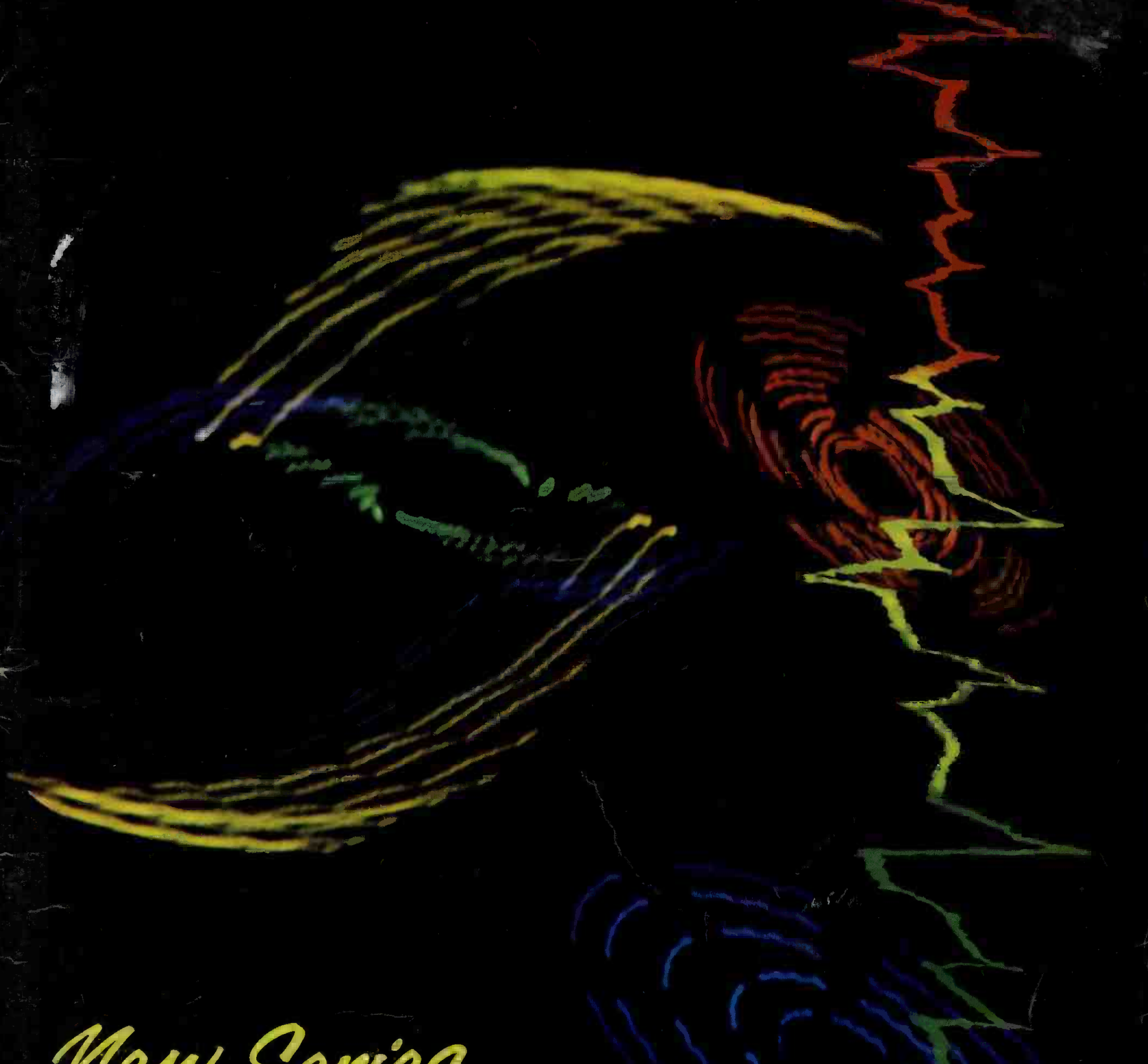
PRACTICAL

ELECTRONICS

AUGUST 1968

PRICE 2/6



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(Available in ready-to-use or kit form)

The newest and most practical innovation in electronic instrumentation is the exciting new ultra-functional styling format from Heath.

Kit IM-25 **£48.10.0** **Ready-to-use** **£59** P.P. 7/6

New Solid-State, High-Impedance Volt-Ohm-Milliammeter . . . IM-25

● 9 a.c. and 9 d.c. voltage ranges from 150 millivolts up 1,500 volts full scale ● 7 resistance ranges, 10 ohms centre scale with multipliers × 1, × 10, × 100, × 1k, × 10k × 100k, and × 1 meg . . . measures from one ohm to 1,000 megohms ● 11 current ranges from 15μA full scale to 1·5A full scale ● 11 megohm input impedance on d.c. ● 10 megohm input impedance on a.c. ● a.c. response to 100kHz ● 6in 200μA meter with zero-centre scales for positive and negative voltage measurements without switching ● Internal battery power or 120/240V a.c., 50Hz ● Circuit board construction for extra-rugged durability.

