PRACTICAL

ELECTRONICS

OCTOBER 1970

PRICE 3/6

PROTON MAGNETOMETER

FERROUS METAL LOCATOR

ALSO INSIDE: TRIAC LAMP REGULATOR for Darkroom Applications

knight-kits FANTASTIC LOW PRICES!

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

KG-865 50 Watt Stereo Amplifier Kit

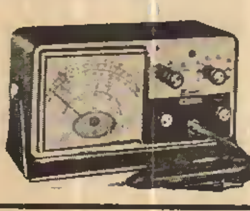
DELUXE FEATURES

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

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

KG-625 Deluxe 6in Vacuum Tube Voltmeter Kit

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

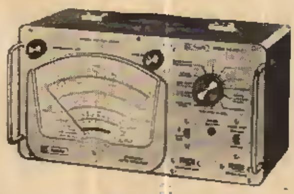


KG-375A Deluxe Solid-State Auto Analyzer Kit

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

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

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



WHY NOT BUY THE PAIR?

KG-371 Deluxe Solid-State Timing Light

Performance surpasses assembled units costing much more

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

ALL SILICON TRANSISTORS

The NEW KG-980 Stereo FM Receiver Kit

Designed to Satisfy the Most Critical Listener

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

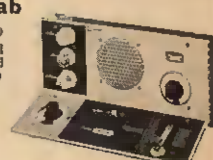
STAR ROAMER 5-Band Shortwave Receiver Kit

Bandspread: *electrical, calibrated 0–100* ● **Sensitivity:** *10µV for 10dB signal-to-noise ratio* ● **I.F. Bandwidth:** *5kHz at 6dB down* ● **Beat Frequency:** *variable, 0–5kHz* ● **Speaker:** *4in permanent magnet type* ● **Power Supply:** *fused, transformer operated* ● **Headphone Output:** *low impedance* ● **Valve Complements:** *1–6BE6, 1–6HR6, 1–12AX7, 1–6AK6 or 1–6AR5* ● **Power Requirements:** *230–250V, 50Hz a.c.; 15W* ● **Covers 200 to 400kHz and 550kHz to 30MHz in 5 Band-switched Ranges ● Superheterodyne Circuit includes controlled regenerative I.F. stage ● A.V.C. reduces fading and blasting; A.N.L. cuts noise to a minimum ● Aerial Trimmer effectively peaks incoming signals for best reception ● Illuminated "S" Meter; Large, Easy-to-Read 7½in Slide Rule Dial.**
Recommended List Price £21.19.0: **14 GNS.** Assembled Price **19 GNS.**

100-in-1 Electronic Science Lab

LOOK AT THE PROJECTS YOU CAN BUILD

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



KG-640 20,000 ohms/Volt VOM Kit

BIG PROFESSIONAL SIZE 62 RANGE MULTIMETER

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

JASON TAPE

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

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

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GARRARD 1025 Autochangers complete with GARRARD STEREO CARTRIDGE 7½ GNS.

MAGNETIC CARTRIDGES Goldring 800H 7½ GNS.

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2N918	7/6	AF117	5/-	OA10	5/-
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2N920	5/-	AF124	6/-	OA70	2/-
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2N3731	12/6	BCY31	6/-	OC42	6/-
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for fast, easy, reliable soldering

Contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux required.

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Ecomically packed for general electrical and electronic soldering. 75 ft. 18 gauge on plastic reel. Recommended retail price **15/-**

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*Recommended Price

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easily adjustable for all standard diameters. Plastic covered handles can also be used as wire cutter. Recommended retail price **8/6**

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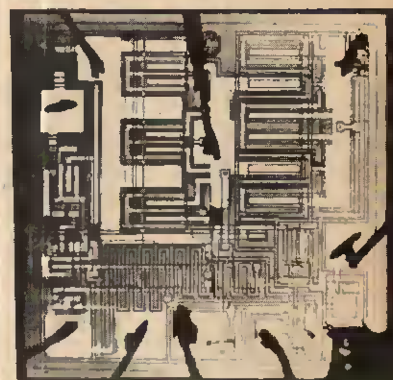

the world's most advanced high fidelity amplifier

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

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

■ SPECIFICATIONS

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

■ CIRCUIT DESCRIPTION

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

■ APPLICATIONS

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

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

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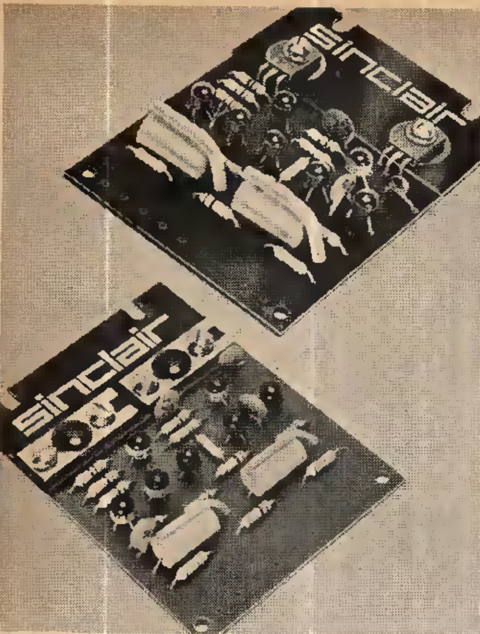


Z.30 & Z.50 POWER AMPLIFIERS

The Z.30 together with the Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0·2% at full output and all lower outputs. Whether you use the Z.30 or Z.50 power amplifiers in your Project 60 system will depend on personal preference, but they are the same physical size and may be used with other units in the Project 60 range equally well. For operating from mains, for the Z.30 use PZ.5 for most domestic requirements, or PZ.6 if you have very low efficiency loudspeakers. For Z.50, use the PZ.8 described below.

SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications.)

Power Outputs
Z.30 15 watts R.M.S. into 8 ohms, using 35V: 20 watts R.M.S. into 3 ohms using 30 volts.

Z.50 40 watts R.M.S. into 3 ohms from 40V: 30 watts R.M.S. into 8 ohms, using 50 volts.

Frequency response 30 to 300,000 Hz ±1dB

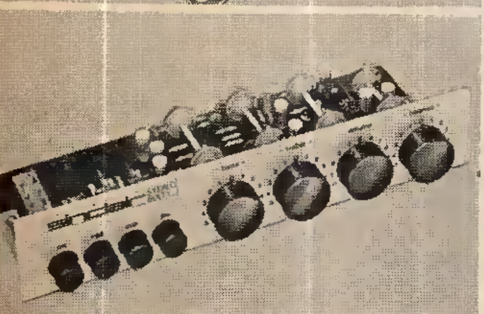
Distortion 0·02% into 8 ohms

Signal to noise ratio better than 70dB unweighted

Input sensitivity 250mV into 100 Kohms. For speakers from 3 to 15 ohms impedance. Size 3½ × 2¼ × ½ ins.

Z.30 *Built, tested and guaranteed* **89/6**

Z.50 *Built, tested and guaranteed* **109/6**



STEREO 60 Preamp/Control Unit

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

- Input sensitivities—Mag. p.u. —3mV: correct to R.I.A.A. curve ±1dB: 20 to 25,000 Hz. Radio, Ceramic p.u. and Aux.—each up to 3mV.
- Output —250mV.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone controls—TREBLE +15 to —15dB at 10kHz: Bass +15 to —15dB at 100Hz.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8¼ × 1½ × 4 ins.

Built, tested and guaranteed **£9.19.6**

ACTIVE FILTER UNIT

For use between Stereo 60 unit and two Z.30s or Z.50s, the A.F.U. matches the Stereo 60 in styling and is as easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The Sinclair A.F.U. is suitable also for use with any other amplifier system.

Two stages of filtering are incorporated—rumble (high pass) and scratch (low pass). H.F cut-off (—3dB) variable from 28kHz to 5kHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Filter slope, both sections 12dB per octave. Distortion at 1kHz (35V supply) 0·02% at rated output.

Built, tested and guaranteed **£5.19.6**

POWER SUPPLY UNITS

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

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

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

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P.E.10

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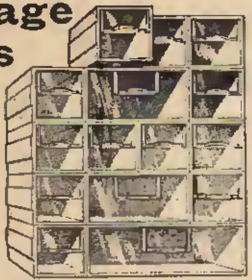

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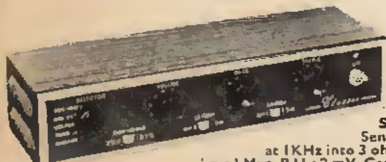
Measuring 17½in × 10¾in × 6¾in, the Duo type 2 speakers are beautifully finished in teak veneer with matching vynair grills. They incorporate a 10½in × 6½in drive unit and high frequency speaker, both of which are of 3 ohms. impedance. The Duo speaker system is also available separately at

£6.6.0 each plus 15/- P. & P.

Complete stereo system **£41** plus £2.10.0 P. & P.

or with Viscount Mk. II Amplifier and Magnetic Cartridge **£45** plus £2.10.0 P. & P.



The Classic

Teak finished case

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Plus P. & P. 7/6

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

THE RELIANT Mk. II

SOLID STATE GENERAL PURPOSE AMPLIFIER

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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 × 4½ × 2½in. Mk. I £6.10.0 plus 7/6 P. & P. Less teak finished case.

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£5.5.0 Plus P. & P. 7/6. Circuit 2/6. Free with parts.

The Viscount F.E.T. Mk. I £14.5.0 Plus 7/6 P. & P.

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

SPECIFICATION

Output per channel—10W rms. Frequency bandwidth 20Hz to 20kHz ±1dB @ 1W. Total distortion @ 1kHz @ 9W 0·5%. Input sensitivities—CER. P.U. 100mV into 3 MΩ; Tuner 100mV into 100KΩ; Tape 100mV into 100kΩ. Overload Factor—Better than 26dB. Signal to noise ratio—70dB on all inputs (with vol. max).

Controls—6 position selector switch (3 pos. stereo and 3 pos. mono), separate vol. controls for left and right channels. Bass ±14dB @ 60Hz; Treble (with D.P.S. on/off) ±12dB @ 10kHz. Tape recording output sockets on each channel. Size 12½in × 6in × 2¾in in teak-finished case. Built and tested.

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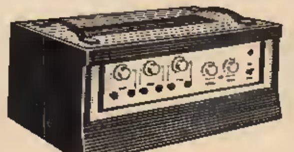
Mk. II (MAG. P.U.) £15.15.0

Specification same as Mk. I, but with the following inputs: Mag. P.U. CER. P.U. Tuner.

Spec. on Mag. P.U. 3mV @ 1kHz input impedance 47kΩ. Fully equalised to within ±1dB RIAA. Signal to noise ratio—65dB (vol. max.).

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



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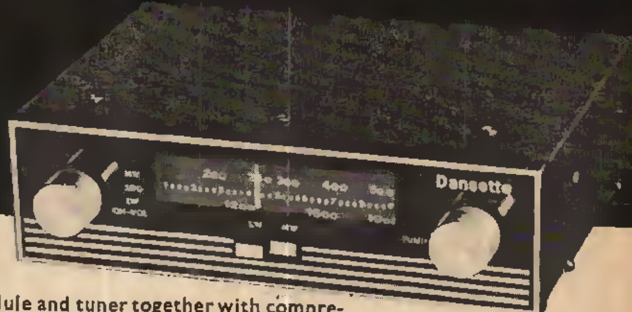

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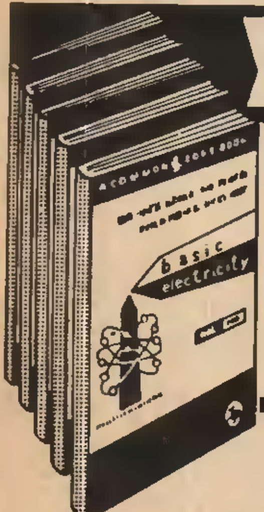

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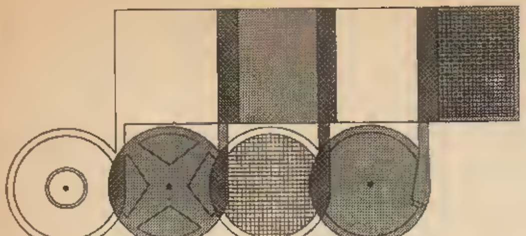

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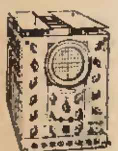

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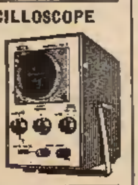

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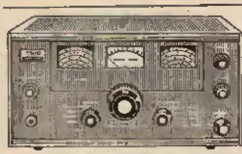

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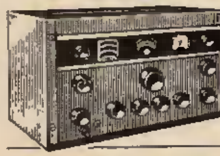

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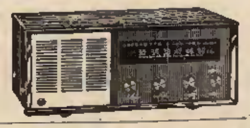

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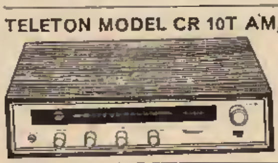

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5mA	27/6	300mA	27/6	15V. A.C.	27/6
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750mA	27/6	3V. D.C.	27/6	150V. A.C.	27/6
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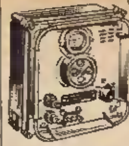

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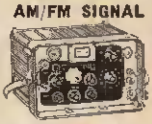

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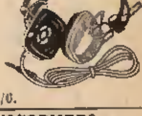

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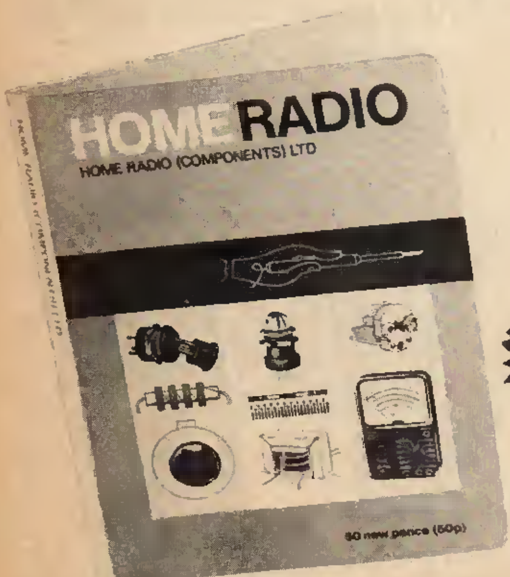

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VOL. 6 No. 10
October 1970

PRACTICAL ELECTRONICS

THE IC INVASION

THE BRITISH IC industry is worried. Justly, so, for three-quarters of the U.K. market for these devices has been captured by American companies. The four indigenous IC manufacturers have the remaining quarter of this market to divide between themselves; and their hold on even this fraction is far from secure. In fact, one firm seems on the point of throwing in the towel. The head of the Mullard Organisation has openly confessed his company's inability to produce IC devices at prices comparable with those of U.S. competitors. The other three home IC makers have not been so forthcoming. But there is little doubt that despite the shot in the arm provided by the British taxpayer, this trio on which Mintech based its main hopes for the future of U.K. microelectronics, is feeling the same cold blasts from across the Atlantic.

Allegations of price cutting and dumping have been voiced aloud. Governmental action to limit the number of IC devices imported has been urged. But can such extreme measures really help in the long run? Electronic equipment manufacturers in other countries will continue to use the more favourably priced devices. Their finished products will thus have built-in price advantages over similar type products produced in this country and using mainly all-British components.

Protection of the home IC industry cannot conceivably benefit the home electronic equipment industry. The big question surely is, which branch of the electronics industry is the more valuable national asset and has the best chance in the future against increasing world-wide competition.

If the hard economic realities are indeed against the home IC maker, it might be just as well to bow to the inevitable and, instead, capitalise to the full on this country's skills in designing and building equipment—selecting the best available components from an open competitive market.

This certainly is a form of exercise familiar enough to many PRACTICAL ELECTRONICS readers—to introduce a more homely slant into this topic. . . . After all, the amateur market is to a great extent a microcosm of the professional or industrial market. The advertisements of component retailers reflect trends in the bigger world outside. Thus readers who have been studying the components listed in these announcements will not have been taken by surprise by the IC industry's recent desperate cries for help. Clearly, the invasion by U.S. manufacturers has resulted in great price reductions in a variety of IC devices.

We all like to support home industries. But without these "foreigners" the amateur's chance to gain experience in the vital area of microelectronics would be severely curbed.

F.E.B.

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

BEGINNERS

NEWS AND COMMENT

Our November issue will be published on Thursday, October 15

Practical Electronics, Fleetway House, Farringdon St., London, E.C.4. Phone: *Editorial* 01-634 4452; *Advertisements* 01-634 4202

TELESCOPE TRACKER

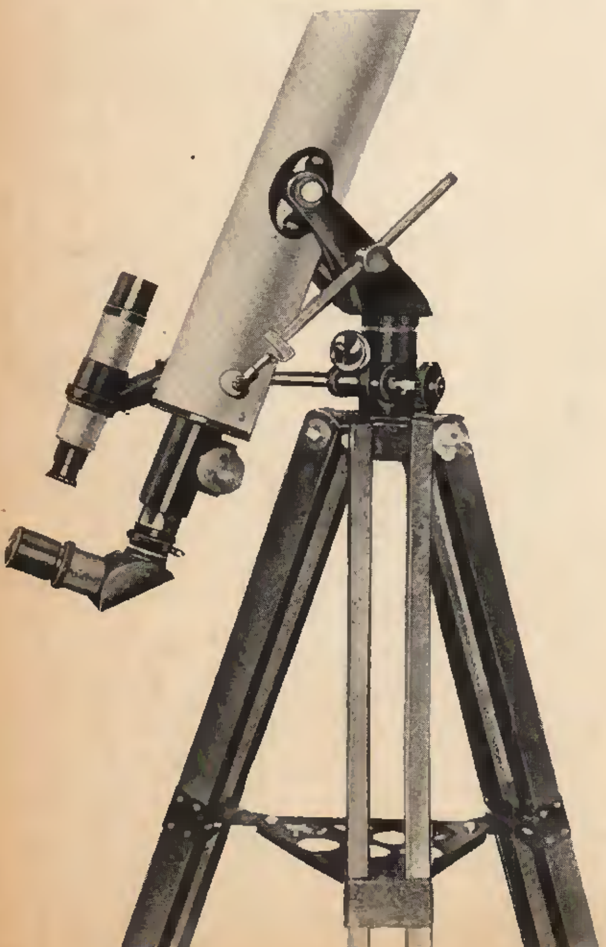
By J. J. A. Tennant

The Moon Probe programme and the startling astronomical developments over the last few years have created such interest that many people have bought small telescopes. Though a small instrument of up to 3 inches diameter is capable of satisfying the needs of most amateurs, half its potential is lost without adequate means of synchronously tracking the moon, planet, satellite or star under view.

This article describes the construction of a compact and relatively inexpensive drive unit using a mains type synchronous motor, driven from a constant frequency generator designed for 12 volt operation (batteries or mains unit), that can easily be fitted to tripod telescopes to provide tracking facilities. The system can also be used for larger telescopes with equatorial mountings.

TRACKING

The apparent motion of the stars about the north pole star is 360 degrees in 24 hours, or 15 degrees per hour; this figure is better appreciated in terms of sun or moon widths of approximately 0·5 degrees. The moon moves by its width every 2 minutes and since the optical gain or magnification of a telescope increases the apparent speed, it follows that high magnifications require constant use of slow motion controls to keep the object in view. Most small telescopes are fitted with a slow motion slewing control in the form of a knurled knob, spring loaded against backlash, that has a rate of about 0·5 degrees per revolution and a total slew of approximately 20 degrees.



Mains type synchronous motors fitted with reduction gearboxes are available on the surplus market, with a final speed of 0·25 to 4 revs per minute. Such a motor is fitted to the telescope frame and coupled to the slow motion knob by means of accurately fitted *high quality* gears to give a slew of approximately 15 degrees per hour with the motor energised at 50Hz. Using the circuit to be described the motor speed can be varied accurately by changing the frequency of the supply. Adequate torque is available from the motor to rotate the telescope and an anti-backlash device can be used, e.g., centre sprung double gears.

FREQUENCY GENERATOR

A hybrid unijunction bistable circuit is used for the frequency generator because:

(1) The timing stability is excellent being dependent upon C_t and R_t according to $f = \frac{1}{2\ R_t.C_t}$ (where f represents frequency).

(2) The stability is independent of transistor parameters and is reasonably independent of supply voltage changes.

(3) The timing capacitor C_t may be quite small (0·1 to 0·22μFd) and the inexactitude and variations of electrolytics are avoided.

(4) The frequency may be readily and continuously varied over a wide range by changing only one component—R_t, and temperature compensation (if required) can be easily applied.

(5) An equal mark to space ratio of well shaped rectangular wave form is obtained to feed a step up transformer.

The behaviour of the unijunction transistor is shown in Fig. 1. The capacitor C_t charges until the emitter voltage is approximately 60 per cent of the voltage across b1, b2 (peak point) when the emitter to b1 junction becomes almost a short circuit and the capacitor rapidly discharges.

TRACKER CIRCUIT

The unijunction transistor operating as described above fires the bistable circuit (Fig. 2) which is fitted with speed up capacitors C2 and C3, producing a rectangular waveform at the collectors of TR3 and TR5. Emitter followers TR2 and TR6 pass this waveform, via reverse voltage protective diodes D1 and D2, to the bases of TR1 and TR7 which perform a switching action and can therefore control powers of approximately 5 times that of the normal class A operation.

The emitter resistors R1 and R15 dissipate some useful power and reduce output voltage but apply local feedback to linearise the waveform and prevent thermal runaway. The values of R1 and R15 may be varied to increase efficiency or reduce current drain as desired; changing R3 and R13 to vary the base drive.

The collectors of TR1 and TR7 are connected to the centre tapped secondary winding of a small mains transformer T1; in this circuit the secondary winding is used as a primary. The primary winding forms a tuned secondary, the output of which feeds the synchronous motor to track the telescope.

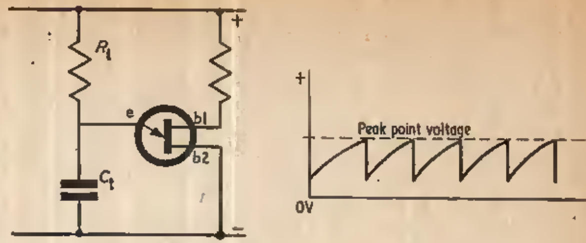


Fig. 1. Unijunction oscillator basic circuit and curve showing voltage variation across C_t

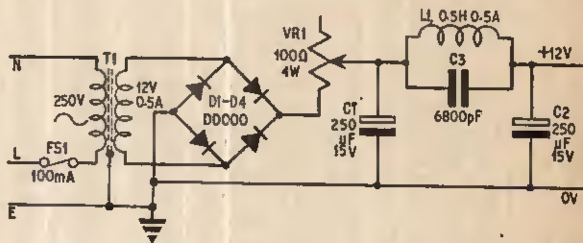


Fig. 3. Mains power supply for the telescope tracker

POWER SUPPLY

The circuit needs approximately 200mA at 12V d.c. and this can be supplied from a bank of U2 cells, an accumulator or alternatively from a simple mains power supply as shown in Fig. 3. In the mains supply circuit VR1 is adjusted to give 12 volts output on load and the choke L1 and capacitor C1 are resonated at mains frequency.

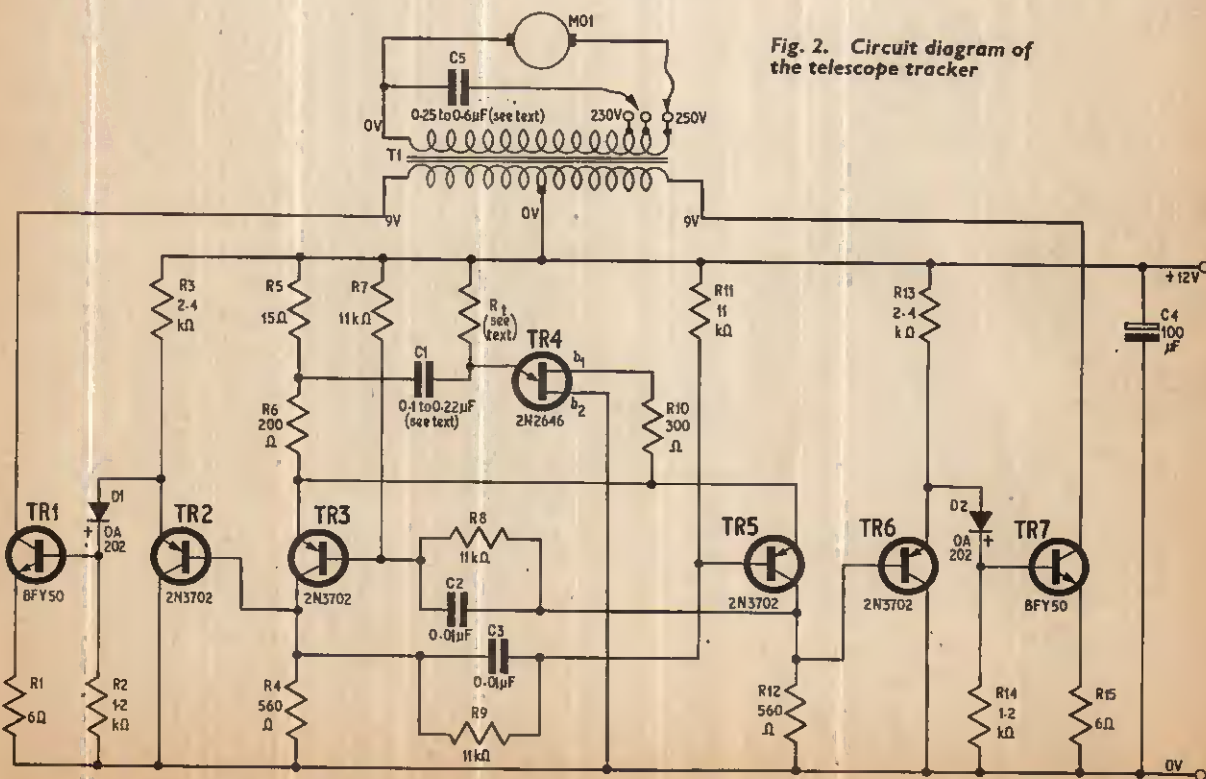


Fig. 2. Circuit diagram of the telescope tracker

CONSTRUCTIONAL DETAILS

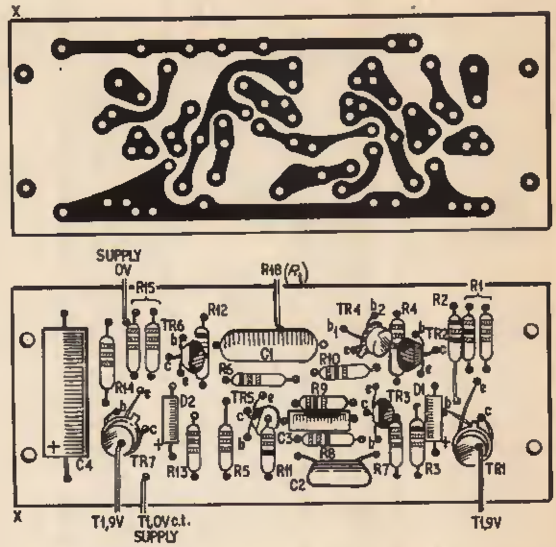


Fig. 4. Layout and wiring of the printed circuit board

COMPONENTS . . .

Resistors

R1 6Ω (2 × 12Ω in parallel)
R2 1·2kΩ
R3 2·4kΩ
R4 560Ω
R5 15Ω
R6 200Ω
R7 11kΩ
R8 11kΩ
R9 11kΩ
R10 300Ω
R11 11kΩ
R12 560Ω
R13 2·4kΩ
R14 1·2kΩ
R15 6Ω (2 × 12Ω in parallel)
R16 approx. 20kΩ }
R17 approx. 30kΩ } (see text)
R18 approx. 30kΩ }
All $\frac{1}{8}$W carbon 5%

Potentiometers

VR1 20kΩ carbon preset
VR2 10kΩ carbon preset
VR3 20kΩ carbon lin.

Capacitors

C1 0·1μF–0·22μF (see text)
C2 0·01μF polyester
C3 0·01μF polyester
C4 100μF elect. 15V
C5 0·25μF–0·6μF 450V (see text)

Semiconductors

D1 OA202
D2 OA202
TR1 BFY50
TR2 2N3702
TR3 2N3702
TR4 2N2646 (unijunction)
TR5 2N3702
TR6 2N3702
TR7 BFY50

Switches

S1 3-way wafer
S2 single-pole on/off toggle
S3 single-pole on/off toggle

Miscellaneous

T1 Mains transformer 200/250V primary 9V–0–9V secondary—used in reverse (Douglas L.T. type)
M01 Synchronous mains motor, 0·25–4 r.p.m.
Printed circuit board, metal case, gears

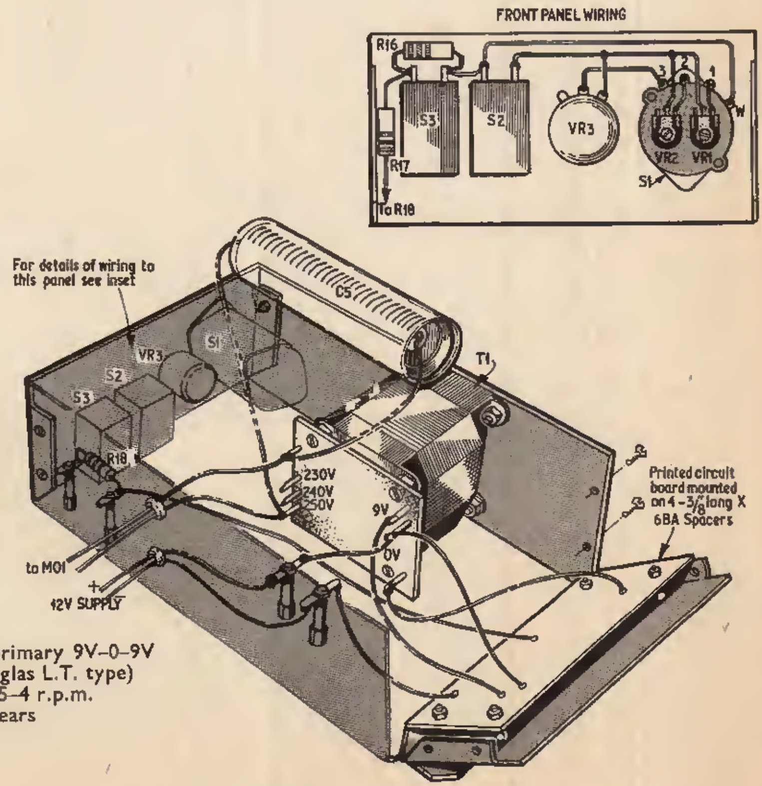
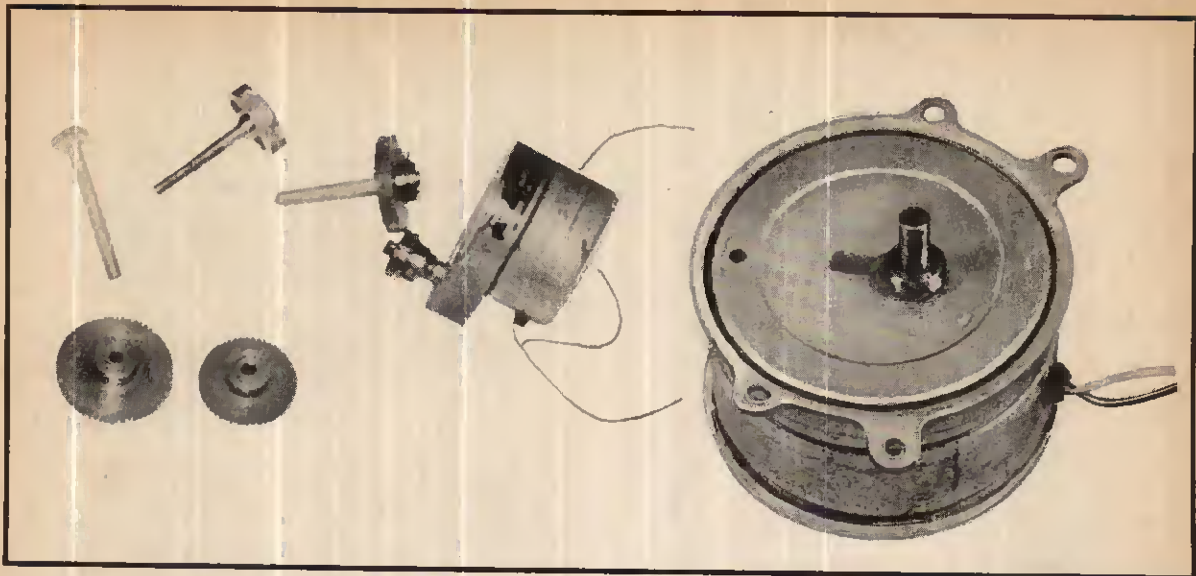


Fig. 5. Wiring diagram of the components mounted inside the tracker case



CONSTRUCTION

Most of the components are mounted on a printed circuit board, shown full size in Fig. 4. The board is fitted, together with the output transformer (T1), C5, the controls and associated resistors, inside a metal case of suitable size. A layout and wiring diagram of the components inside the case is shown in Fig. 5. The mains or battery supply is accommodated outside the case as is the tracking motor MO1.

