 0·15in, **1/3**
3¾ x 2½ x 15 in, **3/3**
3¾ x 3¾ x 0·15in, **3/11**
5 x 2½ x 0·15in, **3/11**
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17 x 2½ x 0·15in, **11/-**
17 x 3¾ x 0·15in, **14/8**
3¾ x 2½ x 0·1in, **4/2**
3¾ x 3¾ x 0·1in, **4/9**
5 x 2½ x 0·1in, **4/7**
5 x 3¾ x 0·1in, **5/6**
Spot Face Cutter **7/-**. Pin Insert Tool, **9/6.**
Terminal Pins, **3/6** for 36.
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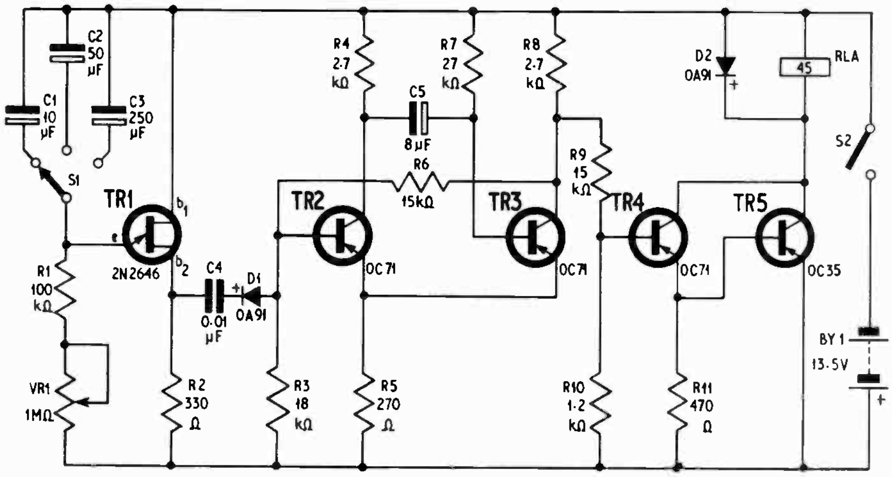


Fig. 1. Complete circuit of the camera triggering unit

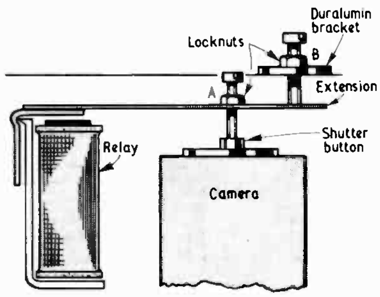


Fig. 2. An extension bar is fixed to the relay armature (Araldite can be used), but at a slight angle to suit the position of the camera button (see photograph). Relay movement is adjusted by set screws A and B

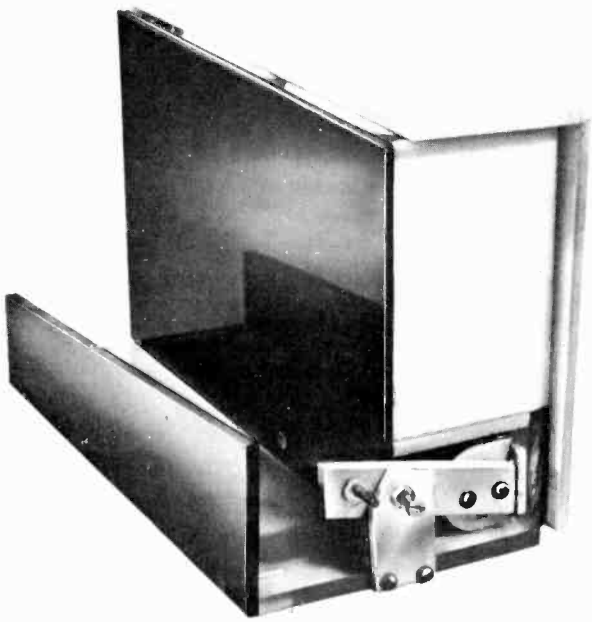
PHYSICAL LAYOUT

Since a compact and rigid unit is desirable, it was decided to build the device to fit the camera. For this reason, no detailed drawings are given of the case. The photographs and drawings illustrate the essential features and it should not be difficult to design a unit suitable for the type of cine camera used. The case is made from sheet Perspex since it is easily worked and results in a pleasing appearance.

The author's camera (an Ilford "Elmo") was very easy to use since the shutter button is situated at the bottom edge of the front panel, and both the camera and the relay could be mounted on a common baseboard. Along one side of the base is a side wall which serves to locate the camera, which in turn is held firmly in place by a $\frac{1}{4}$in Whitworth bolt into the tripod bush. The other side of the base is occupied by a box housing the relay and, over it, the batteries and electronics.

Once the camera has been fixed, the relay (minus its contacts and with a $\frac{1}{16}$in duralumin extension arm glued or bolted to the armature) should be positioned so that the extension comes just in front of the shutter button. It can then be firmly bolted to the base.

Adjustment of the relay is quite critical and is accomplished by means of two set-screws, A and B (Fig. 2). Screw A is fitted to the relay extension and is adjusted so that the shutter is just operated when the relay is fully closed. Screw B is fitted to a bracket mounted on the base and is set so that the extension arm moves back just sufficiently to allow the shutter to reset.



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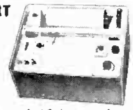

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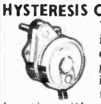

With integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz torque at 1 r.p.m. 240V, 50c/s. L left, R right. 15 r.p.m. L. 8 r.p.m R and L, 6 r.p.m. L. 4 r.p.m., ½, ⅓, ¼ r.p.m. L, 1/5 r.p.m., 1/6 r.p.m., R and L, 1/10 r.p.m., 1/12, 1/15 r.p.m. L. Also 120V 50c/s 2, 1/6, 1/12, 5/12, 4/11, 1/10 r.p.m. **25/-.** P. 3/-.

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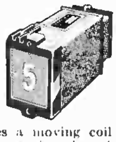

Ideally suitable for use in conjunction with transistorised decade counting devices. No need for amplifiers or relays as only a few milliwatts of power are required to charge the digits. The DIGIVISOR incorporates a moving coil movement which moves a translucent scale through an optical system and the resultant single plane image is projected on a screen. The translucent scale is made to represent digits 0–9. Specifications: 6·3V 250 microamp. Image height ⅝in. Size 4 9/16 2 39/64 1⅜in. Our price **3½ gns.** List price 8½ gns.

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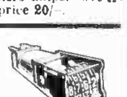

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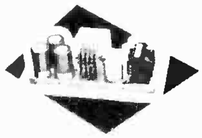

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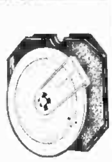

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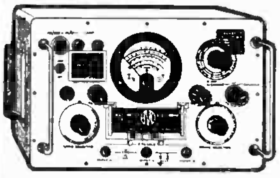

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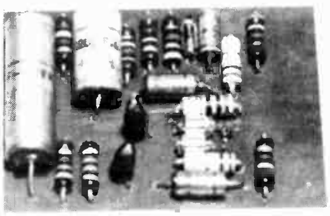

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	All above modules have a signal to noise ratio of –64dB. and by switching a single resistor can be set to give 40, 50, or 60dB. gain.	
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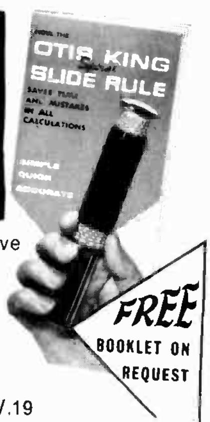

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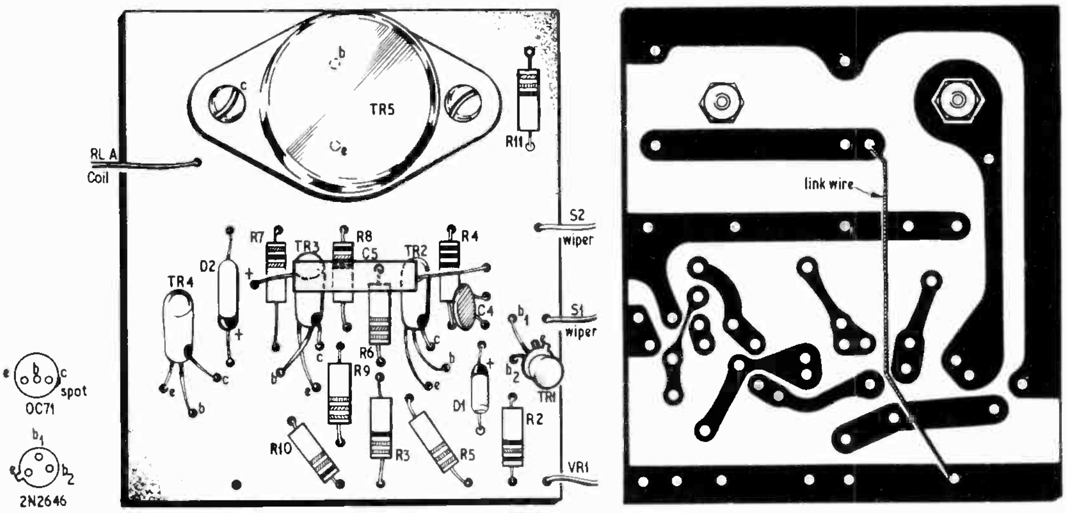
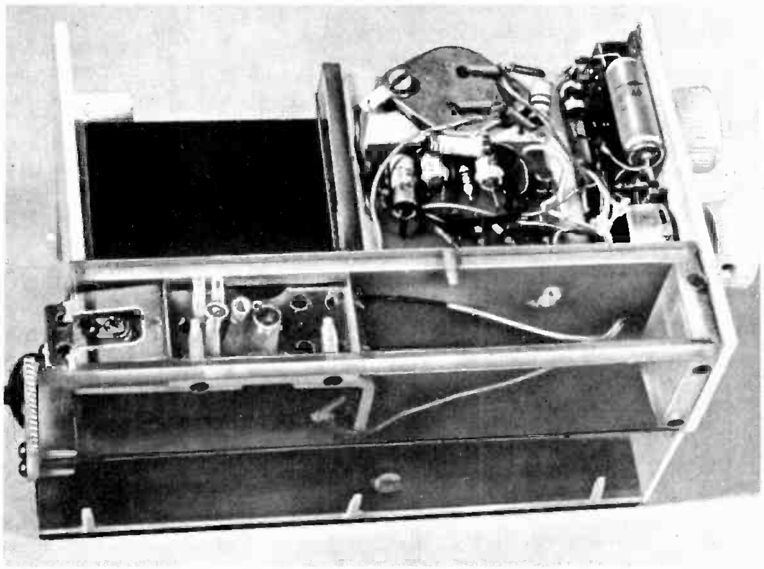


Fig. 3. Full size layout of components on the printed circuit board

COMPONENTS . . .



