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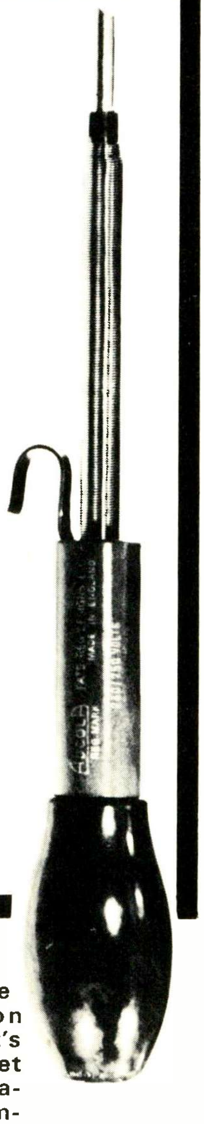

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B 42 LL 3/16″ — 4.75 mm CHISEL FACE
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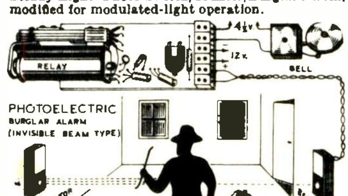

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CONTENTS: 2 Lenses, Infra-red Filter, Lampholder, Bracket, Plans, etc. Everything (except plywood) to build 1 miniature invisible beam projector and photocell receiver for use with Junior Photoelectric Kit.
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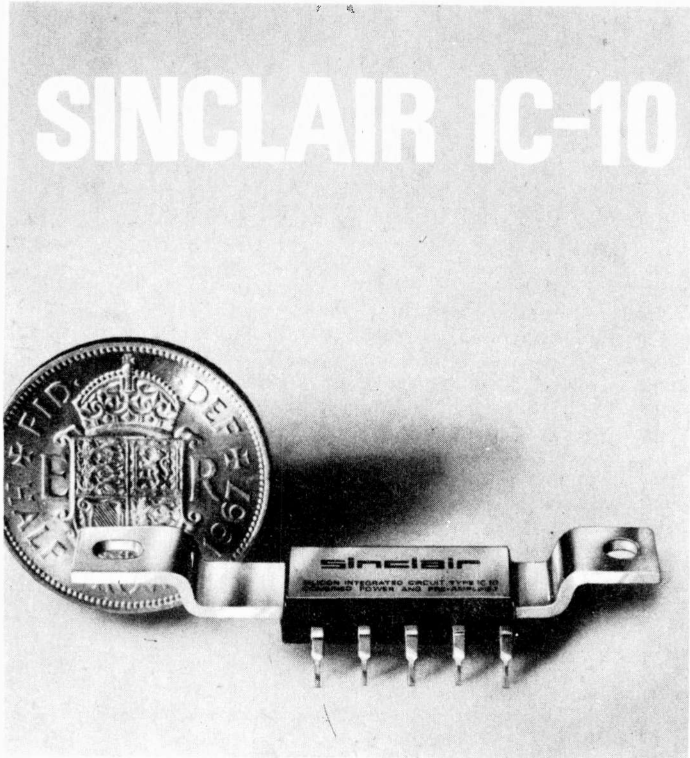
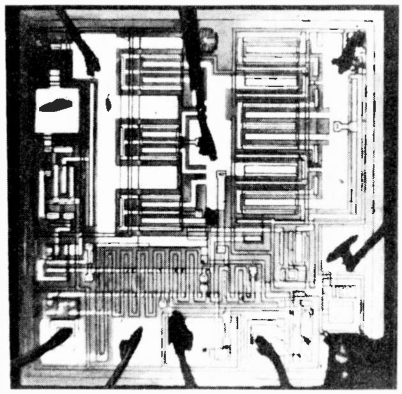


MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



the world's most advanced high fidelity amplifier

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

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

■ SPECIFICATIONS

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

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feed-back is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently 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 20 WATT R.M.S. POWER AMPLIFIER (40 WATTS PEAK)

Z.50 40 WATT R.M.S. POWER AMPLIFIER (80 WATT PEAK)

The Z.30 together with the higher powered Z.50 are both of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0·02% at full output and all lower outputs. Whether you use the Z.30 or Z.50 power amplifiers in your Project 60 system will depend on personal preference, but they are both the same physical size and may be used with other units in the Project 60 range equally well. The Z.30 is unique in that it may be used with any power source between 8 and 35 volts without need for adjustment and may thus be driven from a car battery for example. For operating from mains, for the Z.30 use PZ.5 power supply unit for most domestic requirements, or PZ.6 if you have very low efficiency loudspeakers. For Z.50, use the PZ.5, PZ.6 or the PZ.8 described below.

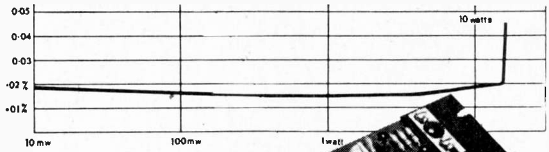
Power Outputs

Z.30 15 watts R.M.S. into 8 ohms, using 35V/20 watts R.M.S. continuous into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms: 30 watts R.M.S. into 8 ohms, continuous, using 50V.
Frequency response 30 to 300,000Hz ± 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"

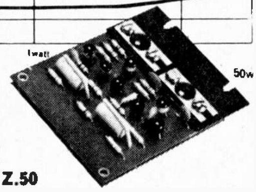
APPLICATIONS

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

The Z.50 is completely interchangeable with the Z.30 and can be used in all Z.30 applications.



Power versus distortion curve of Sinclair Z.30 and Z.50 amplifiers



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

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

STEREO 60 Preamp/Control unit

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to achieving a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.

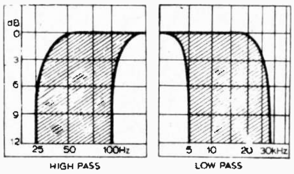
STEREO 60 SPECIFICATIONS

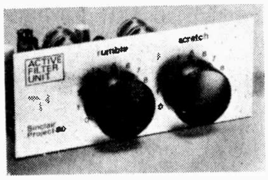
- Input sensitivities—Radio—up to 3mV Mag. p.u.—3mV: correct to R.I.A.A. curve ±1dB; 20 to 25,000Hz. Ceramic p.u.—up to 3mV: Aux.—up to 3mV.
- Output—250mV.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone controls—TREBLE +15 to −15dB at 10KHz: BASS +15 to −15dB at 100Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8½ × 1½ × 4in.

STEREO 60 *Built, tested and guaranteed* **£9.19.6**

ACTIVE FILTER UNIT High Pass and Low Pass

For use between Stereo 60 unit and two Z.30s or Z.50s, the Active Filter Unit matches the Stereo 60 in styling and is as easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible by reason of the careful design and generous negative feedback employed.

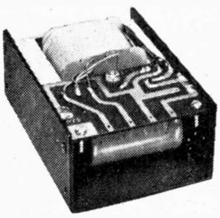




Two stages of filtering are incorporated—rumble (high pass) and scratch (low pass).
Supply voltage—15 to 35V. Current—3mA
H.F cut-off (−3dB) variable from 28kHz to 5kHz
L.F cut-off (−3dB) variable from 25Hz to 100Hz
Filterslope, both sections 12dB per octave
Distortion at 1kHz (35V supply) 0·02% at rate output

Built, tested and guaranteed **£5.19.6**

SINCLAIR POWER UNITS



PZ-5 *30 volts unstabilised* **£4.19.6**

PZ-6 *35 volts stabilised* **£7.19.6**

PZ-8 *45 volts stabilised (less mains transformer) for use with Z.50* **£5.19.6**

Mains transformer for PZ-8 *£5.19.6*

BUILDING A PROJECT 60 ASSEMBLY

The illustration here shows quite clearly how easily Project 60 can be contained in one of today's slim, modern plinths. Very little space is required to house these Sinclair units, and within the space of the motor plinth, you can install a stereo amplifier of the very highest quality. If, for example you have already put together an assembly as illustrated here, adding the Active Filter Unit would be very easy.

If at any time within 3 months of purchasing Project 60 modules 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 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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A 5 Germ. R.F. PNP T0-5	=2N1303, NKT164-7, 2G301-3	£1.10	£4.10	£7.10	£60
A 6 Germ. V.H.F. PNP T0-1	=AF116-7, KNT667, 2G417	£3.10	£15	£25	£200
A 7 Assorted Germ. A.F.-R.F. PNP mixed cans, general purpose		15s.	£2.10	£4	£32
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A 9 Sil. Alloy PNP T0-5	=2S301-5, BCY17-29, BCY30-34	£2	£7.10	£12.10	£100
A10 Sil. Alloy PNP S0-2	=2S321-325, OC200-205	£2	£7.10	£12.10	£100

A1 to A7 Guaranteed 80% Good usable Transistors ideal for low cost production work and experimental use. A8 to A10 are all perfect devices, factory tested, no open or short circuit Transistors in these lots.

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400PIV,	14/–	12/–	10/–

All tested perfect functional devices guaranteed.

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each ONE PRICE ONLY PNP. NPN. SILICON PLANAR 1/6 EACH each

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BC109	2N697	2N1613	2N3707	2N3391
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BFY51	2N708	2N2904	2S102	2N2906
BFX84	2N929	2N2905	2S103	2N2907
BFX86	2N930	2N2924	2S104	2N2696
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AC128	ACY29	NKT212	OC44	2G302	
AC130	ACY30	NKT213	OC45	2G303	
ACY19	ACY31	NKT214	OC71	2G308	1/6
ACY20	ACY34	NKT215	OC72	2G371	each
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400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **6d.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **7d.** 0·047μF, **9d.** 0·068μF, 0·1μF, **10d.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **7d.** 0·1μF, **9d.** 0·15μF, 0·22μF, **11d.** 0·33μF, **1/3.** 0·47μF, **1/6.** 0·68μF, **2/3.** 1·0μF, **2/6.**
250V: P.C. mounting miniature ±20%: 0·01μF, 0·015μF, 0·022μF, **7d,** 0·033μF, 0·047μF, 0·068μF, **8d.** 0·1μF, **9d.** 0·15μF, 0·22μF, **1/-.** 0·33μF, **1/4.**

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Selection of ceramic and polyester capacitors 100pF to 1·0μF. Total 100 capacitors, **£2.18.0.**

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320μF	6V	200μF	10V	100μF	12V	8μF	40V	10μF	64V

1/- each.

250μF 12V, 100μF 40V **1/6.** 1000μF 25V **6/-.** 2500μF 25V **9/-.** 500μF 50V **5/-.** 1000μF 50V **8/-.**

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2½ × 3¾	3/3	3/6	Pin insertion tool	9/6	9/6
2½ × 5	3/9	4/3	Pkt. 36 pins	3/–	3/–
3¾ × 3¾	3/9	3/9	Spot face cutter	7/3	7/3
3¾ × 5	5/3	5/3			
17 × 3¾	14/6	—			

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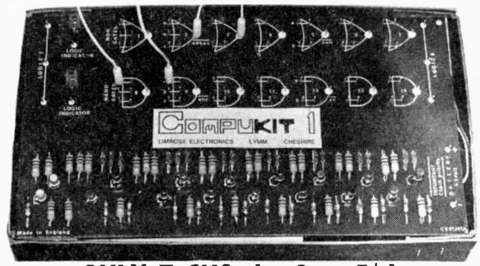

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The 66 inch OTIS KING scales give you *extra* accuracy. Write today for free booklet, or send 82/6 for this invaluable spiral slide rule on approval with money back guarantee if not satisfied.

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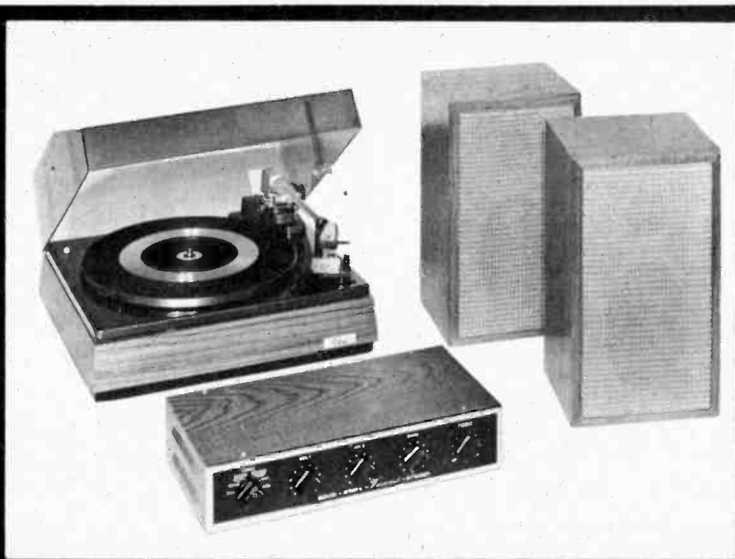
Complete Stereo System £41

WITH VISCOUNT F.E.T. FIELD EFFECT TRANSISTORS AMPLIFIER

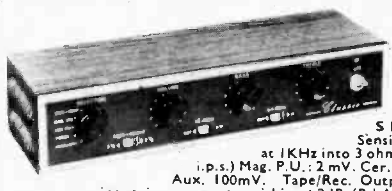


This superb stereo system is a real price breakthrough. It comprises the VISCOUNT F.E.T. Mk. I amplifier on which full details are given below, the famous Garrard SP25 Mk. II (including teak veneer base and transparent cover) with diamond cartridge or 2025 TC and the very successful DUO type 2 speakers.

Measuring 17½in × 10¾in × 6¼in, 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.

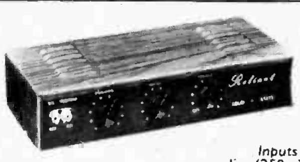


The Classic

Teak finished case

£9.10
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*: Boss: 13dB at 60Hz. *Treble*: ±14dB at 15KHz. *Total Distortion*: (for 10 watt output) < 1·5%. Signal Noise: < −60dB. A.C. Mains 200–250V. Size 12¼in long, 4¼in deep, 2¾in high. **Built and tested.**

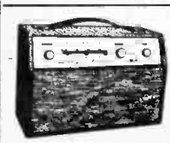


THE RELIANT Mk. II

SOLID STATE GENERAL PURPOSE AMPLIFIER

£7.5.0 Plus P. & P. 7/6
In teak finished case

SPECIFICATION: *Output*: 10 watts into a 3 ohms speaker. *Inputs*: (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors*: 4 silicon and three germanium. *Mains input*: 220/250 volts. Size: 10½ × 4¾ × 2½in. Mk. I £6.10.0 plus 7/6 P. & P. Less teak finished case.



ELEGANT SEVEN Mk. III (350mW Output)

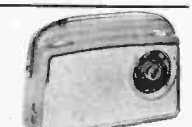
7-transistor fully tunable M.W.-L.W. Superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. **MAINS POWER PACK KIT: 9/6 extra.**

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

THE DORSET (600mW Output)

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

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



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.

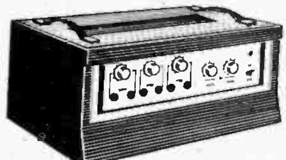
SPECIFICATION

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).

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.

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 12¼in × 6in × 2¾in in teak-finished case. Built and tested.
Post & packing 10/- extra.
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



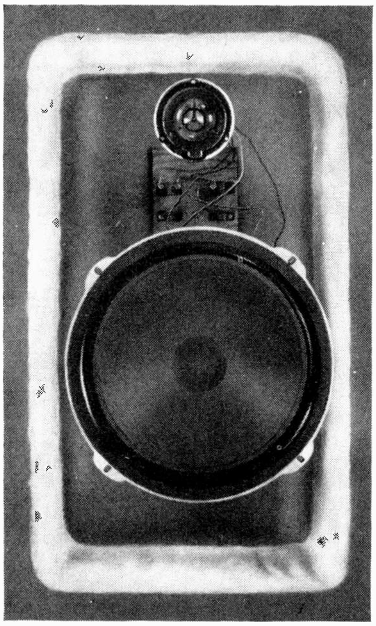
Price £28.10.0
Plus 20/- P. & P.

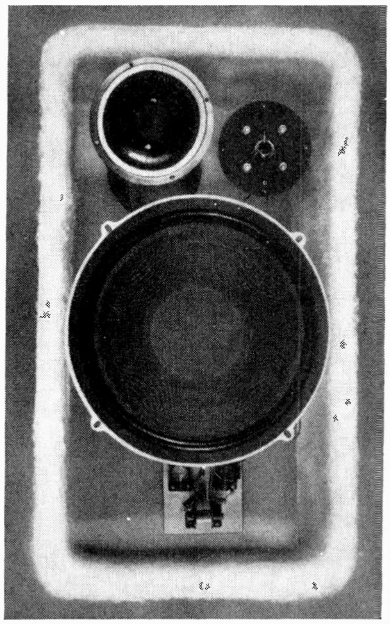
An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.

TECHNICAL SPECIFICATIONS
3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **Sensitivities and Input Impedances.** Channels 1 and 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 and 4 300mV at 1m. Suitable for most high output instruments (gram, tuner, organ, etc.). Input sensitivity relative to 10W output. Tone Controls are common to all inputs. **Bass Boost** +12dB at 60 Hz/s. **Bass Cut** −13dB at 60 Hz/s. **Treble Boost** +11dB at 15 KHz/s. **Treble Cut** −12dB at 15KHz/s. With bass and treble controls central −3dB points are 30Hz/s and 20 KHz/s. **Power output.** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sinc wave 38·5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3·2% at 1KHz/s. Total distortion at 20 watts 0·15% at 1KHz/s. **Negative feed back** 20dB at 1KHz/s. **Signal to noise ratio** 60dB. **Mains voltages.** Adjustable from 200–250V. A.C. 50–60Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

Two new Build-it-yourself speaker kits from Wharfedale

"Why don't you produce kits for bigger speakers?" people asked us when Unit 3 proved such a success.
We hope you'll like our answer—Unit 4 (2-speaker floor standing system) and Unit 5 (3-speaker monitor system).
So if you're a high fidelity enthusiast who enjoys building his own equipment, send for details.





Unit 4 full range floor standing system.

2 speakers (12″ Bass and 3″ Treble) to give full range, balanced reproduction.

Frequency response of 45-17,000 Hz. when housed in suitable cabinet.

Superior 4-element crossover unit ensures optimum performance from each speaker.

Rec. Retail Price £16-0-0

Unit 5 the monitor system you can build yourself.

3 speakers (12″ Bass, 5″ Mid-Range unit, and 1″ Treble) give clean, smooth performance.

Frequency response of 40-20,000 Hz. when housed in suitable cabinet.

Unique mechanical/electrical 6 element crossover unit.

Rec. Retail Price £23-10-0.

All kits include speakers, crossover network, acoustic wadding, mounting bolts and connecting wire, together with full assembly instructions. No expert technical knowledge needed.

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To: Rank Wharfedale Ltd., Idle, Bradford.

Please send me leaflets describing your speaker kits.

Name (Block capitals, please) ....

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the true sound in High Fidelity

WHARFEDALE

Rank Wharfedale Ltd.,
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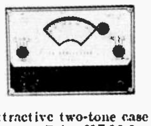
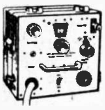
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR



Sine 18–200,000Hz; Square 18–50,000Hz. Output max +10dB (10kΩ). Operation internal batteries.
Attractive two-tone case 7⅜in × 5in × 2in. Price £17.10.0 Carr. 3/6.

CLASS D WAVEMETERS



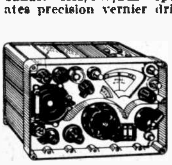
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6, or brand new with accessories. £7.19.6. Carr. 7/6.

CLASS D WAVEMETERS No. 2

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

R209 MK II COMMUNICATION RECEIVER

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

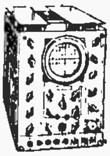


£15 Carr. 20/-.

B.C. 221 FREQUENCY METERS

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

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



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

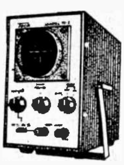
MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts.

£20. Carr. 20/-.

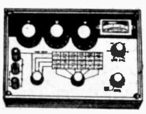
SOLARTRON CD. 71152 DOUBLE BEAM OSCILLOSCOPES. D.C. to 9 Mc/s. Perfect order. £65. Carr. 50/-.

TO-2 PORTABLE OSCILLOSCOPE



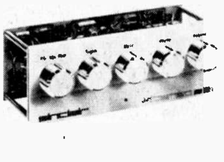
A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. £22.10.0. Carr. 10/-.

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



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1%. L.1 μH – 111 HENRYS 6 Ranges –2%. C. 10pF ±1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¼×5×2in. £20. P. & P. 5/-.

HALF PRICE OFFER! SINCLAIR STEREO 25



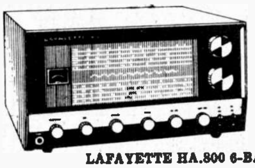
Hi-Fi solid state pre-amplifier and control unit incorporating treble, bass, volume and balance controls. Switched input for p.u. (magnetic and ceramic), mike and radio. Will also accept tape head. Operates from 9V–12V battery (20V max. 7·5mA). Frequency response 25Hz–30kHz ±1dB. Noise level better than –50dB on all inputs. Principally designed for use with Z12 Amplifier but full instructions are supplied to enable it to be used with any amplifier. Size 6½" × 2½" × 2½" overall plus knobs. Brushed and polished aluminium front panel with matching knobs. Supplied brand new and guaranteed, with full instructions. Original price £9.19.6. OUR PRICE £4.19.6. P. & P. 3/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

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

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

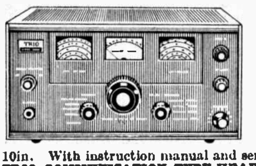
LAFAYETTE SOLID STATE HA600 RECEIVER



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

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

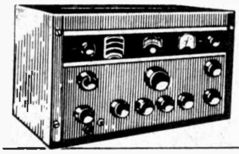
TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



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

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

RCA COMMUNICATION RECEIVER AR88D

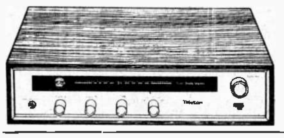


Latest release by ministry BRAND NEW in original cases. 110–250V a.c. operation. Frequency in 6 Bands. 535Kc/s–32Mc/s continuous. Output impedance 2·5–600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £65. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

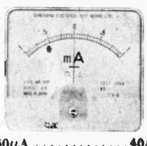
A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone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

TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4+4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540–1600 KHz FM 88–108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13¾" × 3½" × 9½" approx. Price £29.19.6. Carr. 7/6.

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. 1²¹/₃₂in square fronts.

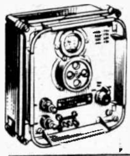
	500-0-500μA 27/6	50mA 27/6	150V. D.C. 27/6
	1mA 27/6	100mA 27/6	300V. D.C. 27/6
	1-0-1mA 27/6	150mA 27/6	500V. D.C. 27/6
	2mA 27/6	200mA 27/6	750V. D.C. 27/6
	5mA 27/6	300mA 27/6	15V. A.C. 27/6
	10mA 27/6	500mA 27/6	50V. A.C. 27/6
50μA 40/-	750mA 27/6	3V. D.C. 27/6	150V. A.C. 27/6
50-0-50μA 37/6	1 amp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

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

POWER RHEOSTATS

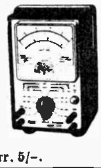
High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, 14/6. P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, 21/-. P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, 27/6. P. & P. 1/6.

CRYSTAL CALIBRATORS No. 10



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

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



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

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

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

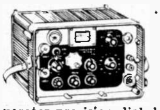
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5–1,500V. A.c. volts 1·5–1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. £17.10.0. P. & P. 6/-. Additional Probes available: R.F. 42/6. H.V. 50/-.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

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

AM/FM SIGNAL GENERATORS



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

RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPES

5MHz Pass Band. Separate Y1, Y2 amplifiers. Calibrated triggered sweep from 0·2μsec to 100msec/cm. Supplied complete with all accessories and instructions, £87, Carr. paid.

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

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz–30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3¼. Complete with instructions and leads. £7.19.6. P.&P. 4/-.

TE-1035 STEREO HEADPHONES

Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable headband. 8 ohm impedance. 25–18,000Hz. With lead and stereo jack plug.
ONLY 39/6. P.&P. 2/6.

AUTO TRANSFORMERS

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

150 W.	£2.2.6,	P. & P. 3/6
300 W.	£3.5.0,	P. & P. 4/6
500 W.	£4.10.0,	P. & P. 6/6
1,000 W.	£6.10.0,	P. & P. 7/6
1,500 W.	£8.19.6,	P. & P. 8/6
7,500 W.	£15.10.0,	P. & P. 20/-

G. W. SMITH & CO (RADIO) LTD.
Also see oppos. page

VARIABLE TRANSFORMERS

Input 230V a.c. 50/60Hz. Output variable 0–260V.

BENCH MOUNTING

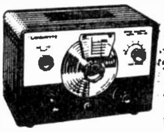
1 amp, **£5.10.0**; 2½ amp, **£6.15.0**; 5 amp **£9.15.0**; 8 amp, **£14.10.0**; 10 amp, **£18.10.0**; 20 amp, **£37.0.0.**

PANEL MOUNTING

1 amp, **£5.10.0**; 2½ amp, **£6.12.6.**

TE-20RF SIGNAL GENERATOR

Accurate wide range single generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instructions. **£15.0.0.** P. & P. 7/6. S.A.E. for details.



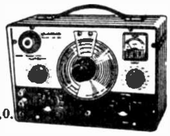
TE22 SINE SQUARE WAVE AUDIO GENERATORS

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

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

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c.



Brand New £17.10.0. Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

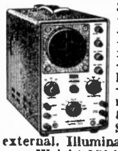
J1B. AUDIO SIGNAL GENERATOR. 15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. **£30.0.0.**

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

TT1S. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. **£37.10.0.**

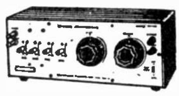
Carriage 10/- per item.

TO-3 PORTABLE OSCILLOSCOPE



3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps-1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5 cps -800 KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220/240V. A.C. Supplied brand new with handbook. **£37.10.0.** Carr. 10/-

TE111. DECADE RESISTANCE ATTENUATOR



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

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR

New high quality portable instrument. Sine 1Hz to 100kHz. Square 20Hz to 20kHz. Output max. +10dB (10kΩ). Operation 220/240V a.c. Size 215mm × 150mm × 120mm. Price **£27.10.0.** Carr. 5/-.

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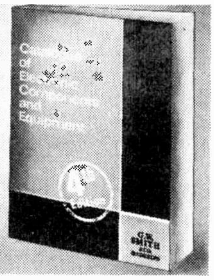
The latest edition giving full details of a comprehensive range of HI FI EQUIPMENT, COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT.... Over 230 pages, fully illustrated and detailing thousands of items—many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-



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FULL CURRENT RANGE OFFERED, BRAND NEW AT FANTASTIC SAVINGS

1025 stereo	£7.19.6	SL72B	£24.19.6
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3000 stereo	£9.19.6	SL75B	£27.19.6
SP25 MKII	£10.19.6	SL95B	£37.10.0
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1. For SP25, SL65, SL55, 3000, 2025T/C, 2025, 1000. **£4.10.0**
2. For AP75, SL75, SL95. **£5.19.6**
3. For SP25 etc. to operate with lid in place **£5.19.6**

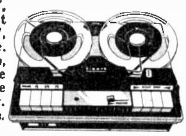
Carriage 7/6 extra each type. Full range of Garrard accessories available.

SPECIAL OFFERS!

Garrard SP25 fitted Goldring G800 cartridge and wooden plinth. Total list price £32.8.5.
OUR PRICE £19.15.0. Carr. 10/-.
Plastic Cover 25/- extra.
GOLDRING GL69 fitted Goldring G800 cartridge complete with deluxe base and cover. Total list price £50.16.0.
OUR PRICE £39. Carr. 20/-.

RTC 249 4 TRACK TAPE DECK

British made. Speed 1⅞", 3¾", 7½" P.S. Marriott Heads (XRP817, XES11). 7" reel size. Push button controls, fully interlocking. Size 13" × 10" × 1½" above unit plate, 4½" below. Full instructions. **£13.19.6.** Carr. 7/6.



MULTIMETERS *for EVERY purpose!*

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

TE-900 20,000 Ω VOLT GIANT MULTIMETER

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

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

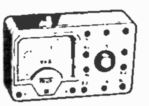
MODEL TE300 30,000 O.P.V. Mirror scale, overload protection. 0/0·6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30µA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. —20 to +63dB. **£5.19.6.** P. & P. 3/-.

MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000 V.D.C. 0/10/50/250/1,000 V.A.C. 0/50 µA/250 MA. 0/60K/6 meg. —20 to +62 db. **75/-.** P. & P. 2/6.

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

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

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



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

SAVE UP TO 33⅓% ON HI-FI EQUIPMENT
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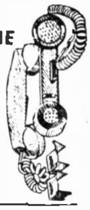
AVO CT471A MULTIMETER

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

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



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

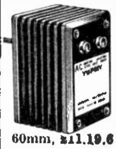
SINCLAIR EQUIPMENT

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

PEAK SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

SOLID STATE VARIABLE A.C. VOLTAGE REGULATORS



Compact and panel mounting. Ideal for control of lamps, drills, electrical appliances, etc. Input 230/240V a.c. Output continuously variable from 20V to 230V.
Model MR2305 5A 68 × 46 × 43mm, **£8.7.6.** Model MR2310 10A 90 × 68 × 60mm, **£11.19.6** Postage 2/6.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 2-way units and fitted adjustable level controls. 8 ohm impedance. 20-20,000cps. Complete with spring lead & stereo jack plug **£7.19.6.** P. & P. 2/6.

RECORDING HEADS

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

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

AMERICAN TAPE

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

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

Postage 2/-. Over £3 post paid.

TAPE CASSETTES

Top quality in plastic library boxes.

C60 60 min	8/6	3 for 24/6
C90 90 min	12/6	3 for 36/-
C120 120 min	15/-	3 for 43/6

Cassette Head Cleaner 11/3. All Post Extra.

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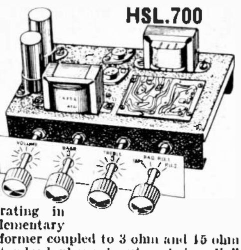
MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200-240v. Controls: bass, treble, volume/on/off. Function selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9¼ . 5 4¼in. high.

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

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

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

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

LOUDSPEAKER BARGAINS

3in 4 ohm 10/-, P. & P. 1/6. 5in 3 ohm 16/-, P. & P. 3/-. 7 × 4in 3 ohm 21/-, P & P. 4/-. 10 × 6in 3 ohm 27/6, P. & P. 6/-. E.M.I. 8 × 5in 3 ohm with high flux magnet 26/-, P. & P. 4/-. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet 42/-, (15 ohm 45/-), P. & P. 6/-. E.M.I. 13 × 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network 4 gns, P. & P. 6/-.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £5.10.0, P. & P. 7/6. Guitar models: 25w £6.10.0. 35w £8.10.0.

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

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

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

MAGNAVOX DESK TYPE MOVING COIL MICROPHONE. Medium impedance. Brand New—Special Price 42/-. P. & P. 2/-.