When the telescope is tripod mounted and has a slow motion tracking screw the motor may be geared directly to this screw and hence revolve the telescope through an angle of some 20 degrees. The coupling gear ratio can be ascertained by calculation of the number of revolutions of the tracking screw to swing the telescope through 15 degrees. Assuming the speed of the motor is known the gear ratio can be found in the following manner

$$\text{Gear ratio} = \frac{\text{motor speed in rev. per min.} \times 60}{\text{revolutions of tracking screw required for 15 degree swing}}$$

Assuming the motor speed to be 0·5 r.p.m. and that 15·5 turns of the slow motion screw produce a 15 degree swing of the telescope the gear ratio required is:

$$\frac{0{\cdot}5.60}{15{\cdot}5} \text{ or } 30/15{\cdot}5$$

Since this is almost 2/1, gears of that ratio may be used and the slight error will be easily compensated by frequency adjustment in the circuit.

TESTING

The circuit should be set up with a polyester capacitor of $0{\cdot}22\mu F$ as C1 and a 100 kilohm resistor as R_t; the output waveform is examined on an oscilloscope and C5 adjusted until the waveform is as shown in Fig. 6b. If an oscilloscope is not available then the transformer should be resonated, with the load applied, by monitoring the output voltage with a voltmeter (approximately 180V r.m.s.) and adjusting C5 in fine increments for a maximum reading.

Use should be made of the primary tappings of the transformer (if available) not only to achieve the required output but to incrementally change the effect of C5. Fig. 6a indicates an output waveform without C5 and Fig. 6c shows a waveform with the transformer resonated for 50Hz but with the generator frequency changed.

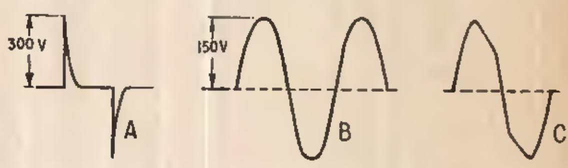
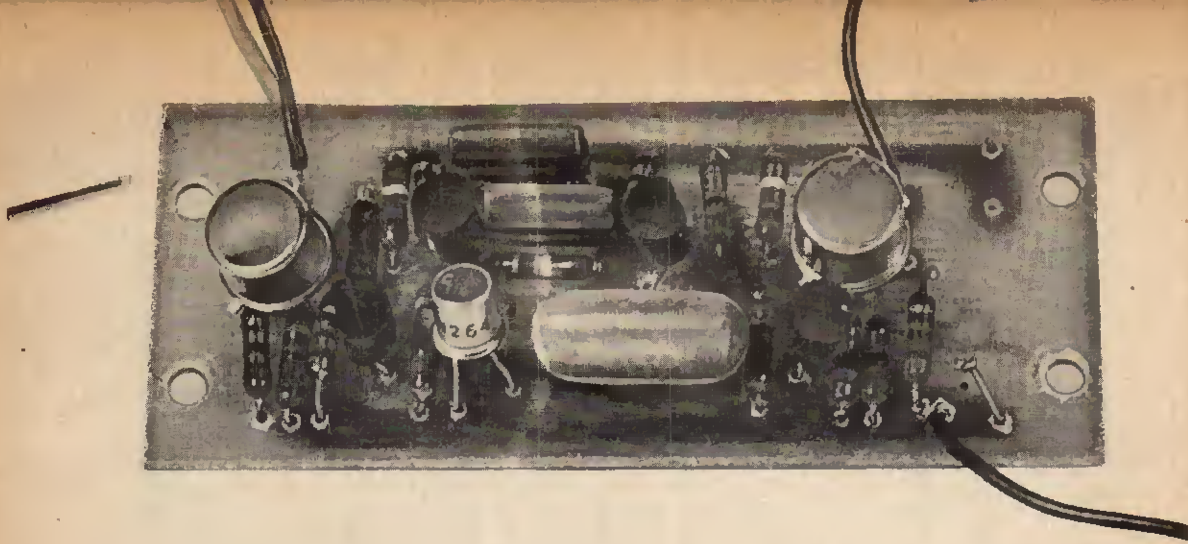
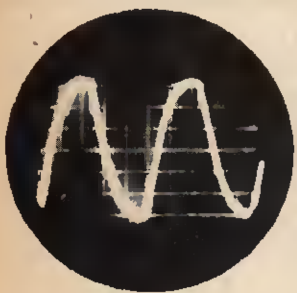
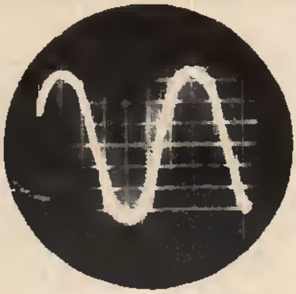


Fig. 6. Graphs of output voltage (a) without C5, (b) in resonance, (c) with transformer resonated for 50Hz but with the generator frequency changed





Off tune waveform
50V per division,
130V Avo monitor



On tune waveform
50V per division,
140V Avo monitor

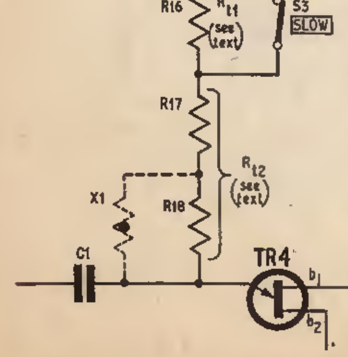


***Fig. 7.** Control circuit used to replace R_t in telescope tracker circuit*

The output frequency should be accurately determined by connecting the generator to a household electric clock and noting the timing error over a period of hours. If this frequency is not close to 50Hz R_t should be changed and C5 readjusted. Finally, with C1 and C5 set for 50Hz replace R_t with a variable resistor to slow the frequency until the drive motor to be used will no longer start up on load: this value of R_t should be measured as $R_{t\ slow}$; similarly determine the upper limit $R_{t\ fast}$. The output voltage should be at least 150 volts r.m.s. in the slow and fast condition dependent upon R1 and R15.

CONTROL CIRCUIT

The timing resistor R_t is replaced by the circuit of Fig. 7. Switch S3 (slow) is normally closed, and when S2 (fast) is closed resistor combination R_{t2} has the value of $R_{t\ fast}$. The variable resistors VR1, VR2 and VR3 are chosen and adjusted for star, moon and auxiliary rates and switch S3 is used to introduce R_{t1} such that $R_{t1} + R_{t2} + \text{VR1 (etc.)} = R_{t\ slow}$. The thermistor indicated may be used to shunt part of R_{t2} to give temperature compensation (if required) for the temperature coefficient of C1 (of the order of +300 parts per million per degree centigrade).

FINAL SETTING UP

Direct the telescope to a bright star group and use the fast and slow switches to centralise the group such that stars can be observed on the edges of the field of view. Preset VR2 is adjusted until the group is synchronously tracked. Repeat the above procedure using the moon, which moves relative to the stars, and adjust VR1 using a prominent crater as a marker. The remaining variable resistor VR3 is fitted with a suitable knob and used to track satellites, etc.

If the drive is fitted to a telescope, with an equatorial mount, as a 360 degree drive, the adjustment of VR2 can be accurately set by leaving the unit powered and performing a 24 hour check, preferably with the generator kept indoors at a reasonably constant temperature. The degree of temperature compensation can then be determined by noting the angular error over 24 hours for a given temperature change and determining the necessary change in the value of R_t to correct this. It will be found that a thermistor that changes from, say 10 kilohms to 3 kilohms (0 degrees C —30 degrees C) can be used as indicated in Fig. 7 to compensate for the change in value of C1. ★

LIGHT OPERATED SWITCH

By T. F. Carruthers

The circuit to be described was designed to operate a bench light when the daylight fell below a certain level. The unit was to switch sharply and accurately at the same light level each time, to avoid repeated setting and interactions between the light sensor and the switched light when switching begins.

CIRCUIT DESCRIPTION

To ensure accurate switching an amplifier with high impedance must be used to amplify current taken from the voltage developed across the light dependent resistor (Fig. 1). A common collector amplifier is used, the first transistor (TR1) is a silicon device to prevent leakage current affecting the voltage across the l.d.r. (X1); all leakage current passes through R1. Transistor TR2 need not be silicon, an OC71 would do, but an OC200 is used to prevent variations in switching due to temperature variations. Theoretically the input impedance of the stage is $h_{FE}^2 R_1$ so that for circuit used the input impedance should be of the order the of 160 megohms for an h_{FE} of only 40.

Transistor TR3 is the power switch and is an *npn* device, in order to improve the switching time positive feedback is applied by R4. The feedback resistor couples the collector of TR3 to the base of TR1. When light is falling on the l.d.r. TR3 is off and the only effect of R4 is to shunt the l.d.r.; once the voltage at the l.d.r. rises to a sufficient level, due to failing light causing its resistance to rise, TR1 starts to conduct and the collector voltage of TR3 begins to rise. This voltage rise at TR3 collector is fed back via R4 and since the impedances around the base of TR1 are large in value then the voltage drop across R4 is small and the base voltage of TR1 rises causing TR1 to switch fully on. The regenerative effect ensures rapid switching.

Zener diode D6 is used to supply a constant voltage to the emitter of TR2; this stabilises the switching voltage required at the base of TR1. If a Zener diode is considered an expensive luxury, then it is possible to change VR1 to 100Ω and omit D6. This will reduce the accuracy of the switching and the level at which the device switches will be more dependent on variations of supply voltage.

POWER SWITCHING

The switching operation is performed by a thyristor with a voltage rating of 350 volts or more at 0·5A. Resistor R7 may need to be changed if the specified thyristor is not used.

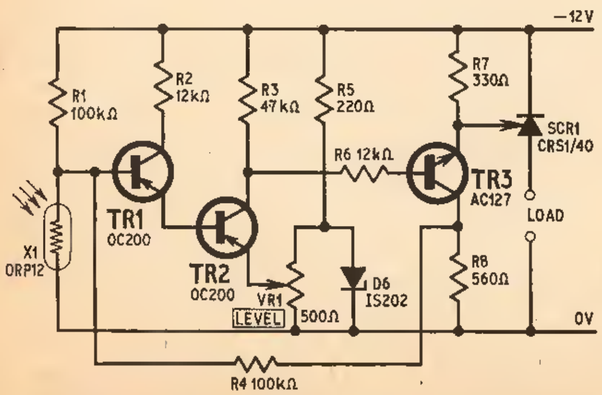


Fig. 1. Circuit diagram of the light operated switch for use with a 12V supply and 12V load

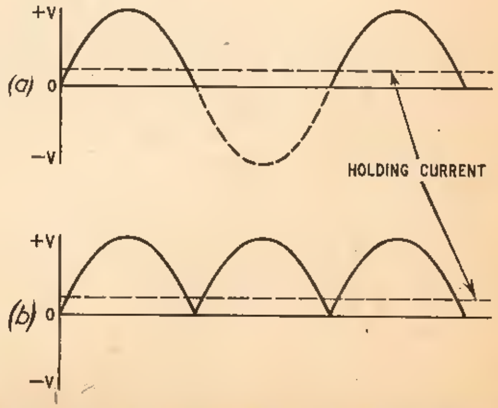


Fig. 2(a). Current supplied to load when a.c. is applied directly across the thyristor. (b) Current supplied to load when full wave rectified

To switch on the thyristor it is necessary to supply a pulse of current to the gate of the device, this is done by switching TR3. To switch off the thyristor the load current must be reduced to a low level, typically 10mA. If the thyristor is fed from an a.c. source the load current is reduced to zero every half cycle. Unfortunately such a system would supply half wave rectified power (see Fig. 2a) to the light and this causes a flickering effect which can be disconcerting. This may be avoided by full wave rectifying the mains before feeding it to the thyristor (Fig. 2b). A full wave rectified mains supply circuit is shown in Fig. 3.

If the unit is required to switch off when the light level increases, C1 should be omitted from the supply circuit (Fig. 3). For most uses it is better that the light should remain on, independent of changes in light level, this allows the l.d.r. to be placed on the workspace to be illuminated. Also if the l.d.r. is placed in a window headlamps from cars passing may cause the unit to switch unless it locks on.

Capacitor C1 will maintain the current to the load above the thyristor holding current (see Fig. 2), the value given is sufficient for use with a load of up to 200 watts, for greater loads a value must be determined by trial and error. The current rating of C1 is important, this can be calculated by:

$$\text{max. surge current} = \frac{\text{load power}}{\text{supply voltage}}$$

RELAY OPERATION

A relay may be used in preference to a thyristor for switching the load as shown in Fig. 4. If a relay is used its coil resistance must be greater than 150Ω to prevent the current through TR3 becoming excessive. If the coil resistance is less than this, but the relay only requires 100mA or less to operate, then R6 may be replaced by a resistor of sufficient value to limit the current through TR3 to 100mA or less. The relay should be wired to latch on (see Fig. 4).

When a relay is used it is not necessary to rectify the mains before supplying the load as the contacts will pass the full waveform to the load; this represents a considerable saving in cost of diodes. Diode D7 protects TR3 from the back e.m.f. generated when the relay is

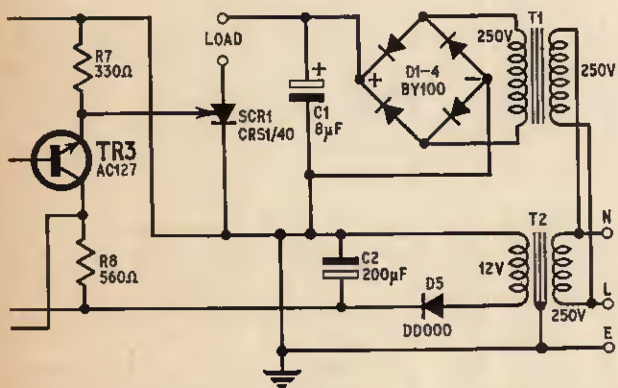


Fig. 3. Circuit of a mains supply using two transformers and full wave rectification of the 250V load supply

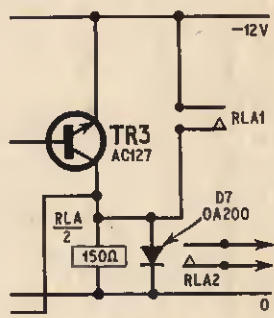


Fig. 4. Modified circuit using a relay to switch the load

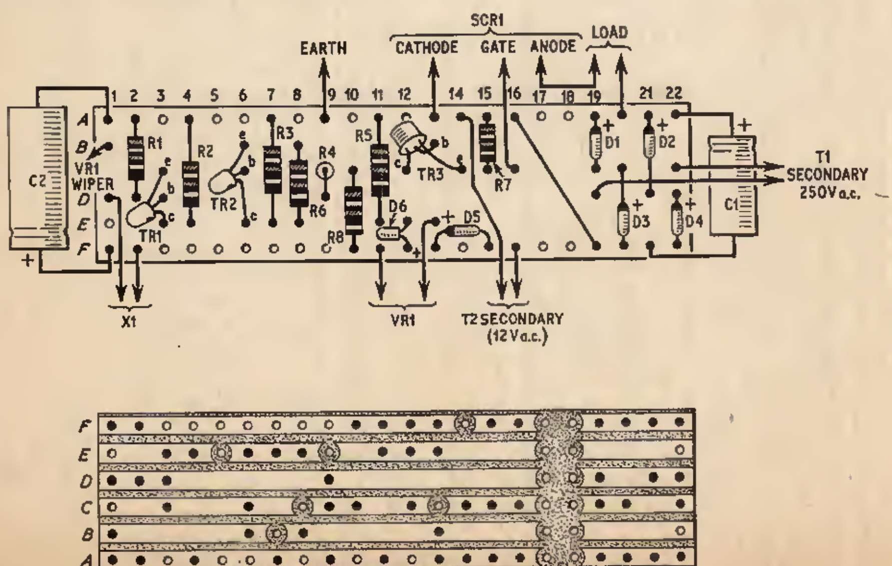
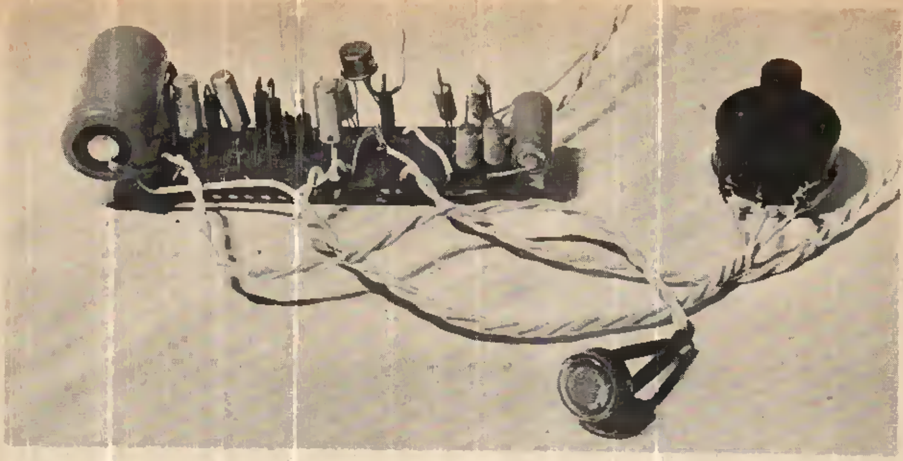


Fig. 5. Veroboard layout and wiring of the mains supply and mains load switching light operated switch (see text)



de-energised. Contacts RLA1 latch the relay on and the circuit must then be disconnected from the supply to turn the load off. For non-latching operation RLA1 contacts can be omitted.

CONSTRUCTION

The circuit is assembled on a single piece of Veroboard as shown in Fig. 5. Transformer T1, VR1, X1 and the thyristor can be mounted around the Veroboard in a small metal case. When a mains supply is used an adequate earth must be provided to the Veroboard and the metal case.

COMPONENTS . . .

Resistors
R1 100kΩ
R2 12kΩ
R3 4·7kΩ
R4 100kΩ
R5 220Ω
R6 12kΩ
R7 330Ω } not required for relay version
R8 560Ω
All ±10%, ½W carbon

Capacitors
C1 8μF elect. 250V } for mains supply version
C2 200μF elect. 15V } only

Semiconductors
TR1 OC200
TR2 OC200
TR3 AC127
D6 1S202 (4·7V Zener diode)
SCR1 CRS1/40 not required for relay version
D1–4 BY100 }
D5 DD000 } or mains supply version only
or DD003 }

Miscellaneous
X1 ORP12 photocell
VR1 500Ω carbon potentiometer
RLA 12V 150Ω relay with two pairs of normally open contacts, one pair rated at 250V 1A (see text—for relay version only)
T1 Mains isolation transformer—100W } for mains supply
T2 Mains transformer: secondary 12V 0·5A } version only
Veroboard, case

If a battery is used to supply the circuit, components D1–5, C1 and C2 can be omitted from the Veroboard and the connections to T1 secondary (12V a.c.) connected to the supply—make sure that the negative line is applied to the strip *A* on the board. The breaks at 14*F* and 17–18*A* should not be made when a battery supply is used. All wires carrying mains voltage should be insulated and of sufficient size to carry the load current.

Once complete the unit can be tested by connecting a load and varying the light falling on X1; VR1 is used to set the switching level.

LOAD POWER

Load power is limited by T1 rating, D1–4 rating and the thyristor rating. Using the components specified the load power is limited to 100 watts by T1. When a battery supply is used the load power is limited only by the thyristor and for a 12V supply would be 12 watts, this power could be increased by using a thyristor with a higher current rating.

When switching inductive lamps the thyristor should be able to pass the cold resistance current—normally about twice the normal current.

If the relay circuit in Fig. 4 is used, T1 can be omitted and the supply fed from T2 and D2 or a battery. The relay contacts RLA2 should be rated at 250V a.c. 1 amp for a 100W load or at higher current ratings for increased loads.

APPLICATIONS

The switch unit is very versatile and may be used for a number of jobs; the switch will operate mains lamps or car parking lights. When used for the second of these a non-latching relay should be employed and the l.d.r. sited away from the switched lights and from any other source of artificial light. If protection against shadows falling across the l.d.r. or momentary illumination is required a capacitor can be placed across the l.d.r. the value of which is best found by trial and error—too large a value should be avoided as this would slow down the switching speed—10μF is a good value to use as a starting point.

The switch may also be used as a burglar alarm; if the unit is arranged so that a thief interrupts a beam of light falling on the l.d.r., the switch will power an alarm that can be locked on to indicate an intruder. The light beam may be made invisible by the use of an OCP71, in place of the ORP12, and an infra red light source. Any bulb with an infra red filter may be used and the beam focused on the sensitive section of the OCP71. ★

AUDIO TRENDS

By F. C. JUDD

ONCE again an audio products exhibition is with us and what was formerly the International Audio and Photocine Fair is now the International Audio and Music Fair to be held at Olympia from October 19 to 24, with trade only day on the October 19.

Why has "music" come into the name of the exhibition? Many may be wondering for example if the exhibition has been extended to cover electronic and other musical instruments. In fact it has not and "music" denotes general interest in music reproduction which is to be promoted by approximately 20 special presentations during the course of the exhibition in the form of music recitals and lectures.

The organisers also hope to present the Moog Electronic Music Synthesiser with demonstrations of its capabilities. The fact remains however, that a combined audio and musical instrument fair might prove as successful in this country as the annual "Firato" exhibition in Holland.

SONEX '71

Following the successful Sonex '70 exhibition at the Skyway Hotel (Nr. London Airport) last April, the organisers, British Audio Promotions Limited, have now decided to run "Sonex '71" at the same venue.

The Daystrom (Heathkit) Audio Signal Generator (sine or square wave) type AO-1U

The dates have been announced as Wednesday, March 31 to Sunday, April 4, 1971 with the first *two* days for the trade only.

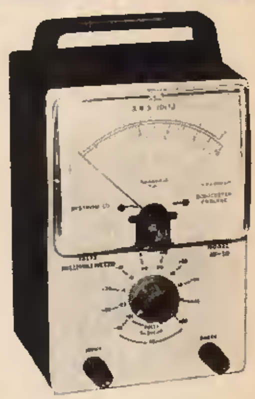
Two whole days for trade visitors only, was apparently supported by a large majority of exhibitors. The number of exhibitors at "Sonex '71" is expected to be not less than 60.

AUDIO TEST EQUIPMENT

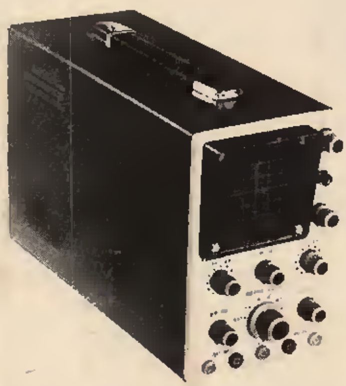
No new audio products with any significant developments have been announced since Sonex '70 and the time of writing is too early for notice from manufacturers of anything outstanding they are likely to be showing at Olympia. For this reason most of this month's *Audio Trends* is devoted to a few items of currently available audio test equipment which may well be of interest to those who construct a good deal of audio equipment and have little time to build their own test gear.

Accurate test equipment is, of course, invaluable in all applications of electronics and particularly in the design and development of circuitry. In audio work the two main essential instruments are perhaps the audio signal generator and the oscilloscope. An oscilloscope with reasonably accurate calibration can be used to measure audio signal amplitudes as well as show defects and distortion.

Since this article was prepared the name Daystrom has been superseded by Heath-Gloucester Ltd.



The Daystrom Model AV-3U audio millivolt meter



The Daystrom Model OS2 general purpose oscilloscope

The ideal combination is a signal generator, oscilloscope and audio millivolt meter. A distortion meter might be considered a luxury as far as the amateur equipment constructor is concerned but is an essential piece of equipment in a design laboratory.

TEST GEAR IN KIT FORM

The greatest problem in building one's own test gear is that of reasonably accurate calibration, for unless

this can be carried out the equipment would be virtually useless. Most test equipment available in kit form is pre-calibrated or requires only simple adjustment to effect calibration and in any event the suppliers of kits usually undertake to calibrate the finished instrument for a nominal charge.

Well known for test equipment kits are Daystrom (Heathkit) and three of their least expensive models are shown in the photographs. Their audio signal generator type AO-1U covers a frequency range of 20Hz to 150kHz in four ranges and provides a sine-wave output of up to 10 volts at less than 1 per cent distortion. The generator also provides a square-wave output over the frequency range 20 to 25,000Hz with a rise time of less than 3 microseconds. A fast rise time on the squarewave output of an audio signal generator is essential for square wave tests on amplifiers. This Daystrom kit costs £14 16s 0d but can be purchased assembled and tested for £19 18s 0d.

Also from the Daystrom range are the model OS-2 general purpose oscilloscope and the AV-3U audio millivolt meter both of which are suitable for a wide range of audio equipment tests. The O-S2 'scope costs £24 18s 0d as a kit, or £32 18s 0d assembled and tested. It has a bandwidth of 2Hz to 3MHz and a timebase range of 20Hz to 200kHz. Other features are synchronisation, horizontal 50Hz sweep, a 1 volt reference signal and switched internal/external Y plate connections.

The AV-3U audio millivolt meter has a lowest range of 0 to 10mV and a highest range of 0 to 300V. On the lower ranges (10 millivolts to 100 volts) the input impedance is 10 megohms. The intermediate ranges are more than sufficient for all audio work and aside from calibration in volts there is also a decibel scale directly related to the voltage readings.

The Grundig MV-20 audio millivolt meter

The Grundig TG-20 audio signal generator with sine or square wave output

READY-TO-USE EQUIPMENT

Many of the larger radio component stockists carry a wide variety of test equipment suitable for the amateur and at reasonably low prices. In the Nombrex range for instance, stocked by many dealers, there is a transistorised audio generator with sine or square-wave output at £19 19s 0d.

There are also various Japanese made instruments of reasonable accuracy on the market and among these is an audio millivolt meter at £17 10s 0d, a sine/square wave audio generator at £17 and a fairly versatile oscilloscope with a 3 inch diameter screen at £37 10s 0d. These are stocked by Henry's Radio Limited, 303 Edgware Road, London, W.2., whose special test equipment catalogue is available free on request.

The items mentioned above are from this catalogue and they have sufficient range and accurate enough calibration for all but precise audio tests and measurement.

HIGH GRADE EQUIPMENT

The greater the accuracy and versatility of test instruments, the more costly they become. For laboratory work where a high degree of accuracy is required there are many makes and types of instruments to choose from. However, the Grundig range is perhaps not so well known in this country as their tape recorders but does include an audio signal generator and a millivolt meter with fairly high accuracy and performance at a reasonably low price.

The Grundig millivolt meter type MV-20 has a minimum range of 0–3mV and a maximum range of 0–300V with 9 ranges in between. On all ranges the input impedance is 10 megohms and the frequency response is flat from 10Hz to 1MHz. The instrument is also calibrated in decibels in relation to the voltage scales and has provision for checking its own calibration. It retails at £55 5s 0d.

Also from the Grundig range comes their TG-20 audio signal generator which employs a Wien bridge oscillator and delivers a sine or square wave output signal. This covers a frequency range of 10 to 1MHz and it has a calibrated output attenuator. The distortion factor is better than 0·2 per cent at the lower frequencies (40 to 150Hz) and better than 0·1 per cent for the remainder of the ranges. It retails at £48 10s 0d.

Further details of these and all other Grundig test instruments, most of which are high grade laboratory type, are available from Grundig (G.B.) Limited, Newlands Park, London, S.E.26.

TAPE RECORDERS

Grundig have just announced the release of four new stereo tape recorders; an automatic portable cassette recorder; a high fidelity three speed professional portable tape recorder; a new loudspeaker system called the "Troika" and a new systemised hi fi outfit, comprising a tuner amplifier, two loudspeakers and a transcription unit.

The new TK3200 portable tape recorder is a half-track mono machine intended for professional use and should be up to that standard since it retails at £178 3s 0d. The new domestic recorders cover a wide variety of facilities and are available for half or quarter-track stereo with prices ranging from £54 15s 7d for the TK21 model to £157 14s 0d for the TK248.

The TK248 is a de-luxe model with twin 8 watt output stages, four built-in loudspeakers and facilities for multi-play, signal mixing, echo and monitoring on or off tape.

PROTON

ARCHAEOLOGISTS, treasure hunters and skin divers have a common problem, where to dig or dive to discover the loot. A buried metal locator would come in handy, but most are either expensive or have too limited a range. The one described here is a proton magnetometer utilising discoveries made in nuclear magnetic resonance first published in 1946.