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- R2 330Ω
- R3 18kΩ
- R4 2·7kΩ
- R5 270Ω
- R6 15kΩ
- R7 27kΩ
- R8 2·7kΩ
- R9 15kΩ
- R10 1·2kΩ
- R11 470Ω
- All 10% ¼W carbon

Potentiometer
- VR1 1MΩ linear carbon

Capacitors
- C1 10 μF elect. 25V
- C2 50μF elect. 25V
- C3 250μF elect. 25V
- C4 0·01μF disc ceramic
- C5 8μF elect. 25V

Semiconductors
- TR1 2N2646 unijunction
- TR2, 3, 4 OC71 or similar (3 off)
- TR5 OC35 *or* XC141
- D1, D2 OA91 *or* OA81 diodes (2 off)

Relay
- RLA 45Ω P.O. type 3,000 without contacts

Batteries
- BY1 13·5V (made up from three 4·5V flatpack batteries No. 1289)

Switches
- S1 Single-pole, 3-way wafer switch *or* 4-pole 3-way wafer using only 1 pole
- S2 Single-pole on-off slide switch *or* 2-pole 2-way slide using only 1 pole 1 way

Miscellaneous
- Printed circuit board 2½in × 2¼in
- Perspex sheet ¼in, ⅛in, $\frac{1}{16}$in thick
- Sponge plastics padding
- Knobs, nuts and bolts

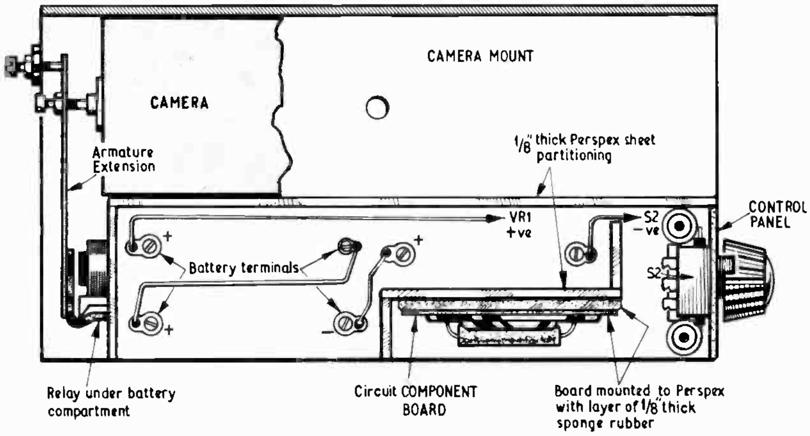

Fig. 4. Layout of the triggering unit showing the battery positions and component board

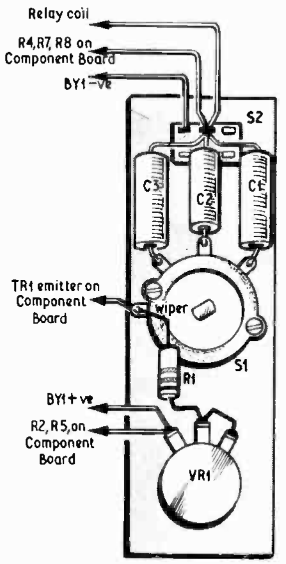

Fig. 5. Wiring of the control panel components

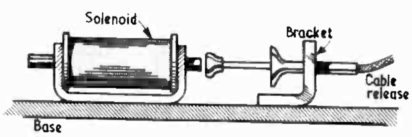

Fig. 6. Solenoid operated cable release as an alternative shutter control

ELECTRONICS BOARD

The circuit requires a 13·5 volt d.c. supply which is obtained from three 4·5V flatpack batteries. They are mounted in the box with their contacts folded over to press on suitably placed 4B.A. bolts (with solder tags) set in the base. To allow easy changing of the batteries, the side and top of the box can be removed together. A block of sponge plastics is glued to the top to ensure that good contact is maintained between the batteries and the terminals.

The space corresponding to what would be the fourth battery, is in fact occupied by the electronics, mounted on a printed circuit board. This board (Fig. 3) holds all the components except switches S1 and S2, capacitors C1, C2, and C3 and VR1 together with R1. The power transistor TR5 operates well within its ratings and does not require a heat sink; it may therefore be mounted on the circuit board.

A compartment, constructed of $\frac{1}{16}$in Perspex, is fixed into the box to keep the batteries in place, and the circuit board is fitted with sponge plastics glued to the Perspex. The complete wiring diagram is given in Fig. 4, with front panel wiring in Fig. 5.

OPERATION

A standard 50ft run of film, having 72 frames per foot, has about 3,500 frames available for a run, allowing some 100 frames for a safety margin. Knowing how long is required for a run, it is easy to calculate the required frame rate, and the controls on the unit can then be set to give this rate.

The camera should be mounted on the base plate of the control unit, and the set screws A and B checked to ensure that the shutter is operating correctly. Where the camera cannot be adapted, an alternative solution would be to use a cable release and actuate it by means of a small solenoid. Fig. 6 illustrates one way this might be achieved.

Before starting a run, care should be taken to fix the unit very firmly so that no movement can occur. Now all that is needed is patience! ★

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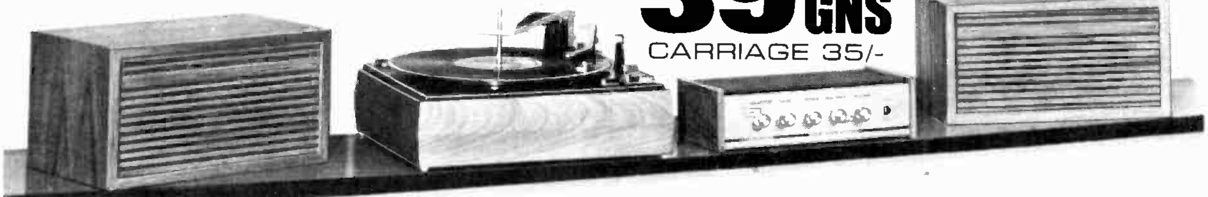

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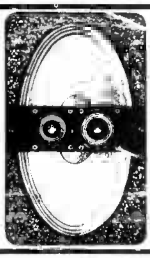

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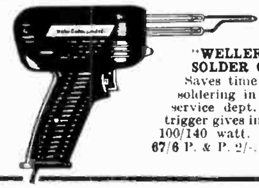

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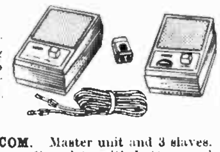

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By F. J. Stone

CONDUCTIVE GLASS

Conductive glass to many people will trigger off inventive thoughts connected with photo-electric devices. Anyone who wishes to obtain some of this material to experiment with will find out that it is not so easy as it might seem. But if they are determined enough they can make their own. This article describes the method developed by the author for making transparent conductive glass, by plating glass with a thin film of tin oxide. It also describes some unusual properties and possible applications of conductive glass.

The processes detailed below are safe and harmless if all normal precautions are taken. This implies that some experience in chemical laboratory practice is required.

MATERIALS REQUIRED

The materials required are glass, stannous oxide (SnO); hydrochloric acid (HCl); and an electric hot plate. Glass is easy to obtain (a local glazier will only be too pleased to sell some odd cuts). Stannous oxide generally needs to be ordered through a local chemist (100g are about 25 shillings). But most chemists can supply hydrochloric acid (about 5 shillings a bottle). Both the stannous oxide and the hydrochloric acid must be as pure as can be obtained. The electric hot plate must be of the square type.

PREPARATION OF STANNOUS CHLORIDE

Mix a small amount of stannous oxide with some hydrochloric acid in a test tube. Warm this over a candle or a gas burner, adding more hydrochloric acid until all the stannous oxide has dissolved. Place a small amount of this liquid (stannous chloride solution $SnCl_2{:}2H_2O$), on to a piece of glass 2 to 4 inches square on top of an electric hot plate that is just warm (30 deg. C to 40 deg. C), making sure none of the liquid runs off the glass on to the hot plate. Add more of the liquid every time it evaporates to a solid, until it is all converted. Note there is no reason why any other method of obtaining stannous chloride should not be used. The method detailed above was used by the writer as stannous oxide was already at hand.

PREPARING THE GLASS

Cut two pieces of glass 2 to 4 inches square. Cut eight small pieces of glass $\frac{3}{8}$ of an inch square. Clean the two large pieces of glass with, if possible, ammonium carbonate, then wash them well under cold running water. This is necessary because any minute speck of dirt will break up the film.

Remove the stannous chloride ($SnCl_2$) from the first piece of glass and make a pile on the edge of one of the cleaned glass plates, see Fig. 1. Put this glass plate on top of the electric hot plate. Place two of the $\frac{3}{8}$ of an inch square pieces of glass one on top of another, in each corner of the glass. Place the other cleaned glass plate on top of this. Bring the electric hot plate up to full heat slowly.

BLOWING THE VAPOUR

When the pile of stannous chloride begins to smoke heavily, very very gently blow this vapour through between the two glass plates. A battery operated fan positioned about 2 to 3 feet away is normally sufficient. The slower the vapour passes through between the glass plates the more the glass is plated. Continue

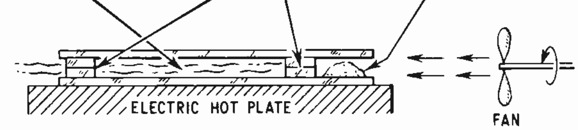
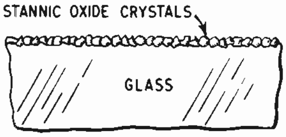


Fig. 1. The two glass plates in position for the tinning process

Fig. 2. Greatly magnified cross-section of the coated glass



blowing until it has stopped smoking, then turn off the hot plate, letting the glass cool down with the hot plate (about 40 minutes).

When the glass has cooled down remove it from the hot plate. Cut $\frac{1}{8}$ of an inch from each side of the lower glass plate where the glass stand-offs and stannous chloride were, leaving a transparent conductive glass, a glass just as transparent as a thick polythene sheet.

If insufficient stannous chloride is used the glass will have a rainbow effect across it. This is still conductive but of very high resistance; it is also more transparent.

The amount of stannous chloride used will depend on the resistance and transparency required and also the area to be plated. This must be worked out by trial and error to suit different types of hot plates and fans etc.

IMPORTANT WARNING

Most people have heard of tin poisoning, and all should know that hydrochloric acid is poisonous and can burn the skin and eyes. The stannous chloride vapour will not burn the skin, but it should not be inhaled or swallowed as it can be very dangerous. Therefore the vapour should have a free path to the open air and of course food and any cooking utensils should be well away and covered up. It should also be realised that if the windows are wide open a slight draft could blow the vapour into one's face.

All the rules of chemistry must be followed regarding the use of test tubes and acids. However, with a sensible attitude one can proceed without any danger.

HEATING THE GLASS

Anyone who has had to repair a pane of glass knows that cutting glass is more of an art than a science. This is also true when heating plate glass. For any kind of success two rules must be followed. Never heat or cool glass too quickly, and keep the whole piece of glass at an even temperature. It is no good trying a square piece of glass on a round type of hot plate as the heat is not distributed evenly. Nor a square piece of glass the same size as a square hot plate since the heat is not evenly distributed at the edges of the hot plate. The glass should be in even contact with the hot plate.

CHEMICAL THEORY

The stannous chloride changes to vapour at about 400 deg. C, and is mixed with the air. When this vapour comes into contact with the hot glass some of the molecules dis-associate into tin and chlorine. One tin atom combines with two atoms of oxygen from the air and this molecule combines with others and crystallises on to the semi-molten glass, where the crystals grow in all directions until each crystal is in contact with its neighbours forming a continuous thin film of stannic oxide on the glass, see Fig. 2.

PROPERTIES OF GLASS AND FILM

The glass, after plating with stannic oxide, retains the same physical properties as ordinary glass except that it is slightly harder and, of course, not so transparent. Stannic oxide films are used in the automatic bottle manufacturing process as a lubricant to stop the breakages due to the cold metal jaws coming in contact with the hot glass bottles.

The film itself is very hard and very firmly adhered to the glass. It is like a very fine transparent sand paper. If one tries to remove it with a razor blade or a knife all one can see is a thin film of steel left on the stannic oxide.

There is one way of removing the stannic oxide film. This is by making the stannic oxide the negative electrode in a bath of hydrochloric acid and have a positive electrode of zinc and connect it up to a battery charger.

MASKING

If it is desired to leave portions of the glass free of the film, these areas should first be covered with small strips of glass or painted with a paste made of powdered glass.

Although the glass is conductive it is not of zero resistance. A resistance of less than 1 kilohm has been achieved, measured between two strips of copper both one inch long and one inch apart. The linearity of the resistance across the glass plate depends on the even flow of the stannous chloride vapour. This can be improved upon by using glass strips in place of square glass stand-offs.

The thickness of the stannic oxide film cannot be determined as the glass in the first place is not even within a few thousandths of an inch.

INCREASING THE RESISTANCE

The resistance of the film is greatly increased if a very small amount (1 part in 10^3) of impurities is added to the stannous chloride solution, like copper, zinc, or even silver salts. No impurities have been found that decreased the resistance. If the stannic oxide film is rubbed with copper the over-all resistance is decreased.