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

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

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

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

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 5:1 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. 1⅛" × ⅞" × ⅜". 5/- each. P. & P. 1/- (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7" to approx. 56". Maximum diameter ½". 10/- each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6" to approx. 22½". Maximum diameter ¼". 5/- each. P. & P. 1/-.

TRANSFORMER BARGAINS!

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price 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 × 1/16in. 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.

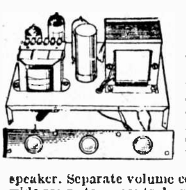
Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

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 1¾ × 1½ × ⅝in. Brand new — complete with instructions. Price 17/6. P. & P. 2/6.

SPECIAL PURCHASE!
E.M.I. 4-SPEED PLAYER
Heavy 8¼in. 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 14¼ × 12in., clearance 2 in. 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.



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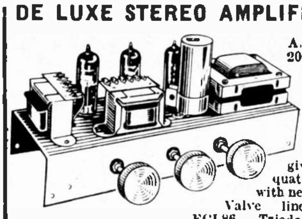

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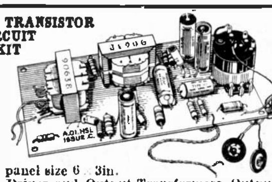

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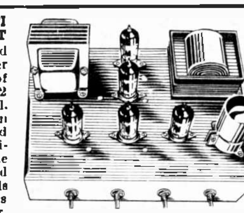

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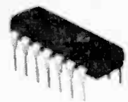

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VOL. 6 No. 9
September 1970

PRACTICAL ELECTRONICS

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SELF-GENERATING

RECENT developments portend a dramatic expansion of what has become popularly known as "Spare Part Surgery", a subject which implicates electronics to a very great extent. Human heart transplants have provided sensational headlines in the recent past. Even more startling are the possibilities of using inorganic replacements for decayed or damaged body organs.

The possibility has become almost a certainty now that electric power can be produced directly from the living system. Several American companies have proved the feasibility of a "biological fuel cell". Tiny electrodes of gold-palladium inserted into the blood stream react with the blood and provide an e.m.f. in a manner reminiscent of the voltaic cell. The amount of current produced is said to be sufficient to power a heart pacemaker for a lifetime. It is suggested that groups of cells could be linked together to form a battery capable of providing greater power. This then leads to the likely use in the future of artificial hearts, which are already in the experimental stage.

Much further work is required before this biological fuel cell materialises as an aid for the surgeon. But in the meanwhile another important innovation in medical electronics is the tiny nuclear-electronic power converter which will operate a heart pacemaker for an estimated 10 years. This "atomic battery" has been well publicised recently following the first implantation of this device in a human patient in this country.

Unlike either the atomic battery or the conventional chemical battery normally used to operate pacemakers, the biological fuel cell is expected to last as long as the body system is functioning. Use of the living system itself to produce electrical energy for electronic or electromechanical transplants is an audacious idea, yet it is a perfectly logical step as technology marches on. The electrical nature of the nervous system is well known, the muscles being servo-operated by minute electric currents generated by chemical reaction at the nerve ends. Thus there is a striking similarity between living systems and man-made electronic systems.

With an internal source of power on tap, there will be greater scope to exploit the latest technical developments in the commendable attempt to alleviate pain and discomfort and to prolong life. But since important ethical principles are involved, the engineer's natural eagerness to advance his own technology must always remain subservient to the opinions of the medical profession and other competent authorities. And this must be seen to be so, to allay any alarm and distress this rather special and intrusive use of technology might cause in the mind of the ordinary person.

F.E.B.

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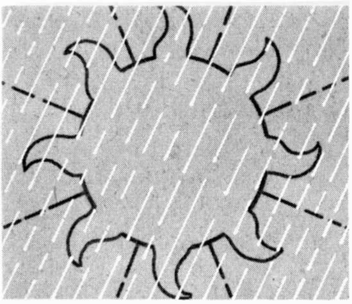


THE HUMIDISTAT

By D. BOLLEN

It is sometimes necessary to control the level of humidity in, say, a glasshouse or storeroom. A simple approach is to employ a switch actuated by a humidity sensor. When the level of humidity departs from a required value, the switch closes and applies suitable corrective action. A disadvantage of many humidistats, particularly the hygroscopic and chemical types, is that they need regular re-calibration to maintain accuracy.

The unit described here exploits the well-known principle of the psychrometer, and uses two negative coefficient thermistors to sense humidity. One thermistor is continuously wetted and is placed in a well ventilated position; the process of evaporation makes it slightly cooler than its companion dry thermistor if atmospheric humidity is less than 100 per cent. A definite relationship exists between wet and dry thermistor temperatures for a given level of humidity. Provided that the supply of moisture to the wet thermistor is maintained, and there is not an excessive build-up of dirt, calibration will hold good for long periods.

HUMIDITY SENSOR

Consider the circuit and curves of Fig. 1. Two thermistors are arranged in the form of a simple potential divider, fed from a fixed input voltage V_i. When the atmosphere is saturated (humidity 100 per cent) both resistances will have the same nominal value, thus giving a potential divider output of $0{\cdot}5\ V_i$. If there is now an ambient temperature change, this will be sensed by both thermistors, and the same resistance ratio and output voltage will be maintained over a wide range of temperature, hence the straight line representing 100 per cent humidity on the graph of Fig. 1.

Assume now that humidity has been reduced to 50 per cent, with the ambient temperature standing at 20 degrees Centigrade. Evaporation of moisture from the wet thermistor will reduce its temperature and increase its resistance, but the dry thermistor resistance

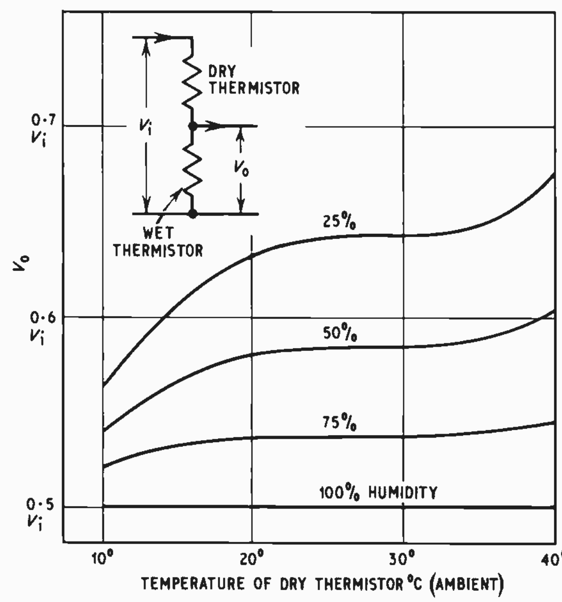
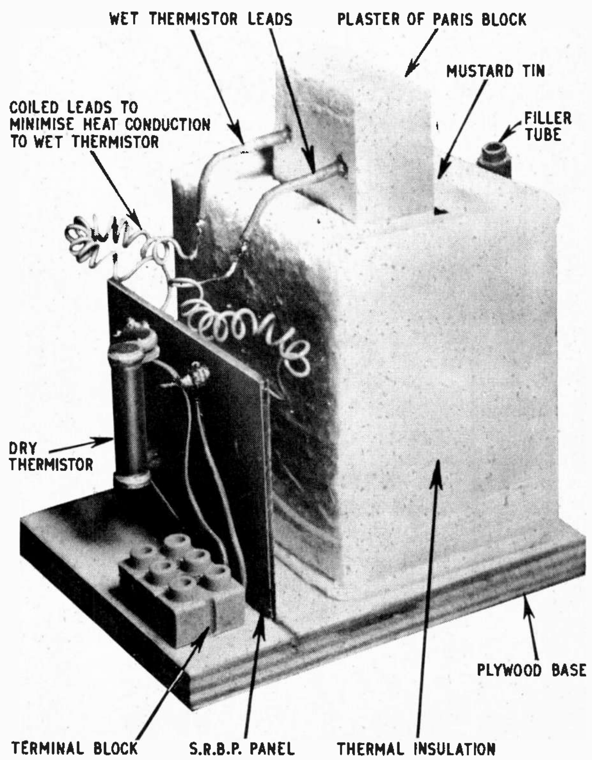
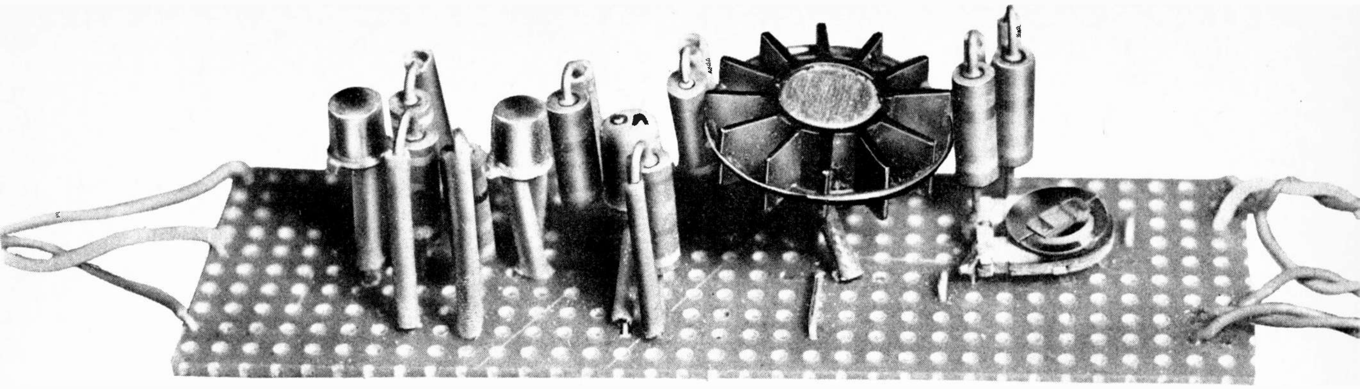


Fig. 1. Basic humidity sensor circuit with curves showing how output varies with humidity and temperature



***(right)** The complete humidity sensor without its case*



remains at the 20 degrees Centigrade value. With wet thermistor resistance greater than dry thermistor resistance, the output voltage from the potential divider will have increased to 0·58 V_i, shown by the 50 per cent humidity curve in Fig. 1.

ACCURACY

Ideally, the sensor should respond only to changes in humidity and not to variations of ambient temperature. If the two thermistors had a linear resistance/temperature characteristic the curves of Fig. 1 would take the form of straight, sloping lines originating near 0 degrees Centigrade, with slope inversely proportional to humidity. Such a law would render the sensor highly temperature dependent. Fortunately, the natural non-linearity of the thermistors makes a useful contribution here, by causing a flattening off of the curves between 20 degrees and 30 degrees Centigrade. Remembering that the sensor output was 0·58 V_i at 20 degrees Centigrade for a 50 per cent level of humidity, it can be seen from Fig. 1 that there is virtually no change of output when the ambient temperature is increased to above 30 degrees Centigrade. It follows that the humidistat will offer good accuracy when operated at normal to very warm room temperatures while handling humidity levels of 25 to 100 per cent; this covers the majority of standard applications. However, in environments colder than 20 degrees Centigrade, or hotter than 30 degrees Centigrade, the humidistat will have a higher temperature dependence, and should only be used where the temperature is fairly constant.

HUMIDISTAT CIRCUIT

The purpose of the humidistat circuit shown in Fig. 2 is to measure and amplify the small voltage changes generated by the thermistor sensor. In Fig. 2, the sensor is represented by thermistors X1 (dry) and X2 (wet). As in Fig. 1, a drop in humidity will increase the resistance of X2 and cause a rise in output voltage at the junction of X1 and X2.

COMPONENTS . . .

Resistors
- R1 3·3kΩ
- R2 2·7kΩ
- R3 1kΩ
- R4 1·5kΩ
- R5 1kΩ
- R6 470Ω
- R7 150Ω
- R8 10Ω
- All ±10%, ½ watt carbon

Potentiometers
- VR1 500Ω miniature skeleton preset
- VR2 2·5kΩ linear carbon or wirewound

Thermistors
- X1, X2 VA1005, CZ1, or Radiospares TH2A

Semiconductors
- TR1 BC107
- TR2 BC107
- TR3 ACY20
- D1 ZB12, 12V 250mW

Miscellaneous
- RLA Radiospares type 11A relay (see text)
- Veroboard 0·1in matrix 1in × 3·4in. Terminal blocks. Plywood. Perforated zinc. TO5 clip-on heat sink (cooler). Expanded polystyrene. Plaster of paris. Epoxy resin glue.

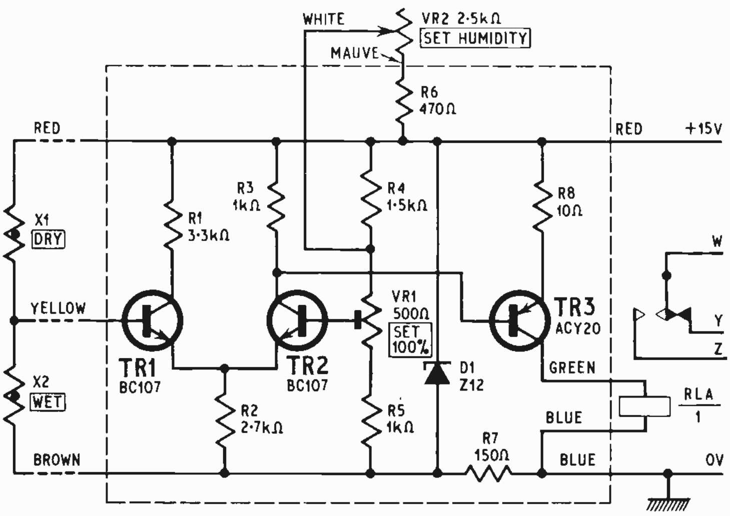


Fig. 2. Circuit diagram of the humidistat

Long-tailed pair TR1 and TR2 in Fig. 2 acts as an amplifying bridge circuit, where the sensor voltage is compared with a reference voltage derived from Zener diode D1, VR1, VR2, R4, R5, and R6. Normally, TR2 is just biased off, with its collector voltage close to that of the positive supply rail. Hence, direct coupled *pnp* relay driver TR3 will also be off and the relay RLA will not be energised.

Following a slight increase of humidity, the voltage at the junction of X1 and X2 will fall, tending to turn TR1 off. At the same time, TR2 and TR3 are turned on, and the relay is energised, closing contacts W and Z.

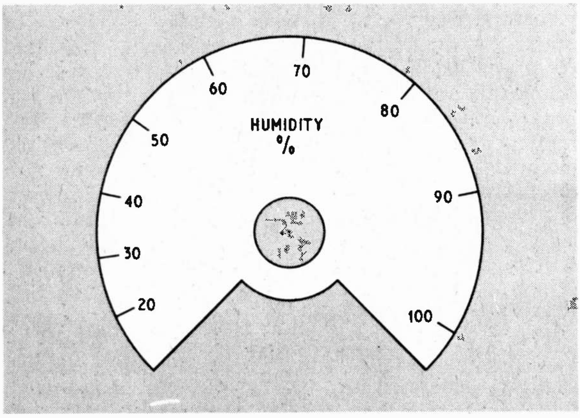


Fig. 3. Dial calibration for VR2

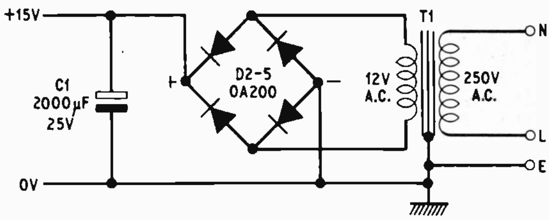


Fig. 4. Power supply for the humidistat

CONTROL

One possible way of reducing relative humidity is to heat the air. If relay contacts W and Z are wired in series with the supply to a domestic type fan heater, corrective action will be applied whenever the level of humidity exceeds a pre-determined value. However, it would be wasteful to have the fan heater responding to every small fluctuation of humidity, switching on and off at frequent intervals. The humidistat circuit therefore incorporates some backlash, which is determined mainly by the beta of TR3 and emitter resistor R8. At a nominal setting of 60 per cent humidity, and with 10 ohms for R8, humidity will cycle between ± 3 per cent of the set value. If a smaller deviation is required, R8 can be shorted out of circuit.

If VR1 in Fig. 2 was used as a set humidity control, the dial graduations would be cramped towards the 100 per cent end of the scale. Most applications involve humidity levels lying between 50 and 100 per cent, and it is desirable that the scale should be expanded over this range. Potentiometer VR2 and R6 across R4 provide the necessary scale correction—when VR2 is used as a set humidity control—and yields the dial calibration shown in Fig. 3, with well-spaced divisions where they are most needed.

Power supply requirements for the Fig. 2 circuit are 15 volts $\pm$ 2 volts at up to 100mA. A simple bridge rectifier and smoothing circuit, similar to that shown in Fig. 4, will serve to power the humidistat.

CONSTRUCTING THE SENSOR

The wet thermistor is embedded in a block of plaster of paris; this material is extremely porous and can be cleaned readily with an old toothbrush while moist. The plaster block stands in a tin containing water, which is thermally insulated by a covering of expanded polystyrene (ceiling tile), see Fig. 5. Capillary action takes water to the exposed top of the porous block where it then evaporates and cools X2.

Commence construction by fitting sleeving to the

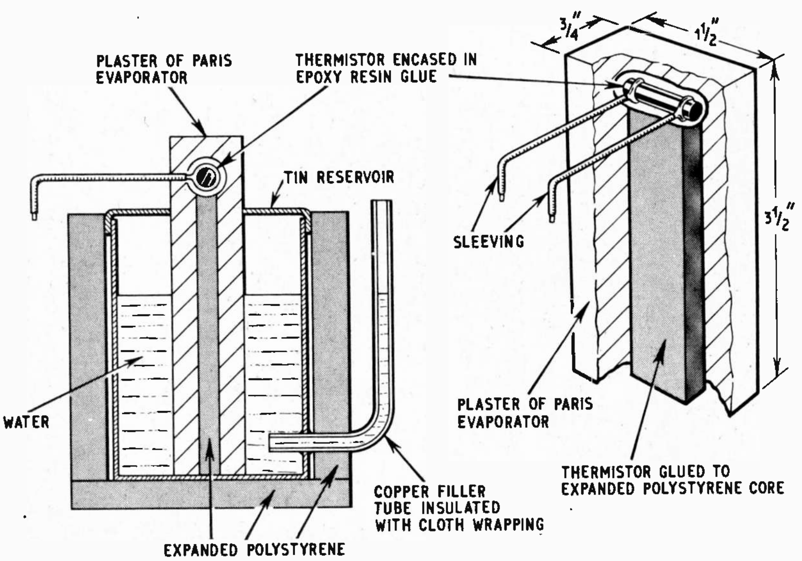


Fig. 5. Details of the wet thermistor housing

leads of X2, then coat the body and sleeved leads of the thermistor with a generous layer of warmed epoxy resin glue. It is most important to ensure that the thermistor is made completely waterproof. A second application of glue, after the first has set hard, is advised, and can be used to attach the thermistor to the expanded polystyrene mould core.

Next, prepare a cardboard mould, with two holes to take the thermistor leads, and fix the polystyrene core inside with small wedges or strips of adhesive tape. Mix the plaster of paris with water, to a thin consistency, and pour into the mould without delay. After several hours, remove the plaster block by tearing away the mould, and leave to dry out completely.

Cut a hole in the mustard tin lid to clear the plaster block, and solder the copper water filler tube to the base of the tin. Paint the tin to prevent rusting. Wind a length of cloth around the copper tube and cover the tin with panels of expanded polystyrene, held in place with adhesive tape.

The dry thermistor X1 can be mounted on a small piece of s.r.b.p. board which is attached to a plywood base, along with a terminal block to take the leads from the remote amplifier panel; see first photograph.

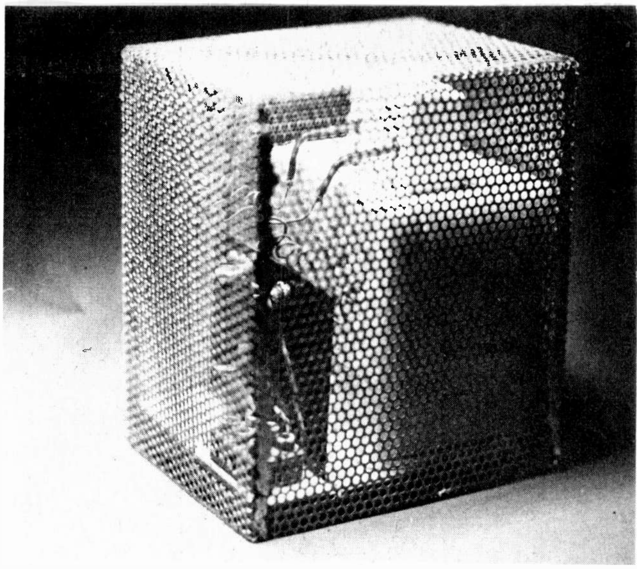
AMPLIFIER CONSTRUCTION

The amplifier components, within the dotted boundary in Fig. 2, are mounted on a 0·1 inch matrix Veroboard, 10 holes wide by 34 holes long, with copper strips running parallel to the longest side. Component layout and wiring diagrams are given in Fig. 6.

Break the Veroboard copper strips with a spot face cutter in the positions shown in Fig. 6. To avoid overheating the transistors, insert and solder all resistors, VR1, wire links, and flying leads first. Transistor TR3 should be provided with a clip-on heat sink.

RELAY

Any relay with a contact rating of 5 to 10 amps at 250 volts a.c., a pull-in voltage of about 6 volts, and a maximum coil current of 100mA at 12 volts can be used with the humidistat amplifier. The Radiospares type 11A normally just operates at 9 volts, but the armature return spring can be stretched to increase sensitivity.



TESTING THE HUMIDISTAT

Lay out the humidistat amplifier panel on a bench or table, and connect up the sensor (X1 and X2), the relay RLA, the set humidity potentiometer VR2, and a 15 volt d.c. supply. Colour coded connections are shown in Fig. 6. Ensure that the X2 plaster block is completely dry, and has attained ambient temperature.

Set VR1 fully anti-clockwise and VR2 at maximum resistance. The relay should be energised. Now rotate VR1 slowly clockwise until the relay armature just drops out. Try rocking the spindle of VR2 to make the relay contacts open and close. The maximum resistance setting of VR2 now corresponds to 100 per cent humidity, with the relay just opening as VR2 slider approaches the end of its track.

As a final check, set VR2 slider at the mid-track position and warm X1 by gripping between the thumb and forefinger. After a short delay the relay armature should drop out, then pull in again as X1 is allowed to cool. During final assembly, when the amplifier panel is placed in a box, take care not to alter VR1 setting.

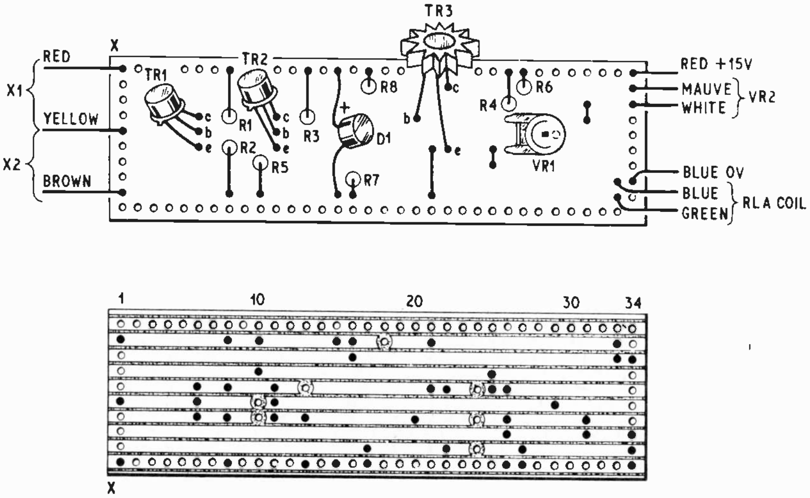


Fig. 6. Layout and wiring details of the humidistat amplifier

EXAMPLES OF HUMIDITY CONTROL

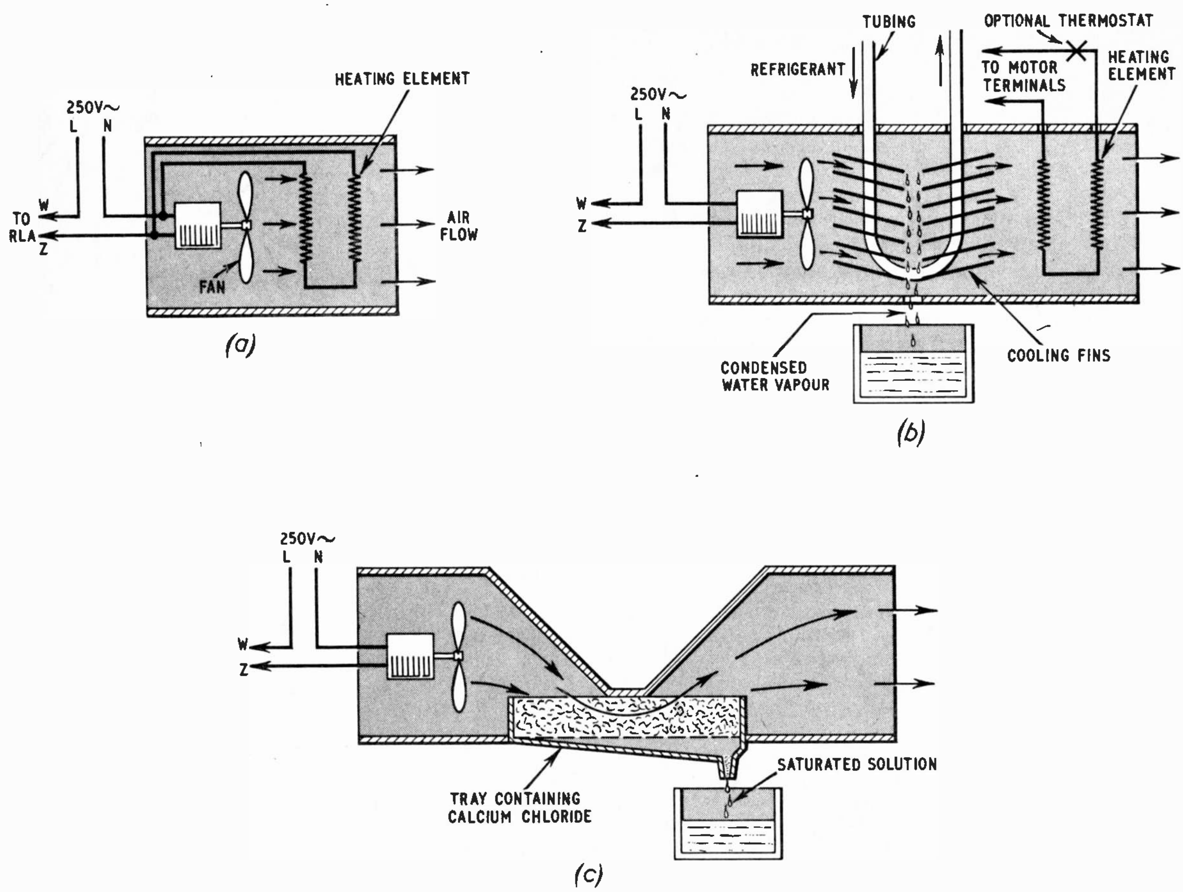
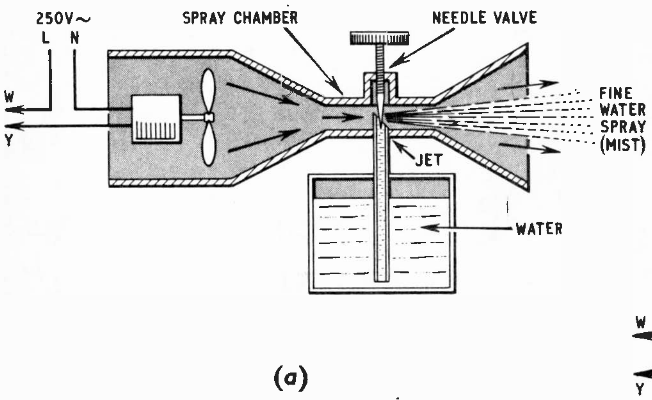


Fig. 7. Equipment for decreasing humidity: (a) fan heater, (b) dew-point condenser, (c) desiccator



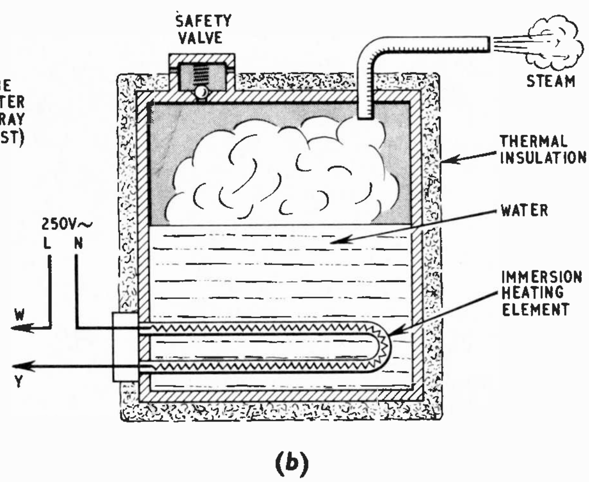


Fig. 8. Equipment for increasing humidity: (a) water spray, (b) steam jet

HOUSING THE AMPLIFIER

Amplifier panel, power pack, and relay can be conveniently mounted inside a small wood or metal box, together with a terminal block to take the leads from the thermistor sensor and humidity control equipment. Alternatively, the humidistat assembly could form part of the main equipment inside a single housing, with the sensor situated elsewhere in a well ventilated position.

Mount the set humidity control VR2 on the front panel of the box, with a calibrated scale traced from Fig. 3. If desired, the calibration can be checked against a wet and dry bulb hygrometer, after filling the humidistat water reservoir.

DECREASING HUMIDITY

To decrease humidity in an environment, the air can either be heated, cooled down to dew-point to condense out the water vapour, or passed through a desiccant. The first method has the advantage of simplicity, but also carries the penalty of an uncontrolled temperature change, which may not be satisfactory for glasshouses or rooms where people are working.

In Fig. 7a, a 1 to 2 kilowatt fan heater is wired in series with a mains supply and the normally open contacts W and Z of RLA1. The heater is switched on when ambient humidity rises above the level set by VR2.

Although more complicated, the technique of cooling air to condense out water vapour is very effective. In Fig. 7b, air from a fan is directed over fins which are cooled by a refrigerant. Excess water vapour condenses on the fins and drips into a water container, then the air is reheated to bring it back to its original temperature. Control of both humidity and temperature is easy to achieve with the one unit, by placing a thermostat in series with the heating element.

To construct a de-humidifier similar to that shown in Fig. 7b, air could be directed around the ice box of an old refrigerator, and elements taken from an electric toaster would serve to re-heat the air.