Some care is required in putting together the high gain amplifier, but otherwise construction is straightforward, using standard components, and the exotic nuclear material is distilled water.

Essentially, the magnetometer measures the intensity of the earth's magnetic field at two nearby points. A difference in the intensities produces an output from the device, which can be either an audio signal or a meter reading.

The earth's field is normally uniform, but will be disturbed by local concentrations of magnetic materials, such as iron ore or just iron junk. Hence the magnetometer can only be used to search for ferrous materials or compounds. For this purpose it is extremely sensitive with considerable range.

It will, under ideal conditions, detect a one pound mass of iron at about four or five feet below one of the bottles, and larger masses at much greater distances. Typical of the latter is a twelve foot length of three inch diameter iron water pipe at twelve feet. It is difficult to give performance figures, since much depends upon the size, density and attitude of the object disturbing the field, and experiment provides the best answers.

This high sensitivity to field variations means that the magnetometer may only be used remote from known earth field disturbers, such as buildings and power lines.

ATOMIC PRINCIPLES

To understand the principles involved is easy, if the cobwebs and dust are shaken off the school books and memories of atomic particles. Remember that old friend, the hydrogen atom, first in the atomic table, with just one proton and one orbiting electron, as simple a thing as any alchemist could wish.

The orbiting electron acts just like electric current in a coil of wire and sets up a magnetic field about the atom as seen in Fig. 1. The proton, the main mass of the atom, is also in motion, spinning about its centre, so that the whole atom looks like a magnetic gyroscope, whose magnetic poles are on its spin axis.

Gyroscopes have idiosyncracies revealed to mechanical engineers, one of them being that they will precess if acted upon by an external field. In the hydrogen proton's case, its spin axis will wobble or precess about the direction of the earth's magnetic field, if that is the only magnetic field acting on it. This is shown in Fig. 2. The frequency of precession will be proportional to the strength of the field and is given by

$v = kB$ where v = frequency of precession

$k = 4{\cdot}26 \times 10^3$ Hz/weber for hydrogen

B = intensity of magnetic field.

USE OF DISTILLED WATER

If a coil of wire is wound round a small plastic bottle containing distilled water, sufficient current can be passed through the coil to set up a local field in the bottle very much greater than any external field, in this case the earth's.

A number of the spinning protons of the hydrogen atoms, remember H_2O, happily line themselves up with their spin axes along the direction of the induced field. If the current is suddenly cut off, the induced field collapses, and the protons try to realign themselves with the earth's field.

Because they behave as gyroscopes, they cannot simply switch back, but must precess back at the precessional frequency. In doing so they set up a very weak alternating field in the bottle, and an alternating voltage is induced in the coil. This voltage falls to zero as realignment with the earth's field is completed. Fig. 3 shows the signal that would be seen on an oscilloscope.

A combination of nucleonics and electronics provide an extremely sensitive detector with long range search capability. Detection principle is based on local variation in earth's magnetic field.

by L. HUGGARD, B.Sc.

MAGNETOMETER

FERROUS METAL LOCATOR

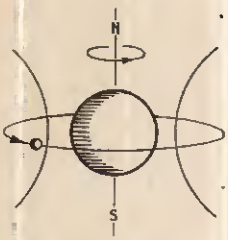


Fig. 1. Magnetic field around hydrogen proton produced by orbiting electron

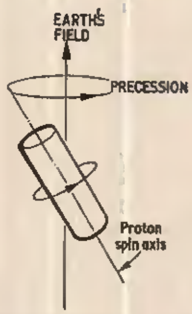


Fig. 2 Precession of proton relative to earth's field when acted upon by external magnetic influence

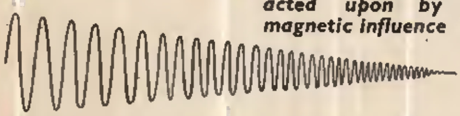


Fig. 3. Diminishing alternating voltage set up by precession frequencies from the detector coils

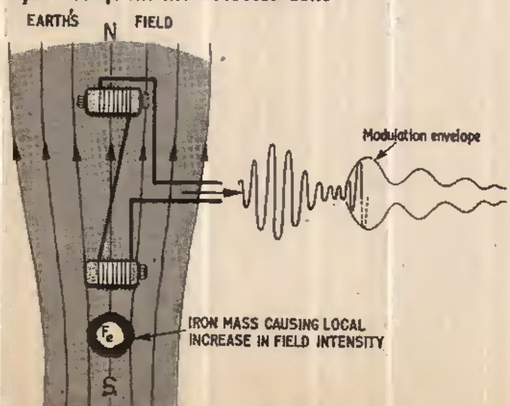


Fig. 4. Modulated output produced by mixing the two precession frequencies from the detector coils

BASIC MAGNETOMETER

This phenomena can now be used to make a ferrous metal detector. Two such bottles filled with distilled water are spaced about six feet apart. The longitudinal axes of the bottles lie east–west.

The coils wound round the bottles are connected in series and a current passed through them. After three seconds, the current is cut off and an amplifier connected across the coils. If the intensity of the earth's field is the same at each bottle, the precession frequency at each will be the same, and the signals from both coils of equal frequency.

If, on the other hand, the field intensities were different due to some local magnetic disturbance, then the signal frequencies will differ, and the difference can be detected.

The amplifier input signal is then the sum of two signals of slightly different frequencies and its output will be a signal of a third frequency which is half the sum of the two input frequencies. The amplitude of this is modulated at a fourth frequency equal to the difference between the original two input frequencies. This composite output signal can be heard in a headset as a note of about 2kHz with a marked quaver. This is illustrated in Fig. 4.

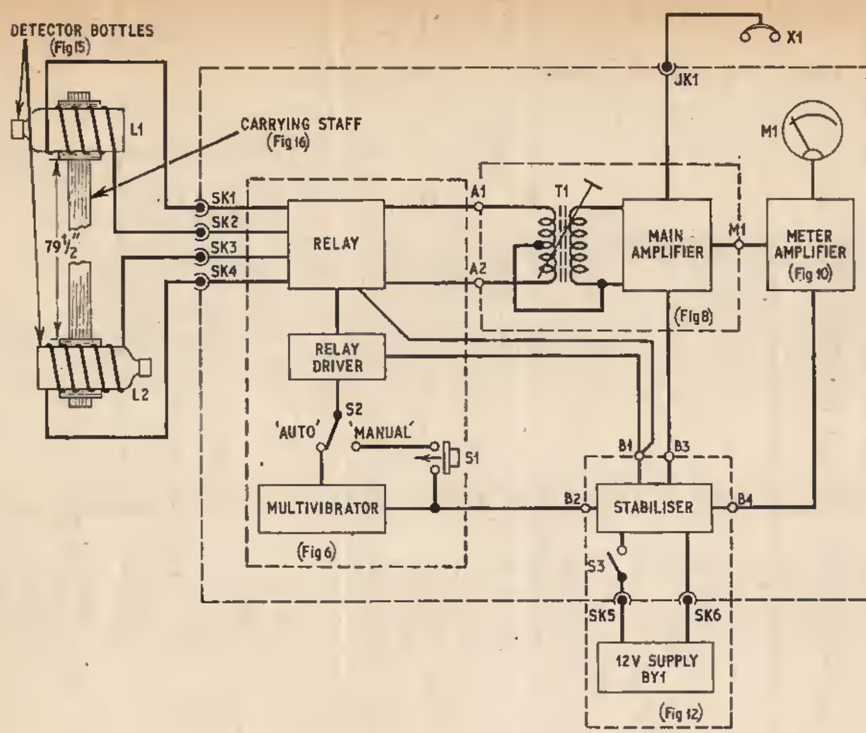


Fig. 5. Block diagram of proton magnetometer

The greater the difference in the field intensities between the two bottles, the faster will be the quaver. It only remains to reach for the shovel and see what is causing the magnetic difference.

CIRCUIT BLOCKS

Now look at the block schematic of the magnetometer in Fig. 5. There are in effect six units comprising: two detector bottles, relay circuit, multivibrator, main amplifier, meter amplifier, and power supply. These form what might be called a de-luxe unit. The relay and meter circuits may be omitted if costs have to be kept down.

The relay is used to switch the series wound coils, L1, L2 from the "polarise" condition to "detect". In the "polarise" condition the relay passes current through the coils via terminal B1 at the stabiliser. On "detect" the relay switches the precession frequencies produced at the coils to the main amplifier input terminals A1, A2. Detection of the modulation envelope is then provided for, both aurally and visually, by the headphones X1 and meter M1.

The relay can be made to operate manually by the push-switch S1 or automatically when coupled via S2 to the multivibrator; this switch does in fact select the mode.

The multivibrator switches the relay on for about three seconds and off for the same period. This continuous operation is particularly useful when searching. The manual option is used when setting up or detecting a very small frequency difference.

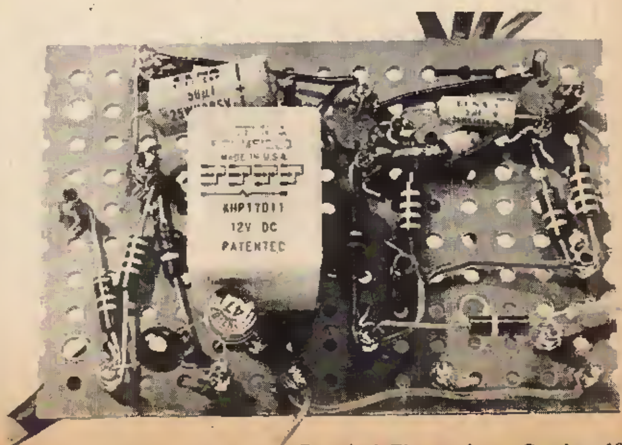
RELAY DRIVER AND MULTIVIBRATOR

The circuit diagram of the relay driver and multivibrator is given in Fig. 6. Here TR1 and TR2, in modified super alpha configuration, drive the relay. The relay contacts are shown in the quiescent state. A 1W resistor, R1, can be inserted in the "polarise" circuit to reduce the detector coil current and so cut down on battery consumption. It follows that the higher the value of this resistance the smaller will be the signal presented to the main amplifier, so the choice of value should be made when the unit is completed and tested; 4·7 ohms is a suitable value to start with. "Cut and try" methods should provide balance between a tolerable signal and battery economy.

The multivibrator, comprising TR3 and TR4, provides an equal mark-space output of three seconds duration at the collector of TR3. This is passed via S2, when switched to the "auto" mode, to the base of TR2.

Details for assembling and wiring this circuit module are given in Fig. 7.

Relay driver and multivibrator board



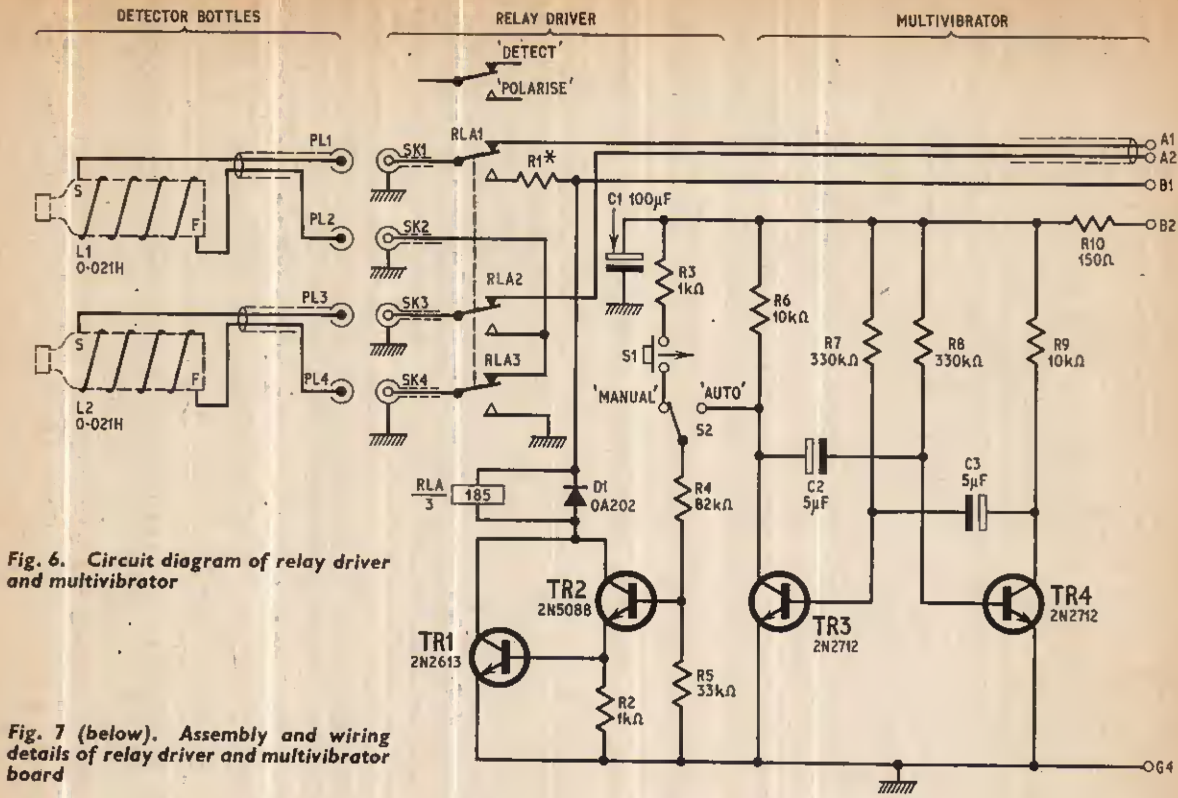
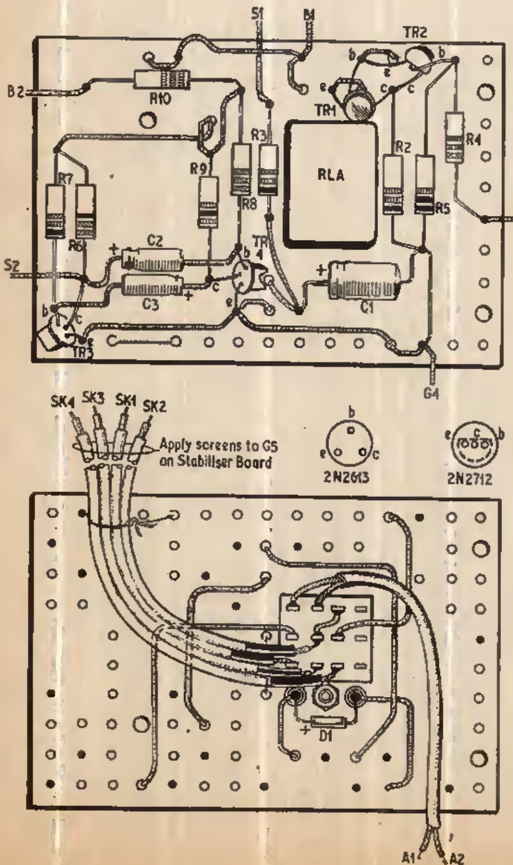


Fig. 6. Circuit diagram of relay driver and multivibrator

Fig. 7 (below). Assembly and wiring details of relay driver and multivibrator board



COMPONENTS . . .

RELAY DRIVER AND MULTIVIBRATOR

Resistors

R1*	See text	R6	10k Ω
R2	1k Ω	R7	330k Ω
R3	1k Ω	R8	330k Ω
R4	82k Ω	R9	10k Ω
R5	33k Ω	R10	150 Ω

All ½W, 10% carbon except where otherwise stated.

Capacitors

C1 100μF elect. 25V
C2 5μF elect. 25V
C3 5μF elect. 25V

Transistors

TR1 2N2613
TR2 2N5088
TR3, TR4 2N2712 (2 off)

Diodes

D1 0A202

Switches

S1 Press switch
S2 Single-pole changeover

Relay

RLA 12V 185Ω 4 pole-changeover
STC miniature relay type 25 (Electroniques)

Miscellaneous

Veroboard 4in × 2½in, 0·15 matrix plain, SK1–SK4 phono sockets (4 off)

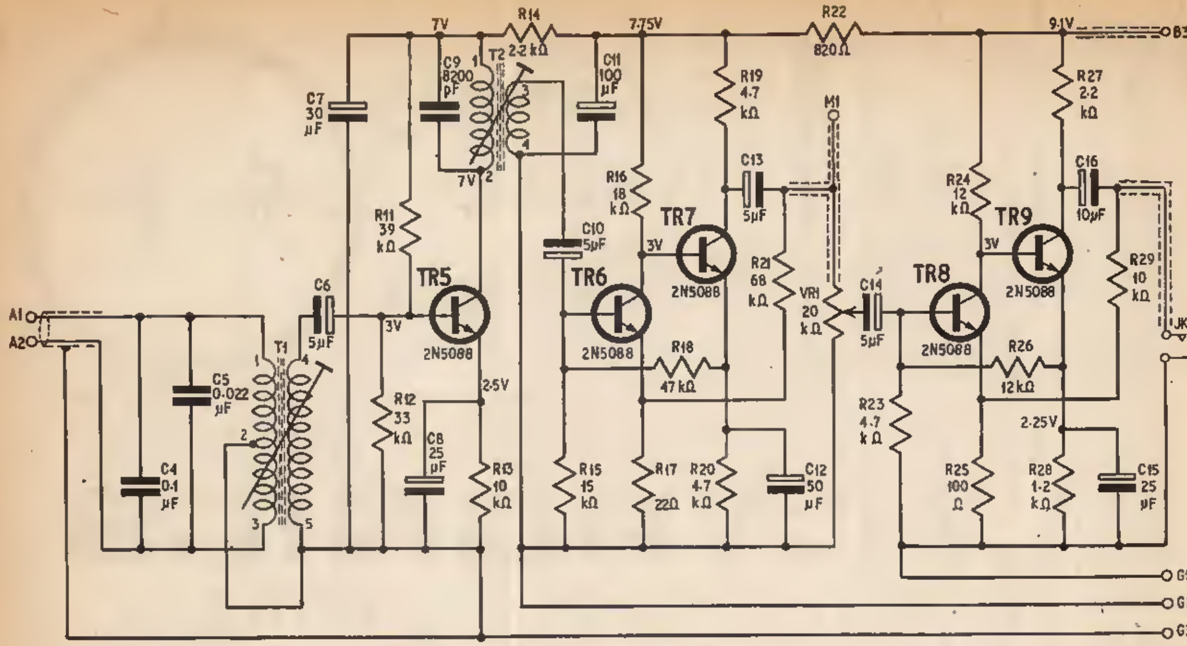


Fig. 8. Circuit diagram of main amplifier

MAIN AMPLIFIER

The main amplifier, seen in Fig. 8, serves to increase the level of the precession voltages. A ferrite cored transformer, T1, with the primary centre tapped, is tuned to the required frequency by C4 and C5. The first stage comprising TR5 has a tuned collector load resonant at the same precession frequency.

The output from the secondary of T2 feeds the d.c. coupled amplifier TR6–TR7. This acts, in effect, as a pre-amplifier to the meter circuit, the input for this being taken from M1.

The bandwidth of the tuned circuits is about 300Hz, which has proved adequate on field trials.

VR1 is the volume control for the headphone amplifier, TR8–TR9, the output being taken via JK1.

The headphones used should preferably be high impedance crystal, since magnetic ones can cause feedback trouble if brought too close to the detector bottles and so cause the amplifier to oscillate.

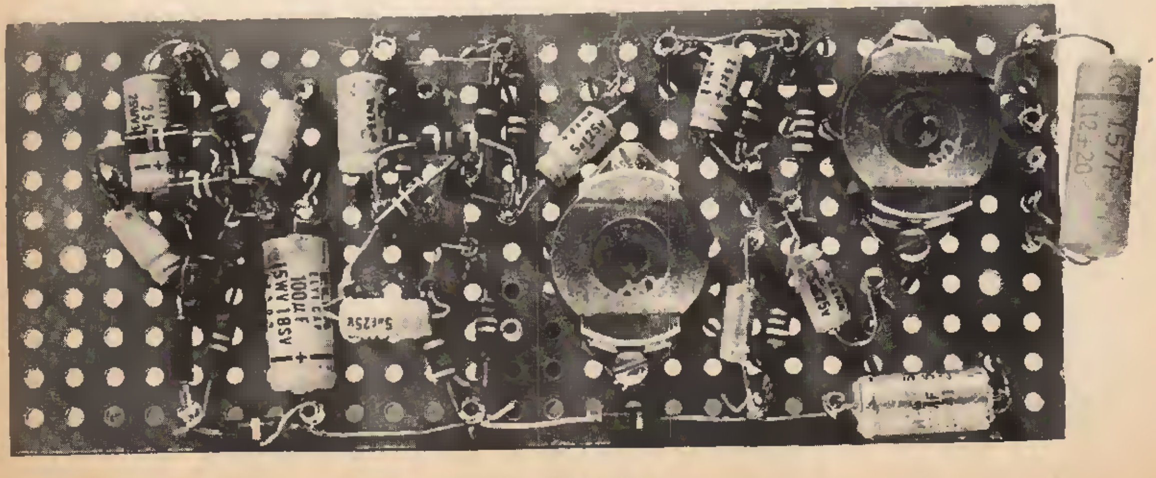
(In field trials magnetic phones were used and proved trouble-free provided they were maintained in the plane of the detector bottles.)

AMPLIFIER CONSTRUCTION

Since the amplifier provides high gain, the wiring layout and constructional details of Fig. 9 should be adhered to, to prevent instability.

Both of the transformers are contained in Vinkor adjustable pot cores. To wind T1 use 40 s.w.g. enamel covered wire. Slip a couple of inches of fine sleeving over the start to protect the leadout, then wind on seven hundred and fifty turns. Put on another piece of sleeving over the finish leadout and wrap a layer of cellotape round the winding.

Put on two more windings of three hundred and seventy-five turns each and identify the starts and finishes with different coloured sleeving. Wind a layer or two of plastic electrical tape around the completed



Main amplifier board

COMPLETE STEREO SYSTEM

FOR ONLY **39 GNS**
CARRIAGE 35/-

PREMIER STEREO SYSTEM "ONE" Consists of an all transistor stereo amplifier. Garrard 2025 T/C auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12 × 5½ × 3½in. high (Amplifier available separately if required **£14.19.6**. Carr. 7/6).

PREMIER STEREO SYSTEM "TWO"

As system "ONE" above but with Garrard SP25.

PREMIER PRICE **45 Gns.** Carr. 35/-

AURIGA 8 WAVEBAND TRANSISTOR PORTABLE

Covers Medium, Long and six Short Waves and includes many features not normally found in this price range. Ten transistors and two diodes. Push-Pull output. Press-button dial illumination. Volume, tone, tuning and wavechange controls. Telescopic aerial. Uses 6 × 1½V batteries. Sockets for external batteries, tape recorder and aerial. Elegant black and chrome cabinet. Size 11in × 3¾in × 7½in.

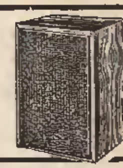
PREMIER PRICE **16 Gns.** P. & P. 7/6

TELETON SAQ203E STEREO AMPLIFIER

A small but powerful amplifier designed for stereo hi-fi reproduction. 10 watts per channel music power. Inputs for Gram (Magnetic and Crystal), Tuner and Auxiliary. Tape Record output. Controls: Volume, Balance, Bass, Treble, Stereo/Mono slide switch. Stereo headphone socket. Attractive oiled walnut cabinet with brushed aluminium front panel. List Price £28.7.0.

PREMIER PRICE **22 Gns.** P. & P. 10/-

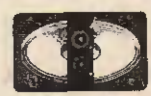
PREMIER SPEAKER CABINET



Teak finish with black front. Size 16in × 10in × 7½in. Cut out for 13in × 8in speaker.

ONLY **49/6** P. & P. 7/6.

E.M.I. 13×8in. HI-FI SPEAKERS



Fitted two 2½in tweeters and crossover network. Available with 8 or 15 ohm impedance. Handling capacity 10W. Brand new.

79/6 P. & P. 7/6

HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft. lead and stereo jack plug.

59/6 P. & P. 5/-.

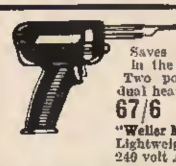
MONO HEADPHONES 2000 ohm 14/6 P. & P. 2/6.
STEREO STETHOSCOPE SET Low imp. 25/- P. & P. 2/-
MONO STETHOSCOPE SET Low imp. 10/6 P. & P. 2/-.

PREMIER STEREO SYSTEM "FOUR"

Teleton SAQ203E Amplifier (as above) ..	£23.2.0
Garrard SP25	£11.19.6
Shure M8D	£6.19.6
Teak base and cover	£5.10.0
Pair of Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
Total cost if purchased separately	£73.16.0

PREMIER PRICE **65 GNS.** Carr. 35/-

"WELLER EXPERT" SOLDER GUN.



Saves time and simplifies soldering in the home and service dept. Two position trigger gives instant dual heat 100/140 watt. 240 volt A.C

67/6 P. & P. 2/-

"Weller Marksman" Soldering Iron Lightweight. 3/16" pencil bit. 25 watt. 240 volt A.C. 31/6. P. & P. 2/-.

SPECIAL OFFER!

Garrard SP25 Mk. II Single Record Player. Fitted Audio Technica AT66 Stereo Cartridge. Complete in Teak Plinth with Rigid Perspex Cover. Total list Price over £24.

PREMIER PRICE **18 Gns.** P. & P. 10/-.

VERITAS V-149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1·5V, max. output 2·5V, gain 6dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

Mono Model **59/6** Stereo Model **69/6** P. & P. 2/6

POCKET SIZE MULTI-TESTER With wide angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt D.C. 10,000 ohms/volt A.C.

19 Ranges: 0–5–25–50–250–500–2500 volts D.C. 0–10–50–100–500–1000 volts A.C. 0–50μA–2·5mA–250mA D.C. 0–6000 ohms–6 megohms. 10μ μf–0·001 mfd–1 mfd. −20 to +22dB. Complete battery, test lead and instructions.

£4.19.6 P. & P. 3/6.

MIDLAND CASSETTE TAPE RECORDER 12-115

Solid state incorporating piano key controls for trouble-free 2-track recording. Inputs for mike and aux. Earphone socket. Complete with batteries and earpiece. Size 10¾in × 5¾in × 2¾in.

PREMIER EXCLUSIVE! **£16.10.0** P. & P. 7/6

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

LP3	3"	250'	P.V.C.	5/6
TT3	3"	450'	POLYESTER	7/6
DT3	3½"	600'	POLYESTER	11/6
SP5	5"	600'	P.V.C.	8/6
LP5	5"	900'	P.V.C.	10/-
DT5	5"	1200'	POLYESTER	15/-
LP6	5¾"	1200'	P.V.C.	12/6
DT6	5¾"	1800'	POLYESTER	22/6
TT6	5¾"	2400'	POLYESTER	37/6
SP7	7"	1200'	P.V.C.	12/6
LP7	7"	1800'	P.V.C.	15/-
DT7	7"	2400'	POLYESTER	25/-
TT7	7"	3600'	POLYESTER	50/-

TAPE SPOOLS 3" 1/-, 5", 5¾", 7" 1/9.
Post and Packing 3" 1/-, 5", 5¾" 1/6, 7" 2/-. (3 reels and over Post Free.)

TAPE CASSETTES

C60 (60 min.)	7/6	3 for 21/-
C90 (90 min.)	12/6	3 for 36/-
C120 (120 min.)	17/6	3 for 51/-

P. & P. 1/-.

All cassettes can be supplied with library cases at 6d extra each.

PREMIER RADIO

23, TOTTENHAM COURT ROAD, LONDON, W.1 Tel: 01-636 3451

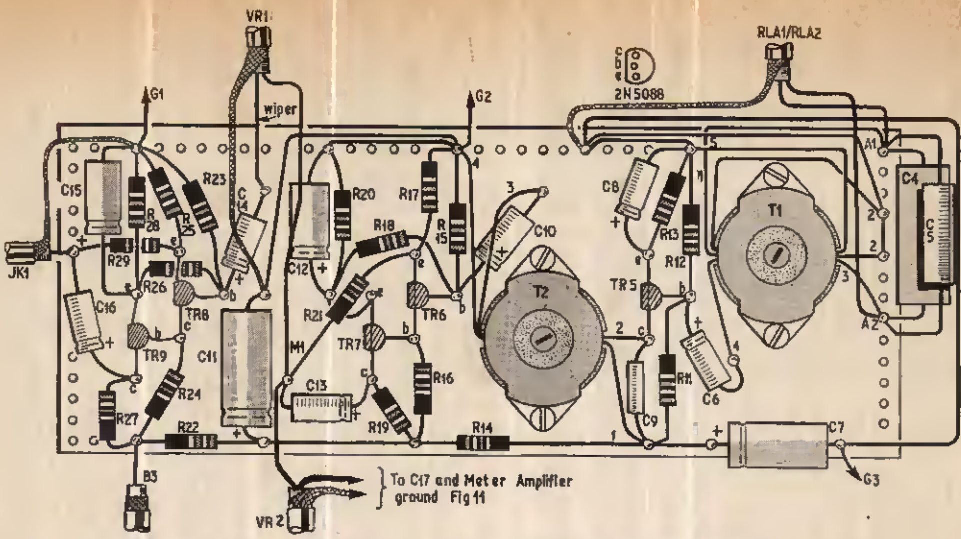


Fig. 9. Assembly and wiring layout of main amplifier board

COMPONENTS . . .

MAIN AMPLIFIER

Resistors

R11	39k Ω
R12	33k Ω
R13	10k Ω metal oxide
R14	2·2k Ω
R15	15k Ω
R16	18k Ω
R17	22 Ω
R18	47k Ω
R19	4·7k Ω
R20	4·7k Ω
R21	68k Ω
R22	820 Ω
R23	4·7k Ω
R24	12k Ω
R25	100 Ω
R26	12k Ω
R27	2·2k Ω
R28	1·2k Ω
R29	10k Ω

All ½ watt, 10% carbon except where otherwise stated.

Capacitors

C4	0·1μF	polyester	10%
C5	0·022μF	polyester	10%
C6	5μF	elect.	6V
C7	30μF	elect.	15V
C8	25μF	elect.	6V
C9	8,200pF	polystyrene	10%
C10	5μF	elect.	6V
C11	100μF	elect.	15V
C12	50μF	elect.	15V
C13	5μF	elect.	15V
C14	5μF	elect.	6V
C15	25μF	elect.	6V
C16	10μF	elect.	15V

Transistors
TR5–TR9 2N5088 (5 off)

Transformers
T1–T2 LA2301 pot cores—Type "B" Assembly consisting of adjuster, clip, cup core, bobbin and tag board. (Gurney's Radio, 91 The Broadway, Southall, Middlesex) (2 off)
(see text)

Potentiometers
VR1 20k Ω linear

Socket
JK1 Standard jack socket

Miscellaneous
Veroboard 6½in × 2¾in, 0·15in matrix, plain 40 s.w.g. wire

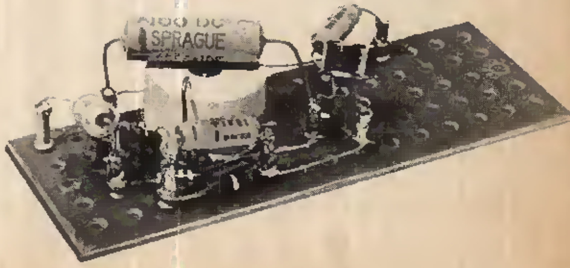
windings then very carefully assemble the bobbin in the ferrite core. Ensure that nothing gets trapped between the two halves of the core, preventing them mating.

