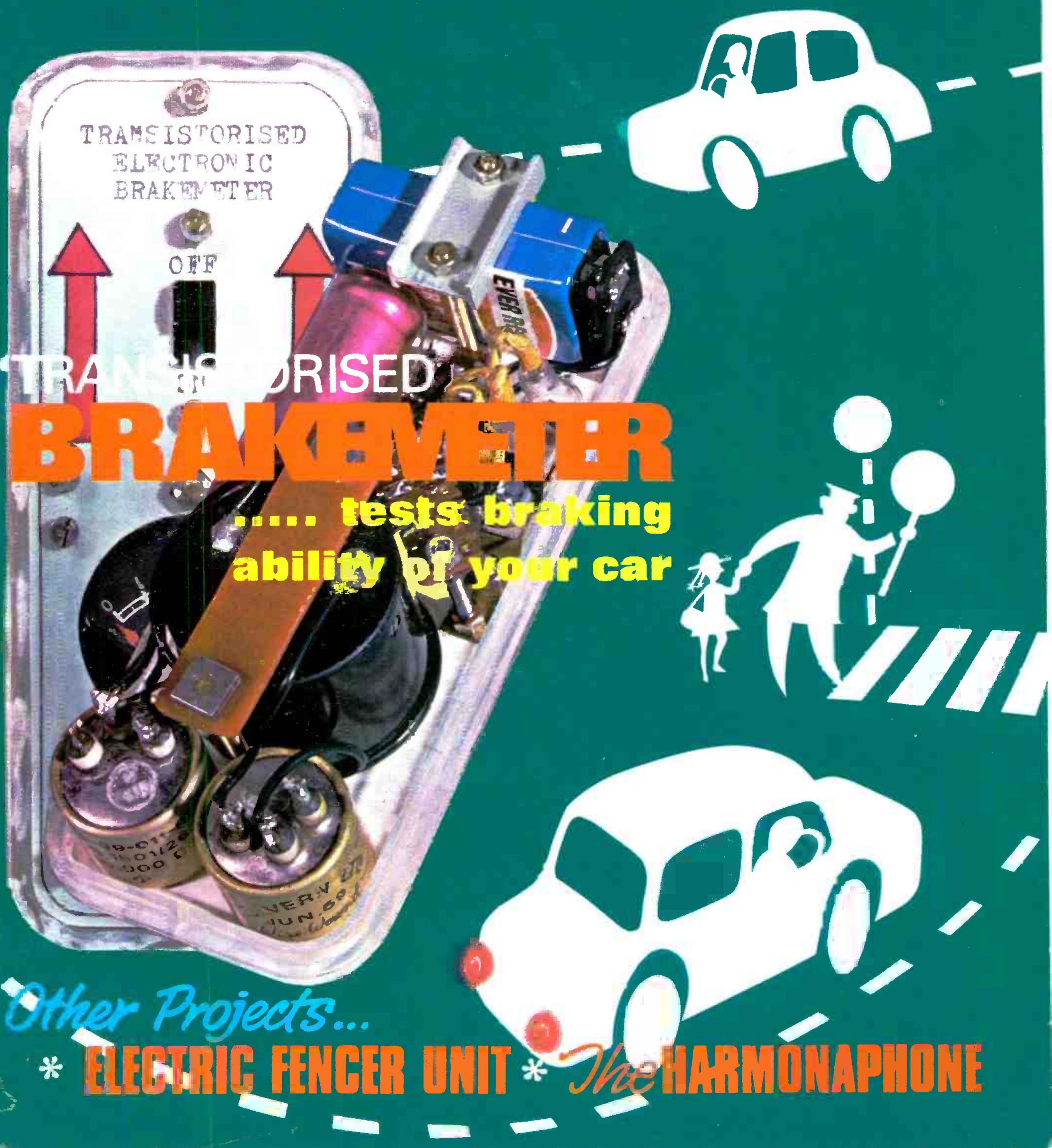
PRACTICAL

ELECTRONICS

FEBRUARY 1969 THREE SHILLINGS



TRANSISTORISED

BRAKEMETER

..... tests braking ability of your car

Other Projects...

* ELECTRIC FENCER UNIT * *The* HARMONAPHONE

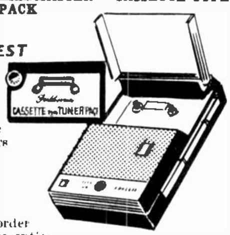
GARRARD DECKS

1025 Stereo/mono cart	£7.19.6
2025 Stereo/mono cart	£8.19.6
3000/S Stereo/mono cart	£9.19.6
3000/D Stereo Diamond cart	£10.19.6
SP25 less cart	£11.19.6
SP25/Deram Stereo cart.........	£17.4.6
AT60 less cart	£13.19.6
AT60/Deram Stereo cart.........	£19.4.6
AP75 less cart	£22.11.6
SL75 less cart	£34.18.9
SL95 less cart	£44.6.9

All plus P. & P. 12/6.

NEW—FIELDMASTER CASSETTE-TYPE TUNER PACK

THE BEST OF ITS TYPE

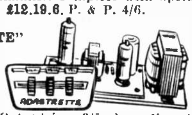


Uses 4 top grade transistors Fits in place of tape cassette and converts recorder to radio reception. Covers full medium wave, battery operated. Highly sensitive circuit. **99/6.** P. & P. 2/6.

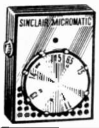
NEW—ADASTRA "DOUBLE 5" STEREO AMPLIFIER.

10 transistor circuit. Volume, Treble, Bass, on/off and Balance controls. Inputs for magnetic and ceramic cartridges, tuner and microphone. Output 5 watts per channel. Complete with operating booklet. **£12.19.6.** P. & P. 4/6.

"ADASTRETTE"



2/3 watt Record Player Amplifier. ECL82 and EZ80 valves. Output imp 3/5 ohms. Easy to fit into cabinet. Separate control panel with on/off, volume and tone controls. Complete with instructions. **£4.7.6.** P. & P. 4/6.



SINCLAIR MICROMATIC M.W. POCKET RADIO

The set that plays anywhere! 6 stage transistor set complete with earpiece. Ready built and fully guaranteed. Only **59/6.** P. & P. 3/6. Or in kit form **49/6.** P.&P. 3/6

FEW ONLY—MAGNAVOX 4 TRACK TAPE DECKS. £16.19.6. Carr. 12/6.

SHIRA 62D MULTI-TESTER 20,000 o.p.v.

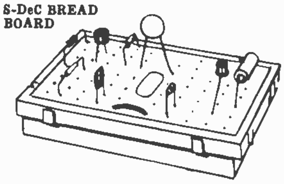
D.C. voltage: 5, 25, 50, 250, 500, 2·5kV (20,000Ω per volt). A.C. voltage: 10, 50, 100, 500, 1,000V (10,000Ω per volt). D.C. current: 0-50A, 0-2·5MA, 0-250MA. Resistance: 0-6K, 0-6mg (300Ω and 30kΩ at centre scale). Capacitance: 10F to 0·001F, 0·001F to 0·1F. Decibels: —20 to +22dB. Size 4½" × 3¼" × 1". **69/6.** P. & P. 3/6.

TTC-C1001 MULTI-TESTER. In leather case. 20,000 o.p.v. A.C. volts 10, 50, 250, 1,000V, D.C. volts 5-25, 125, 500, 2,500V. D.C. current 0-50A, 0-250mA. Resistance 0-60kΩ, 0-6MΩ. Decibels —20 to +22dB. Size of meter 4½" × 3¾" × 1". **85/-.** P. & P. 3/6.

9 in 1 ELECTRONIC KIT

Build nine different projects from one basic kit—no mechanical knowledge required. Build a Police Siren, Metronome, Morse Code Amplifier, Electronic Massager, W/T Transmitter, Radio Telephone, One-transistor Radio, Two-transistor Radio, Electronic Music Kit. Completely safe—operated on 9V PP3 battery. Complete with simple step by step instructions. Only **69/6.** P. & P. 5/-.

S-DeC BREAD BOARD

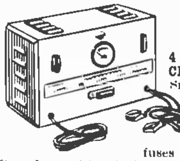


Solderless bread board panels, for fast reliable component connections.

Single DeCs. One S-DeC with control panel, jig and accessories, for solderless connections to controls, etc., with booklet "Projects on S-DeC" giving construction details for a variety of circuits. **29/6.** P. & P. 2/6.

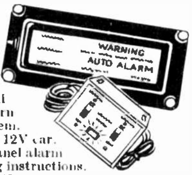
2 DeC Kit. Two decks, control panel and accessory kit together with components tray and lid all in a black plastic box. Instructions and project book included. **69/6.** P. & P. 2/6.

4-DeC Kit. Four S-DeCs with two control panels, jigs and accessories, and the booklet "Projects on S-DeC", all contained in a strong attractive plastic case. Ideal for the professional user. **£5.17.6.** P. & P. 3/6.



4 AMP BATTERY CHARGER

Smart hammer grey case. 1½" meter. 6V and 12V switching. Safety fuses and heat vents. Complete with 5' three core mains lead. 5' red and black battery leads with heavy duty crocodile clips. **59/6.** P. & P. 4/6.



CAR BURGLAR ALARM

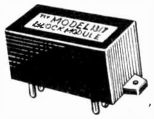
With combined emergency warning light system. Fits any 6V or 12V car. With switch panel alarm unit and fitting instructions. **39/6.** P. & P. 3/6.

NEW TRANSISTOR CHECKER.

For measuring alpha, beta and Ico factors of transistors, also forchecking germanium and silicon diodes. Internal 9V battery. Wide reading scale. Moulded case size 7" × 4½" × 3½". Ranges: alpha, 0·7-0·9967; beta, 0-300; Ico, 0-50-5,000A. Diode Test: forward and reverse internal resistance. Resistance: 200Ω-1MΩ. Complete with connectors and instruction booklet. **£7.19.6.** P. & P. 3/6.

EAGLE TT144 TRANSISTOR TESTER

Tests in-circuit or out of circuit. Identifies PNP and NPN types. Indicator lamp provides positive information on the following tests: Electrode open circuits and current drain. Provides reliable GO-NO-GO tests at practical collector currents of from 5-50mA or more on power transistors. With accessories and instructions. Size 3⅞in. × 6¼in. × 2¼in. **£4.19.6.** P. & P. 3/6.



NEW TRANSISTOR MODULES

E1311. Phono Pre-Amplifier. Size 2" × 1" × ½" built-in R.I.A.A. Characteristics enabling low output magnetic pick-up cartridges to be amplified up to 1V. Input, 100kΩ; gain, 28dB; max. output 3V; max. input: 50mV; distortion, 0·15% (at 1V level); power supply, 9-12V. **29/6.** P.&P. 2/-.

E1312. Tape Pre-Amplifier. Incorporating N.A.R.T.B. curve characteristics, this amplifies tape head signals up to 1V within the frequency range of 30Hz-15kHz. Input imp. 100kΩ; gain, 25dB; max. output, 2V; max. input, 50mV; distortion, 0·15% (at 1V level); power supply, 9-12V. **29/6.** P.&P. 2/-.

E1313. Microphone Pre-Amplifier. Enables a low output microphone to be used with an amplifier or radio. Input imp., 100kΩ; gain, 28dB; max. output, 3V; max. input, 50mV; distortion, 0·15% (at 1V level); freq. res., 10hz-50kHz; power supply, 9-12V. **29/6.** P. & P. 2/-.

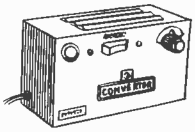
E1314. Power Amplifier. When used in conjunction with E1311, E1312 and E1313 units, this amplifier module produces about 300mW output for speaker connection (8-16Ω), without necessity for an output transformer. Input imp., 1,000Ω; gain, 20dB output, 300mW; distortion, 3% (at 200mW output level); freq. res., 50Hz-10kHz; power supply, 9V; current 20mA at no signal, 80mA at max. output. **29/6.** P.&P. 2/-.

E1315. Electronic Organ Tone Oscillator. Used in conjunction with an organ key board, variable resistances and a 9V power supply, this module acts as the oscillator unit for an electronic organ. Tone frequency, 200-1,000Hz; output, 80mW; current, 15mA. **25/-.** P. & P. 2/-.

E1316. Morse Code Oscillator. A transistorised morse code oscillator (buzzer) to be used in conjunction with an operating key. Suitable for direct connection to a loudspeaker. Tone frequency, 400Hz; power output, 80mW; power supply, 3-9V; current, 45mA. **25/-.** P. & P. 2/-.

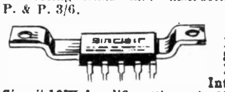
E1317. Wireless Code Oscillator/Transmitter. Can be used with an ordinary A.M. radio receiver for modulated signal transmissions, and for bench trouble shooting when servicing. Transmitter freq., 400Hz-30MHz; tone freq., 400Hz; power supply, 9V d.c.; current 35mA. **25/-.** P. & P. 2/-.

E1318. Dual Lamp Flasher. A switch module for electronically alternating two miniature bulbs, 6V, 100-200mA. Ideal for models, toy boats and planes, displays, warning and security devices, communication signals, etc. Flasher time, ½ second; power supply, 6V d.c.; current, 150mA; lamp, 6V 150mA. **25/-** P. & P. 2/-.



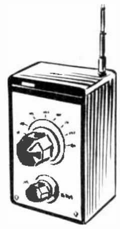
AC/DC CONVERTOR

Enables transistor equipment to be operated from a.c. mains. 6/9/12V output selector switch and on/off switch. Grey case, size 4" × 2¾" × 2". Complete with mains lead, connecting leads and instructions. **59/6.** P. & P. 3/6.



NEW—SINCLAIR IC-10 Integrated Circuit 10W Amplifier. Size only 1" × 0·4" × 0·2". A true hi-fi amplifier complete with manual giving details of a wide range of applications and instructions. Guaranteed 5 years. Only **59/6.** P. & P. 1/6.

NEW—VHF AIRCRAFT BAND CONVERTOR.



When placed within 1" of a MW band radio full coverage of VHF Aircraft Band 108-135Mc/s can be obtained. All transistor, 9V battery operation. Fully tunable. 18½" × 7 section telescopic aerial. Size 4" × 2¾" × 1½". **79/6.** P. & P. 3/6.

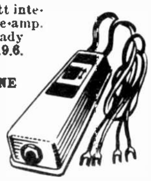
SPECIAL PURCHASE!

DE-LUXE STEREO HEADPHONES

With soft rubber earpieces. Impedance 8-16Ω. Frequency response, 23Hz-13kHz. With lead and stereo plug. Only **59/6.** P. & P. 3/6.

NEW STEREO/MONO HEADPHONES

SDH7. Soft rubber earpieces with slide switch for mono/stereo listening and individual volume controls. Impedance 8-16Ω. Frequency response, 25Hz-15kHz. With lead and stereo plug. **£6.6.0.** P.&P.3/6.

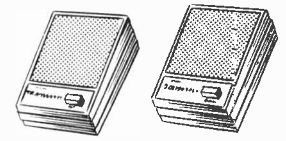


SINCLAIR Z12 12 watt integrated amp. and pre-amp. Size 3 × 1¾ × 1¼in. Ready built with manual **£4.9.6.** P. & P. 3/6.

STEREO HEADPHONE JUNCTION BOX

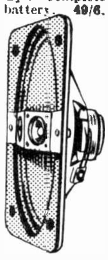
Enable headphones to be used with any amplifier. Incorporates amplifier leads, speaker terminals, jack socket and speaker/headphone switch. **29/6.** P. & P. 2/-.

COMPACT 2-WAY INTERCOMS



For table or wall mounting. Smart two tone grey cases size 3½" × 1¼" × 2½". Complete with lead, staples and 9V battery. **49/6.** P. & P. 3/6.

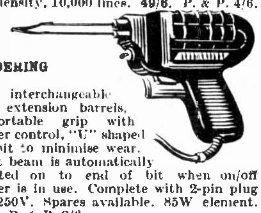
E.M.I. COMBINATION LOUDSPEAKERS



13¼" × 8¼" elliptical with two 2½" tweeters; 15Ω impedance; power handling, 10W. Brand new and guaranteed. **99/6.** P. & P. 7/6. (Also available without tweeters. **59/6.** P. & P. 7/6.)

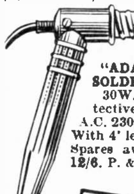
"HI-TEN" LOUDSPEAKER

British made full range 10" unit handles up to 10W. Ceramic magnet. Frequency response, 40Hz-10kHz; imp., 15Ω; flux density, 10,000 lines. **49/6.** P. & P. 4/6.



SOLDERING GUN

With interchangeable tips, extension barrels, comfortable grip with trigger control, "U" shaped 3½" bit to minimise wear. Light beam is automatically directed on to end of bit when on/off trigger is in use. Complete with 2-pin plug 230-250V. Spares available. 85W element. **49/6.** P. & P. 2/6.



"ADASTRA" SOLDERING IRON

30W. Employs its protective cover as a handle. A.C. 230/250V. Adjustable bit. With 4' lead. Spares available. **12/6.** P. & P. 2/6.

CALL IN AT OUR NEW —

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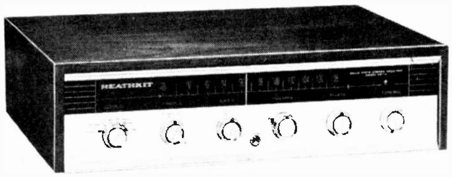
Look What's New from HEATHKIT

Low-cost FM Stereo Receiver, AR-17

Kit K/AR-17
£39.0.0
P.P. 10/6

28 transistor, 7 diode circuit, 14 watts music power, 10 watts r.m.s. from 25–35,000Hz ± 1dB. Automatic stereo indicator light. Adjustable phase control. Complete front panel controls. Flywheel tuning. Factory assembled and aligned FM front-end. Circuit board assembly. Compact 10⅜″ deep × 3″ high × 12″ wide. Use free standing with Heathkit cabinet optional extra.

Cabinet walnut or teak finish **£3.10.0** extra



Quality FM Stereo Receiver, AR-14

Kit K/AR-14
£54.0.0
P.P. 13/6

31 transistor, 10 diode circuit can deliver ±1dB, 15 to 50,000Hz at 10 watts per channel (20 watts total) 15 watts per channel 1HF music power (30 watts total). Wide-band FM/FM stereo tuner plus two preamps, two power amplifiers. Compact only 3⅞″ high × 15¼″ wide × 12″ deep. Install in a wall, free standing or in Heathkit cabinet optional extra. 210–240V 50Hz a.c.

Cabinet walnut or teak finish **£4.10.0** extra

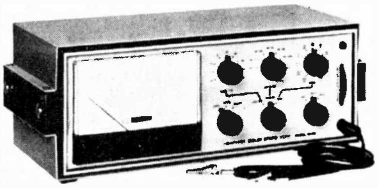
Low-cost FM Mono Receiver, AR-27

Kit K/AR-27
£22.10.0
P.P. 10/6

13 transistor, 6 diode circuit. 7 watts music power. ±1db, 25 to 60,000Hz at 6 watts. Input connectors for phono and aux. Complete front panel controls. Flywheel tuning, factory prealigned FM tuner. Circuit board assembly. Compact bookshelf size. Install in a wall, free standing or in cabinet optional extra. 210–240V 50Hz a.c. operation.

Cabinet walnut veneered **£3.10.0**

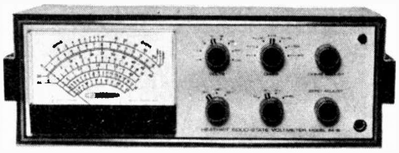
Solid-State Volt-ohm-Milliammeter, IM-25



Kit K/IM-25
£48.10.0
P.P. 10/6

9 a.c. and 9 d.c. ranges 150mV up to 1,500V f.s. 7 resistance ranges, 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . measures from 1 ohm to 1,000Mohms. 11 current ranges from 15μA full scale to 1·5A full scale. 11Mohm input impedance d.c. 10Mohm input impedance a.c. 6″ 200μA meter. Internal battery power or 120/240V a.c. 50Hz supply. PCB construction.

Solid-State Volt-ohm Meter, IM-16



Kit K/IM-16
£28.8.0
P.P. 10/6

8 a.c. and 8 d.c. ranges 0–5V to 1,500V f.s. 7 ohmmeter ranges with 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . 11Mohm input on d.c., 1Mohm on a.c. Internal battery power or 120/240V a.c. 50Hz supply.

Solid-State Low Voltage Power Supply, IP-27

Kit K/IP-27
£46.12.0
P.P. 10/6

0·5 to 50V d.c. with better than ±15 Millivolts regulation. Four current ranges 50mA; 150mA, 500mA, and 1·5 amperes. Adjustable current limiter: 30 to 100% all ranges. Panel meter for output voltage or current.

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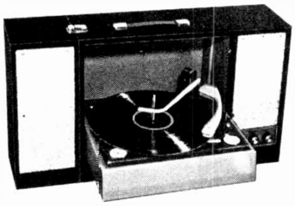


STEREO RECORD PLAYER, SRP-1

Two built-in speakers
Suitcase portability

Kit **£28.6.0** P.P. 10/6

CAR RADIO, CR-1

High performance at low cost. 12 v pos. or 12 v neg. operation. 4 watts output

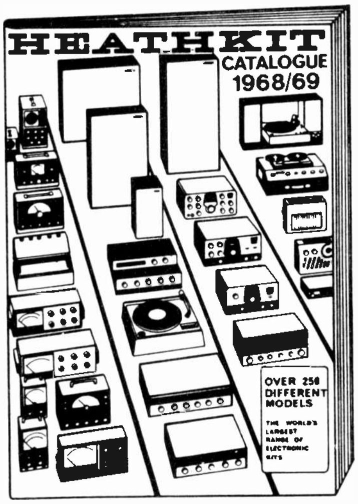
Kit (incl. spkr.) **£14.12.0** P.P. 4/6

STEREO TAPE RECORDER, STR-1

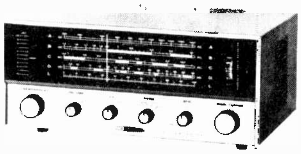
Built-in speakers. Many features unobtainable elsewhere at this price

Kit **£58.0.0** P.P. 10/6

MANY OTHER INSTRUMENTS FOR TEST AND SERVICE IN RANGE

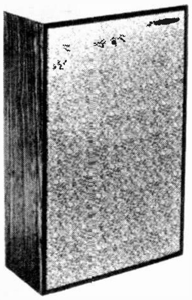


MANY SHORTWAVE RECEIVERS including:



4-BAND RECEIVER, GR-64E

Cover 1 MH/z to 30 MH/z plus 550 kH/z to 1620 kH/z AM broadcast band. Built-in speaker. Handsome low-boy styling. Kit **£22.8.0** P.P. 9/-



BERKELEY Slim-line SPEAKER SYSTEM

Kit **£21.4.0** P.P. 13/6

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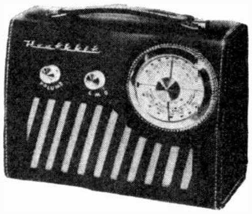
PORTABLE RADIO UXR-1

Kit coloured case
£12.8.0 P.P. 4/6

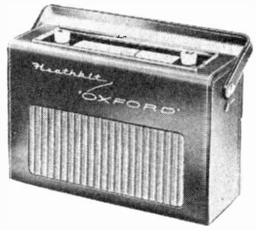
Kit leather case
£13.8.0 P.P. 4/6



PORTABLE RADIO UXR-2

In black or natural leather

Kit **£15.10.0**
P.P. 6/-



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AC107	3/–	OC170	3/–
AC126	2/4	OC171	4/–
AC127	2/4	OC200	3/6
AC128	2/4	OC201	7/–
ACY17	3/–	2G301	2/6
AF114	4/–	2G303	2/6
AF115	3/6	2N711	10/–
AF116	3/6	2N1302-3	4/–
AF117	3/6	2N1304-5	5/–
AF118	3/6	2N1306-7	6/–
AF119	3/6	2N1308-9	8/–
AF186	10/–	2N3844A	5/–
AF139	10/–	**Power Transistors**	
BFY50	4/–	OC20	10/–
BSY25	7/6	OC23	10/–
BSY26	3/–	OC25	8/–
BSY27	3/–	OC26	5/–
BSY28	3/–	OC28	7/6
BSY29	3/–	OC35	5/–
BSY95A	3/–	OC36	7/6
OC41	2/6	AD149	10/–
OC44	1/11	AUY10	30/–
OC45	1/9	**Diodes**	
OC71	2/6	AAY42	2/–
OC72	2/6	OA95	2/–
OC73	3/6	OA70	1/9
OC81	2/6	OA79	1/9
OC81D	2/6	OA81	1/9
OC83	4/–	OA73	2/–
OC139	2/6	IN914	1/6
OC140	3/6		

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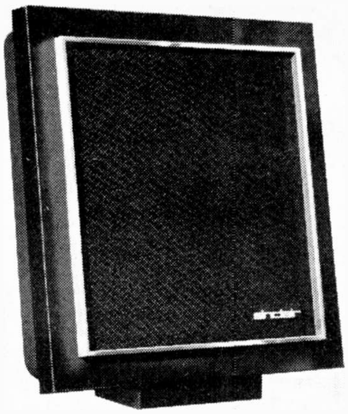

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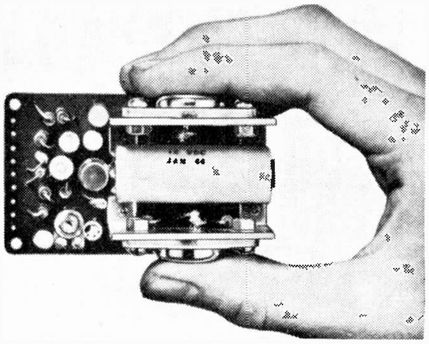
£7.19.6



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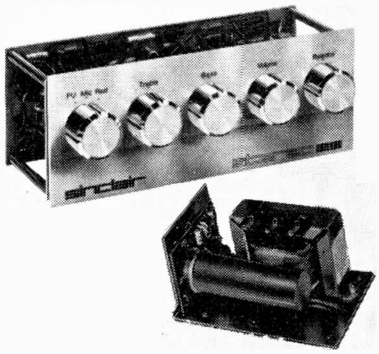
12 watt hi-fi amplifier/pre-amp

This eight transistor amplifier is the most successful of its kind ever designed and is easily adapted to a wide variety of applications. The Z.12 is supplied ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo. Size—3in × 1¾in × 1½in. Class B Ultralinear Output: Frequency response from 15 to 50,000Hz ±1dB: Suitable for 3 to 15 ohm loudspeakers. Two 3 ohm speakers may be used in parallel: Input 2mV into 2kΩ. Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak) Power requirements 6—20V d.c. from battery or PZ.4 Mains Supply Unit.

89/6



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Pre-amp/Control Unit for Z.12, IC.10 and other good Stereo assemblies. Switched inputs for P.U. (equalised to R.I.A.A. curve from 50 to 20,000Hz ±1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/Input are solid aluminium. Size—6½ × 2½ × 2½in plus knobs. Built, tested and guaranteed.

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Kit in fitted pack with earpiece, solder and instructions

49/6

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59/6

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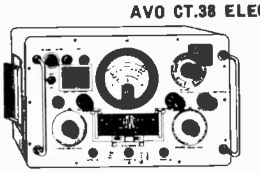

High quality 97 range instrument which measures a.c. and d.c. Voltage, Current, Resistance and Power output. Ranges d.c. volts 250mV–10,000V. (10megΩ-110megΩ input). D.c. current 10μA 25 amps. Ohms: 0–1,000mgΩ. A.c. volt 100mV–250V (with RF measuring head up to 250Mc/s). A.c. current 10μA–25 amps. Power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

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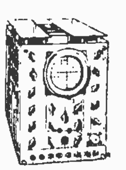

An excellent general purpose D/B oscilloscope. T.B. 2c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V a.c. Supplied in excellent working condition. **£22.10.0.** Or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

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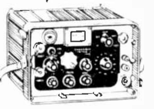

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80Mc/s. AM/C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition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

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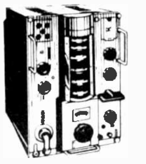

Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650kc/s – 30Mc/s, I/F 500 kc/s. Incorporates 2 R.F. and 3 I.F. stages, band-pass filter, noise limiter, crystal controlled B.F.O., calibrator I/F, output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19½ 13½ . 16in. Weight 114lb. Offered in good working condition, **£22.10.0.** Carr. 30/-. A few available Brand New **£35.** Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above 15kc/s–700kc/s. **£17.10.0** Carr. 30/-.

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1 μ/watt to 6 watts.

£20. Carr. 20/-.

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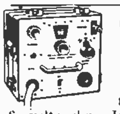

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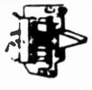

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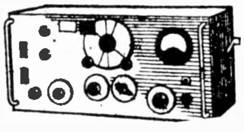

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VOL. 5 No. 2
February 1969

PRACTICAL
ELECTRONICS

POST OFFICE PRIVILEGE

When the Post Office Bill, at present before Parliament, becomes law, the present Postmaster General and his department will be replaced by two separate bodies: a new Minister of Posts and Telecommunications and a new public authority, the Post Office. This Minister will assume responsibility of the Postmaster General's wireless telegraphy functions. The Post Office will be sponsored within the Government by the new Ministry of Posts and Telecommunications and will run the Postal, Telecommunication, Giro, Remittance, and National Data Processing services.

Already a fair amount of comment and apprehension has been aroused by certain clauses in this Bill, concerning telecommunications. Clause No. 24 for example states that subject to certain provisions, the Post Office shall have, throughout the British Islands, the exclusive privilege of running systems for the conveyance of all kinds of communications through the agency of electric, magnetic, electro-magnetic, electro-chemical, or electro-mechanical energy.

Pretty daunting at first glance. However, the Post Office authorities have been at great pains to emphasise that the wording of this clause is merely a re-statement in modern terms, of the old Telegraph Act of 1869. At present the Postmaster General has the exclusive privilege of sending telegraphic messages, and this power is to be re-enacted in the current Bill by Clauses 24–27 and vested in the new Post Office.

There are many electronic devices and systems in everyday use which might be considered as coming within the scope of Clause 24. In order to allay fears and misunderstanding in this respect, we set out now what is believed to be the true position concerning the legality of such apparatus.

The Post Office exclusive privilege is not infringed provided the whole system is installed in a single set of premises (which can include outbuildings, i.e. greenhouse or garage), or in a motor car or private boat, and is for the sole use of members of the same household or firm. Thus intercom systems, intruder alarms, and devices for sensing, measuring or indicating physical phenomena, or for controlling equipment or electrical circuits are all permitted.

Almost every other kind of communication does infringe the Postmaster General's exclusive privilege at present, and will infringe the new Post Office exclusive

continued on page 133

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our March issue will be published on Friday, February 14

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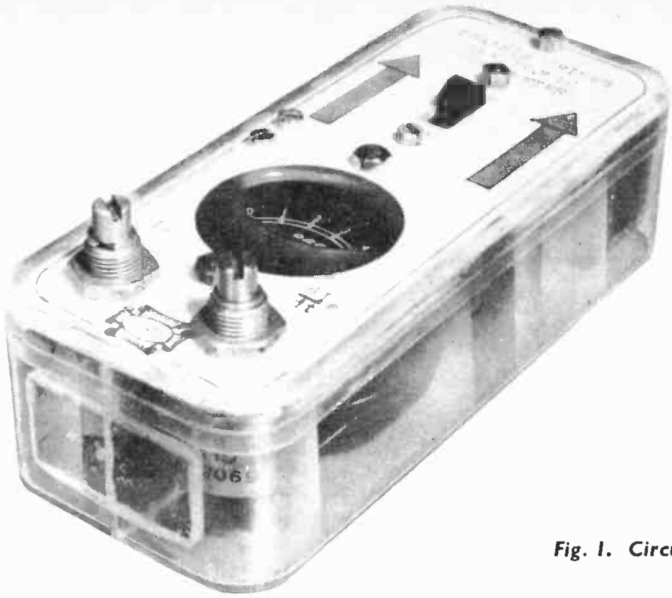


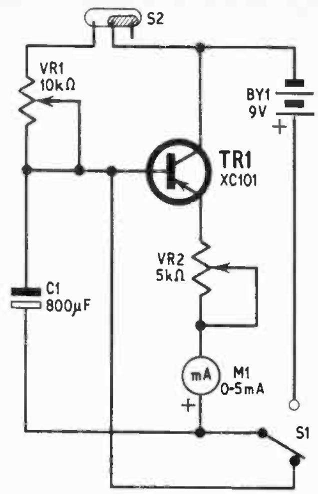


Fig. 1. Circuit diagram of the transistorised brakemeter

MOTOR CAR brake wear occurs so gradually that, until the foot-pedal movement is excessive, or there is some other indication, the driver may well not detect it. The electronic brakemeter is intended to provide a periodical check of braking efficiency. Although the meter shown is a "go/no-go" device—i.e. showing the brakes to be either satisfactory or not—calibration can be carried out so that actual percentage braking efficiency is indicated.

The meter is, in fact, an electronic clock which measures the time during which the vehicle is being retarded (when the brakes are applied). If the initial speed is known, then the average retardation can be calculated; from this, the braking efficiency can be obtained. In practice, a speed of 30m.p.h. is used and the existing meter scale is not altered; one arbitrarily selected value represents the braking efficiency criterion.