ELECTROPLATING

The conductive glass can be electroplated with copper from the cupric sulphate solution. Make sure that the stannic oxide film is very clean first by dipping it in a bath of hydrochloric acid, then under cold running water, then in a bath of sulphuric acid, then again under cold running water.

Make a connection at one end and dip the opposite end in the solution up to ¼ of an inch away from the connection. At first, use a low plating current. Only the top ¼ of an inch or so that is in the solution will become plated with copper, because of the resistance of the stannic oxide film.

When the top ¼ of an inch is plated with a thin film of copper withdraw it and when the next ¼ of an inch is plated withdraw that and so on. In this way an even film can be plated across the stannic oxide film. The plating current can then be increased and a thicker plate of copper laid.

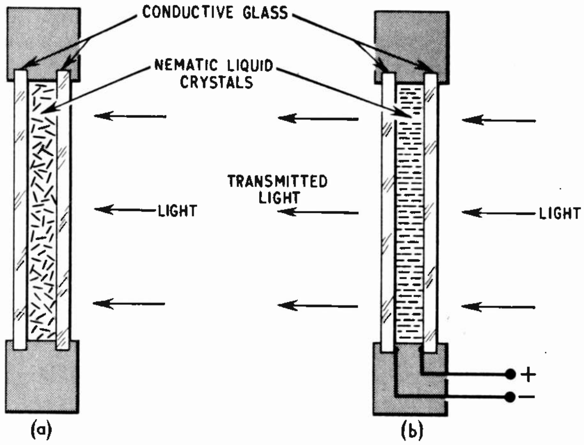


Fig. 3. The variable transparent window. (a) not energised, not transparent; (b) energised, transparent

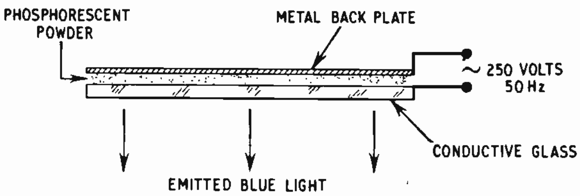


Fig. 4. The electroluminescence panel lamp

The copper can be etched off using a solution of ferric chloride, provided nail varnish is painted on those areas where the copper is to remain.

TIN OXIDE RESISTORS

Using the above techniques it is possible to make many tin oxide resistors, even variable resistors, on one piece of glass with copper circuitry and soldered-on capacitors and transistors. Fine adjustment of the resistors can be achieved by rubbing the stannic oxide film with copper, then painting with varnish or epoxy resin. Commercially made tin oxide resistors are well known for their good temperature stability, but this cannot be claimed for these "home made" varieties.

VARIABLE TRANSPARENCY

Another application of conductive glass is the variable transparent window, see Fig. 3. This device depends on the action of the so-called nematic liquid

crystals. This type of liquid appears as if it had millions of very small elongated needlelike crystals immersed in it. The crystals are normally quite haphazardly arranged and the liquid is not transparent. But when the liquid is subject to an electric field the crystals align themselves parallel to the electric field and the liquid becomes transparent.

In the variable transparent window the liquid is placed between two plates of conductive glass anything up to a $\frac{1}{4}$ of an inch apart. A direct voltage is applied between the two conductive glass plates and therefore the crystals align and the window becomes transparent. By varying the applied voltage the transparency can be varied.

COLOUR CONTROL

It has been recently discovered in America that by mixing a small amount of dye in a solution of one of the nematic liquid crystals it is possible to vary the colour of the transmitted light by varying the applied voltage, although only from a reddish-orange to a yellow. In this type of device the resistance of the stannic oxide film is of no consequence as it is purely electrostatic and no current flows.

It has been known for a long time that not only does an electrostatic field align molecules and crystals, but it can also modify the electronic valency of atoms in a crystal thus altering the properties of the material.

It has been recently discovered in Russia that when a photographic film of a special type is placed between a metal back plate and a piece of conductive glass at the front, the speed of the film can be varied by varying the applied voltage. Thus it is possible to vary the speed of the shutter as well as the speed of the film without changing the roll of film that is in the camera.

ELECTROLUMINESCENCE PANEL

The electroluminescence panel lamp is another example of the use of conductive glass. This devise consists of a phosphorescent powder (ZnS) sandwiched between a piece of conductive glass and a metal back plate, see Fig. 4. When it is supplied with an alternating voltage the phosphor emits light. This type of lamp is the most efficient known with an efficiency of 95 per cent to 99 per cent, although the light is very dull. It is, after all, only a parallel-plate capacitor. Furthermore it is only possible to obtain two colours, blue and green.

One interesting fact about this type of lamp is that there is a colour shift of the blue type to green with an increase in the applied frequency up to 400Hz, above which the efficiency falls off. This type of lamp is a solid state device and never burns out.

There are many devices built around this effect, including a picture intensifier, which has a layer of photoconductive material (CdS) laid on top of the phosphor, then another piece of conductive glass on top of that.

FURTHER IDEAS?

Conductive glass is used in many types of T.V. camera tubes and photoelectric devices. But it can also be used in applications that are not so sophisticated, like heating the back window of a car, for instance.

It would seem there are many uses that conductive glass could be put to by electronics enthusiasts. How about, for example, a pair of variable sun glasses electronically controlled by a photoconductive cell?

★

COLD CATHODE TUBES By J. B. Dance M.Sc.

Part SIX

INDICATOR TUBES

Cold cathode gas filled tubes have been widely used for providing a visual display of information stored in a circuit, for example, for displaying the state of the count in a counting circuit or the switching state of a logic circuit.

Miniature neon diodes are often used as a simple and economical device for providing a display of information, but they can act only as on-off indicators, the indication being provided as a glow or the absence of a glow.

Other types of cold cathode tube are available, however, which indicate the state of the count as a glow in the gas, the glow being in the actual shape of the digit to be indicated. A row of such tubes can be used to display any number of digits in the same way that the number would be written down on paper.

READOUT

Any system used to provide information from an electronic circuit is known as a readout system, since the information is read out of the circuit concerned. Cold cathode tubes and other devices which provide a display of information for an observer to see are said to provide visual readout, but circuits can also provide electrical readout in the form of electrical pulses to an output socket or in the form of a changing voltage or current.

Electrical readout signals can be used to operate other electronic equipment or to operate an electronic typewriter which will print out the information onto paper, thus avoiding the possibility of human error in copying the information.

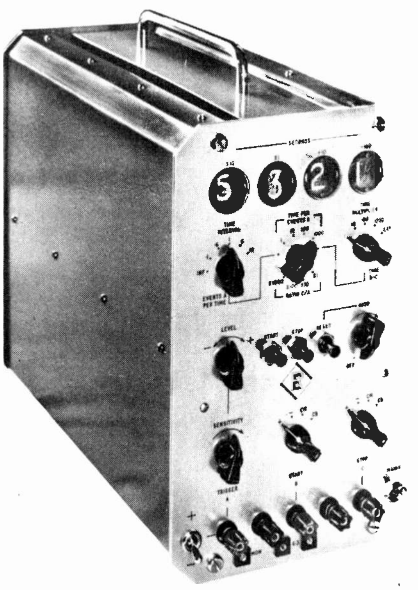
Both visual and electrical readout can be in either digital or analogue form. A digital readout system provides a display in numerical form, whilst an analogue system provides a display as a variable quantity such as the movement of a meter needle, or the movement of a spot of light on a cathode ray tube.

Various pseudo-digital readout systems are also available, such as that provided by decade stepping tubes. Although such a display is not in actual numerical form, each stepping tube nevertheless displays a single digit.

IN-LINE DIGITAL SYSTEM

Ideally a readout system should be of an "in-line" digital type in which the information is displayed as numbers in a horizontal line, just as the number would be written down.

Miniature neon diodes may be used to display the number of counts recorded in a circuit if they are arranged in rows, each vertical row containing ten diodes (Fig. 6.1). Only one of the diodes in any



Research Electronics counter using Mullard ZM1020 readout tubes

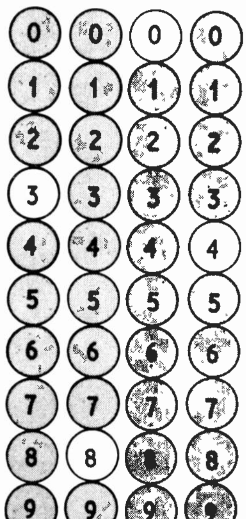


Fig. 6.1. Miniature neon display indicating a count of 3804

S.T.C. end-viewing tube type GN-4

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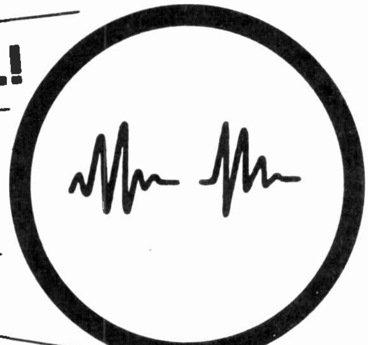

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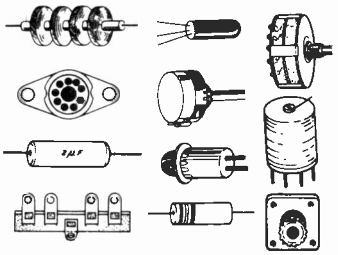

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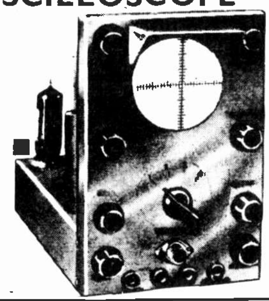

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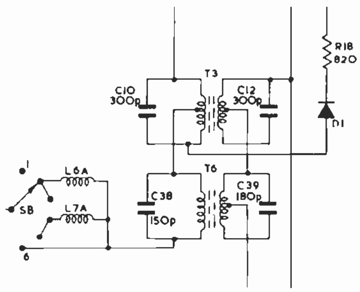

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vertical row glows at any one time, the number being painted on a transparent mask through which the light from the glowing tube passes.

Neon tube readout from valve circuits is easy to arrange, since it is only necessary to connect a neon diode across the valve anode resistor or from the valve anode to chassis (with a suitable current limiting resistor in series with the diode).

However, most transistor circuits operate at voltages which are less than the striking voltage of any available neon tubes. Special tubes and circuits have been developed to overcome this difficulty and some of these are described as follows.

THE "DIGITUBE"

The "Digitube" (a product of the Fujitsu Company of Japan) can be used to provide visual readout from a transistor binary stage. This type of tube contains two cathodes and a single anode; it may be used in the type of circuit shown in Fig. 6.2.

The transistors TR1 and TR2 are connected as a bistable circuit. When TR1 is conducting, TR2 will be non-conducting. In this case the potential drop across the collector load resistor R1 will ensure that the cathode k_1 of the Digitube is kept at a lower potential than cathode k_2, since there is no appreciable voltage drop across R2 when TR2 is cut off.

The potential between the tube anode and k_1 is thus greater than that between the anode and k_2; all of the current passing through the tube tends to pass to k_1 which is surrounded by a glow. The current flowing through the Digitube anode resistor R3 to the cathode k_1 is sufficient to keep the potential between the anode and k_2 below the maintaining voltage for this gap.

When the bistable circuit is switched and TR2 conducts, the cathode k_2 of the Digitube will glow, but the glow at k_1 will be extinguished. An observer can see a glow only when one of the two cathodes is glowing, since the other cathode is screened from view.