If test equipment is at hand, the inductance of the seven hundred and fifty turn winding should be 0·196H, and its resistance about 56 ohms. The resistance of each of the other windings will be 28 ohms.

COUPLING TRANSFORMER

The coupling transformer T2 is built in the same way. Its primary winding has 1,076 turns of 40 s.w.g. and the secondary 258 turns of 40 s.w.g. When finished the primary inductance should be 0·4H and its resistance about 88 ohms. The secondary resistance will be about 26 ohms.

Since final tuning of the amplifier is made during field trials, the capacitors C4, C5 and C9 should be temporarily connected using crocodile clips.



Meter amplifier board

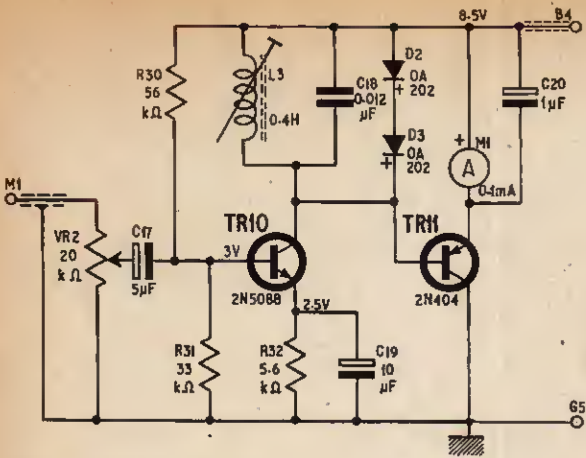


Fig. 10. Circuit diagram of meter amplifier

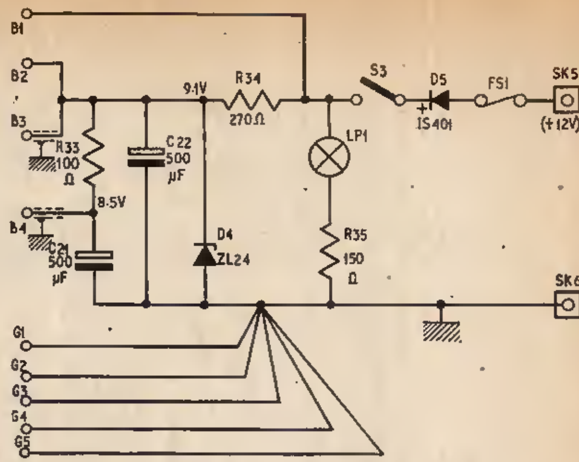


Fig. 12. Circuit diagram of stabiliser circuit

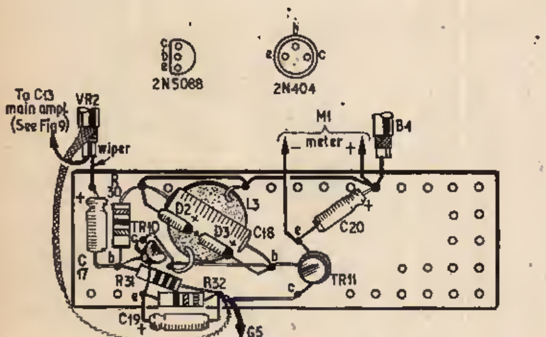


Fig. 11. Assembly and wiring layout of main amplifier board

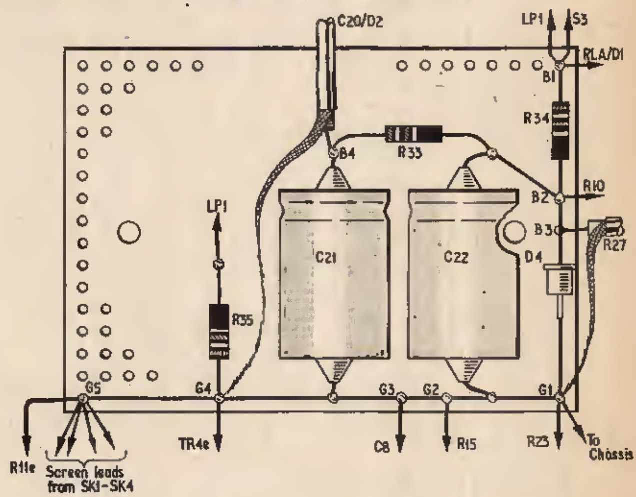


Fig. 13. Assembly and wiring layout of the stabiliser board

COMPONENTS . . .

METER AMPLIFIER

Resistors
R30 56k Ω
R31 33k Ω
R32 5·6k Ω
All ½W, 10% carbon

Capacitors
C17 5µF elect. 15V
C18 0·012µF 5% polystyrene
C19 10µF 6V
C20 1µF 15V

Potentiometer
VR2 20k Ω linear

Transistors
TR10 2N5088
TR11 2N404

Diodes
D2, D3 0A202 (2 off)

Inductor
L3 0·4H LA2301 pot core—Type "B" Assembly (See text)

Meter
M1 0–1mA moving coil 2¼in square

COMPONENTS . . .

STABILISER

Resistors
R33 100 Ω R34 270 Ω R35 150 Ω
All ½W, 10% carbon

Capacitors
C21 500µF elect. 15V
C22 500µF elect. 15V

Diodes
D4 ZL24 9·1V 1·5W Zener
D5 1S401

Switch
S3 Single pole on/off

Lamp
LP1 6V 0·06A MES bulb to fit Eagle IL.115 Indicator Lens (G. W. Smith Ltd)

Fuse
FS1 2A fuse and holder

Sockets
SK5, SK6 4mm insulated terminals coloured red and black (2 off)

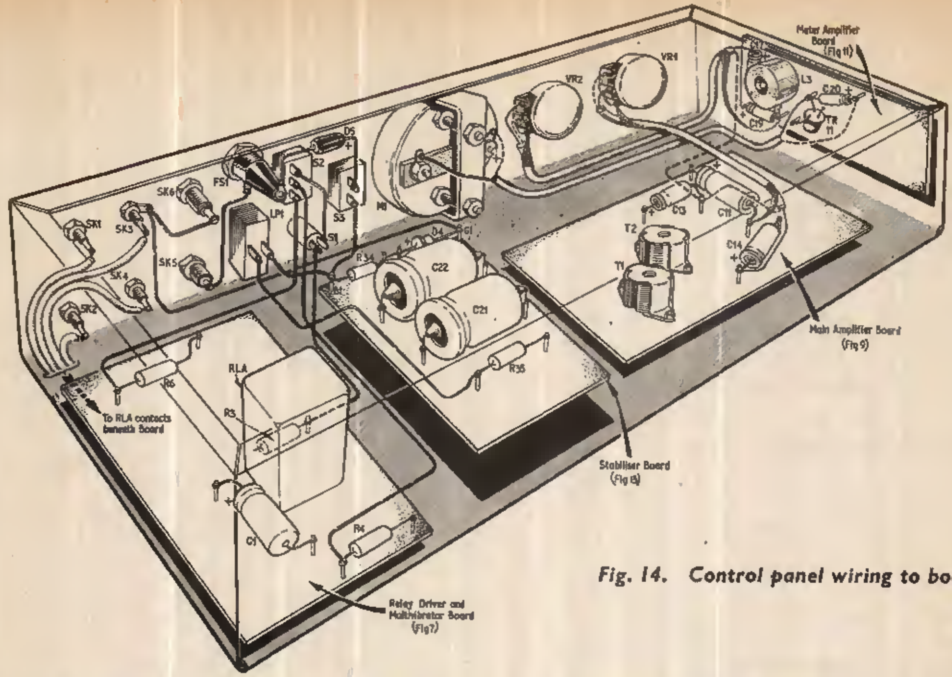


Fig. 14. Control panel wiring to boards

METER AMPLIFIER

The circuit for the meter amplifier is given in Fig. 10. Here VR2 acts as a sensitivity control in feeding the complementary pair TR10 and TR11.

The meter circuit can be used in conjunction with, or to replace the headset.

The meter needle follows the amplitude of the amplifier output which varies at a rate equal to the difference between the two input frequencies. It is particularly useful with very low difference frequencies.

Constructional details of this module are given in Fig. 11.

The inductor L3 is contained in an adjustable pot core, the type being the LA2301, the same as used in the main amplifier.

To achieve the specified inductance, 1,076 turns of 40 s.w.g. enamel covered wire should be wound on the bobbin. With the winding complete the free ends should be cleaned and the bobbin assembled in the cup cores.

The mating surfaces of the cores should be fixed together with an adhesive such as Araldite, and the whole stuck to the Veroboard.

POWER SUPPLY

The power supply stabiliser circuit is shown in Fig. 12. Here the diode D5 will prevent damage if incorrect connection to the power source is made.

The supply to the main amplifier and multivibrator is taken from the Zener diode D4, and that for the meter circuit is additionally decoupled by R33 and C21.

Three separate chassis connections, G1–G3, are made between the main amplifier and stabiliser to prevent the possibility of oscillation.

The supply lead from the 12V battery must be screened. The centre wire is positive and terminates at SK5; the negative screen at SK6. Constructional details are given in Fig. 13.

Since the magnetometer draws about 750mA during "polarise", an adequate heavy duty power source must be used.

CHASSIS ASSEMBLY

Assembly details of the modules on the chassis and front panel interwiring is given in Fig. 14. It should be emphasised that the chassis must be aluminium, and contain as few iron parts as possible, ideally none.

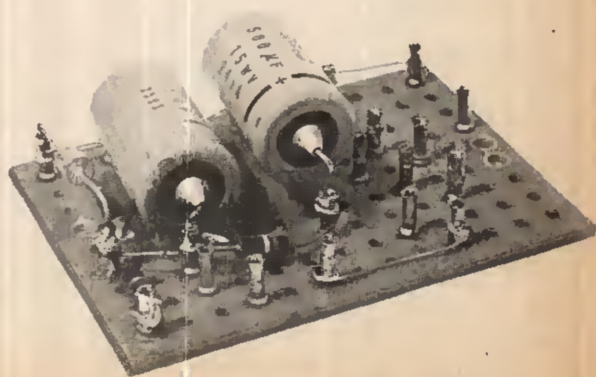
DETECTOR BOTTLES

The detector bottles are plastic, 1⅝in outside diameter and 4in long. The bottle caps must be plastic.

COIL FORMERS

The coil formers for the bottles are made to be a sliding fit. One way to do this is to roll each bottle in a couple of thicknesses of paper, cover that with a layer of thin plastic sheet, such as is used for food wrapping, and then wind on two or three layers of glass cloth as shown in Fig. 15.

The glass cloth is impregnated with epoxy resin and left to cure. The final thickness of the former wall



Prototype power supply stabiliser board

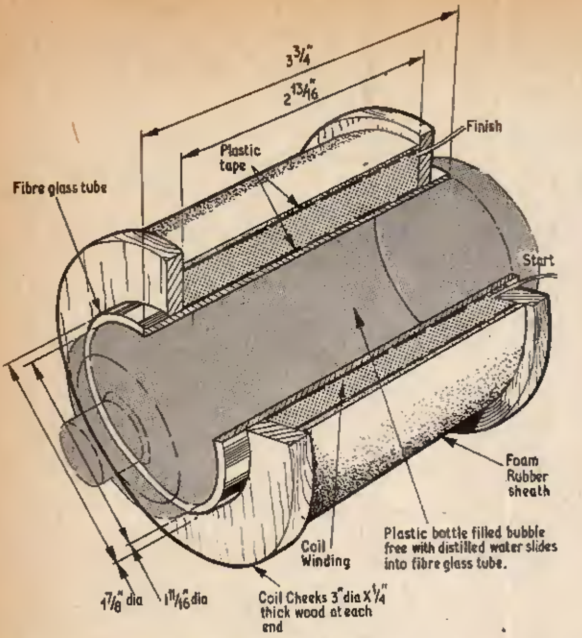


Fig. 15. Constructional details of detector coil former

COMPONENTS . . .

Detector Coils

L1, L2 0·021H 750 turns of 24 s.w.g. enamelled copper wire wound on 1⅝in × 4in plastic bottle formers (2 off) (See text)
PL1–PL4 Phono plugs (4 off)

Carrying staff

¼in wood cut as required 4–½in brass wood screws (see text)

All Other Miscellaneous Items

Aluminium chassis and top panel 13½in × 5in × 2½in (H. L. Smith)
Knobs (2 off), carrying strap, plastic covered connecting wire, twin conductor screened lead, single conductor screened lead.
BY1 — 12V, HP1

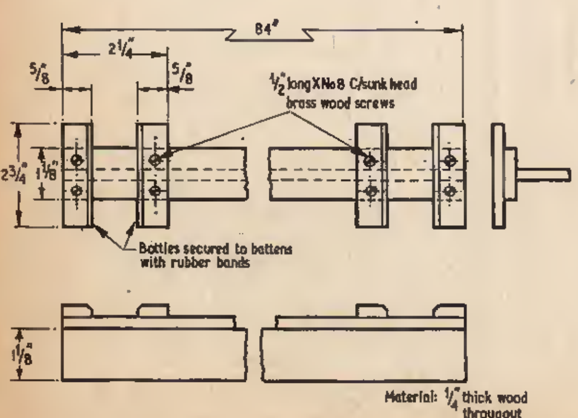


Fig. 16. Constructional details of carrying staff

should be about $\frac{1}{16}$in. Once the epoxy has hardened, the outer surfaces should be sanded smooth, and two wooden cheek pieces epoxied on. This gives a very rugged former. Two small holes are drilled in one cheek, one close to the bottom, the other near the top, to bring the ends of the coil out through. The former is then covered with a layer of insulating tape.

WINDING THE DETECTOR COILS

Carefully solder an eight inch length of fine plastic covered multistrand wire to the start of the coil wire and insulate the joint with thin sleeving.

Three inches of the multistrand wire are passed out through the bottom hole in the cheek to make the wiring connections to. Seven hundred and fifty turns of 24 s.w.g. enamelled coil wire are now wound on. The winding should be as neat and even as possible.

If a lot of rough use is foreseen in the future, it might be prudent to spend a little more and use coil wire with a tougher coating. A suitable coating is armoured polythermaleze. With the winding completed the free end is joined to another piece of multistrand, the joint insulated and the wire taken out through the remaining hole in the cheek.

The complete winding is covered with a couple of layers of plastic insulating tape. For further protection, put on a layer of thin foam rubber or plastic. At this point take a break to steady the hands and then make the second coil in exactly the same way.

Now if it is possible to measure the coils, the inductance of each should be 0·021H and the resistance about 7·9 ohms.

CARRYING STAFF

Details of the carrying staff construction are given in Fig. 16. This is of wood, the cross members being attached with brass wood screws.

D.C. CHECK OUT

Give the wiring and all solder joints a final careful check, making sure that all semiconductors are connected correctly. Set all controls to minimum and connect to a 12V power source. Switch on and check all given d.c. voltages with a test meter (20,000 ohms per volt).

Operate the press switch S1 which should energise the relay when the switch S2 is at "Manual". Switch the latter to "Auto"; the relay should now cycle on for three seconds and off for three seconds.

If the periods are unequal try substituting different electrolytics for either C2 or C3 in the multivibrator. These capacitors have a very wide manufacturing tolerance which may affect the timing. Once the meter circuit is cycling correctly, connect the test meter across the detector input sockets SK1 and SK4. The meter should read 12V when the relay is closed, and zero volts when it is open. Switch the supply off.

Check that the meter reads about 43 ohms across the input sockets SK1 and SK3. This ensures that the relay is switching the two inputs to the input transformer.

METER AND FIELD CHECK

Connect up the detector bottles and turn the supply on again.

If an oscillator is available, make a loop of wire across its outputs and set it near the end of one of the bottles.

Turn up the amplifier gain control slightly and a loud note should be heard in the headsets if the oscillator is adjusted between 2,000Hz and 2,500Hz. At this

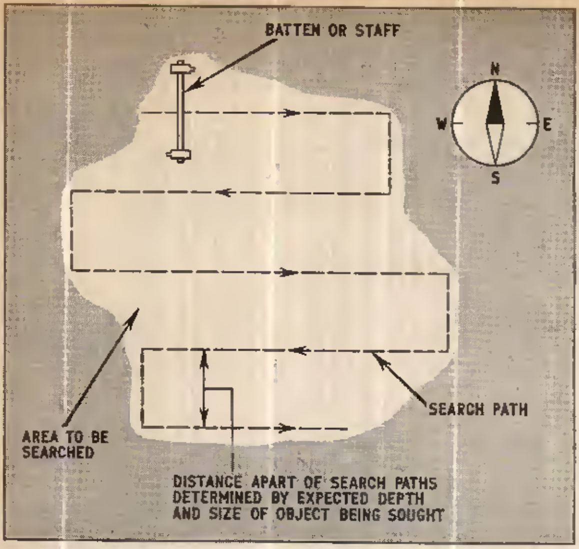


Fig. 17. Search pattern that should be followed when using the magnetometer

Place a pound mass of iron—pair of pliers or hammer—about two feet below one of the bottles and switch S2 to "Auto".

QUAVERING NOTE

A note with a marked quaver should be heard on the "detect" portion of the relay cycle. Adjust the gain to give a convenient output in the headset.

Vary the distance between the iron mass and the bottle until the note peaks about five times during "detect".

Try going up or down a few preferred values on the tuning capacitors to get the loudest signal. Then fine tune by adjusting the tuning core in the ferrite cores. If the gain of the meter circuit is turned up the meter should follow the amplitude of the detected signal, the height of the peaks shown falling over the detect period.

All is now in order, heave a sigh of relief, the magnetometer is ready to go to work.

USING THE MAGETOMETER

It is probably obvious by now how the device can be used. The area to be searched should be traversed,

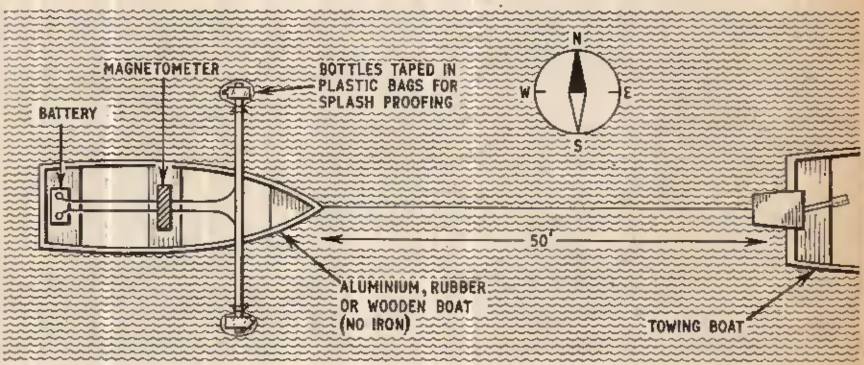


Fig. 18. Arrangement of magnetometer equipment in a boat

frequency turn up the meter gain control until the meter reads about half scale. Turn the oscillator off, whereupon the note should disappear, and the meter needle fall to zero.

Switch S2 to "Auto", the coils will now be energised each time the relay is closed. This can be checked by holding a compass near each one and seeing that a field is produced.

No further testing can be carried out indoors. The unit must be taken to some spot at least a quarter of a mile from all wires, buildings, and possible sources of electrical or magnetic interference and ferrous junk.

TUNING

The resonant circuits have now to be tuned to the exact precession frequency produced by the earth's field at the site chosen for the test. This will be between 2kHz and 2·5kHz.

Once so tuned the magnetometer can be used within a radius of a hundred miles or so of the test site. At greater distances the tuning should be checked, and corrected if necessary.

The staff with the bottles should be set with the bottle axes pointing east–west, that is the staff points north–south (see Fig. 4). The chassis should be somewhere along a line east–west through the middle of the staff.

With S2 switched to "Manual", turn the audio gain full up. There should only be some noise in the headset, and no trace of oscillation. Now turn the gain down to about half.

moving so that the coil axes point east–west; this gives maximum sensitivity.

Move fairly slowly, remember that it takes six seconds for one polarise and detect cycle, so do not overshoot small objects.

Alternatively, walk a couple of steps, let the device cycle and then move on a few more. Once something is detected, move around until the quaver reaches its fastest, when the "something" should be somewhere beneath.

DETECTION CAPABILITY

The size of that something and how far down it is will only be resolved by digging. As a rough and ready guide as to what to expect, a one pound mass should be detectable at about five feet below one of the bottles, and a one ton mass at around forty feet.

Size, distribution of metal and the attitude of the object all affect the magnetometer's ability to detect it; the best way to evaluate its performance is by experiment with a number of different objects.

In Fig. 17 is shown the traverse pattern that should be employed for overland searches.

When working from a boat it is simpler to keep the bottles near the surface, rather than make an elaborate underwater housing to get it near the bottom. Using this method, some idea of a wreck size and depth can be more easily estimated. A typical arrangement for aquatic search purposes is given in Fig. 18. ★

THERMISTOR THERMOMETER

A SPECIAL PROJECT FOR BEGINNERS

THIS month we present an Air Thermometer with a range of 0–50°C (32–122°F) which is more than adequate for indoor measurement. Since the readout is essentially a linear function of temperature, a sensitive 50μA moving coil meter can be used directly, no scale re-calibration being necessary.

THERMISTOR BRIDGE

The element of the circuit in Fig. 1 which makes temperature measurement possible is the thermistor X1. Unlike ordinary conductors its resistance decreases with increasing temperature. In order to magnify the effect of the current variations produced, the thermistor has been arranged with other resistors and potentiometers to form a bridge circuit and so multiply the effects of thermal changes at the meter.

To understand the working of the bridge let S1 be switched to the temperature measurement position. Looking round the bridge arms it can be seen that the lower arms are of equal resistance with variation possible at the upper arms in VR1 and the thermistor.

To arrange that zero current through the meter coincides with an environmental temperature at the thermistor of 0°C means adjusting VR1 until the voltages across R3 and the meter M1 are equal. The bridge is then said to be balanced.

When the thermistor subsequently is exposed to other higher temperatures in the range 0–50°C its resistance changes proportionally to the new temperature and the bridge is unbalanced. The voltage across R3 and M1, is then proportional to the temperature change.

LINEAR TRACKING

In order to linearise the thermistor's logarithmic resistance/temperature characteristic it is necessary to add the resistors R5 and R6. Since manufacturing spreads can provide variations of $\pm$20 per cent on this characteristic it may be necessary, in individual cases, to vary slightly by experiment, the value of those resistors for linear tracking of the meter with temperature change.

CONSTRUCTION

The T-Dec is used for mounting the majority of small components, the pre-set potentiometers being connected to the control panel. Assembly details are shown in the photograph.

Be careful when soldering the thermistor leads to wire lengths as the former are fragile, in addition they should not be reduced in length. When joints are made they should be sleeved to prevent inadvertent short circuits.

Since there is nothing critical in the circuit apart from the calibrations, other constructional methods may be employed.

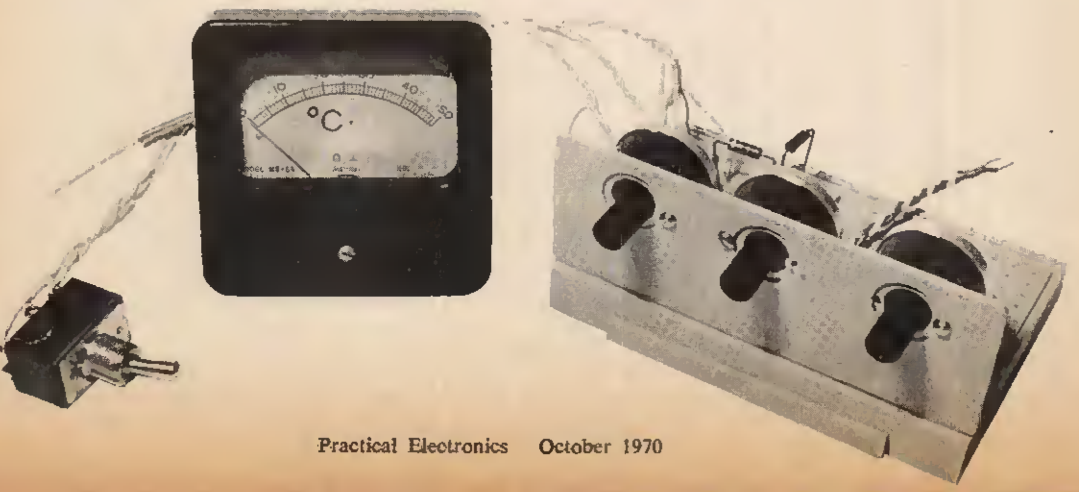
CALIBRATION

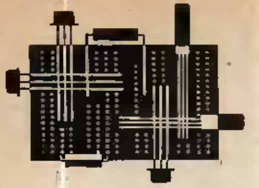
The requirements for calibration are an ordinary Celsius mercury thermometer and environments for fixing the scale limits. Since the stabilisation of the zero point (0°C) takes some time a refrigerator freezer compartment is to be preferred in fixing this lower reference.

With the potentiometer VR3 set to about mid-position and the thermistor placed in the freezer, adjust VR1 for a null on the meter. This adjustment should be maintained over a period of ten minutes.

To fix the upper point (50°C), the thermistor should be transferred to a water bath heated to this temperature. Since the thermistor lead is glass encapsulated this can be partially immersed, but make sure the wire leads do not come in contact with the water.

To obviate inaccuracies, the water should be stirred from time to time with the bulb thermometer. When this indicates 50°C adjust VR3 so that the meter needle aligns at 50μA. The calibration procedure should be repeated at least twice.





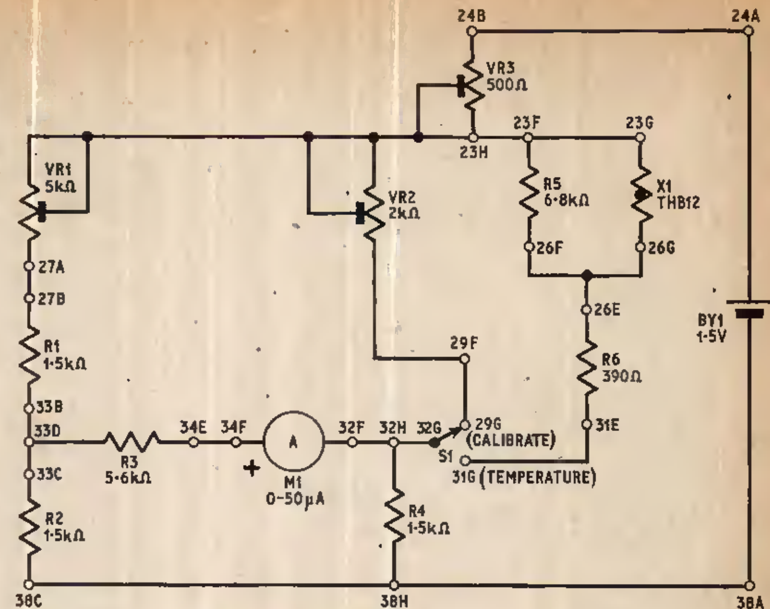


Fig. 1. Circuit diagram of the air thermometer

The meter should be checked for tracking linearity by reducing the temperature of the water bath. If iced water is added this part of the calibration can be rapidly undertaken. Once again before each measurement the water should be stirred and comparisons between meter and bulb thermometer made at 10 degree intervals.

If the readings are graphed, temperature against microamps, the plots made should roughly align with a straight edge; if not the value of R5 and R6 may need to be slightly altered. Here, R5 will affect the lower end of the meter scale and R6 the upper. Experiment with resistor values approximating to those given should provide linear tracking.

BATTERY CHECK

With deterioration of the battery and consequent reduced line voltage, meter readings will be displaced from true so it is necessary to compensate for this.

In the initial calibration it was arranged that the peak temperature reading should coincide with the 50 mark on the meter. If a potentiometer is arranged to have the same total resistance as that contained in the thermistor arm at that temperature then it can be switched in when required as an upper point calibration check.

VR2 is adjusted to achieve this; when it is necessary to check the battery condition S1 is switched to "calibrate". If the meter needle shows full scale deflection, all is well; if not, VR3 should be adjusted.

★

COMPONENTS . . .

Resistors
R1 1·5kΩ R3 5·6kΩ R5 6·8kΩ
R2 1·5kΩ R4 1·5kΩ R6 390Ω
All 10%, ½ watt carbon

Thermistor
X1 THB12 (Radiospares)

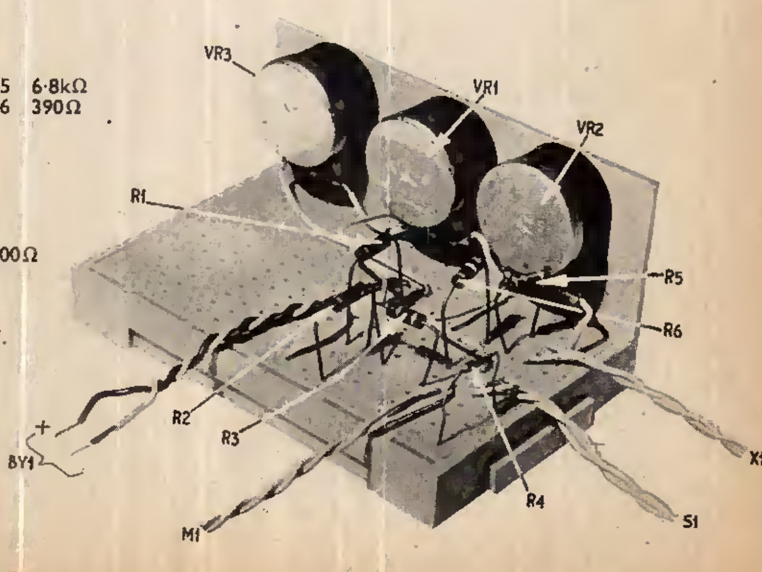
Potentiometers
VR1 5kΩ VR2 2kΩ VR3 500Ω
All wirewound linear presets

Meter
M1 Moving coil meter, 0–50μA f.s.d.

Switch
S1 Single-pole, double-throw toggle switch

Battery
BY1 1½ volt, HP2

Miscellaneous
T-Dec, connecting wire



THIS concluding article in the series continues with electromechanical output transducers, particle and radiation sensors, then follows with special purpose semiconductor devices.

CONCLUSION OF A NEW SERIES FOR THE BEGINNER

THIS

ELECTROMECHANICAL OUTPUT TRANSDUCERS

We are concerned here with devices that provide a mechanical force to push, pull, rotate, or accurately position some mechanical system in response to an electrical signal.