BRAKEMETER THEORY

Braking efficiency is based on the retarding force that the brakes apply to the vehicle. From Newton's second law of motion, ($P = mf$) it will be seen that if the retarding force (P) is equal to the mass (m), then the retardation (f) is unity ($1g$). This retardation is referred to as 100 per cent braking efficiency and means that the braking force is equal to the weight of the vehicle.

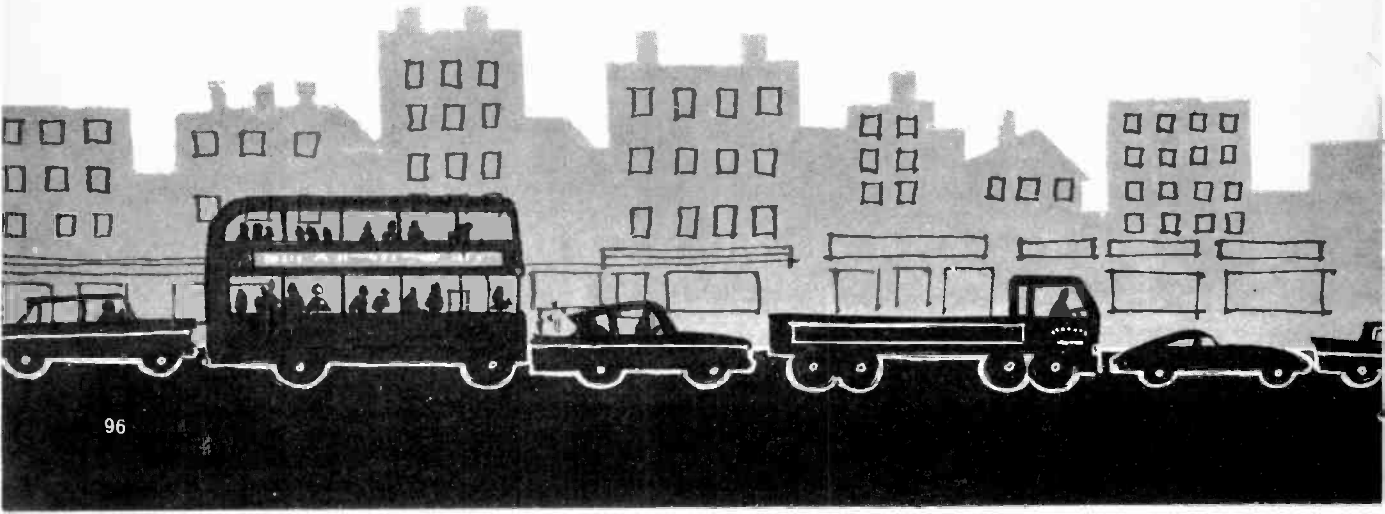
Under normal conditions braking efficiencies as high as this are unlikely, but with ideal conditions 100 per cent, or even higher, can be achieved. The law requires that the braking efficiency is at least 50 per cent ($0{\cdot}5g$) for foot brakes and 25 per cent for hand brakes. From the gravitational equation $v = u - ft$ (where u and v are initial and final speeds respectively), we can calculate the retardation time (t). For a vehicle at 30m.p.h. (44ft/sec) and 65 per cent brake efficiency, we can write:

$$u = ft \text{ (since } v \text{ is zero)}$$

$$44 = 0{\cdot}65 \times 32{\cdot}2t \quad (g = 32{\cdot}2\text{ft/sec}^2)$$

$$t = \frac{44}{20{\cdot}93} = 2{\cdot}1\text{sec.}$$

Our electronic clock has simply to be able to measure this time with acceptable accuracy to indicate an average efficiency of 65 per cent. The electronic brakemeter performs two functions:



(a) it senses the instant the brakes are applied (as the vehicle decelerates) and the instant it stops, and
(b) it measures the time between these instants, i.e. when the retardation is taking place.

Thus the meter will give us the overall efficiency of the brakes during the time in coming to rest. Commercial meters give the maximum efficiency shortly after the brakes are applied and hence are inclined to give slightly better readings than the electronic brakemeter, due to brake fade. This must be remembered when testing and continuous braking applied until the vehicle stops.

CIRCUIT DESCRIPTION

The brakemeter circuit is shown in Fig. 1. S2 is a mercury switch mounted at a slight angle so that when the unit is horizontal, as it must be in the vehicle when being used, the contacts are not made. When the brakemeter is retarded from a constant velocity, the mercury moves up the slight incline and the contacts make. This condition is maintained until the vehicle stops, when the mercury drops back and the contacts open.

The actual timing element consists of the general-purpose audio transistor TR1 with the variable resistor VR2 and the milliammeter in the emitter circuit. VR1 forms the bias resistor and C1 is a reservoir capacitor between the base and emitter.

The action of the circuit is as follows: when S1 is closed, the supply voltage is applied to the collector of TR1. Since no bias is applied via VR1, the collector current is very small and there is little or no indication at the meter. This would be the circuit condition just before applying the vehicle brakes.

The mercury switch is connected between the bias resistor and the supply voltage so that as the vehicle decelerates, the mercury closes the contacts and bias current flows through VR1. When this happens, C1, which is of the order of 800μF, starts to charge and the potential across it rises, increasing the bias of TR1. The emitter current I_e rises until the vehicle stops. The mercury switch then opens; current rise stops and the bias for TR1 is now dependent on the charge stored in C1. This decays, but so gradually that the meter needle falls very slowly—it may well be of the order of several minutes before zero is reached—giving ample time for a meter reading to be taken by the driver. The switch contacts across C1 are part of the on-off switch S1 and ensure that the capacitor can be rapidly and completely discharged between checks.

COMPONENTS AND VALUES

The basic circuit component is the transistor. This is of the general-purpose type, of which there are many to choose from. The OC72 and the XC101 are the obvious of the *pnp* types, but *npn* types can be used if available. In this case, however, the battery and meter polarities must be reversed and the capacitor C1 must be connected with its positive pole to the base. When choosing the transistor, the maximum emitter current (VR2 at a minimum) must be larger than the meter full-scale deflection.

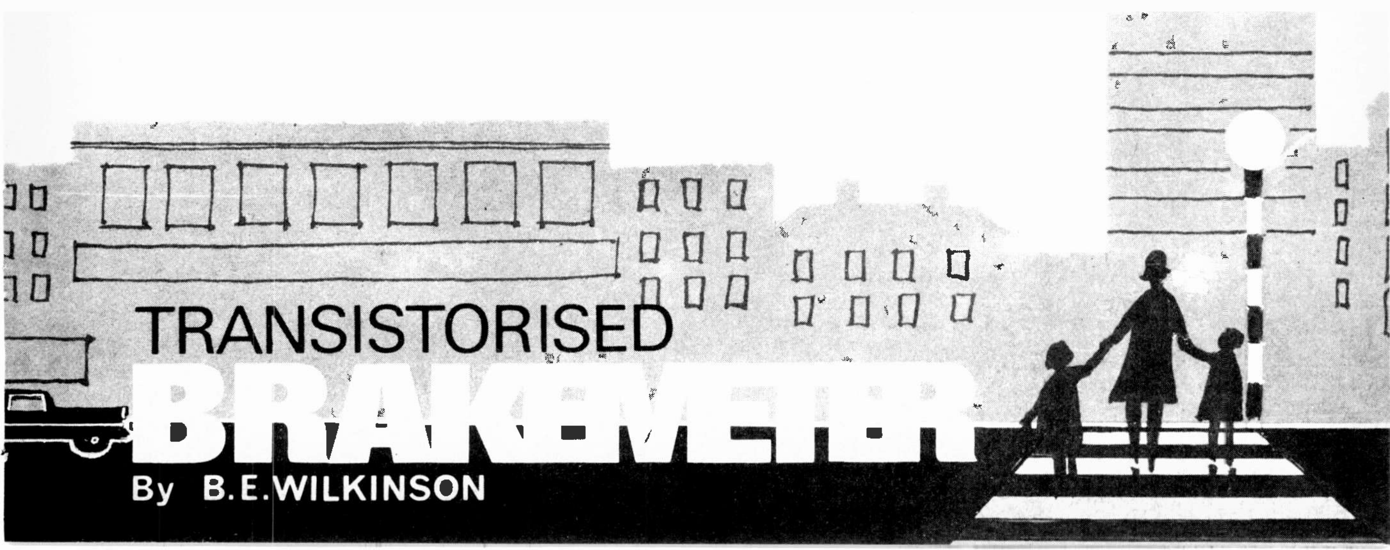
The value of C1 is by no means critical and anything between 500 and 1,000μF (or even higher) is perfectly suitable. The working voltage of such a capacitor will be low, if the component is to be compact, but there should be no problem here as the supply is only 9 volts. The important value in this part of the circuit is the *RC* product. VR1 can be increased for a smaller capacitor, but the disadvantage is that a small capacitor causes the meter needle to drop more rapidly when the mercury switch opens.

Potentiometers VR1 and VR2 are selected by checking in the completed circuit. VR1 must control the charging rate of C1 and thus the emitter current rise (dI_e/dt), so that the meter swing is not unduly fast or slow. If the vehicle is to be stopped from 30m.p.h. with a braking efficiency of 65 per cent, then the time involved, as we have already seen, is 2·1sec. If we arbitrarily select a suitable point on the scale (say 3, where the scale is from 0 to 5) to represent this efficiency, VR1 must be selected so that the needle will approach this point in about 2 seconds; 10 kilohms is a suitable value when the capacitor is 800μF.

VR2 controls the emitter current (I_e). If this potentiometer is too large, the adjustment will be critical and cramped towards one end, while if it is too small, current control may be limited. In practice, 5 kilohms is suitable. The mercury switch is a standard changeover component and operates as a make and break switch with only two of the three contacts used.

Emitter current is measured with the moving coil milliammeter—0 to 1 or 0 to 5mA, as available—it must be remembered though, that the full-scale deflection current must be less than the maximum TR1 emitter current. The meter shown is a miniature type (1in diameter face); this allows the final instrument to be compact, although a larger scale is more accurately and easily read.

The main function of S1 is to switch the 9V supply, however a changeover switch is used so that in the



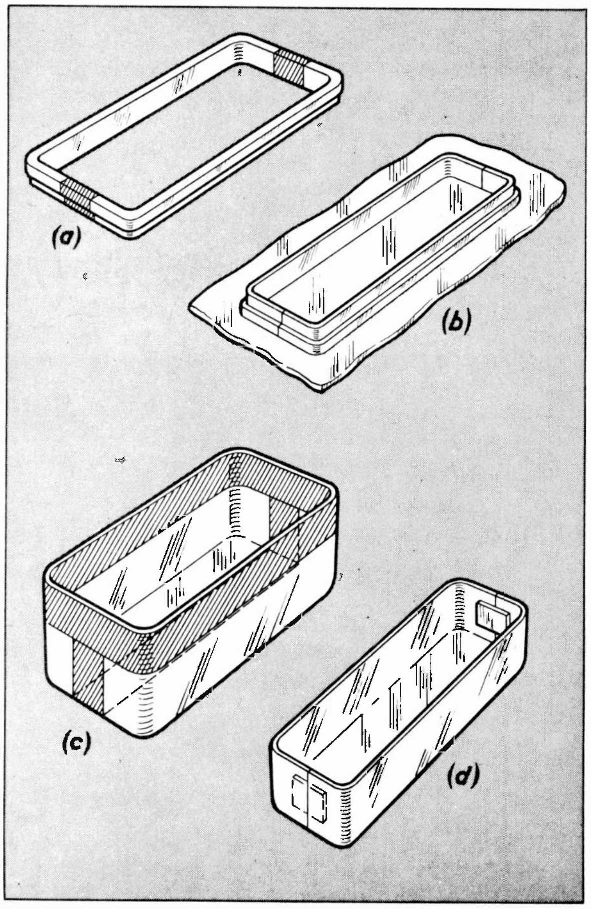


Fig. 2. Manufacture of case from a plastics box: (a) Top of lid sawn off leaving frame—shaded section removed. (b) Frame joined and glued to sheet of plastics from original lid—edges trimmed when set. (c) Depth and width of box reduced by removal of shaded areas. (d) Sides joined together and reinforced with plastics strips. Final case size 5½in × 2¼in × 1½in.

off position, the capacitor C1 is short-circuited. The switch shown is a slide unit consisting of two three-contact changeover switches.

CONSTRUCTION AND WIRING

The selection of a suitable plastics container for the unit usually presents a problem. Ready-made polystyrene boxes are rarely suitable in shape or size, so it is as well to obtain the nearest and alter it. Fig. 2 shows how this has been carried out for the brakemeter shown, the final size being 2¼in × 5½in × 1½in. The original plastics lunch box was found to be suitable in length only, so adjustments were made.

The top of the lid was carefully sawn off, leaving the frame, a section of which was then removed from each short side. The two pieces of frame were then joined up using polystyrene cement to form the required shape. A sheet of plastics from the cut-off top was then stuck to the lid frame and trimmed when the cement had hardened. Before altering the base the components were mounted on the lid, this allows the depth of box required to be accurately determined. The box is cut depth-wise by removing a section.

The width is then reduced by cutting as shown in Fig. 2. The first cut is along the centre line of the box as it will be; the unwanted section is cut out and the edges sandpapered flat and joined with cement. Since the box is now seamed, it is weaker than before and so reinforcement is provided by plastics strips stuck as shown.

The control face can be made neater by fitting a white card under the transparent lid. This is held in position by the potentiometer nuts, etc. and carries the title of the instrument and control indications. The two arrows (red) indicate the vehicle's direction of travel. VR2 is annotated I_e (emitter current), while the rate of change of emitter current (VR1) is annotated dI_e/dt.

Component layout is very much a matter of choice, the only significance being the position of the mercury switch. This must be arranged so that, when the meter is used, the switch tube is inclined slightly in the vehicle's direction of travel (Fig. 3). A satisfactory layout is shown in Fig. 4. Here, the components are arranged around a symmetrical control face layout.

The on/off switch and most meters carry their own fixing devices, but improvisation is necessary to mount the 9V battery, the mercury switch and the transistor. The battery mount consists of two lengths of 6B.A. threaded rod (or long bolts), held to the control face by means of nuts. The battery is held in position by a short strip of metal (in this case a piece of H-section curtain rail) and two 6B.A. nuts. The battery clip is simply the clip-plate from a discarded PP3 battery.

Mercury switches generally require a special mount as the basic switch is a glass tube, containing the mercury and the contacts. Fig. 3 shows how the switch is mounted on the lid. The glass tube is lashed with cotton to a small brass strip, which is bent to carry the switch at an angle. This angle must not be great enough to prevent the mercury from moving with a small retardation, and yet it must not be so small that vehicle vibration causes the switch to operate. In practice, an elevation of five degrees is found to be satisfactory.

The strip is held in position by two 6B.A. nuts and bolts. One of these is longer than the other and carries (between two 6B.A. nuts) a small strip of Veroboard, to which the transistor is soldered. Of the conducting strips, four are used; three carry the transistor and the fourth is a connection between the mercury switch and VR1.

The meter used had no fixing holes and has been positioned against the lid by means of a plastics strip and two 4B.A. bolts; however, the majority of meters

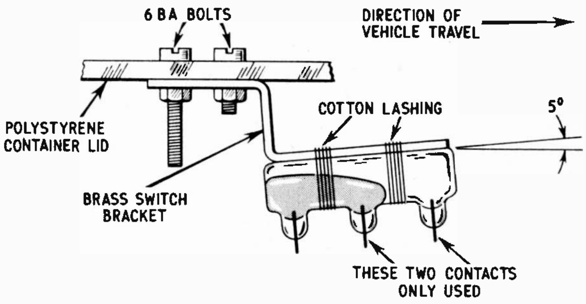
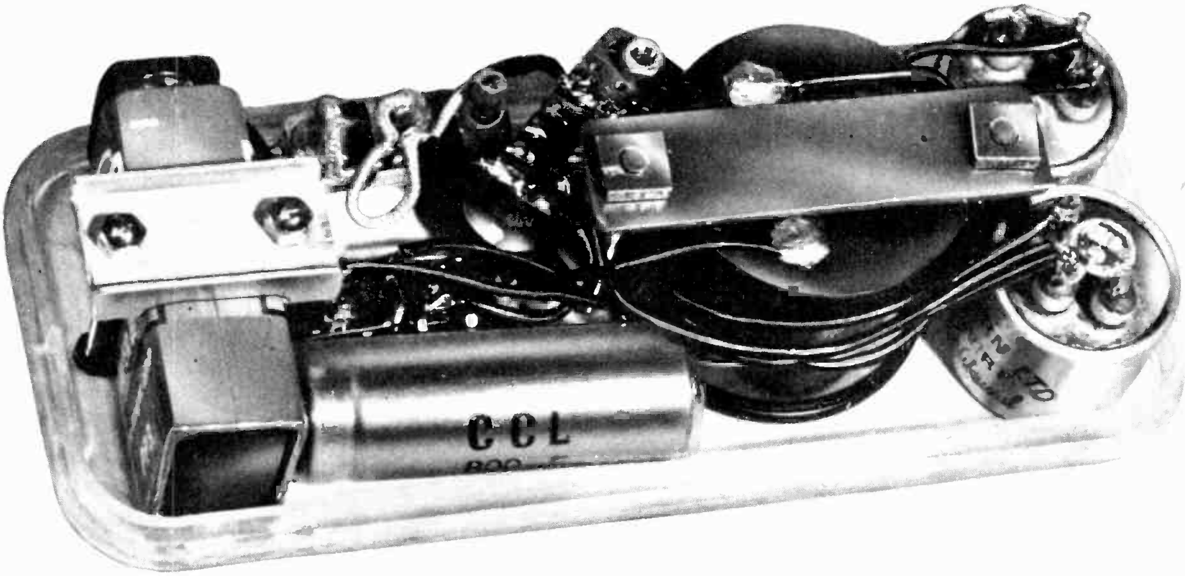


Fig. 3. Details of mercury switch mounting



COMPONENTS...

Potentiometers
VR1 10kΩ
VR2 5kΩ

Capacitor
C1 800μF elect. 15V

Transistor
TR1 XC101 *or* OC71

Miscellaneous
S1 Double pole change-over slide switch
S2 Mercury switch (Proops Bros. Ltd., 52 Tottenham Court Rd., London, W.1)
BY1 9V battery, PP3
M1 0–5mA moving coil milliammeter
Small piece of Veroboard
Plastics case (see text)
18 s.w.g. brass strip and 6B.A. fixings

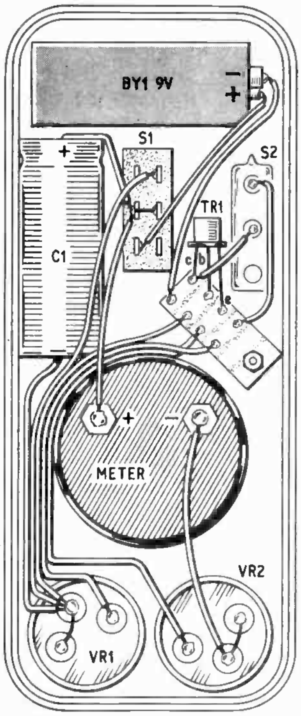


Fig. 4. Layout and wiring diagram of the brakemeter

have a fixing flange. The capacitor is supported by its leads, though a small strap could be used if the component requires it. Fig. 4 is intended as a guide, since the actual wiring will depend on the relative positions of the components, as decided by the reader. Points to observe are the correct polarities of the capacitor and meter.

TESTING THE BRAKEMETER

Having completed the brakemeter, it is first necessary to check that the circuit is working correctly. For this, turn VR1 to a minimum and VR2 to a maximum, tilt the unit to operate the mercury swich and switch on S1. In this condition, there should be little or no meter indication. Adjust VR2 until the meter needle is at full scale deflection and observe that there is more adjustment available to take the emitter current above this value. Now increase the value of VR1 to about half its available sweep.

Switch off S1 to short-circuit any charge on C1 and then switch on. With the unit tilted, observe that the needle climbs steadily to full-scale deflection. Repeat the test with VR1 less and greater, checking that the needle climb is faster and slower respectively. If the meter behaviour is not, in principle, as described, then the wiring should be checked. Further failure should suggest that a component (probably transistor or capacitor) is faulty.

The reader will have observed the insistence that the maximum emitter current is greater than the meter full-scale deflection; there is a reason for this: the charge of C1 through VR1, and thus the current rise, is exponential. This means that the needle moves rapidly at first, but slows down until it approaches the current representing full C1 charge very slowly. It will be clear that the time scale is non-linear and some difficulty would be experienced in obtaining accurate readings where the needle climb is very slow. By setting the limiting value of I_e above full-scale deflection, we ensure that the needle operates over the initial, and therefore more linear, part of the charging curve.

CALIBRATION—GO/NO-GO

The brakemeter can be calibrated in two ways:

(a) to provide indication of the minimum required efficiency; indication is thus that the brakes are efficient or inefficient;

(b) to provide an indication of the actual brake efficiency, meter readings being converted into percentages from a table.

Calibrating for minimum acceptable efficiency is useful as readings above indicate the brakes to be satisfactory, while those below indicate that some adjustment is necessary.

The minimum acceptable efficiency can be determined by the legal requirement, or it can be higher to provide a better margin of safety. Suppose we accept a figure of 70 per cent (a retardation of $0{\cdot}7g$). From 30m.p.h., this would cause the vehicle to stop in 1·95 seconds. The obvious way to calibrate then, is to use a stopwatch; this should be an instrument with a large sweep if accuracy is to be obtained. To calibrate, proceed as follows:

1. Hold the brakemeter in the left hand and the stopwatch in the right hand.
2. Switch on the brakemeter, but do not tilt to operate the mercury switch.
3. Simultaneously tilt the brakemeter forward and start the watch. As the hand approaches 1·95 seconds, tilt the brakemeter back to open the mercury switch. Note the meter reading.
4. Adjust VR1 and repeat the test until this time coincides with some arbitrary reading.

CALIBRATION—ACTUAL EFFICIENCY

The second calibration method involves representing each value on the scale by a percentage of brake efficiency. The first step is to adjust the meter as above, so that the criterion of acceptability is at a convenient scale value. Having determined this, the time taken for the needle to reach other scale values is measured and the brake efficiencies calculated.

As an example, if the meter needle took 3 seconds to reach a scale value of (say) 4, what percentage brake efficiency would this represent? As far as the vehicle itself is concerned, this would represent stopping from 30m.p.h. in 3 seconds. From the formula $u = ft$, we can write $44 = 3f$ or $f = 14{\cdot}6\text{ft/sec}^2$. Now $1g$ is $32{\cdot}2\text{ft/sec}^2$ so that the retardation is

$$P = 14{\cdot}6/32{\cdot}2 = 0{\cdot}45g.$$

A scale value of 4 then, represents 45 per cent braking efficiency.

Clearly, once VR1 and VR2 have been suitably preset, values of braking efficiency can be calculated for all scale values. It should be remembered that the higher the scale value, the lower will be the braking efficiency. To ensure that VR1 and VR2 are not moved after calibration, control knobs are not fitted and it is useful to seal the shafts with a small splash of paint.

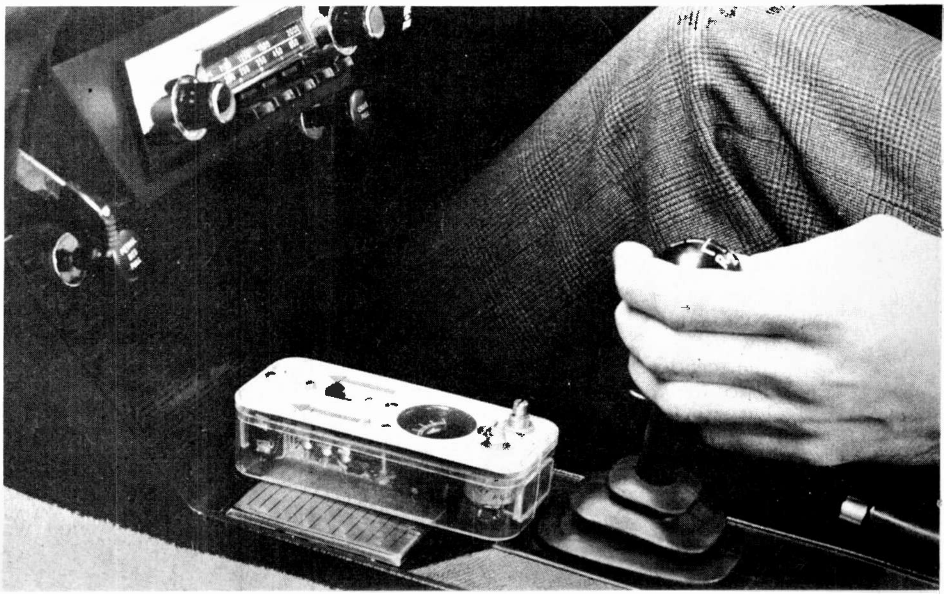
CALIBRATION USING A PENDULUM

While a stopwatch is a quick and easy way of calibrating the brakemeter, it is not essential as there is another way of measuring small time periods—the pendulum. A simple pendulum consists of a small bob-weight suspended by a length of thread; the time (t) for a complete swing (back and forth) is given by $2\pi\sqrt{(l/g)}$, where l is the length of the thread (ft) and g is the gravitational constant ($32{\cdot}2\text{ft/sec}^2$).

This can be re-arranged to the form $l = gt^2/4\pi^2$, which it will be seen, gives us the length of thread required in terms of the time t. Now, we have already established that the retardation time for a braking efficiency of 70 per cent is 1·95 seconds. If we put this in the above expression we get:

$$l = \frac{32{\cdot}2 \times (1{\cdot}95)^2}{4 \times (3{\cdot}14)^2} = 3{\cdot}1\text{ft}$$

It will be noticed that this is quite a convenient length. The pendulum can be suspended from a pin pushed into the top of a door frame. The bob-weight should be physically small (to reduce air drag) and weigh a couple of ounces approximately. Once the



Brakemeter in use in the car. The meter should be placed in such a way that it will not move forward during braking. It is advisable to turn the unit on just before brake testing to avoid incorrect readings

Table 1: BRAKING EFFICIENCY AGAINST RETARDATION TIME AND PENDULUM LENGTH

For Vehicle Speed 30m.p.h. (44ft/sec)

Braking Efficiency (Percentage)	Retardation Time (Seconds)	Pendulum Length (Feet)
100	1·367	1·531
90	1·518	1·879
80	1·708	2·380
70	1·952	3·108
60	2·277	4·231
50	2·733	6·092
40	3·416	9·523
30	4·555	16·92
20	6·832	38·09

pendulum has been rigged, it can be checked against the second hand of any watch or clock. With the duration of a complete swing as 1·95 seconds, there should be 30·71 swings per minute. In practice, approximately 31 is sufficiently accurate.

The pendulum should swing through a few inches only as the mathematical relation is accurate only for small displacements. To calibrate the brakemeter with the pendulum, proceed as follows:

1. Set the pendulum swinging.
2. Tilt the brakemeter forward to operate the mercury switch.
3. View the pendulum so that as it reaches the vertical—i.e. it is travelling at maximum speed—it passes some convenient mark on the wall or floor.
4. As it passes the mark, operate the on—off switch.
5. When it again passes the mark after one complete swing (travelling in the same direction), tilt the meter back to open the mercury switch.
6. Now observe the meter reading; this represents 1·95 seconds or 70 per cent braking efficiency.

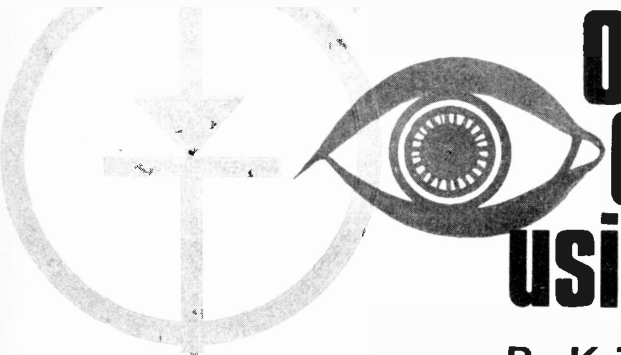
A number of readings should be taken to ensure consistency and, where necessary, VR1 can be adjusted to bring the meter reading to some convenient value on the scale. Pendula can, of course, be rigged to represent the retardation times associated with any braking efficiency. Table 1 gives relevant information for a number of braking efficiencies.

BATTERY TEST

The performance of the brake meter is obviously dependent on the battery condition and the question arises of when the battery is considered to be exhausted. A partially exhausted battery will tend to recover when not used, but the current drain from it will gradually fall when it is switched on. This is indicated by a noticeable slowing of the meter response. The battery test then, is as follows:

1. Tilt the meter to close the mercury switch.
2. Switch on S1 and observe the needle rise to full scale deflection (timing it if possible). Leave the meter tilted and switched on for some 5 minutes and then switch off.
3. Now tilt the meter, switch on and observe that the needle response is not noticeably slower. If it is, then replace the battery.

The battery used in the brakemeter is a 9V transistor radio type PP3, though larger capacity batteries of the same supply voltage will give satisfactory performance for a longer period without replacement. ★



OPTICAL COMMUNICATION using LASER DIODES

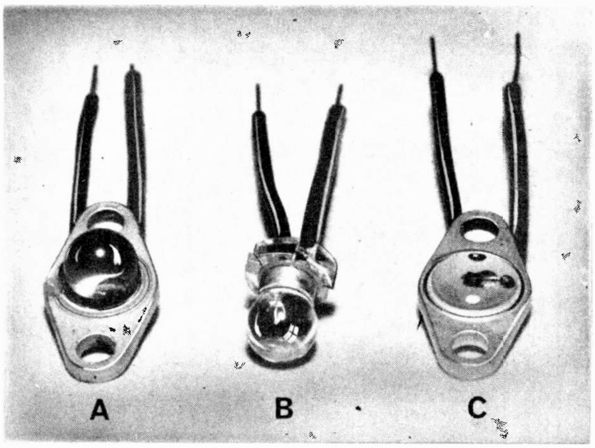
By K.T. WILSON

WITHIN the last few years, light emitting diodes have become an important source of coherent light. Gallium arsenide was the first material used for this purpose; gallium phosphide diodes are now in production; laser diodes using silicon carbide are more recent. The effect is not new (it was first reported in 1932) but only now has semiconductor technology advanced sufficiently to produce optical diodes with a usable output.

THE GALLIUM ARSENIDE DIODE

The appearance of some commercially available gallium arsenide diode lamps is shown in the photograph. Essentially the structure is of a *pn* semiconductor diode, surrounded by a sphere of resin which focuses the radiation into a narrow cone. This sphere may be regarded as a matching device which couples the gallium arsenide light source efficiently to air.

Electrically, the gallium arsenide diodes behave like any other semiconductor diodes, having a forward current/voltage characteristic as shown in Fig. 1. At forward currents of more than 2mA light is emitted and at higher current levels, the graph of light output against diode current is linear (Fig. 2). As with any other semiconductor device, the junction may be damaged by excessive current (due to local overheating) and a maximum continuous current is specified by the manufacturer (100mA in the case of the GAL 1). The diodes may also be used with short pulses, and a maximum pulsed current (3A for the GAL 1) is also specified.



Two types of gallium arsenide diodes. (A) and (C) show the high power diode (10mW at 1A) GAL 2, with alternative optical couplers, and (B) shows the lower power diode GAL 1
(Plessey)

Optically, the diodes behave as point sources of light with an extremely small time constant (unlike an incandescent filament lamp). These characteristics make it possible to obtain a beam which diverges very little from the parallel ray condition when the diode is placed at the focus of a lens, and to modulate this beam at high frequencies (flat response to modulation frequencies up to 75MHz is claimed).

COMMUNICATIONS USING THE GALLIUM ARSENIDE DIODE

The range over which an effective beam can be sent is difficult to calculate; most published reports work on the assumption that the diode is slightly off the focal point of the lens and forms a focused image at some distance from the lens (Fig. 3). In this case, the magnification of the image is given by v/u, and the area of the image by $a(v/u)$ where a is the area of the source.

A better though more difficult approach is to calculate the divergence of beams from the focal point of the lens using a more accurate formula for lens refraction. This method indicates rather less beam divergence and agrees with the results found in practice, where divergencies of less than 1cm in three metres could be easily obtained using cheap lenses.

In practice, the gallium arsenide diode may be used for communications over a considerable distance, despite the very low power output of 0·5mW, provided that the transmitting diode is located accurately at the focus of a lens and that the receiver is equally able to focus the received beam on to a suitable receiving device.

The choice of receiving device is important, for the emission from the gallium arsenide diode is in the infra-red region. Although infra-red radiation is invisible to the naked eye, high power pulsed conditions can cause the eye to fluoresce giving the appearance of a red glow. Close viewing of a diode under these conditions may result in damage to the eye, but under the operating conditions described in this article, the diodes are rendered completely safe to use.