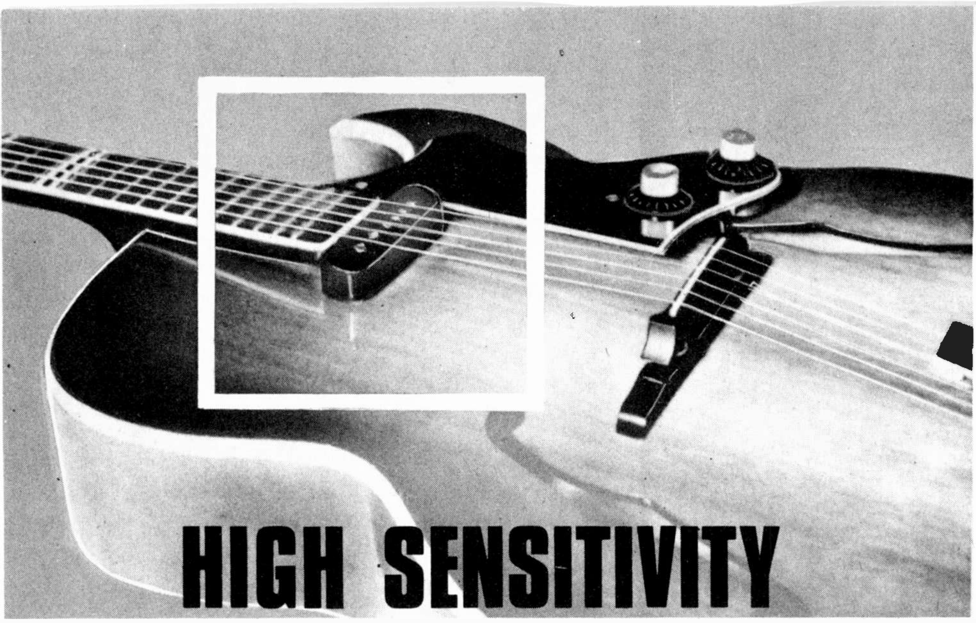
If air is blown over a desiccant, such as calcium chloride, water vapour is extracted from the air to form a saturated solution on the surface of the chemical, which drips away to expose a fresh, absorbant surface. Over a period of time, the solid desiccant is converted to a liquid. The advantage of using a desiccant for air drying is that it does not introduce any significant change of air temperature. In Fig. 7c, the calcium chloride is contained in a tray, with the air flow from a fan arranged to pass over and through the desiccant.

INCREASING HUMIDITY

Some environments are naturally dry, and water vapour has to be added to the air to maintain humidity at a constant level. Note here that the control equipment is wired to RLA1 contacts W and Y, so that corrective action takes place with a drop in humidity.

Looking at Fig. 8a, a fan blows air at high velocity over a needle valve jet to form a fine water spray. Evaporation will cause some degree of air cooling and it may be found necessary to heat the water in the spray container to offset the change of air temperature.

In Fig. 8b, a small boiler is heated by an immersion element. The water in the boiler is maintained close to boiling point by efficient thermal lagging. At a command from the humidistat, the heater is switched on, the water boils, and a jet of steam adds water vapour to the air. Steam heat will, of course, tend to raise the air temperature. ★



HIGH SENSITIVITY GUITAR PICK-UP

By L. F. Dickson

THE pick-up to be described is a moderately high impedance unit which will readily match any commercial guitar amplifier. It is ideal for mounting in solid guitars but can be adapted for use with acoustic instruments.

There are few parts required including six small magnets and a coil mounted on a platform or base, preferably made of steel. The magnets employed in this design are bar or rod type.

MAGNET ASSEMBLY

The magnet assembly is made up on a small piece of 18 s.w.g. bright mild steel sheet ¾in wide by 2¼in long. Mark the centre line along the length of the strip and mark off six stations at ⅜in intervals (or dimensions to suit your guitar string spacings if different) along this line. Work from the centre to each end in turn when marking these string spacings.

At these six points, drill six holes through the strip with an eleven sixtyfourths drill. Lightly ream the holes with the tag end of a suitable file so that the magnets are a firm push fit in the holes (see Fig. 1). Drill a small hole ⅛in dia. as indicated for the wires. The assembly is now ready to accept the coil.

MAKING THE COIL FORMER

Coil winding may, at first, sound formidable but, in fact, is quite easy, although patience and care are required. The coil should have a d.c. resistance of about 5 kilohms and will require 5,000 turns of 47 s.w.g. enamelled copper wire. This is obtainable from some of the component suppliers advertising in this magazine: about 2 ounces will be enough for this coil.

To construct a bobbin or former (as shown in Fig. 2) a scrap of ¼in or 6mm ply about 2in square and two pieces of 1/16 sheet s.r.b.p. about 3in square and four 6B.A. nuts and bolts are required.

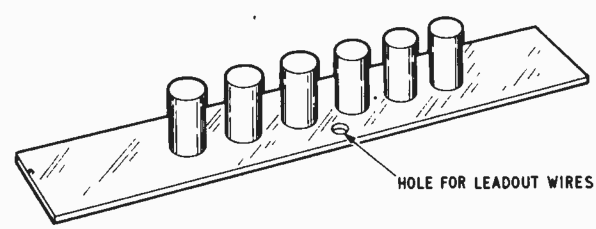


Fig. 1. Magnet assembly with the six magnets in position ready to accept the coil

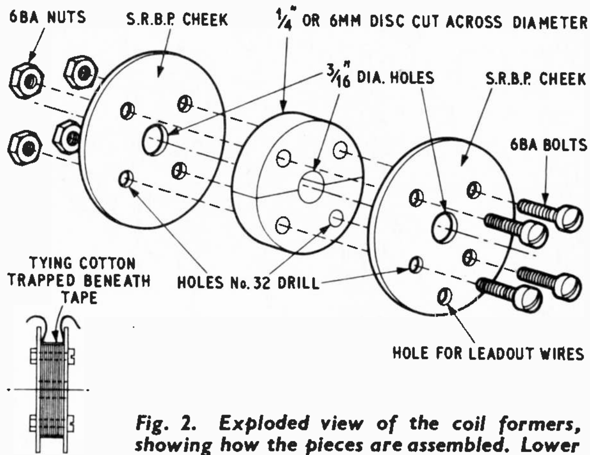
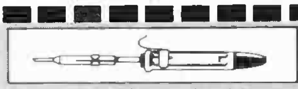
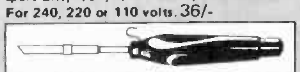


Fig. 2. Exploded view of the coil formers, showing how the pieces are assembled. Lower left—how the tying cotton is positioned under the tape before winding

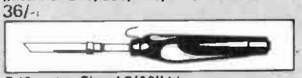


G 18 watts. Fitted 3/32" bit for miniature work on production lines. Interchangeable spare bits, 1/8", 3/16" and 1/4" available. For 240, 220 or 110 volts. 36/-



E 20 watts. Fitted with 1/4" bit. Interchangeable spare bits 3/32", 1/8", 3/16" available. For 240, 220, 110 volts. 36/-

ES 25 watts. Fitted with 1/8" bit. Interchangeable bits 3/32", 3/16" and 1/4" available. Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. 36/-



F 40 watts. Fitted 5/16" bit. Interchangeable bits 1/4", 3/16", 1/8", 3/32" available. Very high temperature iron. For 240, 220, 110, 24 or 20 volts. 47/0.

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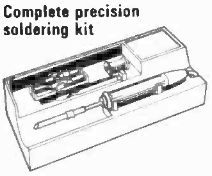

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Begin by marking and cutting the ply into a disc 1¼in diameter and do the same with the sheet s.r.b.p. making these 2in diameter. Drill through the centre of all three pieces with a number 12 drill and assemble temporarily, bolting together with a 2B.A. nut and bolt.

Mark off and drill four holes with a number 32 drill at 90 degree intervals half an inch from the centre. The former can now be dismantled and the wood centre piece cut in half across its diameter. Re-assemble the former, bolting together with the four 6B.A. nuts and bolts and note that the centre now has two slots across its face the thickness of the saw cut.

Drill a small hole in one cheek plate just outside the periphery of the wooden centre for a lead-out wire.

PREPARING FOR WINDING

A temporary set-up for turning the former can be provided by a hand drill fixed in a vice; alternatively a slow turning lathe with hand clutch would be useful. Check the gear ratio of the hand drill to determine the turns required to rotate the bobbin 5,000 times. This can be done by counting the teeth. Divide the number of turns of wire required (5,000) by the gear ratio of the drill and this will indicate the number of times the handle must be turned.

Now prepare the bobbin for winding but first ascertain that the edges of the "cheeks" are very smooth or they will cut the wire, which is only 0·002in diameter and needs careful handling.

A few "odds and ends" will be needed; these are four lengths of sewing cotton each about 6in long, some thin insulating tape (*not* transparent cellulose adhesive tape) ¼in wide and a foot or so of very thin p.v.c. covered flexible wire (size 7/·0048). About a foot of thin screened pick-up wire and a thin polythene bag are also required.

Begin by cutting a piece of the tape of sufficient length to go round the centre of the former with about an inch to spare (about 6in). A rounded or slightly angled cut across one end will make the tape easy to introduce into one of the slots. Push the tape about half an inch into one of the slots and, sticky side outermost, wrap the tape round the former.

Place a length of cotton across the cheeks, trapping it beneath the tape. Place the remaining lengths of cotton similarly at equal spacings round the bobbin and continue wrapping the tape, finishing with about half an inch over-lap at the slot where you started. Fig. 2 shows one cotton trapped beneath the tape.

The four loose ends of cotton on each side of the bobbin can now be taped temporarily to the face of the cheeks to prevent them from getting in the way when rotating the bobbin.

Cut a length of the thin p.v.c. wire about 3in long and bare and tin about ½in at both ends. Carefully bare the end of the enamelled copper wire for about an inch by rubbing very lightly all round with fine sand-paper. The copper will show brighter when cleaned. Wrap this around the tinned end of the thin p.v.c. covered wire and lightly coat with solder.

A hand drill can now be fixed in a vice (turning hand uppermost) and the bobbin fixed to the chuck by means of a 2B.A. bolt which is already fixed through the centre hole of the bobbin with a nut. Check that the bobbin does not slip when the chuck is rotated.

WINDING THE COIL

The p.v.c. wire, with the 47 s.w.g. wire attached, can be threaded through the hole in the cheek of the bobbin. Leave the soldered joint just inside the hole and tape down to the sticky face of the lining tape with another short length of masking tape. The beginning of the winding will be securely held.

The reel of 47 s.w.g. wire can be stood on one end and the wire will run over the upper end as the chuck is rotated, if we position the reel beneath the chuck. It is important that the enamel coating on the 47 s.w.g. is not scraped or damaged and the wire is not allowed to kink.

Guide the wire on to the bobbin very lightly with one hand while slowly turning the drill handle with the other. Endeavour to pile it evenly across the width of the former. Five thousand turns of wire should just fill to within about $\frac{3}{32}$in from the outer edge of the cheeks of the bobbin.

When the winding is complete, hold the winding firmly so that it does not work loose, then attach a p.v.c. lead-out wire to a bared end of the winding. Before removing from the chuck, un-tape the ends of the cotton and *lightly* tie the mating ends over the coil, then cut a few strips about ½in wide from the polythene bag.

After removing the bobbin from the chuck, dismantle by removing the four 6B.A. bolts and the cheek plates. Push out the wood centre, being especially careful not to catch any of the loops of wire, and cut off the surplus masking tape that was threaded into the slot in the centre of the coil.

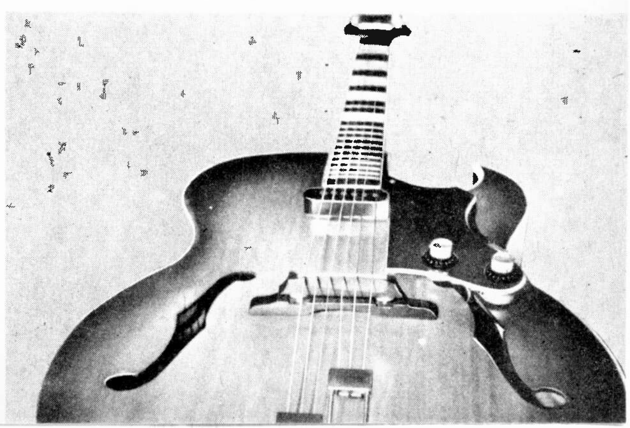
Position the two p.v.c. leads together and carefully bind the coil with the polythene strips by passing through the centre hole and half-lapping the strip edges. A termination to the binding can be made effectively by applying a spot of polystyrene cement to the polythene and welding the join.

The circular bound coil which results can now be quite safely squeezed into an oblong shape and fitted over the magnets. Feed the two p.v.c. wire ends through the hole in the platform.

YOU WILL NEED . . .

Six Eclipse bar magnets $\frac{3}{16}$in × ½in (James Neill & Co. (Sheffield) Ltd., Napier Street, Sheffield 11)
Miniature p.v.c. wire 7/·0048
Enamelled copper wire 47 s.w.g. (2 ounce reel)
Bondaglass casting resin and catalyst
Bondaglass colouring pigment
Bondaglass release agent No. 2
Miniature screened lead, single conductor (1ft)
Steel sheet 18 s.w.g. 1 sq ft
S.R.B.P. sheet $\frac{1}{16}$in thick, 3in × 6in
Scrap of ¼in plywood about 2in square
Wood strip 1in square × 3¼in long

View of pick-up mounted on an f-hole guitar



If an ohmmeter is available check the coil resistance. If the coil does not fit snugly enough on the magnets it can be tied in position with further lengths of cotton.

RESIN MOULD

The completed pick-up assembly is moulded in resin; Bondaglass casting resin or similar products can be used to encapsulate the pick-up assembly. It is supplied with the accelerator ready mixed and only requires the catalyst to be added. The resin is clear so a colouring pigment can be added if desired.

A mould must be made in which to encapsulate the pick-up; this can be made from brass, copper or steel. Do not use plastics or card. The finished "case" can be any size to suit the constructor's needs or taste, but a suitable size would be about $3\frac{3}{4}$in long, 1in wide and $\frac{5}{8}$in deep, with parallel sides and radiused ends as suggested in Fig. 3.

The base plate of the mould is about one inch larger all round than the body dimensions. The sides are pre-formed round a wood block cut and shaped to the intended finished case size. The metal is butt jointed in the centre of one side and a capping plate sweated over the join on the outside.

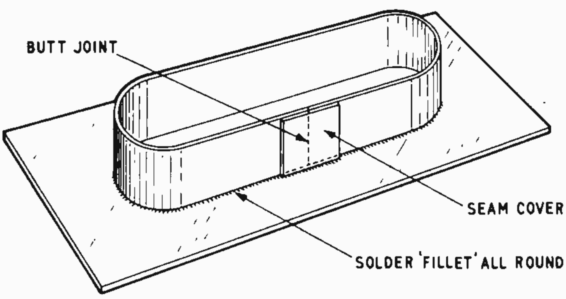
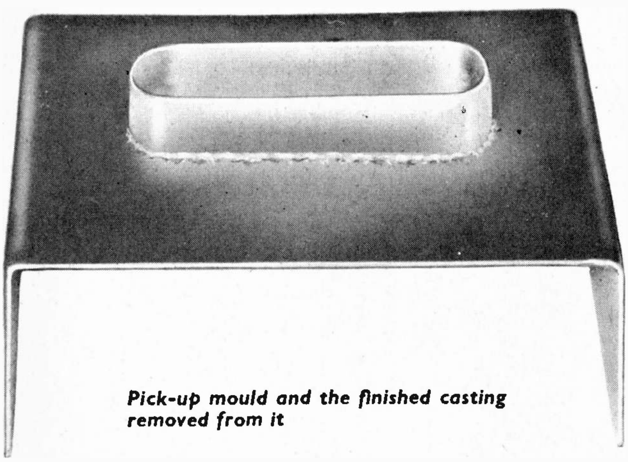
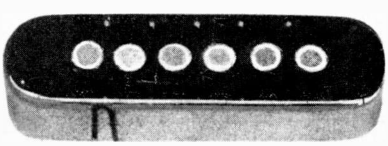


Fig. 3. Suggested mould for casting the pick-up body. The material used would preferably be 18 s.w.g. brass, copper or steel





Pick-up mould and the finished casting removed from it

Cut a piece of metal (not aluminium) about 3in by 5in for the base and a strip the same width as the intended height of the pick-up of suitable size to shape round the block, also a small piece for the seam cover. The seam cover is best sweated over the joint whilst the side is still round the block.

Position the body on the base and thoroughly clean the surfaces to be joined. Use a large soldering iron to run a solder fillet all round the join. Some assistance may be required to perform this operation.

When the mould is cool, clean up the inside and polish with metal polish. The resin will faithfully reproduce the detail of any surface against which it is cast, so all surplus solder and other projections must be cleaned off.

Now is a good time to attach the screened lead to the pick-up assembly. Make the join as close to the platform as possible and connect the outer terminal wire of the coil to the screen, soldering both to the platform, so earthing the metal work. The inner termination of the coil is connected to the inner conductor of the screened lead and insulated.

CASTING

Place the pick-up assembly centrally in the mould and note the position of the two end magnets. Mark their position and drill two holes (number 26 drill) in the base of the mould to coincide with the position the magnets occupy. These will be "release" holes. Remove the pick-up assembly.

The inside of the mould should now be coated with a "releasing" agent, such as the alcohol based liquid prepared especially for metal moulds by the resin manufacturer. Let this dry thoroughly whilst mixing the resin and pigment to the maker's recommendations. Measure out sufficient resin to fill the mould, using an empty glass jar or similar container.

On the underside of the mould base, cover the release holes with pieces of masking tape pressed down firmly and place the pick-up assembly centrally in the mould with the platform uppermost. Tape the screened lead to the outside of the mould to keep it under control whilst the resin is setting.

The catalyst may now be added to the resin (follow the maker's instruction). Pour some of the mixture into the mould at one end and tilt slightly to enable the resin to run more freely between the magnets and coil.

Continue pouring the resin in slowly at one end so as to prevent the formation of air bubbles, until the mould is full. The casting will set in about 40 minutes but is best left for a couple of hours to "cure" before removing from the mould.

When it is ready for removal peel off the tape covering the release holes and insert a 4B.A. bolt in the holes alternately, tapping very gently with a light hammer; after a few taps the casting should come readily out of the mould. The top edge all round the casting should then be slightly chamferred or radiused with a fine file, the whole body being finally polished with metal polish or, better still, buffed on a polishing mop if one is available.

MOUNTING THE PICK-UP

Reference to Fig. 4 will show a method of mounting which needs little explanation. This method, basically, is adopted almost universally by professional guitar makers. Mount the finished pick-up on a strip of metal the same width as the body and about $4\frac{1}{2}$in long, inserting two small pieces of foam plastic or felt between them and glueing with impact adhesive.

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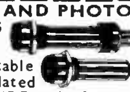

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170	9–12	3c/o +1 H.D. c/o		12/6
230	6–12	2 c/o		12/6
280	6–12	2 c/o	I.B.	14/6
700	12–24	2 c/o	I.B.	12/6
700	16–24	4 c/o	I.B.	15/6
700	16–24	4M 2B	I.B.	12/6
1250	36–45	6M		12/6
2500	36–45	6M		12/6
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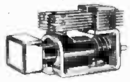

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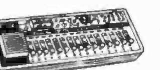

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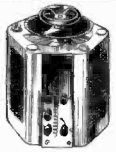

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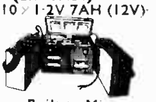

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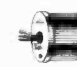

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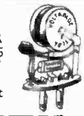

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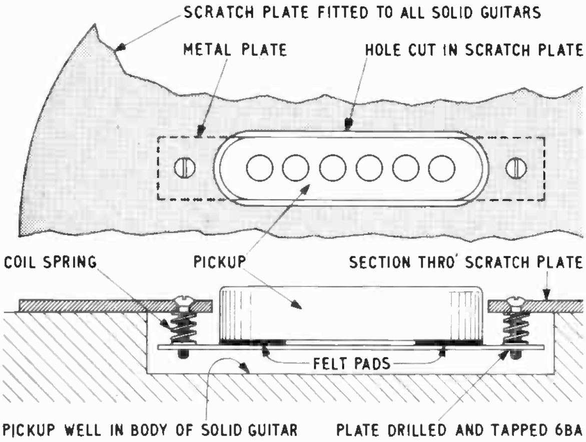


Fig. 4. Pick-up fitted in the well of a solid guitar body

The body of solid instruments has a "well" of suitable dimensions cut to about half the thickness of the body, or a little less, at a position close to the end of the finger board, and another close to the position the bridge will occupy when two pick-ups are fitted. These wells are interconnected by a channel to take wiring and controls and the whole is covered by an artistically shaped plastics plate known as a "scratch" plate, to which pick-ups and controls are attached.

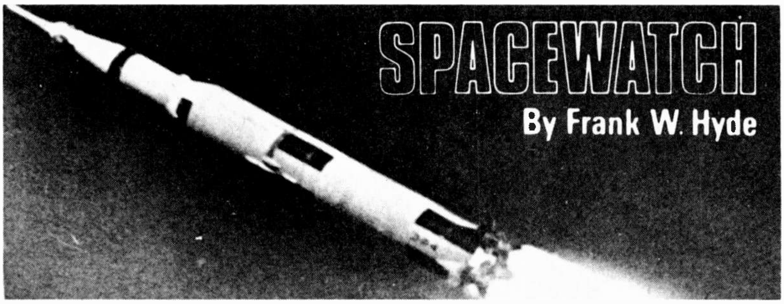
The usual method of attaching the pick-up (Fig. 4) is to mount it on a metal plate, with a tapped hole at each end and about half an inch away from the pick-up body. Corresponding holes are drilled in the scratch plate through which are passed bolts to screw in to the tapped holes in the mounting plate. The bolts also pass through coiled compression springs positioned between the mounting plate and the underside of the scratch plate. On some American made instruments, rubber grommets are used instead of springs.

The action of turning the bolts or screws will cause the mounting plate to come closer or further away from the scratch plate, so adjusting the height of the pick-up relative to the strings. Two or even three of these pick-ups may be so fitted with whatever switching and control arrangement the player may decide.

Acoustic instruments of the "*f*" sound hole type can also be fitted with this pick-up, provided the strings are of sufficient height above the top of the guitar body. In this case, the pick-up should be equipped with "feet" cut from thin felt and lightly spot glued to the top of the guitar just forward of the end of the finger board. This will not impair the acoustic qualities of the instrument. The scratch plate on this type of instrument is usually mounted on brackets holding it some distance away from the body and will accommodate volume and tone controls quite readily in most instances.

In use, the pick-up will be very robust, completely impervious to moisture and likely to give many years of unfailing service. Frequency response is fairly linear and the output should be in the region of at least 200mV peak-to-peak.

A pick-up having four poles suitably spaced for a bass guitar can be made in exactly the same way but in this instance the coil should have a d.c. resistance of approximately 8 kilohms. ★



FIRST CHINESE SATELLITE

China's first successful launch of an earth satellite took place on April 24, 1970. Peking announced the event the next day on a frequency of 20·009MHz.

The satellite signals were of an unusual nature in that there was a one minute cycle of alternate music and telemetry. The music consisted of five bars of "Tungfanghung" (The East is Red).

G. E. Perry at Kettering Grammar school, well known for his tracking of Russian satellites and probes, picked up the signals at the end of the twelfth orbit at 14.02 UT on April 25. His analysis of the signals showed that the first 40 seconds of the one minute period was devoted to the musical theme. This was followed by an interval of 5 seconds, a 10 second transmission of telemetry and a further interval of 5 seconds. After this the cycle was repeated.

The telemetry consists of audio tones in steps of 13·6Hz. The duration of the first tone, which is of the same frequency as the highest musical frequency, has a duration of twice the time of the succeeding tones. The frequency is one hundred times the minimum difference between tones. The first tone is followed by 20 tones of equal duration followed by several rapid tones. Perry suggests that the outputs are quantised at 32 levels before transmission and points out that there is the possibility that the readout is a five-bit binary code.

APOLLO 14

The launch of *Apollo 14* will not now take place before January 31, 1971. The crew, Alan Shephard, Stuart Roosaand and Edgar Michell will make for the *Apollo 13* moon site at the hilly Fra Mauro area.

The necessary modifications recommended by the *Apollo 13* review board are being implemented. The principal changes will include stainless steel tubes to carry the wiring inside tanks in place of Teflon. The fans used to stir up the liquid oxygen will be removed from the tanks to obviate the need of wires that might introduce a fire hazard.

An additional oxygen tank will be added to the service module and will be used when the normal tanks are 70 per cent emptied. Oxygen tank failure alarms are to be fitted and additional warning and alarm to watch sub-systems operation are being added. Some of these will operate in the spacecraft and some at the ground control centre at Houston.

TRACKING STATION IN SPAIN

The third and final link which will form the world-wide tracking system of three main stations spaced equidistant round the earth has just been completed in Spain, 40 miles from Madrid. This facility will enable continuous monitoring of spacecraft several hundred million miles into space. It is possible that under certain conditions the monitoring may extend to the edge of the solar system.

The US National and Aeronautics Space Administration have an agreement with the Instituto de Technica Aerospacial for this new facility, in addition to that one existing and using the 85 foot antennas for deep space tracking. The three larger stations with 210 foot antennas (one at Goldstone in USA, one at Tidbinbilla near Canberra and the new one near Madrid) will greatly extend the efficiency of the system.

At Goldstone the antenna has for several months been used to study the Einstein relativity theory. This uses the signals from the small 7 watt transmitters aboard *Mariner 6* and *Mariner 7* which are moving in orbit behind the sun. The distances at which successful contact has been made is 251 million miles for *Mariner 6* and 242 million miles for *Mariner 7*.

WEIGHTLESSNESS

The recent Russian long period orbital experiments with astronauts is reported to have revealed a number of effects which need careful and objective appraisal.

Future manned flights to Mars will require very long periods in the artificial environment of a spacecraft and generally the problem of environment can be solved by the improvements that can be made in the life support systems. However, the medical considerations of weightlessness and its effects on the human body are important and must influence the progress that is to be made in planetary exploration.

MINERAL DEFICIENCY

The two-man *Gemini* flights revealed that the minerals important to the human skeleton were very much depleted. If this continued in spite of enriched calcium diet and exercise, such as on a spaceflight of many months, then a fragility of bone could arise.

Another more serious process is that known as cardiovascular deconditioning, which leads to an impairment of the circulatory system. On earth, in normal gravitation conditions, the lower limbs have about a litre of blood indistribution. During weightlessness there is a redistribution and some blood rises to the chest level. This can produce a distention of the vessels near the heart and also an increase in urine output. The result of this is that the amount of blood in circulation is reduced by more than 10 per cent.

These changes are not of great importance in moonflights. All the astronauts showed an unsteadiness on their feet on return but this passed off fairly quickly. Long flights of many months to Mars, for example, could mean that even in the reduced gravitational field that exists on that planet the astronauts might need time to recover before they could carry out their physical tasks.

It is clear that there is much work to be done in this field before extensive manned flights can be undertaken. It may be that a form of artificial gravity will need to be built in the spacecraft. Provision of adequate exercising facilities, so designed that gravity can be simulated, could be a more simple answer. It may well be that there is a minimum level of gravity required to offset these effects, in which case the problem may not be a formidable or costly one.

Only after long periods of weightlessness have been experienced can it be decided just how important the effects described are to the future well being of the astronaut and any other space traveller.

URANUS AND NEPTUNE

Two Russian astronomers have recently suggested that the temperatures at the centre of the Uranus and Neptune planets is very high. These two members of the Moscow Institute of Earth Physics put forward the hypothesis that only the outer surface down to a depth of a few hundred kilometers has cooled to any great extent during the time since their formation.

Assuming a period of 5 billion years and a surface temperature of —173°C, then the interior or core temperature will be of the order of 26,400°C for Uranus and 31,000°C for Neptune. From this they conclude that the planets have hot cores and icy surfaces. This hypothesis can be tested, for if the planets have a magnetic field it will support the idea of a hot interior.

MAKING THE MOST OF LOGIC IC's

PART THREE—By R. W. COLES

DIODE TRANSISTOR LOGIC

Diode Transistor Logic, like RTL, was initially used in discrete component form, the general circuitry will therefore be familiar to many readers who have had any experience of logic design.

Again like RTL, DTL was an early starter in the integrated circuit field, and since its inception, has become very popular with system designers because of its range of advantages coupled with a low price tag.

A departure from the usual trend in i.c. logic, DTL is available in several variations, depending on the manufacturer, but these variations are not basic, and in this discussion we will deal with what can be considered the "typical" trend in DTL characteristics at the present time.

One of the major features of recent DTL circuitry is its compatibility with what must certainly be the king of i.c. logic, the Transistor Transistor Logic family (TTL). Manufacturers now offer these two families under a common title of CCSL (compatible current sinking logic); the advantage of this compatibility will become obvious when TTL is dealt with later in this series.

BASIC DTL GATE

The building block on which DTL circuitry is based is the basic gate arrangement shown in Fig. 3.1. This is employed in the various gates, flip-flops, and monostables available in this family, with only minor changes. If this circuit is analysed, it will be a simple matter to understand the more complex arrangements described later.

Unlike RTL, the DTL gate is used as either a positive logic NAND gate, or a negative logic NOR gate, the gate operation being of the current sinking type. The components on the silicon chip, from which the circuit is constructed, are diodes, *npn* transistors, and silicon resistors.

The only other component to be utilised in any of the more complex arrangements, is a capacitor, formed by a reverse biased diode, but this is only used in a certain kind of flip-flop, and the monostable.

CURRENT SINKING

Fig. 3.2 shows a "skeleton" version of the basic gate, which is included to make explanation simple, and to show the current sinking path into an external circuit (gate 1). The inputs to the gate are applied to diodes D1 and D2, and may comprise either a positive voltage (which will reverse bias the input diodes), or an effective ground path (through a bottomed output transistor in a previous gate) which allows current to flow out of the diodes to earth.

TR1 is an emitter follower, providing current (not voltage) gain, and allowing the use of a fairly large resistor in the R1 position, thus limiting the current which can flow out of the input diodes. This is desirable, as this current will, of course, have to be sunk by the output of another gate.

Any reduction here will increase the number of inputs an output can handle, i.e. the fan-out will be increased. Diode D3 is used to increase the voltage necessary at the base of TR1, before TR2 will turn on, to give a "low" output. The total voltage which will be necessary, in fact, is the sum of the V_{be} of TR1 and TR2, and the forward voltage drop of D3, making about 1·8 volts in all.