Solenoid

The solenoid in Fig. 7.1a is a straightforward example of a mechanical output transducer for pushing or pulling. A cylindrical plunger of ferrous material is drawn into the coil by the magnetic field arising from a current flowing in the wire turns. The force is only attractive and the plunger is returned to its original position by a spring when the current ceases to flow.

Electromagnet

Another simple type of transducer for supplying a mechanical force is the electromagnet with pivoted armature as in Fig. 7.1b. When a current flows through the coil, the core is magnetised and attracts the ferrous armature against the tension of a return spring.

Servomechanisms

A more sophisticated arrangement for accurate linear or rotational positioning is the d.c. proportional servo, so called because the output motion is proportional to the input signal. Applications include the remote panning of closed-circuit television cameras, rotating aerials, and radio control of models.

The servo uses a d.c. motor as an output transducer, which is coupled via a gearbox to a feedback potentiometer. As the diagram in Fig. 7.1c shows, a pinion gear on the gearbox shaft can convert the rotational motion of the motor spindle into a linear push-pull movement when so required.

The d.c. servo operates as follows. In the absence of an input signal the motor is stationary with zero volts at the amplifier output, and the potentiometer slider is half way along the resistance track. When a d.c. signal is applied to the comparator, it will be amplified to a level sufficient to cause the motor to rotate.

The potentiometer slider moves to a setting where the feedback signal has the same value as the input signal and is of opposite polarity, thus cancelling the input signal and switching the motor off.

Stepping Motor

Stepping motors are derived from synchronous motors of the type used in clock and timer mechanisms.

When connected to a special electronic switch circuit, the stepping motor can be speed-controlled in both directions, and will also offer a rotational output consisting of a series of angular steps. The stepping motor armature has permanent magnet poles—usually 12—and two field coils, see Fig. 7.1d.

If a single pulse is fed to one of the inputs of the electronic switch the armature will move $\frac{1}{12}$ of a revolution, but a fast train of pulses at the input will cause smooth rotation at a rate dependent on pulse repetition frequency. Thus, there can be complete control of motor speed and spindle positioning.

PARTICLE AND RADIATION SENSORS

Radioactive substances emit electromagnetic waves (gamma rays) and high speed atomic particles. Gamma radiation is equivalent to x-rays of high energy. There are several kinds of particle, such as the fast moving electron (beta particle) and the helium nucleus (alpha particle).

Silicon Alpha Detector

Alpha particles can be counted by specially constructed silicon diodes, and germanium diodes—with an extra layer of intrinsic semiconductor material inserted between the *n*- and *p*-type regions (*pin* diode)—will respond to gamma rays.

The silicon diode in Fig. 7.2a has a gold leaf window which offers little resistance to the passage of an alpha particle. When reverse biased, the diode emits a pulse as an alpha particle penetrates the window and causes ionisation of silicon atoms.

Geiger-Müller Tube

The Geiger-Müller tube (Fig. 7.2b) is an extremely sensitive detector of individual beta particles and gamma ray quanta. The tube is filled with an inert gas plus additives to ensure that an electrical discharge between the cylindrical and wire electrodes is quenched quickly.

ELECTROMECHANICAL OUTPUT TRANSDUCERS

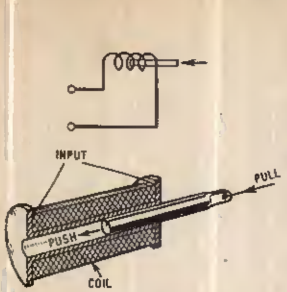


Fig. 7.1a. Moving core solenoid

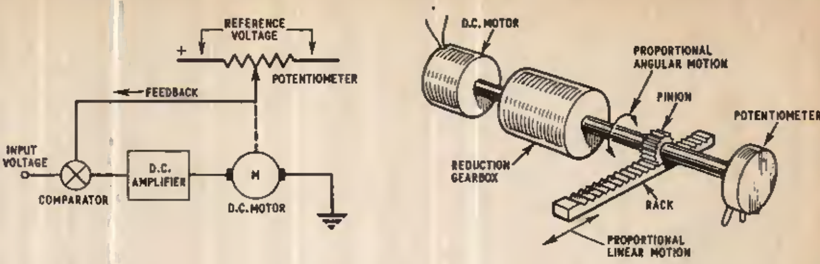


Fig. 7.1c. Proportional d.c. servo mechanism

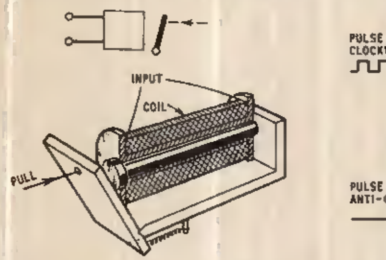


Fig. 7.1b. Electromagnet relay switch

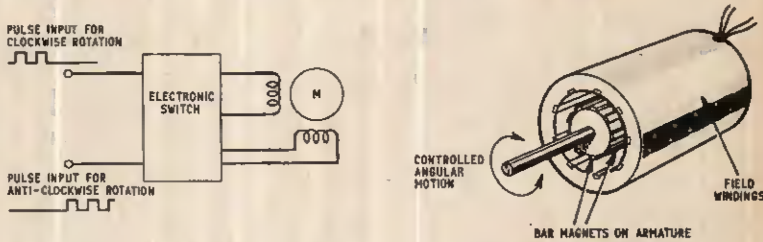


Fig. 7.1d. Synchronous stepping motor (magslip)

WAY TO ELECTRONICS 7

RADIATION SENSORS

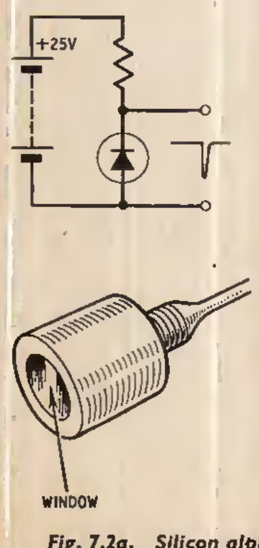


Fig. 7.2a. Silicon alpha particle detector

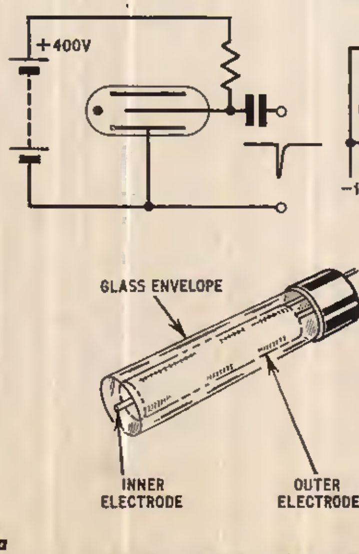


Fig. 7.2b. Geiger-Müller tube

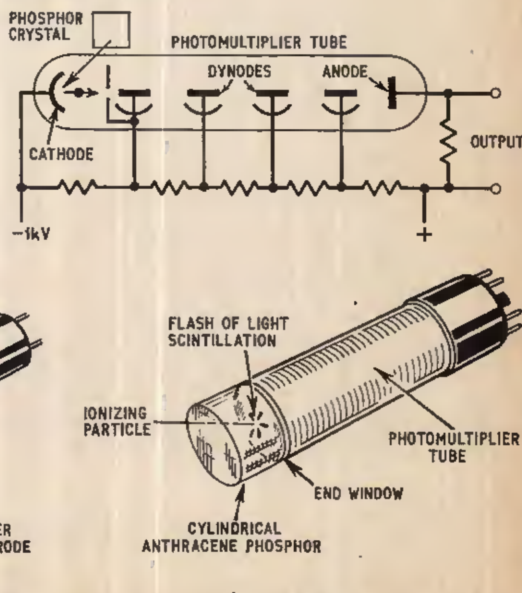


Fig. 7.2c. Scintillation counter

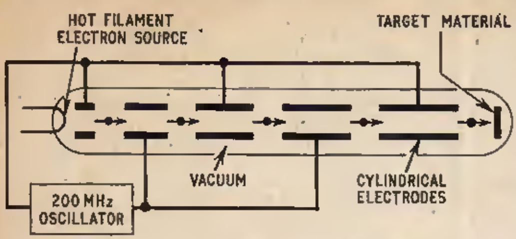


Fig. 7.3a. Linear particle accelerator

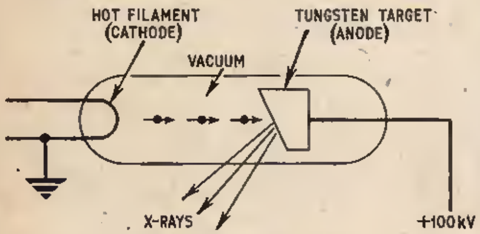


Fig. 7.3b. X-ray tube

On arrival of a particle, a momentary discharge takes place, due to ionisation of gas atoms, thus giving an output pulse. The tube is ready to receive the next particle after a recuperation period of about 200 microseconds.

Scintillation Counter

Certain transparent materials and crystals will emit flashes of light when bombarded by nuclear particles. In the scintillation counter, a photomultiplier tube is employed to detect each flash.

Briefly, the process is as follows, see Fig. 7.2c. A minute flash of light within the transparent block of material is picked up by the photomultiplier cathode, which then ejects a few electrons. The electrons then travel to the first dynode and liberate more electrons. So, at each dynode there is a progressive multiplication of the electron stream, leading to a large electrical output pulse when the electrons finally arrive at the anode.

Particle Accelerator

The linear accelerator in Fig. 7.3a emits a beam of high speed electrons having the same properties as beta particles from a radioactive substance.

Electrons from a hot filament source are accelerated along the tube by an alternating, high frequency field applied to cylindrical electrodes. The electrons are given a "kick" by the high frequency field at each gap between adjacent electrodes, thus gaining velocity and resulting in a high energy beam. This beam can either be used to bombard a target or may be emitted from the tube via a thin window.

X-Ray Tube

An x-ray tube is shown in Fig. 7.3b. A hot filament cathode provides a source of electrons, which are accelerated towards the anode by a large positive potential. When the electrons strike the anode target, about one per cent of their energy is converted into x-rays, the remainder is given off as heat. The x-rays emerge from the tube in a conical beam.

THE SEMICONDUCTOR FAMILY

Transistors and semiconductor diodes are important members of a growing family of devices, all depending on the special properties of *pn* junctions. Some of these associated devices will now be examined.

FIELD EFFECT TRANSISTORS

A conventional or bipolar transistor, as explained in Part 3, uses a current on its base terminal to control a flow of current between emitter and collector, and is characterised by an intrinsically low value of input impedance. With the field effect or unipolar transistor (f.e.t.), on the other hand, a voltage on the gate terminal controls a flow of current between source and drain, and input impedance is very high.

The three basic circuit configurations of an f.e.t., common source, common drain, and common gate, behave in much the same way as common emitter, common collector, and common base bipolar circuits respectively. Like a *pnp* bipolar transistor, a *p*-channel f.e.t. has a negative supply voltage on its drain, and the *n*-channel f.e.t. is orientated as an *npn* device. There are two types of f.e.t. construction: junction and insulated gate.

A figure for the d.c. gain of an f.e.t. is obtained from the ratio of a small change of drain current to a small change of gate voltage, called *mutual conductance* or *transconductance* (g_m), and is expressed either as mA/V or μmho, where 1,000 μmho = 1mA/V. A typical g_m for a junction f.e.t. is 4mA/V or 4,000 μmho.

Junction f.e.t.

Looking at the diagram of an *n*-channel junction f.e.t. in Fig. 7.4, a bar of *n*-type silicon is provided with source and drain connections at each end, termed "ohmic" because the connections do not involve *pn* junctions and the bar behaves as a plain resistance. Two *p*-type silicon gate regions are formed on opposite sides of the bar to create a channel through which electrons moving from source to drain must pass. The gates make two *pn* junctions with the bar, having associated depletion regions as explained in Part 2.

If a voltage is applied between gates and source, to reverse bias the *pn* gate junctions, the depletion regions —shown dotted in Fig 7.4—will extend towards each other, making the channel narrower, and tending to "pinch off" a flow of electrons from source to drain. Gate input impedance is high because only a minute leakage current can pass through the depletion regions as long as the gate junctions remain in the reverse biased condition. It follows that external input biasing of a junction f.e.t. should be such that the gate is always maintained at a lower potential than the source, to preserve the depletion regions.

The two separate gate regions of the junction device are usually joined together internally, but some f.e.t.s have independent gate connections to allow two input signals to be mixed together to yield a combined output; see dual gate f.e.t. circuit symbol, Fig. 7.4.

Insulated gate f.e.t.

The insulated gate field effect transistor or i.g.f.e.t. (also called metal oxide silicon or m.o.s.f.e.t.) has a gate electrode which is completely insulated from source and drain by a layer of metal oxide, irrespective of input voltage polarity. There is also an extra terminal labelled "substrate" which can either be joined externally to the source, or may be used as an independent bias or input terminal. The gain of an

F.E.T. AND U.J.T.

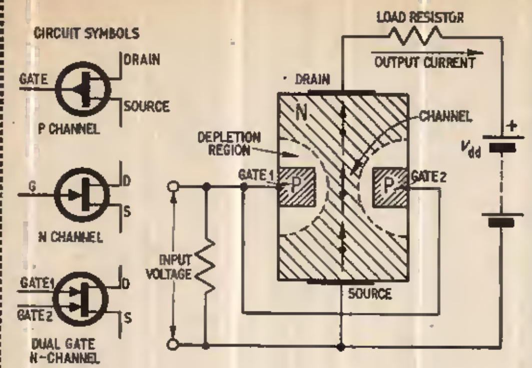


Fig. 7.4. N-channel junction field effect transistor and circuit symbols

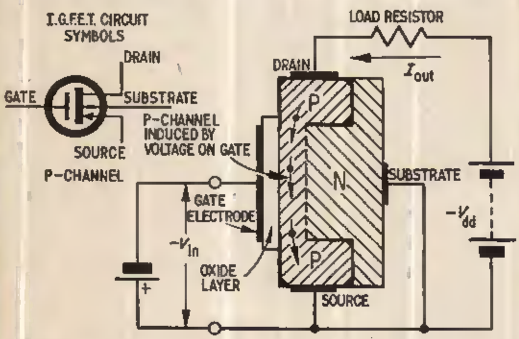


Fig. 7.5a. Enhancement mode P-channel i.g.f.e.t.

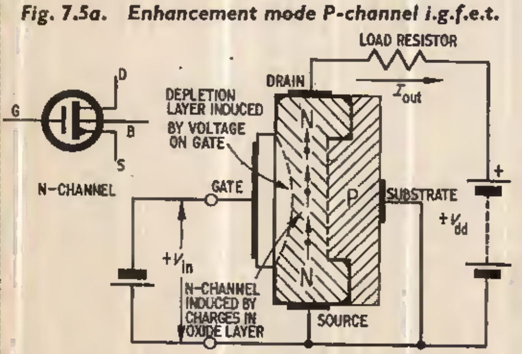


Fig. 7.5b. Depletion mode P-channel i.g.f.e.t.

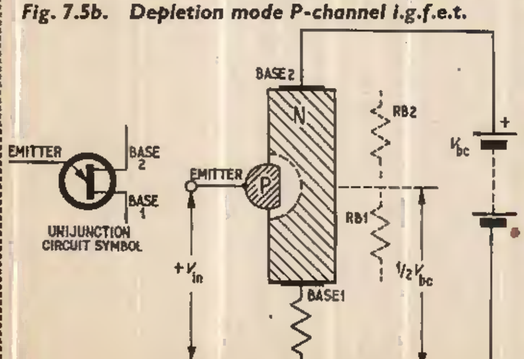


Fig. 7.6. Unijunction transistor

i.g.f.e.t. usually lies somewhere between 0·5–2mA/V, slightly lower than for a junction f.e.t.

There are two distinct kinds of i.g.f.e.t. In the enhancement mode there is no flow of current between source and drain when the gate is at source potential. A depletion mode device, on the other hand, has mean conductivity between source and drain when the gate is at source potential.

Enhancement mode

An enhancement mode *p*-channel i.g.f.e.t. is shown in Fig. 7.5a. Source and drain are formed by two *p*-type regions which are separated physically and electrically by an *n*-type substrate. For a current to flow between source and drain, the intervening substrate must be given *p*-type properties. How then is this achieved?

Consider the gate electrode and substrate as the plates of a capacitor, separated by the oxide insulator. A negative charge on the gate electrode will induce a positive charge in the substrate by normal capacitor action, in effect replacing the *n*-type surplus of electrons with a *p*-type surplus of holes directly under the oxide layer, and this forms a narrow channel linking source and drain.

Because the enhancement mode device can only conduct as a result of a voltage on its gate, it is normally biased so that the gate is at about $0{\cdot}5\,V_{dd}$, or alternatively with the gate directly coupled to the drain of a previous, similar stage.

Depletion mode

The depletion mode *n*-channel i.g.f.e.t. shown in Fig. 7.5b operates in the following manner. With the gate at source potential, electrical charges naturally present in the oxide layer will induce a narrow *n*-type channel in the *p*-type substrate, thus linking *n*-type source and drain regions and permitting a current to flow. If the gate is made negative with respect to source, a depletion region will be induced in the channel and source-drain current will be reduced.

The interesting thing here is that a positive voltage applied to the gate merely increases the width of the existing *n*-channel and promotes a greater flow of current between source and drain, without lowering input impedance, as would be the case with a junction f.e.t. or thermionic triode. So, the depletion mode i.g.f.e.t. can operate satisfactorily with zero external bias on its gate.

UNIJUNCTION TRANSISTOR

A unijunction transistor is a three terminal device with one *pn* junction, which acts as a voltage controlled switch by changing from a high to a low impedance state when an input voltage reaches a set value.

It can be seen from Fig. 7.6 that the structure of a unijunction resembles a junction f.e.t. with a single gate, but the mode of operation is quite different. A bar of *n*-type silicon has ohmic connections at each end—termed base 1 and base 2—with a pellet of *p*-type semiconductor fused into one side of the bar to form an emitter region.

If a voltage V_{bc} is applied to base 1 and base 2, the bar will behave like a plain resistance, with a voltage gradient distributed along its length. Assume that the potential midway along the bar, in the vicinity of the emitter pellet is $0{\cdot}5\,V_{bc}$, and that the bar resistance is represented by two equal resistances R_{B_1} and R_{B_2}. As long as the emitter potential is less than $0{\cdot}5\,V_{bc}$, the *pn* junction will be reversed biased and non-conducting, with a high internal impedance. However, if the

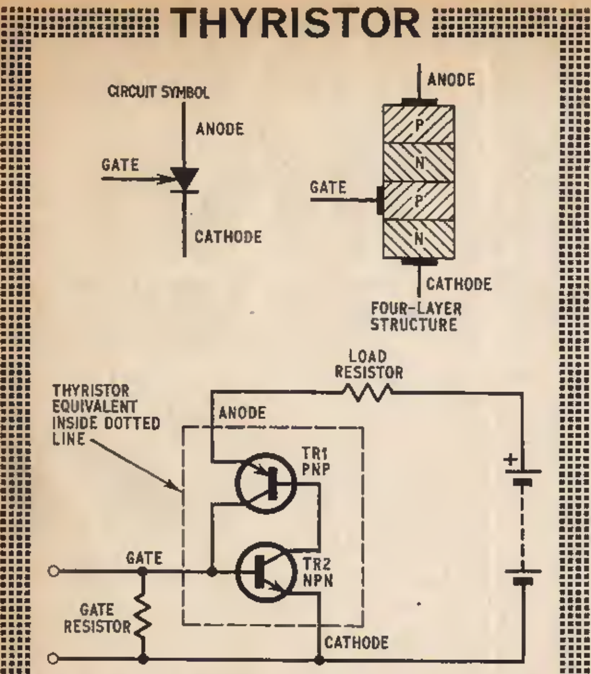


Fig. 7.7. The thyristor and an equivalent circuit showing the principle of operation

potential of the emitter should exceed $0{\cdot}5V_{bc}$, the *pn* junction will start to conduct with forward bias, and in this condition the resistance of R_{B_1} is lowered by a mechanism of hole injection from the emitter region. As R_{B_1} grows smaller so current flow and hole injection increase, creating an avalanche effect which rapidly lowers emitter impedance. To reset the unijunction to its former high impedance state, the emitter voltage must be brought down almost to the level of base 1 potential.

The unijunction is often employed as a capacitor discharger in timing circuits.

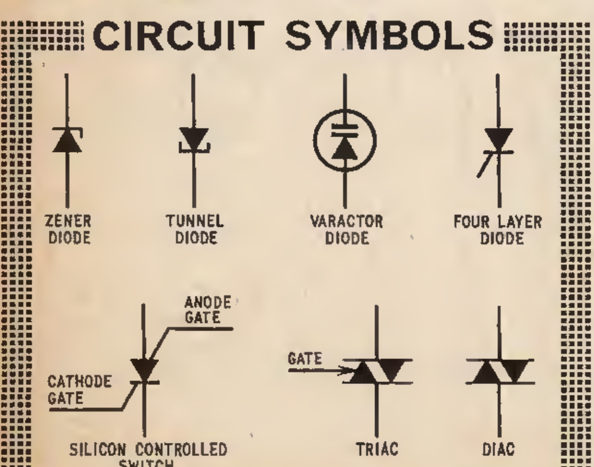


Fig. 7.8. Circuit symbols of various other devices

THYRISTOR

The thyristor, or silicon controlled rectifier (s.c.r.) is a three terminal, four layer *pnpn* device which conducts in one direction only, like a diode, when triggered by an input current. Because the thyristor has four semiconductor layers and three junctions, with built-in transistor action, its operation is best explained by using a simplified model or equivalent circuit where two complementary transistors TR1 and TR2 represent the thyristor, as in Fig. 7.7.

In the absence of an input current on the gate terminal (base of TR2), both transistors are switched off and no current flows between anode and cathode terminals. It can be seen that TR1 and TR2 are connected so that a flow of collector current in one will cause a flow of base current in the other.

If a small positive input current is applied to the gate terminal, it will tend to turn TR2 on, and TR2 collector current turns TR1 on. As TR1 goes on, its collector current reinforces the gate input current (positive feedback), and so the circuit rapidly reaches the condition where TR1 and TR2 are holding each other fully on, and remain so when the gate input current is removed. In other words, the thyristor has a self-latching action, and can only be reset by removal of the anode supply voltage.

If the battery of Fig. 7.7. circuit is replaced by an a.c. supply, the thyristor will behave like a half-wave rectifier when a continuous gate signal is present, conducting during alternate half-cycles via the load resistor. When the gate signal is removed, the device turns off as soon as the a.c. potential reaches zero during a cycle, and then remains off until another gate signal is applied.

So, the mean current flowing via the load resistor can be controlled by timed gate pulses, and this is the principle of one type of electric motor speed controller. The outstanding advantage of thyristors is that they are capable of handling large output currents at high voltages with minimum heat dissipation, and are therefore useful for controlling mains powered equipment.

OTHER SEMICONDUCTOR DEVICES

There are, in addition to those already covered in this series, a few devices which have been designed to exploit some special semiconductor property, or are derived from more common devices, see circuit symbols Fig. 7.8 and following list.

Zener diode. Variant of the silicon diode used for voltage stabilisation or as a voltage reference.

Tunnel diode. Specially doped diode which can be made to function as an amplifier, switch, or oscillator at high frequencies.

Varactor diode. Behaves like a small variable capacitor when biased by a variable reverse voltage.

Four layer diode. A small, two terminal version of the thyristor; switches on when the anode-cathode voltage reaches a set value.

Silicon controlled switch. A four layer device akin to the thyristor which has each semiconductor layer made accessible. Used for switching applications.

Triac. Bidirectional thyristor used for full-wave control of a.c. currents.

Diac. Bidirectional version of a four layer diode. Normally employed with triac in control circuits.

This series of articles has attempted to introduce the beginner to basic principles in electronic components and circuitry. A wealth of more detailed information appears in some of our other published articles and in books usually available in public libraries. ★

NEXT MONTH-WE INTRODUCE

the PE GEMINI

DUAL PURPOSE STEREO AMPLIFIER

Designed to provide the high standard of performance expected from modern sound reproducing systems, this amplifier has, in addition, microphone mixing facilities which extend the general usefulness of the equipment in the area of home entertainment and also make it suitable for discotheque and p.a. applications

- 30W output per channel into 8Ω
- 20W into 15Ω
- 15 W into 4Ω
- Disc, tape, radio, and Mic. inputs
- Mic. can be mixed with any other input
- Truly complementary output transistors
- Full range filters and tone controls
- Outputs open and short circuit proof
- Low impedance stabilised power supply
- Two units in matching style

SEE AND HEAR THE CHANGING PATTERNS OF HOME ENTERTAINMENT... ON STAND 68

The PE GEMINI Amplifier, and a new design electronic controlled mood lighting system will be demonstrated at the International Audio and Music Fair, Olympia, London

ALSO IN THIS ISSUE

SPECIAL SUPPLEMENT ON AUDIO EQUIPMENT

A guide to hi-fi system planning. Deals with practical matters such as matching and connecting up the various items, from pick-ups to loudspeakers, and their maintenance

PRACTICAL ELECTRONICS

NOVEMBER ISSUE ON SALE OCTOBER 15

Mini Computers Through Dealers

PLANS for the setting up of appointed dealers to market their low cost System 21 display terminals and computers was outlined at the official opening (July 29) of Viatron Computer Systems (U.K.) Ltd., at Finchley.

Marketing will be handled through dealers who can provide supporting software systems and management consultancy associated with data processing.

The basic System 21 terminal configuration includes a micro-processor with two Viatape recorders, which accept tape cassette cartridges similar to those used on the entertainment market; keyboard; two data channels and a video display.

The 2111 Microprocessor has a main memory capacity of 400 characters. This 400-character memory is divided into five separate 80-character storage areas, designated as the READ record, WRITE record, MASTER record, CONTROL 1 record, and CONTROL 2 record.

Integral to the microprocessor are four input/output channels. Two of these internal data channels are devoted solely to reading and/or writing from one or two Viatape recorders.

C.C.T.V. Camera

ONE of the latest constructional projects to be produced for schools and other teaching establishments by the Mullard Educational Service is a closed-circuit television camera. It can be built for as little as £45—claimed to be two or three times less than the cost of the cheapest professional camera.

The camera uses a 1 inch vidicon tube which, together with the lens system, accounts for approximately 75 per cent of the total cost.

It employs extremely simple basic circuitry, easy for the student to construct. No extravagant claims are made for the camera's performance, but given reasonable lighting conditions it will provide an output signal of 1·0V p-p into 75 Ω; capable of producing an acceptable picture on a TV monitor. The low impedance signal output further allows the distribution of the TV signal to other monitors at remote positions. At a recent press reception the camera was demonstrated and proved to give an excellent picture for its price and simplicity.

A block schematic of the camera and preliminary information about the circuit are available now. A more formal publication will be issued later in the year. Linstead Electronics will be marketing a kit for the camera as well as complete units. It is hoped that a modulator will later be added to the circuitry.

The complete prototype Mullard camera made from readily available components for about £45

Speed Radar

MARCONI Marine's new SAMI doppler Speed of Approach Measurement Indicator shown on the left in use on an oil jetty on the River Thames as a 100,000 ton tanker comes in to berth. Speed of approach is measured on the large meter in the upper cabinet and also on that in the lower cabinet, while a permanent record is simultaneously made showing direction of movement, as well as speed, on the graph recorder in the upper cabinet. The upper cabinet which contains all the signal processing circuitry is detachable and may be sited separately in a pressure proof hut. Information regarding the speed and movement of the vessel is passed to the pilot by v.h.f. radiotelephone.

Now a very necessary equipment—with the size of ships increasing it is more difficult for the pilot to judge the speed of approach—the speed indicator can assist in the docking of all vessels in any weather conditions.

Automatic Control

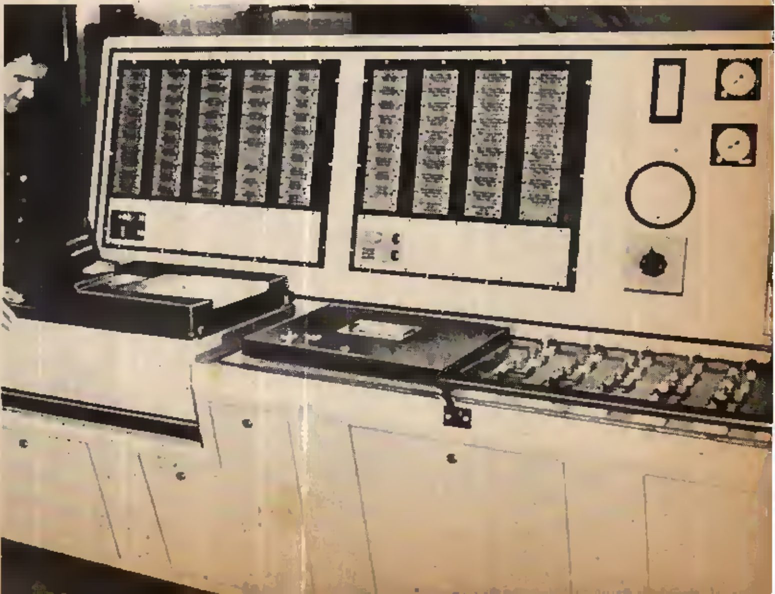
THE Norwegian fisheries research vessel "*G.O. Sars*", designed to meet future demands in fisheries investigation for the next decades, carries a computer data logging system, acoustical instrumentation and a complete machinery remote control console. All monitoring and bridge remote control equipment was supplied by Amund Clausen A/S.

The remote control console is shown below; this console is linked to a slave console on the bridge and comprises control instruments, pressure and temperature measuring devices for all essential engine functions, engine speed, propeller speed and pitch monitoring and control for all four main engines. The engines are automatically speed synchronised before they are coupled to the reduction gear, load distribution and propeller pitch regulation to protect the engines are also automatic.

Monitoring System

AN alarm, scanning and monitoring system, manufactured by Decca and called ISIS 300, provides a standard range of instrumentation from which individual configurations may be selected for vessels ranging from yachts to supertankers.

The photograph below shows an installation in the 250,000 ton *Esso Northumbria*, the largest vessel built in Britain. The system's local scanning facility covers 120 points on the main machinery, cargo pumps and electrical generating equipment.



AUDIOMETRY...

ASSESSMENT OF HEARING IMPAIRMENTS

By S. A. HARDY

ELECTRONICS plays a very large part in providing diagnostic and remedial equipment for the hard of hearing. The hearing aid is widely publicised and advertisements for these devices appear regularly in the daily press. However, little mention is made of the diagnostic facilities available, for example, local medical centres and education authorities. Also it is seldom pointed out that a hearing aid should *only* be used if prescribed by an otologist (ear specialist) as in some cases a hearing aid would serve no useful purpose, or may be a source of great discomfort to the user even to the point of accelerating the degeneration of a hearing impairment.