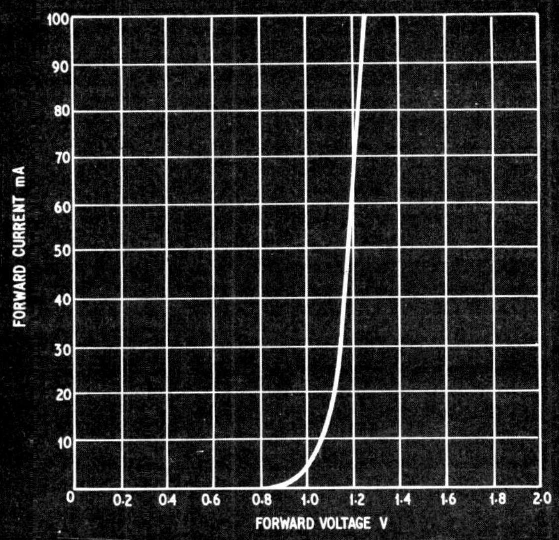


Fig. 1. Forward characteristic of the gallium arsenide diode GAL 1

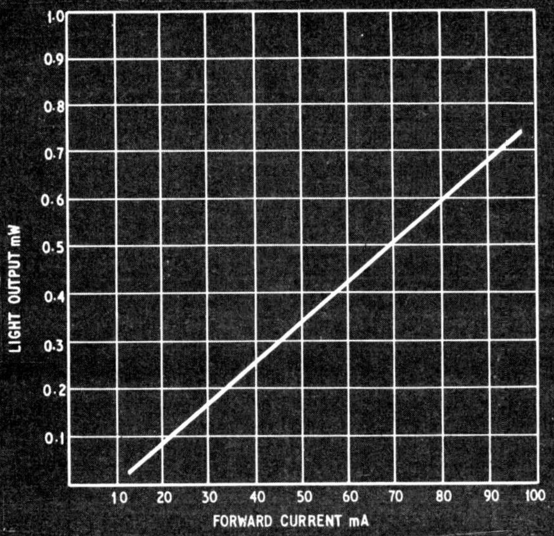


Fig. 2. Typical light output of the GAL 1 diode when pulsed at 25° centigrade

COMMUNICATION EXPERIMENTS

Where long-range working is not required, a phototransistor of the OCP71 family may be used as the receiving device; alternatively, the paint may be scraped off any glass encapsulated transistor. The phototransistor should be mounted at the focus of a parabolic mirror as shown in Fig. 4.

The focus is the point at which parallel rays all meet, and it is most easily found by placing a small light bulb near the mirror and adjusting its position until the projected beam is of the same size as the mirror; an old car headlamp reflector is ideal. The position of the focus is shown by the position in which the bulb filament was mounted.

The phototransistor may be mounted with Plasticine and the leads taken to an amplifier such as is shown in Fig. 5. The mirror should be earthed to avoid pick-up of mains hum. The gain should be high enough to give a loud noise output when the equipment is used indoors in darkness.

One difficulty should be mentioned here; if the phototransistor is exposed to sunlight, maximum current flows in the collector circuit of TR1 and the transistor "bottoms", hence no signal is available to the amplifier. If the phototransistor is exposed to light from an a.c. mains source, then a strong 50Hz

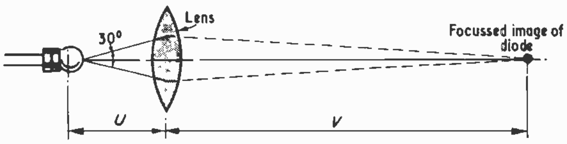


Fig. 3. Focusing the beam—for the lens to focus all the radiation from the diode its diameter should be more than twice its focal length (u)

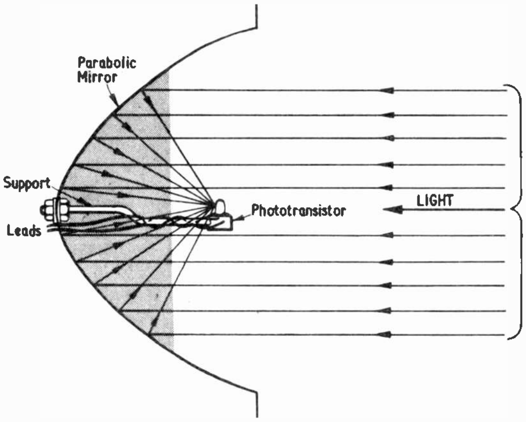
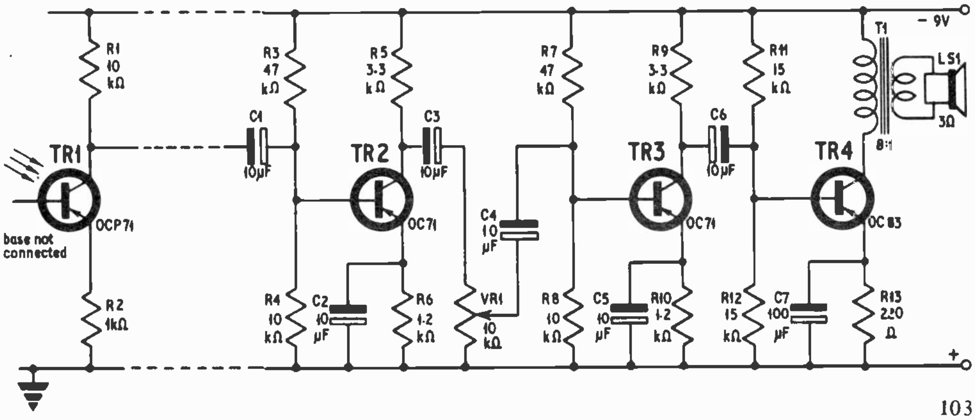


Fig. 4. Phototransistor mounted in the parabolic mirror

Fig. 5. Circuit diagram of optical receiver



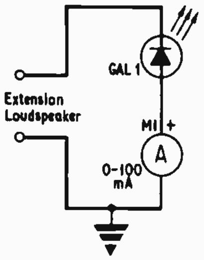


Fig. 6. Test circuit GAL 1. This should not be attempted if the radio or tape recorder chassis is not earthed or if one side of the mains is connected to chassis (live)

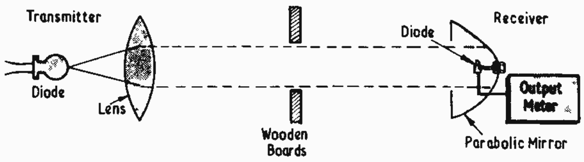


Fig. 7. Set-up for measuring effective beam-width. The boards are moved together until the output meter reading falls by 10 per cent, this is the effective beam width

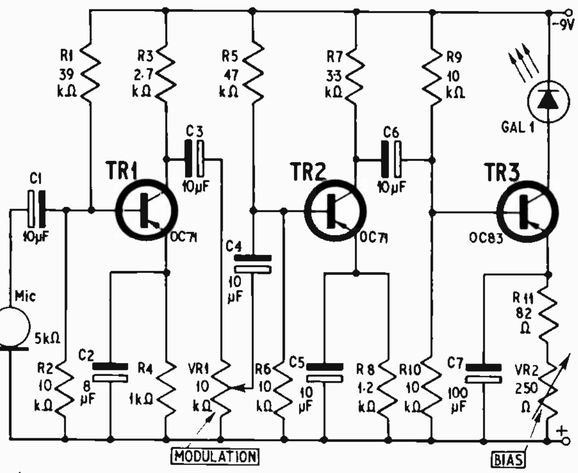


Fig. 8. Basic transmitter circuit for use with the GAL 1 gallium arsenide diode

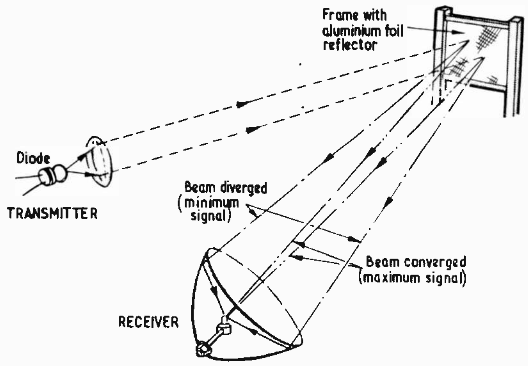


Fig. 9. Set-up for a reflective communication system using an aluminium foil reflector

note is heard (this is a good way of checking that the receiver is working). Later, we shall describe methods of avoiding such effects, but they are no hindrance to experimental work if they are borne in mind.

TESTING THE DIODE FOR POSITION

Once the receiver is working, the diode can be tested. A quick test method is to connect the diode across the extension loudspeaker socket of a radio set or tape recorder, using a milliammeter to check the mean current through the diode (Fig. 6). The diode rectifies any a.c. feeding to the milliammeter. The modulated light transmitted by the diode is of only half the audio waveform, so that the sound heard on the receiver is very distorted. This is of no importance when setting up to investigate focusing and range.

Using a lens of about 10cm focal length in front of the diode, and adjusting for the loudest note on the receiver, the beam width can be determined as shown in Fig. 7.

ACTIVE COMMUNICATION SYSTEMS

To avoid the distortion due to diode rectification, sufficient standing current must be passed to prevent the diode from cutting off during audio peaks. Fig. 8 shows a suitable circuit for modulating a gallium arsenide diode from a dynamic microphone. It is also possible to transmit using a carbon microphone, battery, and diode, but the standing current is variable and the quality poor.

For maximum range, the parabolic mirror on the receiver should be fitted with a filter to exclude light outside the infra-red region. Such filters are obtainable from large photographic dealers; failing this, deep red filters as found on the older type of darkroom safelights may suffice. For maximum sensitivity the phototransistor should be replaced by a silicon photovoltaic diode, which has maximum sensitivity at the wavelength emitted by gallium arsenide diodes.

The main disadvantage of this type of communication system is that one cannot have both range and portability. For maximum range, the beam must be near parallel and the transmitter must be precisely aimed at the mirror of the receiver. This can be achieved only if both are fixed, having been lined up for maximum signal strength.

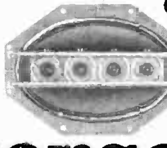
The beam can be broadened by removing the lens, or reducing the distance between diode and lens so that the beam spreads out. There is then little difficulty in locating the receiver with the beam but, since only a fraction of the spread beam is intercepted by the receiver, the signal is attenuated. This condition can be acceptable, but only for short range work.

MODULATED REFLECTOR

The use of gallium arsenide diodes in reflective communicating systems is one of the most fascinating fields open to the experimenter. The principle is shown in Fig. 9, the gallium arsenide diode emits a continuous unmodulated beam. The beam is kept narrow by using a lens with the diode at the focus. The aluminium foil reflector reflects this beam back to the receiver, which is of the same form as that detailed earlier. If the aluminium foil is now vibrated its movement causes the reflected beam to be diverged and converged alternately so that the beam at the receiver varies in amplitude in sympathy with this vibration.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the help given by the Alan Clark Research centre and the Components Division of Plessey Ltd. in the preparation of this article. ★

How do you measure the extra quality of EMI  speakers?

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16V ..	2·5	10	20	40	80	125	250	400	640	1,000
25V ..	1·6	6·4	12·5	25	50	80	160	250	400	640
40V ..	1	4	8	16	32	50	100	160	250	400
64V ..	0·64	2·5	5	10	20	32	64	100	160	250
Prices:	1/– each			10d. each			**1/3**	**1/6**	**1/9**	**2/6**

	(Large)				
25V	800	1,250	2,000	4,000	6,400
40V	500	800	1,250	2,500	4,000
64V	320	500	800	1,600	2,500
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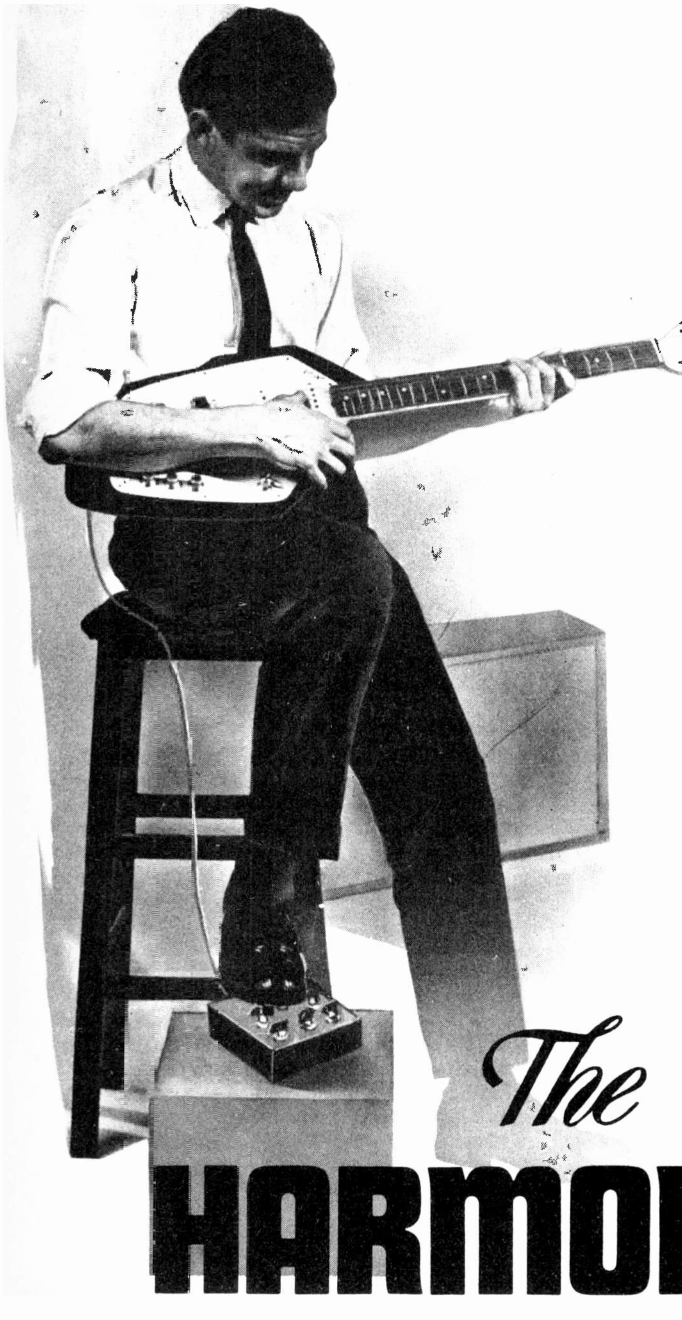
A simple electronic device for augmenting, in an unusual way, the sounds of guitars and many other instruments with magnetic pick-ups or microphones. Gives "fuzz" and "subs".



The HARMONAPHONE

By M.P.R. HAMER

THE colouring of the sound of a fundamental tone from a musical instrument depends on the number of harmonic overtones present, besides the fundamental, and the range over which these harmonics are spread. It is very rare for a note from a musical instrument to contain many sub-harmonics—frequencies lower than the fundamental note. Several electronic devices which are on sale to the general public produce changes in the sound of a note by artificial means; a treble booster, for example, can amplify the harmonics at higher frequencies to a greater degree than the lower ones, but this has the effect of reducing the fundamental tone to give the sound more "force".

On a large number of modern records, however, engineers often dub a piano or organ, playing along with a guitar in order to give the guitar a greater body of sound.

The "Harmonaphone" provides a simple means of augmenting the sound of a single instrument, without the use of additional instruments.

OPERATION

The "Harmonaphone" adds sub-harmonics f_1 and f_2 on to any note which is fed into it. The output of the device is controlled by the mixer unit, in which the relative volumes of the direct signal (f), sub-harmonics f_1 and f_2 and a square wave signal of the fundamental frequency, can be adjusted to give a wide range of different effects. The square wave signal produces the standard "fuzz" effect.

It will be found that a rather unpleasant sound is produced if more than one note is fed into the input at the same time. A foot-switch is therefore included to switch the Harmonaphone "in" and "out". This means that, with a guitar, for example, chords should only be played with the Harmonaphone switched out, and the Harmonaphone switched in for guitar "breaks" by means of the foot-switch.

The Harmonaphone has one input into which is plugged the magnetic or acoustic pick-up fitted to a guitar or similar instrument, or microphone placed in front of an instrument (e.g. oboe, flute, clarinet).

CIRCUIT FUNCTION

The input signal is fed into a pre-amplifier, which is connected to the input of a Schmitt trigger (see Fig. 1). This is turned on by the one edge of the "sine-wave" input, and off by the other edge (Fig. 2).

The two switching voltages are made distinctly different by the different values of the collector resistors in the triggering circuit. The reason for giving the trigger such a large hysteresis is that the input signal often contains harmonics of quite large amplitude, superimposed on the fundamental, and these can cause double triggering if the trigger has a small hysteresis.

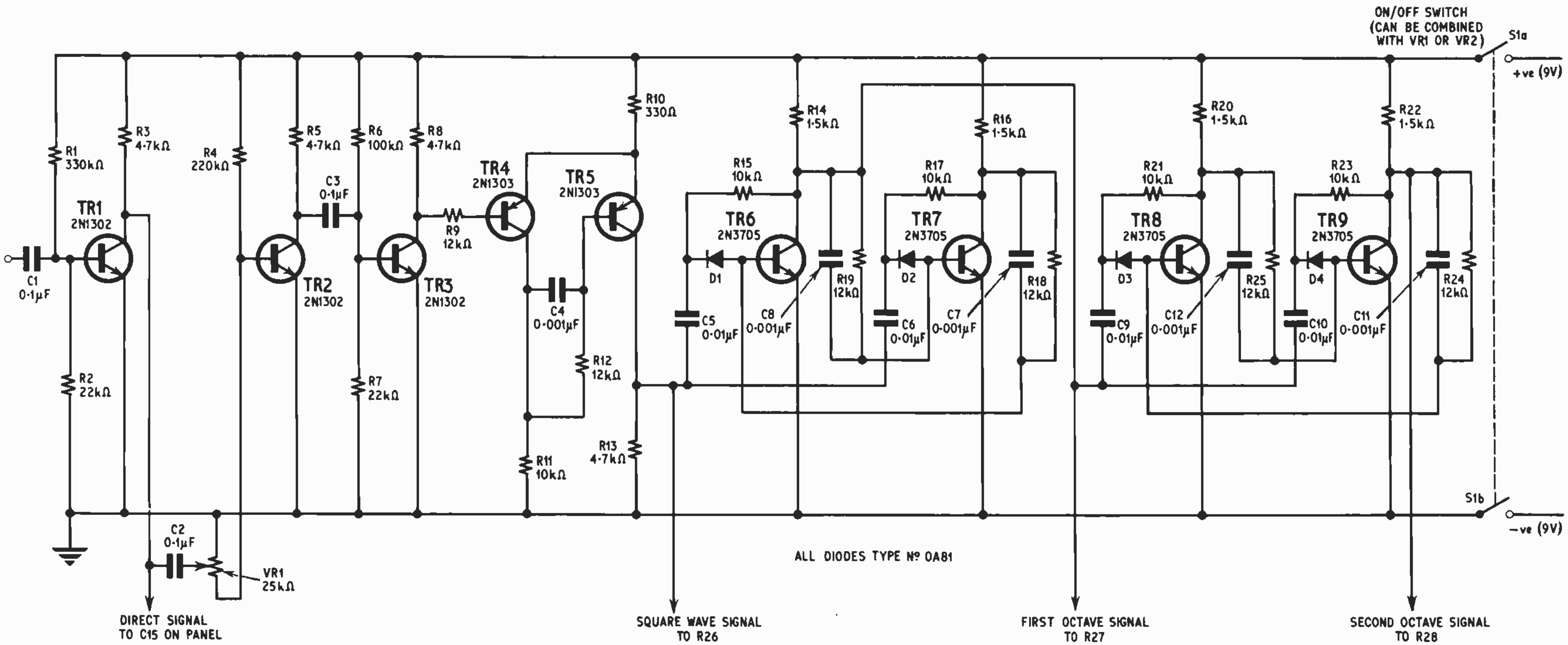


Fig. 1. Circuit diagram of the amplifier, squarer, and dividers (refer also to Figs. 3 and 4)

COMPONENTS . . .

Resistors

Pre-amp		*Trigger*		*Divider 1*		*Divider 2*		*Mixer*	
R1	330kΩ	R9	12kΩ	R14	1·5kΩ	R20	1·5kΩ	R26	33kΩ
R2	22kΩ	R10	330Ω	R15	10kΩ	R21	10kΩ	R27	33kΩ
R3	4·7kΩ	R11	10kΩ	R16	1·5kΩ	R22	1·5kΩ	R28	33kΩ
R4	220kΩ	R12	12kΩ	R17	10kΩ	R23	10kΩ	R29	100kΩ
R5	4·7kΩ	R13	4·7kΩ	R18	12kΩ	R24	12kΩ	R30	100kΩ
R6	100kΩ			R19	12kΩ	R25	12kΩ	R31	100kΩ
R7	22kΩ								
R8	4·7kΩ								

R32 Resistor to reduce relay battery consumption. Find maximum possible value by experiment (see text)

All ±10%, ½W carbon

Capacitors

Pre-amp		*Trigger*		*Divider 1*		*Divider 2*		*Mixer*	
C1	0·1μF	C4	0·001μF	C5	0·01μF	C9	0·01μF	C13	0·05μF
C2	0·1μF			C6	0·01μF	C10	0·01μF	C14	0·1μF
C3	0·1μF			C7	0·001μF	C11	0·001μF	C15	0·05μF
				C8	0·001μF	C12	0·001μF		

All capacitors can be paper, polyester or polystyrene types

Transistors

Pre-amp
TR1, TR2, TR3 } 2N1302

Trigger
TR4, TR5 } 2N1303

Divider 2
TR8, TR9 } 2N3705

Divider 1
TR6, TR7 } 2N3705

Diodes

D1, D2, D3, D4 OA81 (4 off)

Potentiometers

VR1 25kΩ Linear
VR2*, VR3, VR4, VR5 100kΩ Linear carbon
* One potentiometer (VR2) to have built in switch S1, unless a separate on/off switch is used

Miscellaneous

S2 Footswitch single-pole push button push on, push off
RLA 9V relay, two-pole, two-way (see text)
Two-pin socket or two single sockets
Standard jack socket
Standard jack plug
Printed circuit board 4in × 2½in
Metal case (see text), knobs

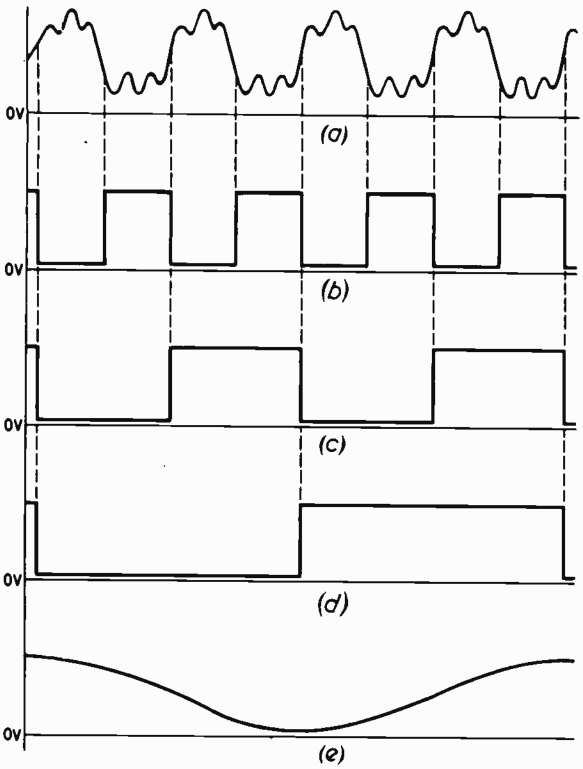


Fig. 2. Waveforms, based on the fundamental tone, appearing at different parts of the circuit
(a) Input signal
(b) Output of Schmitt trigger (TR5 collector)
(c) Output of first divider (TR6 collector)
(d) Output of second divider (TR9 collector)
(e) Output after being fed through RC filter in mixer

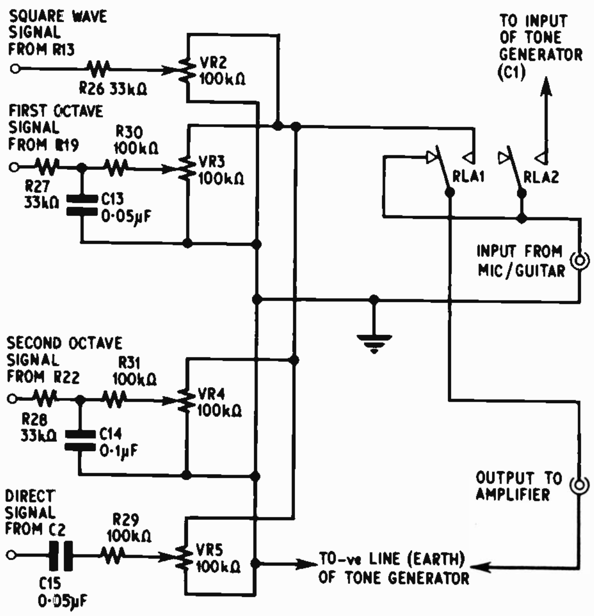


Fig. 3. Mixer and filter circuit with relay contact, input, and output connections

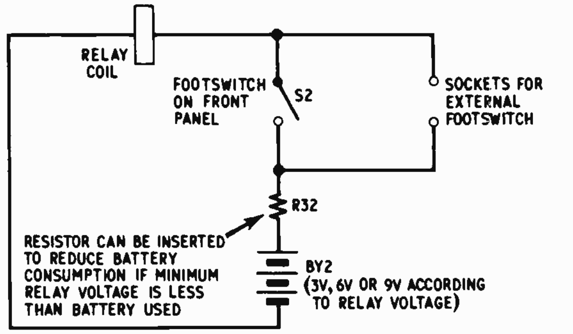


Fig. 4. Independent relay circuit. The relay can be any type with two or more changeover sets. Battery voltage and R32 depend on the relay

A potentiometer (VR1) is included to adjust the amplitude of the signal fed into the Schmitt trigger. This is adjusted so that the device works for the quietest notes, but is not sensitive to background noise. The output of the trigger, which is a square-wave of the same frequency as the input note, besides being used for the "fuzz" effect, is fed into two bistable frequency dividers in series. The output of each of these is taken from the collectors of one transistor in each divider.

In the mixer (Fig. 3) the square-wave signals from these dividers are passed through RC filters to produce sine wave signals. These two signals, and the square wave for the "fuzz" effect, are each fed to one of three potentiometers, which are used to vary the combination of signals in the output. The total signal generated by the device is then added to the original signal, which is taken from the collector of TR1, and whose volume is controlled by a fourth potentiometer. The final signal is fed via the output lead to a power amplifier.

COMPONENT NOTES

The pre-amplifier has three transistors, each having its emitter grounded, so as to give maximum gain. If the transistors used have low gains, or the input signal from the microphone or pick-up is very weak, it may be necessary to double the first stage of the pre-amplifier. This is mentioned later.

The gain of the pre-amplifier should be such that the device will oscillate through internal feedback with VR1 turned to the maximum sensitivity position. *PNP* transistors may be used in place of *npn*, and vice versa, provided that the battery connections and diodes are reversed. The printed board may also have to be altered.

The battery voltage for the device is given as 9V, but this is far from critical. A separate battery is used to operate a relay, switching the device "in" and "out". The relay is operated by a footswitch, which can be either on the front panel of the Harmonaphone, or in a remote position. The battery voltage for the relay is chosen according to the relay used and a resistor can be included to reduce the relay current if a convenient battery delivers too high a voltage (see Fig. 4).

The transistors used in the trigger and dividers need not be of particularly good quality, as they are only used for switching. Therefore, if substitutes are used for those suggested, a great deal of expense is not necessary.

The transistors in the pre-amplifier, however, should be of reasonable quality. The diodes can be of almost any type and component values in the dividers are not critical.

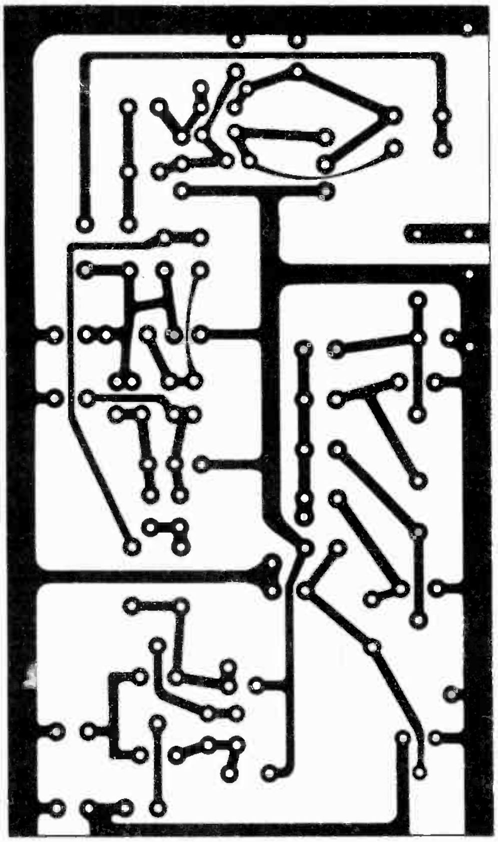


Fig. 5a. Full size printed circuit pattern on the back of the board

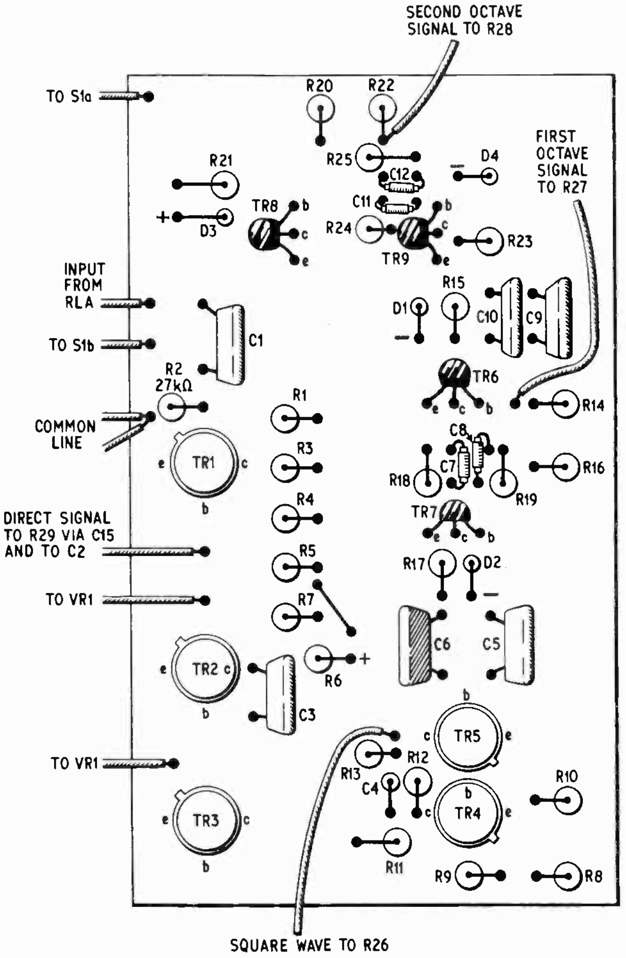


Fig. 5b. Layout of components with transistor connections and leads to mixer

If the device is not housed in a metal case, it is advisable to use screened wire for some of the longer leads, especially in the input circuit.

CONSTRUCTION AND TESTING

As the circuit is fairly complex, a printed circuit board for the tone generator will greatly reduce the size and complexity of the device. The complete layout for such a board is shown in Fig. 5. All resistors are mounted vertically and transistor connections are planned for 2N1302, 2N1303, and 2N3705 transistors, as stated in the component list. Equivalent transistors may, of course, be used, but the 2N3705 was chosen because it is a small transistor, adequate for use in the divider circuits. In the prototype the printed circuit board was 4in × 2½in and is shown full size.

The printed circuit board should be constructed, wired, and checked. When an input signal, say from a signal generator, is connected to the input, a square wave signal should appear on TR5 output when VR1 is adjusted to a suitable setting. At the same time, square wave signals one and two octaves lower should appear on TR6 collector and TR9 collector respectively.

Care should be taken in connecting the battery, as each side has to be connected at two different points on the board and confusion can easily occur.

Once the tone generator is complete and tested, the construction of a box for the device can be started. A suggested layout for the front panel is shown, as viewed from behind (Fig. 6). The mixer circuit is wired in the box, the tags on the potentiometers providing supports for the components. Both a footswitch and sockets for an external footswitch are shown in the diagram.

If extra contacts are available on the relay, these can be used to switch on the tone generator, in order to reduce battery consumption. This is, however, perhaps an unnecessary precaution and has the disadvantage that the footswitch may accidentally be left in the on position. The use of a separate on/off switch is therefore advisable. This can be combined with a potentiometer, for example, VR2.