Kit IM-16 **£28.8.0** **Ready-to-use** **£35.8.0** P.P. 6/-

New Solid-State Volt-Ohm Meter . . . IM-16

● 8 a.c. and 8 d.c. ranges from 0·5 volts to 1,500 volts full scale ● 7 ohm-meter ranges with 10 ohms at centre scale and multipliers of × 1, ×10, ×100, × 1k, × 10k, × 100k, and ×1 megohm ● 11 megohm input on d.c. ranges, 1 megohm on a.c. ranges ● Operates on either built-in battery power or 120/240V a.c. 50Hz ● Circuit-board construction.

Kit IP-17 **£37.4.0** **Ready-to-use** **£46** P.P. 10/6

IP-27 not illustrated, but similar in styling.

New Variable Control Regulated High Voltage Power Supply . . . IP-17

● Furnishes 0 to 400 volts d.c. @ 100mA maximum with better than 1% regulation for 0 to full load and ±10 volt line variation ● Furnishes 6V a.c. @ 4 amperes and 12V a.c. @ 2 amperes for tube filaments ● Provides 0 to —100 volts d.c. bias @ 1 milliampere maximum ● Features separate panel meters for continuous monitor for output current and voltage. ● Terminals are isolated from chassis for safety ● High voltage and bias may be switched "off" while filament voltage is "on" ● Modern circuit board and wiring harness construction ● 120/240V a.c. 50Hz operation.

New Improved Version Of The Famous Heathkit Solid State, Voltage-Regulated, Current-Limited Power Supply . . . IP-27

● New zener reference ● New improved circuitry is virtually immune to overload due to exotic transients ● 0·5 to 50 volts d.c. with better than ±15 millivolts regulation ● Four current ranges 50mA, 150mA, 500mA and 1·5 amperes ● Adjustable current limiter: 30 to 100% on all ranges ● Panel meter shows output voltage or current ● "Pinball" lights indicate "voltage" or "current" meter reading ● Up-to-date construction ● Unequalled performance in a laboratory power supply.

Kit IP–27 £46.12.0. Ready to use £55. P.P. 9/–.

FULL SPECIFICATION ON ANY MODEL AVAILABLE ON REQUEST

New Solid-State Volt-Ohm-Meter, IM-17

● Just right for the home owner, boater, model builder, hams, sophisticated enough for even radio and TV servicing ● Solid-state circuit ● FET input ● 4 silicon transistors, 1 diode circuit ● 4 a.c. voltage ranges ● 4 d.c. voltage ranges, 4 ohm ranges, 11 megohm input d.c. 1 megohm input a.c. 4½in 200μA Meter ● Self powered ● Rugged polypropylene case with self cover and handle. Storage space for own test leads ● PCB construction.

Kit £12.12.0. Ready to use £17.10.0. P.P. 4/6.

DAYSTROM LTD., Dept. P.E.8, GLOUCESTER | **Please use coupon on right for enquiries**

SUMMER BARGAIN!

HARVERSONS SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer, EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7" w. × 3" d. × 6" h. overall. A.C. mains 200/240v. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. LIMITED NUMBER ONLY.
Our Rock Bottom Bargain Price 49/6 P. & P. 6/-

E.M.I. 3¾in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. 3 or 8 ohm. 15/-. P. & P. 2/6. 15 ohm, 18/6. P. & P. 2/6.

TRANSISTOR STEREO 8 + 8

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push-pull output per channel (16W mono), Integrated pre-amp. with Bass, Treble and Volume controls.* Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief Specification: Freq. response ±3dB, 20-20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

PRICES:
Amplifier Kit, £9.10.0 (Built and Tested £12.10.0). P. & P. 4/6.
Power Pack Kit, £2.10.0 (Built and Tested £3) P. & P. 4/-.
Cabinet (as illust.), £2.10.0. P. & P. 5/6.
(Special Offer—£14.10.0, post free if all above kits ordered at same time or built and tested for £18 post free).
Circuit diagram, construction details and parts list (free with kit) 1/6 (S.A.E.).

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1 (as illus. in June issue)

● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel size 6 × 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. SPECIAL PRICE 45/-. P. & P. 3/-. Also ready built and tested, 52/6. P. & P. 3/-.

FM/AM TUNER HEAD by Dormer and Wadsworth with valve and tuner head circuit diagram. (See June issue). ONLY 27/6 each. P. & P. 3/-.

GORLER F.M. TUNER HEAD. 88-100 Mc/s 10·7 Mc/s. I.F., 15/-, Plus 2/6 P. & P. (ECC85 valves, 8/6 extra.)

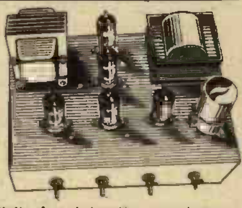
BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. A.C. Sec. 240v. at 50mA and 6·3v. at 1·5 amp. Stock size 2¾" × ¾" × 1¾" 10/6. P. & P. 3/6. (Special quotations for quantities).