AUDIOMETER

The measurement of the sensitivity of a patient's hearing under set conditions is of prime importance to the otologist who is making a diagnosis of a hearing impairment.

A simplified block diagram of an audiometer is shown in Fig. 1. The audio sine wave generator may be of the continuously variable tuning type, or it may have preselected fixed frequencies which are based on the physical scale of C = 256Hz and not the British standard concert pitch based on A = 440Hz—where C would be 261·6Hz. The output from the oscillator is fed into an attenuator which is calibrated in decibels against laboratory standards. All extraneous equipment, such as the headset and bone conduction transducer, are included in the calibration process.

Signals are passed from the attenuator into a linear frequency response amplifier which drives either the headset or a bone conduction transducer, probably of the type shown in Fig. 2. The headsets used are of the type which exclude external noise, also the earpieces may be independently selected so that whilst one ear is being tested the other can be fed from a masking (white) noise generator at a preset level. This avoids the possibility of erroneous results due to the tone being fed to the ear under investigation being heard by the other through bone conduction.

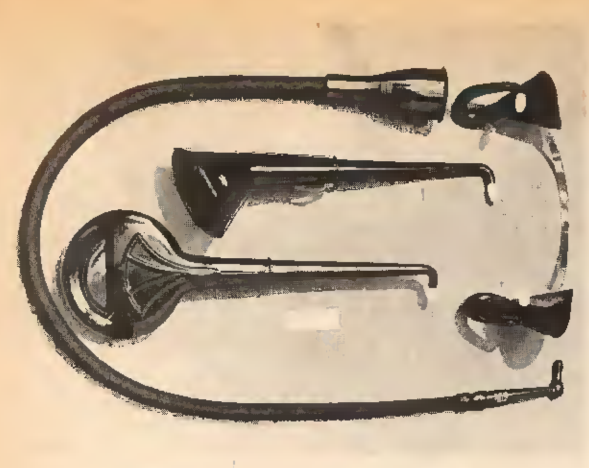
The basis of the audiometric tests is to select at random certain frequencies and moving the attenuator from maximum attenuation to minimum. The patient presses a switch, illuminating a lamp on the audiometer, as soon as the sound becomes audible. The audiometrician, not necessarily an otologist, then prepares a graph called an audiogram which in this particular case would show the patient's threshold to hearing.

AUDIOMETRIC TESTS

A few audiometric tests used in determination of hearing malfunctions, other than the threshold test mentioned in the previous paragraph, are outlined below to demonstrate the usage of the different transducers:

(a) The *Rinne* test is conducted by placing a bone conduction transducer on the mastoid bone just behind the ear under test—the patient then indicates when a tone is no longer audible at a particular level. The tone is then fed directly to the ear at the same level and should be perfectly audible in the case of the healthy ear. The use of masking noise for the ear not under investigation is necessary to avoid ambiguous results.

(b) The *Weber* test is conducted with both of the patient's ears occluded to external noise and tones are fed to a bone conduction transducer placed on the centre line of the forehead. The patient then indicates the ear in which the tones appear. This test is used to prove the binaural function of the ears.



A range of early horn hearing aids

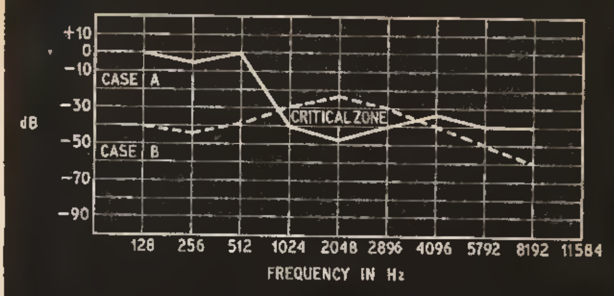


Fig. 3. Audiogram showing the critical area of hearing impairment

(c) The *Gelle* test is carried out by slightly increasing the air pressure in the external auditory meatus and simultaneously introducing a tone via an earpiece. In a normal ear the threshold of hearing slightly increases at frequencies below 1kHz as the pressure is increased. This test is used to show seizure of the stapes.

(d) The *Bing* test is used to demonstrate malfunctions of the middle ear mechanism. This test is carried out by placing a bone conduction transducer against the mastoid bone adjacent to the ear under investigation and the tone level is then turned down until inaudible, then the ear canal is closed off. The tone then becomes audible again in the case of normal ear.

(The titles for the above list are of American origin.)

HEARING AID REQUIREMENTS

Most of the consonants in human speech have frequency products which lie in the range of 1kHz to 4kHz and an impairment of hearing in this frequency range renders speech unintelligible, especially in the presence of background noises. The audiogram (Fig. 3) shows the critical area below which a hearing aid becomes a necessity. For instance case A would find a hearing aid a necessity, even though the low frequency response of the ear is satisfactory. Whereas case B could get by without an aid because the impairment is over the whole frequency spectrum, but there is an improvement over the critical area of the audiogram.

HEARING AIDS

There are many types of hearing aid available from reputable manufacturers. However, the circuits given in Figs. 4 and 5 are Mullard experimental circuits and the design considerations discussed are the same for both aids. Both circuits have TR1 (input) and TR2 (driver) collector currents of approximately 250 microamperes, this being the lowest practicable value consistent with low noise level without signal clipping. Transistor TR3 in both circuits are class A power amplifiers and have standing collector currents of roughly 2·5mA to give outputs of about 0·5mW.

The circuit in Fig. 4, though having more components, is able to cope with large variations in ambient temperature and by siting the volume control between the input and driver stages contact noise generated by the microphone is reduced. If a mercury cell (such as the Mallory RM625) is used; the decoupling components R3 and C3 may be omitted and the cell life is about 100 hours. This circuit gives an output of 0·4mW for 5 per cent total harmonic distortion with an

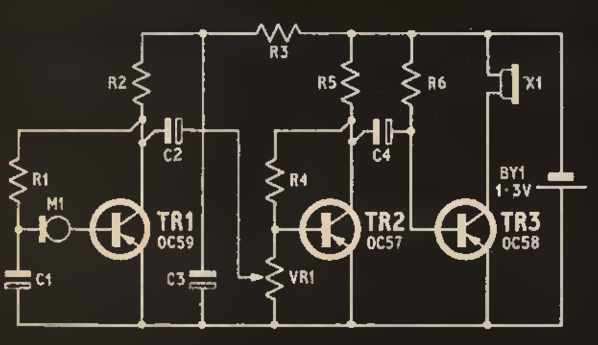


Fig. 4. Hearing aid circuit by Mullard

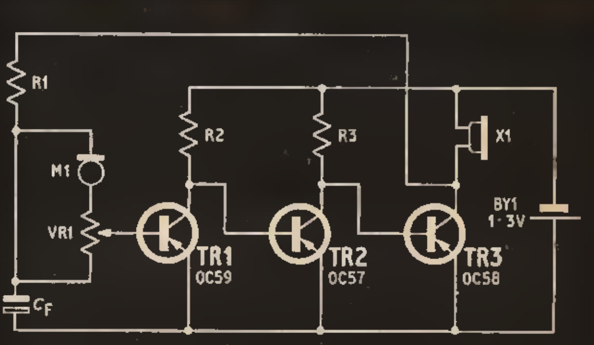
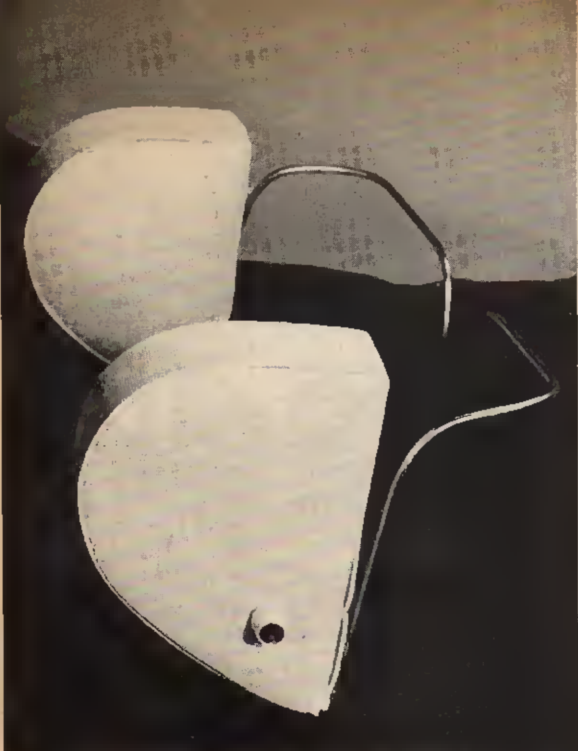


Fig. 5. Mullard hearing aid circuit using a d.c. amplifier

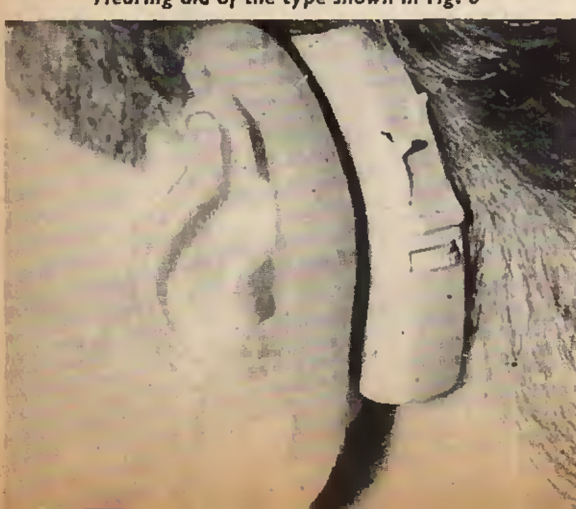


The Audiorama headrest type hearing aid

electrical frequency response that is flat to within 0·25dB between 100Hz and 4kHz.

The circuit of Fig. 5 is intended for use in spectacle frames, hence the requirement of the minimum number of components. However, the d.c. coupled amplifier of this type relies on the feedback loop to govern the d.c. stabilisation of the transistors and their temperature dependent characteristics. Thus the choice of R1 and C_f are critical, as R1 sets TR3 collector standing current and C_f affects the working frequency range of the circuit. A loss of 6dB at 1kHz is considered permissible and a time constant of one second (R1 × C_f) is required. The predicted electrical frequency response of this circuit is within 1·5dB of the response level at 1kHz over the range of 300Hz to 5kHz. However, the battery drain is slightly higher and the circuit has an ambient temperature limitation of 0 to 39 degrees C, the ideal working point being set at 25 degrees C.

Hearing aid of the type shown in Fig. 6



Both circuits have an approximate acoustic gain of 50dB allowing for an overall air to air loss in the microphone and earpiece of 35dB.

TRANSDUCERS

Both circuits (Figs. 4 and 5) use electromagnetic devices for the microphones and earpieces. Two advantages of the electromagnetic device are that it is not affected by high humidity levels and it is less sensitive to contact noise than the higher gain crystal counterpart. Most hearing aids are designed to drive electromagnetic earpieces or bone conduction transducers which are sometimes used for certain types of deafness.

Some aids, such as the spectacle frame or behind the ear device, have the transducer mounted in the body of the aid with a small bore (⅛in internal diameter) flexible polythene acoustic coupling tube which terminates in a special acrylic perspex ear insert as shown in Fig. 6. Also the type of transducer that is fitted directly into the outer ear canal, though similar to the earpiece supplied with some transistor radios, has the ear insert moulded to fit the individual's ear for maximum efficiency and comfort.

When a hearing aid is prescribed utilising either of the above inserts, casts are made by the consultant from which the insert is manufactured. This is done by filling the contours of the part of the ear where the insert is to be situated with a special compound. The compound consists of two chemical components which,

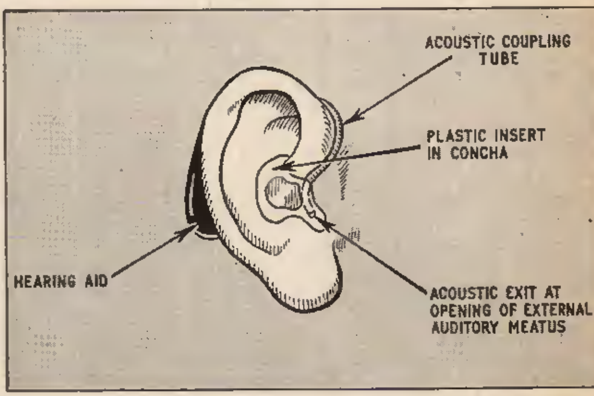


Fig. 6. A hearing aid using an acoustic coupling from the transducer in the aid to the outer ear canal

on mixing, are semi fluid but rapidly harden after a short period of time though retaining a certain amount of flexibility. This impression is then used to form the casting mould for the plastic insert. The process is much the same for the manufacture of dentures.

It is not usually convenient to use a hearing aid all the time and some people do have hearing impairments that do not require the use of an aid. For this reason Audiorama (a member of the Plessey group of companies) manufacture a headrest for domestic usage in conjunction with television, radio, tape and disc replay equipment. The headrest (Fig. 7) also provides protection from the hazard of equipment using the live chassis a.c./d.c. technique.

Future trends with the advent of integrated circuits should result in even smaller hearing aids with much improved frequency responses and power gains allowing for the limitations of acoustic feedback. ★

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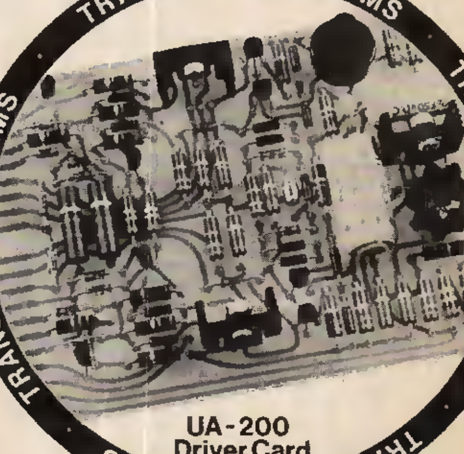

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THE SOLAR ECLIPSE OF 1970

The eclipse of the sun on March 7 this year was perhaps the most important in the history of astronomy. The extensive techniques of all the disciplines associated with astronomy and space environment has brought a wealth of data for analysis. Though much of this data will take some time to evaluate, a good deal of preliminary information has been given out from various sources. This information is mainly concerned with the corona and the effects observed in the ionosphere.

Before the advent of the Lyot type of coronagraph, astronomers had to rely on the eclipses for observation of the corona. It is still true that only at the time of the eclipse can the best observations of the visual corona be made. To this is added the techniques of radio astronomy, rocketry and other space research methods. The eclipse this year was therefore a considerable adventure with the very important advantage of cross correlation of data.

There was an important prediction of the shape of the corona as it would be at the time of the eclipse by K. H. Schatten. This prediction was based on the measurements of the photospheric magnetic field in the weeks that immediately preceded the eclipse. A number of the predictions were fulfilled particularly the presence of large helmet type streamers.

SPACECRAFT EXPERIMENTS

However, in other respects there were a number of predictions not observed and it would seem that the deductions based on spacecraft observations need modification in the light of this eclipse. Rocket observations had been made on a number of occasions before the eclipse using a coronagraph. Special experiments carried out by the Naval Research Laboratory of Washington made use of an *Aerobee* rocket launched from New Mexico two hours after the eclipse.

One important observation was directed to the examination of white light corona at 3 solar radii. Normally when using earth based telescopes this area of the corona is difficult to observe.

The Los Alamos Scientific Laboratory made airborne observations of the corona, the chromosphere and geophysical observations of the environment during the eclipse. The aircraft flew at a speed of 508 knots at a height of just over 36,000 feet. The observations were thus enabled to be carried out for a period of 5 minutes 30 seconds which was two minutes more than for earth based instruments.

A very comprehensive experiment using five spectroheliographs were flown on an *Aerobee* Rocket from Wallops Island. This was fired into the eclipse path to photograph and scan the ultraviolet and the XUV flash spectrum electronically.

Unfortunately, only part of the data was found usable in the form of a film in a cassette. The whole payload sank into the Atlantic because of the malfunction of the recovery system. The payload was recovered by the Naval Research and Development Salvage unit.

The recovery was on March 22 and it is thought that the cassette which was coated in Teflon owes its survival to the slowing down of electrolysis by the presence of the Teflon.

ECLIPSE EFFECTS

The effects in the ionosphere of the solar eclipse showed a reduction of the electron content of the "F" layer by as much as 30 per cent. There were a number of effects in the ionosphere on radio propagation over a very wide range of frequencies. Satellite transmissions have yielded a great deal of data so that it will be some time before the final conclusions can be drawn.

Measurements were also made at very low frequencies in region of 10 to 20kHz; three phase changes were noted. At even lower frequencies, 1 to 10kHz, some extraordinary phenomena appeared. During and for about an hour after the eclipse, "risers" were noted at 1·8kHz and 2·4kHz. Risers are musical tones of rising frequency.

A number of suggestions have been put forward as a tentative explanation, all of which involve the "D" layer which is also very much reduced in density during total eclipse.

Certain travelling ionospheric disturbances that were observed may be caused by gravity waves. The timings of certain oscillations show a near agreement with the possible effects of the cool shadow of the moon moving at supersonic speed across the atmosphere and generating gravity waves as suggested by Chimonas and Hines.

MARINER TO VENUS AND MERCURY

The launch in 1974 of the *Mariner* with two objectives, Venus and Mercury, will carry seven experiments. These have been chosen from the 40 or so suggestions that were put forward. The total payload will be 113 pounds out of the total weight of the probe which is 900 pounds.

The probe will swing by Venus in 1974 at a distance of about 3,300 miles and will then proceed toward Mercury under gravity alone to pass the planet at a distance of some 630 miles a month later.

With the completion of the other two large dishes at Madrid and Canberra, there will be continuous contact by television and telemetry direct to earth. This means no storage on tape and re-transmission. All events recorded will be in real time. Many more pictures will be transmitted and it is expected that some 5,700 frames will be transmitted of Venus and 2,700 of Mercury.

It is hoped that the ultra violet "clouds" which circulate round Venus every five days will be observed. The infra red radiometer will look for "holes" in the Venusian cloud cover. The photographs of Mercury should reveal whether it has satellites and also whether there are any special features on the surface. There will also be an ultraviolet spectrometer which will determine by solar occultation whether Mercury has an atmosphere.

The occultation of the two transmitters will provide data as to the mass and radius, and whether it has an atmosphere and an ionosphere.

The magnetic fields near the planets and the particle densities will be measured by other experiments aboard the spacecraft.

MOONQUAKES

Every month, when the moon comes to its closest point to the earth, it suffers a slight quake. This occurs every 28·2 days and the seismometer set up by the *Apollo 12* crew has been sending continuous signals since last November. It is from the strong and weak signals that this new state of the moon has been derived. Identical patterns appear at the time of the closest approach each month.

It has, of course, been known for a long time that the moon bulges toward the earth about one metre at this time. These results also confirm that the moon has residual heat.

TRIAC LAMP REGULATOR

By J. N. WATT

SUITABLE FOR PHOTOGRAPHIC COLOUR PROCESSING CONTROL

COLOUR printing is becoming more and more popular with amateur photographers. In this process it is vital that the enlarger lamp output remains constant despite mains voltage fluctuations, for not only will the density of prints be affected by any changes, but colour balance will be altered also.

Since correct colour balance is probably the most difficult characteristic to achieve in printing, it is worth while to go to some trouble to eliminate as many variables as possible. A constant light output from the enlarger lamp will certainly go a long way towards achieving this.

In black and white printing also, a stable light level will assist in producing consistent results.

CONSTANT VOLTAGE

Probably the best method of ensuring a constant level of illumination is to run the enlarger from a constant voltage transformer—indeed, this is done in commercial colour printing laboratories. However, the cost of such a transformer could approach that of the enlarger itself.

The alternatives are either to work in the darkroom at times when mains voltage fluctuations are at a minimum, or use a resistive dropper in series with the enlarger lamp.

The resistance of the dropper is adjusted to give a constant voltage across the lamp. Since this voltage can be no higher than the lowest mains voltage experienced, a lamp of a lower rating is sometimes used, although as enlarger lamps are normally arranged to be overrun in any case, the light loss is often acceptable.

The disadvantages of a system using such a resistor are fairly obvious. It is wasteful, since excess voltage is spent as heat, and a large unwieldy resistor is required to achieve this dissipation.

SOLID STATE CONTROL

The use of some kind of solid state semi conductor device seems to be called for, and it is actually quite easy to construct a lamp dimmer control using a thyristor and a bridge rectifier. This would remove the objections of large bulk and the need for the dissipation of heat.

A further improvement is the use of a triac with a saving in components, for no bridge rectifier is then needed, to obtain full wave control.

TRIAC

Many readers are no doubt familiar with the operation of the thyristor in control applications. The triac operates in principle like the thyristor. When triggered into the conducting state by a suitable gate signal it will remain so until the current through the device is reduced to less than the holding current.

It is different however, in that it can conduct in either direction on application of a positive or negative gate signal. Having three electrodes and bilateral a.c. operation provides the derivative, triac, from *tri*ode, *a.c.*

In Fig. 1 is given the circuit of the controller. The symbol for the triac is that of two thyristors in inverse parallel. Because of its bi-directional properties MT1 and MT2 are used in place of anode and cathode, MT being the bi-directional anode, or more commonly termed "main terminal".

Integral to this particular device is a diac, or bi-directional trigger diode. The symbol for this logically enough is two diodes in inverse parallel. The input to the diac is the gate input which controls the triac in phase with the load current.

TRIGGER INPUT

The capacitor and resistor network preceding the triac gate make up a phase control circuit. By varying VR1 the phase angle at which conduction begins may be varied. The π arrangement of C4, R6 and C5 in combination with VR1, forms a circuit with a double time constant which provides smooth control from low to full power.

When the voltage on the gate capacitor exceeds the breakover voltage on the trigger diode this conducts and switches the triac on for periods in the positive and negative half cycles. The length of these periods is

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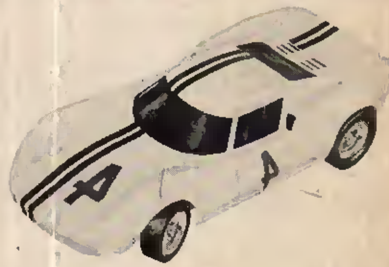

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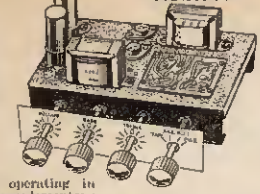

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SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 6:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2 × 1 × 1½ in. Only 8/6. P. & P. 2/6.

HONEYWELL MICROSWITCHES S/P. C/O. Push-button action. Rating 250v. AC at 15 amps. Size approx. 1½" × ⅞" × ½". 5/- each. P. & P. 1/- (6 or more post free).

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

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price 35/-. P. & P. 6/-.
MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. 14/-. P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. 17/6. P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. 27/6. P. & P. 3/6. Tapped Primary 200-220-240V. Sec. 21·5V at 500mA. 12/6. P. & P. 2/6.
BATTERY CHARGER TRANSFORMERS. 200/240V. input. Nominal output for 6 or 12V. batteries 3 amps. Size approx. 3 × 2½ × 2½in. Brand New. Price 21/-. P. & P. 5/-.

HIGH GRADE COPPER LAMINATE BOARDS
8 × 6 × $\frac{1}{16}$ in. FIVE for 10/-. P. & P. 2/-.

STOCKISTS OF SINCLAIR EQUIPMENT
Z.30 Amplifier 89/6. P. & P. 2/6. Stereo 60 Pre-Amplifier £9.19.6. P. & P. 5/-. PZ5 Power Supply £4.19.6. P. & P. 3/6. PZ6 Power Supply £7.19.6. P. & P. 3/6. IC.10 Integrated Circuit 59/6. P. & P. 2/-.

. SPECIAL OFFER ! !

HI-FI LOUDSPEAKER SYSTEM. Beautifully made teak finish enclosure with most attractive Tygan front. Size 16½" high × 10½" wide × 6" deep. Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, two H.F. tweeter units and crossover. Power handling 10 watts. Available 3 or 15 ohm impedance. **8 Gns.** Carriage 10/-

TRANSISTOR STEREO 8 + 8 MK II

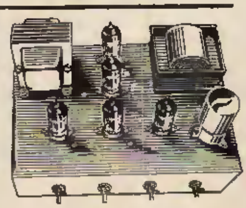
Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ± 3dB. 20–20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.
PRICES: AMPLIFIER KIT **£10.10.0;** POWER PACK KIT **£3.0.0;** CABINET **£3.0.0.** All Post Free.
Also available STEREO 10 + 10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT **£12.** POWER PACK KIT £3.10.0.
Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9–18V. Battery or from H.T. line 200/300V. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1½ × 1½ × ½in. Brand new—complete with instructions. Price 17/6. P. & P. 2/6.

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

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE 75/-. P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.
DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2in. below 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE 79/6. P. & P. 9/6.

10/14 WATT HI-FI AMPLIFIER KIT

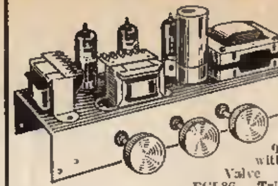


A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 2/6 (Free with parts). All parts sold separately. ONLY £7.19.6. P. & P. 8/6. Also available ready built and tested complete with std. input sockets, £9.19.6. P. & P. 8/6.

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

VERY POWERFUL COMPACT MOTOR
For 12v. D.C. operation. Off load consumption approx. 100mA. Totally enclosed. Quiet in operation with high starting torque. Overall size approx. 1⅞"L × 1½" dia. Free shaft $\frac{3}{16}$" dia. × ⅞"L. Ideal for Model Makers, etc. ONLY 7/6 each P. & P. 1/-.
3 or more post free (A few 6v. versions also available).

DE LUXE STEREO AMPLIFIER

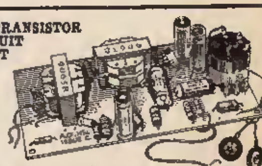


A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8.18.6.** P. & P. 8/-.

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6.19.6.** Carr. 6/6. With stereo cartridge **£7.19.6.** Carr. 6/6.
LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for Latest Prices!
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, 3500, etc. With rigid transparent plastic cover. Special design enables above models to be used with cover in position. Also suitable for housing AT60 and SP25. OUR PRICE **£5.15.0** complete. P. & P. 8/6.

LATEST ACOS GP91/18C Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. 30/-. P. & P. 1/6.
SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus 50/-. P. & P. 2/-.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. 32/6. P. & P. 2/-.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. 30/-. P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



Peak output in excess of 1½ watts. All standard British components. Built on printed circuit panel size 6 × 3in. Generous size Driver and Output Transformers. Output transformer tapped for 3 ohm and 15 ohm speakers. Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p). 9 volt operation. Everything supplied, wire, battery clips, solder, etc. Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 49/6.** P. & P. 3/-. Also ready built and tested, 55/-. P. & P. 3/-.

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

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

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer, EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.
OUR ROCK BOTTOM BARGAIN PRICE 55/- P. & P. 6/-

Open 9-5.30 Monday to Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

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

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

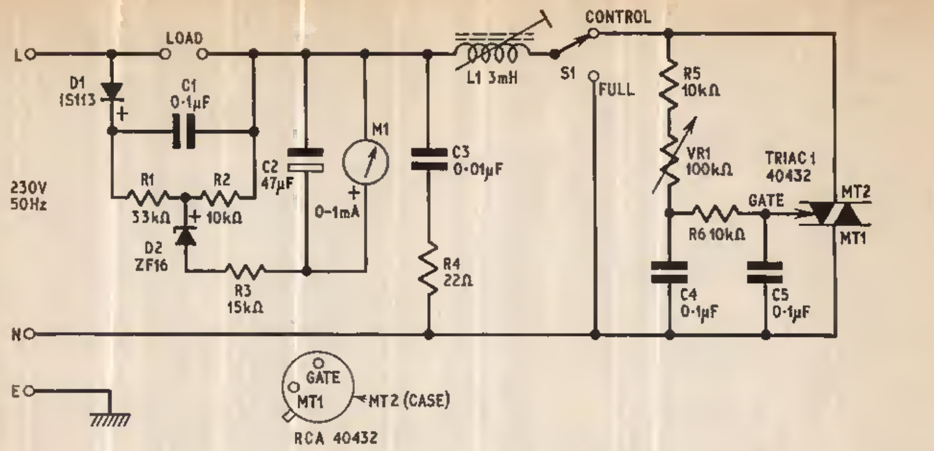


Fig. 1. Complete circuit of the triac lamp controller with meter circuit and interference suppression

governed by the setting of VR1, the cumulative effect of which is to permit the power to the load to be varied.

Typical load voltage waveforms for early triggering in the cycle are given in Fig. 2. Here, the power available would be near maximum.

INTERFERENCE SUPPRESSION

Improvements in the manufacture of s.c.r.'s and triacs has resulted in faster turn on times. In the case of the 40432 triac used, this time is about 2 to 3 microseconds. Pulses with such short rise times are a source of radio frequency interference and some form of suppression is necessary.

In the circuit, L1 and C3 prevent interference being fed back via the mains leads. Radiated interference is kept to a minimum by mounting the components in a metal box, then earthing this.

In practical tests carried out with a transistor radio, interference was only apparent with the radio held about a foot away from the completed controller.

The inductor L1 is made up by pile winding about 400 turns of 26 s.w.g. enamelled copper wire on a small Aladdin coil former complete with iron dust core.

Since this coil appears in series with the load there is a power handling limit of 200 watts.

VOLTAGE MONITORING

In order to be of value in enlarger lamp controlling, an accurate means must be provided for measuring the voltage applied to the lamp. Unfortunately, an ordinary moving coil voltmeter is calibrated for r.m.s. sine wave voltages, which is not much use for measuring the distorted waveshapes as given in Fig. 2.

A "true" r.m.s. voltmeter would indicate correctly since lamp light output is strictly dependent on applied r.m.s. voltage; but such r.m.s. meters are expensive and not easy to obtain.

METER CIRCUIT

The meter circuit, which is in parallel with the load terminals in Fig. 1, was developed to overcome this problem and found to be not only accurate in use but to have an advantage over r.m.s. meters for the range of voltage employed.

The diode D1 permits only positive going half cycles to charge C1.

R1 and R2 prevent the circuit from becoming a peak reading voltmeter and in combination with C1 effect a compromise between peak and average voltages to indicate true r.m.s. lamp output over the range 190 to 250 volts.

Since only this limited range is required, advantage is taken of the technique of expanding the meter scale with the Zener diode D2. The capacitor C2 removes the 50Hz ripple and gives meter needle stability.

As the object of the meter is to maintain a steady light output irrespective of mains fluctuation, calibration is unnecessary as the only requirement is an arbitrary constant meter setting.