If the battery provides a larger than necessary voltage for the relay, a resistor should be included to reduce battery consumption. The value of this must be found by experiment. When a suitable value has been found for a new battery, it should be checked with an old one

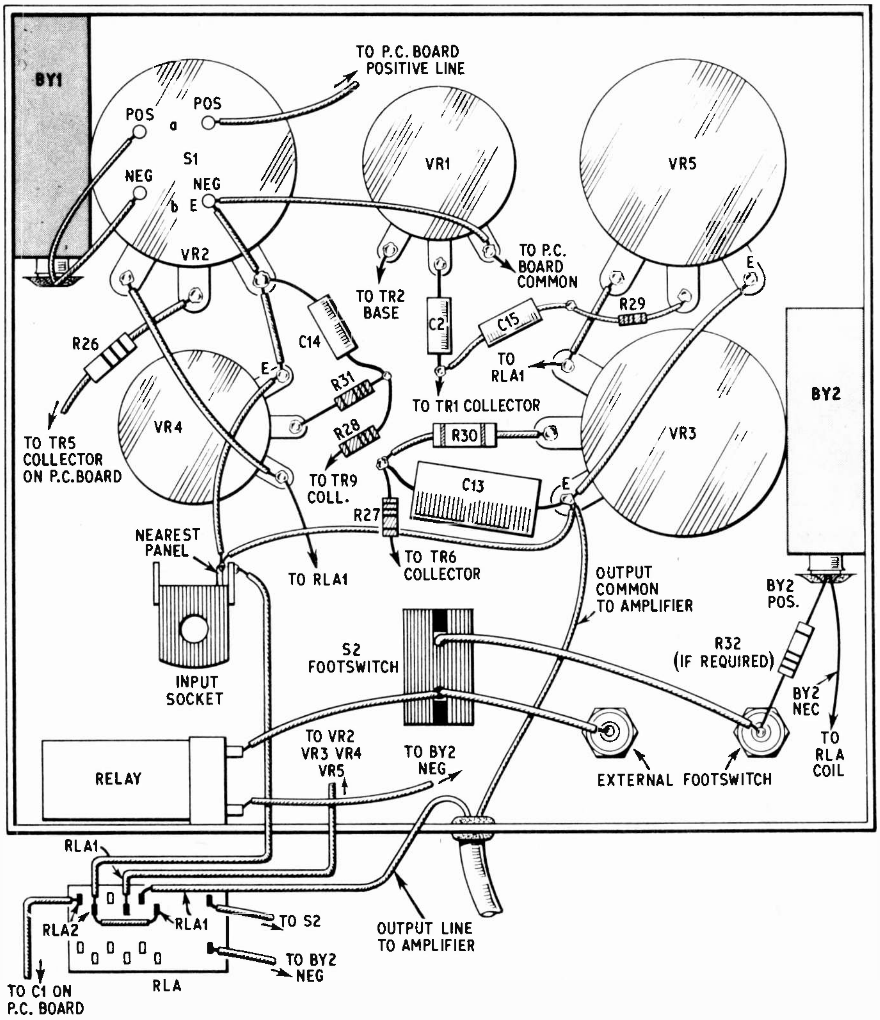


Fig. 6. Layout and wiring of the mixer and relay circuits inside the box. Connections to the printed circuit board are also shown

and reduced if necessary. The actual relay type is not important so long as it has at least two sets of change-over contacts.

Two jack sockets can be mounted on the panel for output and input, or one socket for input and a lead (screened pair) with a jack plug for the output. The leads to the printed circuit board need not be screened if the box is metallic and connected to the earth line.

The board should be mounted in a manner that gives easy access to the back of the panel for alterations or repairs and for this the wires to the board should be long enough to enable the board to be withdrawn a few inches out of the box. If the top of the board faces upwards, it should be checked that none of the components touches the clips on the batteries or the components of the mixer unit or, indeed, the case.

The prototype fitted easily into a metal box, about 6in × 6in × 2in. The front panel was the top face of the box and a hinged lid formed the base of the Harmonaphone. The lid was fastened by one screw, so that the batteries could be replaced easily. None of the wiring under the front panel (the mixer unit) filled the box to a greater depth than the potentiometers on to which the wiring was attached. The potentiometers were mounted so that they formed ready-made battery retainers with the walls of the box (see Fig. 6). The relay was bolted to the side of the box.

The printed circuit board (tone generator) was insulated from the metal base of the box by means of padding, which also protected it against damage. It was found unnecessary to mount the board rigidly in the box. Instead a square piece of foam rubber, about ¼in thick, was layed over the wiring of the front panel; the printed circuit board was sandwiched between this and the felt padding, which was glued to the lid of the box. Hence the board was both insulated from the wiring of the front panel and the metal box, and was cushioned against blows on the box itself. Also, of course, this arrangement makes access to both the board and front panel wiring very easy.

If one wishes to mount the board on rigid supports, the wiring in the box should be carefully planned and insulated, to ensure that none of it can touch the printed circuit board. Also, provision must be made for bolts or nuts fastening the board to these supports, possibly by making the board slightly larger. The supports

The complete Harmonaphone ready for use

could be fixed to the front panel, but preferably to the lid, so that access to both the board and panel wiring is possible when the lid is lifted. In this case the wires to the board are best made a little longer.

If it is found that the gain of the pre-amplifier is not adequate, either because the transistors used have poor gains, or the pick-up used with the Harmonaphone has a very low output, an additional stage of the pre-amp can easily be added to the wiring on the back of the control panel.

An additional 2N1302 can be supported by soldering its emitter lead to any point connected to earth (negative), either on a potentiometer or the input socket. The original input line is then connected to its collector which is connected through a 4·7 kilohm resistor to the positive supply.

A 22 kilohm resistor is connected between emitter and base, which is connected to the input socket via a 0·1μF capacitor and through a 330 kilohm resistor to the positive supply line. This doubling of the first stage of the pre-amp should, however, be unnecessary if high gain transistors are used. A high gain 2N2926 could be tried.

Finally, rubber feet can be glued on to the base of the Harmonaphone case to prevent it sliding across the floor when the footswitch is used.

SETTING UP

In setting up the device, the pick-up or microphone is plugged into the input, and the output of the device into the amplifier. The amplifier volume is adjusted to the desired level. The on/off switch is then switched on and the foot-switch put in the "on" position.

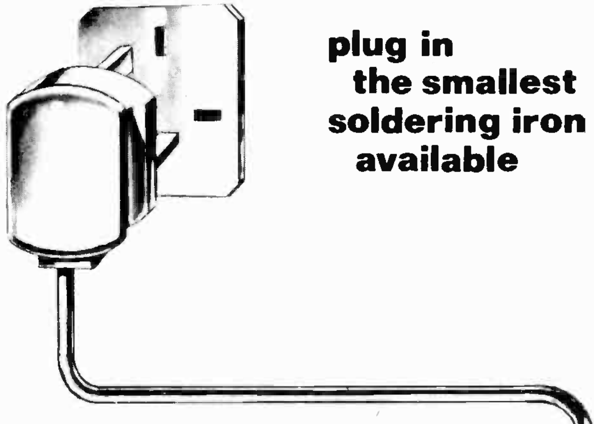
The "fuzz" volume (VR2) is turned up slightly, then the sensitivity control (VR1) is turned up, while the instrument is being played, until suitable triggering is obtained. Then the "fuzz" volume is turned off, and the direct signal volume (VR5) adjusted to give the required direct signal volume, this being of the same order as that when the foot-switch is off. Then the three other volumes ("fuzz", first octave, and second octave) are adjusted to give the desired sound.

The best results are obtained with instruments which produce the purest notes. If the harmonics are too strong, the Schmitt trigger may seem unable to "make up its mind" which signal it is responding to. The result is a yodelling sound, as the output changes from one octave to another.

In this case a filter can be put in the input. This will depend on the type of guitar and pick-up and is a matter of experiment. Often a bass-booster or treble-booster, included between the pick-up and Harmonaphone input, will eliminate many unwanted harmonics. If it is intended for use with one instrument only, then the filters found to produce the best input signal can be built into the Harmonaphone.

USE OF THE HARMONAPHONE

In small groups and bands the Harmonaphone provides an excellent means of producing a "full" sound. It may even be used to provide bass when the group is lacking a bass guitar or double bass, but does have an ordinary guitar. Also, it has the advantage that the output sound has only a slight dependence on the input sound. Consequently, even a very simple wind instrument, such as a recorder, may be used to produce a church organ sound if the amplifier, into which the Harmonaphone is plugged, has reasonable echo or reverberation facilities. ★



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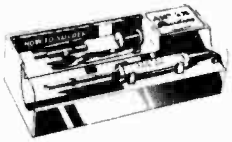

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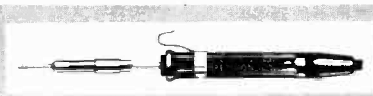

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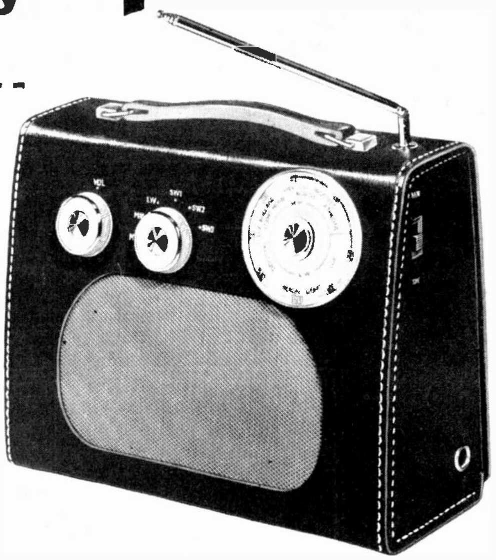

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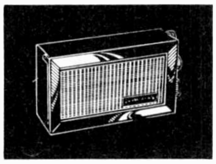

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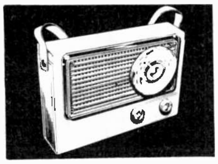

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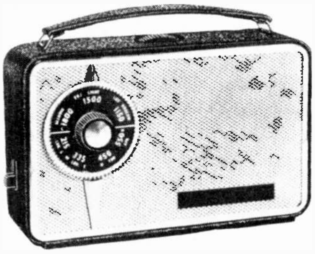

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MAKING MUSIC

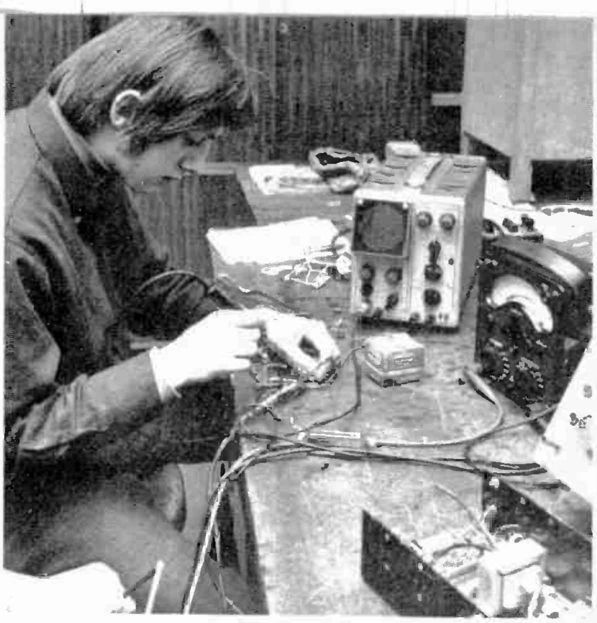
THE increasing demand for technologists, especially in electronics, is evident when scanning the Situations Vacant pages of the National Press. Headmasters of Secondary Schools and Technical Schools are beginning to introduce electronics in some form or other to boys who have a basic interest.

Some Colleges organise special courses in this subject while most tend to rely on the conventional City and Guilds or National Certificate courses. In the former category, the London College of Furniture runs an extensive two year course covering either Pianoforte and Harpsichord Construction and Tuning, or Electric and Electronic Musical Instrument Technology. The latter is an intensive course covering design and servicing, leading to the College Diploma and possibly the Graduateship of the Institute of Musical Instrument Technology.

The syllabus includes lectures from well-known experts who visit the College, including David Mawn, Ralph West, William Walker, Gerald Van Epps, Derek Underdown, R. Twydell, and L. R. Avery (all well-known in this field) as well as others who are experts in special branches.

Students have visited various firms who manufacture electronic musical instruments, such as the Hammond Organ Co., Selmer, Livingston, Hohners and Hill, Norman & Beard (pipe organs) as well as seeing educational films. A recent special course for service engineers was attended by forty men from all parts of the country, and ten firms sent their organs for demonstration by their leading designers; this was at the request, and had the full support, of the Association of Musical Instrument Industries.

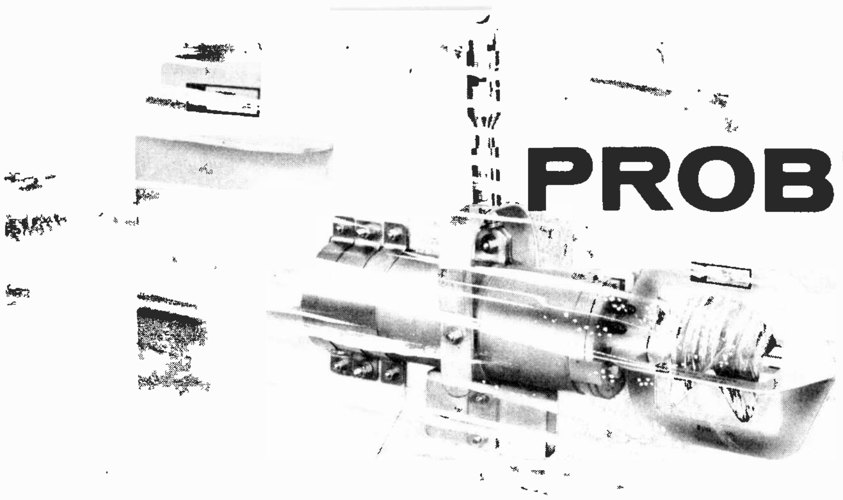
The Lecturer in charge of the Musical Instrument Technology section, Mr J. W. T. Roope, will be pleased to offer any further information if interested readers would write to him at the London School of Furniture, Pitfield Street, London, N.1. ★



Roderic (from the Isle of Wight) is constructing a "fuzz box"

Paul (who began his electronic work in Belgium) is working with a digital frequency meter

Students from London, Wales, Cornwall and Cyprus working on their various projects



PROBING THE OCEAN

PART 2

By P. R. HINCHCLIFFE B.Sc.

LAST month's article outlined the electronic methods used to determine depth, pressure, temperature, and salinity of the ocean. Special studies will now be described, including water flow speed (current), light absorption, topography, chemical analysis, and gravitational influences.

CURRENT MEASUREMENT

Originally current measurement was a simple task, one merely had to take down the sails of the survey boat and observe the drifting of the boat. However, the modern oceanographer is interested not only in surface currents but also those at all depths below the surface.

There are two distinct problems to be tackled here. First, path measurements, the following and charting of entire currents and measurement of current velocity in different places along the current. This may be done by a series of methods, including the use of polythene envelopes and weighted bottles, which rely on the assistance of fishermen, who recover the objects, record their position and time of recovery, and send them back to the research station.

For deeper work, a reject parachute or metal drogue may be moored to a radio buoy and pulled along by the current.

For accurate path measurements a "swallow float" is used. This is made up of two hollow metal tubes, one of which carries the electrical apparatus necessary to work a "pinger" and the other is weighted carefully in such a way that it maintains the required depth.

The pinger is a simple device (Fig. 12), giving a repetitive audio "ping" through the water. C1 is charged to 360V via R1. C2 is charged via R2 to the trigger voltage of the discharge tube, causing the tube to conduct, discharging C1 through the transducer, and discharging C2 to restart the cycle. The resultant output causes the transducer to go into severely damped mechanical oscillations of about 10kHz, giving a sound in the water similar to a muffled bell.

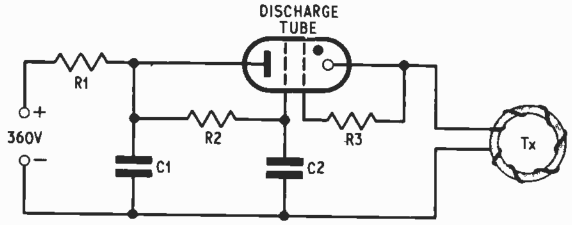
The repetition rate of the ping is controlled by the time constant of R_2C_2 and is of the order of one ping per second. By using two vertical arrays of hydrophones below a ship, the depth and position of the float may be followed from some distance away.

The second set of current measurements required are flow measurements—the variation of current velocity and direction with time at one point in the sea. The main problems involved here are those of mooring a current meter in one position, as mooring wires must be slack enough to allow for tidal and wave motions. However, once these problems are overcome, electronics offers us a variety of means for measuring currents.

CURRENT METER

The typical current meter has a layout similar to that of the salinity, depth and temperature probe described

Fig. 12. Acoustic pinger



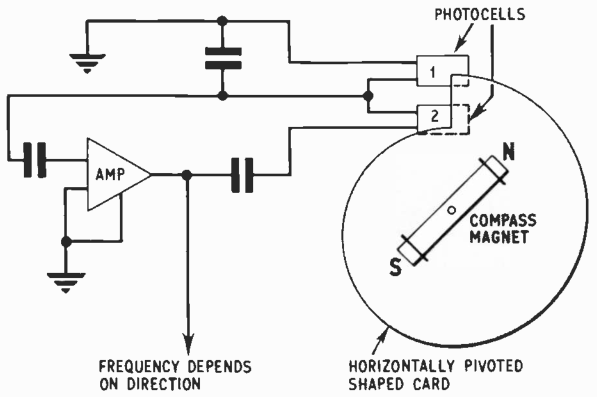


Fig. 13. Direction transducer for current meter

earlier. Again, three frequency channels are used, for current direction, velocity, and depth. The depth sensor is usually a vibrotron as on the s.t.d. probe.

The current direction indicator consists of a compass needle stuck to a shaped card (Fig: 13). As the meter rotates due to the action of the current on its direction fins, the compass "follows" the North and South poles and the areas of the photocells illuminated by a light above the probe are varied. This alters the ratio of the resistance of one cell to that of the other cell, which in turn controls the frequency of the Wien bridge oscillator network—hence we get the direction of current analogued by the frequency of a signal.

The current is made to turn a savonius rotor (interlocking semi-cylinders, a form of rotor which is more sensitive than an ordinary propeller) which operates a series of switches via a magnetic coupling through the hull of the meter. These switches key a 100kHz oscillator, the pulses from which operate a 5·5kHz standard telemetry frequency. Hence in this case the information (current velocity) is given by the frequency of pulsing the carrier signal.

The three frequencies (including one for pressure) are fed up a cable via a swivel transformer. Coils are wound on each half of a split core, each half of which may rotate freely with respect to the other whilst maintaining electrical coupling to allow the meter to swing in the current.

Alternatively the frequencies may be stored on magnetic tape, dispensing with the need for heavy swivel transformers which may create a serious weight problem when many meters are on the same hawser. The discriminated signal may then be fed on to an X1, X2, Y recorder to give a plot of current and direction versus depth, or versus time at a known depth. The depth sensor is necessary due to the drifting of the hawser from the vertical position.

MEASUREMENT OF OTHER PHYSICAL PARAMETERS

Underwater available light, light absorption and turbidity of the water may all be measured using a suitable optical system attached to a conventional photocell or photomultiplier tube. One use of these measurements is underwater photography.

The deep sea camera is a useful tool for studying sea bottom creatures and sediment formations. It is lowered to the bottom and its progress is followed by a "pinger" trace as described in the section on depth measurement. When a trigger dangling below the camera touches the sea bed the flash guns fire, the film is wound on and the pinger rate is temporarily increased.

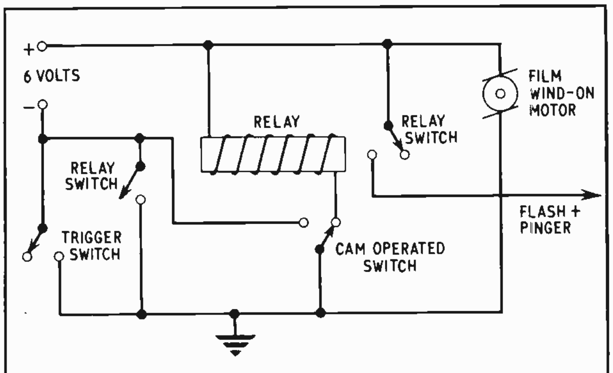


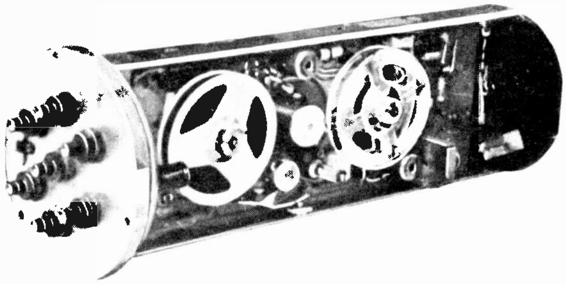
Fig. 14. Relay latching circuit for underwater camera

The crew on board ship then raise the camera slightly, following the height above the sea bed carefully on the pinger trace, move it to the next location and then repeat the process of lowering and taking the photograph until the film is finished.

The circuit involves a simple self-latching relay device (Fig. 14). The relay switches on the flash and motor and changes the pinger rate. On completing the film wind-on, the motor switches off the relay (hence resetting the latch) and subsequently switches off itself.

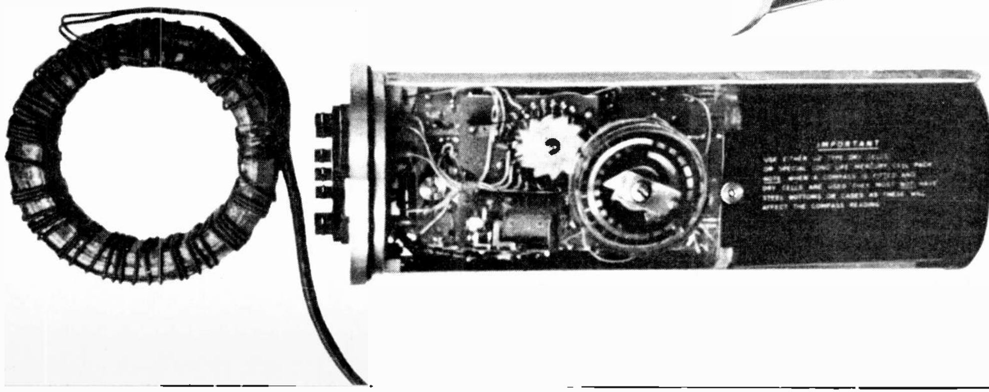
Two more parameters, which are really geological, are the variations in the earth's gravitational and magnetic fields with position on the surface. Ocean floor surveys of these parameters are very rewarding to the oceanographer, and the techniques used are worthy of mention here. The problem now is not to penetrate a hostile environment to take the measurements, but to measure minute but long period changes in the face of large and relatively short period fluctuation of the values to be measured.

For example, whilst the ship has been steaming for 15 minutes the acceleration due to gravity may have changed sufficiently to be measured, but during that time the apparatus on board ship will have been subjected to accelerations due to wave motion of up to 10,000 times



Current recording meter (right)—magnetic tape recorder for in situ data storage. The complete unit is shown in the heading picture (Plessey)

Magnetostrictive transducer (below) as used in "pingers" alongside current direction recording meter



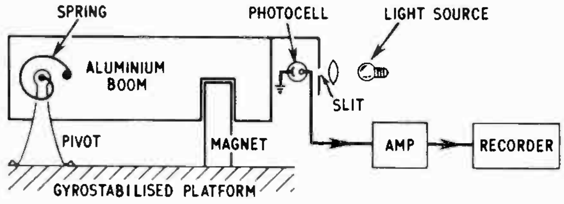
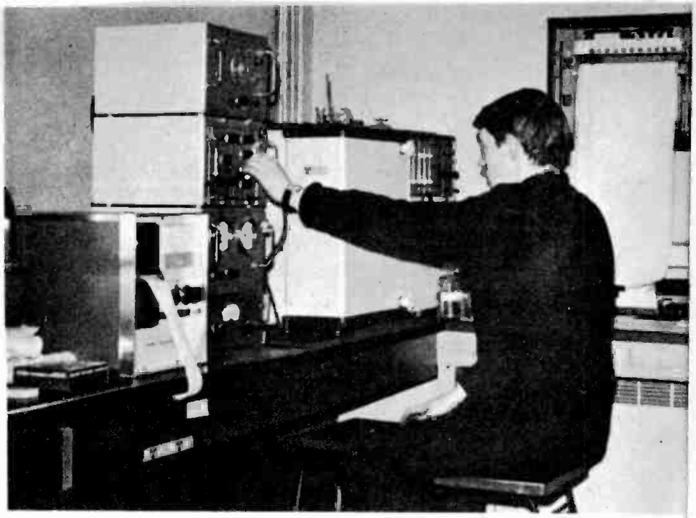


Fig. 15. Gravity meter



Panchromatograph gas-liquid chromatograph. The integrator is shown left, next is the control unit for the oven, then the oven, and far right is the pen recorder (Pye)

greater than the actual gravitational variations, say, once every 10 seconds. This difficulty is overcome by damping.

Fig. 15 shows a simplified gravity meter. The angle of the heavy pivoted boom varies with gravity. If it tries to move too quickly the magnet will induce eddy currents in the aluminium which damp the motion. In this way wave motion can be reduced by a factor of 1/250 for a 6 second period. An electrical filter may then reduce this still excessive "noise" by 1/10,000 or more.

The magnetic field variations across the Earth's surface are measured by variations in the rotational frequency of a proton about the field. This frequency is in the audio range.

Water is a good source of protons (hydrogen atom nuclei), and a plastic bottle full of it is towed behind the ship in a "fish" about 30ft below the surface and far enough behind the ship to be out of range of its magnetic field disturbances. Rotation of the protons is stimulated by applying a very strong polarising field and removing it suddenly.

Direct current is passed along the cable to the "fish" (Fig. 16) where it polarises the coil until the relay switches the coil over to the cable preamplifier. The resultant rotational frequency is then amplified on board ship and passed into a pulse shaper. Dividing by 500 creates spaced pulses which are used to start and stop a counter fed with a 1MHz stabilised signal.

If the frequency of proton rotation is f, the interval between start and stop of the counter will be $500/f$ seconds, and so the count will be $10^6 \times 500/f$. This may be conveniently recorded on a digtial readout, ready for computerisation. The initial voltage of each signal is about one microvolt, and this decays very rapidly (decay time of about 2·5 seconds), so the amplifiers must be tuned to the limits of the frequency variations to try to reduce noise.

ELECTRONICS IN CHEMICAL OCEANOGRAPHY

Chemical analysis techniques as applied to oceanography are becoming constantly more refined, and the chemist is relying more and more upon electronics.

The main use of electronics here is in temperature and light control, although there are other important uses. For example in a sensitive technique known as gas-liquid chromatography, the sample to be analysed is carried as a vapour in a stream of hot nitrogen through a tube packed with an absorbant powder coated in a suitable liquid solvent, which has the ability to separate the chemical components of the sample.

The tube, or column, must be kept either at an accurately constant temperature or else the temperature must rise at an accurately known rate. This is achieved using an electronic temperature programming unit

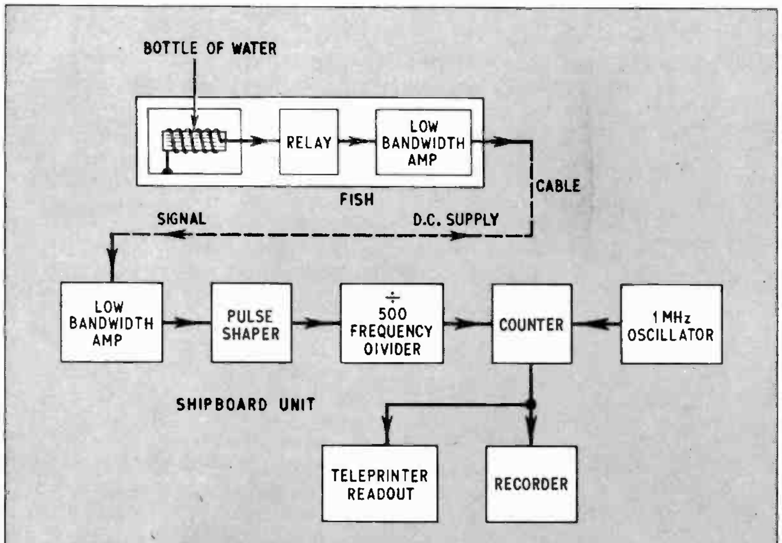
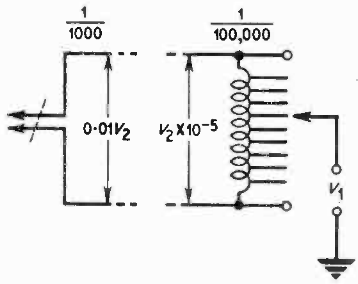


Fig. 16. Block diagram of a magnetometer

CORRECTION TO PART 1

The right-hand section of Fig. 9a should be as shown below. The letter "y" under "TEMP" in Fig. 11c should be under the word "DEPTH"



Part of Fig. 9a

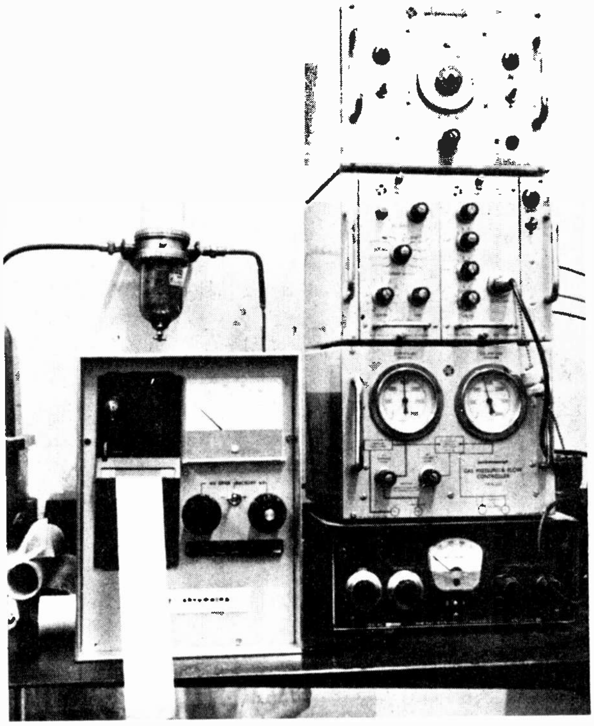
which relies on an accurate thermostatic device linked with an electronic clock.

Once the components of the sample are separated they must be detected in the issuing nitrogen stream. The stream is passed through a hydrogen/air flame, and when one of the sample components passes through the flame it burns up, ionising the flame and hence lowering the electrical resistance of the flame. This causes the applied voltage across the flame to vary with the amount of sample in the flame at different times. This voltage is recorded against time on a pen recorder, giving a series of peaks, each one representing a component of the sample.

As well as a visual indication of the composition of the sample, a measure of the relative quantities of the components may be obtained by attaching an integrator to the recorder input. When the signal from the recorder passes a certain "cut-off" level above the ambient signal, the integrator switches the signal via a d.c. amplifier to a sawtooth (RC) oscillator, the frequency of which is determined by the signal voltage.

The output is shaped, amplified and fed to an electro-mechanical counter, which changes the figures on a printing block. Hence the larger the signal the greater the frequency, and the greater will be the count over a given period of time.

When the signal drops below the cut-off level, the counter automatically prints the count on to a tape. This print-out is directly proportioned to the weight of the component in the sample. The figures are then easily converted to a percentage composition which is most useful in this sort of analysis.



Integrator unit and control unit for Pye panchromatograph gas-liquid chromatograph machine

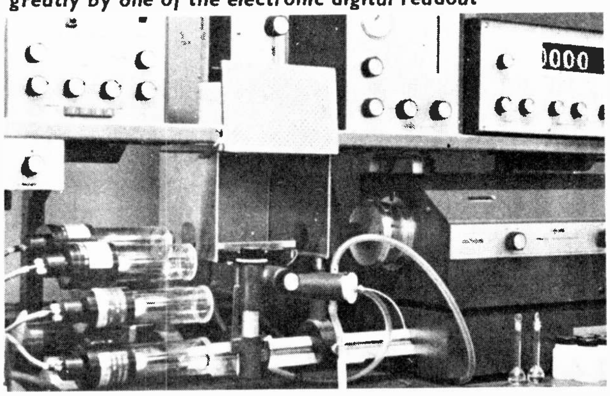
CHEMOSTAT

Digital readouts and integrators are very useful additions to many precise chemical analysing machines in which the required parameter is represented by an analogue voltage. However, as mentioned earlier, probably the most important electronic units in analytical chemistry are light measurement and temperature control units.

An interesting device which requires both these units is the "chemostat". One important aspect of chemical oceanography is the chemistry of marine life, in particular the minute plant-like organisms called phytoplankton. The chemostat is a device for growing these organisms in the laboratory.

Sea water in which these organisms are growing is turbid, and the population density of the growing culture may be estimated by measuring the absorption of a beam of light passing through it. They must be kept thermostated fairly accurately as they are quite delicate creatures.

Atomic absorption spectrometer—a sensitive tool for the analytical chemist, the usefulness of which is enhanced greatly by one of the electronic digital readout



The chemostat unit consists of three jars, one containing the sterile nutrient solution that the plankton require, connected via a syphon and a magnetic valve to the second vessel which contains the growing culture. This is illuminated by daylight tubes (phytoplankton are photosynthesisers like land plants) and kept at a steady temperature by a thermostating system.

Through the culture vessel a beam of light is passed so that it activates a photocell, the resistance of which forms part of a resistance bridge circuit. The output of this bridge is applied to an amplifier.

When the light intensity drops below a certain level corresponding to the optimum maximum growing density of the organisms, the amplifier causes the magnetic valve to open which causes the nutrient solution to enter the culture flask, replenishing the stock and sweeping the grown organisms into the third vessel, from which they may be periodically harvested. The thermostat bath may contain a number of these units all operated from a central control device.

OTHER TECHNIQUES

The systems described above are, of course, just a representative sample of the direct uses of electronics in oceanography. There are also indirect uses such as radio-navigation, which enables the accurate fixing of survey spots in the ocean without having to resort to the stars as a means of navigation. Satellite telemetry can provide the rapid accumulation of results from a number of survey areas with the use of computers to analyse results.