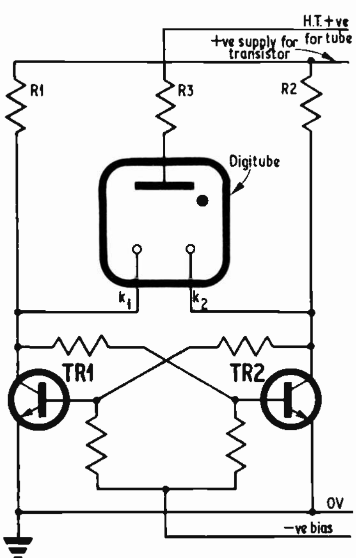
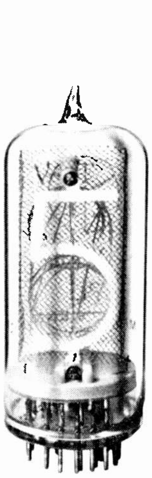


Fig. 6.2. Bistable control of a two-cathode Digitube



Ericsson GR10G side-viewing tube

"DIGITUBE" BINARY STAGE

The simple circuit of Fig. 6.2 is used as a binary stage and can in this case only indicate a count of zero or unity. In most transistor counting circuits a number of these binary stages can be cascaded so that a larger number can be indicated. Four cascaded binary stages can indicate a count of up to fifteen (i.e. they will count on a scale of sixteen), but a feedback system is usually employed so that the four cascaded binaries are reset at the tenth pulse. Thus four Digitubes are required in each decade of the transistor counting circuit.

Ions are always present in the Digitube when the circuit is in use, thus enabling the glow to be transfered easily from one cathode to the other when the binary circuit changes its state. The anode to cathode striking voltage of the non-conducting section of the tube is lowered almost to the maintaining voltage by the presence of the ions from the discharge in the other section of the tube. Thus a change of a few volts is sufficient to change the position of the glow in the tube.

TRANSISTOR CONTROLLED NEON DIODE

The Hivac Company have devised a rather different type of circuit for the control of a miniature neon diode by a low voltage transistor circuit. Although their miniature indicator diodes have only two electrodes, steady ionisation is maintained by a very small current which passes through the tube at all times when it is operational.

This current is not great enough to produce a glow in the gas which is visible in daylight, but a larger current passes when the binary to which the tube is connected is in one of its two states; the indicator tube then emits a glow.

NUMERICAL INDICATOR TUBES

Tubes which indicate actual digits are known as numerical indicator tubes or digital indicator tubes. Various trade names are also applied to them: for example, the Ericsson digital indicator tubes are known as "Digitrons"; the Hivac tubes as "Numicators"; the S.T.C. tubes as "Nodistrons"; the Burroughs (U.S.A.) tubes as "Nixie" tubes.

Similar tubes can be used to indicate letters of the alphabet, mathematical signs, or any one of several other symbols. Some are made to indicate a combination of two symbols, such as mA or μs.

Numerical and symbol indicating tubes have a number of cathodes stacked closely behind one another, each cathode being in the shape of one of the digits or symbols to be displayed. The stack of cathodes is surrounded by a common anode in the form of a wire mesh.

At any one time when one of the cathodes is conducting this is surrounded by a red glow. The presence of any other cathodes in between the observer and the glow does not greatly impair visibility of the glow, since the glow is several times wider than the cathode material itself.

SWITCHING CONTROL

One type of circuit in which a numerical indicator tube may be used is shown in Fig. 6.3. The potential is applied between the anode and the particular cathode which is selected by means of a switch. Only this cathode can pass a current and therefore it is only this selected cathode which glows.

In most practical applications it is often necessary to control the display by means of a transistor switching

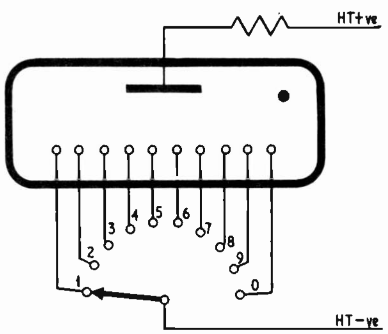
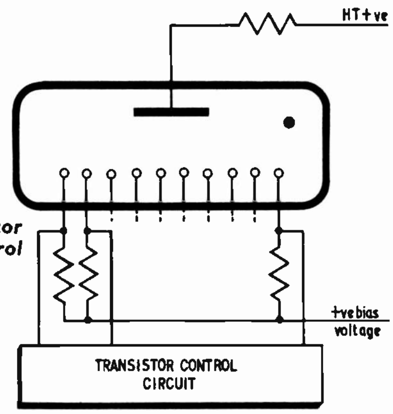


Fig. 6.3. Manual switching of a digital indicator tube

Fig. 6.4 (right). Transistor switching can also control a digital indicator



circuit. The type of basic circuit shown in Fig. 6.4 may be suitable. A positive bias voltage is applied to all of the tube cathodes via resistors, as shown. The transistor control circuit effectively earths only one of the cathodes at any time. This cathode is therefore at a lower potential than the other cathodes and will pass a current.

If the positive bias voltage is adequate, no other cathode will pass enough current to cause it to emit an appreciable glow.

The bias voltage applied to the non-glowing cathodes is known as the pre-bias voltage. If this voltage is too low, all of the cathodes will be surrounded with some glow and a rather indistinct or even unreadable display will result.

If it is required to use digital indicator tubes to provide an in-line display from a transistor cascaded binary counting circuit, some means must be employed to convert the binary electrical readout from the counting circuit into decimal readout. A matrix of diodes is often used for this purpose.

If, however, the transistor counting circuit consists of a "ring of ten" circuit, the readout is of a more suitable type for the operation of a numerical indicator tube.

CURRENT LIMITATIONS

The manufacturers of numerical and symbol indicator tubes recommend maximum and minimum values of the current which should be passed through the tube. If the maximum current is exceeded, excessive sputtering will probably result in a very much reduced tube life, whereas if the current passing is below the minimum recommended value, some of the larger cathodes may not be completely covered by the glow and a defective display will result.

In some tubes a resistor should be employed in series with one or more of the cathodes of small area so that the current passing to these cathodes when they are glowing is less than that which passes to the other cathodes.

LIFE AND RELIABILITY

Numerical indicator tubes employ metal cathodes and have an extremely long life when used in correctly designed circuits. Some cathode material is gradually sputtered away, but the wire mesh anode prevents an excessive amount of this material from being deposited on the glass envelope of the tube where it would cause unwanted reflections and may even obscure the display.

Some long life numerical indicator tubes contain mercury vapour which emits a blue glow when the tube is operating. A red filter is often employed on the front of the envelope of such tubes so that the blue glow is not visible. Some of these tubes have a life of about 150,000 hours or even more and will therefore normally outlast the equipment in which they are being used.

TWO VIEWING TYPES

Small numerical indicator tubes are useful for miniature equipment, but larger types are available which can provide a display which is readable from a considerable distance. Tubes which display large digits require more current, but the operating potentials are very similar to that of the smaller tubes.

Some tubes are side viewing types, but others are viewed through the domed end of the tube. It is usually easier to fit large cathodes in the side viewing tubes and such tubes have the advantage that they occupy less depth behind the instrument panel than the end viewing types. However, the latter have the advantage that they occupy less front panel space and are more easily arranged in rows or columns close together.

POINT INDICATOR TUBES

Another type of indicator tube displays a single digit by means of the position of a point of light in the tube. Such tubes are of a similar construction to a decade stepping tube, but have only ten wire cathodes surrounding a common anode. The domed end of such a tube is placed in a numbered escutcheon, as in the case of the decade stepping tube.

The glow in a point indicator tube steps around the tube as the circuit counts. The current passed by this type of tube is much smaller than that passed by numerical indicator tubes due to the smaller cathode area.

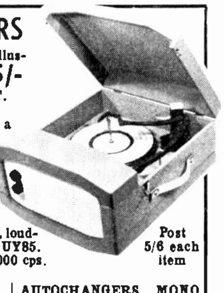
Point indicator tubes are especially useful when a decade stepping tube circuit is preceeded by a fast valve or transistor scaling circuit, so that the overall counting speed is much greater than that of the decade stepping tube circuit.

Such tubes can be used to display the state of the count in the fast valve or transistor counting circuits and have the advantage that the type of display is then the same in all decades of the instrument. This arrangement is usually more economical than if transistor or valve circuits were used throughout for the counting.

CLOCK FACE TUBES

Clock face tubes are useful for displaying the count in transistor counting circuits. In such a tube the

DE LUXE PLAYERS



PORTABLE CABINET As illustrated. To fit standard player or autochanger. **75/-**

RCS AMPLIFIER 3 WATT. Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on panel. Supplied with knobs, loudspeaker and valves UCL82, UY85. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6**

Post 5/6 each item

SINGLE PLAYERS	MONO	AUTOCHANGERS	MONO
EMI Junior Mains	£2.19.6	Balfour Princess	£5.5.6
Garrard SRP22 ...	£6.19.6	BSR Superslim UA25	£6.19.6
Garrard SP25 MkII	£12.19.6	MA70 Transcription	£13.19.6
		Garrard 3000 with Sonotone 9TA diamond.	£12.19.6

All fitted LP/78 stylii and pickup cartridge complete. Stereo/mono pick-ups 20/- extra except 3000.

GARRARD TEAKWOOD BASE WB.1. Ready cut out for mounting 1025, 3000, SP25, AT60, etc. **65/-**

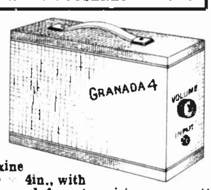
GARRARD PLASTIC COVER SPC.1 for WB.1 BASE. Dnrable tinted atttactive appearance. **65/-**

E.M.I. PICK-UP ARM. Complete with mono cartridge 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-. ACOS LP only 10/6

CRYSTAL MIKE INSERTS

1¼" dia. 6/6: ACOS 1¾" dia. 9/6. BM3, 1" dia. 9/6
QUALITY RIBBON MIKE WITH GOOSENECK £11.11.0

PORTABLE TRANSISTOR AMPLIFIER PLUS DYNAMIC MICROPHONE



A self-contained fully portable mini p.a. system. Many uses — ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player Amplifier, etc. Attractive rexine covered cabinet, size 12 × 9 × 4in., with powerful 7 × 4in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP9 battery. Brand new in Makers' carton with full makers' guarantee. World famous make. Only **90/-** Post Free

WEYRAD P50 — TRANSISTOR COILS

RA2W 6 in. Ferrite Aerial with car aerial coil	12/6	Spare Cores	6d.
Osc. P50/1AC	5/4	Driver Trans. LFDT4	9/6
I.F. P50/2CC 470 kc/s	5/7	Printed Circuit, PCA1	9/6
3rd I.F. P50/3CC	6/-	J.B. Tuning Gang	10/6
		Weyrad Booklet	2/-

Telescopic Chrome Aerials 6in. extends to 23in. 5/-.
Ferrite Rods Only 8 × ⅜in. 4/-. 6 × ¼in. 5/-.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 5/-. STEREO L/S 10/6, D.P. 14/6. Edge 5K. S.P. Transistor, 5/-.

80 Ohm Coax 8d. yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. 20/-; 60 yd. 30/-.
FRINGE LOW LOSS Ideal 625 lines **1/6 yd.**

WIRE-WOUND 3-WATT POTS. T.V. Type. Knurled Knob. Values 10 Ω to 30 K., Carbon 30 K to 2 meg. **4/6**

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 10 OHMS to 100 K. **7/6**

VEROBOARD 0·15 MATRIX
2½ × 5in. 3/8. 2½ × 3¾in. 3/2. 3¾ × 3¾in. 3/8. 3¾ × 5in. 5/2.
EDGE CONNECTORS 16 way 5/-; 24 way 7/6.
PINS 36 per packet 3/4. FACE CUTTERS 7/6.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 6d. per 1in., 3¾in. wide 9d. per 1in.; 5in. wide 1/- per 1in. (up to 17in.).
S.R.B.P. undrilled 1/16in. Board 10 × 8in. 3/-.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides, 7×4in., 5/6; 9×7in., 6/6; 11×3in., 6/6; 11×7in. 7/6; 13×9in., 9/6; 14×11in., 12/6; 15×14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12×12in. 6/6; 14×9in. 5/6; 12×8in. 4/6; 10×7in. 3/6; 8×6in. 2/6; 6×4in., 1/6.