CONSTRUCTION

All of the components of the controller fit inside a 4½in by 3½in by 2¼in die cast box. This provides at once, a robust housing as well as electrical screening. Reference to Fig. 3 gives the complete prototype wiring

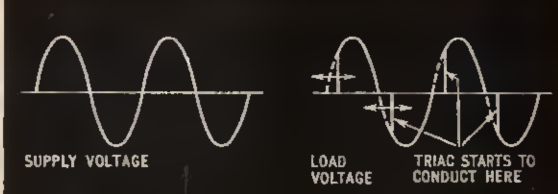


Fig. 2. Supply and load waveforms indicating triac switch on points

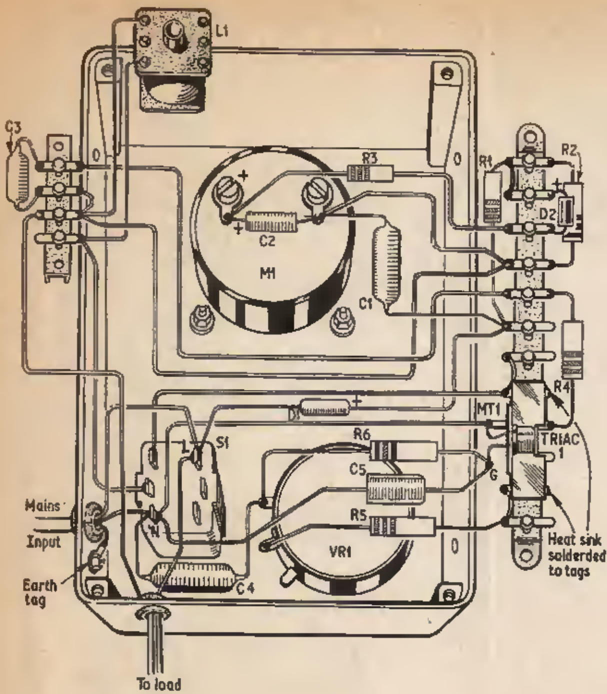
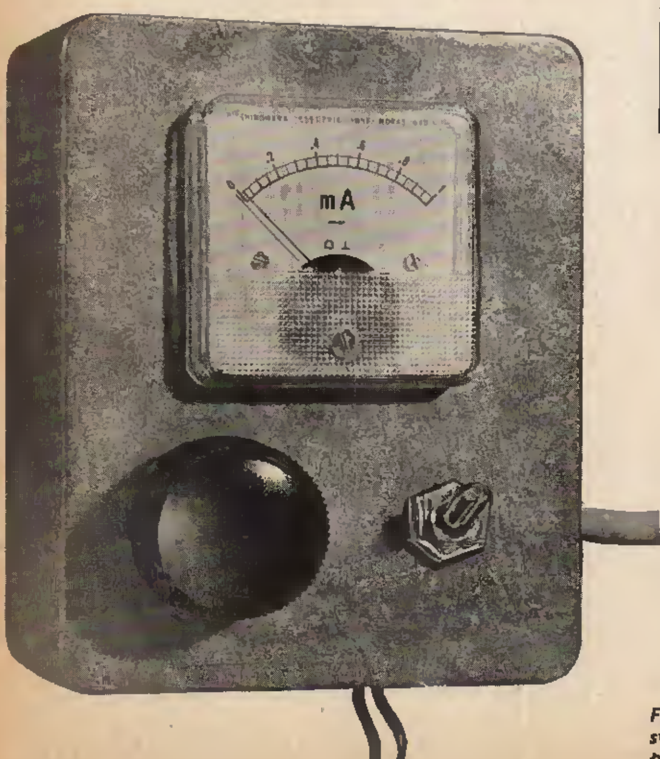


Fig. 3. Wiring of the controller in a diecast box. The tag strips are shown removed from their mountings to show the connections of the triac mounted on the heat sink (note the two leads which connect to tags)



COMPONENTS . . .

Resistors
- R1 33kΩ 1W
- R2 10kΩ 1W
- R3 15kΩ
- R4 22Ω
- R5 10kΩ
- R6 10kΩ
- All ±10% ½ watt carbon except R1 and R2

Potentiometer
- VR1 100kΩ wirewound

Capacitors
- C1 0·1μF polyester
- C2 47μF elect. 6V
- C3 0·01μF polyester
- C4 0·1μF polyester
- C5 0·1μF polyester

Triac
- Triac 1 40432 (R.C.A.) with heatsink (Electrovalue, 28 St. Jude's Road, Englefield Green, Egham, Surrey)

Diodes
- D1 1S113
- D2 ZF16 16V Zener

Inductor
- L1 3mH (for details see text)

Meter
- M1 0·1mA f.s.d. moving coil

Switch
- S1 Single pole changeover toggle switch

Miscellaneous
- Die-cast box (Eddystone) 4½ in × 3½ in × 2¼ in
- Aladdin coil former 4mm with square base, dust iron core, 26 s.w.g. enamelled copper wire
- Tag strip

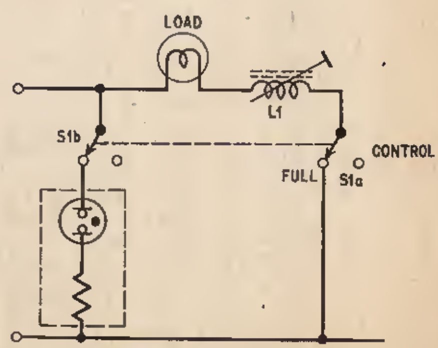


Fig. 4. The substitution of a double-pole change-over switch for S1 enables a neon lamp to be used as a full power indicator.

BSR 4-SPEED SUPERSLIM AUTO RECORD CHANGER

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. Size 13¾ × 11¼in. Above motor board 3¼in. below 2¾in. AC 200/250v.

with STEREO/MONO XTAL **£7** Post 5/-

BSR UA70 Stereo/Mono Transcription Auto Changer. Calibrated Stylus Pressure. **£14**

BSR Minichanger UA50 Stereo/Mono. Plays 12", 10" or 7" records. Size 12 × 8½in. AC 200/250v. Post 5/-. **£8**

GARRARD PLAYERS with Sonotone 9TA Cartridges. Stereo Diamond/Mono Sapphire. SP25 Mk II £15. AT60 Mk II £15. Model 3000 £13. Post 5/-.

RECORD PLAYER PORTABLE CABINET Space for amplifier and autochanger. Post 5/-. **75/-**

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made tested. 2-stage with triode pentode valve, 3 watts output. Tone and volume controls. Isolated mains transformer. Knobs, loudspeaker, valves ECL82, EZ80. Response 50-12,000 cps. Sensitivity 200mV. Post 5/-. **£4**

RCS 2 WATT AMPLIFIER with loudspeaker and valve UCL82. Post 5/-. **£3**

R.C.S. TEAKWOOD BASE Ready cut out for mounting (state player make and model). **77/6**

R.C.S. PLASTIC COVERS FOR ABOVE BASE. Durable tinted plastic, attractive appearance. **77/6**

EMI PICK-UP ARM. Complete with mono cartridge 29/6.

EMI JUNIOR 4 SPEED RECORD PLAYER. Mains operated motor, turntable and pick up. Post 5/-. **£3**

HI-FI PICK UP CARTRIDGES

GP94 55/-; GP93 45/-; GP91 30/-; GP67 19/6, ACOS L.P. only 10/6. All standard fixing complete with stylus.

CRYSTAL MIKE INSERTS

1¼" dia. 6/6. ACOS 1½" dia. 12/6. BM3, 1" dia. 9/6

PORTABLE AMPLIFIER

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. Uses PP9 battery. Brand new with famous makers' guarantee. Post 5/-. **75/-**

WEYRAD P50 — TRANSISTOR COILS

RA2W Ferrite Aerial	13/-	Spare Cores	6d.
Osc. P50/1AC	6/-	Driver Trans. LFDT4	10/-
I.F. P50/2CC 470 kc/s	6/7	Printed Circuit, PCA1	10/-
3rd I.F. P50/3CC	6/7	J.B. Tuning Gang	10/6
P51/1 or P51/2	6/7	Weyrad Booklet	2/-
P51/3	6/7	OPT1	11/-

Ferrite Rod 8 × ⅜in. 4/-. 6 × ½in. 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 11/-, D.P. 15/- Edge 5K. S.P. Transistor, 5/-.

80ohm Coax 9d. yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. 28/-; 60 yd. 40/-.

FRINGE LOW LOSS Ideal 625 lines **2/- yd.**

WIRE-WOUND 3-WATT POTS. Small type with small knob. Values 10 Ω to 30 K., Carbon 30 K to 2 meg. **5/-**

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 10 OHMS to 100 K. **8/-**

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 $\frac{1}{16}$in. Board 10 × 8in. 3/-.

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

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.

1½inch DIAMETER WAVE-CHANGE SWITCHES. 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. 1 inch DIAMETER 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/-, 6 wafer 42/-.

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
DE LUXE STEREO HEADPHONES 8 ohms	65/-

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER

200/250 v. A.C. Leaflet S.A.E. **47/6** Post 2/6

★ GENERAL PURPOSE TRANSISTOR PRE AMPLIFIER BRITISH MADE ★

for Mike, Tape, P.U., Guitar.

Battery 9-12v. or H.T. line 200-300v. D.C. operation. Size 1¼" × 1¼" × ½". Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions supplied. Brand new. Guaranteed. Details S.A.E. **17/6** Post 2/6.

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	2/6	100/25V	2/-	16+16/500V	11/-
4/350V	2/6	250/25V	2/6	50+50/350V	7/-
8/450V	2/6	500/25V	4/-	60+100/350V	11/6
16/450V	3/-	8+8/450V	3/6	32+32/250V	3/6
32/450V	4/-	8+16/450V	4/-	32+32/450V	6/6
25/25V	2/-	16+16/450V	5/-	32+32+32/350v.	6/6
50/50V	2/-	32+32/350V	5/-	100+50+50/350v.	9/6

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 2/-; 500, 1000mF 12V 3/6; 2000mF 25V 7/-.

CERAMIC. 1pF to 0.01mF, 9d. Silver Mica 2 to 5000pF, 9d.

PAPER 350V-0·1 9d. 0·5 2/6; 1mF 3/-; 2mF 150V 3/-. 500V-0·001 to 0·05 9d; 0·1 1/-; 0·25 1/6; 0·47 5/-. 1,000V-0·001, 0·0022, 0·0047, 0·01, 0·02, 1/6; 0·047, 0·1, 2/6.

SILVER MICA. Close tolerance 1%. 2·2-500pF 1/6; 560-2,200pF 2/-; 2,700-5,600pF 4/-; 6,800pF-0·01, mfd 6/-; each.

TWIN GANG. "0-0" 208pF+176pF, 11/-; Slow motion drive 365pF+365pF with 25pF+25pF, 11/-; 500pF slow motion, standard 9/-; small 3-gang 500pF 22/-. SHORT WAVE. 25pF, 11/-.

CHROME TELESCOPIC AERIALS 23in. 5/-.

TUNING. Solid dielectric. 100pF, 300pF, 500pF, 7/- each.

TRIMMERS. Compression 30, 50, 70pF, 1/-; 100pF, 150pF, 1/6; 250pF, 1/6; 600pF, 750pF, 2/-; 1000pF, 2/6.

RECTIFIERS CONTACT COOLED half wave 60mA 7/6; 85mA 9/6. SILICON BYZ13 6/-; BY100 10/-.

Full wave Bridge Rectifiers 75mA 10/-; 150mA 19/6.

EX-GOVT. RECTIFIERS 250v. 200mA 6/-.

NEON PANEL INDICATORS 250v. AC/DC Red, Amber 4/-.

RESISTORS. Preferred values, 10 ohms to 10 meg. ⅛ w., ¼ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.

HIGH STABILITY. ½ w. 2% 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; 2½ watt, 1 ohm to 8·2 ohms. 2/-

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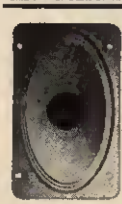

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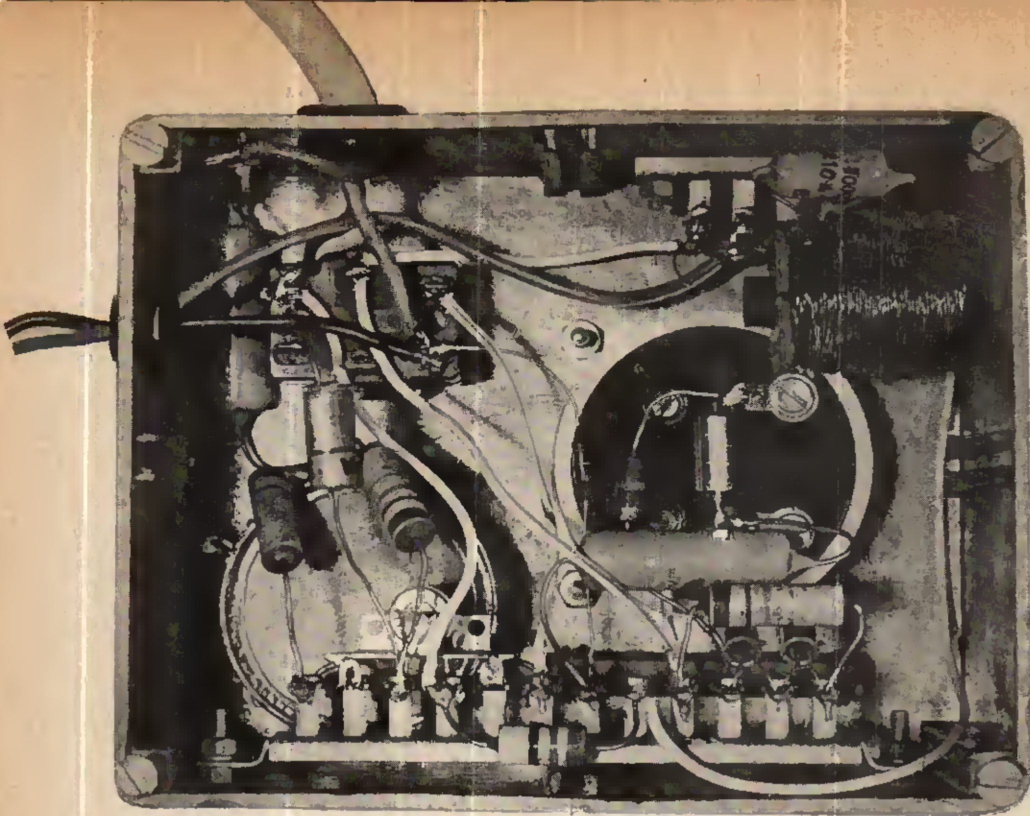

and component layout details. Here, mounting strips with ceramic stand-offs are used to carry the majority of components, with the remainder supported by the switch, control potentiometer and meter terminals.

When ordering the triac the heat sink should be included. The latter is soldered to the long tag strip terminals, then the triac is clipped in. A view of the heat sink mounted triac is given in Fig. 3.

In view of the light loading of the triac—less than 1A —the use of a heat sink as such is not really called for, but it does provide a convenient way of mounting.

If a double-pole change-over switch is available, it is worth while to make use of the second pole as in Fig. 4 to bring in a neon indicator.

The neon will light when the enlarger lamp has full, uncontrolled, power applied to it, and acts as a warning to the photographer that this is so. The inadvertent use of this setting for exposing, giving over-exposure of the print, should thus be avoided.

USING THE CONTROLLER

The output of the controller is adjusted as required so that a constant meter reading is obtained; the reading chosen must, of course, be a little lower than that given by the lowest mains voltage likely to be encountered.

The switch S1 can be used to apply the full voltage to the lamp for the purpose of focusing.

The numbered curves A and B in Fig. 5 indicate light output from a 75 watt enlarger lamp with:

(a) Variation of applied voltage, that is, without the controller.

(b) Variation of mains voltage but with a constant meter reading setting of 0·6mA.

Graph (c) Uncontrolled meter reading with changing mains voltage.

The output of the lamp in the lower graph is expressed in terms of the reading on a Weston-3 exposure meter. It can be seen that the change of almost 1½ stops, given by an uncontrolled lamp when the mains changes from 250 volts to 200 volts, can be reduced to zero by this controller, so giving good correction for both black and white and colour photography. ★

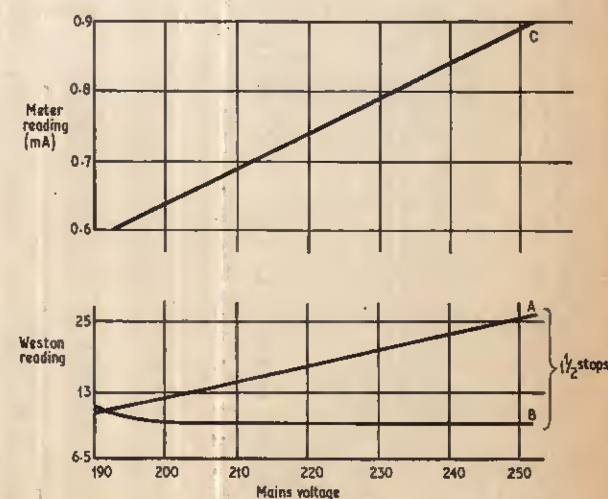

Fig. 5. Graphs showing light output from 75W enlarger lamp with: (a) Variation of applied voltage, (b) variation of mains voltage with constant meter reading of 0.6mA, (c) Uncontrolled meter reading with changing mains voltage

MAKING THE MOST OF LOGIC IC's

PART FOUR—By R. W. COLES
PRACTICAL DTL—SLIDE PROJECTOR DELAY TIMER

Diode transistor logic is available in all of the three package outlines commonly used to house integrated circuits, namely the modified TO-5 can, the miniature flat-pack, and the most popular of all, the 14-pin dual in-line plastic package. The dual in-line package is recommended to amateurs because of its cheapness and comparative simplicity in use.

It might be thought that "breadboarding" is a thing of the past with such sophisticated circuits as these, but this is far from true. With logic i.c.s it is a simple matter to "breadboard" complete systems instead of just individual circuit blocks. These ready made blocks are just as robust as transistors, and in many respects they are more so.

Home designed printed circuit boards are still useful for the finished article, although the layout design will take much longer. It is very difficult to remove a package with so many pins once it has been soldered to such a board.

I.C. BREADBOARDING

One breadboarding system that can be used with success, enabling easy removal of the integrated circuit package, employs plain white stiff cardboard, which is obtainable from most stationers very cheaply.

The package layout is first decided upon, and then roughly sketched out on the board, holes are then made in the board to correspond with the i.c. lead-outs. There is no need for accurate marking out; an i.c. can be used directly as a guide. These holes can be made simply with dividers or the point of a pair of compasses. If they are made to take the lead-out tags tightly, there will be no need to anchor the packages to the board.

All that remains is to wire up the circuit as required. The wiring can be drawn on the board before assembly, but remember, manufacturer's diagrams of i.c. pin connections, unlike those of valves, assume you are looking down on the top of the package.

By this time you may be asking yourself just what you can build with i.c. DTL circuitry. Of course you would like to build your own computer, but it could be far too expensive.

There are vast new areas open to the experimenter working with just a handful of gates and flip-flops. Examples are logic control of a model railway system; an automatic dipping headlight system for a car, which provides a manual back-up and manual override. Automatic indication of an approaching car when in the manual state can be included, with a warning signal when you have overridden the automatic system. Perhaps you might like to try digital control of a model aircraft. Another idea is a digital clock with a display on numeral indicators. This article concerns itself with one application—a slide projector delay timer.

SLIDE PROJECTOR DELAY TIMER

This simple design, which employs DTL integrated circuits, is intended to be used in conjunction with an automatic slide projector, and allows such a projector to run continuously and unattended, changing slides roughly every ten seconds. It is mainly intended for use with a circular slide magazine containing 100 slides which, in the case of the prototype, was fitted to a Gnome projector with remote slide changing capability.

The main use of such an installation is as a visual demonstration aid at exhibitions (the original set-up was used to simulate a radar display) the projector being behind an imitation radar console.

An automatic slide projector of this type changes slides when a remote control button is pressed twice, the first press causes the slide carrier, containing the slide, to move to the open position, and also rotates the magazine one position. The second press allows the carrier to return to the display state with the new slide.

If instead of pressing the button twice, it is kept depressed after the first press, the above process continues indefinitely, with the disadvantage that whereas it takes about two to three seconds to change a slide, the time during which the slide is projected only amounts to about half a second. This situation is clearly unsatisfactory for the continuous display sequence, as it results in only a brief display every two to three seconds.

Experiments with the button show that a press of $1\frac{1}{4}$ seconds was sufficient to produce a complete change of slide, a shorter press resulted in only half a change, and a longer press caused the mechanism to commence a second change. A suitable interval between changes was decided on as about ten seconds.

PULSE FREQUENCY DIVISION

In this particular application the requirement was to design a timer which closed a pair of relay contacts, wired in parallel with the change button, for $1\frac{1}{4}$ seconds in every ten. The eventual design utilises a pulse generator to provide one pulse every $1\frac{1}{4}$ seconds. The output of this generator is divided by eight in a binary counter.

As each of the counter's eight states lasts for $1\frac{1}{4}$ seconds, and occurs once in every ten ($8 \times 1\frac{1}{4}$), it is a simple matter to decode one of these states and use the resultant output to operate a relay.

The circuit used is shown in Fig. 4.1a, and contains three bistable i.c. packages type 9945, and one triple 3-input gate package type 9962; the pin connections

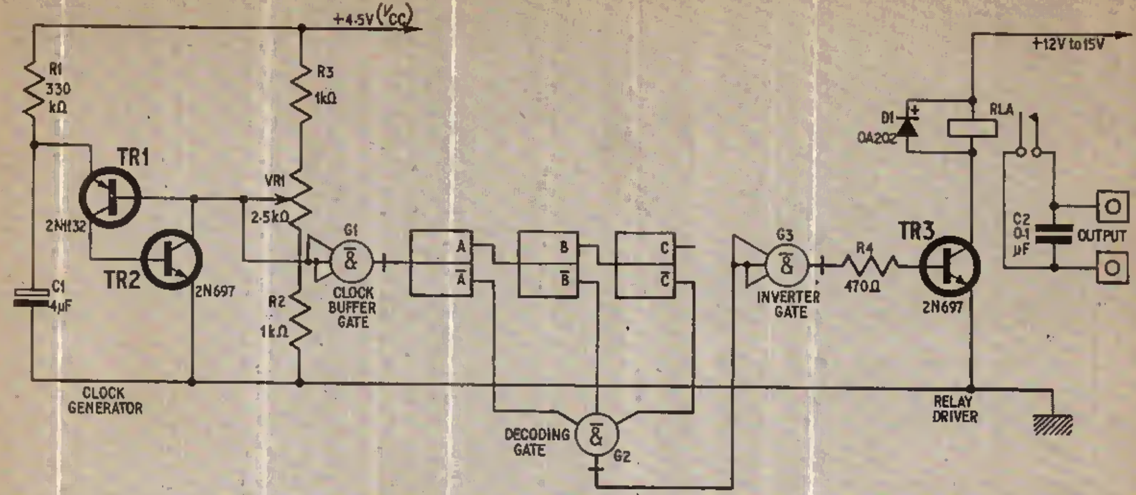

Fig. 4.1a. Block diagram of integrated circuits with the additional discreet components required to make up the delay timer for a slide projector. VR1 is adjusted so that the projector just goes through one slide change for each relay operation. Gates G1, G2, G3 are contained in one i.c. package type 9962, 862P or MIC962, the bistables are type 9945, 845P or MIC945 (3 off)

A	B	C
0	0	0
1	0	0
0	1	0
1	1	0
0	0	1
1	0	1
0	1	1
1	1	1
0	0	0
1	0	0
	etc	

Relay operates

Recycles

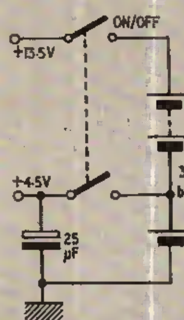

Fig. 4.1b (left). Truth table for the counter states

Fig. 4.1c (right). Suggested arrangement for supplying the d.c. power

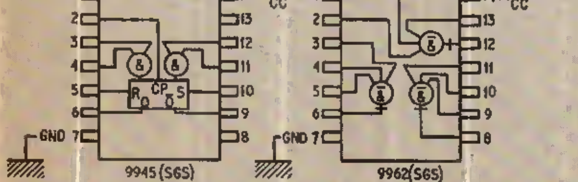

Fig. 4.2. Diagram of integrated circuit dual in-line outlines with arrangements of pin connections looking down on the top

for these are given in Fig. 4.2. In addition three discrete transistors are used in the clock generator and relay driver circuitry, together with five resistors and two capacitors.

The pulse circuit, which generates a negative going, steep-sided pulse every 1¼ seconds is ideally suited for this application as it uses few components, has a very high input impedance due to the complementary pair of transistors being used as a four layer diode, and produces a short output pulse with transition times of short duration. The time between pulses is set by the *CR* time of R1 and C1.

The capacitor charges through the resistor until the emitter of the transistor TR1 reaches a potential more positive than its base, which is set to a reference voltage adjusted by VR1. As soon as its base-emitter junction is forward biased in this way, it conducts sharply, and in turn causes the *npn* transistor TR2 to turn on.

This process is regenerative; the capacitor is discharged through these two transistors which effectively short it to earth. When it has discharged TR1 is no longer forward biased, so it turns off and presents a high impedance to the CR network, which allows the capacitor to begin charging slowly again.

The output pulse is taken from the wiper of VR1, which rests at the reference potential of about three volts until TR2 saturates; then it drops to about 200mV to form the pulse.

This output is passed through one of the gates in the package, which speeds up its already fast edges and acts as a buffer to raise the pulse amplitude and current drive capability (i.e. fan-out). It also inverts the pulse.

DECODING

The flip-flops used in the 3-bit ripple counter are of the d.c. coupled set/reset type, and require two external feedback connections to enable their outputs to change state after the application of a negative going edge to their clock input terminal.

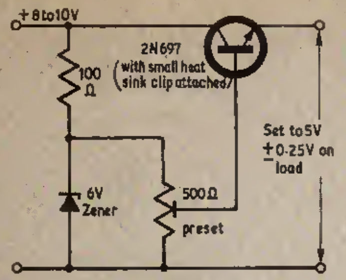

Fig. 4.3. Simple voltage regulator for connection between 9V d.c. power supply and the 5V power line of the i.c.s. A 25μF capacitor should be connected across the 5V output

Output A is connected to clock B input and so on, each stage dividing the clock frequency by two. Flip-flop C is up for four input pulses and down for four input pulses; after eight such pulses the counter ends up at the first state of 000.

The correct interval between relay operations is obtained by decoding one of these eight states in one of the three input gates (G2).

The 1¼ second pulse at the output of this gate drives the relay via the third gate, which is used simply as an inverter, and a relay driving stage TR3.

The actual state of the counter which is decoded is immaterial, as they all must last for 1¼ seconds, and be separated by ten seconds. The state 000 is shown decoded in Fig. 4.1b. To decode any other state, it is necessary to feed to the logic gate the three counter outputs which are at a logic "1" state at that time.

Thus to decode 101 the outputs A $\bar{B}$ C are fed to the gate inputs. This last point is mentioned because it would be quite possible to decode more than one state and use this extra output (or outputs) to initiate other actions. For instance, a tape recorder could be started up by the counter state after that which changed the slide, perhaps giving a short commentary on the picture being displayed.

POWER SUPPLY

The power supply poses a slight problem, as the 5V required by the i.c.s is not available from dry batteries directly, and a simple mains supply without regulation is unlikely to be accurate enough. The prototype was run from a 4·5V battery with no noticeable ill-effects.

The best solution is to use a higher voltage from either a power supply or batteries and trim this to exactly 5V with a Zener diode emitter follower regulator, a suitable circuit being shown in Fig. 4.3. The supply to the relay circuit does not need to be accurately set and can be between 12 and 15 volts derived from batteries or a mains fed power supply.

Next month: Part 5 will study transistor transistor logic (TTL) in which multi-emitter element transistors are incorporated in the i.c. package. The application of TTL to designing a binary adder will follow in Part 6.

NEWS BRIEFS

Manchester and Southampton Exhibitions Full

STAND space at both of the professional electronic instrument shows sponsored by the Electronic Promotion Group, one at Manchester and the other at Southampton in September, are filled to capacity, claim the organisers.

There are 37 exhibitors at the Electronic Instruments Exhibition at the Hotel Piccadilly, Manchester, from September 15 to 17. This is the fourth and biggest of the Manchester series.

The Southampton show, with 27 exhibitors at the Skyway Hotel from September 22 to 24, is also completely full up. This is the first EPG-backed exhibition in southern England and is part of the EPG policy of picking a new centre each year. Last year, in addition to the Manchester show, a similar exhibition was held in Coventry.

Collision Course Solution

A solution to air traffic jams and a method of drastically reducing the possibility of mid-air collisions through use of the fastest computer system ever developed has just been unveiled in U.S.A. Called the Staran IV system it has been developed by Goodyear Aerospace Corporation of Akron, Ohio, and can perform more than 40-million mathematical operations per second in predicting which planes are on collision courses and determining evasive action.

One feature of the system is its ability to single out planes on collision courses and show them to air traffic controllers on a viewing screen as if they were the only planes in the air.

Use of the Staran IV has been proposed to the U.S. Federal Aviation Administration who are analysing the system and considering its possible installation at U.S. airports.

Thames Navigation Improvements

DECCA Radar have received an order from The Port of London Authority for replacement of the existing Thames Navigation Service Stage Two, which is the Gravesend to Cliffe section, to be completed in 1971.

Existing fixed coil displays designed in the 50's will be replaced by the latest Decca equipment incorporating Deccaspot. With a 25ft scanner, two 25kW transceivers, three 16in displays, a Ferranti micro-wave link, and Cossor u.h.f. radio, the system will be identical to that of the Crayfordness–Broadness section.

Deccaspot will be used for channel marking and for showing the designated anchorages recently published on Admiralty charts. This is a new system of very accurately positioned electronic spot markers, permanently displayed on the p.p.i.

Flying Darkroom Transmitters

THE first half of a $8 million contract worth $4,172,500 has just been awarded to the Goodyear Aerospace Corporation (GAC) of Akron, Ohio, U.S.A. by the U.S. Air Force.

The contract is for 70 completely equipped, air mobile laboratories for processing and interpreting aerial reconnaissance film.

Included will be "data link" electronic equipment which can receive signals from reconnaissance aircraft and display in a matter of minutes, the terrain being covered. Thus, it is no longer necessary for reconnaissance aircraft to land and have film processed before intelligence officers can see what data is being gathered.

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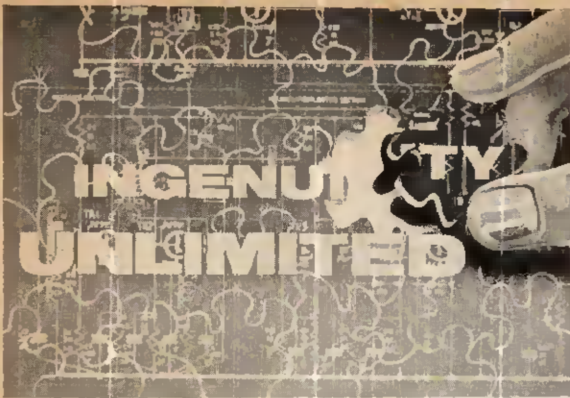

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

MAGNETIC COMBINATION LOCK

THE system described here has extremely high security characteristics, and its principles can be safely described in detail to the most doubtful looking individuals without fear of compromising the security of one's abode. The standard door-lock may be used, and the power normally associated with operating heavy lock plunger solenoids is thus unnecessary.