TR2 is the current sinking, or output device, and is connected in the common emitter configuration to provide both current and voltage gain. When this

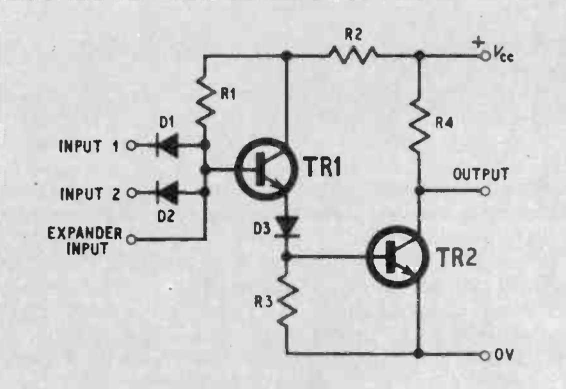


Fig. 3.1. Basic gate circuit of DTL

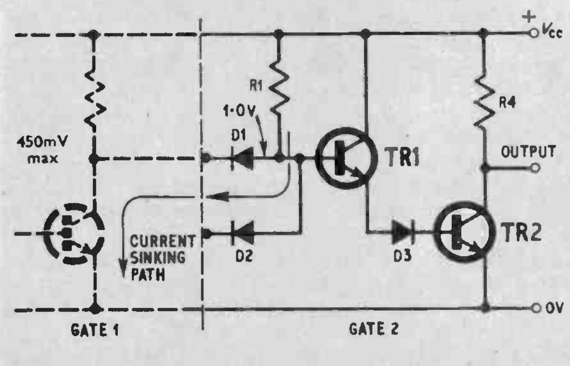


Fig. 3.2. Two gate i.c.s connected to illustrate current sinking path

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

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

Fig. 3.3. Logic symbols of (a) positive logic NAND gate and (b) negative logic NOR gate with truth tables

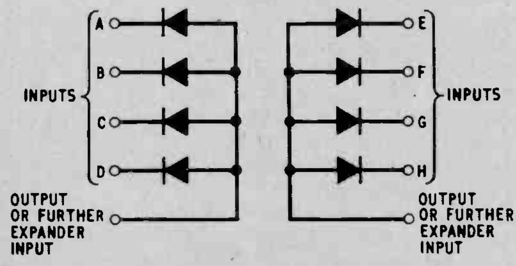


Fig. 3.4. Typical dual gate expander integrated circuit. The two halves can be used together or separately

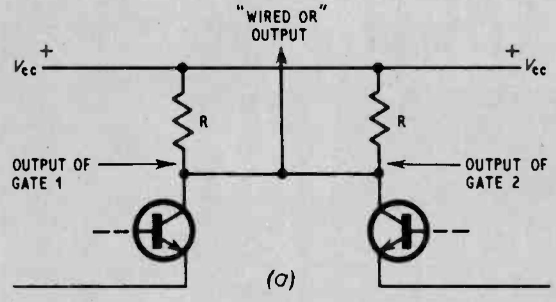


Fig. 3.5a. Circuit layout

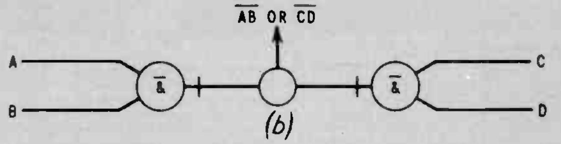


Fig. 3.5b. Symbolic layout

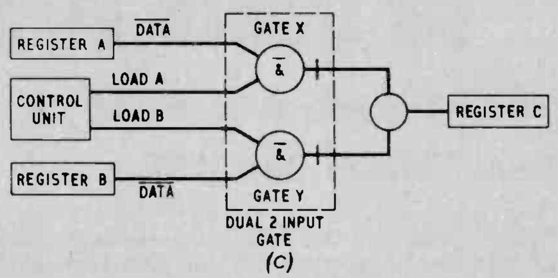


Fig. 3.5c. Typical application

Fig. 3.5. Wired-OR logic circuits

transistor is off, the full positive supply, V_{CC}, is fed out of the gate, via R4, reverse biasing any following gate input connected to it.

When TR2 is turned hard on, it provides the earth path for any following connected inputs. The voltage at the collector of TR2 in this condition is determined by the number of inputs connected. This number is limited so that this voltage does not rise above 450mV in practice.

DYNAMIC CONDITIONS

Let us now consider this gate under various input conditions. If one of the inputs is low, current will flow out of the diode concerned. The voltage presented to the base of TR1 will be the sum of the output voltage of the previous gate (which is a maximum of 450mV in the low state) and the forward drop of the input diode (about 600mV).

As the voltage necessary to turn on TR1 and TR2 is 1·8V, these transistors will not turn on, and the output will be high, at $+V_{CC}$.

If both inputs are high, both the input diodes will be reverse biased; the base of TR1 will be effectively connected to $+V_{CC}$ through R1, turning TR1 and TR2 hard on and giving a low output.

From this it can be seen that using positive logic any "0" input will give a "1" output, and two "1" inputs will give a "0" output (i.e. NAND). Using negative logic, any 1 input will give a 0 output, and two 0 inputs will give a 1 output (i.e. NOR). The logic diagrams for these two configurations, and the truth tables showing their performance for various inputs, are given in Fig. 3.3.

EXPANDER INPUTS

Each of the integrated circuit families has its own unique family characteristics, not only in the circuitry used, but also in the way it may be used to implement logic functions. DTL incorporates several very useful features which can simplify logic layouts considerably.

A scan through any manufacturer's catalogue shows that many of the gates have "expander" inputs available, and an example of this is shown in Fig. 3.1. This input gives direct access to the base of the first transistor, by-passing the input diodes. As its name suggests, it is intended to allow the connection of extra diodes to increase the fan-in of the gate.

These extra input diodes may be discrete silicon switches, or, more usually, they may be in the form of another i.c. package, usually containing about eight diodes, as shown in Fig. 3.4.

It can be seen that this gate expander has further expander inputs, and in fact the number of inputs to the basic gate can be increased to more than twenty by this method, without adversely affecting its operation.

WIRED "OR"

The outputs of the standard series of DTL gates may be connected together to produce what is called the "wired-OR" logic function. This most useful feature allows the outputs of several gates to be connected together as an OR function without any extra components being used.

This function, which may also be called "dot-OR" or "distributive-OR", was used in logic designs before the advent of integrated circuits, because it effected real economies.

The operation of wired-OR is quite simple, and is shown in Fig. 3.5a. If either of the output transistors is cut on, it will sink the current through the output resistors of both gates, giving a common low level output. The only affect this will have on the gate concerned, is a slight reduction of fan-out, because of the reduction in the effective value of the load resistance.

If both gate outputs are low at the same time, the same result will be produced, and only if both gates have high level outputs will the wired-OR output rise. Although this operation is called wired-OR, it could also be called "wired-AND" if negative logic is assumed, because the outputs of both gates have to be high to give a high output.

By connecting the outputs together in this way the fan-out available is reduced; in practice it may be assumed that for each extra gate output, the fan-out is reduced by one load.

IMPROVING FAN-OUT

To overcome the slight disadvantage of losing fan-out capability when using wired-OR with standard DTL gates, an alternative gate is available without an internal load resistor. This type of gate can be wired together with an external resistor equal to one standard load or, alternatively, a group of these gates may be combined with a single standard gate. This will provide the necessary load without recourse to a discrete resistor.

In both of these cases the fan-out will be the same as for a single standard gate, no matter how many gates are involved.

A SIMPLE EXAMPLE

As a simple example of the use of this important logic function, consider Fig. 3.5c, which represents part of a digital computer. Here a dual two-input gate is used to route data from one of two shift registers, into a third, in serial form.

The instruction to load data from register A or B, is in the form of a positive logic 1, fed to the appropriate two-input gate from the control unit, which will in turn be controlled by the programme. The data from the two source registers is in the inverted form ($\overline{\text{data}}$) so that after passing through the NAND gate, it will be restored to its true form.

The action of this system is quite simple. If the programme requires that data from register A be transferred to C, a logical one is applied to the control input of gate X, and shift pulses are applied to both registers.

The $\overline{\text{data}}$ from A will therefore open or close gate X, depending on whether ones or noughts are present, and the true data will be shifted into C.

Alternatively, if the programme requires that data from B should be transferred, then a logic 1 will be applied to gate Y, the action continuing as before. The logic for this operation could be expressed as $\overline{A}$ and $\overline{LA}$ or $\overline{B}$ and $\overline{LB}$, where LA and LB are the control signals.

SPEED

Diode Transistor Logic is generally rated as a medium speed family, though some manufacturers offer variations which may be either much faster or slower than the average. A good example of this is the Ferranti Micronor II series which is roughly twice as fast as what we will be taking as the "typical" DTL characteristic.

The speed of a logic gate, usually called its propagation delay, may be defined as the time taken to produce an appropriate output level after the arrival of a certain input level. For DTL this time is usually of the order of 40ns. In practical terms this means that any pulse applied to a gate input which is not substantially longer than 40ns, will not have any affect on the gate output.

The figure of 40ns is only a typical value; under certain output conditions the delay will be longer or shorter. In addition, there are quite different figures for delay to high-level output, and delay to low-level output, due to the change in output impedance of the gate.

When the output level is dropping, the output transistor will be turned on, and the output impedance will be equal to the saturation resistance of the transistor, perhaps 50 ohms.

When the output level is rising the transistor will be turned off, and the output impedance will be equal to the load resistance, typically 6 kilohms.

As the main factor affecting the propagation delay is the effective capacitive load on the gate, it can be seen that this differing output impedance will in turn give a delay time which depends on whether the gate output is rising or falling.

FLIP-FLOP

There are usually two types of flip-flop in any manufacturer's DTL range, the d.c. coupled type, referred to as a JK element, and the capacitively coupled type, referred to as a pulse triggered binary.

The former type can be operated at up to about 8MHz, depending on the exact circuitry used. It is used in shift registers as well as counters and frequency dividers. The latter type is specifically designed for high speed counters and dividers operating at up to 20MHz.

It is unlikely that the speed of a logic family will be of importance to any amateur experimenter, as most designs will be run at lower speeds than the maximum available, even with a slow logic type. However, there is one speed problem which is important, even in designs which run very slowly indeed; this concerns the rise time of the clock pulse in counters or shift registers.

CLOCK PULSE

Of the two types of flip-flop mentioned above, the pulse triggered type requires a very fast clock pulse rise time which must not be longer than 25ns. The d.c. coupled flip-flop does not require anything like such a rapid rise time, but it is recommended to keep it below 2μs or trouble may be experienced.

As a general rule, no matter how infrequently each clock pulse occurs, it is vital to ensure that its leading edge is very fast, so fast in fact that the resolution available on the simpler oscilloscopes will make it immeasurable.

This problem is not as difficult to solve as it may sound, because any clock pulse edge which is too slow may be speeded up by using a DTL gate as a buffer. If necessary, more than one gate may be used in series, each gate speeding up the clock pulse leading edge by at least ten times.

If, however, the source of clock pulses has a very poor rise time (for example, those derived from sine waves), it is best to use a Schmitt trigger circuit to speed them up. An example of both methods is shown in Fig. 3.6.

In the first example (Fig. 3.6a) the clock pulses are derived from a conventional multivibrator, and speeded up by two gates in series.

In the second example (Fig. 3.6b) the pulses are derived from the 50Hz mains, via a Zener diode rectifier-squarer, the speed-up being performed by a simple complementary Schmitt trigger. The output of this is passed through a single gate to increase the speed-up and provide the fan-out necessary to drive several flip-flop clock inputs.

FAN-OUT

As we have already investigated the subject of fan-out when dealing with RTL, it is not necessary to go very deeply into this specification when considering DTL. The reasons why fan-out is limited have been mentioned when dealing with the circuit of the basic gate. The

guide, under the very worst conditions, the smallest value for noise immunity is 200mV. Under normal operating conditions a noise voltage of at least 500mV is necessary to upset the operation of a gate or flip-flop.

As a practical guide, if a system occasionally malfunctions, and the design can be considered sound, noise may be suspected as the cause.

The first thing to consider is adequate supply decoupling. It is best to decouple the 5V supply line every five i.c. packages with a capacitor of about $0{\cdot}1\mu F$ to ensure that noise voltage spikes are prevented from travelling via this line from one package to another.

The next "noise-abatement" rule is never to use connecting wires (or printed circuit runs) of longer than about 12in. This minimises the risk of pick-up, and also prevents "transmission-line" reflections that can occur due to the fast square leading edges present when gates switch.

OUTPUT LOGIC LEVELS

The output voltage of a DTL gate, under various loading conditions, has a major implication on the noise immunity of a system.

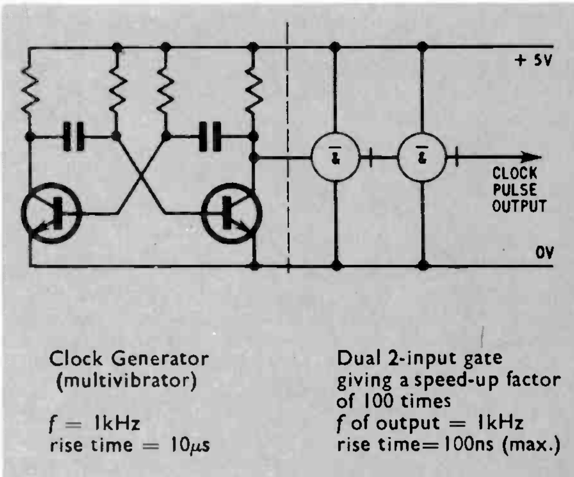


Fig. 3.6a. DTL gates used to speed up the rise time of a multivibrator (clock generator) wave form

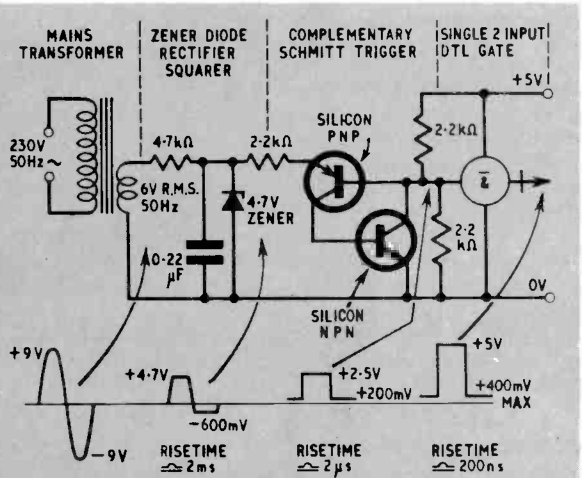


Fig. 3.6b. DTL gate used to speed up the rise time of a Schmitt trigger

discussion of the wired-OR function mentioned the special fan-out rules to be employed in that special case.

The fan-out of the DTL gate is normally quoted as eight loads, or gate inputs. However, in cases where a greater driving capability is required, a special buffer gate is available which has a fan-out of 25 loads, making it particularly useful for driving long clock lines.

The circuit of the buffer gate follows the same principles as the basic gate, except that an extra transistor is used to provide increased current gain.

NOISE IMMUNITY

Due to the circuitry used in the basic DTL gate, it is difficult to evolve any simple rule to describe the effects of noise pulses on a logic system. The immunity varies with fan-out, supply voltage, temperature, noise polarity, and gate output level.

A detailed discussion of all of these variables would be out of place in an article such as this, but as a useful

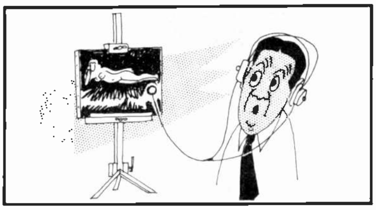
The worst case output voltages of a gate are those used to derive the noise immunity figures given previously. When a gate output is high, the only current it is called upon to supply is the leakage of the input diodes of other gates connected to it. This current will be very small, so the voltage dropped across the output load resistor will also be very small.

It is most unlikely that the high level gate output voltage will drop below 3V, even at maximum fan-out.

In the low level output state, however, the output transistor will be called upon to sink a much larger forward current from the same input diodes, but as the resistance of a saturated transistor is much lower than that of the output load resistor, the output voltage in this state is unlikely to rise above 400mV.

Next month a simple application—a slide projector delay timer—will be described which employs only four DTL packages and a few discrete components.

ON THE FRINGE



ANTIQUE RECORDINGS

When talking about recordings we generally think in terms of tape or LP's or maybe the earlier types made on cylinders. Could there have ever been recordings made before this on any other type of medium? I was pondering the possibilities of this only a few weeks back and by a peculiar coincidence saw a letter by a fellow from New Jersey, USA, who has come across some pretty staggering facts.

It has been suggested that the process of making hand-thrown clay pots or even the brushstrokes produced in painting a canvas, could result in the direct mechanical recording of short snatches of conversation or other ambient sounds present at the time.

To check the hypothesis a pick-up cartridge, suitably furnished with a large wooden stylus and connected to a simple amplifier and headphones, was held against a newly-made pot that was allowed to revolve on a well balanced turntable. Now it was previously known that the potter's wheel used to produce the pot had developed a pronounced "chatter" and so on "play-back" the same anomaly was expected to be heard.

Indeed this seems to have been the case, but more interesting still, it appears that odd sounds made during the fashioning of the pot also could be detected! Similar effects, I understand, have been noticed in brushstrokes made with oil paints. If you like the idea and would care to experiment, here's a set-up that seems to work:

Hook up a taut canvas to a small wooden stretcher or frame and arrange things so that it can be free to vibrate. To ensure that this is so you will need gently to apply an old pick-up stylus to the canvas (connect the pick-up to the input of an amplifier, see Fig. 1) and "speak to it". Assuming all is O.K. you should hear your voice. If a few brushstrokes are made while a radio or other source of noise is functioning nearby and then allowed to dry hard, subsequent examination of the strokes with a magnifying glass should reveal that certain strokes do carry the expected striations. Actually, if you can run the stylus over the canvas at the correct speed, a brief snatch (possibly distorted!) of the original is likely to be heard.

If you can afford a Ming vase or a Constable it might be worth a bit more research to see whether any hidden secrets became enmeshed in the finished work!

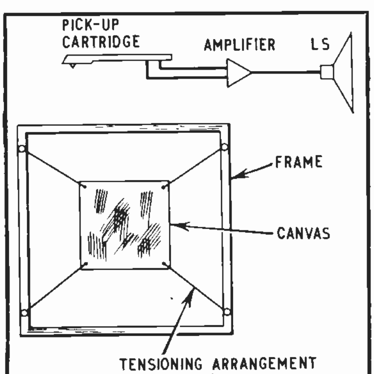


Fig. 1

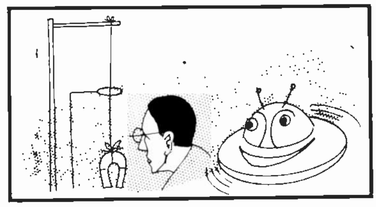
TACTILE IMAGER

Have you ever thought just how perceptive your skin is? Indeed, you might fancy performing a little experiment to demonstrate this point! First blindfold yourself, then ask your wife or girl friend to "write" on the back of your hand with the end of a clean spent match. Try asking them to write single letters of the alphabet to begin with. The results of determining what has been written are generally incredibly good and go to show us that we often have faculties we barely credited the existence of.

This ease we seem to have of "seeing" with the skin has quite recently been put to good use in helping the blind to obtain a kind of graphico-tactile impression of their surroundings. The idea has been brought to a reality by Professors P. Bach-y-Rita and C. Collins of the University of the Pacific, Stockton, California.

Their system, which they refer to as a tactile imager, relies upon a miniature television camera which feeds a processing unit driving a 20 × 20 matrix of vibrators. These are plastic tipped devices, each actuated by a solenoid and situated about 12mm apart. The matrix is made to form part of the back of a dental-chair and in use transforms the images received by the camera into tactile impulses that effectively form a two dimensional reproduction of the scene. In operation the blind person sits in the chair and simply points the camera while getting a tactile representation of the picture "drummed" out on his back.

After only short periods of training with the machine, pupils have been able to distinguish between various overlapping objects and relationships between a number of objects in the same field. There are likely to be many other applications for this system and one can imagine it being useful in enabling the deaf to learn about the way speech is formed. No doubt a modified version of the system could be utilised in providing "feeling" to artificial limbs and other prosthetic devices.



UFOLOGISTS

It's possible that you have not heard of the term Ufology, but, believe me, it does exist. Currently, there are thousands of people constantly engaged on the look-out for "flying saucers" (or UFOs—unidentified flying objects) who call themselves by this name. From the fact that there are many well authenticated reports on the subject, and often by highly qualified reliable individuals, the case for UFOs, whilst by no means proven, appears to be worth some examination.

From the people "in the know" on this subject I gather that there exist a number of ways in which UFOs might be detected. Apart from the use of radar, more simple systems apparently rely upon little more than some method for sensing the magnetic fields that "saucers" are purported to produce.

For your interest a really basic arrangement is shown in the accompanying illustration, Fig. 2. This uses a magnet suspended on a fine piece of wire having only a limited degree of movement within a wire loop. The loop and suspension represent a switch which, if the magnet is influenced by a field, will close causing the associated circuit to latch and thereby actuate a bell or some other indicator.

Obviously a set-up of this type is extremely sensitive to vibration so if you build one don't think that because your brain-child is hooting at you a "flying saucer" is hovering over-head!

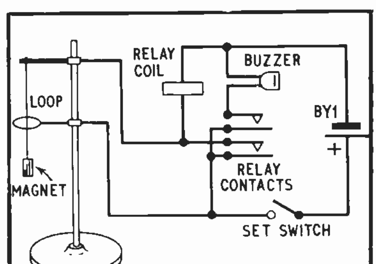
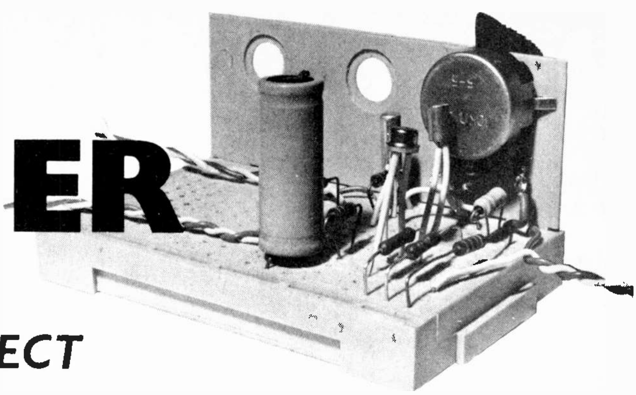
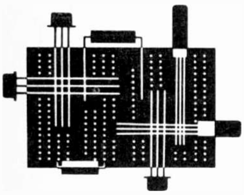


Fig. 2

400mW AMPLIFIER





A SPECIAL PROJECT FOR BEGINNERS

One of the most important applications of transistors is their use to convert a small voltage input into a large voltage output. This process of increasing the signal level is known as amplification.

Amplifiers can be broadly categorised in a number of families which embrace d.c., audio, video and radio frequencies. In this article we will only be concerned with the amplification of audio frequencies which is a band that extends from about 15Hz to 18kHz for the very best of hearing.

In audio amplifiers the power output which can be obtained from a single output stage employing ordinary transistors is usually restricted to about 50 milliwatts. Whilst this is adequate for driving earphones it is rather too small for use with a loudspeaker; an output of approximately 400mW is provided from the amplifier to be described so that it can be used in general purpose applications.

The circuit configuration given in Fig. 1 is probably one of the most common output stages to be currently found in low power amplifiers, so familiarity in this department will no doubt assist in the repair of transistor radio output stages.

QUIESCENT STATE

To understand the working of this circuit it is probably best to find out what is going on when no input signal is applied. This state is called quiescent, that is, all the voltages are static or d.c. at the various junctions. First, we can ignore VR1 and C1 as the capacitor has a very high resistance to d.c.

Looking next at TR1, a *pnp* transistor, it can be seen that this has a negative voltage bias applied to its base via R6 and R1 which drives it into conduction.

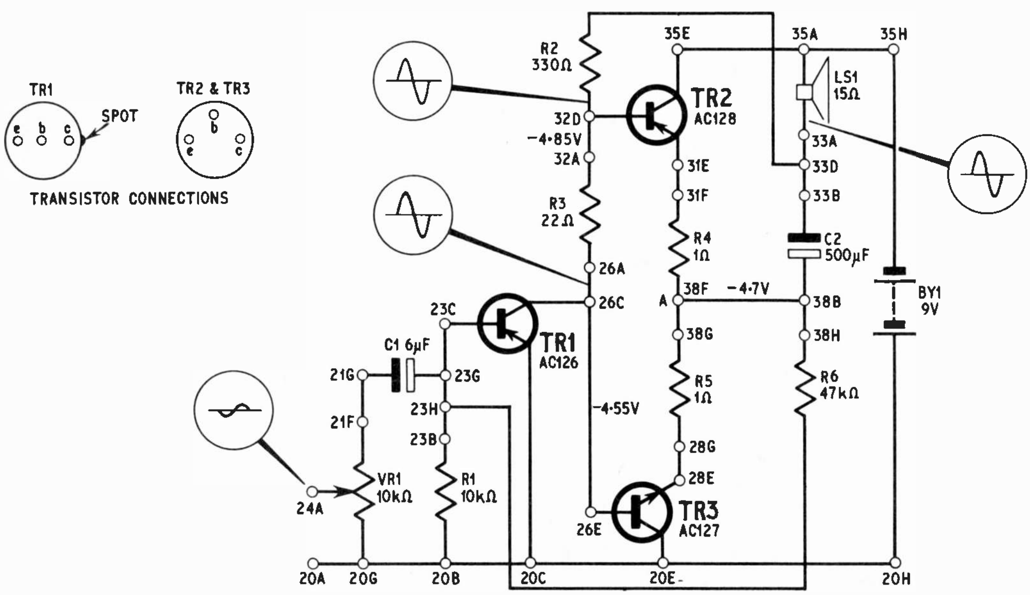


Fig. 1. Circuit diagram of the 400mW amplifier. The a.c. oscillograms and d.c. voltages are measured relative to OV line

The load, or resistance appearing at the transistor collector, is made up of R2, R3, and the loudspeaker LS1. Obviously, since current is passing through these components there will be voltage drops across them. These are in fact, so arranged in polarity as to just switch on TR2 and TR3. If reference is made to point A, the "mid-voltage" line and the transistor bases, the d.c. voltages given indicate a difference of 150 millivolts positive for TR3 and 150 millivolts negative for TR2.

In electronic parlance since no capacitors figure between TR1, TR2 and TR3 they are said to be d.c. coupled. Similarly, the arrangement of transistors TR2 and TR3 is described as complementary since in combination they afford a d.c. path between the 0 volt and minus 9 volt lines.

APPLYING A.C.

Now what happens when an alternating signal is applied. Providing this is less than 18mV r.m.s. and so does not produce distortion, this will appear across R1 and at the base of TR1. Since the function of a transistor is to amplify, an amplified replica of this signal will appear at the bases of TR2 and TR3.

Reference to Fig. 1 shows these signals to be in phase, that is, they move positive and negative together. But since these transistors have very slight d.c. forward biasing, TR2 will conduct on a negative excursion of the base sine wave and TR3 on the positive half.

Ideally, for economic reasons, it would be best if these transistors did not conduct in the quiescent state, then they could be neatly switched on and off by the alternating signal. Unfortunately, because of the characteristics of the transistors this would produce a rather nasty form of distortion at the loudspeaker known as crossover distortion, which is not unlike a rattling noise. A typical waveform showing this effect is given in Fig. 2.

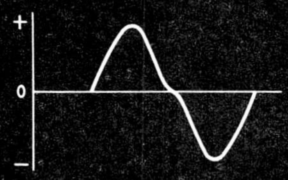


Fig. 2. Waveform showing distortion of the signal at the point of changing polarity of the sine wave. This is known as "crossover distortion".

LOUDSPEAKER OUTPUT

Since a loudspeaker is electrodynamic, power must be supplied to move the mass of the cone. This means that a sizeable alternating current is required. This must be provided by the power transistors TR2 and TR3.

Since these conduct on alternate half cycles the only path to a.c. must be through LS1 and the large value capacitor C2. In practice the voltage drop across this component is very small.

CONSTRUCTION

Construction using the T-Dec is a simple plug-in procedure but see that transistor leads are not allowed to come into contact. The hole numbers for T-Dec are given on the circuit diagram (Fig. 1). Once again other constructional methods can be employed if the advice of the first article in this series is followed.

If this circuit is to perform efficiently with the minimum of distortion it is important that the gain, or h_{FE}, of each output transistor is matched to at least 10 per cent. Most retailers will advise you on this. ★

COMPONENTS . . .

Resistors
- R1 10kΩ
- R2 330Ω
- R3 22Ω
- R4 1Ω 1W wirewound
- R5 1Ω 1W wirewound
- R6 47kΩ
- All ¼W, ±10% carbon except R4 and R5

Potentiometer
- VR1 10kΩ carbon log.

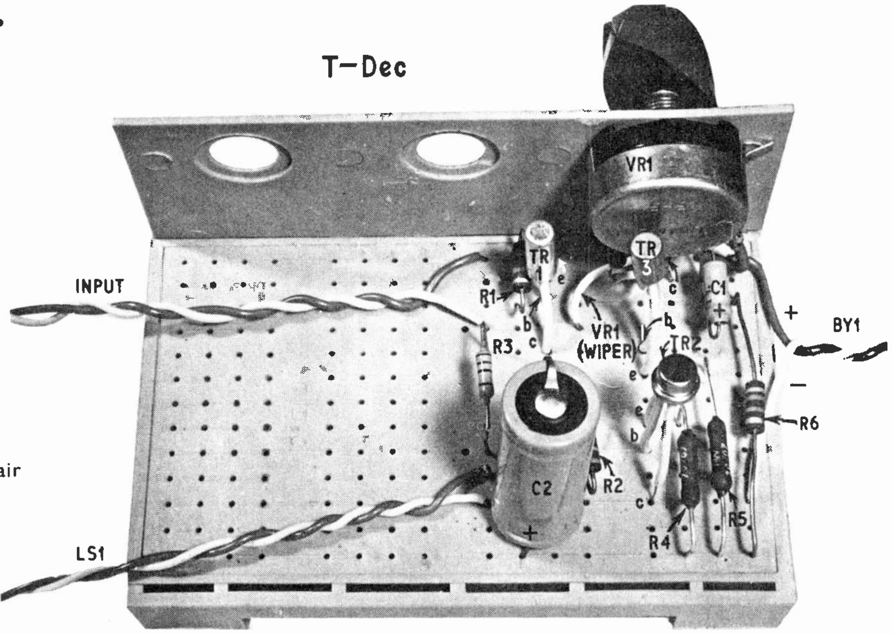
Capacitors
- C1 6μF elect. 15V
- C2 500μF elect. 15V

Transistors
- TR1 AC126
- TR2 AC127 } matched pair
- TR3 AC128 } matched pair

Loudspeaker
- LS1 15Ω

Battery
- BY1 9V PP9

Miscellaneous
- T-Dec, connecting wire



THIS MONTH's article continues the brief survey of transducers—devices that convert one form of energy into another form.

SOUND SENSORS

Sound is a longitudinal pressure wave motion of a medium such as air.

Carbon Microphone

The carbon microphone (Fig. 6.1a) contains loosely packed carbon granules which are brought into more intimate contact by pressure on the diaphragm. Contact resistance between the granules varies with sound pressures, and in turn causes a change of current flowing through the microphone and series resistor R, thus giving rise to an electrical signal.

Crystal and Ceramic Microphone

Crystal and ceramic microphones make use of the piezoelectric effect, whereby certain crystals and ceramic materials are capable of developing an e.m.f. when subjected to strain. The effect is reversible; a voltage applied across the crystal can produce a mechanical force.