Detailed examination of these techniques are, however, outside the scope of this article, the purpose of which is to illustrate the close link-up necessary between the two rapidly growing sciences of oceanography and electronics. ★

THE introduction of the electric fence was a milestone in farming progress. It offers a simple and inexpensive way of controlling livestock on a large scale, and can make the best use of available land. A typical installation will consist of a single run of bare wire, mounted at a height of approximately 3ft and supported by means of insulators on thin metal or wooden posts spaced about 20ft apart. The fence can be quickly set up or re-sited.

The fencer unit itself is usually battery powered and feeds a high voltage, low current pulse to the wire, at intervals of one to four seconds. Rechargeable accumulators, dry batteries, and air oxygen batteries give continuous day and night operation from three weeks up to six months depending on battery type and size. A single fencer unit is capable of energising a fence several miles long, if the post insulators are in good condition.

INTIMATE CONTACT

The fence relies for its action on intimate contact between the wire and the skin of the animal, especially in dry weather. The wire is therefore kept in tension, at a height where the animal must push hard against it when trying to pass through. Cattle quickly find that the wire can administer a sharp "sting" and learn to keep away from it, but animals insulated with thick hair or wool, such as sheep and some goats, may require a two strand fence for effective control.

The old type fencer employs a set of make and break relay contacts to establish a low voltage pulse in the primary winding of a step-up high tension transformer, and is characterised by an audible ticking sound when in action. However, the trend is now towards a new generation of all electronic fencers, where switching is performed by semiconductors. Such circuits bring economies in current consumption and increase the long term reliability of a fence.

The fencer described here is solid state and its design is based on the concept of small size convenience at the expense of operating time, to fulfil the need for a lightweight unit for occasional or standby use. Nevertheless, with an output comparable to a full scale fencer, the unit will run for a fortnight on a day and night basis and yet is contained with batteries in a box measuring 4in × 4in × 2in. It is harmless to animals.

SIMPLE PULSE GENERATOR

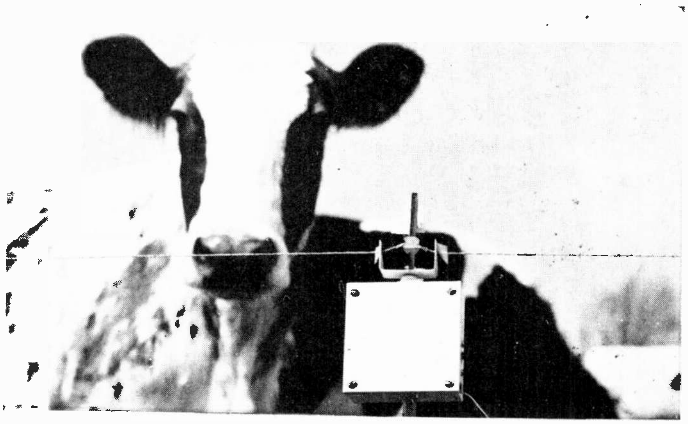
The silicon controlled rectifier, or thyristor, is a rugged device with a good current handling capability. However, once switched on, it can no longer be controlled by a gate signal and it is necessary to cut off the supply to reset the thyristor to its non-conducting state.

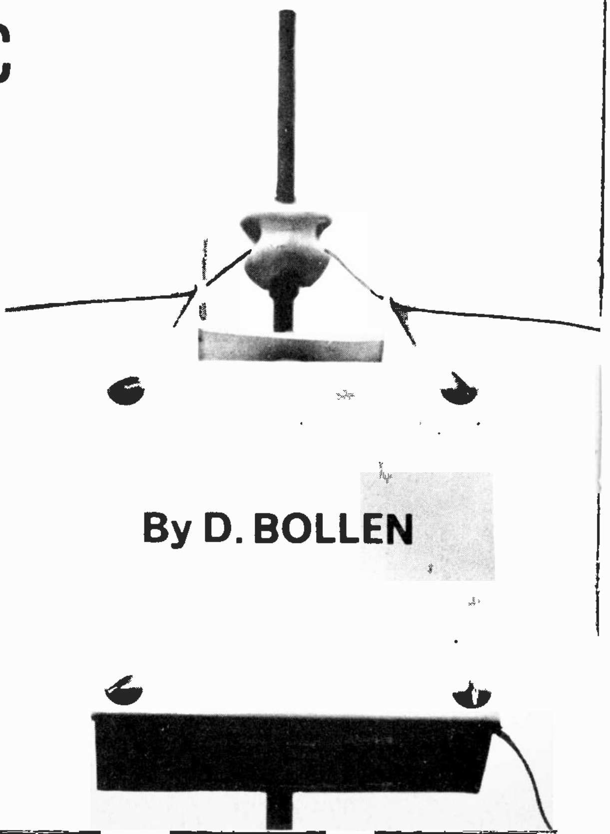
The function of the circuit shown in Fig. 1 is to obtain a train of high voltage pulses from the thyristor SCR1 by causing it to oscillate. When the battery is first connected, SCR1 will not be conducting and capacitor C1 will commence to charge relatively slowly through resistors VR1 and R2. When the potential across C1 equals the knee voltage of the Zener diode D1 plus a small voltage dropped across the thyristor gate junction the gate will go positive and SCR1 will suddenly switch on.

C1 is rapidly discharged into the low impedance winding of T1, and causes a steep sided, high voltage pulse to be developed in the transformer output winding. With C1 momentarily discharged, the voltage across SCR1 will be low. At the same time, due to the fast switch-on speed, overshoot occurs in the transformer winding, driving the thyristor anode negative and switching it off.

Thereafter the process will repeat, for as long as the battery is connected, and at a rate governed by C1 and the total resistance of VR1 and R2.

ELECTRONIC FENCER UNIT





By D. BOLLEN

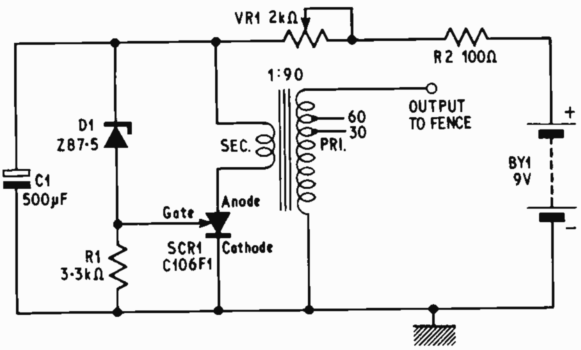


Fig. 1. A simple high voltage pulse generator

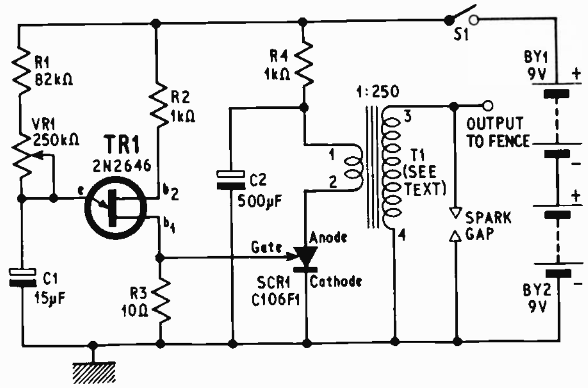


Fig. 2. Circuit diagram of the electronic fençer unit

DISADVANTAGES

Although Fig. 1 is a useful circuit, it does suffer from a number of disadvantages when considered for use as a fencer. As BY1 approaches the end of its useful life, and begins to drop in voltage, so the pulse rate alters.

A point will be reached where D1 no longer conducts and the circuit stops functioning. Also, spreads of thyristor sensitivity and Zener leakage resistance may necessitate individual adjustment of R1. In unfavourable circumstances the battery standing current consumption could be high.

T1 in Fig. 1 is a standard 90 : 1 pentode output transformer, of the type found in old attaché case portable radios. Note that the windings are here reversed, with the 3 ohm speaker winding acting as the primary.

Although the arrangement gives a good shock to the human hand, the voltage generated is hardly adequate as a deterrent to large animals with thick hides or long hair.

FENCER CIRCUIT

In the circuit of Fig. 2, the Zener diode of Fig. 1 is replaced by a unijunction pulse generator, and the pulse rate is now virtually independent of supply voltage. Notice also that the supply voltage is increased to 18 volts and the transformer ratio is now 1–250. Gate resistor R3 is only 10 ohms in the new circuit, low enough to ensure consistant operation over a wide range of thyristor sensitivities, and inter-base resistances of the unijunction transistor TR1.

When S1 is closed, C2 will charge through R4 to almost the full positive rail potential. Meanwhile, C1 is slowly charging through R1 and VR1. When TR1 triggers, C1 is quickly discharged through the emitter/base 1 junction of TR1 and R3, and a positive going pulse is applied to the gate of SCR1. This then conducts and C2 discharges into the transformer winding; the negative going spike will switch the SCR off, as with Fig. 1 circuit. VR1 and R1 determine the rate of charge of C1, and hence the pulse repetition rate. VR1 will allow adjustment of the pulse rate from one pulse a second to one every five seconds.

T1 is a modified output transformer of the type mentioned earlier, or may be specially wound. Full transformer details will be given in the next section.

With this circuit it is possible to generate sparks up to $\frac{1}{4}$in in length, but for fence purposes a spark of 1 or 2 millimetres is sufficient. If the fence voltage is too high, this could cause tracking across insulators in damp weather, and consequent shorting. Output voltage is regulated by a pre-adjusted spark gap.

The fencer circuit will give a useful output down to less than half the specified supply voltage, and will only stop operating when the batteries are virtually exhausted.

Several types of thyristor were tried in the fencer circuit, and all worked reliably. Generally speaking, a thyristor with a peak inverse voltage rating of 50–100 volts, and a current rating of 0·75–2 amps would be suitable.

There is no point in using a large thyristor with threaded screw mounting as wire ended types are preferred. Equally, a high priced thyristor would be a luxury, and the circuit is designed to tolerate inexpensive, unmarked devices, provided that the one employed is not faulty but only suffers a spread in characteristics.

TRANSFORMER

T1 can be a modified Wharfedale OP3 output transformer, prepared in the following way. Firstly, carefully unsolder the transformer leads and remove the tag panel complete with metal lamination cover. The 30 : 1 and 60 : 1 primary tappings are not used, so these leads may be cut short. To avoid dismantling the lamination stack, carefully slit and remove the bobbin outer insulation layers. The transformer secondary windings will now be exposed, consisting of about 28 turns of enamelled wire.

Remove most of the secondary by repeatedly threading the wire through the gap between the bobbin and the laminations, until ten turns remain. Cut short the loose end of the wire and terminate between a new layer of outer insulation. Lengthen the other transformer leads, if necessary, with extra wire and sleeving, taking care that the inner primary winding outlets are well spaced from each other and the laminations. All four leads may be anchored by tying to the bobbin with thin thread.

The next stage is to improve transformer insulation and damp resistance by dipping in a bath of hot paraffin wax. Candles can be melted in a small tin, which is removed from the source of heat when the resulting liquid is quite hot, taking care that the wax bath does not catch fire.

Totally immerse the transformer in the wax; it will be seen to bubble quite vigorously as the trapped air expands. Remove from the bath when all bubbling has stopped, and leave to cool. Bobbin slots may be sealed later by brushing with hot wax.

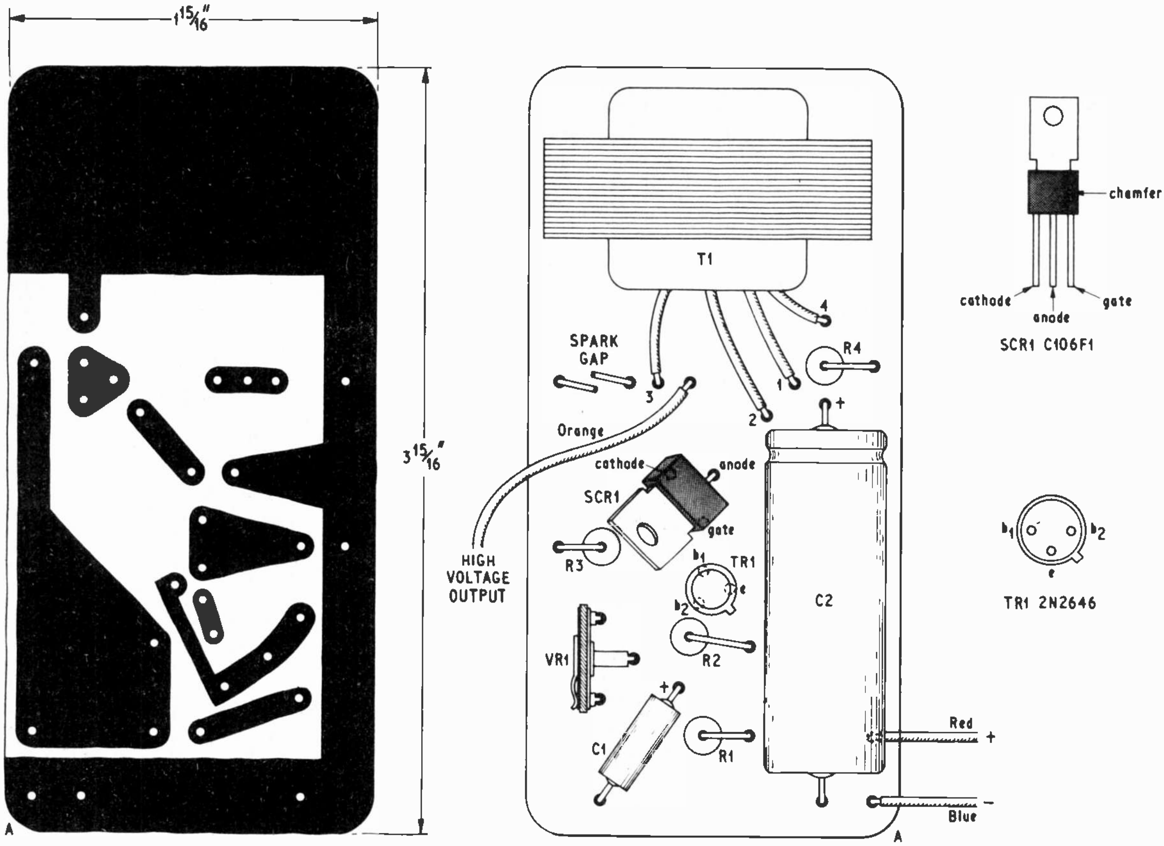


Fig. 3. Printed circuit board pattern (full size) with component layout and thyristor and unijunction transistor connection outlines. The thyristor SCR1 should be bent to one side to avoid contact with the high voltage terminal on the top of the fencer unit

COMPONENTS . . .

Resistors
R1 82kΩ
R2 1kΩ
R3 10Ω
R4 1kΩ
All 10%, ½ watt carbon

Potentiometer
VR1 250kΩ preset vertical skeleton

Capacitors
C1 15µF elect. 25V
C2 500µF elect. 25V

Transistor
TR1 2N2646

Thyristor
SCR1 C106F1 (Rastra Electronics Limited, 275 Kingstreet, Hammersmith, London, W6) or similar type (see text)

Transformer
T1 Wharfedale OP3 (see text)

Batteries
BY1, BY2 9V Vidor VT7 or Ever Ready PP7

Switch
S1 Single pole, on-off slide switch

Miscellaneous
Metal box 4in × 4in × 2in internal (see text)
Feed-through insulator 1½in × ½in (Denco)
Copper clad s.r.b.p. board 4in × 2in
Two pairs of battery press studs

FENCER CONSTRUCTION

An etched circuit was considered worthwhile for a project of this type, to give extra rigidity where the circuit may be required to operate for several years out of doors in fairly arduous conditions. If the larger OP3 transformer is used it can be fixed to the etched panel by epoxy resin glue, to save the small amount of space normally occupied by the transformer frame.

To do this, remove all wax from the base of the lamination stack with a small wire brush, and similarly clean the area of circuit panel where the transformer is to be positioned. Apply a layer of resin mixed with hardener to the panel and laminations, and hold the transformer temporarily in place with a rubber band. The joint will harden very quickly if the assembly is placed on the top of a warm stove.

Mount the other components as in Fig. 3, taking care to observe the correct connections to TR1 and the thyristor leads, also the polarities of C1 and C2. Note that SCR1 is bent to one side to avoid contact with the high voltage terminal on the top of the fencer case.

The spark gap consists of two short, bare wires, from trimmed resistor leads, bent as shown in the diagrams. These spark gap wires should not be allowed to touch each other. Two 4B.A. solder tags are soldered to the negative copper lands on the underside of the circuit panel to serve as mounting brackets, as depicted in Fig. 4.

When the circuit panel is complete, but before fitting the high voltage output lead, it can be tested. Set the spark gap to about 2mm, and VR1 to mid-position.

Place the circuit panel on a spare piece of s.r.b.p., to prevent flashovers, and connect the batteries to the panel via a 0–30mA or 0–50mA meter and a switch.

On switching on, the current should rise to just over 10mA, then fall to approximately 3mA, whereupon a flash will occur across the spark gap and the current will again rise quickly to slightly more than 10mA, and the process repeats itself. The average current demand works out to around 7mA, depending on the pulse rate setting of VR1.

FAULT FINDING

If the current falls to 3mA or less and remains steady at that level, SCR1 will not have fired. First check that the unijunction transistor oscillator is functioning by connecting a pair of headphones, or a voltmeter, across R3 (Fig. 2). A regular "click" or meter needle "twitch" should be observed. It may be that the thyristor is of very low sensitivity, in which case the circuit should start to operate satisfactorily if R3 is increased in value to not more than 56 ohms.

Assuming, on the other hand, that SCR1 has triggered once, and has produced a single spark, but then refuses to re-set itself, this will almost certainly be caused by a thyristor of abnormally high sensitivity. Incidentally, the unit should continue to work when the transformer output terminal is shorted to earth. In the absence of a spark, a "click" will be heard from the transformer laminations. If it does not work when the output is shorted, this will again point to a thyristor of very high gate sensitivity as a likely cause of malfunction. Another indication of failure to re-set will be a steady standing current consumption of about 18mA. Although R3 has been selected to cater for a wide range of SCR sensitivities, the only cure for lack of re-set is to reduce R3 to approximately 5 ohms.

It is emphasised that the above faults will only be present where the thyristor characteristics are at extreme limits, and the circuit should work "first time" in the majority of cases.

INSTALLING THE PANEL AND BATTERIES

The fencer panel and batteries will fit into a standard metal conduit box as used in the electrical trade. Details are given in Fig. 4. It is an inexpensive box, and, as such, needs to be waterproofed at the corners, to prevent rain from seeping onto the circuit panel. Any cracks may be filled with putty, or with epoxy resin, and the joint between the feed-through output terminal and the box must be rendered leakproof.

Temporarily position the batteries and circuit panel inside the box and mark circuit panel mounting holes. A layer of thin s.r.b.p. strip is interposed between the underside of the circuit panel and the battery terminals to prevent short circuits.

Drill and file the box to take the high voltage output terminal, the two circuit panel mounting screws, S1, and the earth lead. The box can be sprayed afterwards with cellulose paint from an aerosol, to give a good finish and protection from the weather.

After fitting the short orange output lead to the circuit panel, mount the panel to the back of the box with two 4B.A. screws and nuts. The battery leads should be tucked between panel and box corner. Mount the feed-through terminal and connect to the orange lead. Fit S1 and wire it in series with the positive red lead from the circuit panel.

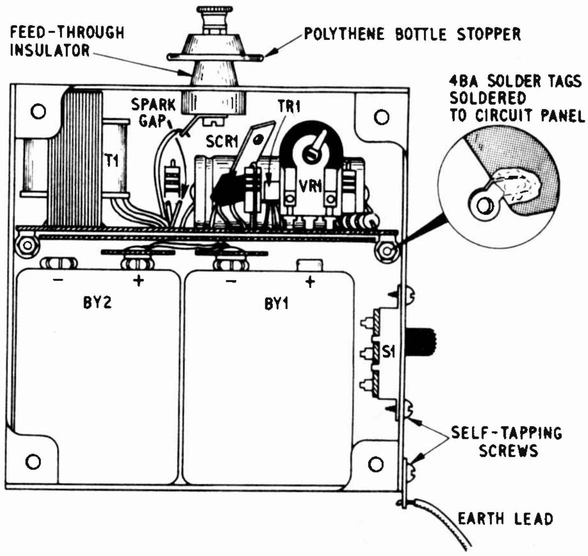


Fig. 4. Installation of circuit panel and batteries in metal case

Next, cut the battery leads to the right length and solder on the battery connectors. With the batteries in place under the circuit panel, check that the fencer works when S1 is closed. Where metal covered batteries are employed, the S1 terminals should be protected by a layer of insulating tape.

It only remains to fit a cork waterproof gasket to the inside of the box lid, and attach the earth lead. A metal meat skewer will serve as an earthing rod.

SETTING UP THE ELECTRIC FENCE

Insulation of the fence wire should be of the highest possible quality, consistent with low cost. Ordinary ceramic aerial egg insulators are excellent for mounting an electric fence wire to posts, as depicted in Fig. 5, and are widely used by farmers. Other types of insulator can be obtained from firms marketing electric fence units.

To achieve a high output strength with very long runs of fence, insulators should be cleaned every six months or so. Also, long grass or weeds must be cut back to prevent them touching the fence wire and reducing output strength.

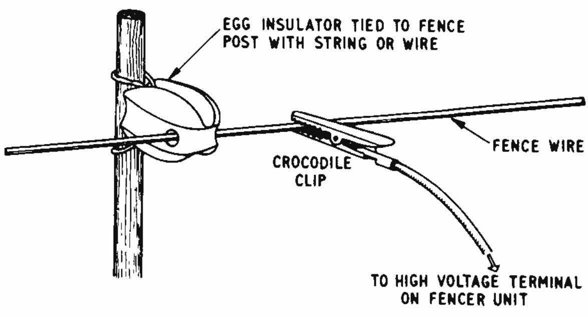


Fig. 5. Insulator details and method of connecting to fencer unit

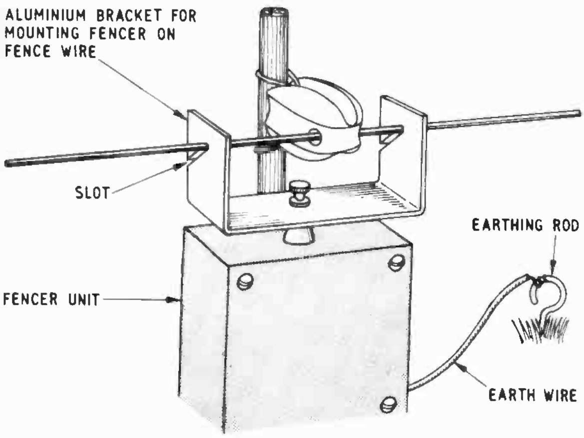


Fig. 6. Alternative arrangement for mounting fencer unit on post

The traditional method of testing a fence is to touch it with a long blade of grass. As the length of grass between the fingers and the wire is reduced, the shock experienced by the fingers will increase, and this gives a very rough estimate of pulse strength. Beware of doing this test in the rain, if not fairly immune to electric shocks.

The prototype fencer was checked with a proprietary electric fence tester, consisting of a control, calibrated from 0–6, and a neon bulb, contained in a small insulated tube. An output of strength 6 was obtained on a short fence, with the full complement of batteries, in dry conditions. The output fell to strength 1 when the supply voltage was reduced to 9 volts.

Further tests were then made, in wet conditions, on a long run of fence in daily use on a dairy farm. The prototype fencer gave an output corresponding very closely to the output from a standard size fencer, when coupled to the same fence.

The fencer unit can either be coupled to the fence wire with a lead terminated by a crocodile clip, as in Fig. 5, or else a simple aluminium bracket with slots, shown in Fig. 6, will allow the fencer to be suspended from the wire where it is supported by a post insulator.

Normally, the spark gap will give an indication that the fencer is operating correctly since, if there is a short on the fence wire, or if the batteries are low, the "click" from the spark will not be audible. A final tip, in very dry conditions it may be necessary to pour water on the soil around the earth rod, to maintain a good connection. ★

AMORPHOUS SEMICONDUCTOR DEVICES

By Dr R. F. Shaw
(Cavendish Laboratory, Cambridge)

A discovery in solid state physics that could have large scale repercussions in the electronics industry by making possible a relatively simple and inexpensive rival to the conventional semiconductor switch

The idea of a semiconducting device with an amorphous material, or glass, as the active element of the device is relatively new. The recent announcement by S. R. Ovshinsky of Energy Conversion Devices Inc., Troy, Michigan, of two such devices has aroused considerable interest.

ATOMIC STRUCTURE

Before describing these devices we should first look at a glass and see why it differs from the single crystal with which conventional semiconductor devices are made. Glasses, unlike most other materials, are not crystalline but are more like extremely viscous supercooled liquids. The atoms in a single crystal are bound in a very definite geometrical relation with all other atoms in the crystal, Fig. 1. However in a glass, due to its liquid like nature, there is very little long range order but there does exist considerable short range or nearest neighbour ordering, Fig. 2.

Quantum theory predicts that as a result of regular spacing of the atoms in a crystal an electron when described by a wave will have a definite wavelength and may move long distances in the crystal before it is scattered. In glasses, due to their irregular or aperiodic structure, the electron motion is severely restricted and may be only from atom to atom being scattered each time.

A crystalline semiconductor has very well defined energy states which an electron may occupy. If one knows these states or levels and their concentration in the crystal he can accurately calculate and predict the electrical and optical behaviour of the crystal. Some of these states are caused by impurities and defects in the crystal. By starting with a very pure crystal one may control its conductivity and the majority carrier, that is *n*- or *p*-type, by controlling the concentration of deliberately added impurities or dopants. The concentration is extremely critical and needs to be controlled to better than one part per million.

CONDUCTIVITY OF GLASSES

Glasses as a consequence of their structure do not have the well defined levels as in crystals. Instead the number of these states is much larger and they are exponentially distributed in an energy continuum. Because these levels do not extend through the crystals they are termed "localised states". The conductivity of glasses are determined mainly by the constituents of the "glassy" compound and may range from 10^2 ohm-cm to 10^{20} ohm-cm. Because of the localised states the addition of small amounts of impurities (up to a few per cent) has little effect on the conductivity. Radiation damage, which disrupts the lattice of a crystal resulting in large changes in its electrical characteristics, has little effect on amorphous semiconductors due to their inherent disorder.

In a switch of the type announced by Energy Conversion Devices Inc., the fabrication is very simple compared with conventional semiconductors. It consists of a thin film of the glass between two electrodes. The devices can be either of the form of two wires embedded in a glass bead and separated by a few microns, or as an evaporated—or "sputtered"—sandwich configuration consisting of an evaporated metal film, then the glass film, and finally another metal film as the top electrode. The electrodes are generally metal, but may be some other material such as graphite. The glasses can also be of different kinds. For instance, the Ovshinsky device uses a glass containing tellurium, arsenic, silicon and germanium, while in work at the Cavendish Laboratory the author has observed switching in amorphous arsenic triselenide.

BISTABLE OR MEMORY SWITCH

The phenomenon of switching can be described by the current-voltage characteristics of a device, Fig. 3. Take the bistable or memory switch now available from Energy Conversion Devices Inc. As the voltage across the device is increased from zero, the current also increases slowly in an ohmic fashion up to a threshold voltage, V_T. Up to this stage the device has a high resistance, of the order of megohms. Once V_T is exceeded the resistance drops extremely rapidly to just a few ohms. The former is termed the high resistance or "off" state, and the latter, the low resistance or "on" state—hence the name "switch". This conducting state is believed to be due to conducting filaments formed due to high fields. They are thermally disrupted by the high power "erase" pulse.

Once the bistable switch is in the on stage the voltage may be removed and re-applied without changing the state, while the device may be switched back to the off state by a high voltage, high current pulse. The device therefore has the ability to function as a memory element for binary notation with the advantage of being capable of interrogation without destroying the existing memory state. This property is not exhibited by any present computer memory element. The ease of fabrication, very small size, low power consumption, fast switching speeds, and unique memory properties promise an interesting future for these bistable switches in computer memories and other applications demanding a memory state.

ASTABLE SWITCH

The other switch, the astable switch—such as the Ovonic threshold switch—has similar high and low impedance states. As the applied voltage is increased up to V_T the device is in the off state, Fig. 4. Once V_T is exceeded, the device switches to the on state in less than $1{\cdot}5 \times 10^{-10}$ seconds. As the current is reduced below a characteristic value, termed the holding current, the device switches back to the off or high impedance state. There is no memory state in the astable switch since it switches back to the high impedance state before the voltage can be reduced to zero. This behaviour is thought to be due to a tunnelling process, holes tunnelling at the anode and electrons tunnelling at the cathode.

The astable switch will find use in computer logic circuitry where fast switching is essential, in trigger circuits, as transient voltage and arc suppressors, and as staircase and other waveform generators. Other applications are being intensively investigated for military uses. One promising potential use is to provide an economic way to switch hundreds or thousands of individual electroluminescent elements in visual displays—such as a flat screen display for television that could conceivably be hung on the wall like a picture.

A.C. OR D.C. OPERATION

One of the important distinctions between these new devices and conventional crystalline devices is that the former are symmetric. Conventional semiconductor devices must be operated on d.c. and the correct polarity is essential. On the other hand the amorphous devices are symmetrical and exhibit the same properties regardless of the direction of the current flow. As a result, they may be operated from either a.c. or d.c., further enhancing their uniqueness as circuit elements. ★

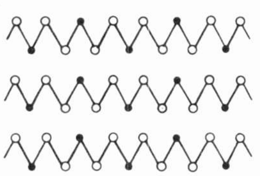


Fig. 1. Atomic arrangement in a crystal

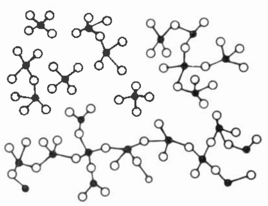


Fig. 2. Atomic arrangement in a glass

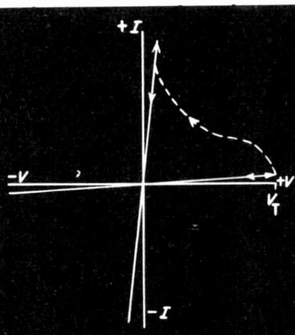


Fig. 3. Current/Voltage characteristic of memory switch

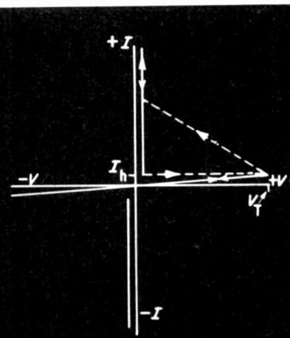


Fig. 4. Current/Voltage characteristic of threshold switch

By M. A. Colwell

Now that the dates and venue for this year's Audio Festival and Fair have been settled (October 16 to 21, Olympia, London) the first question likely to be put by many hi fi enthusiasts is: "How will the intimate atmosphere of the living room be simulated?" Mr. C. Rex Hassan, the organiser, assures us that forseeable problems are not insurmountable when one considers the success of a similar show in Germany in comparable conditions.

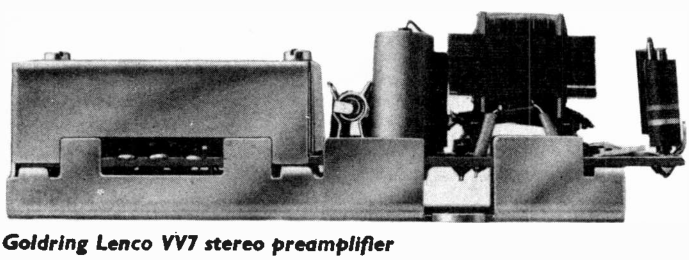
The extended floor area available for display booths will doubtless be welcomed by most exhibitors, but does this mean that each will be fighting for competitive prominence in proportion to stand size, as is frequently seen at electronics trade shows. We are rather inclined to think not in view of the expense involved in special acoustic treatment to demonstration rooms. We can only wait and see!

Whilst we have become accustomed to the Easter holiday day out for this function in the past, it is often a puzzle to wonder "why in the Spring?"—just when people are on the threshold of seasonal outdoor activities.

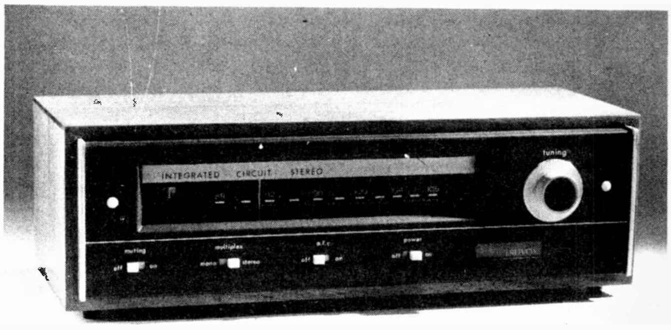
Now if you turn up the diary of events, you can do the Motor Show and the Audio Fair in one day (bless your feet!) and take in the Photo-Cine Fair as well. Come to think of it, the Motor Show should be best timed for the Spring, but not at Hotel Russell, please!