The actual "key" comprises a coded array of tiny magnets, in which the physical positioning and magnetic sense (i.e. position of N and S poles) form the secure code which alone will operate the simple circuit. Furthermore, attempts at solving the coded magnetic field will immediately result in the sounding of the doorbell, or, if desired, and outdoor alarm bell!

Use is made of the existing doorbell push so that if this is pushed in the normal way, the doorbell sounds. If, however, the special magnetic "key" is first correctly placed in position, and the doorbell pushed, the door lock is released.

Circuit operation

The circuit diagram Fig. 1 shows one configuration which applies for a certain combination, using five reed switches. The power supply to the entire circuit is broken by the bell-push S6. This ensures that no current is drawn from the battery except during the instant it is required.

The reed switches S1–S5 are all miniature normally open contact types, i.e. their contacts remain separated in the absence of a strong magnetic field. S4 and S5 have permanent magnets secured close to them so that they then perform as normally closed switches, which require not only an additional magnetic field to part their contacts, but such a field must be of opposite polarity to that of their fitted magnets, so that the two fields cancel.

Unlocking

For bias to be fed to TR2 base the following conditions must be obtained: S1, 2 and 3 contacts must be all closed; S4 and S5 contacts must both be open; and the door-bell push S6 must be operated to complete the voltage supply path.

Thereupon TR2 becomes forward-biased and conducts, causing almost the entire power supply voltage to be dropped across the solenoid X2. The collector of TR1 is practically at earth potential, and the portion of voltage appearing across TR2 emitter and collector is potentially-divided by R1 and VR1. The resulting potential on TR1 base is insufficient to allow TR1 to conduct and so the solenoid X2 is energised, but the bell X1 does not ring.

If the bell-push is operated when any of S1–3 contacts are not closed, or, S4 and S5 contacts are not open, no bias is fed to TR1 base, and it will not conduct. Hence, the solenoid will not operate, and the entire battery supply voltage appears across TR2 emitter/collector. Part of this voltage is tapped off by the wiper of VR1, and the resulting voltage causes sufficient current to flow in TR2 to operate the bell X1.

The bell-push can be operated by a caller, who does not possess a special "key" and the door-bell would ring in the normal manner.

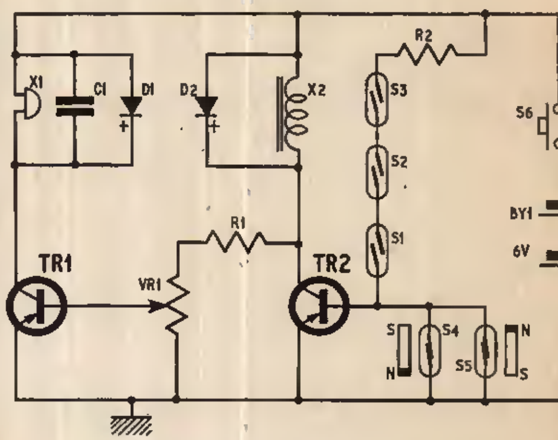

Fig. 1. Circuit of the magnetic combination lock

Components

The solenoid X2 should be capable of operating at 3 volts, and may be operated by a light-duty relay in TR1 collector circuit, in which case a lower-power transistor may be used. Resistor values will depend to some extent on the types of transistors used, and VR1 must be of sufficiently high resistance as not to conduct sufficient current from TR1 collector to earth as to operate X2 (or relay if used) when TR1 is not conducting.

To determine the value of R1 connect up TR2 and X2 only, and connect a 50 kilohm potentiometer (set to maximum resistance!) between base and negative 6V line. Vary the potentiometer, gradually decreasing the resistance until the solenoid or relay is operated. Disconnect and measure resistance arrived at; insert in circuit the next lower preferred value for R1. VR1 should be adjusted to make TR1 ring the bell when the bell-push is operated without the magnetic key, but not to allow the bell to ring when TR2 is conducting.

Solenoid

The circuit described is intended to operate a manually-assisted arrangement, in which X2 merely removes a locking pawl from the standard door knob mechanism, so that the handle may be turned. However, there are now available on the market electrically-operated solenoid locks, but care should be taken to choose a type which will operate from the power available, and which will not draw more current than can be safely supplied by the transistor or relay chosen.

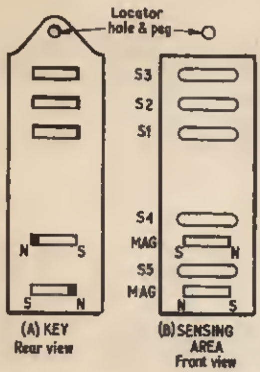

Fig. 2. Suggested arrangement of reed switches

Key

The form taken by the key is governed by the arrangement of the reed switches. Probably the most practical configuration for these is to arrange them in a single row, side by side, making sure that they are close enough to allow a key to be made of reasonable proportions, but not too close so that the field of the fixed magnets interact to give trouble, see Fig. 2.

B. H. Baily,
Dorset.

NOVEL OSCILLATOR

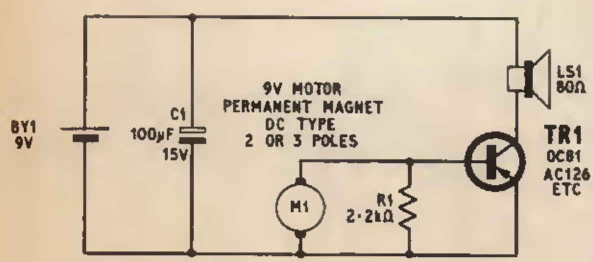

Fig. 1. Simple oscillator circuit diagram

Fig. 1 shows a simple and novel oscillator utilising a motor found in many model trains, cars, etc. When the spindle is rotated, the motor acts as a dynamo and the output is fed to the base of the transistor (any common type should suffice), which acts as a common emitter amplifier.

The frequency of the resultant note depends on the speed of rotation of the motor.

J. M. Maud,
Scunthorpe,
Lincs.

NEWS BRIEFS

S.E.R.T. Computer Group

To encourage Society involvement in the whole field of electronic data processing, the Society of Electronic and Radio Technicians has established a Computer Group Committee to organise Society activities in selected fields. Initially, the Computer Group Committee will be organising meetings and procuring papers in the field of computation.

The committee will be made up of the following personnel: J. Harris (chairman), Kingston College of Further Education; D. J. Dennis, I.B.M.; K. R. Brown, B. Dobson and M. R. Fox, I.C.L.; and J. Cairns, Univac.

The first meeting to be organised by the Computer Group will be a lecture and demonstration by Mr C. J. Fleckney, Information Co-ordinator of I.C.L. to be held at the I.C.L. Training Centre, Icknield Way, Letchworth, Herts. on Wednesday, October 21, commencing at 7.00 p.m.

Navigation System Takes the Air

A lightweight military navigation system announced by Marconi at the end of last year has started flight demonstrations to prospective customers in the Company's Piaggio aircraft. Aimed at a major slice of a prospective £4 million European and U.K. market, this is the first time that this system has flown in Europe.

The equipment, Type AD280, is designed to be mounted in the pilot's instrument panel, and to provide complete VOR and instrument landing facilities in a single unit, including all necessary controls.

The navigation system is designed primarily for small high performance military aircraft, such as the Jaguar and the Phantom, and could also be applied to military helicopters.

Servicing will take the form of removing a faulty module and replacing it with a complete sealed unit. The faulty module will then be returned to the factory for repair or replacement.

The system is the result of over a million dollars expenditure on research and development. Marconi intend to start production at their own factory in Basildon, Essex, and a new, thick-film assembly area will be laid down to produce the assembled substrates for this and other equipment which will be in production next year.

Computers to Train Postcode Operators

Postmen who operate postcode desk keyboards may in future be taught almost entirely by computer. In pioneering this type of training, the Post Office is soon to take delivery of a computer which will individually control up to 20 trainees, allowing each to develop his or her skill at the most suitable pace.

A keyboard simulation is flashed on a television-type screen before him; over this is a superimposed diagram showing how his fingers should be positioned. The letter to be typed will flash on the screen—the position of the flashing letter on the keyboard simulation corresponding with the position of the key which should be pressed.

The aim is to produce operators capable of a speed of 250 characters per minute with an error rate of only one in 2,000 characters. The computer will be programmed to examine the pupil at every stage of training and give revision exercises or prolonged practice sessions on any weak point he may display.

The first computer trainer will be installed at Croydon and the first full class of trainees should be under instruction by the end of the year.

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

QUALITY-TESTED PAKS

6	Matched Trans. OC44/45/81/81D	10/-
20	Red Spot AF Trans. PNP	10/-
16	White Spot RF Trans. PNP	10/-
5	Silicon Rects. 3 A 100-400 PIV	10/-
2	10 A Silicon Rects. 100 PIV	10/-
2	OC1 140 Trans. NPN Switching	10/-
1	12 A SCR 100 PIV	10/-
3	Sil. Trans. 2S303 PNP	10/-
3	200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3	Zener Diodes 1W 33V 5% Tol.	10/-
4	High Current Trans. OC42 Eqvt.	10/-
2	Power Transistors 1 OC26 1 OC35 ...	10/-
5	Silicon Rects. 400 PIV 250mA	10/-
4	OC75 Transistors	10/-
1	Power Trans. OC20 100V	10/-
10	OA202 Sil. Diodes Sub-min.........	10/-
2	Low Noise Trans. NPN 2N929/30......	10/-
1	Sil. Trans. NPN VCB 100 ZT86	10/-
8	OA81 Diodes	10/-
4	OC72 Transistors	10/-
4	OC77 Transistors	10/-
4	Sil. Rects. 400 PIV 500mA	10/-
5	GET884 Trans. Eqvt. OC44..........	10/-
5	GET883 Trans. Eqvt. OC45..........	10/-
2	2N708 Sil. Trans. 300Mc/s NPN	10/-
3	GT31 LF Low Noise Germ Trans.	10/-
6	IN914 Sil. Diodes 75 PIV 75mA	10/-
8	OA95 Germ. Diodes Sub-min. 1N69 .	10/-
3	NPN Germ. Trans. NKT773 Eqvt....	10/-
2	OC22 Power Trans. Germ...........	10/-
2	OC25 Power Trans. Germ.	10/-
4	AC128 Trans. PNP High Gain	10/-
4	AC127/128 Comp. pair PNP/NPN ...	10/-
3	2N1307 PNP Switching Trans.	10/-
7	CG62H Germ. Diodes Eqvt. OA71 ..	10/-
3	AF116 Type Trans.	10/-
12	Assorted Germ. Diodes Marked	10/-
4	AC126 Germ. PNP Trans.	10/-
4	Silicon Rects. 100 PIV 750mA	10/-
3	AF117 Trans......................	10/-
7	OC81 Type Trans.	10/-
3	OC171 Trans......................	10/-
5	2N2926 Sil. Epoxy Trans.	10/-
7	OC71 Type Trans.	10/-
2	2S701 Sil. Trans. Texas	10/-
2	10 A 600 PIV Sil. Rects. 1S45R	10/-
3	BC108 Sil. NPN High Gain Trans. ..	10/-
1	2N910 NPN Sil. Trans. VCB 100	10/-
2	1000 PIV Sil. Rect. 1·5 A R53310 AF	10/-
3	BSY95A Sil. Trans. NPN 200Mc/s ..	10/-
3	OC200 Sil. Trans.	10/-
2	GET880 Low Noise Germ. Trans. ...	10/-
1	AF139 PNP High Freq. Trans.	10/-
3	NPN Trans. 1 ST141 & 2ST140	10/-
4	Madt's 2 MAT100 & 2MAT120	10/-
3	Madt's 2 MAT101 & 1 MAT121	10/-
4	OC44 Germ. Trans. AF	10/-
3	AC127 NPN Germ. Trans.	10/-
1	2N3906 Sil. PNP Trans. Motorola ...	10/-
2	Sil. Power Rects. BYZ13	15/-
1	Sil. Power Trans. NPN 100Mc/s. TK201A........................	15/-
2	2N1132 PNP Epitaxial Planar Sil. ..	10/-
3	2N697 Epitaxial Planar Trans. Sil....	15/-
4	Germ. Power Trans. Eqvt. OC16	15/-
1	Unijunction Trans. 2N2646	15/-
2	Sil. Trans. 200Mc/s 60Vcb ZT83/84 ..	15/-
20	NKT Trans. AF. RF. VHF. Coded + Eqvt. List........................	10/-
2	2N2712 Sil. Epoxy Planar HFE225 ..	15/-
8	BY100 Type Sil. Rects.	20/-
25	Sil. and Germ. Trans. Mixed, all marked, New	30/-

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

TYPE	EACH	TYPE	EACH
2N1613	4/6	IN914	1/-
2N3055	12/6	OA200	1/-
2N3703	3/-	BFY51	3/6
2N3704	3/6	BYZ13	4/6
2N3707	3/9	40362	14/-
2N3819	8/-	22V 1½W Zener	3/6

GIRO No. 388-7006

BI-PAK

63A High Street
WARE
Herts.

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

STEPHENS ELECTRONICS
P.O. BOX 26
AYLESBURY, BUCKS.

SEND S.A.E. FOR LISTS
GUARANTEE
Satisfaction or money refunded.

VALVES

AZ31	9/6	EF184	11/3	PL38	18/-	6U4	15/-
DAF91	8/3	EH90	10/3	PL81	10/3	6AT6	9/9
DAF96	8/3	EL34	9/9	PL81A	12/6	6U6A	15/6
DF91	9/-	EL41	10/-	PL82	7/3	6AV6	6/6
DF96	9/-	EL81	9/6	PL83	10/3	6BA6	9/6
DK91	11/6	EL84	7/9	PL84	8/3	6BE6	12/-
DK96	11/6	EL95	9/-	PL500	16/6	6BR7	15/-
DL92	7/6	EM81	11/6	PL504	17/-	6BR8	19/-
DL94	7/6	EM84/7	12/9	PL505	29/-	6BW6	16/6
DL96	9/3	EY51	7/6	PL508	20/-	6BW7	13/9
DY86/7	8/-	EY86/7	7/9	PL509	30/9	6CD6G	28/-
DY802	8/6	EX40/1	7/6	PL802	17/3	6V6G	8/-
EABC80	10/6	EZ80	6/6	PL805	17/3	6X4	7/6
EBC33	11/-	EZ81	5/9	PY32	10/-	6X5	9/6
EBC41	9/6	GY501	14/6	PY33	10/9	12AU6	15/-
EBC81	6/6	GZ30	9/6	PY81	8/3	12BA6	9/6
EBC90	9/6	GZ32/4	11/9	PY800	8/3	12BE6	12/-
EBF80	8/-	GZ33/7	16/3	PY801	8/3	12BH7	14/-
EBF83	8/-	KT66	25/6	PY82	7/-	35W4	9/6
EBF89	8/-	KT88	32/6	PY83	10/-	50C5	12/6
EB91	5/3	N37	15/6	PY88	8/3	6F23	15/6
ECC81	8/-	N339	25/6	PY500	20/-	6F24/5	12/6
ECC82/3	8/6	PC86/8	10/3	PZ30	16/-	6F26	8/3
ECC84/5	8/6	PC900	10/3	R19	13/-	6F28	11/6
ECC88	11/-	PC95	7/3	R20	15/-	6/30L2	15/6
E88CC	12/6	PC97	8/3	UABC80	10/6	10F1	15/-
ECF80/2	9/6	PCC84	9/3	UBF89	8/-	10F18	10/-
ECF86	11/-	PCC85	8/6	UBC41	9/9	10P13	16/-
ECH35	13/6	PCC88	14/-	UCC85	9/3	10P14	19/-
ECH42	13/3	PCC89	12/3	UCH42	13/9	20P4	20/-
ECH81	10/3	PCC189	12/3	UCH81	10/9	30C1	10/3
ECH83	8/-	PCF80	10/3	UCL82	10/3	30C15	13/9
ECH84	9/6	PCF82	10/6	UCL83	12/3	30C17	15/9
ECLL800	20/-	PCF84	9/6	UF41/2	11/-	30C18	13/6
ECL80	8/-	PCF86	12/3	UF80/5	7/6	30F5	16/6
ECL82	9/9	PCF200/1	16/3	UF89	8/3	30FL1	12/9
ECL83	11/6	PCF801	12/3	UL41	11/6	30FL12	17/6
ECL86	9/9	PCF802	12/3	UL84	11/-	30FL14	13/6
EF39	10/6	PCF805	13/-	UM80/4	9/-	30L1	9/3
EF80	8/-	PCF806	12/3	UY41	8/-	30L15	15/3
EF83	10/-	PCF808	13/6	UY85	6/9	30L17	14/6
EF85	8/3	PCH200	11/6	U25	15/-	30P12	15/6
EF86	13/3	PCL82	10/3	U26	15/-	30PL1	12/9
EF89	8/-	PCL83	12/3	U191	14/6	30P4MR	20/-
EF91	8/6	PCL84	10/3	U193	8/3	30P19	12/9
EF92	10/-	PCL85	10/6	U301	17/-	30PL13	18/6
EF93	9/6	PCL86	10/3	W729	11/-	30PL14	18/6
EF94	15/6	PD500	30/6	Z759	24/6	30PL15	18/6
EF95	12/6	PFL200	14/9	5Y3	8/6		
EF183	11/3	PL36	12/9	5Z4	9/6		

90% B.V.A. BOXED (NORMAL GUARANTEE) OR OWN VALVES SUPPLIED, 1 YEAR'S GUARANTEE. ADD 6d PER VALVE ON ORDERS UNDER 6, OTHERWISE FREE POST AND PACKING.

SEMICONDUCTORS

AC117	12/-	BC115	6/6	BF225	6/-	2N1305	4/10
AC126	4/4	BC117	7/9	BF257	9/6	2N1306	6/2
AC127	4/9	BC118	7/9	BF22A	9/6	2N3055	15/-
AC128	4/6	BC134	11/6	NKT125	5/9	2N3392	5/-
AC176	7/4	BC147	5/8	NKT281	4/-	2N3702	5/6
ACY17	6/-	BC148	4/4	NKT401	17/6	2N3705	4/6
ACY20	6/-	BC152	5/6	OC25	9/6	2N3711	4/9
AD149	11/8	BC175	5/6	OC44	5/6	2N3819	9/-
AD161	6/9	BC187	5/8	OC45	5/4	2N3826	6/-
AD162	6/9	BC213L	5/4	OC71	4/4	2N4062	4/6
AF114	4/8	BDY20	30/6	OC72	5/4	2N4289	4/6
AF115	4/8	BFY50	5/-	OC77	5/6		
AF116	4/9	BFX84	7/-	OC78	5/-		
AF117	4/6	BFX29	7/6	OC81	4/-	**RECTIFIERS**	
AF118	12/-	BF115	5/6	OC81D	4/-	BY126	4/4
AF126	4/8	BF117	9/6	(GET113)		BY127	5/-
AF127	4/8	BF163	7/-	OC84	5/-		
AF139	8/8	BF167	6/-	OC169	4/8		
AF178	9/-	BF173	7/-	OC171	6/-		
AF179	9/-	BF178	7/-	OC200	6/6	**DIODES**	
AF180	12/4	BF180	8/-	OC202	9/6	AA119	2/-
AF181	9/4	BF181	8/-	OC203	6/6	OA47	1/9
AF186	13/4	BF182	8/-	OCP71	12/6	OA79	1/10
AF239	8/6	BF184	5/-	P346A	4/6	OA81	1/10
BC107A	5/-	BF194	5/-	2N456A	17/6	OA91	2/-
BC108B	4/6	BF197	6/4	2N697	5/10	OA202	2/-
BC109C	5/-	BF200	7/4	2N698	10/6	BZY88	
BC113	5/6	BF224	6/-	2N1132	11/6	(SERIES)	6/6

ADD 5d. PER ITEM FOR POST AND PACKING FOR ORDERS UNDER 24 PIECES.

CATHODE RAY TUBES

New and Budget tubes made by the leading British manufacturers Guaranteed for 2 years. In the event of failure under guarantee, replacement is made without the usual time wasting forms and postage expense.

Type		New £	Budget £
MW36-20			4.10.0
MW36-21			4.10.0
MW43-69Z	CRM171		
	CRM172	6.12.0	4.12.6
MW43-80Z	CRM173	6.12.0	4.12.6
AW43-80Z	CME1702	6.12.0	4.12.6
	CME1703	6.12.0	4.12.6
	CME1706	6.12.0	4.12.6
	C17AA	6.12.0	4.12.6
	C17AF	6.12.0	4.12.6
AW43-88	CME1705	6.12.0	4.12.6
AW47-90			
AW47-91	A47-14W	7.13.4	5. 7.6
A47-14W	CME1901	7.13.4	5. 7.6
	CME1902	7.13.4	5. 7.6
	CME1903	7.13.4	5. 7.6
	C19AH	7.13.4	5. 7.6
A47-13W	CME1906	10. 5.6	8.10.0
A47-11W	CME1905	8.17.3	7. 0.0
A47-26W	CME1905	8.17.3	7.15.0
A47-26W/R	CME1913R	9. 6.8	
A50-120W/R	CME2013	10.17.0	
AW53-80		8.18.8	6. 5.0
AW53-88	CME2101	8.18.8	6. 5.0
AW59-90			
AW59-91	CME2303	9.11.8	7. 4.0
A59-15W	CME2301		
	CME2302		
	CME2303	9.11.8	7. 4.0
A59-11W	CME2305		
A59-13W	CME2306	13.13.0	10.19.6
A59-16W	CME2306	13.13.0	10.19.6
A59-23W	CME2305	12.12.0	10.10.0
A59-23W/R		12.12.0	10.10.0
PORTABLE SET TUBES			
TSD217			6.15.0
TSD282			6.15.0
A28-14W		9. 3.4	Not supplied
CME1601			7.15.0
CME1602			8. 0.0

A discount of 10% is also given for the purchase of 3 or more New tubes at any one time.
All types of tubes in stock. Carriage and insurance 15/-.

TRANSISTORISED UHF TUNER UNITS
NEW AND GUARANTEED FOR 3 MONTHS

Complete with Aerial Socket and wires for Radio and Allied TV sets but can be used for most makes.
Continuous Tuning, 90/-; Push Button, 100/-.

STYLII

TC8, GC2, GP59, GC8, DC284, Stereo 105, 106, 208, 2/- each (individually boxed); ST3/5, ST8/9, 9TA, 9TA/HC, GP91, 8/-, Diamond. Post and packing 5d per item for orders under 24.

TAPES (Polyester PVC)

4in L.P., 8/6; 3in L.P., 5/6.
Standard Play: 600ft 5in, 8/6; 900ft 5¾in, 10/6; 1,200ft 7in, 12/6.
Long Play: 900ft 5in, 11/-; 1,200ft 5¾in, 13/-; 1,800ft 7in, 18/-.
Double Play: 1,200ft 5in, 16/-; 1,800ft 5¾in, 19/-; 2,400ft 7in, 28/-.
Philips type Cassettes (in plastic library pack): C60, 10/6; C90, 12/6; C120, 19/6.
Post and packing 1/6 on all orders.

ACOS CARTRIDGES

GP91-1—Medium output Mono Crystal, 21/- inc. P. Tax.
GP91-3sc—High output Mono Crystal (TC8H, TC8M, BSR X3H, X3M), 21/- inc. P. Tax.
GP93-1—Stereophonic Crystal, 24/9 inc. P. Tax.
GP94-1—Stereophonic Ceramic, 31/- inc. P. Tax.
GP95-1—Stereophonic Crystal, 24/9 inc. P. Tax.
GP96/1—Stereophonic Ceramic, 31/6 inc. P. Tax.

TERMS, CASH WITH ORDER ONLY. POST AND PACKING PAYABLE ON ORDERS UP TO £3, AFTER THAT, FREE EXCEPT C.R.T.'s.

BI-PRE-PAK LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC170	4/6
AC126	2/6	OC171	4/6
AC127	3/6	OC200	5/-
AC128	2/6	OC201	5/-
AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF239	12/6	2N711	10/-
AF186	10/-	2N1302-3	4/-
AF139	10/-	2N1304-5	5/-
BC154	5/-	2N1306-7	6/-
BC171 = BC107	2/6	2N1308-9	7/-
BC172 = BC108	2/6	2N3819FET	9/-
BF194	3/-		
BF274	3/-	**Power**	
BFY50	4/-	**Transistors**	
BSY25	7/6	OC20	10/-
BSY26	2/6	OC23	6/-
BSY27	2/6	OC25	5/-
BSY28	2/6	OC26	5/-
BSY29	2/6	OC28	6/-
BSY95A	3/-	OC35	5/-
OC41	2/6	OC36	7/6
OC44	2/6	AD149	6/-
OC45	2/6	AUY10	25/-
OC71	2/6	2S034	5/-
OC72	2/6	2N3055	12/6
OC73	3/6	**Diodes**	
OC81	2/6	AAY42	2/-
OC81D	2/6	OA95	2/-
OC83	4/-	OA79	1/9
OC139	2/6	OA81	1/9
OC140	3/6	IN914	1/6

FREE!

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

SURPLUS INTEGRATED CIRCUITS

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

		Price
NE808A	Single 8 I/P Nand Gate TTL	7/-
NE816A	Dual 4 I/P Nand Gate TTL	7/-
NE825A	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855A	Dual 4 Power Gate TTL	7/-
NE870A	Triple 3 I/P Nand TTL	7/-
SN7430	8 Input Positive Nand Gate TTL	7/-
SP616A	Dual 4 Nant Gate DTL	7/-
SP631A	Quad 2 I/P Gate Expander DTL	7/-
SP670A	Triple 3 Nand Gate TTL	7/-
SP806A	Dual I/P Expander TTL	7/-
SP808A	Single 8 I/P Nand Gate TTL	7/-
SP816A	Dual 4 I/P Nand Gate TTL	7/-
SP825A	D.C. Clocked J-K Flip-Flop TTL	17/6
SP840A	Dual 4 I/P Exclusive OR Gate TTL	7/-
SP855A	Dual 4 Power Gate TTL	7/-
SP870A	Triple 3 I/P Nand TTL	7/-
SP880A	Quad 2 I/P Nand TTL	7/-
NE500K	Video Amplifier	40/-
NE501K	Video Amplifier 40MHz	40/-
NE806J	Dual 4 I/P Expander TTL	7/-
NE808J	Single 8 I/P Nand Gate TTL	7/-
NE816J	Dual 4 I/P Nand Gate TTL	7/-
NE825J	D.C. Clocked J-K Flip-Flop TTL	17/6
NE840J	Dual 4 I/P Exclusive OR Gate TTL	7/-
NE855J	Dual 4 Power Driver TTL	7/-
ST620A	J-K Flip-Flop DTL	17/6
ST659A	Dual 4 Buffer/Driver DTL	7/-

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

NEW TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries. 0·3 to 0·5V, 0·5 to 2mA.	10/-
B77	2	AD161–AD162 NPN/PNP Trans. Comp. Output, Pair	10/-
B81	10	Reed Switches, mixed types large and small	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1M Ω	10/-
B91	8	NKT163/164 PNP Germ. TO-5 equivalent to OC44, OC45	10/-
B92	4	NPN. Sil. Trans. AO6 = BSX20, 2N2369 500 MHz, 360mW	10/-
B93	5	GET113 Trans. equiv. to ACY17–21 PNP Germ.	10/-
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/-
H4	250	Mixed Resistors. Post and Packing 2/-	10/-
H7	40	Wirewound Resistors. Mixed types and values. Postage 1/6	10/-
H8	4	BY127 Sil. Recs 1000 PIV. 1 amp. plastic	10/-
H9	2	OCP71 Light Sensitive Photo Transistor	10/-

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

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

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

LOOK! TRANSISTORS ONLY 6d EACH

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

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

TYPE E
PNP GERMANIUM FULLY MARKED AND TESTED.

AF. or RF.
PLEASE STATE ON ORDER

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

NEW UNMARKED UNTESTED PAKS

B80	8	Dual Trans. Matched O/P pairs NPN. Sil. in TO-5 can	10/-
B83	200	Trans. manufacturer's rejects all types NPN, PNP, Sil. and Germ.	10/-
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	10/-
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	10/-
B88	50	Sil. Trans. NPN, PNP, equiv. to OC200/1, 2N706A, BSY95A, etc.	10/-
B60	10	7 Watt Zener Diodes Mixed Voltages	10/-
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	10/-
H10	25	Mixed volts, 1½ watt Zeners. Top hat type	10/-
H11	30	MAT Series "alloy" *pnp* Transistors	10/-
H15	30	Top Hat Silicon Rectifiers, 750mA. Mixed volts	10/-
H16	8	Experimenters' Pak of Integrated Circuits. Data supplied.	10/-
H20	20	BY126/7 Type Silicon Rectifiers, 1 amp plastic. Mixed volts	10/-

FREE CATALOGUE AND LISTS for: —

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

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

P.O. RELAYS

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

8 FOR 20/-

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

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

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EVERYTHING BRAND NEW AND TO SPECIFICATION • LARGE STOCKS

BARGAINS IN NEW SEMICONDUCTORS

All power types supplied with free insulating sets

1N914	1/3	2N3706	3/3	40512	45/6	BC147	3/6	BFY51	4/3
1N3754	4/-	2N3707	4/-	40602	9/6	BC148	3/3	BSX20	3/9
1N4148	1/9	2N3708	3/-	AC107	14/6	BC149	3/6	BY164	10/-
1N5054	4/-	2N3709	3/-	AC126	6/6	BC153	10/-	BY238	3/6
18940	1/-	2N3710	3/6	AC127	6/-	BC154	11/-	C106B1	14/6
2N696	5/6	2N3711	3/11	AC128	6/-	BC157	3/9	MC140	5/-
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C	1/8W	5%	4·7Ω–330kΩ	E24	2·5d	2d	1·75d
C	1/4W	10%	4·7Ω–10MΩ	E12	2·5d	2d	1·75d
C	1/2W	5%	4·7Ω–10MΩ	E24	3d	2·5d	2·25d
C	1W	10%	4·7Ω–10MΩ	E12	6d	5d	4·5d
MO	1/2W	2%	10Ω–1MΩ	E24	9d	8d	7d
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WW	3W	5%	12Ω–10kΩ	E12	15d all quantities		
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VALUES: E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

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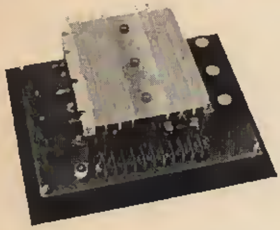

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