In Fig. 6.1b, a slice of piezoelectric material is clamped at one corner. Movement of the diaphragm is transmitted to the opposite corner by a light rod, tending to bend the slice. Conductive coatings on the faces of the slice serve to collect the resulting e.m.f. and yield an output voltage.

Dynamic Microphone

When a conductor is made to vibrate inside a magnetic field it will generate an alternating current; this is the principle of a dynamic microphone, Fig. 6.1c.

The moving coil version has a wire conductor wound on a paper or plastics cylindrical former. This lightweight coil is fixed to the diaphragm. Sound pressure waves move the diaphragm pushing and pulling the coil within the magnetic field, thus generating an electrical signal.

In the case of the ribbon microphone, the conductor is nothing more than a short length of corrugated aluminium alloy foil, which responds directly to sound pressures. An output voltage is set up across the ribbon when it vibrates.

SOUND SENSORS

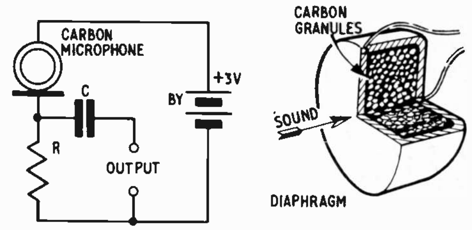


Fig. 6.1a. Carbon microphone

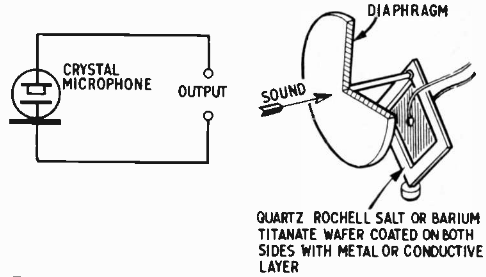


Fig. 6.1b. Piezoelectric microphone

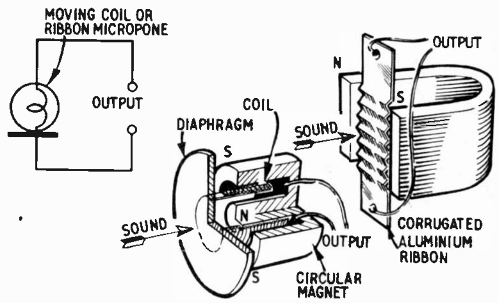


Fig. 6.1c. Dynamic microphones: moving coil and ribbon

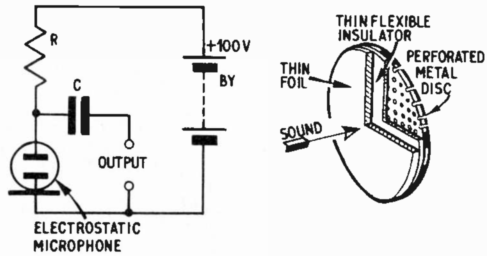
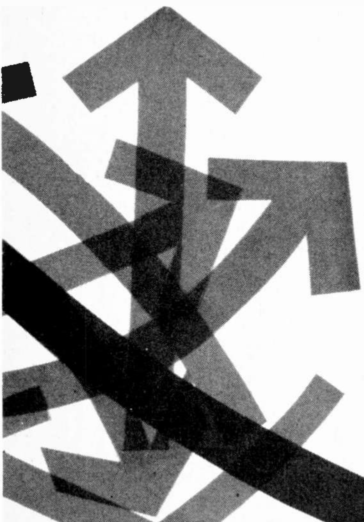


Fig. 6.1d. Electrostatic (capacitor) microphone

Electrostatic Microphones

Fig. 6.1d shows an electrostatic or capacitor microphone. If a charge is applied to the plates of a variable capacitor and the distance between the two electrodes is varied by movement of a diaphragm attached to one



A NEW SERIES FOR THE BEGINNER

of them, the voltage across the electrodes will vary. The greater this distance, the greater will be the voltage. The reverse takes place when the electrodes are brought closer together.

The electrodes of the capacitor microphone are made up of a thin layer of foil or metallised plastics and a rigid perforated metal disc, with a thin flexible insulator or dielectric in between.

The battery and high value resistor R in Fig. 6.1d maintain a steady d.c. charge on the electrodes. Sound pressures acting on the foil cause it to move in relation to the rigid disc and a small alternating voltage is set-up across the microphone.

SOUND EMITTERS

A sound emitter converts electrical signals into pressure waves, usually in air, but sometimes in other gases or liquids. Loudspeakers and earphones are common examples of sound emitters, but there are other devices which emit ultrasonic frequencies well beyond the range of human hearing.

Moving Coil Loudspeaker

The moving coil loudspeaker in Fig. 6.2a is similar to a moving coil microphone, but has a larger diaphragm and magnet assembly. An alternating current flowing through the wire coil makes it vibrate within the magnetic field. The coil is wound round a paper tube which is attached to a large conical diaphragm. The vibrations of the coil are transmitted to the air by a piston-like action of the whole assembly.

Electrostatic Loudspeaker

Fig. 6.2b shows an electrostatic loudspeaker, consisting of a rigid, perforated metal plate and a thin frame of insulated material supporting a stretched metallised membrane. The frame provides a small air-gap between the two electrodes, sufficient to ensure good insulation and allow room for the membrane to vibrate.

A steady d.c. voltage via high value resistor R polarises the electrodes. The membrane is alternately attracted to and repelled by the rigid plate on application of an alternating voltage input, thus imparting pressure variations directly to the air.

Crystal Earphone

A slice of piezoelectric crystal will bend or vibrate when subjected to applied voltages. The crystal earphone in Fig. 6.2c has a small metal diaphragm mechanically coupled to the slice, thereby converting vibrations of the crystal into sound pressure waves.

Ionic Loudspeaker

The ionic loudspeaker in Fig. 6.2d is capable of reproducing sound frequencies above the upper limit of human hearing, and can cover the range 3–50kHz. Air inside a quartz tube is strongly ionised by a large alternating voltage from a high frequency oscillator operating at 27MHz.

Ionised air has very little mass and inertia, and is capable of causing rapid sound pressure changes inside the acoustic horn when the oscillator output level is varied by a suitable input signal.

SOUND EMITTERS

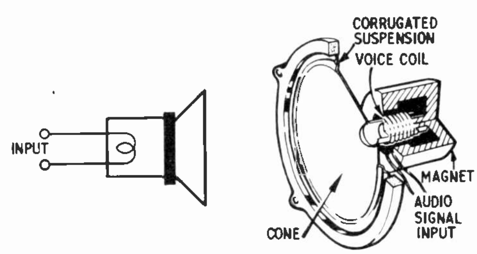


Fig. 6.2a. Moving coil loudspeaker

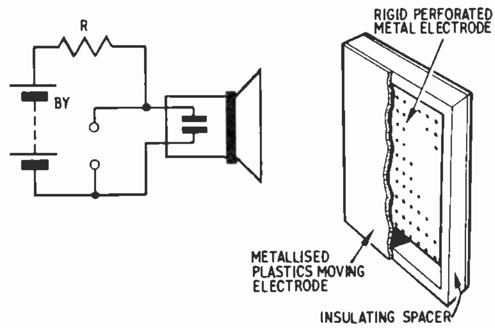


Fig. 6.2b. Electrostatic loudspeaker

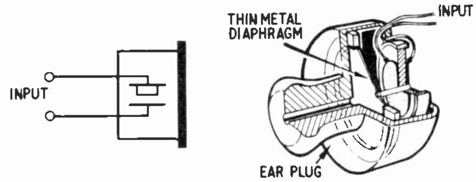


Fig. 6.2c. Crystal earpiece

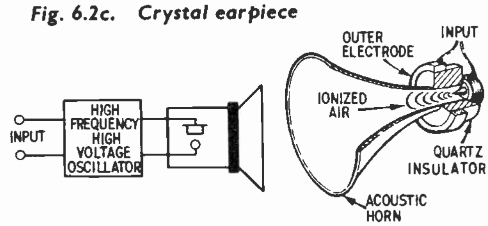


Fig. 6.2d. Ionic loudspeaker

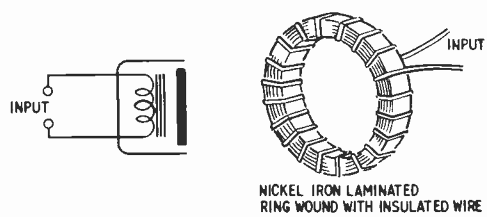


Fig. 6.2e. Magnetostrictive echo sounder

WAY TO ELECTRONICS 6

Echo Sounder

Finally, an example of a sound emitter that works in water instead of air is the magnetostrictive echo sounder, shown in Fig. 6.2e. An alternating current in a coil of wire wound on a nickel iron ring sets up an alternating magnetic field.

A ferromagnetic material like nickel iron exhibits dimensional changes within a magnetic field, so the ring contracts and expands and imparts pressure variations to the surrounding water.

MAGNETIC SENSORS

The Hall effect was first observed in a strip of gold leaf. With a current flowing along the strip, and a magnetic field disposed at right angles to its surface, a small voltage was developed across the strip, due to the sideways deflection of electrons by the magnetic field.

Hall Probe

A modern counterpart is the semiconductor Hall probe, which is used to measure the strength of magnetic fields, see Fig. 6.3a. Instead of gold leaf the probe employs a much more sensitive layer of indium antimonide, to which contacts are attached.

The lateral output voltage is proportional to the product of bias current and magnetic flux density. A typical device will yield 0·5 millivolts output per milliamp-kilogauss.

In the circuit of Fig. 6.3a, a steady d.c. bias current flows from the battery via R between contacts A and B. The magnetic field to be measured is arranged vertically, and the output proportional to field strength is developed across contacts C and D.

Hall effect devices are also employed as mathematical multipliers in analogue computers, where an electromagnet provides the multiplier in the form of a variable magnetic field, the d.c. bias current is the multiplicand, and the output voltage is the product.

Magnetoresistor

Bismuth wire and certain semiconductor materials have the property of increasing in resistance in the presence of a magnetic field. Unfortunately, bismuth wire is also highly temperature dependent.

A modern semiconductor magnetoresistor will yield a typical resistance change of 25% per kilogauss and is virtually immune to temperature, see Fig. 6.3b.

Tape Head

Fig. 6.3c shows a tape playback head, consisting of a "C" shaped stack of soft iron alloy laminations and two bobbins wound with enamelled copper wire.

Unlike the Hall probe and magnetoresistor, a playback head cannot detect a steady magnetic field, but relies on the movement of the tape past the gap in the head to set up a continuously varying magnetic field within the gap, thus inducing alternating currents in the coils. The tape, of course, has a fixed magnetic pattern on its surface, put there during recording.

MAGNETIC FIELD GENERATORS

A magnetoelectric material such as chromium oxide will become magnetised when placed in an electric field, and conversely produces a voltage when subjected to a magnetic field, but this phenomenon has not been widely exploited in electronics.

By far the most common form of magnetic output transducer uses the magnetic field associated with a current flowing in a length or coil of wire. The transducer is coupled to the output of an oscillator or amplifier, examples being the scanning coils in television receivers, tape recording and erase heads, and the inductive loop in short-range communication systems.

Inductive Loop

An interesting example of an inductive loop, now being developed for commercial use in farming, is that of the driverless tractor, Fig. 6.4. A multi-turn rectangular loop of wire is buried beneath the surface of a field, with the turns staggered to give a series of parallel lines of fixed spacing.

The loop is fed from a low frequency oscillator and sets up a magnetic pattern which can be traced by a

MAGNETIC SENSORS

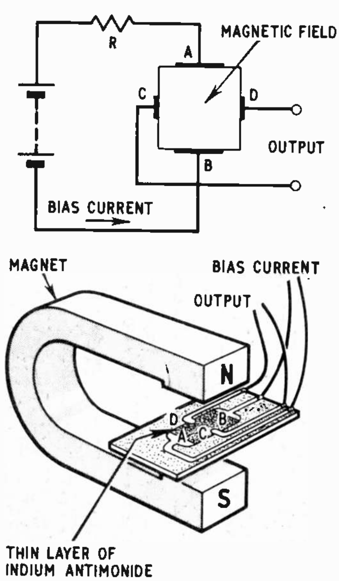


Fig. 6.3a. The Hall Effect probe

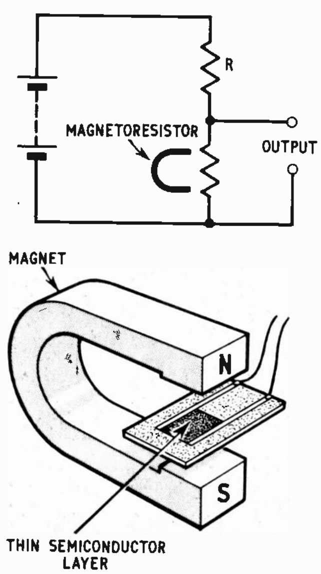


Fig. 6.3b. Magnetoresistor

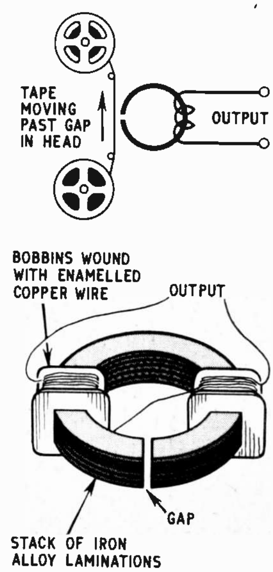


Fig. 6.3c. Tape recorder head

ELECTROMECHANICAL SENSORS

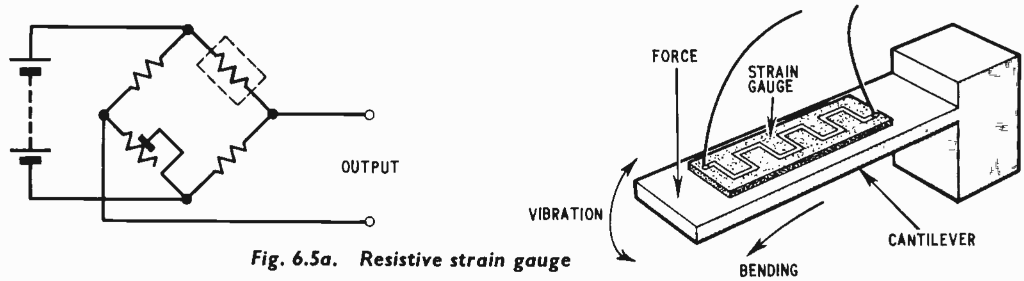


Fig. 6.5a. Resistive strain gauge

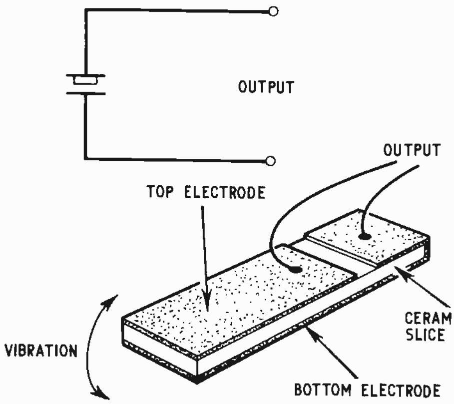


Fig. 6.5b. Piezoelectric strain gauge

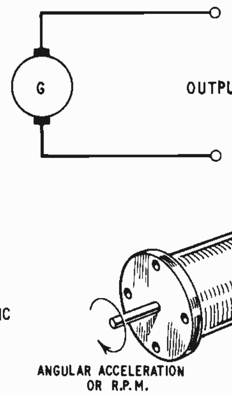


Fig. 6.5c. D.C. tachogenerator

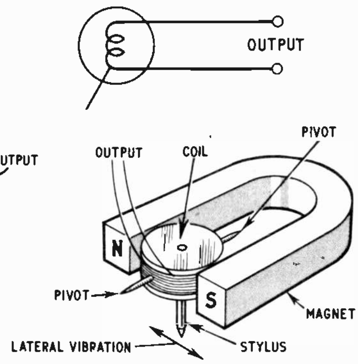


Fig. 6.5d. Moving coil pick-up

driverless tractor equipped with a magnetic sensor. The result is that the tractor can work for long periods with a minimum of supervision.

ELECTROMECHANICAL SENSORS

Mechanics is a subject that includes specialist branches of technology such as dynamics, circular motion, moments of inertia, statics, hydrostatics, elasticity, friction, and so on. There are many forms of transducer for converting mechanical phenomena into electrical signals. Those listed in Fig. 6.5 are intended to be representative rather than comprehensive.

Resistive Strain Gauge

A resistance element embedded in a thin strip of insulating material will show a small resistance variation when the strip is bent, due to dimensional changes of the element.

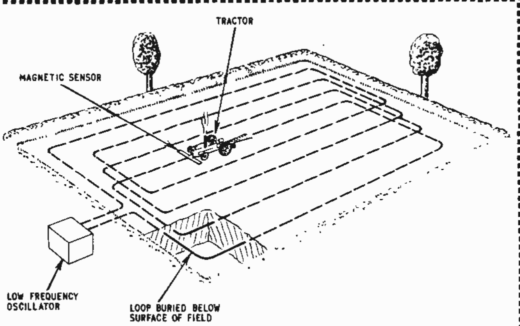


Fig. 6.4. Magnetic field generator; application of inductive loop

The resistive strain gauge (Fig. 6.5a) can be attached to a mechanical device, such as a cantilever, and will respond to the bending or vibration resulting from applied forces. For example, the force acting on the cantilever could arise from hydrostatic pressure on a diaphragm, a mass being subjected to acceleration or gravity, or the impact of a moving body.

The bridge circuit of Fig. 6.5a serves the purpose of cancelling out the intrinsic resistance of the gauge under zero strain conditions, and gives a voltage output only when the strip is bent.

Piezoelectric Strain Gauge

The ceramic strain gauge (Fig. 6.5b) has a larger output than the resistive type and does not require a bridge circuit, but cannot be used to measure very slow rates of deformation; it is principally a vibration sensor and works in much the same way as the active element in a crystal pick-up or microphone.

Tachogenerator

A d.c. tachogenerator is really nothing more than a precision dynamo, constructed to give an output proportional to angular velocity or acceleration, see Fig. 6.5c.

Pick-up Cartridge

With the moving coil or dynamic type of gramophone pick-up cartridge shown in Fig. 6.5d, the stylus tracks the wavy groove in the disc and translates this motion into oscillations of a coil in a permanent magnet field, and so an alternating current output is induced in the coil.

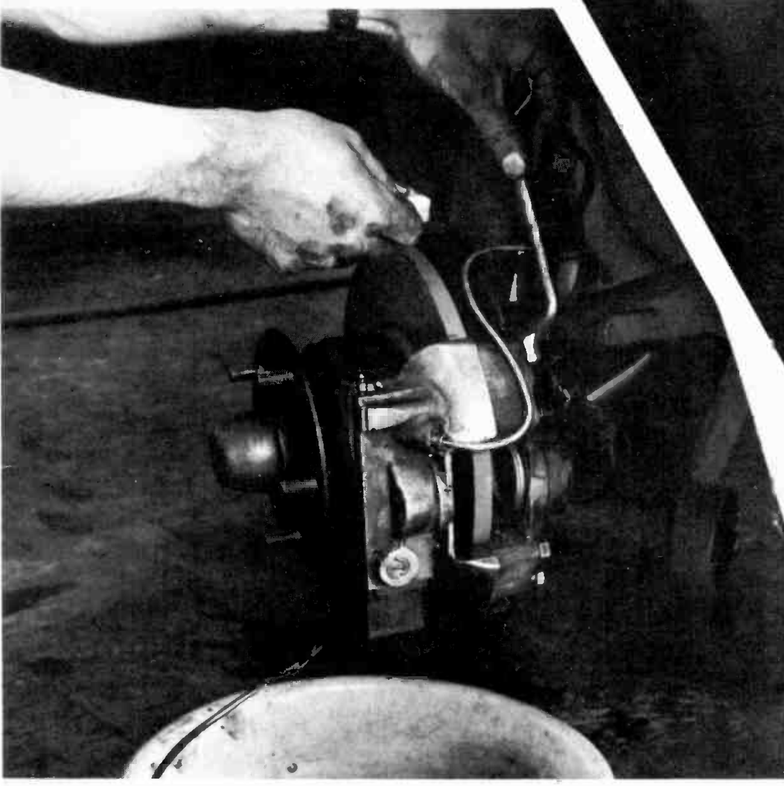
Part seven next month will conclude the section on transducers.

Antilock Braking

MULLARD Research Laboratories have recently developed an electronically-controlled vehicle braking system which will prevent wheels from locking on any road surface. It may prove to be the first-ever economically acceptable system for widespread application in all types of motor vehicles.

The problems of antilock control are partly mechanical and partly electronic. Sensing and computing the dangerous condition of a road wheel is best done by electronic means while releasing and reapplication of the brake is clearly a mechanical operation.

Right—individual wheel control test switches (lower centre) and the instrument (top left) for measuring stopping distances and speed during road tests

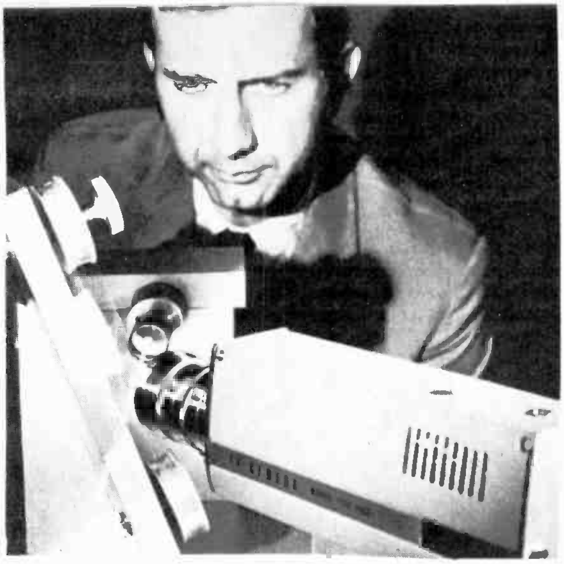


Left—the anti-lock actuator mounted on a disc brake unit showing the toothed ring from which the transducer senses the speed of the wheel

The control circuits can only determine the onset of a dangerous wheel condition. They cannot in themselves modulate brake pressure to prevent the wheel locking and some form of actuator is needed to control brake pressure in response to electronic warnings.

Once pressure is released by a signal from the electronics to prevent the wheel locking, it has to be reapplied to continue to slow the vehicle; in the Mullard system, energy is extracted from the wheel to pressurise the brakes. If the antilock system is working, the wheel cannot lock and the rotating wheel is therefore available to provide the necessary energy. This direct use of wheel energy means that a very small unit is feasible and in the case of the test car the entire mechanism is housed in the existing brake calipers.

The result of this work is a compact "fail-safe" system which can be applied to two or four wheels. When applied to four wheels the stopping distance is reduced (as compared with locked wheels) and steering control is maintained during emergency braking. The system can be fitted to any car which has hydraulic braking.



Electronic Rhino

MINIATURE transmitters are being implanted in the horns of African rhinoceros to discover valuable information about the habits of two of the species.

Terrain over which rhinoceros roam makes it difficult to carry out normal methods of study. It was therefore decided to develop a radio tracking system which would assist in locating individual animals.

After the animal had been drugged with a dart from a gun, a hole was drilled in the posterior horn without unduly weakening it (see photograph). The transmitter was inserted and the aerial accommodated in a groove cut around the horn.

The transmitter is a crystal controlled pulsed oscillator working on approximately 4 metre wavelength. The tuned circuit comprises a trimmer and a one-turn loop aerial. The d.c. power supply is an RM1N Mallory Mercury cell with a capacity of 1,000mAh.

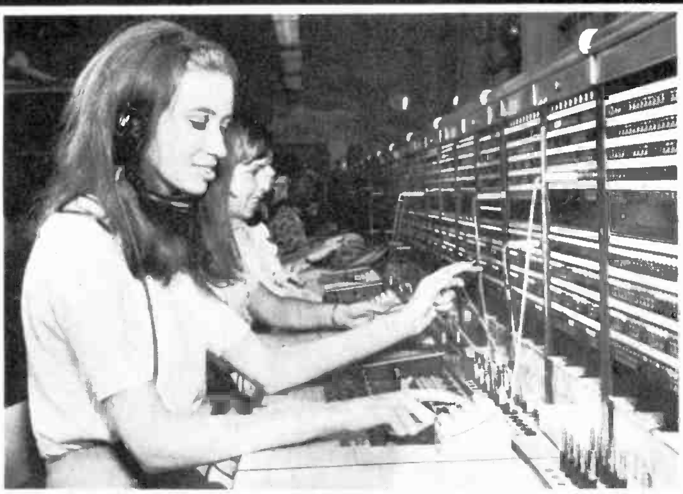
Selectavision Tape

A CARTRIDGE colour television tape player, that RCA expect to market some time in 1972, will be the first consumer product to employ lasers. The RCA system will enable any Selectavision cartridge to be played on all of the world's T.V. systems. The cost of the system is expected to be considerably less than other proposed systems.

The tapes, that are produced by holography, are of polyvinyl chloride (p.v.c.), have no chemical coating, no emulsion, no sprocket holes, are scratch proof, dust proof and virtually indestructible. RCA are already working on an original library of 100 programmes.

The photograph above shows the basic set-up for replaying the tapes using a laser and a television camera; in the prototype equipment these are incorporated, together with the tape transport system, within a unit of approximately the same size as a portable tape recorder.

ELECTRONORAMA



Push-Button Exchanges

THE British Post Office moves into the "push-button age" with an order worth nearly £½ million to T.M.C. for 20,000 operator's keysenders. The keysender replaces the ten hole dial on P.O. main exchange switchboards with a 12 pushbutton configuration contained roughly within the existing dialling area. Already trial keysender installations have shown a marked improvement in operator accuracy and efficiency, coupled with a notable reduction in fatigue.

A typical Key Sender installation at a large P.O. Telephone Exchange where all the operator positions have been converted to Key Sender operation

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.

MODEL RAILWAY POINTS SWITCH

ELECTRICAL switching of model railway points is readily accomplished by an electromagnetic technique, a common method being to provide two solenoids, one to open and the other to close the points, selection being by means of a simple switch. Momentary connection of an a.c. or d.c. source, usually 12V, gives an impulse to a magnetic slug which, through a lever connection, operates the point mechanism, Fig. 1.

An appreciable current is required in many cases and the solenoid is only rated for pulse working—connection to the source for any length of time would cause overheating. A simple spring loaded push button switch may be used, or a lever switch with an "off" end position. But both may be misused, and in any event the simultaneous operation of both solenoids should be excluded mechanically. Finally, the push button control requires further complication if the position of the point is to be indicated after an operation.

The simple electrical point switching method shown in Fig. 3, has the advantage of using circuit components commonly available. In particular, a controlled current pulse is used for switching—no steady currents can flow in the solenoid, and a simple double-pole double-throw panel switch indicates the sense of the point after each switching event.

A rough measurement of the effort required to change a point (by finding the distance moved and the force needed at the solenoid lever) gives values in the region of 10^{-3} to 10^{-1} joules. An electrolytic capacitor of 150μF, when charged to 12 volts, stores some 10^{-2} joules of energy. If discharged through the solenoid rapidly, a sufficient impulse may be available to operate the point. For any particular type of point, this may be investigated easily by touching the leads of such a capacitor (careful about polarity!) on the d.c. train supply at 12 volts, and then touching them on the terminals of one of the point solenoids. A sufficiently large capacitance should be chosen to give a smart operation of the point.

Two modes of operation are possible and are shown in Fig. 2a and b. In Fig. 2a, if the capacitor is initially discharged, on closing the switch, the charging current that flows into C through R (the solenoid, say) will dissipate an energy equal to that finally stored on the capacitor, i.e. $\frac{1}{2}CV^2$ joules. For this purpose the inductance of the solenoid is neglected.

The time taken to complete the flow is of the order of RC, the time constant of the circuit, which for $C = 1{,}000\mu$F and $R = 10$ ohms, will be about 10^{-2} seconds. In Fig. 2b, if the capacitor is initially charged, on closing the switch the stored electrical energy $\frac{1}{2}CV^2$ will be dissipated in the solenoid.

The circuit in Fig. 3 shows a system that economically combines both charge and discharge modes. Coils L1 and L2 are the points solenoids, C the capacitor. With the arms of the D.P.D.T. switched as shown, the capacitor charges from the 12V d.c. source; the charging current flowing in coil L1 operates the points in one sense. On completion of charging, the current in coil L1 falls to zero and the switch "dolly" indicates the position of the points. On switching over the D.P.D.T. switch, the fully charged capacitor is discharged through coil L2, operating the points in the opposite sense. Again, the coil current falls to zero and the switch "dolly" position indicates the point position.

In practice, a separate switch and capacitor are required for each point, the coils of which should be i olated from the track, and care must be exercised he polarity of the high capacity capacitors.

A. E. Kiss, Ph.D.,
Orpington.

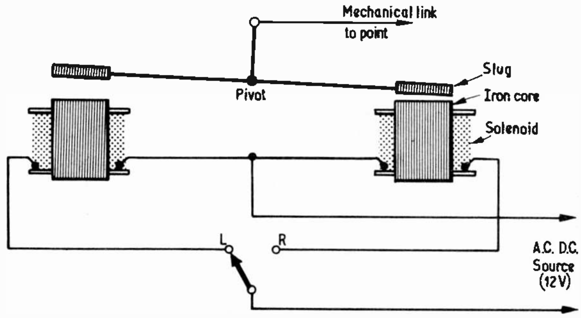


Fig. 1

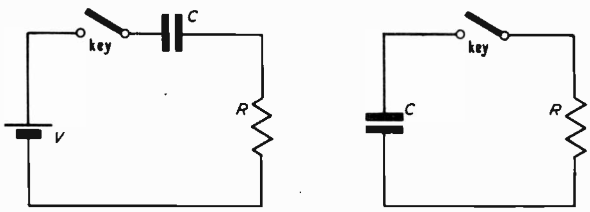


Fig. 2

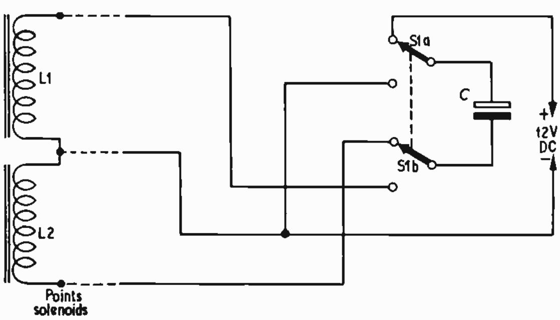


Fig. 3

AUDIO INDICATORS

HAVING been annoyed by motorists failing to cancel indicators, I have installed the device shown in Fig. 1.

The components of the circuit were all salvaged from a broken transistor radio, the transistor being one of the output type and L1 being the secondary (tapped) of the driver transformer.

The unit was assembled and fixed under the dashboard and the speaker, fixed in a location where the driver could hear it, i.e. behind a ventilation grille.

The unit was connected to earth and to an output pin on the flasher unit usually located under the nearside section of the dashboard.