Q MAX CHASSIS CUTTER

Complete: a die, a punch, an Allen screw and key
⅜in. 16/- ⅞in. 17/6 1⅛in. 19/6 1¼in. 24/- 2⅜in. 44/3
⅝in. 16/- 1in. 19/6 1⅜in. 20/6 1⅞in. 29/- 2½in. 57/3
¾in. 16/9 1 5/16in. 19/6 1½in. 21/6 2in. 39/- 1in. sq. 36/6

WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 18/-, 3 wafer 24/-, 4 wafer 30/-, 5 wafer 36/-.
TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6

ALL PURPOSE HEADPHONES

H.R. HEADPHONES 2000 ohms Super Sensitive	35/-
LOW RESISTANCE HEADPHONES 3-5 ohms	39/6
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"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER

200/250 v. A.C. Leaflet S.A.E. Post 2/6 **42/6**

BARGAIN STEREO/MONO SYSTEM

Attractive Slim PLAYER CABINET with B.S.R. Stereo Autochanger, 3 VALVE STEREO AMPLIFIER, two 6½ in. LOUDSPEAKERS. Carr. 10/6 (Only 4 pairs of wires to join). S.A.E. for details. **£19.19.6**

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	2/3	100/25V	2/-	8/600V	9/6
4/350V	2/3	250/25V	2/6	16/600V	12/6
8/450V	2/3	500/25V	4/-	16+16/500V	7/6
16/450V	3/-	8+8/450V	3/6	50+50/350V	7/-
32/450V	3/9	8+16/450V	3/9	60+100/350V	11/6
25/25V	1/9	16+16/450V	4/3	32+32+32/350v.	8/6
50/50V	2/-	32+32/350V	4/6	100+50+50/350v.	9/6

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250mF 15V 2/-; 500, 1000mF 12V 3/6; 2000mF 25V 7/-.
CERAMIC. 500V 1pF to 0.01mF, 9d.
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SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF-0·01, mfd 6/-; each
TWIN GANG. "0-0" 208pF + 176pF, 10/6; 365pF, miniature 10/6; 500pF standard with trimmers, 12/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 19/6. Single "0" 365pF 7/6. TWIN 10/6.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each.
TUNING. Solid dielectric. 100pF, 300pF, 500pF, 7/- each.
TRIMMERS. Compression 30, 50, 70pF, 1/-; 100pF 150pF, 1/3; 250pF, 1/6; 600pF, 750pF, 1/9; 1000pF, 2/6.
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Full wave Bridge 75mA 10/-; 150mA 19/6; TV rects. 10/-.
NEON PANEL INDICATORS 250v. AC/DC Red, Green 3/6.
RESISTORS. Preferred values, 10 ohms to 10 meg.
¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-.
Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt. 10 ohms to 100K. 2/- each; 3 watt. 0·5 ohm to 8·2 ohms. 2/-.
BRAND NEW TRANSISTORS 6/- EACH, OC71, OC72, OC81, OC44, OC45, AF117.
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REPANCO TRANSISTOR TRANSFORMERS.
TT45. Push Pull Drive. 9:1 CT, 6/-. TT46 Output, CT8:1 6/-.
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TT23/4 PAIR 10 watt Amp. Transformers and circuit 35/-.

TRANSISTOR MAINS POWER PACKS, FULL WAVE 9 volt 500mA. Size 4¼ × 2½ × 2in. Metal case. Crackle finish. Output terminals. On/off switch. **49/6**
Half Wave 9 volt 50mA. Size 2¼ × 1¼in. Snap terminals 32/6
9 volt 500mA. TRANSFORMER ONLY. 2¼ × 1¾ × 1½in. 10/6
BENCH POWER PACK 230-250v. A.C. Mains with output Meter. Supplies 6-9-12v. 1 amp D.C. **£7/-/-**

MAINS TRANSFORMERS

Post 5/- each

250-0-250 50 mA. 6.3 v. 2 amps, centre tapped 19/6
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a. 30/-
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a. 35/-
300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a. 45/-
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2½ × 2 × 1½in. 12/6
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HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a. 12/6
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GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. 30/-
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, 35/-
AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 30/-; 500w. 92/6; 1000w. 195/-.
CHARGER TRANSFORMERS. P.&P. 5/-. Input 200/250v. for 6 or 12v., 1½ amp., 17/6; 2 amp., 21/-; 4 amp., 30/-.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 8/9; 2 amp. 11/3; 4 amp. 17/6.

COAXIAL PLUG 1/3, PANEL SOCKETS 1/3. LINE 2/-.
OUTLET BOXES. SURFACE OR FLUSH 4/6.
BALANCED TWIN FEEDERS 1/- yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-.
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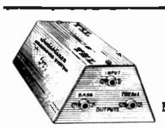


T.S.L. LOUDSPEAKER CROSSOVER HLP2.

2-way crossover for 8 or 15 ohm speakers and tweeters. 3 phono input/output sockets.
Made to sell at 42/-. OUR PRICE Post 2/6. **22/6**

Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.

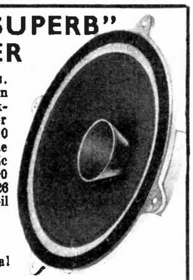
MINI-MODULE LOUDSPEAKER KIT

10 WATT **55/-** CARRIAGE 5/-

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ 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 Design for Mini-Module above. **94/6** Post 5/-

BAKER 12in. "SUPERB" LOUDSPEAKER



Suitable for all Hi-Fi Systems. Provides rich clear reproduction of the deepest bass and remarkable efficiency in the upper register. Response 20-17,000 cps. "Baker" double cone with special "Ferroba" ceramic magnet. Flux density 16,500 gauss. Bass resonance 22-26 cps. 20 watts rating. Voice coil 8 ohms or 15 ohms.

£15 Post Free

48-page Enclosure Manual 5/9 post paid.
LOUDSPEAKER CABINET WADDING 18in wide, 2/6ft

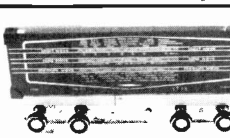
BAKER "GROUP SOUND" SPEAKERS—POST FREE

'Group 25'	'Group 35'	'Group 50'
12in 25 watt **6gns.**	12in 35 watt **8½gns.**	15in 50 watt **18gns.**

ALL MODELS "BAKER SPEAKERS" IN STOCK

Goodmans Tweeter 3½in 3 ohm 35/-, EMI 2½in 8 ohm 17/6.
Horn Tweeters 2-18kc/s, 10W 15 ohm 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2¼in, 3in, 4in, 5in, 7 × 4in. 17/6 each; 6½in 22/6; 8 × 5in, 21/-; 8 × 2½in 21/-; 10 × 6in. 30/-; 10in. or 12in. Double cone 3 or 15 ohm 39/6.
E.M.I. Double Cone 13½ × 8in, 3 or 15 ohm models, 45/-.
DITTO with twin tweeters and X/over 3 or 8 or 15 ohm 79/6.
SPECIAL OFFER! 8 ohm, 2½in; 6 × 4in; 80 ohm, 2½in
15/6 EACH TYPE 25 ohm, 6 × 4in; 35 ohm, 3in; 15 ohm, 7 × 4in., 8 × 5in.
8in LOUDSPEAKER UNITS 3 ohm 27/6; 15 ohm 30/-;
ELAC 8 in. De Luxe Ceramic 3 ohm 45/-; 15 ohm 50/-.
8in LOUDSPEAKER. TWIN CONE 3 ohm 35/-.
5 in. WOOFER. 8 watts max. 20-10,000 cps. 8 or 15 ohm. 39/6.
OUTPUT TRANS. EL84 etc. 4/6; MIKE TRANS. 50:1 3/9.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.

1969 GRAM CHASSIS



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Three Wavebands: Long, Med., Short, Gram. Five Valves: ECH81, EF89, EBC81, EL84, EZ80, 12-month guarantee. A.C. 200-250v. Ferrite Aerial 5 watts 3 ohm. Chassis 13½in. × 7in. × 5in. dial size 13in. × 4in. Two pilot Lamps. Four Knobs. Aligned calibrated. Chassis isolated from mains **£11.18**

AM/FM HI-FI CONTINENTAL STEREO GRAM CHASSIS VHF/FM, LW, MW, S.W. push buttons, 6 valve plus rect. Size 17 × 8 × 6in. **£22.10**

VALVE HOLDERS, 9d.; CERAMIC 1/-; CANS 1/-.

ALL EAGLE PRODUCTS

SUPPLIED AT LOWEST PRICES.
45-PAGE EAGLE CATALOGUE 5/-. Post free.

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **79/6**

BARGAIN DE LUXE TAPE SPLICER Cuts, trims, joins for editing and repairs. With 3 blades. **17/6**

BARGAIN 4 CHANNEL TRANSISTOR MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **59/6**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. Ready built. Printed Circuit. Calibrated slide dial tuning. Size 6 × 4 × 2½in. 9 volt. **£6.19.6**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **69/6**

★ RADIO BOOKS ★ (Postage 9d.)

Practical Transistor Receivers	5/-
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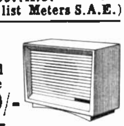
MANUFACTURERS' SURPLUS! **25/-**
TAPE RECORDER CABINET. Grey/Red or Grey 2-tone. Rexine covered. Size 15 × 12 × 5½in. POST FREE

POCKET MOVING COIL MULTIMETER. 0-1,000 A.C./D.C. ohms 0 to 100k, etc. **49/6**
SUPERIOR MOVING COIL MULTIMETER 0-2-500v. D.C, 20,000 ohms per volt, 0-1,000v. A.C. Ohms 0 to 6 meg. 50 Microamps (Full list Meters S.A.E.) **99/6**

BRAND NEW QUALITY EXTENSION LOUDSPEAKER



Handsome plastic cabinet, 20ft. lead and adaptors. For any radio, intercom, tape recorder, etc. 3 to 15 ohm. Size: 7¼" × 5½" × 3". Post 2/6 **30/-**

Minimum Post and Packing 2/6. RETURN OF POST DESPATCH. HI-FI STOCKISTS. CUSTOMERS FREE CAR PARK. CALLERS WELCOME.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, WEST CROYDON
Open Monday to Friday 9-6 (Wed. 1 p.m., Sat. 5 p.m.)

List 1/-. Written guarantee with every purchase. *(Export: Remit cash and extra postage.) Buses 133, 68 pass door. S.R. Stn. Selhurst.* Tel. 01-684 1665

0·0005 mfd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits. **2/6** each. **24/-** doz.

ELLIOT SEALED CONTACT REED RELAY

Three circuits closed by 3V or 100 MA. **9/6** each.

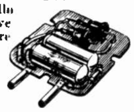
SLIM TUBULAR MICROPHONE

For hand holding or frontal suspension—lever switch—high impedance with lead and plugs for cassette tape recorder but suitable for most amplifiers. **19/6.**

500 MICRO AMP MOVING COIL METER

2in flush mounting round meter ex Government but unused and perfect. **17/6.**

PP3 BATTERY ELIMINATOR

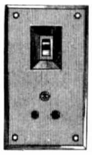


Run your small transistor radio from the mains—full wave circuit—made up ready to wire into your set and adjustable high or low current. **8/6** each.

5000 mfd 12V CONDENSER

Tubular size 3 1in dia., made by Plessey. **4/9** Each, **48/-** doz.

5A, 3 PIN SWITCH SOCKETS

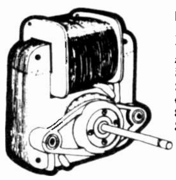


An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only **10/-** plus 3/6 post and insurance. (20 boxes post free.)

5in x 5in PRINTED CIRCUIT BOARD

Ideal for dozens of projects. Heavy copper on 3/32 sheet, **1/6** each or **15/-** per dozen.

MAINS MOTOR



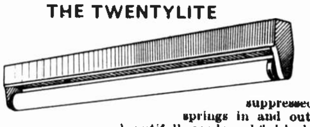
Precision made — as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **9/6.** Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

Horstmann "Time and Set" Switch

(A 15 amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **29/6**, p. & ins. 4/6.