AUTO-AUDIOPHILE

Hi fi and stereo can be found in some cars these days—so they say. This may be fine for some, with adjustable reverberation (window winders), hum



Goldring Lenco VV7 stereo preamplifier



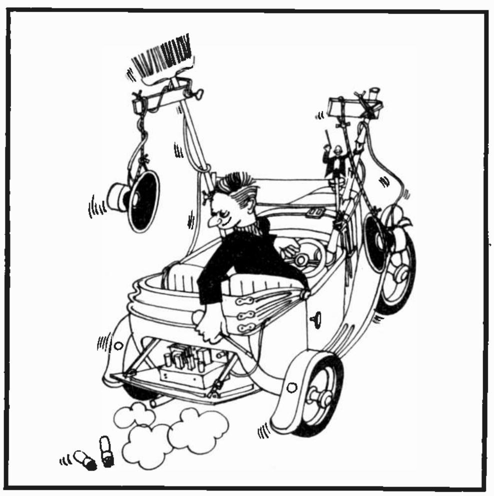
Truvox integrated circuit f.m. tuner

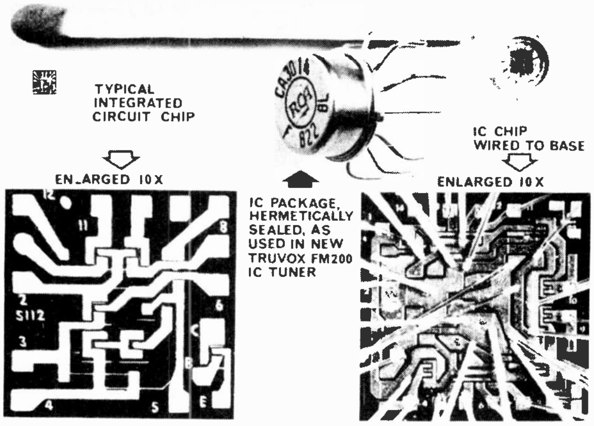
(engine), built-in cabinets (boot), and background noise (horn) but what about stereo! Speakers port and starboard, balance control indicator (speedo on 50), and three-dimensional sound effects outside as well as inside. The mind fair boggles! Still they could run the Audio Fair with the Motor Show, but this is sacrilege of a very high order.

FIRST I.C. F.M. TUNER

Probably one of the most interesting recent innovations is the first use of two integrated circuit packages in the Truvox f.m. tuner. These provide the basic requirements of the i.f. amplifier and f.m. demodulation stages, but they still require the addition of tuned transformers, capacitors, and supply resistors. Although size is not important in domestic equipment, the use of integrated circuits offers a considerable economy in assembly and testing procedures in the factory when compared with discrete component methods. Reliability is considerably improved as well, because the encapsulation protects a large portion of the circuit from environmental hazards.

Both integrated circuits used here come from R.C.A. The first is a wide-band amplifier type CA3012 with built-in power line regulation. Inside this tiny package (a little more than 8mm diameter) are the equivalent of 10 transistors, 7 diodes, and 11 resistors, giving 65dB gain at the 10·7MHz i.f. The second I.C., type CA3014 incorporates a three-stage d.c. amplifier-limiter, power line regulator, and components suitable for the f.m. ratio detector, with a Darlington pair output.





Enlarged view of RCA integrated circuit such as is used in the Truvox f.m. tuner

Sensitivity of the tuner is 2μV for 30dB quieting; 85dB i.f. rejection; 55dB image rejection; 50dB a.m rejection; 30dB stereo separation at 1kHz; frequency response $\pm$1dB from 20Hz to 15kHz. A stereo decoder and f.e.t. front end is incorporated and the price, matching claimed performance, is £59 10s.

SUPERSEDED RANGES

Armstrong have also produced a new a.m./f.m. tuner (type 523, £51 10s) and f.m. tuner (type 524, £39 10s). These will supersede the established 423 and 424 tuners and incorporate built-in stereo decoders and tuning indicators. The new 521 stereo amplifier (£52) has high and low pass filters for controlling rumble and hiss and a socket for stereo headphones. The use of symbols rather than words for the various controls is part of the current practice of international interpretation to help overseas buyers.

Three new items that were introduced at the Dusseldorf Hi Fi 68 Exhibition are the Goldring G800 Super E free field stereo magnetic cartridge (£25 11s), Lenco stereo pre-amplifier type VV7 for magnetic cartridges (£8 10s), and the GL75/P transcription turntable in teak cabinet and Perspex dust cover (£44 2s 8d).

Finally, a note on purchase tax. Readers will know that the "regulator" increase in purchase tax was imposed by the Chancellor of the Exchequer in November. Allowance should be made for this on the prices quoted in this article where applicable.

Armstrong Stereo Amplifier 521

NEWS BRIEFS

Computer Planned Cities

Dr. Constantinos A. Doxiadis of Athens, one of the world's foremost city planners and regional developers is using a Univac Computer to help plan new cities.

In a typical city planning project, the computer receives data concerning the population of the area, physical environment, transport facilities, highways, railways, etc., and services such as electricity, gas and water supplies. From this information the computer provides graphs for the visual interpretation of the data. Use is made of mathematical models providing the future characteristics of the population, predicting its movements, composition and accompanying economic phenomena.

Battery Command Post Simulator

A Battery Command Post Static Trainer for the School of Artillery is designed to train and measure the effectiveness of command post personnel in various tracking processes, in target selection and tactical control, and in the use of electronic counter-measures, moving target indication and various other forms of signal processing.

The system has been developed by EMI engineers and is based on an integrated circuit computer.

New Superconductor

A new superconducting material—Super-Magloy—which is expected to revolutionise high-power magnet technology has been developed by Plessey. Super-Magloy has the property of losing all electrical resistance when its temperature is within a few degrees of absolute zero. In this state, an electric current set up in a closed ring of the metal will persist indefinitely, without further power supply. This phenomenon makes possible enormously powerful magnets of small physical size.

Most superconductors lose their property when placed in strong magnetic fields, but Super-Magloy retains it in fields nearly twice as strong as those possible with other materials. This makes it possible to build an 8,000 h.p. superconductive motor, two-thirds the price and one-eighth the weight of a conventional motor.

CCTV Monitors Silicon Crystal Growth

A closed-circuit TV monitoring and control system helps Motorola engineers keep pace with the ever-tightening materials specifications for silicon crystal growth.

The photograph shows an operator controlling the ingot diameter of silicon crystals being grown in remotely located furnaces. The operator can watch on the monitor screens all ingots and can shut down any malfunctioning furnace instantly.

4

RECOGNITION

BIONICS

BY G.C.BROWN

M.S.H.A.A., A.M.R.S.H.

In the last article the reader will recall that it was said that this month we would attempt to introduce yet another faculty into our model—that of self-mutual recognition. In real animals this ability can of course be founded on quite complex learning sequences. We however, shall consider its exemplification from a point of view which only borders on this; a sort of reflex in fact.

We shall first consider the basic modifications that must be made to the breadboard model, and then discover the rather narrow range of characteristics it will display. Following upon these experiments we shall examine the possibilities for improving its differential acuity.

REQUIRED CHARACTERISTICS

Before attempting to incorporate this new ability, we must obviously settle on which of its special senses we require the model to recognise with. Also just which characteristics of a stimulus we expect it to respond to. Indeed, it may actually respond to stimuli in ways which we did not expect, so it is important that we realise just how specific we want the model to be.

Unless we expect the model to be very particular about what it "recognises", we can only allow ourselves to be content with the impressions perceived through the already extant sensing apparatus. Put in another way, the "front end" of the model must of necessity have the ability to sense as many separate characteristics as possible, in order that a sensible vocabulary of classifications may be built up. To justify anything like the competence exhibited by biological examples, it would without doubt be essential to incorporate whole matrices of artificial neurons involving hundreds of thousands of individual cells. For the purposes of the amateur constructor, to build anything even remotely approaching this would of course be quite out of the question.

There are some compromises which can be accepted however, and these will be examined later. In the meantime though, we shall see to what degree the model (with as few changes to its anatomy as possible), can be apparently encouraged to produce *something like* the desired effect.

PHOTO-SENSE

To begin with then, let us consider how a type of recognition might be elicited through the agency of our model's photo-sense. It must be appreciated, of course, that at best this sense in its present state is rather raw so far as being specific about quality of stimuli is concerned. However, this need not bother us, for at this stage any reaction on the part of the model in response to its "presence" would be a great enough temptation to admit of a recognition process.

In Fig. 4.2 the reader will see all the modifications necessary to bring about a sort of "recognition" in the existing breadboard model. But first look at Fig. 4.1. This shows in "A" how the schematic looks at present: the port and starboard sensors pulling their respective sides of the bistable "down" and producing a negative drive to the opposite "muscle" circuit, and positive pulses for the neutral stimulus part of the "learning" circuit.

This configuration has been adequate up till now, but in order that the new faculty can be sufficiently demonstrative and yet still preserve the existing functions, a few changes are necessary ("B" in Fig. 4.1). If the model is to recognise itself, we would expect to obtain some form of reaction to placing a mirror in front of it. This in fact occurs when the new circuitry is added.

RECOGNITION CIRCUIT OPERATION

In essence, the recognition circuit (Fig. 4.1 and Fig. 4.2) comprises a pilot lamp LP1 which can be controlled by the sensors and bistable via a mirror. The pilot lamp (in the emitter circuit of TR23 and normally on) is mounted in a reflector (a torch type would be ideal) at the forward end of the breadboard and is angled down (see Fig. 4.3) so that at a certain distance from a mirror placed in front the lamp beam would be directed at both sensors.

Once the sensors detect this condition both sides of the scansion bistable are driven "up" (i.e. collectors of both TR10 and TR11 go positive—a bistable will do that if "forced"); the result is that TR18 and TR19 are switched off, hence their common collector point goes to almost rail potential turning TR21 of the recognition

The design and construction of electronic "animals" or machines with artificial intelligence

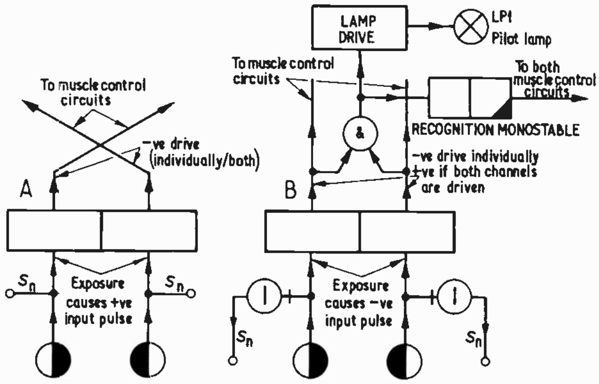


Fig. 4.1. Photo-sensing and scansion bistable. (a) existing arrangement. (b) after modification for "recognition" faculty

mirror, do a kind of "tango". The reader by now will be aware that the word "recognition" has been used very much tongue in cheek—however, although crude, what we have just seen is something not so unlike a recognition process at work.

The remainder of the circuit although somewhat changed since its earlier conception, remains basically unaltered functionally during normal individual channel operation. A close scrutiny of the scansion bistable reveals that in order to achieve this we have, logically speaking, merely "double-negated" the command. The photo-response is therefore positively photo-tropic for single channel stimulation, but there is now additionally a negative tropism for simultaneous activation of the sensors. This last being extended during the recognition process, as previously indicated.

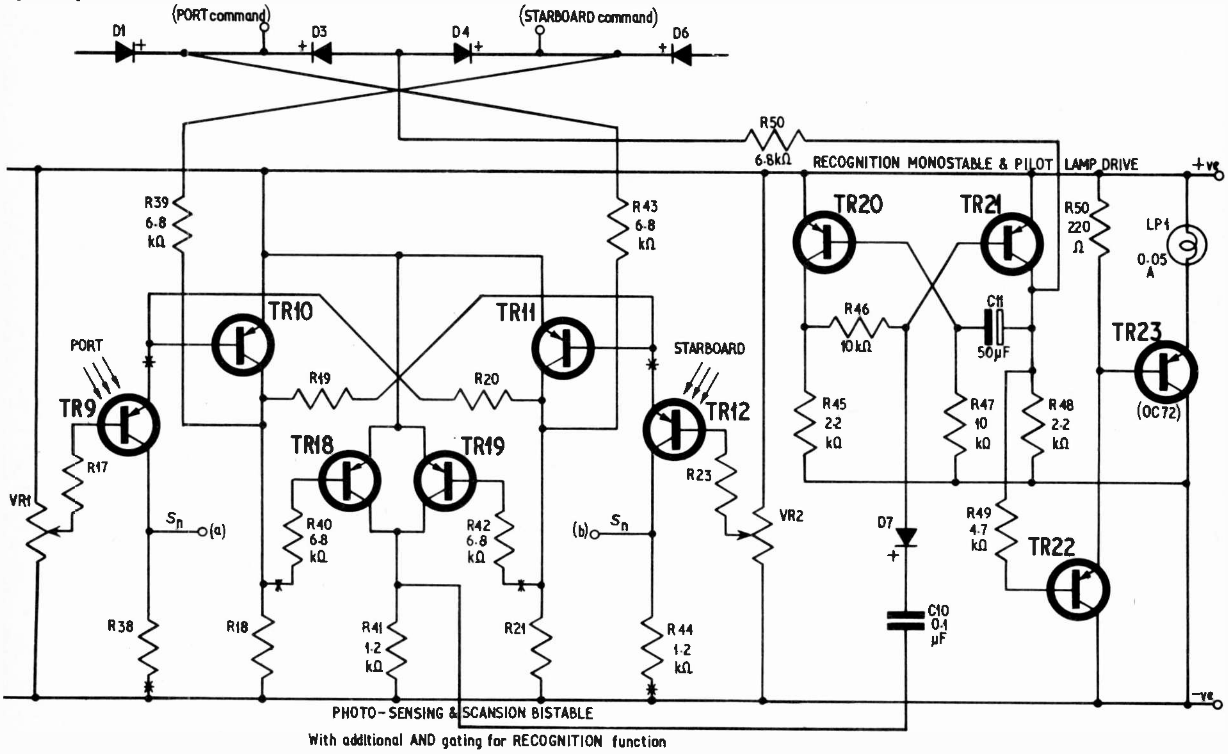


Fig. 4.2. Circuit diagram of the photo-sensing and scansion bistable with additional "AND" gating for recognition function. The value of C11 must be adjusted according to delay required and inherent backlash in drive system

monostable on. TR22, TR23 controlling the lamp are thus turned off and the source of illumination is extinguished. Simultaneously, as the collectors of TR10 and TR11 go positive, a reverse command is given to the muscle circuit and the model retreats. The command is strictly given by the recognition monostable. This is necessary since a short delay is required in order to observe the "recognition" effect.

However, the model will not back-away for long because the lamp has been extinguished by the mere action of reversing; the photo-sensors therefore no longer see the light and, following recovery of the recognition monostable, the muscle control circuits receive the command, "go forward". But then the lamp comes on again, and when the model is within range of the mirror the whole process is repeated—the model will thus, when confronted with itself before a

MUTUAL RECOGNITION

The so-called self recognition process also extends to "mutual" as well, for if we equip two or more models with this type of faculty they will end up interacting with one another, in a way similar to the mirror effect.

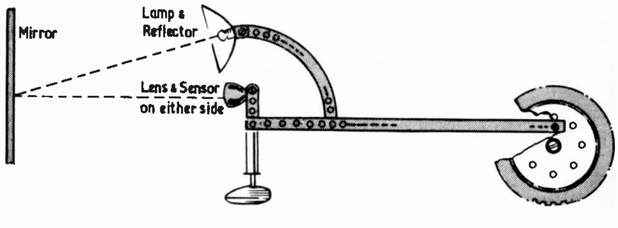


Fig. 4.3. Lamp and reflector mounting arrangement

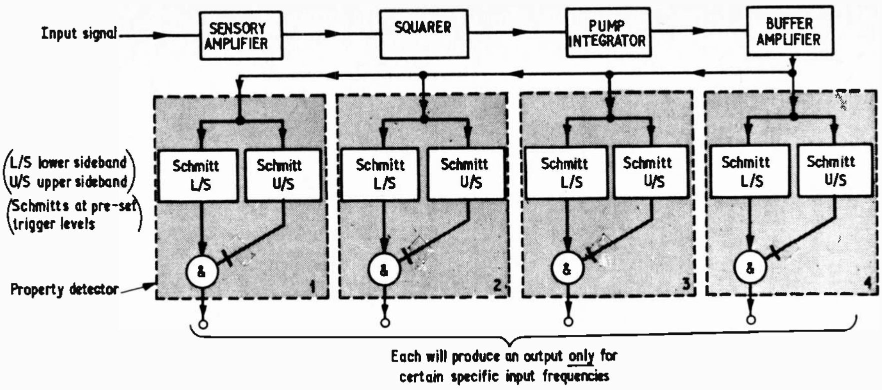


Fig. 4.4. Frequency to voltage conversion device, or property detector

Several beasts, though, reach the dilemma where they can neither approach too close to one another, nor yet completely extricate themselves from their initial introductions!

Hitherto, we have been very unspecific about this recognition process—let us see whether it is possible to conceive of a system which might be more rightly qualified in this way.

When looking for something more specialised in the realm of devices which "recognise", we incidentally come upon the problem that the "means-to-the-end" becomes more and more complex. Take for example the problem of attempting to simulate the hearing process as demonstrated in mammals; first the perception of sounds, that is, not what they may eventually imply once they have stimulated the cortical level.

AUDITORY PERCEPTION

Biologically this task of auditory perception is carried out by what might be called an electro-chemico-mechanical process. Initially the pinna or external ear (relatively decorative in homo sapiens) picks up and focuses sound into the external auditory canal. The sound upon reaching the end of the canal mechanically disturbs the equilibrium of the ear drum and sets it in motion. On the other side of the drum, in the middle ear, three little bones connect it with the organ that is intimately concerned with the perception of sound, a tiny thing looking like a winkle shell called the cochlea. It is within the cochlea that all the basic processing is performed, and this is achieved in each ear by a device called Corti's organ, after its discoverer. This organ, in humans at least, is wedge shaped and measures a little under 35mm in length when unrolled.

Corti's organ is essentially a kind of super-filter, but in addition it is believed to possess other functions as well such as amplitude level detection. In conjunction with its mate in the other ear, it can perform such tasks as phase discrimination, amplitude differentiation, and pulse arrival-time detection. All this from a device about the size of an ear-wig—no apologies for the simile!

When we described the device as a super-filter, this was by no means an idle overstatement. In normal humans, it has been observed that, on average, the organ of Corti has the ability to detect differences in frequency, as small as 1Hz. Now the average frequency range of our hearing is about 60–16,000Hz. This in itself would imply an enormous quantity of filters; but do we fully realise the implication?

In addition to being able to differentiate between tones with only small differences, a healthy ear can generally perceive *any* tone within the normal range, not necessarily whole tones either. Thus the job this tiny organ has to perform is truly incredible; certainly it forces us to reconsider our opinions about our "remarkable" achievements in the field of integrated circuitry!

Having established to some extent what we would be up against were we to be presumptuous enough to attempt the construction of something approaching a biological hearing mechanism, we must now cut our coats according to the cloth and decide how poor the compromise will be. Remember, this still only relates to perception. Recognition implies having a memory, so that a current event may be co-related with similar occurrences in the past and acted upon, if necessary, according to the order of importance.

In electronics we mostly think of resonant filters in terms of RC and LC networks; occasionally quartz becomes involved too! We arrange for these networks to be very fussy about what they pass, and that which a filter ends up allowing through amounts to a measure of its selectivity. In general the LC networks can be made to be the most selective, but unfortunately, at the frequencies which interest us such filters become very bulky indeed. To contemplate employing a whole plexus of these would thus be ludicrous in the extreme.

PULSE COUNTING TECHNIQUES

Nevertheless, there are no end of dodges which can be employed to overcome this difficulty; most of them use pulse counting techniques. Some of the methods, although complicated (and not really applicable where only a few discrete frequencies are involved) need only the addition of a couple of gates or so and one can incorporate almost any number of filters at will.

To give the reader some idea of how this might be done, consider the electronic tachometer (rev'counter) with which so many cars are fitted these days. This generally utilises a pulse-to-voltage system. The impulses occurring at the contact breaker in the car distributor are fed to a diode (or transistor) pump integrator and the output voltage indicated by a meter is proportional to the input pulse rate. Some simple arithmetic and an elementary understanding of the internal combustion engine enable us to convert all this to r.p.m.

FREQUENCY TO VOLTAGE CONVERSION

Examine Fig. 4.4. This too uses much the same principle as the previous example. Here, we are interested in designing a device which might take the place of all those bulky LC filters. The notion here is to convert frequency to voltage, then have a number of

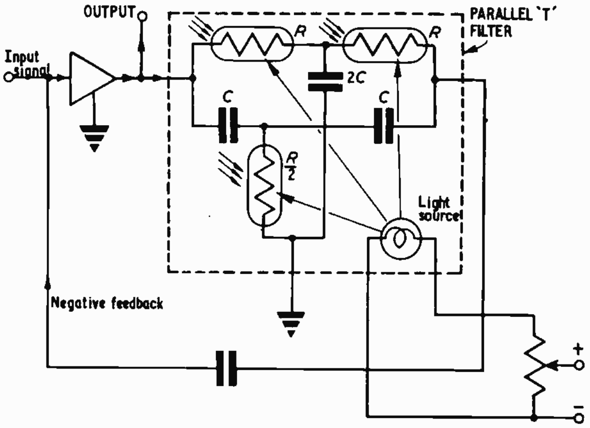


Fig. 4.5. Parallel T filter incorporating light dependent resistors so permitting control by means of a light source

amplitude selectors respond accordingly, each operating at a higher threshold than the last. Providing we don't ask the device to separate several frequencies at once, no difficulties should arise.

Notice that two Schmitts are involved per filter—if this were no so, all the outputs would be active at the higher frequencies. This additionally provides a way of controlling the limits (bandwidth) between which each section will function.

Strictly speaking of course the device is not a filter, but a property detector—an output of "go", or "no go", being given dependent upon the input presented at each Schmitt pair. Thus if one particular Schmitt happens to be on and the signal frequency increases by more than some pre-determined amount, the voltage appearing at the property detector concerned will increase proportionally causing the second Schmitt of the pair to fire. The associated AND gate will therefore be inhibited and the output will change from "1" to "0".

The first Schmitt of the next property detector in-line could be arranged to fire at the same threshold as the second Schmitt in the preceding stage—this would provide a smooth overall response for the range of input frequencies concerned. In this way, a gliding tone fed in at the input would result in the appearance of a series of "ones" rippling along the outputs of the property detectors.

PULSE COUNTER

Another method of filtering that might be employed could be based on the system used in electronic frequency/pulse counters. Assuming one wishes to measure the repetition rate of a train of pulses (and the p.r.f. is constant), it is only necessary basically to run the pulses into a register over some pre-set period of time (for convenience, say 1 second—generally much shorter), then switch off the input and read-out the register to obtain the answer. This scheme though is more complicated than the last, and also suffers from the same disadvantage in that it too can only look at one signal at a time.

PARALLEL T FILTER

Earlier we mentioned the use of RC filters. These certainly consume less space, but generally contribute pretty heavy degrees of attenuation requiring several stages of amplification to make their use a working proposition. A tentative scheme, suggested by one of the author's colleagues, amounts to the use of just one RC filter (a parallel "T" network) whose resonant frequency might be controlled by voltage. Fig. 4.5 shows the general idea.

If the three resistance arms of the normal "T" network are varied together the filter can be tuned. Now this filter is of the rejection type; that is it passes all the frequencies except the narrow range to which it is tuned. It is therefore necessary to invert its response for our purposes so that a sharp peak is produced at the resonant frequency.

This we arrange to do by utilising an amplifier whose loop gain is severely reduced by negative feedback at all frequencies except that to which the filter is tuned. At the resonant frequency the filter has a very high impedance, and as a consequence the feedback becomes negligible. As a result the amplifier gain "soars", and we can now pick-off the desired signal just prior to its entry at the filter.

LIGHT CONTROL

Equal variation in value of the resistance arms in the filter will enable us to move the resonant point through quite a generous frequency range. If, as Fig. 4.5 suggests, we can effectively substitute the elements in the three arms of the network with light dependent resistors, it should be a relatively simple matter to control them using a light source whose output is proportional to a given current or voltage.

As the resistor in the "down stroke" of the "T" requires to be half the value of the other resistors, it would be necessary either to reduce the efficiency of the two cross bar resistors (by say lightly painting them with laquer), or to control each l.d.r. from a separate light source. Each lamp could then have its relative brilliance separately pre-set by a potentiometer.

An audio frequency, voltage controlled, filter of the type discussed could give rise to a particularly interesting property detector (see Fig. 4.6). Essentially, the device could utilise a time-sharing principle. The sweep generator causes the filter to progressively look through a whole range of input frequencies; simultaneously the Schmitt pairs (threshold detectors) will cause the output AND gates to open and close. If during the sweep when one particular gate is open, a signal happens to appear at the filter output, a corresponding pulse will pass through the gate. This could be fed into a bistable memory controlling another AND gate. Further inputs at this frequency would result in the gate opening to indicate recognition of the signal.

It is true that the discussion has been largely hypothetical, but then the reader will remember that we threatened as much in the first article. If it does nothing else, it may well "fire" some constructors to jump clear of the beaten track.

ANXIETY NEUROSIS

While we are still in this happy (?) inventive frame of mind, let's be really outrageous and chance to ponder upon the likelihood of designing a synthetic device that could display a kind of "anxiety neurosis". Maybe though, we should first examine the expression "anxiety".

Just what is anxiety? We have all experienced it at some time or another, but its description is somewhat difficult to pin down. By way of example let us take an imaginary situation involving the initial training of a dog.

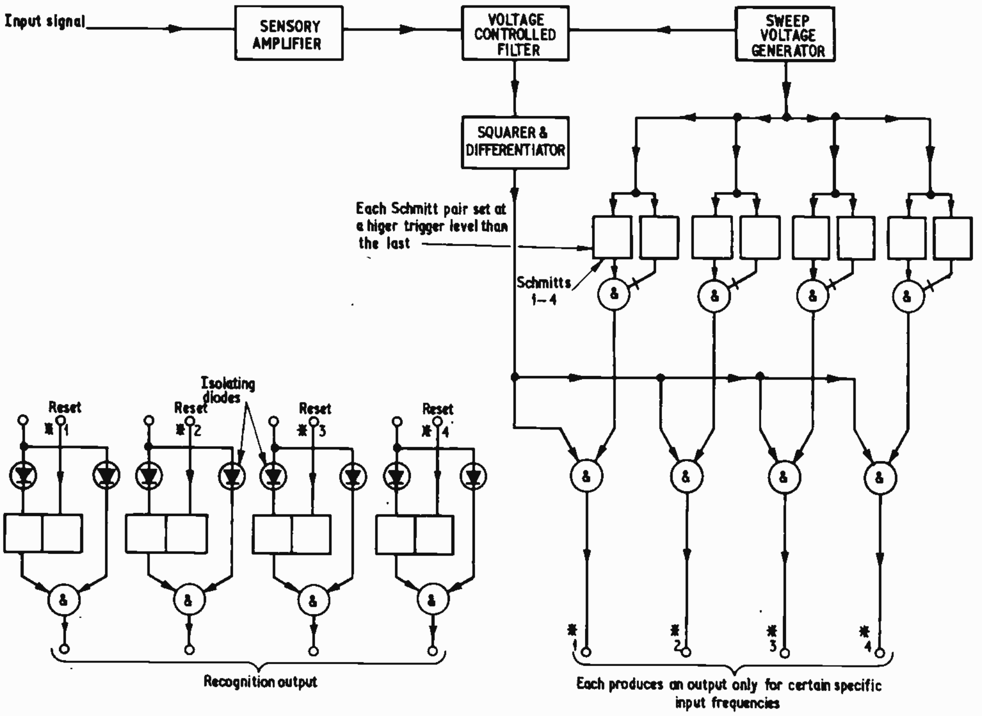


Fig. 4.6. A property detector based on an audio frequency voltage controlled filter

One might suppose that the dog's owner, being a sensible individual, decides that as a prime objective he will attempt to teach the animal some kerb drill. Now the dog is not likely to be very enthusiastic about sitting by the roadside when there are so many other interesting things going on across the other side; much less understand his master's reasons for wishing him to sit still. So, forgetting he is on a short leash, up jumps Rover to be rewarded by a sharp rap across the muzzle and the command of STAY! by his previously amiable companion. Pained and surprised by all this, the animal cowers down and resumes his former position. A little encouragement when the road is clear and the words OFF YOU GO! and the inhibition is removed.

It takes a while before an animal appreciates the kerbside lesson, however, once it is established a dog of reasonable intelligence can often be left for minutes without "moving a whisker".

Suppose, having trained an animal up to this stage, we decide to give the command STAY! but then walk away and not come back. Dutiful beast though he may be, there will come a time when either due to hunger pangs or some other bodily function he will be forced to move. When he does, there will be an instant conflict between his immediate needs and the chances of punishment for disobedience. So Rover sits down again, only to come up against the problem of unsatisfied hunger. Up he gets again to be faced with the prospect of punishment—so he sits down. "Go and tell the poor chap he can move off now", you are probably saying! We are almost beginning to feel anxious *for* him!

PAVLOV'S EXPERIMENT

Obviously this kind of conflict phenomenon can be observed in any number of situations. The inducement of a similar type of effect, produced by more drastic means, has been demonstrated by Pavlov and others. Here an animal was conditioned to obtain its food only at certain times following a signal (a flash of light, or a particular sound).

The food was provided to the animal by way of a small trough arrangement with a lid covering the top. If, following the initial conditioning, the animal lifted the lid to the trough at any time other than when it was supposed to, it received no food. Often it might be given a mild electric shock into the bargain. Not surprisingly, the animal's reaction to this form of treatment was sometimes to completely reject offers of food, even following quite lengthy periods of starvation.

This rather peculiar response to a harmless shock has often been referred to as an "experimental neurosis". But is it neurotic? *We* know that the shock is harmless enough. However, the animal may well consider it to be a direct threat to its very existence. Its refusal to eat then might be accepted as normal, and so we must use the word "neurotic" with some caution.

A MACHINE WITH FOUR SENSES

Take a look at Fig. 4.7. Here we are examining a hypothetical machine's response to the type of situation discussed earlier involving the dog. Like the dog, the machine too needs to be fed—its source of energy though of course comes from a battery. In the diagram we have just about all the essential features for causing an anxiety syndrome to develop.

We will assume that the machine has four basic senses: (a) *Auditory*—sensitive to two tones. (b) *Tactile*—in this case able to sense "heavy blows" to its anatomy, or any traumatic affect directly, or indirectly, threatening its existence. For convenience we will call this a "pain" sensor. (c) *Voltage* (food)—able to sense when the battery voltage drops below a certain level—and in addition capable of sensing if the voltage falls to a

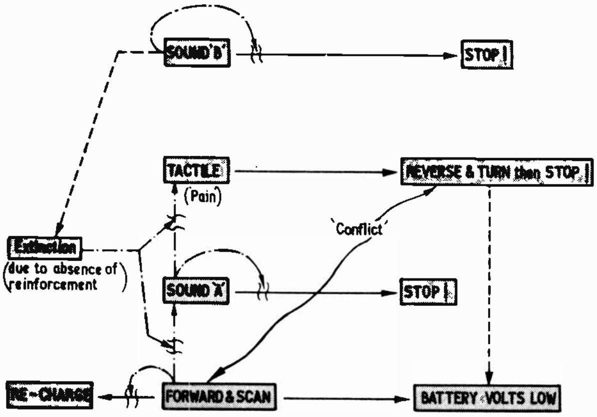


Fig. 4.7. This diagram indicates responses due to various stimuli produced in a machine as described in the text

"dangerous level", i.e. that which would allow the machine to exist in mobile form for only a very short period of time. (d) *Current*—the ability to detect motor current above certain levels, indicating to the machine that it is mobile.

From Fig. 4.7 we can see that the *normal* responses to the various stimuli are shown as continuous lines. Dotted lines indicate "conditioning", while chain dotted-lines show "inhibition".

To begin with we will assume that the battery voltage is low and that the machine is pottering about in search of "food". Now during its rambles sound "A" occurs, resulting in the normal response of STOP! (this might be for only a few seconds). If we shortly follow this with a sudden mechanical jarring to the machine's anatomy ("pain"), and repeat the combination a number of times, a conditioning will result such that "to move FORWARD means sound "A", which means "PAIN" so REVERSE and TURN then STOP!"

Like any other conditioned reflex, if it is not reinforced, even though the reinforcement *is* negative, at least with this sort of tactile stimulus, the result will be extinction of the conditioning. Assuming then that sound "B" appears, followed by this lack of reinforcement—sound "B" would ultimately become conditioned to the extinction condition. Hence for future occasions sound "B" would act as an "all clear".

Consider now the situation where the battery voltage is really low, but that TACTILE conditioning has taken place preventing the machine from obtaining a RE-CHARGE for its battery. In addition let us assume that the benison of sound "B" is absent. The machine would (like the dog) begin to move off in search of nourishment only to be confronted by sound "A" and possibly "pain". It would therefore have no alternative but to make the REVERSE and TURN then STOP procedure in order to overcome the present contingency. However, the battery voltage would still be dwindling, and as a consequence cause FORWARD motion again. It would thus run headlong into the old bogey, "pain".

A DILEMMA

We can realise now that the machine has been confronted with some dilemma indeed. A conflict has therefore arisen between "the need to move forward" versus "the need to remain stationary". This state of affairs would persist until either the machine "died" through lack of "food", or the source of hostile stimuli abated. Now because the machine reacted to the stimuli by oscillating in the way it did, is it in any wise prudent to suggest that the device had become neurotic—I think not! However, we might be forgiven for coming to the conclusion that the machine had developed an "anxiety state" of some kind.