R. J. Marrington,
Hayes,
Middlesex.

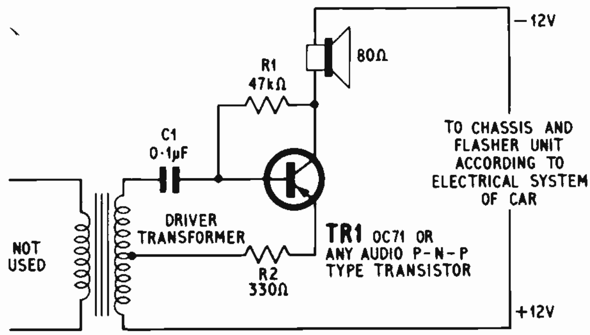


Fig. 1. Circuit diagram of the car indicator alarm

THEATRICAL CUE-LIGHT

SOME readers may be interested in the circuit of a theatrical cue-light which I have designed.

In the circuit, Fig. 1, the thyristors SCR1, 3, 5 and 7 are triggered by press button switches S1 to S4 through the respective gate resistors. When triggered, they turn on two lamps, LP1 and LP2 for SCR1, and also apply a gate current to one of the line of thyristors SCR2, 4, 6 and 8. When all the thyristors have been triggered, a current will flow through SCR2, 4, 6 and 8 and lamps LP3, 5 and 9 will light. The circuit is reset by opening S5.

The components within the dotted line are assembled in the master control box. This would normally be located with the lighting controls with the sub-units distributed to key personnel, e.g. prompter, stage-manager and house-manager.

The method of operation is as follows: As each person is ready to begin they press the switch on their sub-unit thus lighting one lamp on their sub-unit and one on the master control box.

When all the lamps on the master control have been lit as described, the lamps LP3, 6 and 9 will light to inform that everyone is ready to begin.

The master control cues the start of the performance by opening S5 and hence extinguishing all the lamps.

In the prototype it was found that, because of the capacitance caused by having long leads to connect the sub-units to the master control, when the unit was switched on a small current would flow in the thyristor gate circuits causing them to switch on. This was overcome by connecting a $10\mu F$ 16V capacitor between the negative rail and the gates of the affected thyristors, these having the effect of shunting this small current away from the thyristors.

Any type of thyristor may be used provided it can handle the voltages and currents involved. The ones used in the prototype were 600 p.i.v. 1A devices. Some variation in resistor values may be necessary to suit particular thyristors.

D. P. Delaney,
Englefield Green,
Egham, Surrey.

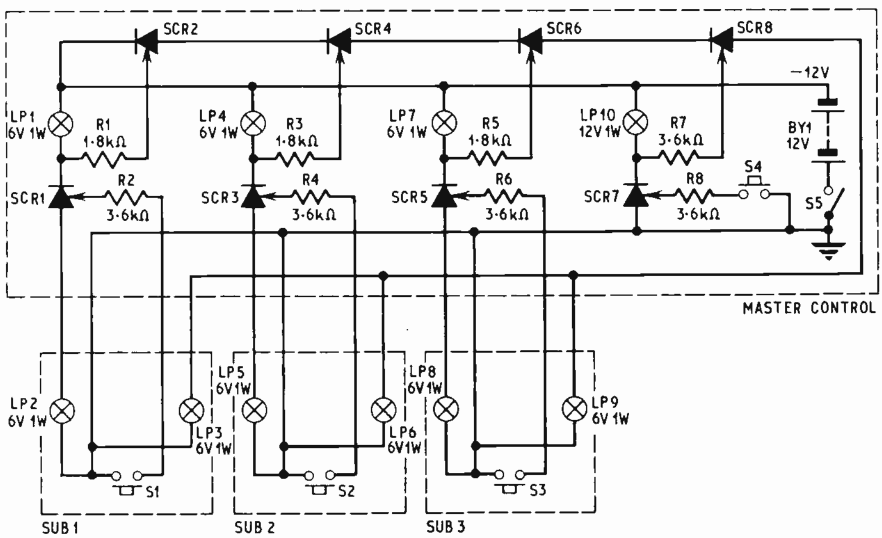
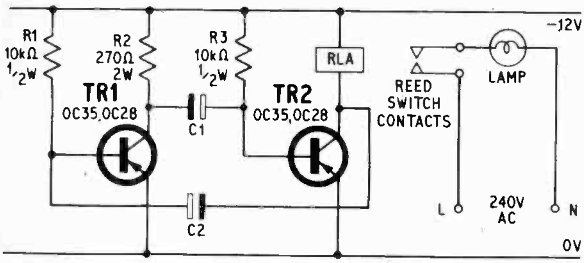


Fig. 1. Circuit diagram of theatrical cue-light

MAINS LAMP FLASHER



THE CIRCUIT diagram above is a cheap, simple, and safe method of flashing a mains a.c. lamp. The circuit is conventional and the rate of flashing may be altered by changing the values of the electrolytic capacitors. The present values give a range of approximately 1 to 4Hz.

The reed switch coil was salvaged from a television receiver, or can be wound from thin wire (approximately 1,000 turns) on a former. The reed switch is inserted in the centre of the former.

The device may also be used to interrupt other a.c. devices at preset intervals, determined by the electrolytic capacitors.

J. S. Maud,
Scunthorpe,
Lincs.

ECONOMICAL IC HOLDER

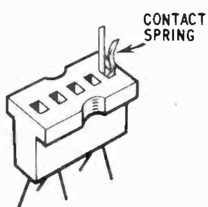


Fig. 1

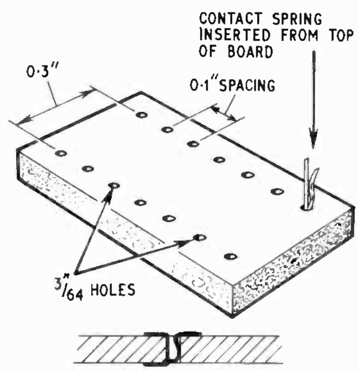


Fig. 2

INTEGRATED circuits are now available at prices which many readers can now afford. However, IC holders, which are invaluable for experimentation, are very expensive items, usually costing more than £1. Because of this situation I have devised a simple i.c. holder using cheap, readily obtainable materials.

There are some transistor sockets available on the market, for less than 1s each, with five contact springs. These contacts are removed as shown in Fig. 1. To make the holder for an integrated circuit, 3/64 in holes are drilled in a piece of hardboard in the appropriate pattern. The pattern shown in Fig. 2 is for a 14-pin DTL package (0·1in matrix veroboard makes a good template). Insert the contact springs into the holes in the hardboard, leaving 1 to 2mm of metal protruding above the board, see Fig. 2. Spread out the protruding sections of the two prongs of the contact and flatten them against the top of the board and, on the underside of the board, bend the other end of the contact sideways to keep it in position.

C Masson,
Edinburgh, 12.

NEWS BRIEFS

Skynet II

HAWKER Siddeley Dynamics Ltd., and GEC-AEI (Electronics) Ltd., have each been given a contract by the Ministry of Technology to develop, in co-operation with American industry, proposals for higher powered Skynet communications satellites for defence purposes. A decision on which firm is to be the eventual prime contractor for two such satellites will be taken later this year. The satellites are to be ready for launching in 1973 as replenishment for the initial two satellites of the Skynet system which were built by the United States. The first of these was successfully launched last November. The replenishment satellites will be substantially more powerful than these first Skynet satellites and will be capable of operating in conjunction with small transportable aerials.

Register for Engineers

LAST September the Board of CEI (Council of Engineering Institutions) passed the following resolution: "The Council of Engineering Institutions will, in collaboration with other interested parties and subject to the agreement of the Privy Council, initiate the formation of an organisation to create and administer a system of qualification and title, and to establish and maintain a composite register covering the principal sections of the engineering community, currently Chartered Engineers, Technician Engineers, and Engineering Technicians."

Subsequently, CEI has prepared outline proposals for the structure for a registering organisation and also for qualifying standards based on those prepared by SCNQT (a group of non chartered institutions drawn together by CEI), for admitting non Chartered Engineers to the register. These proposals were tabled at a meeting between CEI and SCNQT and others last December and subsequently circulated earlier this year to all those institutions who had expressed interest in collaborating with CEI in establishing such a register under the authority of the CEI Charter and By-laws.

Numerous discussions with interested parties have indicated general support for CEI setting up such a register and, on 20th May 1970, the Board agreed to implement its resolution to set up an Engineers Registration Board.

POINTS ARISING

P.E. ORGAN—11 *(March 1970)*

Having conducted some further experiments with the variable vibrato circuit, Fig. 11.2, it was found that if a green spot 2N2926 transistor is used for TR2 and the feedback resistor R3 changed to 1 kilohm the circuit works excellently.

P.E. MARKSMAN *(July 1970)*

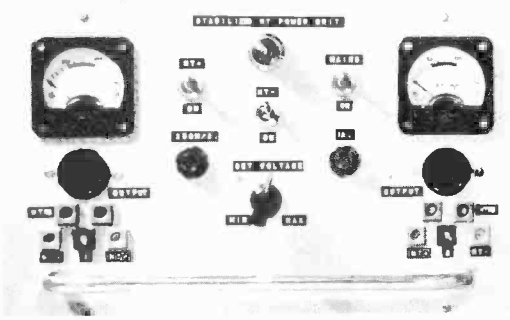
Capacitor C1 should be 1,000μF not 1,000pF as given in the components list.

P.E. COMMUNICATIONS RECEIVER *(October 1969–June 1970)*

See letter on page 741.

TEMPERATURE ALARM *(Ingenuity Unlimited, July 1970)*

See reader's letter on page 742.



VALSTAB POWER SUPPLY UNIT

BY P. CAIRNS

A VERSATILE well equipped workshop, where experimental and repair work is carried out, often requires a range of d.c. and a.c. power supplies suitable for driving both valve and transistor circuitry.

Commercial equipment, including radio, television, and test gear still carry some valve circuits and, where the in-built power supply may have failed, a temporary substitute is a valuable asset. Equipment employing cold cathode tubes also need high voltage d.c. supplies.

The "VALSTAB" is a new P.E. project to fill these needs, while the "TRANSTAB" (to be described in a later article) is its matching companion, specially designed for driving low voltage transistor circuits.

Both power units offer a high degree of voltage stabilisation under variable load conditions.

COST

The "Valstab", described in this article, is a high voltage valve stabilised power unit, whose non-technical features are versatility of range and output, reliability, and portability, coupled with a straightforward form of conventional chassis construction.

The specification for this unit is given in the display panel below, from which it will be seen that both positive and negative voltages are available. To achieve the wide range of output available the circuit is perhaps a little more elaborate than the more orthodox power unit.

It is considered essential that the unit should have sufficient outlet points to allow more than one piece of apparatus to be powered simultaneously, within the limitations of the current and voltage ratings.

The cost can be kept reasonably low without sacrificing any of the principle features which make the project worthwhile. As cost is often an important consideration with such projects, some attempt has been made to give an approximation of the total cost. The figures quoted are included as a very rough guide, as components can vary so widely in price.

Both the Valstab and the Transtab use the same type of cabinet, costing 34s at the time of writing. The meters, if purchased new, can cost up to 75s each depending on the quality and source of supply.

If purchased on the surplus market and calibrated (as described later), the meters can cost as little as 10s each. The total cost of all other components, if bought new, can be as much as £14 10s per unit. If a careful search is made through suppliers' catalogues, advertisements in the technical press, and in shop windows, this figure can be reduced to as low as £8 per unit.

SPECIFICATION

OUTPUT 1	
D.C. Voltage	+175V to 325V
D.C. Current	0 to 100mA (120mA reduced regulation)
Regulation (0–100mA)	Less than 0·5% over 175–325V range
Ripple at 175V full load	Less than 10mV p-p (<0·003%)
Ripple at 325V full load	Less than 50mV p-p (<0·006%)
Change in output for −3% +5% change in mains voltage	Less than 0·5%
OUTPUT 2	
D.C. Voltage	−150V
D.C. Current	0 to 10mA
Regulation	Better than 1%
Ripple	60mV p-p (<0·02%)
OUTPUT 3	
A.C. Voltage (heater supply)	6·3V 4A centre tapped or as available from T1
DIMENSIONS	
Width 12in, height 7in, depth 7in	

APPLICATION

A very wide range of positive voltage output up to 325V is available, stability being maintained for large changes in load current. The −150V auxiliary supply is particularly useful as a negative bias line for use with high gain d.c. amplifiers, pulse and relaxation circuits. Generally speaking the supplies available cover a sufficiently wide range of both voltage and current outputs to meet the requirements of most amateur experimenters and constructors.

As more than one item of apparatus may be required to be supplied at any one time, the various outputs are brought out to two octal sockets, situated on the front panel for ease of operation. This means that various pieces of apparatus which may be used from time to time are each terminated in an octal plug, the supply leads being connected to the appropriate pins.

Any of these pieces of apparatus can be plugged into either socket without the fear of the wrong supply being applied to the wrong piece of equipment. This allows a great deal of versatility of equipment to be achieved once the initial change over to octal plugs is made.

Octal plugs and sockets were chosen in preference to the numerous other types of multi-pin plugs and sockets available because they are cheap, easily obtainable, and simple to wire in.

Besides the octal socket outlets, each supply is also brought out to two groups of wander plug sockets or screw terminals, these also being situated on the front panel.

All controls, fuses, output points, and meters are brought out on the front panel for ease of operation and metering. As all components and valves are amply rated, the power unit should give trouble free and reliable service over a long period of time.

POSITIVE SUPPLY CIRCUIT

The complete circuit diagram of the Valstab is shown in Fig. 1.

The transformer secondary 350V–0–350V output is applied to the full wave rectifying circuit D3 and D4. The network C1, C2, R3, and R4 prevents mains transients being fed via the transformer to the diodes and stabilising circuits, as these transients, although of very short duration, can have quite a high peak voltage. This could be harmful to the rest of the circuit, particularly the rectifiers.

The full wave positive rectified output is then fed to a conventional pi smoothing filter, L1, C3 and C5. The reservoir capacitor C3 is kept to a reasonably low value to prevent excessive surge current passing through the diodes.

The output from the smoothing circuit is fed into the series regulator V1. This being a double triode, the two halves are connected in parallel. The type of valve used (6080) was specifically designed as a series regulator, having a very low r_a, high g_m and high dissipation value. The stopper resistors R5, R6, R11, and R12 prevent parasitic oscillation, while R11 and R12 also limit grid current.

The action of V1 is controlled by the high gain pentode amplifier V3. The actual circuit shown in Fig. 1 is a little unconventional in that the voltage reference tube, which normally holds the cathode of V3 above earth, and acts as the circuit reference point, has in this case been dispensed with.

The cathode is held constant at the earth or common rail level and the −150V stabilised line is utilised as a constant reference point. This was found necessary in order to allow the very wide voltage output range to be achieved. With the conventional type of circuit,

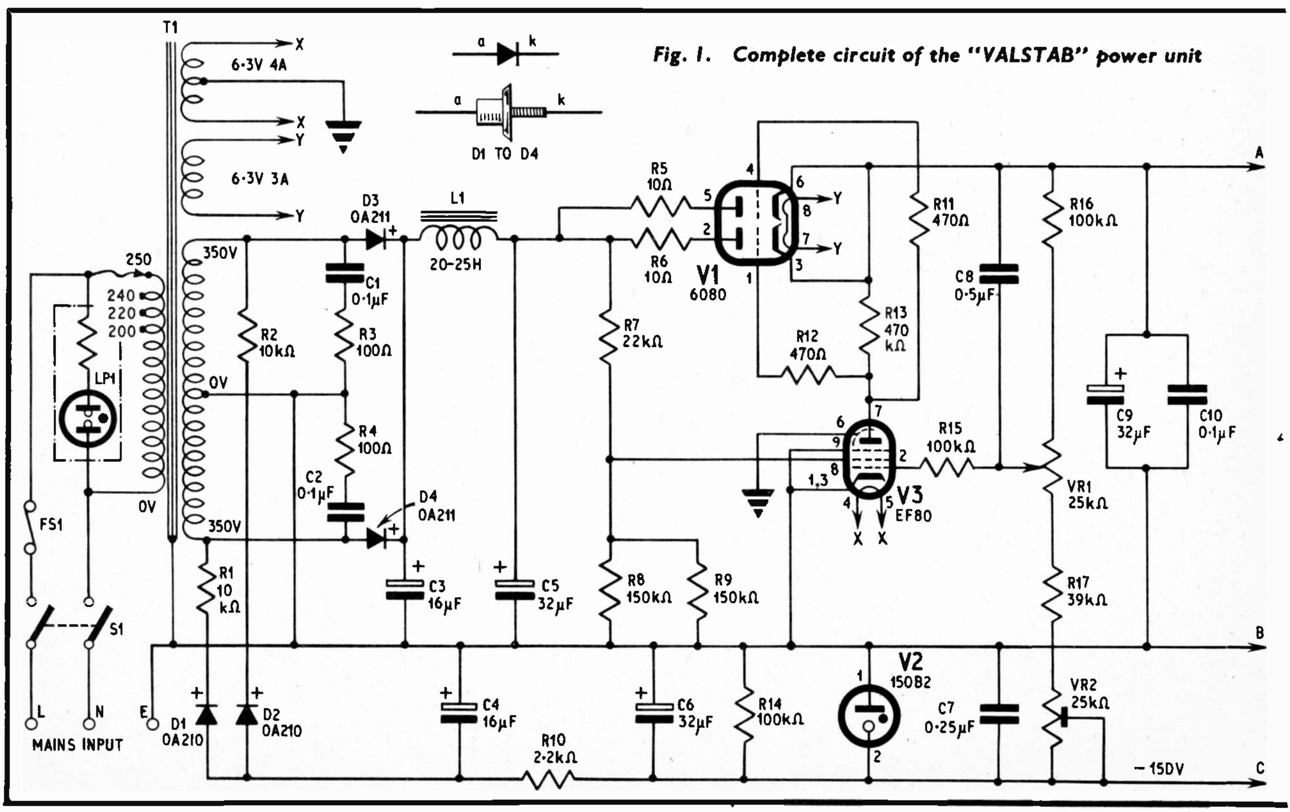


Fig. 1. Complete circuit of the "VALSTAB" power unit

only a relatively narrow output swing is possible, due to the cathode of V3 being held at such a high potential above earth, so limiting the amount of anode swing on V3.

With the circuit shown, however, the full swing of both V3 and V1 valve characteristics are used, allowing a much wider range of output to be obtained on the one control.

The screen grid of V3 is fed from the unstabilised side of the supply via the potential divider R7, R8, and R9, the anode load being R13. The anode is d.c. coupled to the grids of the series regulator V1. The grid of amplifier V3 is d.c. coupled to the h.t. output line via the divider chain R16, VR1, R17, and VR2.

The bottom end of the chain is held constant at −150V with respect to earth, the h.t. output level being adjusted between the limits quoted by means of VR1. VR2 is a preset control which is first set up to ensure that VR1 only swings across the range quoted, and does not let V3 pass beyond its cut-off and saturation limits and so lose stability.

Grid limiting is provided by R15 and decoupling by C8, this also helping to reduce overall ripple. Final smoothing on the regulated output is provided by C9 and helps to achieve the low ripple values quoted.

As the effective capacitance of electrolytic capacitors decreases rapidly at higher frequencies, in order to keep the output impedance of the unit low at the higher frequencies, C9 is shunted by a lower value capacitor C10. Both h.t. voltage and current are metered by M1 and M2 respectively.

NEGATIVE STABILISATION

The subsidiary −150V line is stabilised by means of a gas filled regulator tube V2. This supply is completely independent of the main h.t. supply. The negative line is developed from the secondary of the mains transformer via the dropping resistors R1 and R2, which feed diodes D1 and D2. These give a full wave output which is then applied to the smoothing circuit C4, C6 and R10. R10 also provides the necessary voltage drop to the stabiliser V2.

The negative output line is taken from the cathode of V2, R14 providing a small current bleed across this circuit. Capacitor C7 shunts V2 and prevents any tendency towards self oscillation, these type of valves often being prone to this form of trouble.

STABILISING EFFECT

The action of the stabilising circuit may be described as follows: assume that with the circuit working normally a sudden increase in load current occurs. The h.t. voltage will fall, the voltage drop across the divider network R16, VR1, R17, and VR2, will also fall and thus the grid of V3 will go more negative with respect to the cathode.

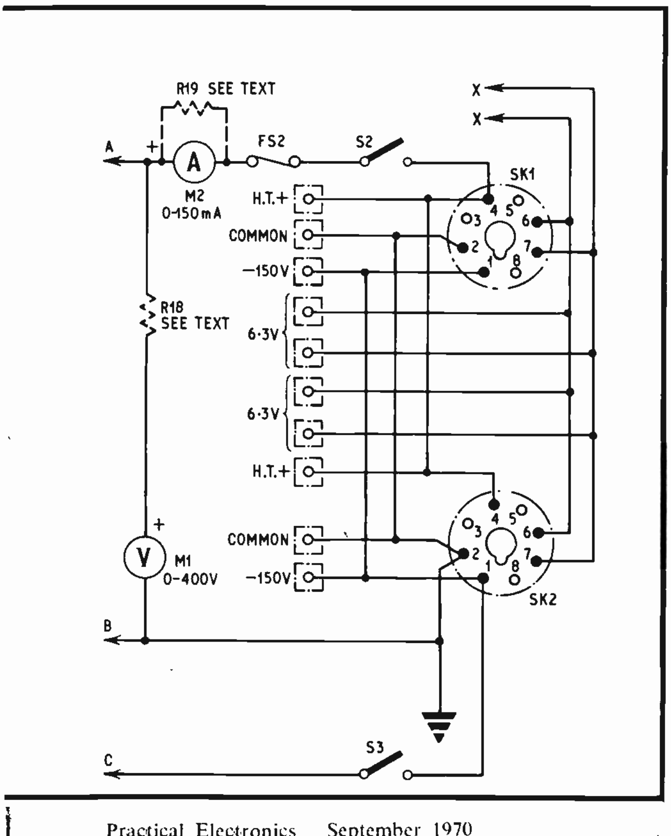
Both the cathode and the bottom of the divider chain always remain constant with respect to one another. The fall in grid voltage will tend to cut V3 off, reducing anode current and thus the voltage drop across the anode load R13. The anode will therefore go more positive and, being d.c. coupled to the grids of the series regulator V1, will drive this valve harder on. This allows more current to flow through V1 from the source to compensate for the initial increase in load current.

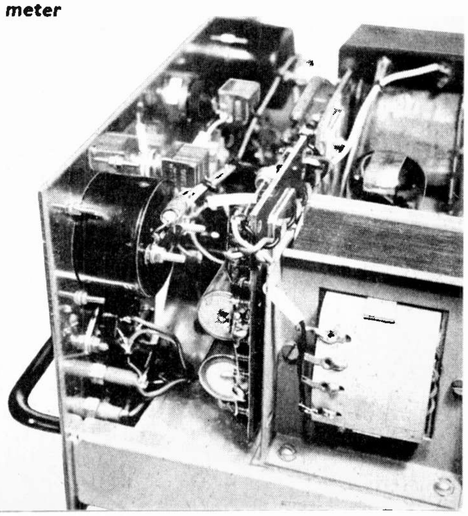
The action is almost instantaneous. The function of the circuit may therefore be shown to form a complete negative feedback loop. In effect, V3 provides amplified negative feedback between the input and output circuits of V1, this keeping the output voltage constant.

Due to the very high gain of the overall circuit, very small changes in h.t. level can be detected, these small changes being amplified and applied to V1 which then compensates for any change in the detected output. This gives a high stabilisation factor.

For a decrease in load current the reverse action occurs, while changes in source voltage due to mains fluctuation are compensated for in a similar manner. This type of circuit allows very low ripple values to be obtained as the amplifier "sees" ripple as a change in mean h.t. value and compensates accordingly.

As VR1 may be considered to control the standing value of V3 grid voltage, altering this control has a similar effect to that described, lowering or raising the grid voltage with respect to the reference level. By this





Side view of the top of the finished chassis. Note the meter shunt mounted on M2 terminals

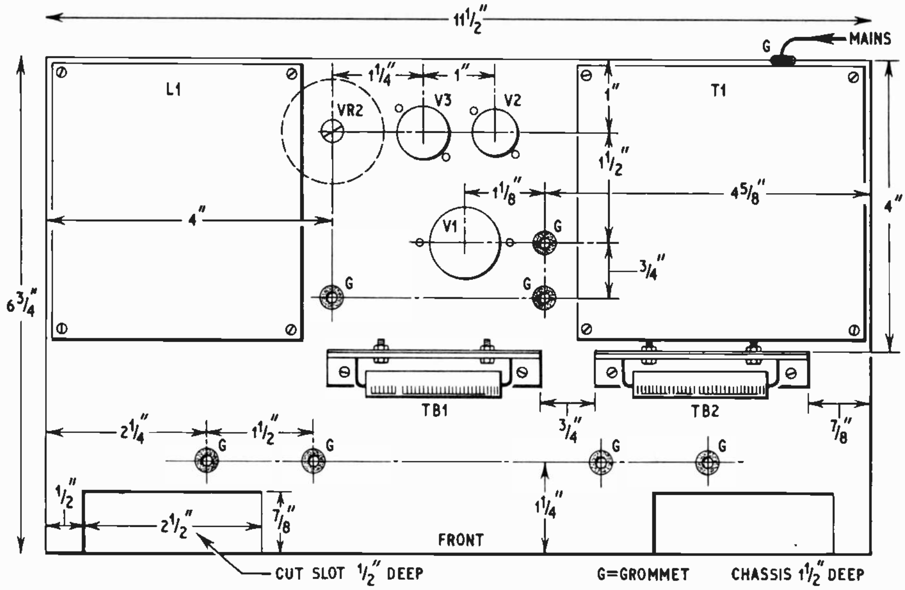


Fig. 2 (above). *Drilling details of the top of the chassis with guide to positions of T1 and L1. Notice the cut outs at the front*

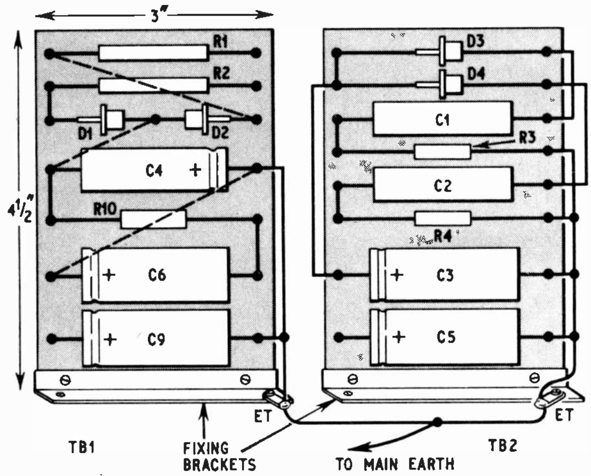
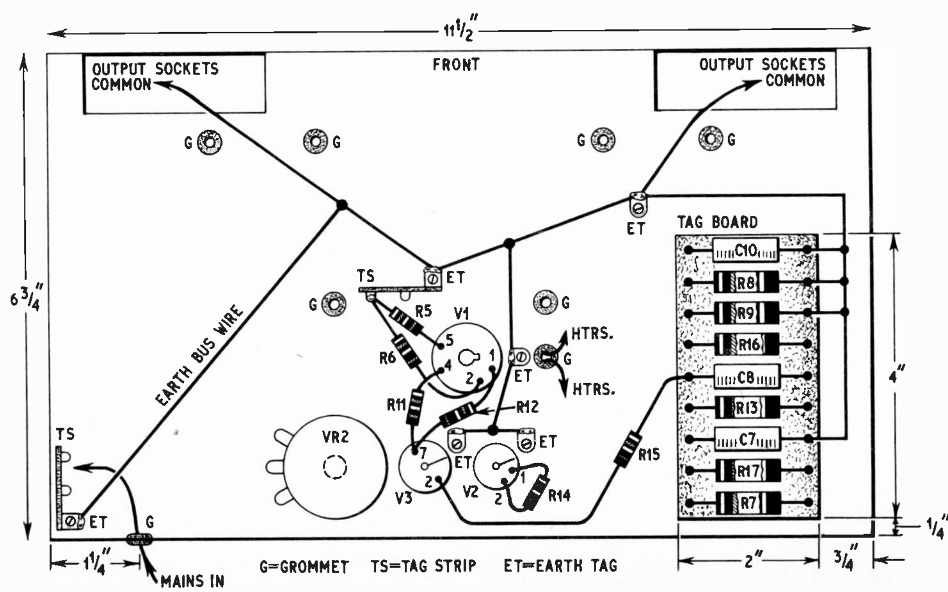


Fig. 3 (left). *Layout and wiring of the two component boards*

Fig. 4 (below). *Underside view of the chassis showing some of the wiring*



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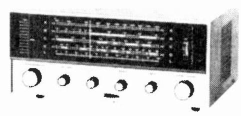

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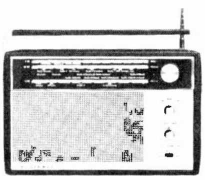

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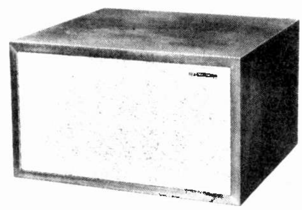

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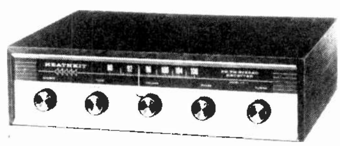

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COMPONENTS . . .

Resistors

R1 10kΩ 5W*	R8 150kΩ 1W	R15 100kΩ ½W
R2 10kΩ 5W*	R9 150kΩ 1W	R16 100kΩ 1W
R3 100Ω ½W	R10 2·2kΩ 5W*	R17 39kΩ 1W
R4 100Ω ½W	R11 470Ω ½W	R18 See text
R5 10Ω 1W	R12 470Ω ½W	R19 See text
R6 10Ω 1W	R13 470kΩ ½W	
R7 22kΩ 1W	R14 100kΩ ½W	*wirewound

All 10% carbon except were stated

Potentiometers
VR1 25kΩ linear wirewound
VR2 25kΩ linear wirewound preset

Capacitors
C1 0·1μF paper 1,000V
C2 0·1μF paper 1,000V
C3 16μF elect. 500V
C4 16μF elect. 250V
C5 32μF elect. 500V
C6 32μF elect. 250V
C7 0·25μF paper 250V
C8 0·5μF paper 500V
C9 32μF elect. 500V
C10 0·1μF paper 500V

Transformer
T1 Any mains transformer with the following *minimum* ratings:
Primary: 0–200, 220, 240V
Secondary 1: 350–0–350V at 120mA
Secondary 2: 6·3V 3A (for V1)
Secondary 3: 6·3V 3A centre tapped (or as required for external use)

Inductor
L1 20H 150mA smoothing choke

Valves
V1 6080 V2 150B2 V3 EF80

Diodes
D1, D2 OA210 (2 off)
D3, D4 OA211 (2 off)

Meters
M1 0–400 or 500V f.s.d. (see text)
M2 0–150mA f.s.d. (see text)

Switches
S1 Double-pole, on-off toggle switch
S2 Single-pole, on-off toggle switch
S3 Single-pole, on-off toggle switch

Fuses and fuseholders
FS1 1A
FS2 250mA

Miscellaneous
LP1 Mains neon indicator with current limit resistor
Cabinet 12in × 7in × 7in aluminium case type W, fully louvred (H. L. Smith & Co. Ltd., 287–289 Edgware Road, London, W.2)
Chassis 11½in × 6¾in × 1½in to suit case
Front Panel 12in × 7in to fit case
Valveholders: International octal (3 off); B9A (1 off); B7G (1 off)
Plugs: International octal (2 off), wander plugs and sockets (10 off)
Knob, large pointer type
Component tag boards (3 off), tag strips
Grommets, 18 s.w.g. tinned copper wire and sleeving
Nuts and bolts, 2B.A., 4B.A., 6B.A.
Chrome handle, 9in. Lettering or transfers

means the output level of the h.t. line can be set to any value in the range quoted; the circuit then automatically stabilises the output at this level.