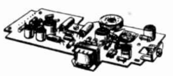
ATLAS SLIMLINE FLUORESCENTS

THE TWENTYLITE

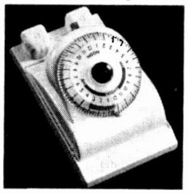


A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses ½ unit). Measures 2ft long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, **39/6** with tube. Assembled ready to install. Postage and insurance 6/6 extra.

1 WATT AMPLIFIER & PREAMP



5 transistors—highly efficient made for use with tapehead G4 but equally suitable for microphone or pick up—limited quantity **29/6.** Full circuit diag. also shows tape controls 5/-.



DREAMLAND CLOCK SWITCH

The wonderful DREAMLAND mains operated clock switch will automatically switch your blanket on and off each evening and you will always have a warm bed. It's luminous; you can always see the time and it's a really beautiful unit. An ideal gift. Can also control tape recorder, radio, lamp, etc., up to 500 watts. **39/6** plus 3/6 post and ins.

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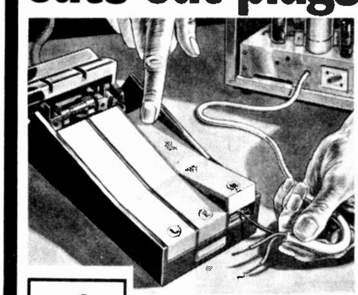

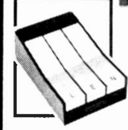

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digits are displayed in a circle like the figures on a clock face. The Z550M tube has been developed by Mullard especially for this purpose. A basic circuit for the use of this tube is shown in Fig. 6.5.

The tube consists of an upper common anode ring, a cathode ring (k) and a lower anode ring. Parts of the cathode ring are covered with material of high work function so that the discharge can take place only at ten points in the tube. The control voltage from the switching circuit is applied to ten trigger electrodes (T) (only two of which can be seen in the cross sectional diagram in Fig. 6.5).

When one of the triggers is at least 5V positive with respect to the other trigger electrodes, that trigger will cause striking at the cathode ring in its immediate neighbourhood. No striking will occur at other points on the cathode ring, since the current taken by the conducting cathode passes through the cathode resistor and produces a potential drop across this resistor.

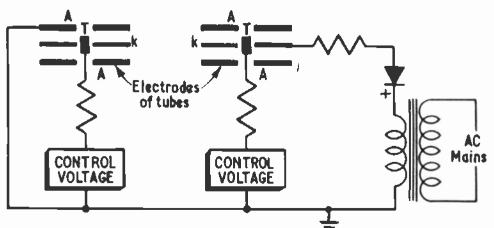


Fig. 6.5. Two sections of a ten-trigger clock face tube with a controlled wave supply

At the end of one half cycle of the sine wave supply, the glow in the tube is extinguished. If the trigger voltages change before the diode in the cathode circuit conducts again, another part of the cathode ring will conduct and another digit will then be indicated.

The light from the gas discharge passes through the holes marked A in Fig. 6.5 to provide the visual display. These holes are in the shape of the digits to be indicated.

Circuits have been developed for the Z550M tube which enable it to count at speeds up to 1kHz. Thus the tube can be used as an indicator for high speed transistor scalers, but in the slower decades the tube can carry out the actual counting operation itself. A uniform type of display is thus presented by all of the decades, but such a scaler is more economical than if transistor counting circuits were used throughout.

ALPHA-NUMERIC DISPLAYS

The alpha-numeric type of tube employs a number of straight line cathodes (usually 13 or 15) in each tube, which are positioned in the shape of a combination of letters or numbers. When certain selected combinations of these cathodes glow, any number or letter can be indicated.

Alpha-numeric tubes tend to require more complicated circuits for their operation than the normal numerical indicator tubes, and the form of the display is not normally as good as that of the tubes which employ separate shaped cathodes for each symbol or digit to be indicated.

In conclusion it should be mentioned that, although cold cathode tubes offer one of the simplest and best methods of displaying information which is stored in electronic circuits, there are a number of other techniques employed, many of which are based on some form of projection device. Electroluminescent digital indicators are also available. ★

BRITISH MUSICAL INSTRUMENT TRADE FAIR

AUGUST 69

By F. C. Judd

So impressive has been the growth of the British musical instrument trade that its fair this year occupied two large adjacent London hotels. Electrical and electronic musical instruments, their amplifiers and accessories formed the greater part of the show with electronic organs creating by far the largest interest although not quite the biggest noise.

SOUNDS CURIOUS

It is these instruments of course that have done much to expand the trade as a whole resulting in keen competition for sales both at home and abroad, although without "electronics" the story might be different.

Even the musical instrument trade jargon has become a curious mixture of musical and electronics terms, but no more curious perhaps than some of the musical instruments whoses sounds are generated electronically and reproduced by amplifiers and loudspeakers.

For instance there were the new Jennings electronic tympani units and their equally new device called the "Bushwhacker" which electronically produces the rhythmic sound favoured by TV entertainer Rolf Harris. This device also creates many "space" noises that will undoubtedly prove attractive to pop groups looking for new sounds.

FOR AMPLIFIED GUITARS

For guitarists there were many new accessories like the Jennings "Scrambler" which is a combination wah-wah, fuzz and volume control unit with rotating foot controls and foot operated switches.

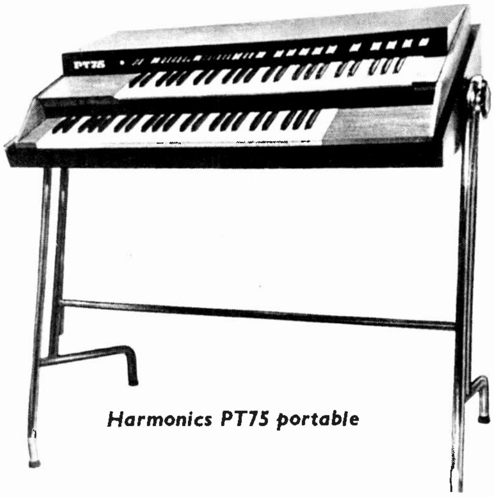
Add-on units for producing reverberation and various percussive and tremulant effects suitable for amplified guitars, as well as electronic organs, were yet another attempt to satisfy the demand for new sounds, although many guitar amplifiers, like those by Dallas Arbiter and Selmer, were being offered with such facilities built in.

ROTATING LOUDSPEAKERS

Rotating loudspeaker tremulant systems are much in demand now and there were many of these on show under such names as pulsation units, rotary loudspeakers, Leslie units etc., by makers such as Jennings, Dallas Arbiter and others.

To cope with these, as well as the more standard form of P.A. type loudspeaker, solid state amplifiers capable of 100 and 200 watts (r.m.s.) appeared to be outmoding the more conventional 50 to 60 watt models.

One demonstrator guitarist mentioned that the constant use of fuzz, plus 200 watts (r.m.s.) power was affecting his hearing! One manufacturer claimed that a group using



Harmonics PT75 portable

his equipment generated a combined power of over 1,500 watts whilst playing! Electronics have indeed contributed much to music.

ELECTRONIC ORGANS

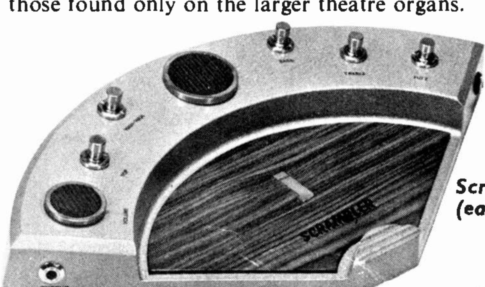
The range of electronic organs now available is comprehensive to say the least, and everything from miniature chord organs at around £15 to full scale electronic church and theatre organs at £5,000 or more could not only be seen but very much heard. The popular "domestic" range by Hammond, Thomas, Lowry, Wurlitzer, to mention only a few, offer a pretty wide choice not only of different models but of effects, voicings and facilities.

The miniature table top chord organs (with loudspeakers) such as those by Rose Morris Limited, start at around £15 and end at around £200 with the smaller transistor chord/keyboard instruments like the Philips Philicord.

The "pop" portables which require external amplifiers range from below £100 to over £500. Among these were the more pretentious models like the PT75 by Harmonics (Bromley) Limited which they claim plays everything from groovy to soft piano and features wah-wah, chimes and a steam organ sound as well as a vast range of percussive and other effects all for £325.

The popular "domestic" range of two manual organs with half or full pedal boards also offers a pretty wide choice. It is quite evident from the great variety of styles, facilities, effects and gadgetry available that the various manufacturers compete pretty fiercely to capture and retain their share of the domestic electronic organ market.

The new Hammond T200, for instance, classified as being "suitable for the entire family", not only features their tone wheel generator system and drawbar harmonic selectors, but also a range of voices and effects approaching those found only on the larger theatre organs.



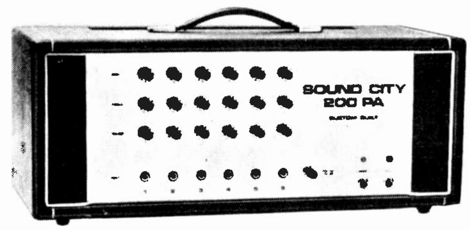
Scrambler (early version)

Jennings sound effects units

Bushwacker

Compton CL72

Hammond L100 portable



Dallas Arbiter Sound City 200 p.a. amplifier

MUSIC TUTORS

It is one thing to design and sell an electronic organ for family entertainment, but quite another getting them to play it with some satisfaction. To this end the Thomas domestic range on show this year featured two unique teaching techniques. One, which has been derived from the Thomas "Colorglow" keyboard system, is called "Chordglow" and helps the player to master chord combinations quickly on the (left hand) lower manual. The required notes for any given chord all light up at the touch of a button. They have also devised recorded tape cassettes which enable the beginner to play with recorded exercises.

Last but not least it should be mentioned that coloured light and stroboscopic light systems electronically controlled from music or direct from musical instruments now seems to be part and parcel of pop music.

Many of these systems were also on show by Rotasound, Jennings, Dallas and others. Several thousand watts of intense flickering light accompanied by around 2,000 watts of highly distorted music power seems to be the ultimate in electronics and pop music at the moment, but—according to the trade experts and many of the musicians (?)—there is now a trend toward *quieter* and much more *pure* sound!

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2N2147	12/6
2N2160	15/0
2N2369A	4/6
2N2398	30/-
2N2904	10/-
2N2904A	12/6
2N2926	5/3
2N3819	13/-
2S002	20/-
2S003	12/-
2S004	11/-
2S005	48/-
2S006	20/-
2S012	50/-
2S012A	55/-
2S013	20/-
2S018	60/-
2S108	60/-
2S301	12/6
2S320	9/-
2S702	15/-
45L	45/-
AC107	10/-
AC126	6/6
AC127	7/6
AC128	6/6
AC176	7/6
ACY17	7/6
ACY18	5/3
ACY19	6/6
ACY20	5/-
ACY21	6/-
ACY22	3/6
ACY28	4/6
AD140	16/-
AD161	11/-
AF114	6/6
AF115	6/3
AF116	6/-
AF117	6/6
AF118	10/-
AF125	6/3
AF178	12/6
AF186	17/6
AFY19	22/6
AS220	7/6
ASZ21	12/6
ASZ23	30/-
ATZ10	30/-
AUY10	39/6
BC107	7/6
BC108	5/-
BC109	7/6
BCY31	13/6
BCY33	7/6
BCY34	6/-
BCY39	24/-
BCY40	12/-
BCZ11	5/-
BDY11	27/6
BDY12	32/-
BFY51	3/6
BFY52	4/6
BPY10	21/6
BSY27	9/6
BSY28	5/-
BSY51	7/6
BSY53	7/6
BSY95A	5/6
BSX82	40/-
BTY88	19/6
BTY95100R	140/-
BY100	5/6
BY114	5/-
BYZ11	9/6
BYZ12	12/-
BYZ13	7/6
BYZ18	15/-
CDT1313	12/6
CG64	2/6
CK707	2/6
CRS1/05	7/6
CV102	3/6
CV103	3/6
CV425	3/6
CV2226	20/-
CV2258	25/-
CV2290	5/-
CV2919	2/6
CV1782	30/-
CV7183	30/-
DD003	3/6
DD190	9/9
DD226A	7/6
EW99	5/-
GET7	5/-
GET8	8/-
GET16	7/3
GET20	10/-
GET88	5/-
GET102	6/-
GET114	4/-
GET115	9/-
GET116	15/-
GET571	5/-
GET872	6/-
GET874	5/-
GET875	6/-