The reader may be interested to know that this so-called "anxiety state" has actually been experimentally induced in a machine of the kind discussed. With a little ingenuity it would thus not be impossible to manufacture one of these "beasts".

Next month we shall be examining some of the fundamental components of biological neural systems and the properties they display, both separately and collectively. It will also be shown just how similar some of their operations appear to be in terms of logical functions and gating. Finally, some more thought will be given to other kinds of property detectors.

To be continued

POST OFFICE PRIVILEGE

continued from page 95

privilege. This extends to every form of telecommunication—radio waves, infra-red, visible light, ultra violet, gamma and X rays.

Undoubtedly this will come as a surprise to some readers for, in the past, wireless telegraphy licences have acted as licences to infringe the exclusive privilege so that many people were unaware that they had needed a licence and been granted it. In the future the Minister of Posts and Telecommunications will have the power to grant the same kind of wireless telegraphy licences.

Having, we believe, put the record straight in this matter, we would like to comment upon one particular kind of communication which is becoming of more and more interest in amateur circles.

Communication by infra-red radiation (beyond one's own premises) is obviously not permitted without licence. Does this mean that the promising field now opening up for private experimental work with gallium arsenide diodes and similar devices is in jeopardy, or will the Minister be persuaded to grant experimental licences for such purposes?

There are three further questions on this subject we would like to pose:

Will not the arbitrary split between the frequency range specified in the Wireless Telegraphy Act 1949 and that implied in the Post Office Bill lead to possible legal anomolies; if, for example, two similar infra-red equipments use different frequencies that happen to fall one on either side of the arbitrary dividing line?

In view of the impracticability of detecting all unauthorised infra-red transmissions, is the enforcement of any regulation a viable proposition?

Finally, in view of the non-interference properties of the narrow beam employed in infra-red transmission should not this method of communication be *encouraged?*

F. E. Bennett—*Editor*

MARKET PLACE

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

FIRST AID

Minor burns and scalds are one of the many hazards that one has to be on guard against in the workshop. The amateur dealing with tools he isn't quite familiar with, the professional, with all his know-how, is sometimes careless, and the youngster is apt to get his fingers burnt prowling around the workshop.

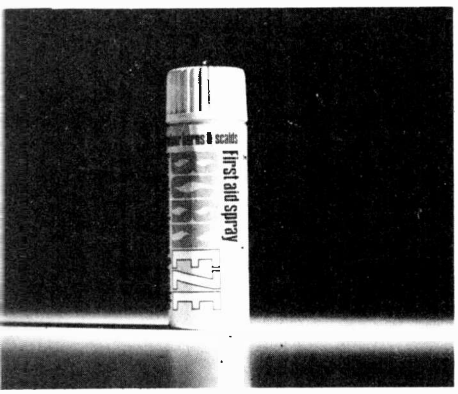
To help solve this problem **Potter and Clark Ltd.,** are producing a first aid spray for treating minor scalds and burns. Called the Burneze it is claimed to give instant relief to minor burns, but does not claim to heal. The spray cools the affected area, relieves the pain and neutralises any swelling. No lint, bandage or other dressing is necessary, but if a dressing is applied it will not stick if Burneze is used first.

Available from most chemists at 7s 3d Burneze would seem to be a most useful asset to have stored in a convenient place in the "lab" or "shack", as well as the home first aid kit. It must be emphasised that Burneze is a poison and should be kept well away from children's reach.

LIGHTING

A new lighting adaptor from **AEI Heating Ltd.,** Redring Works, Peterborough, now makes it possible to control lighting levels for standard or table lamps.

Burneze first aid spray from Potter and Clark Ltd.



The Soft'n Bright Lamp Adaptor can be easily plugged into an existing bulb holder and the bulb simply inserted in the adaptor in the usual way.

The adaptor uses a triac device in the circuit to interrupt the alternating current flow by an adjustable amount each half cycle so that an infinitely variable lighting intensity can be achieved. The light intensity control is mounted on the side of the adaptor. The circuit is fully suppressed against radio interference.

The recommended price of the Soft'n Bright Lamp Adaptor is £3 19s 6d.

DESOLDERING TOOL

Every amateur and professional constructor and designer has probably experienced the exasperating task of trying to desolder a multiple lead component from a printed circuit or wiring board. The problem of trying to remove the solder from each lead and gradually easing the suspect, or wrongly wired component from the board is not new to most of us.

There are many types of desoldering devices available but most devices usually require two hands to operate or require to be spring loaded or foot pumped before they can be used.

The new **Weller Electric Ltd.** desoldering tool does not require an air line or pump and simply slides over the existing barrel of their irons, once the solder bit is removed.

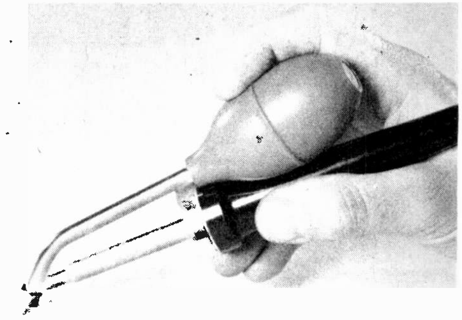
Designed specifically for the temperature controlled irons, making the desoldering tool also temperature controlled, the operation of desoldering can be easily accomplished one handed and can be successfully used with other irons, although here the use of both hands is needed.

The desoldering accessory costs £3 5s and should be ordered as follows: DS-TCP for the low voltage temperature controlled type and DS-W60D for the mains version. The desoldering accessory will shortly be available for all models of Weller's irons.

LITERATURE

With the impending changeover to the Metric System or SI (Systeme International d'Unites) as the system is known, **Electrometer Instruments Ltd** and **Technical Supplies Ltd.,** are producing a metric conversion booklet and pocket chart suitable for students, apprentices, engineers and teachers.

The booklet from Electrometer Instruments Ltd., Fairfield Road, Droysden, Manchester, contains sixteen pages of more than 1,000 conversions from units commonly used to their metric equivalents and vice versa. The booklet is available free to any reader who sends a stamped



Weller Electric Ltd. desoldering accessory

addressed envelope to Electrometer Instruments.

The Metricmaster pocket chart covers English and U.S. to metric equivalents for length, area, volume, weight and liquid capacity on one side and metric to English and U.S. measures on the other. It is claimed that the chart covers up to 10,000,000 to 1 measurements.

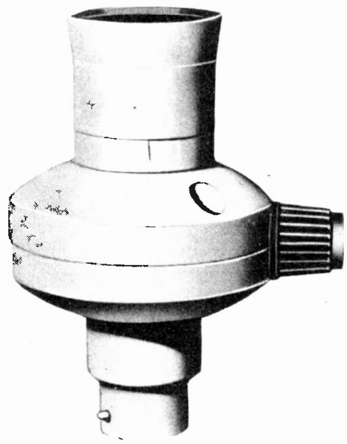
The Metricmaster costs 2s 11d, is distributed by Technical Supplies Ltd., Hudson House, 63, Goldhawk Road, London, W.12, and is available through Messrs W. H. Smith & Son.

The uses of the complete range of Kontakt aerosol sprays has just been published in booklet form and copies are available free from **Special Products Distributors Ltd.,** 81, Piccadilly, London, W.1.

The range of aerosol sprays covers cleaning and freezing to antistatic and graphite sprays.

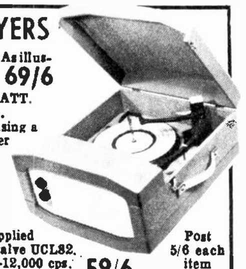
NOTICE

We regret that due to a printer's error in the Advertisement from Messrs Radio Exchange Ltd., on page 9 of the January 1969 issue the size of loudspeaker supplied with the Transona Five kit was wrongly quoted as being 3in.



Soft'n Bright lighting adaptor marketed by AEI Heating Ltd.

DE LUXE PLAYERS



PORTABLE CABINET As illustrated. To fit standard player or autochanger. **69/6**

RCS AMPLIFIER 3 WATT. Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on chassis with knobs. Supplied with loudspeaker and valve UCL82. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6** Post 5/6 each item

SINGLE PLAYERS MONO		AUTOCHANGERS	MONO
BSR GU7.		BSR Superslim	£6.19.6
9v. Battery model	£4.19.6	Garrard AT60	£12.19.6
EMI Junior Mains	£2.19.6	BSR Transcription	UA70
Garrard SRP22 ...	£6.19.6	Stereo/Mono	£12.19.6

All fitted LP/78 stylii mono pickup crystal complete.

Stereo/mono 20/- extra except UA70.

GARRARD TEAKWOOD BASE WB.1. Ready cut out for mounting 1000, 2000, 3000, SP25, AT60. GARRARD PERSPEX COVER SPC.1 for WB.1 **65/-** EACH

PICK-UP ARM Complete with ACOS LP-78 GP67 and Stylii 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-.

CRYSTAL MIKE INSERTS

1½ × ⅝in. 6/6; ACOS 1⅝ × ⅜in. 8/6. BM3, 1" dia. 9/6
MOVING COIL MIKE with Remote Control Switch 19/6

PORTABLE TRANSISTOR AMPLIFIER PLUS DYNAMIC MICROPHONE

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World Famous make ● All for only **90/-** Post Free

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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
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Telescopic Chrome Aerials 6in. extends to 23in. 5/-.
Ferrite Rods 8 × ⅜in. 4/-. 6 × ½in. 5/-.

VOLUME CONTROLS

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

80Ohm Coax 8d. yd.

SEMI-AIR SPACED 40 yd. 20/-; 60 yd. 30/-.

FRINGE LOW LOSS Ideal 625 lines yd. **1/6**

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

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

Q MAX CHASSIS CUTTER

Complete: a die, a punch, an Allen screw and key

½in. 16/-	⅞in. 17/6	1⅛in. 19/6	1½in. 24/-	2 3/32in. 44/3
⅝in. 16/-	1in. 19/6	1¼in. 20/6	1¾in. 29/-	2½in. 57/3
¾in. 16/9	1 1/16in. 19/6	1⅜in. 21/6	2in. 39/-	1in. sq. 36/6

'SONOCOLOR' CINE RECORDING TAPE

5" reel, 900' with LP strobe markings, also cine light deflector-mirror for synchronisation. 14/- each.
UNIVERSAL TAPE CASSETTES C60. OUR PRICE 14/-.

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"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER

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BARGAIN STEREO/MONO SYSTEM

Attractive Slimline PLAYER CABINET with B.S.R. UA25 Deck, 4 + 4 AMPLIFIER and TWO matched LOUDSPEAKERS. Carr. 10/6 (Only 4 pairs of wires to join). **£19.19.6**

NEW TUBULAR ELECTROLYTICS		CAN TYPES
2/350V .. 2/3	100/25V .. 2/-	8/600V .. 9/6
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SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250mF 15V 2/-; 500, 1000mF 12V 3/6; 2000mF 25V 7/-.
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500V-0·001 to 0·05 9d; 0·1 1/-; 0·25 1/6; 0·5 3/-.
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SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF-0·01, mfd 6/-; each
TWIN GANG. "0-0" 208pF + 176pF, 10/6; 365pF, miniature 10/-; 500pF standard with trimmers, 9/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 18/9. Single "0" 365pF 7/6. Twin 10/-.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each. Can be ganged. Couplers 9d each.
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CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
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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.

5 watt	0.5 to 8.2 ohm 3 w.	2/-
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250-0-250 50 mA. 6.3 v. 2 amps, centre tapped	19/6
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JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-.
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DE LUXE STEREO GRAM CHASSIS V.H.F., MW, SW 19-50m. SW 60-180m. Magic eye, push buttons. 6 valve plus rect. Size 15 × 7½ × 6in. high. **£19.19**
WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 17/-, 3 wafer 22/- Additional wafers 5/- each up to 12 max.
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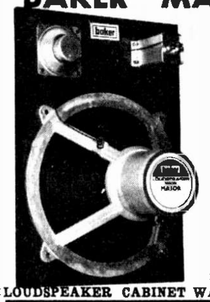
10 WATT 55/-. Carr. 5/-

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8¼ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Woofer Bass unit has a low bass resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm matching.

BAKER MAJOR £8



30-14,500 c.p.s., Hi-Fi double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s. Rated 20 watts. Voice coils available 3 or 8 or 15 ohms. Price £8, or Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. £10.19.6.
LOUDSPEAKER CABINET WADDING 18in wide, 2/6ft

BAKER "GROUP SOUND" SPEAKERS—POST FREE

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

ALL MODELS "BAKER SPEAKERS" IN STOCK

Super Cone Tweeter 3½in square, 3-17kc/s. 10W 17/6.
Quality Horn Tweeters 2-18kc/s, 10W 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2½in, 3in, 4in, 5in, 7 × 4in. 15/6 each; 8in 27/6; 6½in 22/6; 10in 37/6; 8 × 5in, 21/-; 12in. Double cone 3 or 15 ohm 35/-; 10 × 6in, 30/-.
E.M.I. Double Cone 13½ × 8in, 3 or 15 ohm models, 45/- or with twin tweeters, X/over and H/D magnet 79/6.
SPECIAL OFFER! 8 ohm, 2½in; 6 × 4in; 80 ohm, 2½in, 2¾in; **15/6** EACH TYPE 25 ohm, 6 × 4in; 35 ohm, 3in; 15 ohm, 10 × 2½in., 7 × 4in.
5 in. WOOFER. 8 watts max. 30-10,000 cps. 8 or 15 ohm. 39/6.
OUTPUT TRANS. EL84 etc. 4/6; MIKE TRANS. 50:1 3/9.
SPEAKER FRET VARIOUS TYGAN SAMPLES. Send S.A.E.

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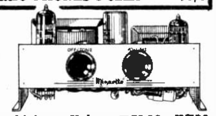
DE LUXE PADDED STEREO PHONES 8 ohms ..	79/6

MINETTE AMPLIFIER



A.c. Mains Transformer.
Chassis size 7 × 3½ × 4in high. Valves ECL82, EZ80. 12 month guarantee. Quality output 3 ohm. With engraved fascia, valves, knobs, volume and tone controls, wired and tested. Post 5/6 **69/6**

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

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

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

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

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Practical Stereo Handbook....................	3/6
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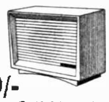
SANGAMO 3 inch SCALE METERS **45/-**

Various calibrations/movements, 500 Microamp; 1 Milliamp; 50-0-50 Microamp, etc. S.A.E. for list.

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

BRAND NEW QUALITY EXTENSION LOUDSPEAKER



Black plastic cabinet, 20ft. lead and adaptors. For any radio, intercom, tape recorder, etc. 3 to 15 ohm. Size: 7½" × 5½" × 3". Post 2/6 PRICE **30/-**

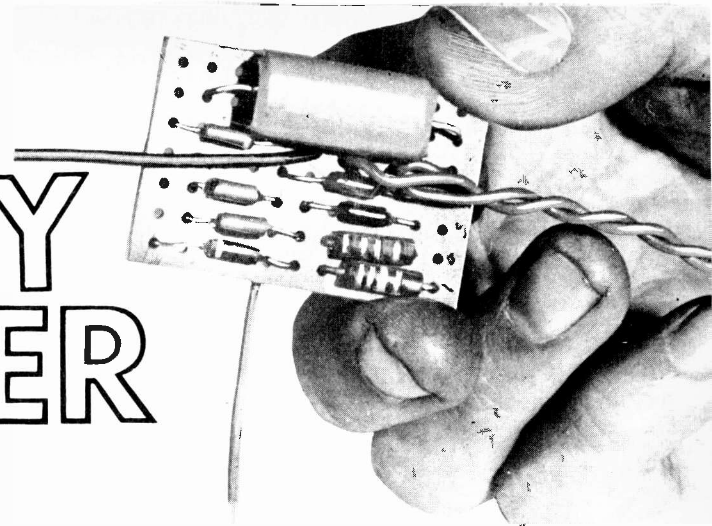
Minimum Post and Packing 2/6. RETURN OF POST DESPATCH. CALLERS WELCOME—CUSTOMERS FREE CAR PARK. *C.O.D. orders £1 min. 5/- extra. Full List 1/-.*

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, WEST CROYDON

Written guarantee with every purchase. *(Export: Send remittance and extra postage, no C.O.D.) Buses 133, 68 pass door. S.R. Stn. Selhurst.* Tel. 01-684 1665

MINIATURE BATTERY CHARGER

By G.N. BARTLETT



THE nickel cadmium battery is initially expensive but since it can give a life of several years, if treated with care, it is obviously worthwhile treating it properly.

Regular and careful charging is a feature of careful maintenance of these batteries, just as it is with a car battery. This article describes the design of a simple constant current charger.

METHODS OF CHARGING

Batteries may be charged either by passing a constant current through them (this current remains constant irrespective of the state of charge of the battery) or by applying a constant voltage so that initially the charging rate is high, but as the battery becomes charged its terminal voltage rises and the current through it reduces to a trickle.

This design deals with a constant current source for charging Deac batteries.

CONSTANT CURRENT THEORY

The term constant current is self-explanatory, and can be understood by reference to Fig. 1a. If output terminals 1 and 2 are shorted, the current $I = V_i/Z$,

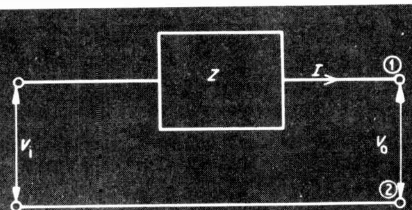


Fig. 1a. Constant current principle. On open circuit load V_i is equal to the applied voltage V_o. The total impedance of the circuit is given by Z

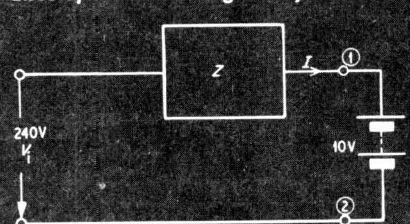


Fig. 1b. If a battery acts as the load, the voltage drop across Z is equal to $V_i - V_o$

where V_i is the applied voltage and Z is the total circuit impedance. In this case $V_i = 240V$, so

$$I = 240/Z \text{ amperes}$$

Suppose, now, that a 10V battery is connected between terminals 1 and 2, the positive terminal being on 1, the short circuit being first removed (see Fig. 1b). The voltage across Z is equal to $(240 - 10)$ volts and $I = (240 - 10)/Z = 230/Z$ amperes.

If Z is 1 kilohm, the short circuit current = 240mA. Charging a 10 volt battery, it falls to 230mA and a 20 volt battery would draw 220mA. The difference in current passed on short circuit, and when charging a battery with a charging voltage of 20V, is only about 8 per cent.

CURRENT LIMITATION BY CAPACITORS

A lot of power would be dissipated by a pure resistance in trying to drop 220 volts, and passing 220mA: $(220 \times 220 \times 10^{-3} = 48{\cdot}4$ watts) requiring a very large resistor.

The voltage supplied to the battery can be effectively dropped if subjected to a frequency selective circuit employing a capacitor. The reactance of a capacitor is expressed by $X_c = 1/(2\pi fC)$.

The current through the load is then given by

$$I = V_i/X_c = 2\pi fCV_i$$

For a 240V, 50Hz mains input supply the load current

$$I = 2\pi.50.C.240.10^{-3} \text{ mA}$$

Whence $I = 75C$ mA where C is in μF

Capacitor (μF)	Charging current (mA)
1	75
0·5	37·5
0·33	25
0·1	7·5
0·05	3·75

In these calculations $I = V_i/X_c$, where X_c is the reactance of the capacitor. In reality, $I = V_i/Z$ where $Z = \sqrt{(X_c^2 + R^2)}$ where R is the total circuit resistance, including the diode and series resistance. However, as this is only 100 to 2000 ohms, it is small compared with X_c.

The smaller the capacitor the larger X_c becomes, and the approximation becomes more accurate.

PRACTICAL CIRCUIT

The component values shown in Fig. 2a have been chosen for charging a 225mAH battery of up to 12V.

The Zener diodes D5 and D6 prevent the output from rising above the level necessary for efficient charging. Without them, the output terminal voltage with no battery connected would rise to mains potential; the low voltage diodes used in the bridge rectifier would certainly be damaged as a result.

The maximum charging voltage per Deac cell (see Table 1) is 1·5V, so if a Zener diode is placed across the output terminals with a striking voltage above the charging voltage, the voltage across the diodes will rise only to the Zener voltage. When the battery is reconnected, the battery starts to charge and the Zener diode is cut off.

Zener diodes OAZ247 can pass up to 25mA. For heavier currents a 7W or 10W device nominally 9·1V (such as ZS9·1) could be used in lieu of the OAZ247. For higher voltages, the ZS12 (11·4V min) could be used. Two in series will operate at 22·8V. This will protect a 14 cell battery with a maximum charging voltage of 21V.

It is not often that voltages higher than these would be used, but if they were, a third Zener could be added in series with the other two. Care must be exercised in selection by observing the *minimum* Zener voltage above that required for charging the battery.

Table 1

No. of cells	Nominal output volts	Voltage for Maximum charging current	D5	D6	Minimum Zener voltage
1	1·2	1·5	OAZ247	Shorted	8·6
2	2·4	3·0	OAZ247	Shorted	8·6
3	3·6	4·5	OAZ247	Shorted	8·6
4	4·8	6·0	OAZ247	Shorted	8·6
5	6·0	7·5	OAZ247	Shorted	8·6
6	7·2	9·0	OAZ247	OAZ247	17·2
7	8·4	10·5	OAZ247	OAZ247	17·2
8	9·6	12·0	OAZ247	OAZ247	17·2
9	10·8	13·5	OAZ247	OAZ247	17·2
10	12·0	15·0	OAZ247	OAZ247	17·2

CHARGING CURRENT

The charging current should not exceed the 10 hour rate, i.e. for a 150mAH cell, the charge current is 150/10 = 15mA and at 225mAH, the current is 225/10 = 22·5mA.

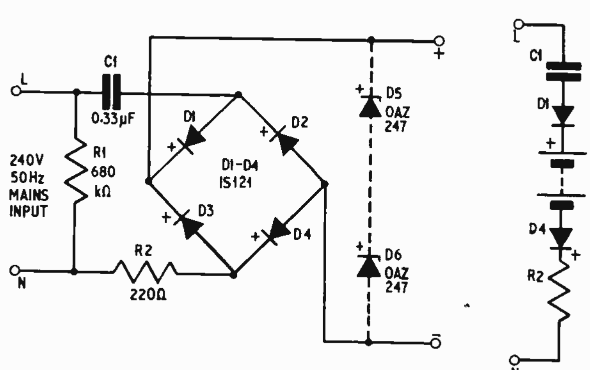


Fig. 2a. Circuit diagram of a 22mA charger with Zener diode protection for up to ten cells.

Fig. 2b. Half-wave equivalent circuit of Fig. 2a

COMPONENTS . . .

Resistors
R1 680kΩ ¼W carbon R2 220Ω ¼W carbon

Capacitor
C1 0·33μF 400V

Diodes
D1–4 IS121 or any silicon diode with p.i.v. greater than 30V and current capacity greater than 20mA peak, 10mA average (4 off).
D5, D6 OAZ247 (2 off) (see text)

Miscellaneous
Veroboard $2\frac{1}{16}$in × $1\frac{1}{8}$in with 0·15in matrix

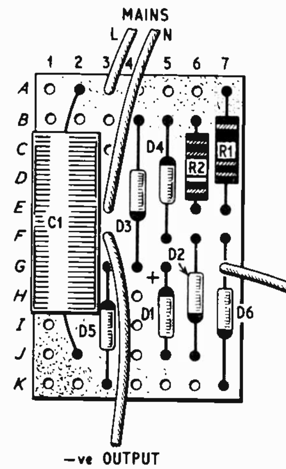


Fig. 3. Layout of components on Veroboard for a ten cell charger. For charging up to five cells replace D6 with a link wire

+ve OUTPUT

CHARGING TIME

The charging rate should be 1·4 times greater than the charge removed.

If current is being replaced at the 10 hour rate the total time required to recharge a fully discharged battery is 10 × 1·4 = 14 hours.

Similarly, at the 20 hour rate the total charge time is 20 × 1·4 = 28 hours.

DESIGNING YOUR OWN CHARGER

1. Check the capacity rating of the battery and decide what charging rate you require, e.g. 10hr, 15hr, 20hr, etc.
2. Calculate the charging current $I = \frac{\text{Capacity}}{\text{Rate}}$ mA.
3. Calculate $C = \frac{I\,(\text{mA})}{75}\ \mu\text{F}$
4. Select the nearest available value of C below the calculated value.
5. If the battery is not to be connected permanently, protect the bridge rectifiers with Zener diodes.
6. If 25mA or less, select either one, two or three OAZ247 and wire in series across the output terminals.
7. If over 25mA, select one, two, or three ZS9·1 and wire in series.

The model shown in Figs. 2 and 3 is a 22mA charger with Zener diode protection for up to 10 cells. This is a compact circuit which could be fitted into equipment using Deac cells.

N.B. The battery should never be charged at a temperature of 32 degrees F or 0 degrees C (freezing point) or lower. Ideally, it should be charged indoors at normal room temperatures. ★

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Report from AMERICA

BY L. HUGGARD B.Sc.

In America, father's lair is in the basement, hidden away amongst the washing machines, water heaters, air conditioners and central heating plant; a holy of holies, safe from the mischievous fingers of the rest of the family.

A basement hideaway puts the American hobbyist ahead of his British counterpart. Certainly in Ohio the full basement is a feature of nearly all houses new and old, and gives the owner additional useable floor space at least equal to the living area of the floor above. The basements are adapted by the houseowner to his needs.

In a new house, it is a bare empty space, concrete or brick walls, and concrete floor, a challenge to the do-it-yourself enthusiast. Basements finish up as anything from a machine shop or beer parlour to a children's playroom, but always with space set aside where father can pursue his indoor interests. Here a workbench can be set up, and a project worked on and left until completed, without the chore of packing it away each evening to make room for the car, or for supper to appear on the kitchen table.

HOME-MADE INDIVIDUALITY

There is time to work at an indoor hobby all through the year. The whole country is nearer the Equator than Britain. Even with daylight saving time, the summer evenings are comparatively short, and it gets dark quickly, within half an hour of the sun going down between nine and ten local time.

Home-made articles have great attraction in America, where everything possible is mass produced. Although there is a great variety to choose from, there is a certain lack of individuality in products ranging from furniture to colour television. The only way to get a unique article is to make it, or follow the deplorable and costly way of instant "customising" with stick-on knick-knacks.

The average American earns between 130 and 200 dollars a week. Though the cost of living in some instances is higher than in Britain, basics like food, clothes, electricity are almost comparable, and with lower direct taxation, and much lower indirect taxation he has more to spend on himself or the family, not to consider instant credit and charge accounts. When pipes leak or domestic appliances fail it is much less costly to carry out repairs at home than to pay for expensive servicing, so that a workroom and tools are almost a necessity.

The selection of tools for the do-it-yourselfer is bewildering. He is very well catered for by a large number of manufacturers and, because of the scale of consumption, and the advantages of mass production, prices of both hand and power tools are very reasonable.

Quality is proportional to price, and the range in quality is great, but the price of one particular article will vary from store to store, so that careful shopping can bring savings. Typical prices are; 10 dollars for a $\frac{1}{4}$in power drill, 28 dollars for a 6$\frac{1}{2}$in power handsaw. Soldering irons start at two dollars, a one inch micrometer at 14 dollars. Hand tools made in America are marginally more expensive than British ones. They are very well made and finished.

SIMPLE ESCAPE

The electrical enthusiast has a wide range of multi-range test meters of the volt/ohm/milliamp variety, to choose from. A number are imported from Japan and appear to be excellent value. A typical 20,000 ohm per volt meter with five a.c. and d.c. ranges, two resistance ranges and a leather case can be had for around seven and a half dollars. Such a meter will be surprisingly accurate, within one per cent of the readings given by an instrument similar to the Avo Model 8.

After waving the dollar wand and creating a workshop the first thing that appears in it is the neighbour's television set, which he has struggled with unsuccessfully, and the family have been deprived of "commercials" for weeks. There is a simple escape, put all the tubes, (sorry! valves)—or as one ham calls them "firebottles"—into a bag and take them to the nearest drug store which will have a comprehensive tester for free use by the customers. After showing him how it works he can pay for snacks until he is finished.

KITS AND BEDLAM ON C.B.

Building from kits can be a lot of fun and very informative. Kits can be purchased off revolving racks, similar to those selling postcards, for a few dollars. These are simple kits suitable for the beginner and contain everything to build a breadboard circuit like a two transistor a.m. radio, or a one tube radio or a code oscillator.

All sorts of kits are available from the major kit suppliers, of whom Heathkit will need no introduction. They market over three hundred different kits, ranging from decade resistance boxes to colour television sets. Other kit manufacturers have similar ranges of equipment.

If serious work is contemplated in the future, this is a very good way to pick up both knowledge and test equipment. Kits cover 'scopes, starting at 62 dollars for a 3in model, and such other useful items like wide-range oscillators from 54 dollars, and stabilised power supplies. There are, needless to say, kits for quality hi fi equipment and ham radio gear.

In all cases savings of up to 50 per cent can be shown over buying similar equipment in the shops. Pocket transistor radios and small "walkie-talkies" are an exception. These are imported in quantity from the Far

East, and are very cheap. Nearly every child has one at just over three dollars for the radio and 12 dollars for a pair of walkie-talkies. The latter may be operated by anyone without a licence on the citizens' band, and no other, provided the power output does not exceed 100 milliwatts, result—bedlam!

COMPONENTS GALORE

The home experimenter can pick up components either locally, in which case the range may be limited, or from mail order firms. Local radio stores tend to cater for the button-pusher rather than the constructor, but may carry a limited range of components and packages of "goodies". Local component suppliers to industry will also sell to anyone. The mail order suppliers have inventories covering almost every component imaginable. All listed in annual 517-page catalogues sent free on request.

As they also supply industry, it is possible for the amateur to purchase the latest semiconductor and other devices that come on the market. He is not neglected, for they also supply bargain parcels of such things as 300 assorted ceramic capacitors for 2½ dollars or 100 assorted transistors for 4 dollars, not to mention pots, switches and hardware similarly packaged. All are sold subject to money being refunded if unsatisfied.

The favourite home project is building or improving hi fi equipment, good quality off-the-shelf equipment is expensive, and kits are an immediate answer to reduce the cost.

For anyone engaged on such a project a 'scope and oscillator are a great help, and most hobbyists have built them from kits. Ham radio enthusiasts can assemble stations from a wide range of kits, this is probably a cheaper way to obtain equipment than building it from scratch, as components tend to come cheaper in a packaged deal like a kit than singly.

TUNE IN TO BIG BEN

There are people who still do it the hard way. Experimenters who run out of ideas will always find something in electronics magazines similar to PRACTICAL ELECTRONICS. Some of the features will describe equipment using integrated circuits or solid state modules available to the amateur here.

For the newcomer one project is a must. Build a short wave receiver and tune into Big Ben and the News, real news covering the big wide world, devoid of commercials, as only the BBC can cover it.

For Future Reference

- An index for volume four (January 1968 to December 1968) is now available price 1s 6d inclusive of postage.
- Easi-binders are available price 15s 0d inclusive of postage. State whether "Vol. 1", "Vol. 2", "Vol. 3", "Vol. 4" or "Vol. 5" is required.

Orders for Binders *and* Indexes should be addressed to the Binding Department.

Orders for copies of the Index *only* should be addressed to the Post Sales Department, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2.

NEWS BRIEFS

Post Office Transistors

A NEW generation of ultra-long life transistors, now being made by the Post Office, will be used in three North Sea telephone cables planned for the early 1970's.

The transistors, which will operate in a series of repeaters at seven mile intervals along the cables, will be capable of amplifying 1,260 telephone conversations. Testing of the transistors is carried out to ensure that not more than one in 500 will fail during a life period of 25 years, this means that up to 10,000 transistors have to be made for every 500 needed. All transistors go through a series of tests and some from each batch are tested over the equivalent of 1,000 years use; about half survive even this test.

Electronic Component Show

THE 21st R.E.C.M.F. Electronic Component Show celebrates its majority this year by going fully international. The organisers, Industrial Exhibitions Limited, report a substantial influx of foreign exhibitors and a general increase in stand size making the show 25 per cent larger than before.

All stand space for the exhibition, which is to take place in May, is now booked and of the 400 exhibitors some 70 are from overseas.

Motorway Signalling System

A SIGNALLING system to be used on 62 miles of motorway in the West Riding of Yorkshire has been ordered from G.E.C. The system is designed around an Elliot computer and will enable police control of the volume and speed of traffic on all sections of the motorway.

When speed has to be restricted on part of the motorway the computer, on receiving an instruction, will automatically set different speeds on the signs leading up to the hazard so that the traffic is gradually slowed down. The system has been designed to allow the addition of surveillance and meteorological data aquisition equipment. Such equipment could actuate the warning signs automatically according to pre-set instructions to cope with fog, ice, or heavy traffic flow.

Logic System Course

SEVEN one-week courses in the theory and practice of integrated circuit logic system design arranged by Mullard Ltd., are being held at the Northern Polytechnic building in Holloway, London, N.7.

The courses will continue every month until May 1969 and are arranged to move progressively from a basic introduction on the theory of logic to the use of integrated circuits in typical systems. The photograph shows members of the first course taking part in individual projects involving the use of integrated circuits.