CHASSIS CONSTRUCTION

The construction of the unit should offer few difficulties, the circuit not being at all critical as regards layout. While the method of construction adopted by the author will be described, any other form of construction may be used to fit in with individual requirements or existing apparatus.

The above chassis layout together with relevant dimensions is shown in Fig. 2. As the dimensions of various manufacturers' transformers and chokes vary slightly, the chassis should be marked out first with the particular transformer and choke to be used. The remainder of the above chassis components, valves and component boards, being located as necessary.

Before mounting any components the two slots should be cut out of the chassis front (shaded portions). These give clearance to the output sockets which could otherwise touch the top of the chassis.

WIRING

The electrolytic smoothing capacitors, diodes, and dropping resistors are all arranged on two tag boards, these being wired up first and then mounted vertically on the chassis by means of small angle brackets. This form of construction allows a great saving in space. If the negative terminals of C4 and C6 are connected to the cans, these must be isolated from the chassis.

If the components are mounted and wired first, fly leads being left for connections coming away from the boards, they are simply mounted on the chassis after the larger components have been fixed in place. The layouts of the two boards are shown in Fig. 3. It will be noted that components which are likely to dissipate most heat (i.e. dropper resistors and diodes) are mounted at the top of the boards.

The under chassis layout, again with dimensions, is shown in Fig. 4. As there is ample space under the chassis, no particular care has to be taken as regards wiring layout, etc. Grommets, earth tags and tag strips should be used where shown.

It will be noticed that an 18 s.w.g. tinned copper wire earth "bus-bar" is used, this being run from the main earth input around the chassis, all earth and common connections being taken to this line. While not essential, this form of earthing is always good policy to adopt in mains power units.

Underside view of part of the chassis showing the wiring of the valveholders

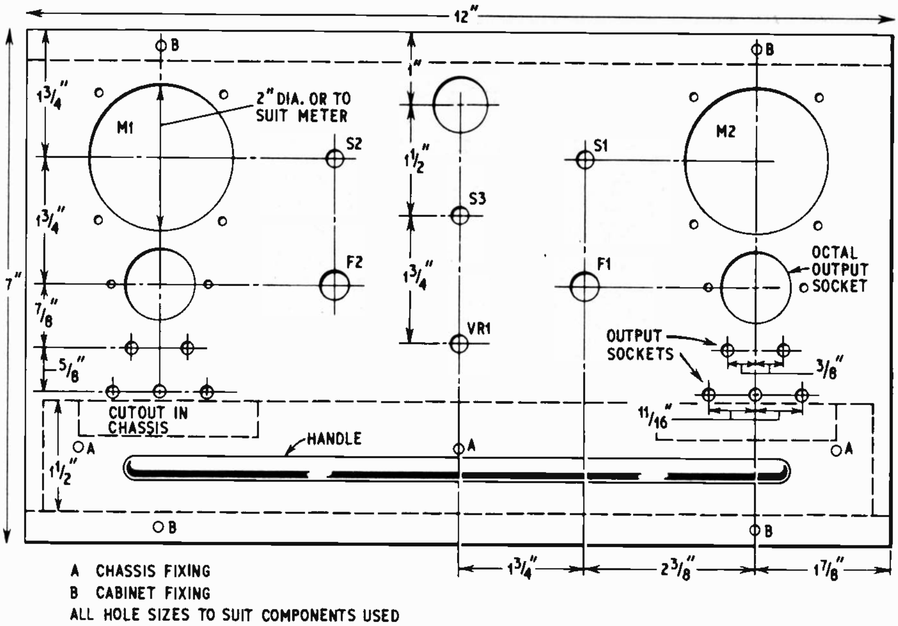


Fig. 5. Drilling details of the front panel with the chassis position shown dotted. The fixing holes for the meters may differ according to the instruments used

FRONT PANEL

The front panel layout together with necessary dimensions is shown in Fig. 5.

As the type and size of meters used may vary, the meter holes should be cut to suit the particular meters which are going to be used (see later). The remainder of the front panel components should be mounted as shown, much of the front panel wiring being done before the panel is fitted to the chassis.

With the particular type of cabinet specified, a lip of approximately ⅜in will be found all round the inside when the front panel is removed. The front panel is fitted into the upper and lower lips by means of self tapping screws.

To allow the chassis to fit into the cabinet, both of the vertical or side lips should be cut off, these serving no particular purpose. As the cabinet is made from aluminium, they can be simply removed using a small hacksaw blade or Abrafile.

When mounting the front panel to the chassis, allow the bottom edge of the front panel to protrude approximately ⅜in below the bottom edge of the chassis. This compensates for the bottom lip of the cabinet as mentioned above.

If the fixing holes are drilled in the front panel first, they can be marked off on the chassis front with the chassis inside the cabinet, the front panel being loosely held in place by two of its four fixing screws. A hole must also be cut in the rear of the cabinet to line up with the grommet for the mains supply lead outlet.

Front panel lettering can be made using either Dymo tape or transfers.

With all the construction completed, final extras in the form of rubber feet and a carrying handle may be fitted if required. Four ⅜in rubber feet mounted on the bottom of the cabinet prevent benches or tables being scratched, while a 9in chrome handle mounted on the bottom of the front panel (as illustrated) or on top of the cabinet, not only improves the appearance of the unit, but also makes the unit portable.

METER CALIBRATION

Before going on to the testing of the unit, a mention may be made on the types of meters used and their calibration. The meters may be any 1½in to 2½in moving coil type instruments, having either round or square faces.

While new meters may be obtained to cover the ranges quoted, these can be rather expensive. However, any moving coil instruments having a basic movement of 1–5mA may be used, these being suitably calibrated using an external shunt for the milliammeter and an external series resistor for the voltmeter.

The meters are calibrated using a scale to suit the particular scale divisions marked on the meter face, new numerals being marked by hand on the scale if necessary.

The shunt resistance R19 is wound using a suitable length of fine resistance wire on a small diameter bobbin or former, normally only a few inches of wire being required. The series voltmeter resistance R18 should be a 5 per cent high stability type.

While calibrating one's own meters can involve extra work, a great saving in cost is made as such instruments can generally be picked up on the surplus market at a very modest price. The accuracy of the calibrated meters can be checked against a normal multirange meter, this being sufficiently accurate for this type of calibration.

SHUNT AND SERIES RESISTORS

Two examples for calculating shunt (R19) and series resistors (R18) are shown below, the equations holding good for all types of moving coil meter. These resistors will only be needed if low rating meters are used.

Assume a 1mA movement, scaled 0–1 f.s.d. in 10 divisions, having a resistance of 50 ohms (meter resistance is normally marked or can be measured), is to be used for the voltmeter.

TEST AND SERVICING PROCEDURE

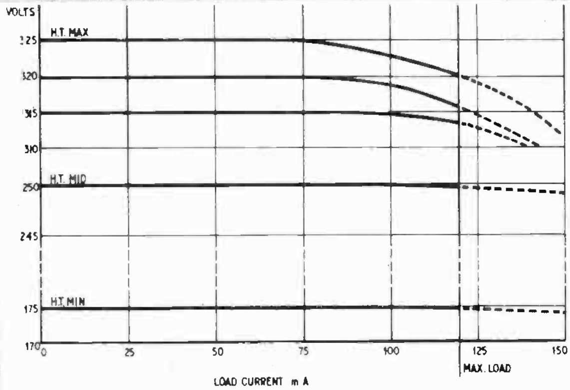


Fig. 6. Regulation characteristics of the Valstab unit

Table 1: VOLTAGE CHECK

All voltages shown were measured with respect to chassis (common line) on a 20kΩ per volt multi-meter under no load conditions. Mains input 246V on 250V tapping. Output 1 voltage set at 250V

V1 anodes (pins 2 and 5)	446V
V1 grids (pins 1 and 4)	118V
V3 anode (pin 7)	118V
V3 screen grid (pin 8)	345V
Wiper of VR1	−8V
Junction of VR1, R16	+23V
Junction of VR1, R17	−32V
Junction of VR2, R17	−120V
V2 cathode	−150V
C4 negative terminal	−157V

TEST 1. H.T. POSITIVE OUTPUT NOT STABILISING OR INCORRECT

(a) Check voltage across C5 or voltage from V1 anode to chassis. If incorrect proceed to Test 2 "No h.t. output". If correct proceed as follows.

(b) Check negative supply across C7. If incorrect proceed to Test 3 "No negative supply output". If correct proceed as follows.

(c) Check that VR2 and VR1 are set up and O.K. Check R16, R17 are correct value. If O.K. proceed to (d).

(d) Check V3 is operating correctly. Check values of R7, R8, R9, R15, R13. Check for short circuit in C8. If O.K. proceed to (e).

(e) Check V1 is operating correctly. Check values of R5, R6, R11, R12.

TEST 2. NO H.T. POSITIVE OUTPUT

Check voltage across C5 or voltage from V1 anode to chassis. If incorrect proceed as in (a) below. If correct proceed as in (b) below

(a) Incorrect voltage across C5
Check voltage across C3
Check voltage on T1 secondary 350–0–350
Check FS1, S1, and mains supply
Check for short circuit across C3, C4, C5, C6, C1, C2
Check for open circuit across D3, D4, L1

(b) Correct voltage across C5
Check V1 is operating
Check for open circuit across R5, R6
Check for short circuit across M1, C9, C10
Check for open circuit across M2, FS2, S2

TEST 3. NO H.T. NEGATIVE OUTPUT

Check voltage across C4. If incorrect proceed as in (a) below. If correct proceed as in (b) below

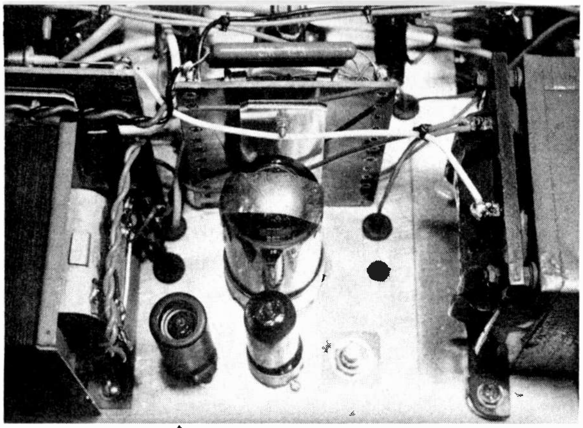
(a) Incorrect voltage across C4
Check voltage on T1 secondary 350–0–350
Check for open circuit across R1, R2, D1, D2, FS1, S1
Check for short circuit across C4

(b) Correct voltage across C4
Check for open circuit across R10, S3
Check for short circuit across C6, R14, V2, C7

Check potential divider R16, VR1, R17, VR2

TEST 4. EXCESSIVE HUM OR NOISE ON H.T.+

Check for faulty choke L1, capacitors C3, C5, C9, C10, C1, C2
Check V1 and V3 for heater-cathode short when warm
Check D3, D4, D1, D2 for correct operation
Check for leakage between transformer windings and chassis



View of the valves between T1 and L1. Note the twisted leads from the transformer

Rescale the dial 0–400 volts f.s.d., each division now representing 40 volts.

$$\text{Series Resistance } R_{18} = \left(\frac{V}{I_{M1}}\right) - R_{M1}$$

Where

V = full scale voltage required (400)

R_{M1} = meter resistance (50)

I_{M1} = basic meter movement in amperes (0·001)

$$R_{18} = \left(\frac{400}{0{\cdot}001}\right) - 50 = 399{,}950 \text{ ohms,}$$

say 400 kilohms.

Assume a 2mA movement, scaled 0–2 f.s.d. in 10 divisions, having a resistance of 30 ohms, is to be used for the milliammeter.

Rescale the dial 0–150mA f.s.d., each division now representing 15mA.

$$\text{Shunt Resistance } R_{19} = \frac{R_{M2}}{n-1}$$

where

R_{M2} = meter resistance (30)

n = ratio by which meter range is to be extended (150 to 2 = 75 to 1).

$$R_{19} = \frac{30}{75-1} = \frac{30}{74} = 0{\cdot}405 \text{ ohms, say } 0{\cdot}4 \text{ ohms.}$$

SETTING UP

The testing of the power unit is quite straightforward, although when testing and setting up, high lethal voltages are present, great care should therefore be taken when working with the unit "live".

Set VR2 to approximately mid-position, switch on and allow the unit to warm up for ten or fifteen minutes. Next check the voltage swing available on VR1, either M1 or an external testmeter being used. Set VR1 to give maximum output (extreme clockwise direction) and adjust VR2 until output voltage falls to 325 volts. VR1 should then give a voltage output swing of approximately 175–325 volts.

A dummy load which will draw 50–100mA should next be connected across the h.t. sockets (a 3 to 6 kilohm 5 or 10 watt resistor being suitable), S2 being switched off. With VR1 set to give minimum output (175 volts), close S2 and ensure that there is no discernible change in the voltage output level.

This should be repeated at mid and maximum outputs (250 and 325 volts). Do not keep S2 closed longer than is necessary so as not to overheat the dummy load resistor.

Should stabilisation not be maintained at one or other of the extreme settings of VR1, a very slight adjustment on VR2 may be made to pull that point into the stabilised zone of the circuit characteristics. The tests are repeated until voltage stabilisation is maintained over the full range of VR1.

Check also that the load current drawn by the dummy load is correctly metered by M2. With the above tests satisfactorily completed, switch off S2 and remove the dummy load from the output sockets.

It now only remains to check the −150V supply and 6·3V heater supplies. Connect a multimeter across the −150V output sockets (remembering that the positive lead of the voltmeter will go to the earth socket) and close S3. The voltage should read 150 ± 2 volts.

Switch off and temporarily connect a 15–20 kilohm 1 watt dummy load resistor across the same output sockets, leaving the meter still in circuit. When S3 is closed there should be negligible change in output voltage.

VOLTAGE CHECKS

Using a suitable a.c. voltage range on the testmeter, check the voltage between earth and each heater output socket; these should read approximately 3·2 volts per side and 6·4 volts across the heater sockets themselves.

Finally, with S2 and S3 closed, check that the correct voltage is present on the correct pin of the two output octal sockets and also all the small sockets. The unit can now be fixed in the cabinet and is ready for use.

In case of difficulty or for future servicing a voltage table is shown in Table 1. The readings listed were taken on a 20 kilohm/volt instrument with VR1 set to give 250 volts out, no external loads being connected. The figures given will of course vary slightly between units due to normal component and valve tolerances. If the unit is correctly wired, however, using the components specified, no difficulty should be encountered with the setting up and testing.

SERVICING AND FAULT FINDING

When working through the fault finding chart, check not only the circuit voltage at individual check points mentioned, but also check circuit for dry joints and incorrect wiring. Components should be checked for both open and short circuit, preferably under normal working conditions. Follow the checking chart carefully for each stage. ★

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1N256	10/-	AA129	5/-	BD123	22/6	GET872B	6/-	OC26	6/-
1N645	5/-	AAZ12	3/6	BD124	12/-	GET873	3/-	OC28	12/6
1N725A	4/-	AAZ13	3/-	BDY11	5/6	GET875	6/-	OC29	14/6
1N4007	4/6	AC107	5/6	BF115	5/6	GET880	8/9	OC30	8/-
1S021	4/-	AC126	4/-	BF117	10/-	GET882	6/-	OC35	6/3
1S113	3/-	AC127	5/-	BF167	6/6	GET885	10/-	OC36	8/6
1S130	2/6	AC128	4/6	BF173	7/3	GEX35	4/6	OC38	10/3
1S131	2/6	AC129	7/6	BF181	6/-	GEX44	1/6	OC41	4/6
2G220	12/6	AC187	11/-	BF184	7/6	GEX941	4/-	OC42	5/-
2G240	3/6	AC188	11/-	BF185	6/-	GJ3M	7/6	OC43	9/-
2G301	3/6	ACY17	4/6	BF194	6/3	GJ4M	7/6	OC44	4/-
2G306	8/-	ACY18	4/-	BF195	5/6	GJ5M	7/6	OC45	3/3
2G371B	4/-	ACY19	5/-	BF196	5/6	HG1005	10/-	OC46	3/-
2G381A	4/6	ACY20	5/-	BF197	5/6	MAT100	6/-	OC58	12/6
2G403	10/-	ACY21	4/6	BFX12	5/6	MAT101	8/3	OC59	17/-
2G414	6/-	ACY22	4/-	BFX13	5/6	MAT120	5/9	OC70	3/6
2G417	6/-	ACY27	5/-	BFX29	12/-	MAT121	6/-	OC71	3/-
2N214	8/6	ACY28	4/-	BFX30	8/6	MJ420	22/-	OC72	4/-
2N404	6/-	ACY39	12/6	BFX35	19/6	MJ421	22/-	OC73	7/3
2N247	9/6	ACY40	4/-	BFX48	8/3	NKT128	6/-	OC74	4/6
2N697	4/-	ACY41	5/-	BFX44	8/3	NKT129	6/-	OC75	4/6
2N698	4/6	ACY44	7/6	BFX68	13/-	NKT135	5/3	OC76	3/-
2N706	3/-	AD140	8/-	BFX68A	13/6	NKT210	6/-	OC77	8/-
2N706A	3/6	AD149	12/-	BFX85	10/-	NKT211	6/6	OC78	3/-
2N708	4/-	AD150	15/-	BFX86	9/6	NKT212	5/4	OC78D	3/3
2N709	12/6	AD161	7/6	BFX87	9/6	NKT213	6/4	OC79	5/-
2N711	7/6	AD162	7/-	BFX88	5/-	NKT214	4/4	OC81	4/-
2N987	10/6	AF106	10/6	BFY20	12/-	NKT215	4/6	OC81D	3/-
2N1090	6/6	AF114	5/-	BFY21	8/6	NKT216	6/4	OC81DM	3/-
2N1091	6/6	AF115	5/9	BFY24	9/-	NKT217	8/4	OC81M	5/-
2N1131	8/6	AF116	4/6	BFY41	9/6	NKT218	22/6	OC82	3/-
2N1132	7/6	AF117	4/6	BFY43	12/6	NKT219	6/6	OC82D	3/-
2N1302	4/-	AF118	12/-	BFY50	5/-	NKT221	5/6	OC83	4/6
2N1303	4/3	AF119	4/-	BFY51	6/-	NKT223	6/6	OC84	4/9
2N1304	4/9	AF124	5/-	BFY53	5/6	NKT224	4/9	OC114	7/6
2N1305	5/-	AF125	5/-	BFY77	12/-	NKT225	4/9	OC122	12/6
2N1306	5/-	AF126	5/-	BFY90	12/6	NKT227	5/6	OC123	4/4
2N1307	5/-	AF127	4/6	BSX27	10/-	NKT229	5/9	OC139	7/6
2N1308	6/-	AF139	7/6	BSX60	18/6	NKT237	7/9	OC140	6/6
2N1309	6/-	AF178	12/6	BSX61	12/-	NKT238	5/9	OC141	12/3
2N1420	7/3	AF179	11/-	BSY26	3/6	NKT240	6/6	OC169	6/-
2N1507	5/6	AF180	12/-	BSY27	4/-	NKT241	6/6	OC170	5/6
2N1526	7/6	AF181	8/-	BSY51	10/-	NKT251	4/9	OC171	6/-
2N1909	45/-	AF186	11/-	BSY78	9/3	NKT261	4/6	OC172	7/-
2N2147	16/6	AFY19	22/6	BSY79	9/3	NKT274	4/9	OC200	5/6
2N2148	12/-	AFZ11	6/-	BSY82	10/-	NKT275	5/-	OC201	8/6
2N2160	14/-	AFZ12	6/6	BSY83	11/-	NKT277	4/9	OC202	8/6
2N2193	5/6	ASY26	5/6	BSY84	12/-	NKT403	9/9	OC203	6/-
2N2287	20/6	ASY27	7/6	BSY95A	3/6	NKT404	12/6	OC204	5/6
2N2297	6/-	ASY28	5/3	BY100	4/6	NKT678	6/-	OC205	9/-
2N2369A	5/-	ASY29	5/-	BY213	5/-	NKT713	7/6	OC206	14/6
2N2410	10/6	ASY36	5/6	BYZ11	5/-	NKT773	6/-	OC207	7/6
2N2411	6/6	ASY50	5/-	BYZ11N	7/6	NKT777	7/6	OC450	6/-
2N2412	6/6	ASY51	7/6	BYZ12	6/-	NKT80113	20/-	OC470	6/-
2N2483	5/6	ASY53	4/9	BYZ14	27/6	O78B	7/6	OCP71	20/-
2N2484	7/6	ASY54	4/9	BYZ15	35/-	OA5	3/6	PS144	4/-
2N2646	11/6	ASY55	6/-	BYZ16	17/6	OA10	3/-	S19T	6/-
2N2696	6/3	ASY62	5/-	C111	13/-	OA47	2/-	SAC40	5/-
2N2865	12/-	ASY86	6/6	C20A	12/6	OA70	1/6	SFT308	7/6
2N2904	7/6	ASZ17	13/6	CR81/05	5/-	OA71	2/-	SJO52F	7/6
2N2904A	8/-	ASZ20	7/3	CS4B	37/6	OA73	2/-	ST722A	5/-
2N2906	8/-	ASZ21	7/6	CS10B	67/6	OA74	4/-	ST7231	12/6
2N2907	7/6	ASZ23	19/6	CV101	5/-	OA79	1/9	SX68	4/-
2N2926	3/-	AUY10	19/6	CV253	20/-	OA81	1/6	SX68UH	4/6
2N2924	4/6	BC107	3/6	CV2154	32/6	OA85	1/6	SX631	7/6
2N3014	7/6	BC108	3/6	CV2155	32/6	OA86	4/-	SX631UC	10/-
2N3054	11/-	BC109	3/6	CV2279	10/6	OA90	1/6	SX680T	4/-
2N3055	14/6	BC113	6/3	CV2923	4/6	OA91	1/6	SX634WK	8/-
2N3705	4/-	BC115	6/6	CV4073	3/-	OA95	1/6	SX753	15/-
2N3706	4/6	BC116	11/6	CV4074	3/6	OA200	2/-	SZ33C	12/-
2N3707	4/-	BC118	6/6	CV7108	80/-	OA202	2/-	V15/10P	15/-
2N3708	4/-	BC121	4/-	CV7109	75/-	OA210	6/6	V15/30P	15/-
2N3709	4/-	BC122	4/-	CV7183	30/-	OA211	10/-	V30/201P	9/6
2N3710	4/-	BC125	13/6	CV7312	10/-	OAZ200	11/-	XA122	6/-
2N3819	8/-	BC126	13/-	CV7324	10/-	OAZ201	10/-	XA124	4/-
2N3820	20/-	BC140	11/-	CV7341	6/-	OAZ202	7/6	XA142	5/-
2N3823	17/-	BC145	15/-	CV7347	4/-	OAZ203	8/-	XA143	5/-
2N3900	10/6	BC147	4/9	CV7361	12/6	OAZ204	8/-	XA152	5/-
2N3900A	11/-	BC148	4/6	D246	7/6	OAZ207	10/-	XA162	8/6
2N5027	10/6	BC149	5/-	DD006	6/6	OAZ208	6/6	XB101	8/6
2N5028	11/6	BC157	4/-	DD007	8/-	OAZ210	6/6	XB121	8/6
2N5307	7/6	BC160	12/6	DD008	7/6	OAZ222	9/6	XK505	5/-
2N5308	7/6	BCY31	6/-	GD3	6/6	OAZ224	9/6	XK518	6/-
2N5309	11/-	BCY32	7/6	GD4	7/-	OAZ241	7/6	Z2A82CR	5/-
2S005	14/-	BCY33	5/-	GD5	6/6	OAZ242	4/6	ZR24	12/6
2S013	15/-	BCY34	5/-	GD6	6/-	OAZ246	4/6	ZS32A	6/-
2S013A	16/6	BCY38	5/6	GD8	5/-	OAZ290	9/-	ZT21	6/-
2S301	12/6	BCY39	7/-	GET102	5/-	OC16	15/-	ZT43	5/-
2S304	9/-	BCY40	7/6	GET113	5/-	OC16T	16/6		
		BCY42	3/-	GET114	4/-	OC19	8/6		

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TERMS C.W.O. no C.O.D.	OPEN DAILY TO CALLERS Mon.–Sat. 9 a.m.–5.30 p.m. Closed Sat. 1.30 p.m.–2.30 p.m. Tel. 01-769 0199/1649

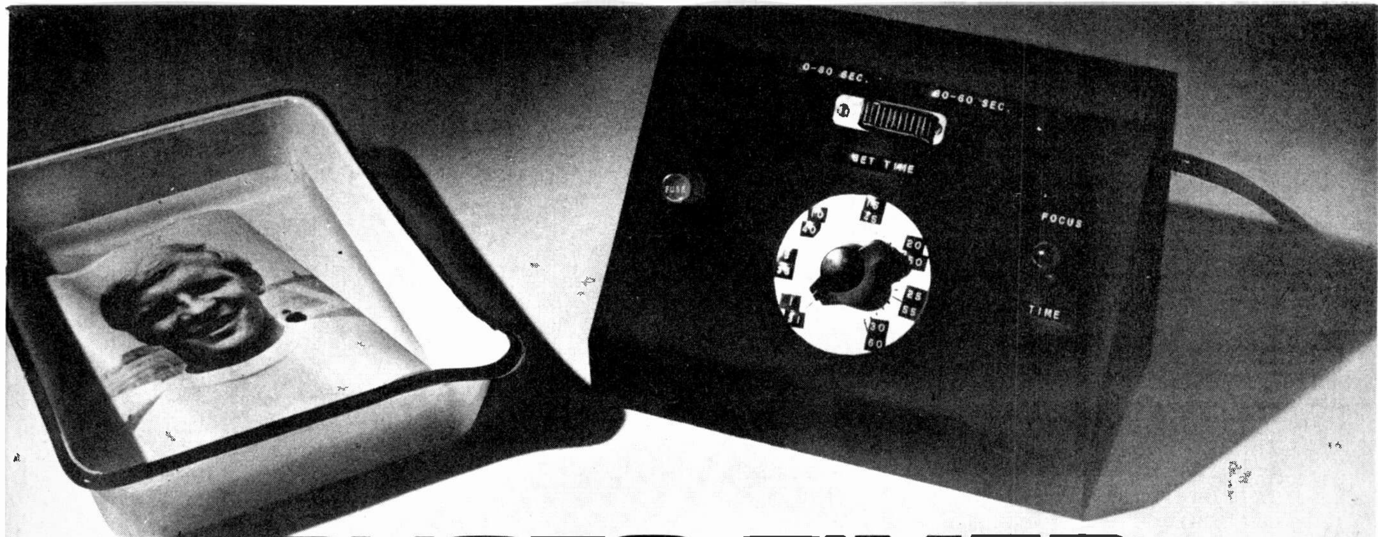


PHOTO TIMER

By B. H. BAILY

THIS timer was primarily designed for use with a 240 volt enlarger as a darkroom universal timer to give times of 1 to 60 seconds. However, in view of its high repeat accuracy—½ second in one minute—it is ideally suited to other applications where high timing accuracy is required.

CIRCUIT

The circuit (Fig. 1) uses two transistors, a 2N2926 and an OC71. A power supply of 12 volts is derived from transformer T1, the output of which is rectified by D2 and smoothed by C2. The heart of the timing circuit is a tantalum capacitor, C1, which charges through VR1 and R1: on the higher time range R2 is included in the charging path. The voltage across C1 is monitored by TR1 and TR2 which act as a comparator, comparing C1 voltage with the reference set at VR2 slider. When this reference is slightly exceeded, D1 conducts, turning on TR1 which then draws current from TR2 base; TR2 immediately conducts, operating RLA, which then locks in via its own contact RLA1. Simultaneously, C1 is shorted to earth by contact RLA2. The timer may be reset by momentary interruption of the relay coil path by operation of S2 to "time" position. Some compensation against timing errors caused by mains variation is achieved by the connection of VR2 across the 12V supply. Transistor TR1 reference voltage remains proportional to the charging potential of C1 despite small changes in supply voltage.

OPERATING SWITCH

The operating switch S2 is a G.P.O. type key switch, having a centre position, one lock position and a biased position, i.e. the switch returns to the centre position when released. This type of switch allows a "focus" facility (the lock position), which is essential when the timer is used in the darkroom. Timers without this feature have a habit of clicking off just as one gets the enlarger lens almost adjusted to the best focus position. In the "focus" position, the relay RLA is held de-energised by S2b contacts. To ensure that the relay pulls in immediately after focussing, a bias is applied to C1 via S2a. If this were not done, one would have to wait for the circuit to "time out" before the enlarger lamp went out.

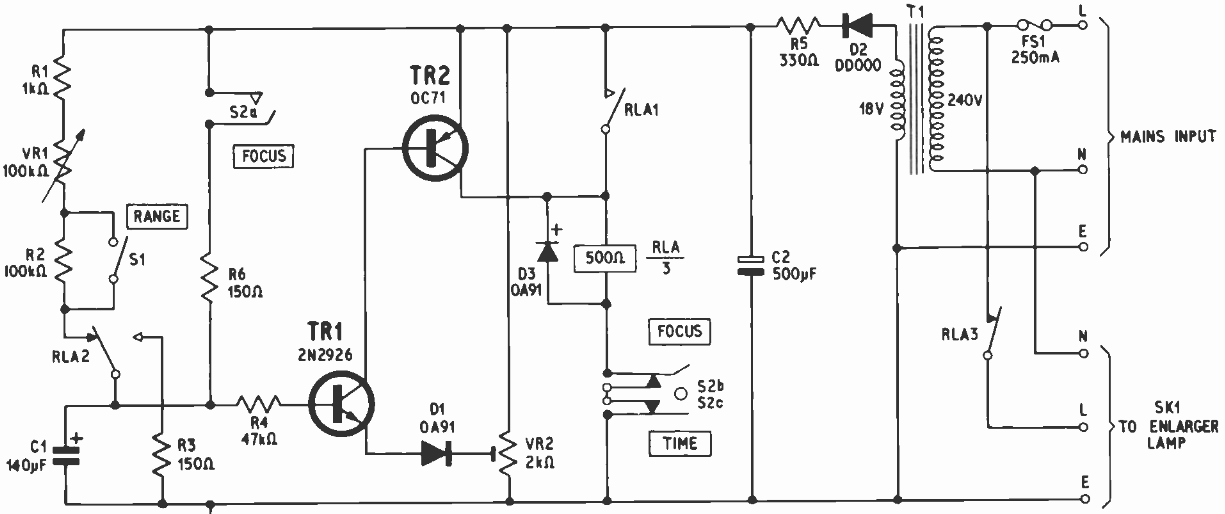


Fig. 1. Circuit diagram of the photo-timer

The relay used is a G.P.O. type, having a coil resistance of 500 ohms. Platinum contacts are used for the enlarger lamp control contacts (RLA3), to ensure adequate current switching capacity.