GET880	9/-
GET885	5/-
GEX54	2/6
GEX541	15/-
GJ3M	3/6
GJ5M	3/6
GJ6M	3/6
GJ7M	6/6
HD2967	4/-
HG5002	4/-
JK9A	22/6
JK10A	15/-
JK10B	15/-
JK19A	22/6
JK21A	12/6
K835A	5/-
MAT101	8/6
MAT120	7/9
NKT128	6/-
NKT142	8/-
NKT211	6/-
NKT214	4/-
NKT216	7/6
NKT217	8/-
NKT218	6/-
NKT221	5/6
NKT223	6/-
NKT224	4/6
NKT225	3/6
NKT227	5/6
NKT228	6/-
NKT251	5/-
NKT265	9/6
NKT274	5/-
NKT304	8/-
NKT352	8/-
NKT404	12/6
NKT452	12/6
NKT675	6/-
NKT676	5/-
NKT677	5/-
NKT678	6/-
NKT713	7/6
NKT777	8/-
OA2	6/3
OA7	4/-
OA10	3/-
OA47	3/-
OA70	2/-
OA79	2/6
OA81	2/6
OA85	2/6
OA86	4/-
OA91	2/6
OA200	3/3
OA202	4/3
OA210	7/6
OAZ200	11/-
OAZ201	10/-
OAZ202	8/6
OAZ204	8/6
OAZ206	8/6
OAZ208	6/6
OAZ222	9/6
OAZ224	10/-
OAZ225	10/-
OAZ242	4/6
OAZ246	4/6
OAZ290	9/6
OAZ292	9/6
OC16	20/-
OC19	7/6
OC20	15/-
OC22	10/-
OC23	11/6
OC24	15/-
OC25	9/-
OC26	7/-
OC28	12/-
OC29	15/-
OC35	12/6
OC36	12/6
OC41	6/-
OC42	5/-
OC43	9/-
OC44	4/-
OC44M	5/6
OC45	3/6
OC45M	4/-
OC46	5/6
OC47	7/6
OC57	16/-
OC58	17/6
OC59	18/6
OC70	4/-
OC71	3/6
OC72	5/-
OC73	7/6
OC74	6/-
OC75	6/-
OC76	5/-
OC77	8/-
OC78	5/-
OC81	5/-
OC81D	3/-
OC81DM	3/-
OC81M	5/6
OC81Z	9/-
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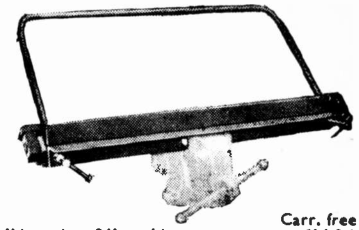

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MINIATURE IRON (Half Size)

HIGH PRODUCTION MINIATURE MODEL D. 50 WATT

Weight ..	2 oz.
Heating time	50 seconds
Bit Sizes ..	1/16″, 3/32″, 1/8″, 3/16″, 1/4″
Nickel or Iron	Plated
Voltage ..	250 to 12 volts
Price	66/-

HIGH PRODUCTION INSTRUMENT MODEL H. 150 WATT

Weight ..	6 oz.
Heating time	1 min. 45 sec.
Bit Sizes ..	3/16″, 1/4″, 3/8″, 7/16″
Nickel or Iron	Plated
Voltage ..	250 to 24 volts
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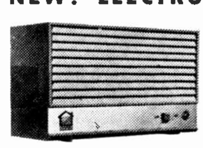
NEW! ELECTROSTATIC — IT'S FANTASTIC



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No moving parts, fans, filters, chemicals. A sealed set of ELECTRODES produces nascent oxygen which mixes with the oxygen in the air to produce OZONE. OZONE is the most powerful SMELL KILLER/AIR CLEANER known to science. Ozone breaks up the airladen molecules of smell—completely dispersing all smells—not disguising them. Its EFFICIENCY will amaze you in KITCHENS, LIVING ROOMS, OFFICES, ETC. Less than a 1d a week to run. No maintenance. Lifetime's wear. Portable.

Fully guaranteed. 220/40v AC. BRITISH MADE—BIG EXPORT WINNER. NEVER BEFORE AN ELECTROSTATIC CLEANER FOR **£6. 19. 6** **Post 4/6** Available from:

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FULLY TESTED AND MARKED

AC107	3/–	OC170	3/–
AC126	2/6	OC171	4/–
AC127	2/6	OC200	3/6
AC128	2/6	OC201	7/–
AC176	5/–	2G301	2/6
ACY17	3/–	2G303	2/6
AF114	4/–	2N711	10/–
AF115	3/6	2N1302-3	4/–
AF116	3/6	2N1304-5	5/–
AF117	3/6	2N1306-7	6/–
AF239	12/6	2N1308-9	8/–
AF186	10/–	2N3844A	5/–
AF139	10/–	**Power Transistors**	
BFY50	4/–		
BSY25	7/6	OC20	10/–
BSY26	3/–	OC23	10/–
BSY27	3/–	OC25	8/–
BSY28	3/–	OC26	5/–
BSY29	3/–	OC28	7/6
BSY95A	3/–	OC35	5/–
OC41	2/6	OC36	7/6
OC44	2/6	AD149	10/–
OC45	2/6	AUY10	30/–
OC71	2/6	2N3055	15/–
OC72	2/6	**Diodes**	
OC73	3/6	AAY42	2/–
OC81	2/6	OA95	2/–
OC81D	2/6	OA70	1/9
OC83	4/–	OA79	1/9
OC139	2/6	OA81	1/9
OC140	3/6	IN914	1/6

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XA PAK

Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.

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XB PAK

Silicon TO-18 CAN type transistors NPN/PNP mixed lots with equivalents to OC200-1, 2N706a, BSY27/29, BSY95A.

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XC PAK

Silicon diodes miniature glass types, finished black with polarity marked, equivalents to OA200, OA202, BAY31-39 and DK10, etc.

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B2	4	Photo Cells, Sun Batteries inc. Book of Instructions	10/-
B77	2	AD161–AD162 NPN/PNP Trans. Comp. Output. Pair	10/-
B79	4	IN4007 Sil. Rec. Diodes 1000 P.I.V. 1 amp. Miniature	10/-
B81	10	Reed Switches, mixed types large and small	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1M Ω	10/-
B91	8	NKT163/164 PNP Germ. TO-5 equivalent to OC44, OC45	10/-
B92	4	NPN. Sil. Trans. AO6 = BSX20, 2N2369 500 MHz, 360mW	10/-
B93	5	GET113 Trans. equiv. to ACY17–21 PNP Germ.	10/-
B94	6	NPN Sil. Planar Epitaxial Trans. CS4 similar to BSY38 or BC108	10/-
B96	5	2N3136 PNP Sil. Trans. TO-18, HFE 100–300 I.C. 600mA. 200 MHz	10/-
B98	10	XB112 and XB102 equiv. to AC126, AC156, OC81/2, OC71/2, NKT271, etc.	10/-
B99	200	Capacitors, Electrolytics paper, silver mica, etc. Post and packing, this Pak 2/6	10/-
H4	250	Mixed Resistors. Post and Packing 2/-	10/-

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

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

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

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Stocks almost exhausted! Place your orders now ! ! !

FANTASTIC TRANSISTOR VALUE

TU. 2. CONTAINING 2 AF186's & 2 AF178's. PRICE 10/- EACH UNIT.
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P & P 2/6d. EACH UNIT

All the Units have many other components, e.g., Capacitors, Resistors, Coils, and Tuning Condensers, etc. ALL TUNER UNITS ARE SUPPLIED WITH CONNECTION DATA.

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B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	10/-
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B86	50	Sil. Diodes sub. min. IN914 and IN916 types	10/-
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AC107	14/6	BC148	3/3	BYZ12	6/-	NKT222	4/-	OC28	12/-	2G381	5/-	2N2477	18/-
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AC176	7/6	BCY31	9/2	C426	8/3	NKT227	5/6	OC43	4/-	2N217	7/6	2N2904A	15/6
AC187	12/-	BCY32	20/5	CG6E	4/-	NKT228	6/-	OC44	3/-	2N352	15/-	2N2924	5/-
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AF114	4/4	BD121	18/6	GMO378	11/-	NKT351	8/-	OC123	7/-	2N657	15/4	2N3710	3/10
AF115	4/4	BD123	23/6	GEX45/1	4/-	NKT352	7/6	OC139	8/-	2N696	5/3	2N3711	3/3
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AF118	16/6	BF154	9/-	K3/50	8/3	NKT404	13/8	OC170	4/-	2N706	3/-	2N3826	6/-
AF124	6/-	BF159	15/-	MAT100	5/-	NKT405	15/-	OC171	6/-	2N706A	3/-	2N3906	7/6
AF126	3/9	BF163	9/-	MAT101	5/6	NKT451	13/8	OC200	6/3	2N708	4/-	2N4058	7/9
AF127	4/-	BF167	6/6	MAT120	5/-	NKT452	13/4	OC201	10/-	2N711	7/6	2N4284	3/-
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BA112	18/-	BSY27	4/-	NKT127	5/8	OA5	3/8	ST140	3/-	2N1177	14/-	2S034	12/6
BA115	2/8	BSY95A	3/4	NKT128	6/-	OA10	6/-	ST141	5/-	2N1302	4/6	2S102	10/-
BA130	3/-	BTX39/		NKT129	5/10	OA47	1/6	TIS44	1/7	2N1303	4/6	2S104	12/6
BAY31	2/6	600R	120/-	NKT141	6/11	OA70	1/6	TIS43	6/9	2N1304	5/-	2S301	7/7
BAY38	3/-	BTX40/		NKT142	5/10	OA73	1/6	U23AAA	5/-	2N1305	5/-	2S302	6/-
BC107	2/9	600R	120/-	NKT143	5/4	OA79	1/6	V405A	9/3	2N1306	6/6	2S304	15/-
BC108	2/9	BTY87/		NKT144	8/-	OA81	1/6	XA102	6/-	2N1307	6/6	2S320	12/6
BC109	2/9	150R	31/-	NKT152	3/4	OA85	1/6	XA702	15/-	2N1308	8/-	2S322	8/-
BC113	5/-	BTY91/		NKT161	5/8	OA90	1/6	ZT22	19/-	2N1309	8/-	2S701	10/-
BC114	7/5	300R	47/-	NKT162	5/8	OA91	1/6	ZT86	27/6	2N1507	4/8	2S702	12/-
BC115	7/11	BY100	5/-	NKT163	5/4	OA95	1/6	ZT2270	19/6	2N1613	6/6	2S711	23/3
BC116	9/-	BY125	3/6	NKT164	5/4	OA200	2/-	1N23A	20/-	2N1496	34/6	2S712	30/3
BC118	5/-	BYX10	3/-	NKT165	5/8	OA202	2/-	1N34A	4/-	2N1711	7/6	2S733	9/9
BC125	12/-	BYX36/150	2/6	NKT211	6/-	OA210	6/4	1N60	4/-	2N2147	17/-	40361	13/3
BC126	12/-	BYX36/300	2/10	NKT212	6/-	OA211	9/-	1N64	4/-	2N2148	12/6	40362	16/3
BC134	5/-	BYX36/600	3/8	NKT213	6/-	OC19	5/-	1N82A	9/6	2N2160	14/9	ZT22	19/-
BC136	7/11	BYY21	25/-	KNT214	4/-	OC20	33/-	1N87A	4/6	2N2218	12/-	ZT86	27/6
BC137	8/6	BYY23	26/3	NKT215	4/-	OC22	13/-	1N191	5/-	2N2243	23/7	ZT2270	19/6
BC138	12/-			NKT216	10/5	OC23	15/-	1S44	1/6	2N2368	6/6		

COMPONENTS

RESISTORS ¼ or ½ Watt 5% LOW NOISE CARBON FILM. 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms and decades (×10, ×100, ×1,000, ×10,000) 1 Meg etc. to 8.2 Megohms (10% tolerance). PRICES: 1-25 4d, 26-99 3d, 100+2d (your selection ¼ and/or ½ Watt mixed).