Course fees are £26 16s 9d inclusive of accommodation and meals. Further information is obtainable from Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

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Miniature Iron 50 watt
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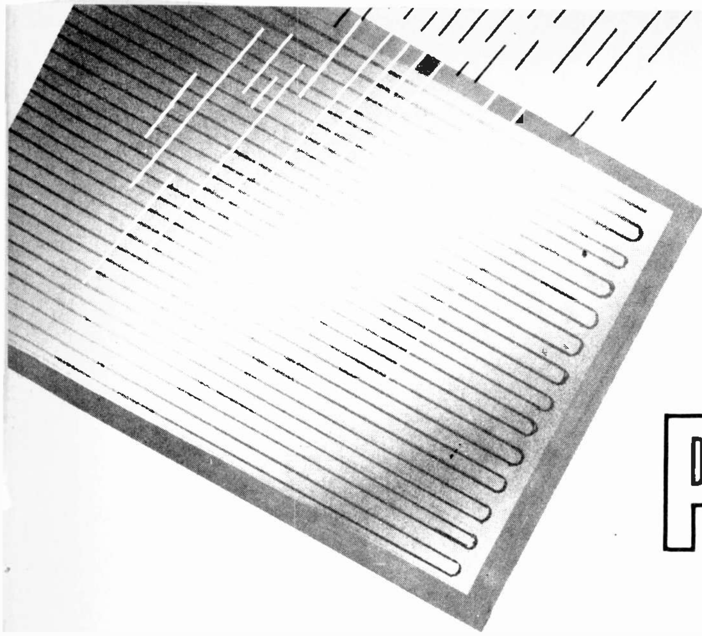


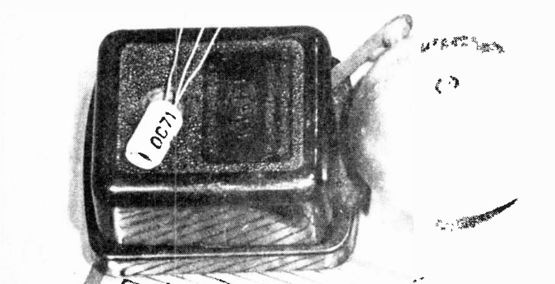
LAUNDRY PROTECTOR

By P.W. HAND

THIS instrument was designed to warn the busy housewife that rain had started falling, so that she could promptly rescue her laundry before it had become soaking wet. It is simple to operate and reasonably robust.

An audible warning is obviously more satisfactory than a visual one, unless the user is hard of hearing. A busy housewife would not normally be expected to stay in one room. She would be more likely to hear a bell, or buzzer, than to see a light, whilst moving about the house doing her chores; she might even be engrossed in her favourite magazine, or novel!

The finished instrument costs very little to make, especially if maximum use is made of components to hand.



The components used are displayed here on the printed circuit board sensor

TRANSISTOR SWITCH

The circuit in Fig. 1 was hooked up. To test this circuit a wire was connected to "A", and another to "B". A tiny drop of water was placed on a piece of glass, and the two wires touched on it. The minute current through the water was sufficient to result in the bell ringing. The circuit uses a current amplifier TR1, with TR2 acting as a switch. A current of about 65mA flows in the collector circuit of TR2 when the bell is ringing. This is well within the capabilities of the transistor used. VR1 is used to set the bias on TR1.

The separation of the printed circuit conductors, and the conductance of the rain will determine the operation of this circuit, which can be set by adjustment of VR1. The diode is inserted across the bell to prevent back e.m.f. through the bell contacts damaging the transistor TR1.

CONSTRUCTION

The instrument is housed in a cigar box or similar small housing to make the finished unit attractive. A small compartment is constructed in one corner of the box to house the small components; these are mounted on two three-way tag strips next to VR1.

The microswitch is fitted to the back of the box, and a small strip of metal attached to the lid is arranged to operate it (see photograph). A toggle switch can be used instead. TR2 is mounted on an aluminium

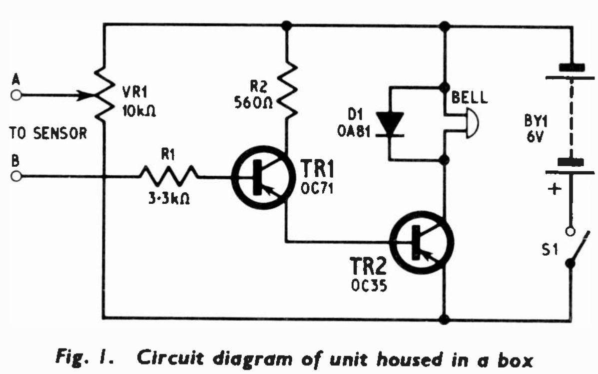


Fig. 1. Circuit diagram of unit housed in a box

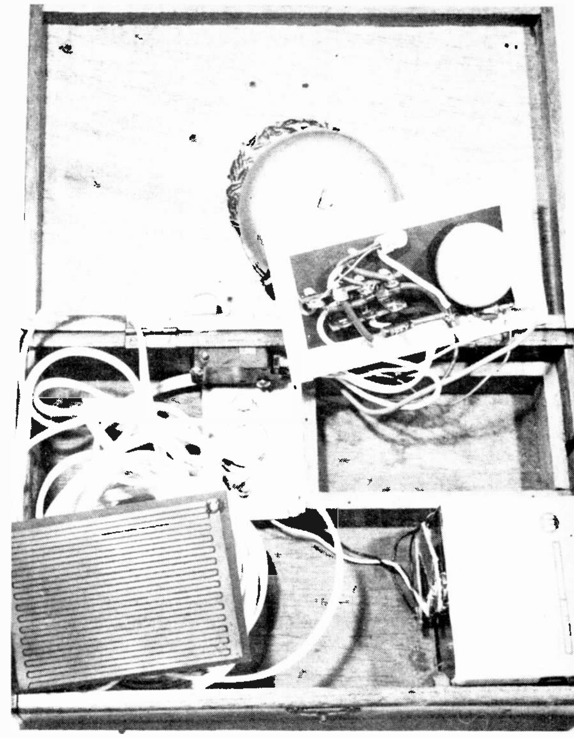
COMPONENTS . . .

Resistors
R1 3·3kΩ R2 560Ω
Both 10%, ½ watt carbon

Potentiometer
VR1 10kΩ linear carbon

Transistors and Diode
TR1 OC71 TR2 OC35
D1 OA81

Miscellaneous
BY1 6V dry battery
Bell (see text)
Miniature microswitch or toggle switch single-pole, on/off
Tag strips
Battery connectors
Box



The assembled component panel is fitted to the corner compartment. The sensor board is shown on the left with its coiled connecting lead. The metal strip attached to the lid operates the microswitch on the back panel

bracket which is screwed to the side of the compartment. The battery is maintained in position by a small strip of wood stuck to the side of the box. All this can be seen in the photograph. The remainder of the space in the box is used to store the rain sensor, and the lead when not in use.

The sensor was made using a small piece of printed circuit board. The pattern can be etched by using a solution of four parts ferric chloride with one part hydrochloric acid and six parts water. *This solution is poisonous and harmful to the skin.* Paint the pattern of the copper to be retained with matt black paint, which is later cleaned off to reveal the copper. Alternatively a photographic negative of the pattern can be used to print direct onto the copper. The size of the sensor is 3¼in × 2¼in, and the width of the conductors is approximately 0·05in, and the spacing of the conductors about 0·025in.

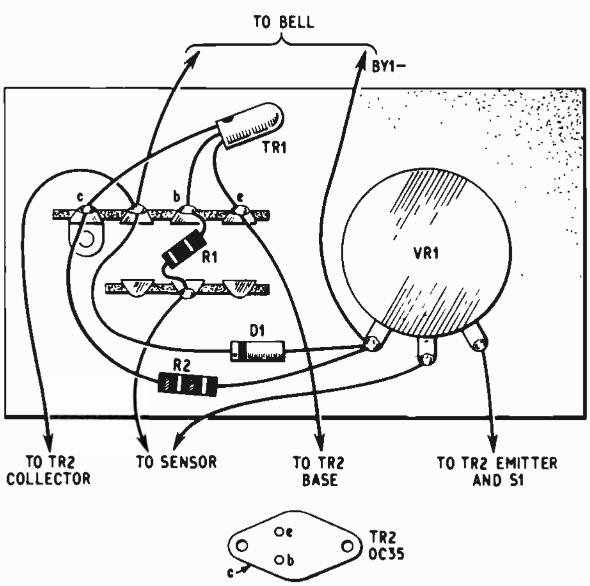


***Fig. 2.** Wiring of components on the compartment panel and connections to TR2 looking at underside*

OPERATION

The simplest method of setting VR1 is to breath heavily onto the sensor to deposit a film of moisture. VR1 is then rotated to increase the base current of TR1 until the bell rings. The moisture is then wiped off with a piece of dry cloth. R1 will limit the base current of TR1 to a safe value if the sensor is short circuited. The microswitch is used to switch the unit off and on, this operation being performed by opening and closing the lid of the box. The bell is fitted inside the lid of the box which acts as a sounding board.

When in use the sensor should, of course, be placed well out in the open, away from walls, fence, or anything that may protect it from the first few drops of rain. The box can be kept indoors or under cover elsewhere, so long as the bell can be heard when set off.

When not in use, the lead to the sensor is coiled up and placed in the box with the sensor.

NOTES ON COMPONENTS

The only components that warrant an extra word or two, are the bell and the OC35. Almost any electromagnetic bell will suit if it will operate from a 6 volt battery. The one used in the prototype (see photograph) is an "under-dome" type drawing 65mA. It was decided to retain the OC35 so that the constructor could use almost any bell, the current of which can be handled adequately by the OC35. But if using the 65mA bell a lower current transistor such as the OC81 can be used. ★

DRY JOINT TESTER

The most reliable way of testing for a dry joint is to measure the resistance between the component lead and the printed circuit board. Our kit for doing this comprises a large scale (3in.) moving coil meter, a variable resistance for adjusting zero setting, and a wiring diagram with instructions. The only additional items you will need are a battery, some wire, a pair of test rods. Price **19/6** postage and insurance 2/6.

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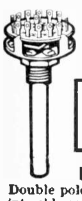

4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 3/6 each. **36/-** dozen, your assortment.

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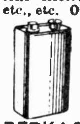

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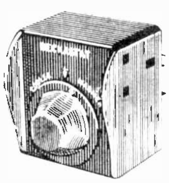

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13 A loading. Will save its cost in a season. **19/6.** Postage and ins. 2/9.

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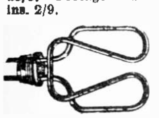

230/240V 1500 watt. Made by Best for kettles with $\frac{9}{16}$ in. dia. hole including: Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Jurymaid, Morroware, Monogram, Pifco, Revo, Towen, Swan. Normally 32/6. Our price **15/-** plus 2/6 post.

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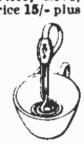

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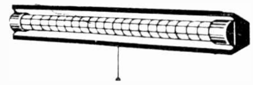
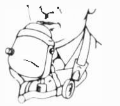
INFRA-RED HEATERS



Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, **19/6**, plus 4/6 post and insurance. Pull switch 3/- extra.

BREAST MICROPHONE

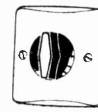


Fine American made dynamic type, adjustable on breast plate with neck straps, **7/6**, post 4/6.

12V BLOWER

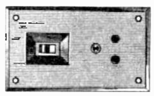
Heavy duty motor with centrifugal blower coupled to one end. Ideal for car heater. **12/6**, plus 4/6 post.

VARYLITE



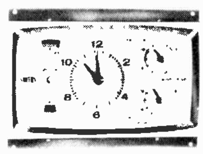
Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob **£3.19.6.**

THIS MONTH'S SNIP



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

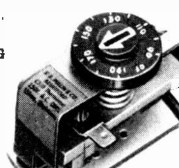
Electric Clock with 20 amp. Switch



Made by Smith's these units are as fitted to 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—also on the left is another timer or alarm—this may be set in minutes up to 4 hours. At the end of the period a bell will sound. 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 ins. 2/9.

PROTECT VALUABLE DEVICES

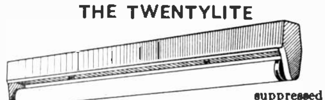
FROM THERMAL RUNWAY OR OVERHEATING



Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected; simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90 deg.—190 deg. F. or with the dial removed range setting is between 80 to 800 deg. F.
Price 10/-

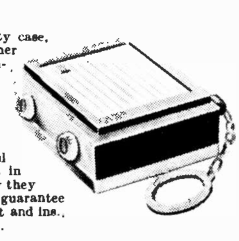
ATLAS SLIMLINE FLUORESCENTS

THE TWENTYLITE



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

MICRO-SONIC



7 transistor Key chain Radio in very pretty case, size $2\frac{3}{8} \times 2\frac{1}{8} \times 1\frac{1}{16}$in.—complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s, or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type

In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new, **19/6** plus 2/6 post and ins., less batteries. Everlasting batteries 7/- pair.

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. Or available made up **29/6** plus 2/6 post.

INDICATOR LAMP

Panel mounting, consists of neon lamp in red plastic lens with resistor in leads for mains operation **2/6** each, **24/-** doz.

SPRING COIL LEADS

As fitted to telephones, 4 core **2/6** each, 3 core **2/-** each.

HEADPHONES

Ex-W.D. unused and perfect, single with headband **4/6.** Double with headband **8/6.**

16 RPM GEARED MOTOR

Made by Smith's Electrics, these are almost silent running, but are very powerful. They operate from normal to 240V. mains and the final shaft speed is 16 r.p.m. **15/-.** Post & ins. 2/9.

COPPER CLAD ELEMENT

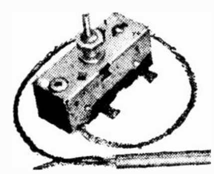
1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above. **12/6** each, plus 4/6 post. **£6** doz. post paid.

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. **19/6.** Kit D—125 w. **22/-.** Kit E—65 w. **19/6.** 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. Kits C, D and E 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.

You never need buy another battery for your transistor radio. Stupendous offer this month—a 6–9V Nickel Cadmium battery stack together with a mains operated charger which you mount on the back of your set. The mains flex unplugs so the set remains completely portable. Offered for less than the cost of the batteries alone. ONLY **29/6** plus 3/6 post.

THERMOSTAT WITH PROBE



This has a sensor attached to a 15A switch by a 14in. length of flexible capillary tubing — control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is heating by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at **12/6** each. Postage and insurance 2/9.

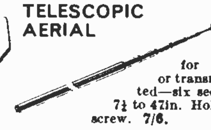
See in the Dark INFRA-RED BINOCULARS

These infra-red binoculars when fed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lenses for TV cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order but sold without a guarantee. Price **£3.17.6**, plus 10/- carr. and ins. Handbook 2/6.

Be first this year! SEED AND PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame. Post and ins. 3/6. **19/6**

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome Plated—six sections, extends from $7\frac{1}{2}$ to 47in. Hole in bottom for 6BA screw. **7/6.**

When postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

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If you are 19 or over, with practical experience in at least one of the main branches of telecommunications, fill in the coupon now. Your starting salary would be £869 (at 19) to £1,130 (at 25 or over); scale maximum £1,304 (rates are higher at Heathrow). Non-contributory pensions for established staff.

Career prospects. Your prospects are excellent, with opportunities to study for higher qualifications in this expanding field.

Apply today, for full details and application form.

Write for details to: Mr. T. H. Mallett, B.Sc. (Eng.), C. Eng., M.I.E.E., Room 705, The Adelphi, John Adam Street, London, W.C.2 marking your envelope 'Recruitment'.

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Address

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RPE3

NATCS National Air Traffic Control Service

Silicon N.P.N. transistors. Similar to 2N2926. All individually tested. Gold plated leads for easy soldering. Unbeatable value at 1/6 each or £5/-/- per 100.

12 VOLT TRANSISTORISED FLUORESCENT LIGHT.* 8 WATT 12in TUBE. Current drain only 700mA! Complete and tested **£2/19/6** only! Or in kit form:

*Case		10/-
Transistor		10/-
Lamp holders—	pair	5/-
Condensers, etc.		3/-
Transformer		13/6
Tube		8/-

*Post and Packing 3/-.

TRANSISTORS
OC200, OC203, OC204, all at 2/- each.
ASY22, 2N753, BSY28, BSY65, 2G344A, 2G345A, 2G345B, 2G371A, 2G378A, all at 1/6 each.
Transistors similar to OC44, OC71 and OC72, all 1/- each.
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30 watt transistors (ASZ17), 10/- each.
ORP 12 Cadmium sulphide light-sensitive resistors 9/-.

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BY100, 800 p.i.v., 2/6 each, 24/- per doz., £7/10/- per 100, £50 per 1,000.
BYZ13, 6-amp, 400 p.i.v., available on same terms.

MULLARD POLYESTER CAPACITORS FAR BELOW COST PRICE!

0·001μF	400 volts	3d	0·15μF	160 volts	6d
0·0015μF	400 volts	3d	0·22μF	160 volts	6d
0·0018μF	400 volts	3d	0·27μF	160 volts	6d
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PAPER CONDENSERS, MIXED BAGS, 0·0001 to 0·5μF. 12/6 per 100.

RESISTORS! Give-away offer! Mixed types and values, ¼ to ½ watt. 6/6 per 100, 55/- per 1,000. Individual resistors 3d each. Also ½ to 3 watt close tolerance. Mixed values. 7/6 100, 55/- 1,000.
WIRE-WOUND RESISTORS. 1 watt to 10 watts. Mixed bags only. 16 for 10/-.

RECORD PLAYER CARTRIDGES
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GP	67/2	Mono.	15/- complete with needles.
GP	91/3	Stereo Compatible	£1/-/- ,,
GP	93/1	Stereo Ceramic	£1/5/- ,,
GP	94/1	Stereo Ceramic	£1/5/- ,,

Small pick-up arms complete with cartridge and needle, 10/- only.

TRANSISTORISED SIGNAL INJECTOR KIT R.F./I.F./A.F. 10/- only
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2½in × 1in	0·15in matrix	1/6	
3¾in × 2½in	0·15in matrix	3/3	
3¾in × 3¾in	0·15in matrix	3/11	
5in × 2½in	0·15in matrix	3/11	
5in × 3¾in	0·15in matrix	5/6	
17in × 2½in	0·15in matrix	11/-	
17in × 3¾in	0·15in matrix	14/8	
3¾in × 2½in	0·1in matrix	4/2	
3¾in × 3¾in	0·1in matrix	4/9	
5in × 2½in	0·1in matrix	4/7	
5in × 3¾in	0·1in matrix	5/6	

Spot Face Cutter 7/6. Pin Insert Tool 9/6. Terminal Pins 3/6—36.

MULTIMETERS. 20,000 ohms per volt.
Ranges: a.c. 1,000V, 500V, 100V, 50V, 10V.
d.c. 250mA, 2·5mA, 50μA
d.c. 2,500V, 500V, 250V, 50V, 25V, 5V.
Resistance: 0/60kΩ and 0/6MΩ.
Special price £4/-/- only.

ELECTROLYTIC CONDENSERS

0·25μF	3 volt	4μF	4 volt	10μF	25 volt	64μF	9 volt
1μF	6 volt	4μF	12 volt	20μF	6 volt	100μF	9 volt
1μF	20 volt	4μF	25 volt	25μF	6 volt	320μF	4 volt
1·25μF	16 volt	5μF	6 volt	25μF	12 volt	320μF	10 volt
2μF	3 volt	6μF	6 volt	25μF	25 volt	400μF	6·4 volt
2μF	350 volt	8μF	3 volt	30μF	6 volt		
2·5μF	16 volt	8μF	12 volt	30μF	10 volt	All at 1/- each.	
3μF	25 volt	8μF	50 volt	50μF	6 volt		
3·2μF	64 volt	10μF	6 volt	64μF	2·5 volt	20 assorted (our selection) 10/-.	

SKELETON PRE-SET POTENTIOMETERS. 100Ω, 100KΩ, 200KΩ, 500KΩ.
SLIDERS. 680KΩ. 6d each.

SMALL TRANSISTOR OUTPUT TRANSFORMERS 2/6 each.
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TAPE RECORDER MICROPHONES 12/-.

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G. F. MILWARD, DRAYTON BASSETT, NEAR TAMWORTH, STAFFS.
Please include suitable amount to cover post and packing. Minimum 2/-. Stamped addressed envelope must accompany any enquiries.
For customers in Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8.

Readout—
A SELECTION FROM OUR POSTBAG

Try it for size

Sir—I was highly amused by a mental picture worked by the criticisms of Edinburgh University Professors W. E. J. Farvis and J. Murray, regarding the empirical approach to circuit design, see December 1968 Editorial.

Do they buy a hat by its volumetric capacity, or—whisper it—try it on?

Horton R. S. Canale, GM3XFC,
Angus,
Scotland.

Licence to move please!

Sir—As you know optical communication has always been a free medium for the experimeter. It is free of all restrictions because it cannot interfere with other systems. However, under the proposed act to make the GPO a corporation this situation will end! Not only will the GPO have absolute power of this free medium, they will also control all types of electric and electronic communications.

This is a disturbing idea as motorists will need a licence to flash their indicators, and telemetry systems will all need licences! Record players would need a licence also, and conceivably the human body would need permission to move a muscle (electro-chemical communication).

I strongly feel that your magazine should petition the government to get this clause removed before it is too late.

J. M. Perry,
Wallasey,
Cheshire.

See this month's editorial comments—Ed.

When is zero not zero?

Sir—I am in the process of constructing a Frost alarm as described in the November 1968 issue of PRACTICAL ELECTRONICS. On reading the paragraph entitled Calibration, it strikes me that this method is unnecessarily complicated.

In our school physics lab, we frequently use a mixture of ice and ice-water as a convenient 0° Centigrade standard of temperature. As the circuit is required to be calibrated to 0° Centigrade, it should be possible to immerse the thermistor and connector in a suitable water-tight plastic bag, in the ice and ice-water mixture. Provided that the mixture is allowed five or ten minutes to attain an equilibrium, the calibration should be possible without the need to alter any refrigerator controls, and with the use of a thermometer simply as a reference instrument.

If it is desired to calibrate the device at 3 or 4° Centigrade, it would be only necessary to allow the ice mixture to warm up in the normal way until the thermometer indicates the required reading. Calibration is then made at this point.

C. Leather,
Haywards Heath,
Sussex.

Switched on

Sir—It may be of interest to your readers to hear on my experiences with the Vari Windscreen Wiper as described in the October issue of P.E.

When the unit was completed, upon test it failed to operate correctly, the fault being that although delay was apparent at the moment of switch on, the unit failed to switch off the motor at the end of one stroke.

Voltage checks revealed the thyristor, although the correct type, was firing at 1·6V positive with respect to cathode. It was noticed also that when the parking switch contacts opened a transient voltage pulse sufficient to operate the thyristor appeared at the gate. Suppressing this with a 32μF capacitor across the parking switch cleared up the trouble completely. Although due to the low firing voltage of the thyristor used, the value of potentiometer VR1 used to give a maximum time constant of approximately 30 seconds, was 1 megohm.

P. J. Hawkins,
Plymouth,
Devon.

I.C. holder

Sir—I have found a plug-in base for the SL701C integrated circuit which forms a very rigid contact and facilitates easy removal and replacement. It is a Grundig Graupner 8-pin socket available at about 2s from radio control shops.

J. P. Cogan,
Cork.

Fab or fantasy

Sir—Soberly considering the implications of Sound Light and Music series, myself being an old square in the world of fab and fantasy, I am left wondering if in every sense, the end truly justifies the means. Recently, my teenage grand-daughter having begun to learn typing, excitedly showed me some weird and wonderful patterns she had produced on paper by using all the characters and signs on the typewriter keys having caused them to form a geometric display by operating the machine in an extremely unorthodox manner.

Disregarding questions of originality or purpose, can that not be included as an example of "serendipic" graphic art produced without the extravagance or strained ingenuity of a cybernetic device. About seventy-two years ago, I was invited to witness the enchanting colour patterns created through a large beautifully made kaleidoscope. This old fashioned toy calls for no great imagination to modify and extend its random capabilities whereby it could compare more than favourably with results from the artful exploitation of phenomena which is otherwise more purposefully employed.

Including electronic music with the foregoing observations, is it possible we are seeing the emergence of an electronic Carnaby Street. While still possessing a reverent regard for those engaged in the dignified furtherance of the sciences hereby concerned, it is with some intrepidation that I shall return to the controls of my oscilloscope lest its wavering green countenance should communicate some ecstatic abstract to remind me that I am not "with it".

In conclusion I wish to express my warm appreciation of the many clear helpful contributions in your publication which have kept me abreast of the spectacular advances in solid state devices. I have been for many years an active practical constructor, now looking on and learning with added interest.

P. Ashdown,
Lymm,
Cheshire.

Readout—

A SELECTION FROM OUR POSTBAG

continued

With or without it?

Sir—May I first of all say, I am a little puzzled by the heavy construction used in the "animal" described by Mr. G. C. Brown in his series Bionics, but the ideas which streamed through my mind on seeing the introduction, would need a ten ton chassis. This is to mean, I have not for many years felt the same interest in any possible project—it has no limit.

My memories went far back to the 1930's, the scream of my breadboard circuit's hand capacitance which caused young friends to jump back.

In the words of the song: "Those were the days my friend!" If young readers see the same interesting possibilities, this series could go on for years.

As I have no interest in a hundred watts hammering out modern beat, it may be that I am not "with it," but thank you gentlemen for the visions of youthful interest returning. It is a long time since I could feel the same interest.

C. S. Burton,
Bulwell,
Nottingham.

But, sir, this series of projects is "with it" in an educational sense!—Ed.

I'm lost

Sir—I know that this is not normal procedure, but I am desperate. I have recently acquired what promises to be a very useful oscilloscope, but with one minor snag, it is u/s, and I am unable to locate the manufacturers, so therefore I cannot obtain a circuit diagram, and hence repair the unit.

I would be grateful if you could advertise on my behalf for assistance in obtaining a circuit diagram as it is possible that another of your readers may already own one of these units.

The information on the unit is as follows: There is no model number or make but a pattern No. 53259 and the unit is called a Miniscope. It can be operated on the standard three wire mains as well as 180V/500Hz or 12V d.c. It has a 2in cathode ray tube of approximate sensitivity of $Y = 4{\cdot}5$ and $X = 4{\cdot}0$V/mm. The timebase range is Off, 20–100, 100–300, 300–1,000, 1,000–5,000 and 5,000–25,000Hz. Amplifier maximum gain is ×400 from 50Hz to 10kHz.

The unit measures approximately 9in × 6in × 2in and is, as far as I can gather, ex-British services.

S.A.C. Munro I.R. V4285549,
c/o 20D Davaar Avenue,
Campbeltown,
Argyll,
Scotland.

Tolerant stockmarket

Sir—I was intrigued to read the article on the *Electronic Stockmarket* in your December 1968 issue, but I should like to point out that due to the wide manufacturing tolerances found in electrolytic capacitors, certain players' positions could gain an unfair advantage during transactions. The smaller a player's cash capacitor, the greater will be his voltage increase in a positive transaction, although of course his loss will also be greater in a negative one, which will tend to reduce this advantage.

However, in order to make the game as fair as possible, I should like to suggest a simple comparative test. Each of the twenty 200μF capacitors (for a four position game) is charged up to the full 9 volt battery potential, then allowed to discharge through a 180 kilohm resistor and the 50μA meter in series. The time for the discharge current to fall to half its initial value gives the time constant of the R-C combination (nominally 36 seconds), the initial value being found accurately beforehand by connecting the resistor and meter directly across the battery.

After this has been repeated for all the capacitors, four with similar time constants can be chosen for the "cash" capacitors, and another four for the "bank" capacitors. The remainder can still be used in the "Stock Exchange" as their inequality will merely add a further interest to the game.

If a 100μA meter is used, the resistor should be 100 kilohms giving a time constant of 20 seconds.

J. D. Archer,
Halifax.

From an engineering point of view, capacitor tolerances are of great significance, and I do not dispute the fact that, under certain unfortunate circumstances, it is possible to find certain bias toward one player's position than another.

During the construction of the prototype game, I gave the matter fair thought and consideration, particularly when I found that the capacitors were given a tolerance of −10 to +50 per cent.

I took 50 of these capacitors at random and checked their capacitance on a proprietary tester; 47 showed capacitances of around 220μF. The remaining three components measured slightly under 200μF.

I produced the prototype without selecting matched capacitors and, once built, was found to produce convincingly random winnings over the course of many trial games. It was therefore decided to leave well alone so far as the prototype was concerned, but I did give further thought to the possibilities of capacitance tolerance. This brought to light a number of interesting factors.

The tolerance of a capacitor, expressed as a percentage, will not manifest itself in the same proportion so far as resultant voltage after "transfer to another capacitor" is concerned. In fact, the law of resultant voltage to difference between capacitances is inverse. This is partially compensated by the higher (or lower) voltage applied for the next transfer, but some loss (or gain) will result.

So far as the bank capacitors are concerned, the effect of deviation would seem more important. However, suppose that a player has a sub-normal "bank" capacitance. It will then be easier to charge this capacitor to the "million" threshold than if its value were either normal or above-normal.

However, from the standpoint of this Game, the "millions" monitor circuit is not without its limitations, and a certain drain is to be expected throughout the time of a game. The capacitor itself will have a certain amount of leakage proportional to its actual capacitance value.

Consider the monitor circuit leakage; the lower capacitor, whilst receiving more benefit from charge transfer to it, will suffer slightly higher losses from it during the course of play, due to its lower capacitance-to-leakage ratio. Here lies another levelling factor.

The progress of the game depends in essence on random occurrences. We can never know how random the randomness can be without studying events from the beginning of time to infinity! The "un-randomness" of randomness is so disposed as to veil the small effects these theoretically display. During games with various players, the predisposition to winning and losing was more apparently associated with particular players, rather than the position at which each played.

The above factors weighed heavily against the inclusion of a capacitor selection procedure which might well add undue confusion to the already complicated text, particularly so far as newcomers to the subject are concerned.—
B.H.B.

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CERAMIC DISC CAPACITORS (Hunts.). 500V ±20%; 100, 220, 330pF. −20%, +80%; 470, 680, 1,000pF. **5d each.**

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

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

Small (all values in μF)

4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
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25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

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Tubular, 10%, 160V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/3.** 0·47μF, **1/6.** 0·68μF, **2/3.** 1μF, **2/8.**
400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022μF, **7d.** 0·033μF, **8d.** 0·047μF, **9d.** 0·068, 0·1μF, **11d.** 0·15μF, **1/2.** 0·22μF, **1/6.** 0·33μF, **2/3.** 0·47μF, **2/8.**
Modular, metallised, P.C. mounting, 20%, 250V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/5.** 0·47μF, **1/8.** 0·68μF, **2/3.** 1μF, **2/9.**

POLYSTYRENE CAPACITORS: 5%. 160V (unencapsulated): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, **5d.** 1,000, 1,500, 2,200pF, **6d.** 3,300, 4,700, 5,600pF, **7d.** 6,800, 8,200, 10,000pF, **8d.** 15,000, 22,000pF, **9d.**
1%, 100V (encapsulated): 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820pF, **1/-.** 1,000, 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900pF, **1/3.** 4,700, 5,000, 5,600, 6,800, 8,200, 10,000, 12,000, 15,000pF, **1/6.** 18,000, 22,000, 27,000, 33,000, 39,000pF, **1/9.** 0·047, 5,000, 0·056μF, **2/-.** 0·068, 0·082, 0·1μF, **2/3.** 0·12μF, **2/9.** 0·15, 0·18μF, **3/-.** 0·22μF, **4/-.** 0·27, 0·33μF, **5/-.** 0·39μF, **5/9.** 0·47, 0·5μF, **6/3.**

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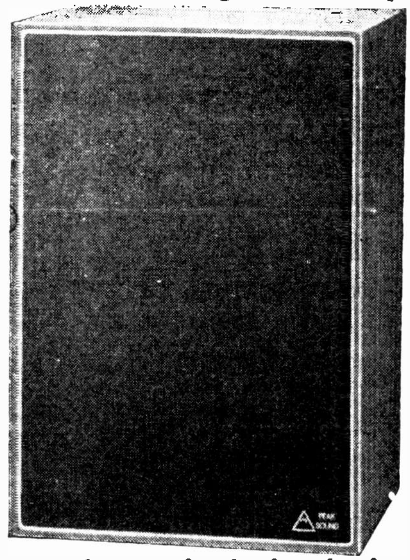

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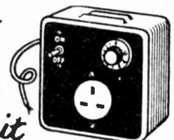

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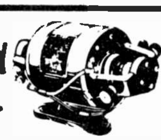

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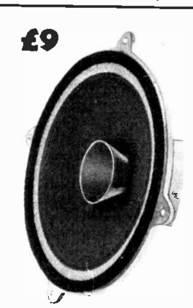

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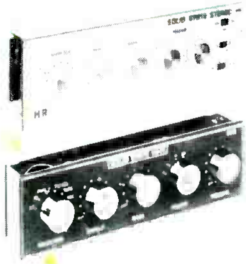

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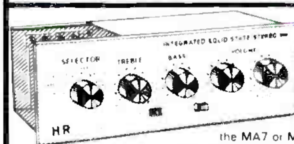

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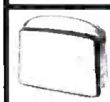

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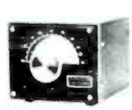

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