CONSTRUCTION

The smaller components can be wired on a single 13 way tagstrip as shown in Fig. 2, secured to the inside of the cabinet. The cabinet is a metal sloping front type measuring 8 × 5 × 5 inches, which houses all components without wastage of space, and allows good earthing to be effected. A slide switch is used for the time range switch to avoid accidental change of range.

To avoid unnecessary extra mains leads, the enlarger output is taken from the timer already "live" and needs only to be connected to the lamp via the 3 pin socket SK1. Wiring of all components inside the case is shown in Fig. 3.

CALIBRATION

Accuracy of the timer will depend to some degree on the choice of components. The time scale potentiometer should be wire-wound, of precision pattern if possible. This will ensure a consistent and linear scale calibration. To calibrate the finished timer, first mark on a circular cardboard scale as in the photograph the two extremes reached by the pointer knob. With S1 set to 1–30 seconds position, test the anti-clockwise position by operating the "time" switch. The relay should latch after about 1 second, due to the inclusion of R1. Next, turn VR1 to maximum time and again operate timer. If the relay pulls in early (before 30 seconds have elapsed), adjust VR2 towards the "live" end of its travel, or vice versa. Switch "range" to 30–60 seconds and check for accurate one minute timing. If this is incorrect, re-adjust VR2 to correct, and on the 1–30 second range find the exact point at which 30 seconds timing is achieved. Mark this point and leave VR2 set. Potentiometer VR2 has a slightly greater control over the longer periods of time than the shorter intervals, since the charging of C1 is exponential.

Finally, the intermediate timing calibrations for the five second intervals can be determined by experiment, and marked in. The one second graduations may be filled in by eye afterwards, since they obey a strictly linear law.

Note: Be sure to earth all darkroom equipment. Use three core cable and three pin plugs for the timer and enlarger, and earth all metal cabinets. ★

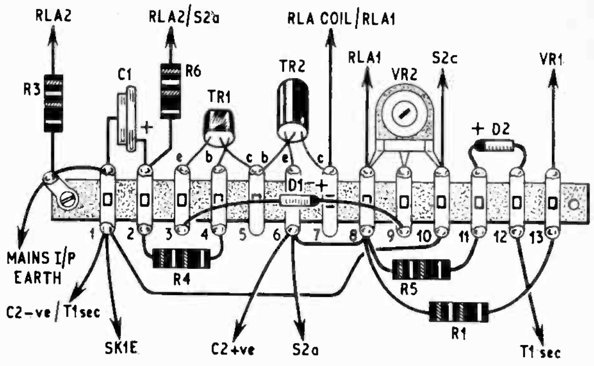


Fig. 2. Tag strip wiring diagram

COMPONENTS . . .

Resistors
- R1 1k Ω
- R2 100k Ω
- R3 150 Ω
- R4 47k Ω
- R5 330 Ω
- R6 150 Ω. All ½W, 5% carbon

Capacitors
- C1 140μF tantalum 50V
- C2 500μF elect. 25V

Semiconductors
- TR1 2N2926 (green)
- TR2 OC71
- D1, D3 OA91
- D2 DD000 or similar 50 p.i.v.

Miscellaneous
- VR1 100k Ω wirewound potentiometer
- VR2 2k Ω skeleton preset potentiometer
- S1 D.P.S.T. slide switch
- S2 Three-pole three-way G.P.O. keyswitch (see text)
- RLA G.P.O. type relay, coil resistance 500 Ω having one set of changeover contacts, one set of normally open contacts and one set of normally closed platinum contacts
- T1 Mains transformer 220/240V primary 18V secondary
- SK1 3 pin mains socket (flying lead type)
- FS1 250mA fuse and holder
- Metal case (see text)
- Knob, pointer
- 13 way tagstrip

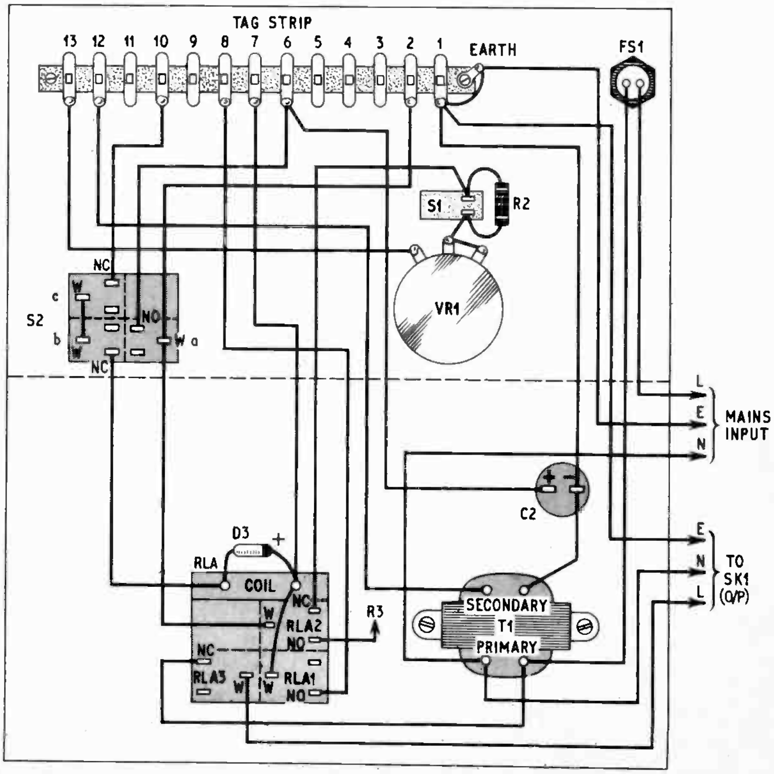


Fig. 3. Photo-timer layout and wiring diagram. Components mounted on the tag strip have been omitted for clarity

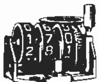
2½kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater (2½ kW), switch down for half heat 1¼kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit **£3.15.0.** Post and ins. 7/6.

FLUORESCENT CONTROL KITS

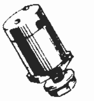
Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. **19/6.** Kit B—30-40 w. **19/6.** Kit C—80 w. **25/6.** Kit MF1 is for 6in., 9in. and 12in. miniature tubes, **19/6.** Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kit C, 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then, 3/6 on each two kits ordered.

3 DIGIT COUNTER



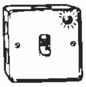
For Tape Recorder or other application, re-settable by depressing button. Price **5/6.**

TRANSDUCER



Made by Acos, reference No. I.D.1001. For measuring vibrations, etc., to be used in conjunction with "G" Meter. Regular price £5. Our price **49/6.** Brand new and unused.

ISOLATION SWITCH



20 Amp D.P. 250 volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on. **4/6. 48/-** per dozen.

LIGHT CELL

Almost zero resistant in sunlight increases to 10 K. Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ¼in. thick. Rated at 500 MW, wire ended, **8/6** with circuit.

FLEX BARGAINS

Screened 2 Core Flex. Each core 14/0076 Copper PVC insulated and coloured, the cores laid together and metal braided overall. Price **£2.15.0** per 100 yds. coil, p. & p. 6/6.

15 Amp 3 Core Non-kink Flex. 70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3 Kw. fires. Regular prices 3/6 per yd. 50 yd. coil **£4.10.0,** p. & p. 6/6.

10 Amp 3 Core Non-kink Flex. As above but cores are 28/0076 Copper. Normal price 2/6 per yd. 100 yd. coil **£7.10.0,** p. & p. 6/6.

6 Amp 2 Core Flex. As above, but 2 Cores each 23/0076 as used for Vacuum Cleaners. Electric Blankets, etc. **39/6** 100 yd. coil, p. & p. 6/6.

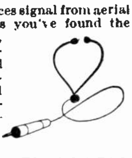
23/0076 Triple Core P.V.C. covered, circular, normally sold at 1/6 yd. Our price 100 yd. coil **£5.19.6.** Post and insurance 6/6.

6, 12 or 24 VOLT SOLENOID

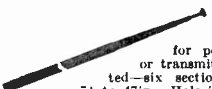
For energising Reed Switches, etc., **4/6** each, please state voltage.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kits comprises two special transistors and all parts including probe tube and crystal earpiece **29/6,** twin stethoset instead of earpiece **11/-** extra—post and ins. 2/9.

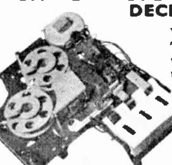


TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. **7/6** KNUCKLED MODEL FOR F.M. **9/6.**

BATTERY OPERATED TAPE DECK



With Capstan control. This unit is extremely well made and measures approx. 6 × 5 × 2in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 volts. Supplied complete with 2 spools ready to install. Record, Replayhead is the sensitive M4 type intended for use with transtor, amplifier. Price **79/6.** Post and insurance 4/6.

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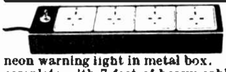
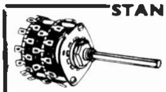


Just what you need for work bench or lab. 4 × 13 amp sockets and on/off switch with neon warning light in metal box. Takes standard 13 amp fused plugs. Supplied complete with 7 feet of heavy cable.

39/6 wired up, ready to work plus 4/6 post and insurance.

5 amp 3 pin model **35/-.** 15 amp 3 pin model **45/-.**

STANDARD WAFER SWITCHES



Standard size 1¼ wafer—silver-plated 5-amp contact, standard ¼in spindle 2in long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
2 poles	6/6	6/6	6/6	6/6	6/6	6/6	6/6	10/6	10/6
3 poles	6/6	6/6	6/6	6/6	10/6	10/6	10/6	14/6	14/6
4 poles	6/6	6/6	6/6	10/6	10/6	10/6	10/6	18/6	18/6
5 poles	6/6	6/6	10/6	10/6	14/6	14/6	14/6	22/6	22/6
6 poles	6/6	10/6	10/6	10/6	14/6	14/6	14/6	26/6	26/6
7 poles	10/6	10/6	10/6	14/6	18/6	18/6	18/6	30/6	30/6
8 poles	10/6	10/6	10/6	14/6	18/6	18/6	18/6	34/6	34/6
9 poles	10/6	10/6	14/6	14/6	22/6	22/6	22/6	38/6	38/6
10 poles	10/6	10/6	14/6	18/6	22/6	22/6	22/6	42/6	42/6
11 poles	10/6	14/6	14/6	18/6	26/6	26/6	26/6	46/6	46/6
12 poles	10/6	14/6	14/6	18/6	26/6	26/6	26/6	50/6	50/6

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FULL F1 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi lead and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Mounlded fibre—Freq. response 30-10,000 c.p.s.—Specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis Diam. 12in.—12⅜in. over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4, holes—¼in. diam. on pitch circle 11⅝in. diam.—Overall height 5¼in. A £6 speaker offered for only **£3.19.6.** 12in. 40 watt **£8.19.6.** 15in. 25 watt **£7.19.6.** 18in. 100 watt **£19.10,** plus 7/6 p. & p.

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Made by Hinchley, normal primary tapped 200/250V, 2 secondaries 275-0-275V at 90mA. 6·3V at 4 amps. Upright mounting, stock size 1¾ × 2¼in. Today's regular price 39/6. Special snip price **19/6** plus 4/6 post and ins.

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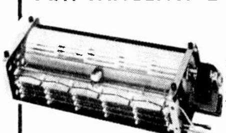
(A 15 amp Switch). Just the thing if you want to come home to a warm home without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing.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

OUT OF SEASON BARGAIN

3 kW TANGENTIAL HEATER UNIT



This heater unit is the very latest type, most efficient and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. **59/6.** 2kW Model as above except 2 kilowatts **39/6.** Postage and insurance 6/6. Don't miss this.

MOST AMAZING BARGAIN

PRINCESS AUTO CHANGER

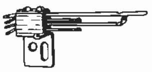
The most amazing bargain ever! A brand new Auto change record player for less than the price of a single player . . . due to a frustrated export order we are able to offer the Balfour Princess 4 Speed Autochanger—a really fine machine at about one-third of its regular price.

The Balfour has two unique features (1) A patented brush system which automatically cleans stylus after each record playing and (2) at shut off the pick-up locks itself into its recess—other features include pick-up height and stylus pressure adjustments, and motor suitable for our 230/240 or for 115V. continental mains.

Beautifully styled—this is a high class expensive instrument but you can purchase one this month for only **59/6** plus 10/6 post and packing. One point, these changers have been to France and back and the vibrations of the journey, etc., may have loosened screws or otherwise put them out of adjustment. However, with each we supply a 16 page service manual and fault finding chart which is so detailed that if necessary you could completely re-build the changer. So this is truly a bargain that you will not want to miss so order today.

NEED A SPECIAL SWITCH?

Double Leaf Contact



Very slight pressure closes both contacts, 1/3 each, **12/-** doz. Plastic push-rod suitable for operating, 1/- each, **9/-** doz.

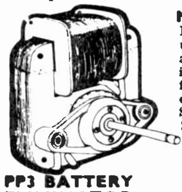
ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to control many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6,** less than the value of the clock alone—post and insurance 2/9.

DRILL CONTROLLER

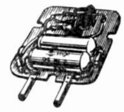
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **19/6** plus 2/6 post and insurance. Made up model also available, **37/6** plus 2/6 p. & p.

MAINS MOTOR



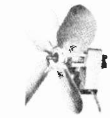
Precision made — as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **9/6.** Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

PP3 BATTERY ELIMINATOR



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

AC FAN



Small but very powerful mains motor with 5½in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **17/6.** post 4/6. Mounts from back or front with 4BA screws.

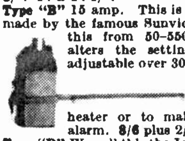
BALANCED ARMATURE UNIT

500 ohm, operates speaker or microphone, so useful in intercom or similar circuits. **6/6** ea., **£3.10.0** doz. 80 ohm model **5/6.**

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F. **9/6** plus 1/- post. Suitable box for wall mounting. 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550°F. Internal screw alters the setting to this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm. **8/6** plus 2/6 post and insurance.

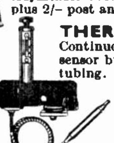


Type "D" We call this the Ice-stat as it cuts in and out at around freezing point. 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yd. **10/-**) is wound round the pipes. 7/6 P. & P. 1/-.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. **9/6,** plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price **18/-** plus 2/- post and insurance.

THERMOSTAT



Continuously variable 30°-90°C. Has sensor bulb connected by 33in. of flexible tubing. On operation 15 amp 250 volt switch is opened and in addition a plunger moves through approx. ⅛in. This could be used to open valve on ventilator, etc. **19/6** plus 4/6 p. and ins.

230 VOLT SOLENOID

⅜in. stroke. Size 2⅛in. × 2in. × 1⅜in. **14/6,** postage 2/9.

Where postage is not stated then orders over £5 are post free. Below £5 add 2/9. Semiconductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LTD

Dept. PE, 266 London Road, Croydon CRO 2TH

Also 102/3 Tamworth Road, Croydon

Readout—
A SELECTION FROM OUR POSTBAG

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

P.E. communications receiver

Sir—I am at present constructing the P.E. Wideband H.F. Communications Receiver and I think that Mr R. Hirst's description of the receiver and of its construction are excellent.

However, there are one or two points that I would like clarified.

Firstly, in the preview of this receiver in the September 1969 issue, it is described as having a built-in crystal comparator to ensure accurate alignment. If this were described I am sure that others who, like myself, have not access to a vast array of test equipment, would benefit.

Secondly, the receiver is designed primarily for the reception of S.S.B., but so far as I can understand, it provides only for Upper Sideband, and not for Lower (or inverted) Sideband reception.

Since the inverted form is, I believe, used on the 160, 80, and 40 meter bands by amateurs, I am sure that facilities for reception of this mode would be very useful. I would think that facilities for switching out the 36MHz crystal in the 1st oscillator, and replacing it with a 32MHz crystal would cater for this.

Thirdly, it was stated that optional arrangements for a local oscillator would be described, but the series has now been concluded with no such provision. Also, I would like to know how stable I can expect the oscillator that has been described to be.

Fourthly, if A1 transmissions are received by the "offset" method, then will not the a.g.c. fail to respond to the signal, and indeed possibly allow another signal to control the receiver gain? I would think that a switch to render a.g.c. unoperative, or audio devised a.g.c. would solve this problem.

Lastly, in order to connect the a.g.c. module to the receiver, will it not be necessary to have two output sockets on the first i.f. module?

I realise that the above list is one of only minor points, and I most certainly do not wish to detract from Mr Hirst's marvellous design, but merely to ensure that my finished receiver will give the best possible performance of which it is capable.

R. Smith,
Basingstoke.

As you will appreciate, the designing of a piece of equipment of this nature for a large and varied range of applications requires considerable predesign thought on the part of the designer. Due to the flexibility of this type of wideband design, one could have written a never ending series around peripheral equipment. Bearing this in mind, perhaps you would consider the following observations upon your comments a reasonable compromise between what one would have liked to have done and what one had the space to do it in.

1. As you quite rightly state, the initial intention had been to describe a crystal comparator and the original equipment around which the design was centred had this unit included. When, however, the cost and the ability of the constructor to actually set up the crystal comparator was considered in much more detail, a certain amount of doubt surrounded the adviseability of including this particular unit in the finalised design.

2. As you quite rightly suggest, the receiver is designed primarily for upper sideband reception but as you will see from the introduction to the series, the design was intended for receiver enthusiasts with some knowledge of the particular subject. There are two ways of simply converting the receiver for lower sideband reception.

   (a) By changing the second oscillator to 32MHz.
   (b) Change the sideband filter.

   Obviously the first suggestion is the most simple to carry out.

3. Regarding the optional local oscillator arrangements, you simply have to use the second oscillator circuit and use the crystal (with the required tuned collector load) for the frequency you require.

4. If A1 reception is required, one would use the arrangement that does not include the a.g.c. Unit where the i.f. gain is manually controlled by the front panel Carrier Control.

5. In order to connect the A.G.C. module, it will be necessary to add a socket to the first i.f. unit, in parallel with the output to the sideband filter unit, in a manner similar to that used on the second and first oscillator units.

Your observations are quite correct and no doubt other constructors will make the basic receiver with all types of modifications to suit their own requirements and as you will understand, the permutations are innumerable.

I hope that the comments will convey to you the reasons for failing to enumerate all the variables.—R.H.

Fringe benefit

Sir—I should like to take this opportunity of congratulating you on the publication of Gerry Brown's "On the Fringe," particularly that part on the possibilities of emotions in plants. Many publishers fight shy of anything which may turn out to be controversial, and the layman has little opportunity to learn of, and udge for himself, the truth about such subjects.

I personally think that there are many things in nature that before today were the prerogative of top scientists to investigate, and most of these were too concerned with keeping up prestige to "dabble" in anything which might show them up as cranks. Now, with the abundance of i.c.'s, it is quite within the realms of possibility for an amateur to make sophisticated equipment, such as d.c. amps., simply by connecting up an i.c., and, as Gerry Brown has done, try out some of these fringe experiments in confidence that if the experiment turns out unsuccessful, nothing is lost. If successful, it could well be that great scientific discoveries could be achieved by a determined "dabbler".

I have no doubt that there will be many letters as a result of this subject on plant emotions, as it is my experience that many who are keen electronic enthusiasts have the kind of minds which are stimulated by new challenges.

I look forward to seeing full articles covering the construction of suitable apparatus for testing out E.S.P. also, and may even get around to having a go myself when time permits!

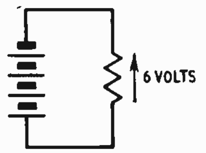
B. H. Baily,
Ferndown,
Dorset.

Readout—

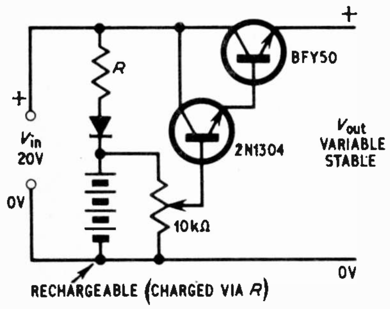
A SELECTION FROM OUR POSTBAG

Now we've Zene it all

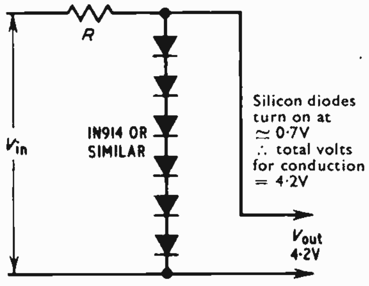
Sir—I was interested to note that in B. Grainger's letter (July 1970 Readout) he wants an equivalent to a Zener diode. Here's one: A battery!



As used in a power supply unit:



and another (even worse!): Shunt stabilising.



L. Cook,
City University,
London, E.C.1.

Mobile rally

Sir,—Readers may be interested to learn that a Mobile Rally is being organised by the Peterborough Amateur Radio and Electronics Society on Sunday, September 20, from 2 to 5 p.m., in the Walton Senior School, Mountsteven Avenue, Peterborough.

There will be numerous trade-stalls and exhibition stands of electronic components, plus a giant sale of surplus equipment. Entertainment is to be provided for wives and families, and parking space will be ample.

Talk-in stations will be G3QS on 1,980 kHz, and G3RED on 2 metres. A special feature will be a display of antique wireless receivers, complete with cats-whiskers and horn loudspeakers!

Further details can be obtained from the hon. secretary:

Douglas Byrne, G3KPO,
Jersey House, Eye,
Peterborough,
Hunts.

Temperature alarm

Sir—Thank you for publishing my article under the Ingenuity Unlimited pages in the July issue of your magazine.

I would however like to point out an error; the bridge rectifier has been rotated a quarter of a turn so that the leads from the Wheatstone bridge network and the leads to the transistor have become transposed.

It may help anyone constructing the temperature alarm to note that the battery BY1 need not be $1\frac{1}{2}$V but can be increased to a maximum limited by the breakdown voltages of the components used. This can be done to increase the sensitivity of the circuit. Sensitivity can also be greatly improved by the addition of a second transistor; a revised circuit diagram is shown below.

D. G. Warner,
Birmingham

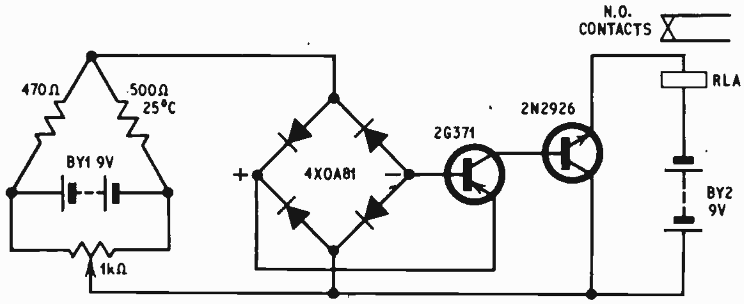


Fig. 1. Improved temperature alarm circuit

Courses...

BRENTFORD

September 21, 7.15 p.m. *Radio Amateurs' Course.*
September 22, 24, 7.15 p.m. *Radio and Television Servicing.*
September 23, 7.15 p.m. *High Fidelity and Tape Recording.*
November 6, 7.15 p.m. *Mathematics of Radio.* Fee is £3 or as an extra class £1.

All above courses held at Brentford Centre of Adult Education, Brentford Secondary Girls' School, Clifden Road, Brentford.
Enrolments: September 10, 11, 14 and 15; 6.30–8.30 p.m.

CRANFORD

September 21, 7.15 p.m. *Radio Hobbies*, at Cranford School, Woodfield Road, Cranford.

Enrolments: September 10, 11, 14 and 15; 6.30–8.30 p.m.

FARNBOROUGH

City & Guilds Amateurs' Examination Course.

Commences Mid-September and full details available from The Principal, Cove Further Education Centre, Cove County Secondary School, St. John's Road, Farnborough, Hants.

GLASGOW

September 15, 7.0 p.m. *Radio Amateurs' Examination Course*, at Glasgow College of Nautical Studies, 21, Thistle Street, Glasgow, C.5.

Enrolments: September 15, 7.0 p.m. Fees: £3.

HESTON

September 25, 7.15 p.m. *Basic Electronics Hobby Course*, at Heston School, Heston Road, Heston.

Enrolments: September 10, 11, 14 and 15; 6.30–8.30 p.m.

ORPINGTON

September 23, 7.30 p.m. *Everyman's (and Woman's) Electronics*, at Orpington & District Adult Education Centre, Newsteadwood School for Girls, Avebury Road, Orpington, Kent.

Postal enrolments commence September 1. Fees: £2 10s. (30 weeks).

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 13¼ × 11¼in. Above motor board 3¼in. below 2¼in. AC 200/250v.

with STEREO/MONO XTAL **£6.19.6** Post 5/6

BSR UA70 Stereo/Mono Transcription Auto Changer. Calibrated Stylus Pressure. **£12.19.6**

BSR Minichanger UA50 Stereo/Mono. Plays 12", 10" or 7" records. Size 12 × 8¼in. AC 200/250v. Post 5/6. **£7.19.6**

GARRARD PLAYERS with Sonotone 9TA Cartridges. Stereo Diamond/Mono Sapphire. SP25 Mk II £14.19.6. AT60 Mk II £14.19.6. Model 3000 £12.19.6. Post 5/6.

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

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made and tested. A 2-stage unit using triode pentode valve, giving 3 watts output. Tone and volume controls. Isolated mains transformer. With knobs, loudspeaker and valves ECL82, EZ80. Frequency response 50-12,000 cps. Sensitivity 200mV. Post 5/6. **89/6**

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.

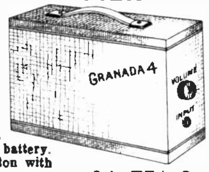
EMI JUNIOR 4 SPEED RECORD PLAYER
Mains operated motor, turntable and pick up complete. Post 5/6. **59/6**

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 1¾" 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 in Makers' carton with full makers' guarantee. World famous make.

Only **75/-** Post 5/-

WEYRAD P50 — TRANSISTOR COILS

RA2W Ferrite Aerial	12/6	Spare Cores	6d.
Osc. P50/1AC	5/4	Driver Trans. LFDT4	9/6
I.F. P50/2CC 470 kc/s	5/7	Printed Circuit, PCA1	9/6
3rd I.F. P50/3CC	6/-	J.B. Tuning Gang	10/6
P51/1 or P51/2	5/7	Weyrad Booklet	2/-
P51/3	6/-	OPT1	10/6

Ferrite Rod 8 × ⅜in. 4/-. 6 × ¼in. 5/-

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 5/- STEREO L/S 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.

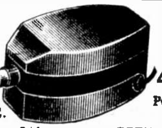
1¼inch DIAMETER WAVE-CHANGE SWITCHES. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each. 1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way 4/6 each. 1 inch DIAMETER Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 18/-. 3 wafer 24/-, 4 wafer 30/-, 5 wafer 36/-.

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 PADDED STEREO PHONES 8 ohms	79/6

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER



200/250 v. A.C. Leaflet S.A.E. **42/6** 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 1½" × 1½" × 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 each**

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.	8/6
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. ¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-. Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K. 2/- each; 2½ watt. 1 ohm to 8·2 ohms. 2/-

Q MAX CHASSIS CUTTER

Complete: a die, a punch, an Allen screw and key
⅜in. 16/-; ⅝in. 17/6; 1⅛in. 19/6; 1⅜in. 24/-; 2$\frac{3}{32}$ in. 44/3
½in. 16/-; 1in. 19/6; 1⅛in. 20/6; 1½in. 29/-; 2½in. 57/3
¾in. 16/9; 1$\frac{1}{16}$in. 19/6; 1¼in. 21/6; 2in. 39/-; 1in. sq. 36/6

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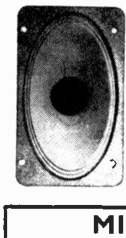

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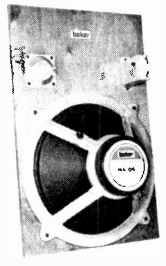

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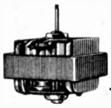

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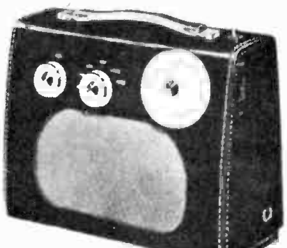

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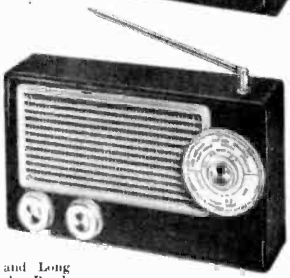

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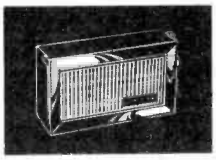

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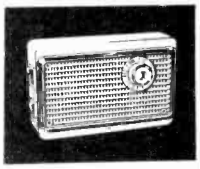

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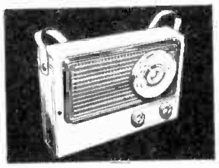

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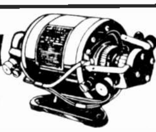

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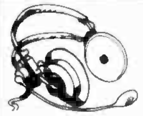

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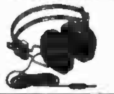

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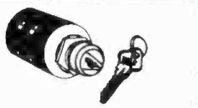

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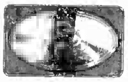

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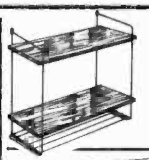

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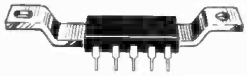

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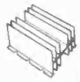

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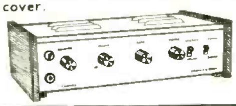

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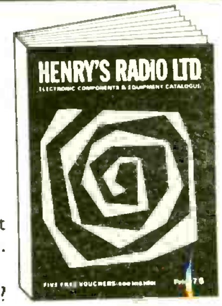

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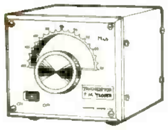

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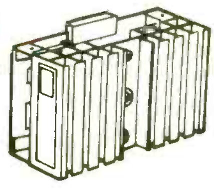

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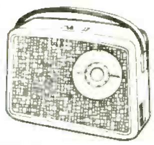

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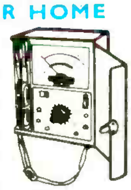

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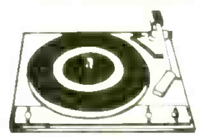

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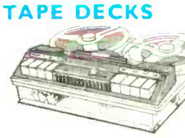

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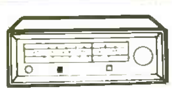

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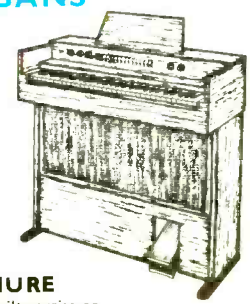

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