SKELETON PRESET POTS. 20% Tol. Linear. Low noise. Available in sub-miniature or standard size, horizontal or vertical. 100, 250, 500, 1k, 2.5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2.5 Meg, 5 Meg. NEW PRICE: 1/- each or any selection of 12 pieces 10/-.

ELECTROLYTIC CAPACITORS (Mullard). −10% to +50% tol. Subminiature (all values in μF).

4V	8	32	64	125	250	400
6.4V	6.4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2.5	10	20	40	80	125
25V	1.6	6.4	12.5	25	50	80
40V	1	4	8	16	32	50
64V	0.64	2.5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

MIN. POLYESTER CAPACITORS. Printed circuit type 250 Vdc working. 0.01, 0.015, 0.022, 7d each; 0.033, 0.047, 8d each; 0.068, 0.10, 9d each.

VEROBOARD 0.15" Matrix FLUX COATED 2½ × 3¾", 3/3. 2½ × 5", 3¾ × 3¾", 3/11. 3¾ × 5", 5/6. 3¾ × 18", 18/-. BARGAIN PACK of 36 square inches all good size pieces only 10/- pack.

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400piv 3Amp
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2N2926 LOW COST NPN PLANAR **2/-**
25+1/8 100+1/6

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100	9d	1/6	2/3	4/6
200	1/3	2/-	2/9	5/-
400	—	2/6	4/-	8/-
600	—	3/-	4/6	9/6
800	—	3/9	5/-	11/3
1000	—	6/-	6/6	14/-

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PIV	1A	3A	10A	30A	100A
50	7/6	9/-	7/6	25/-	20/-
100	—	10/-	10/-	30/-	22/-
200	8/6		12/6	42/-	35/-
300		11/-	—	51/-	—
400	9/6	12/6	15/-	60/-	45/-
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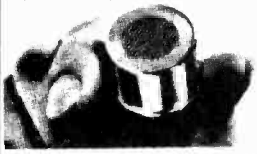

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ELECTROLYTIC CAPACITORS (Mullard). −10% to + 50%.

Working Voltage (V)—Capacitance (μF)

4V	6·4V	10V	16V	25V	40V	64V	Price each	Pack Prices 10 off	25 off	100 off
8	6·4	4	2·5	1·6	1	0·64	1/4	12/4	26/6	89/6
32	25	16	10	6·4	4	2·5	1/2	10/6	23/-	80/3
64	50	32	20	12·5	8	5	1/2	10/4	22/6	77/9
125	100	64	40	25	16	10	1/-	8/9	18/9	63/6
250	200	125	80	50	32	20	1/1	9/6	20/9	70/9
400	320	200	125	80	50	32	1/2	10/4	22/6	77/9
800	640	400	250	160	100	64	1/6	13/4	29/6	102/9
1,250	1,000	640	400	250	160	100	2/-	18/10	37/9	134/4
2,000	1,600	1,000	640	400	250	160	2/6	22/3	44/3	165/6
3,200	2,500	1,600	1,000	640	400	250	3/-	26/9	59/-	204/3
				800	500	320	5/3	46/6	101/-	343/9
				1,250	800	500	6/6	57/6	125/4	427/-
				2,000	1,250	800	8/-	71/4	157/-	541/8
				4,000	2,500	1,600	12/6	91/6	194/9	843/9
				6,400	4,000	2,500	15/-	133/4	281/8	1,000/-

POLYESTER CAPACITORS (Mullard)

Tubular, 10%, 160V:
Prices per Capacitance value (μF)

	each	10 off	25 off	100 off
0·01, 0·015, 0·022	7d	5/1	10/11	36/5
0·033, 0·047	7d	5/8	11/10	37/6
0·068	8d	6/6	13/6	43/9
0·1	9d	6/8	14/3	47/7
0·15	11d	7/6	16/6	57/3
0·22	1/-	8/2	17/9	61/5
0·33	1/3	10/11	23/3	77/1
0·47	1/6	13/2	28/1	93/9
0·68	2/3	19/5	42/3	140/7
1·0	2/8	23/4	48/9	165/7

Tubular, 10%, 400V:
Prices per Capacitance value (μF)

	each	10 off	25 off	100 off
0·001, 0·0015, 0·0022	6d	4/6	9/9	33/4
0·0033, 0·0047	6d	4/6	9/10	33/6
0·0068, 0·01	7d	5/1	10/11	36/5
0·015	7d	5/2	11/10	37/6
0·022	7d	5/3	12/-	37/9
0·033	8d	5/8	12/7	42/7
0·047	9d	6/7	14/5	49/-
0·068	11d	7/8	16/7	51/-
0·1	11d	8/-	17/2	57/4
0·15	1/2	10/3	22/-	74/-
0·22	1/6	14/3	28/5	95/10
0·33	2/3	19/7	42/3	140/7
0·47	2/8	23/4	48/9	165/7

Modular, metallised, P.C. mounting, 250V:
Prices per Capacitance value (μF)

	each	10 off	25 off	100 off
0·01, 0·015	7d	5/2	11/3	38/7
0·022	7d	5/4	11/9	41/8
0·033, 0·047	8d	5/11	12/10	43/9
0·068	9d	6/7	14/1	47/1
0·1	9d	6/9	14/9	51/-
0·15	11d	8/2	18/-	62/6
0·22	1/-	8/9	18/11	63/6
0·33	1/5	12/6	27/-	91/8
0·47	1/8	14/8	31/9	107/10
0·68	2/3	19/10	43/2	146/9
1·0	2/9	23/8	49/8	160/4

CAPACITORS

Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radical leads.
± 10% tolerance. 100V working.
Prices—per Capacitance value (μF)

	each	10off	25 off	100 off
0·001, 0·002, 0·005, 0·01, 0·02	6d	4/3	8/4	30/-
0·05	8d	6/-	12/6	41/8
0·1	10d	7/1	15/6	51/-
0·2	1/2	10/-	20/10	68/6

Polystyrene film, Tubular, Axial leads. Unencapsulated. ± 5% or ± 1pf tolerance. 160V working.
Prices—per Capacitance value (μμF)

	each	10 off	25 off	100 off
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 180, 220, 270, 330, 390	5d	3/7	7/9	24/-
470, 560, 680, 820, 1,000, 1,500	6d	4/-	8/8	26/8
2,200, 3,300, 4,700, 5,600 ..	7d	5/-	10/10	33/4
6,800, 8,200, 10,000, 15,000 ..	8d	6/-	13/-	40/-
22,000	9d	6/9	18/-	45/4

POTENTIOMETERS (Carbon)

Miniature, fully enclosed, rear tags, carbon brush wiper, Long Life, low noise. Body dia, ¾in. Spindle, 1in × ¼in. ¼W at 70°C. ± 20% below ½M, ± 30% over ½M. Lin. 100 Ohms to 10 Megohms. Log. 5 Kohms to 5 Megohms.

Prices—per ohmic value	each	10 off	25 off	100 off
	2/-	18/4	41/8	150/-

GANGED STEREO POTENTIOMETERS (Carbon)

¼W at 70°C. Long Spindle.
Logarithmic and Linear: 5k + 5k to 1M + 1M.

Prices—per ohmic value	each	10 off	25 off	100 off
	8/-	70/-	162/6	575/-

SKELETON PRE-SET POTENTIOMETERS (Carbon)

High quality pre-sets suitable for printed circuit boards of 0·1in P.C.M. 100 ohms to 5 Megohms (Linear only). Miniature: 0·3W at 70°C. ± 20% below ½M, ± 30% above ½M. Horizontal (0·7in + 0·4in P.C.M.) or Vertical (0·4in × 0·2in P.C.M.). Subminiature: 0·1W at 70°C. ± 20% below 2·5M, ± 30% above.

Prices—per ohmic value	each	10 off	25 off	100 off
Miniature (0·3W)	1/-	8/9	18/9	66/8
Subminiature (0·1W)	10d	7/1	14/7	46/8

RESISTORS

High stability, carbon film, low noise. Capless construction, molecular termination bonding.
Dimensions (mm): Body: ¼W; 8 × 2·8
½W; 10 × 4·3
Leads: 35
10% ranges; 10 Ohms to 10 Megohms (E12 Renard Series).
5% ranges; 4·7 Ohms to 1 Megohms (E24 Renard Series).
Prices—per Ohmic value.

		each	10 off	25 off	100 off
¼W	10%	2d	1/6	3/3	10/4
¼W	5%	2½d	1/9	3/8	11/8
½W	10%	2½d	1/9	3/8	11/7
½W	5%	3d	2/-	4/-	12/10

SEMICONDUCTORS

Prices Type	1 off	10 off	25 off	100 off
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AC127	2/6	18/9	45/-	166/3
AC128	2/6	18/9	45/-	166/3
AD140	8/-	60/-	144/-	533/4
AD149	9/-	67/6	162/-	600/-
AF115	2/6	18/9	45/-	166/3
AF116	2/6	18/9	45/-	166/3
AF117	2/6	18/9	45/-	166/3
BC107	3/6	26/3	63/-	232/9
BC108	3/-	22/6	54/-	199/6
BC109	3/6	26/3	63/-	232/9
BY234	2/9	24/3	52/4	177/-
BY235	3/-	26/3	56/3	187/6
BY236	3/3	28/8	61/9	208/4
BY237	3/6	30/8	65/6	218/9
BY238	3/9	34/4	71/6	227/6
BYZ10	6/-	45/-	108/-	399/-
BYZ11	5/4	40/-	96/-	354/8
BYZ12	4/8	35/-	84/-	310/4
BYZ13	4/-	30/-	72/-	266/-
OA5	2/-	15/-	36/-	133/4
OA81	2/-	15/-	36/-	133/4
OA202	2/-	15/-	36/-	133/4
OC23	7/4	58/8	132/-	497/8
OC25	6/-	45/-	108/-	399/-
OC28	9/-	67/6	162/-	598/6
OC35	6/-	45/-	108/-	399/-
OC44	3/-	22/6	54/-	199/6
OC45	2/6	18/9	45/-	166/3
OC71	2/-	15/-	36/-	133/4
OC72	2/6	18/9	45/-	166/3
OC75	2/4	17/6	42/-	155/4
OC81	2/-	15/-	36/-	133/4
OC81D	2/4	17/6	42/-	155/4
OC82D	2/4	17/6	42/-	155/4
OC139	3/4	25/-	60/-	221/8
OC170	2/6	18/9	45/-	166/3
OC171	2/6	18/9	45/-	166/3
2N2926 (Green)	2/8	20/-	48/-	177/4

Thyristors (5A)—Stud mounting.

Prices P.I.V.	1 off	10 off	25 off	100 off
100	8/-	60/-	144/-	532/-
200	10/-	75/-	160/-	665/-
400	15/-	112/6	270/-	997/-

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Prices	1 off	10 off	25 off
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2½in × 3¾in	3/3	30/-	67/9
2½in × 5in	3/11	35/10	80/9
3¾in × 3¾in	3/11	35/10	80/9
3¾in × 5in	5/6	50/-	114/7
0·1in Matrix			
2½in × 3¾in	4/-	37/8	86/-
2½in × 5in	4/6	42/6	96/3
3¾in × 3¾in	4/6	43/4	100/-
3¾in × 5in	5/6	48/4	111/5
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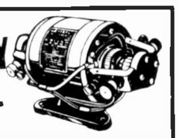

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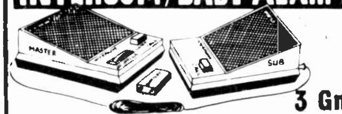

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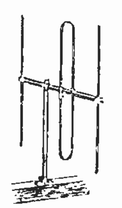

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