3-VALVE AUDIO AMPLIFIER MODEL HA34

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £4.5.0. P. & P. 6/-.

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

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 2/6. (Free with parts.) All parts sold separately. ONLY £7.9.6. P. & P. 8/6. Also available ready built and tested complete with std. input sockets. £9.5.0. P. & P. 8/6.

MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1½ × 1½ × ¾ in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair plus 2/- P. & P.

HUGE PURCHASE! E.M.I. 4-Speed Player. Heavy 8¾in. metal turntable. Low flutter performance 200/250v. shaded motor (90v. tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o styli for LP/78. LIMITED NUMBER. ONLY 63/-. P. & P. 6/6.

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing.
E.M.I. MODEL 999 Single player with unit mounted pick-up arm and mono cart. £5.5.0.
B.S.R. UA25 with latest mono compatible Cart. ... £6.19.6
All plus Carriage and Packing 6/6.
LATEST GARRARD MODELS ALL types available 1000, SP25, 3000, AT60, etc. Send S.A.E. for latest Bargain Prices!

LATEST B.S.R. X1H MONO COMPATIBLE CARTRIDGE With turnover sapphire styli for playing EP, LP and Stereo records with mono equip. ONLY 22/6. P. & P. 1/6

SONOTONE 9TAHC Compatible Stereo Cartridge with diamond stylus 50/-. P. & P. 1/6.

MONO T/O CARTRIDGE. Complete with LP & 78 sapphire styli. Brand New 12/6. P. & P. 2/-.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3in. d. × 6in. h. Ready built and tested. PRICE 75/-. P. & P. 6/-.
ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/P CABINET

Uncut motor board size 14½in. × 12in. clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD Autochanger or Single Player Unit (except AT60 and SP25). Size 18in. × 15in. × 8in. PRICE £3.9.6. P. & P. 9/6.

BRAND NEW 3 OHM LOUDSPEAKERS

5in., 14/-; 6½in., 18/6; 8in., 27/-; 7in. × 4in. 18/6; 10in. × 6in., 27/6. E.M.I. 8in. × 5in. with high flux magnet 21/-. E.M.I. 13½in. × 8in. with high flux ceramic magnet, 42/- (15 ohm, 45/-). P. & P. 5in. 2/-, 6½in. & 8in. 2/6, 10in. & 12in. 3/6 per speaker.
BRAND NEW. 12in. 15w. H/D Speakers, 3 or 15 ohm. By well-known British maker. Now with Hi Flux ceramic ferrobar magnet assembly, £5.10.0. P. & P. 5/-. Guitar models: 25W, £6; 35W, £8.

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170 HIGH ST., MERTON, S.W.19 01-540 3985

Open all day Saturday. Early closing Wed., 1 p.m. A few minutes from South Wimbledon Tube Station. (Please write clearly).
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RIDICULOUS PRICE

IDEAL BACKGROUND MUSIC – LANGUAGE COURSES, ETC. 200ft. HIGH QUALITY AMPEX TAPE. WILL FIT ALL TAPE RECORDERS.
CANNOT BE REPEATED

NEARLY ALL GONE HURRY! NOW ONLY 18/- EACH P&P 6d.

FULL CIRCUIT – INSTRUCTIONS – PARTS LIST TO BUILD YOUR OWN
TELEPHONE ANSWERING/RECORD MACHINE – QUICK – AUTOMATIC
TAKES 100's OF CALLS: *CHEAP TO BUILD.* SEND NOW **25/-**

7" AMPEX TAPE SPOOLS, ONLY 2/6
P. & P. 6d.

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105/107 DAWES ROAD, FULHAM, S.W.6
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17in.—£11.10.0 Carr. 30/-
19in. SLIM-LINE 24 gns.

TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS

FREE ILLUSTRATED LIST OF TELEVISIONS
17"—19"—21"—23"

WIDE RANGE OF MODELS SIZES AND PRICES
DEMONSTRATIONS DAILY

STEREOGRAM CABINET £19

An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel
BLACK LEATHERETTE SIDE PANELS
Dimensions: 52" × 17½" × 12". Speaker positions for Twin 10" × 5" Speakers

OTHER MODELS—SEND FOR LIST

TRANSISTOR CHASSIS D1 59/6
6 Transistors, LW/MW. Telescopic Aerial. Brand New. Famous British Manufacturer (LESS SPEAKERS). P. & P. 4/6.

TRANSISTOR CHASSIS D2 59/6
8 Transistors LW/MW. Brand New. Famous Manufacturer (LESS SPEAKER 10Ω) Dia. 9½" × 5". P. & P. 4/6.

TRANSISTOR RECORD PLAYER CABINETS 19/6 P. & P. 7/6.

SINGLE PLAYER CABINETS 15/6. P. & P. 7/6.

TRANSISTOR CASES 19/6. Cloth covered, many colours. Size 9½" × 6½" × 3½". P. & P. 3/6. Similar cases in plastic 7/6.

COCKTAIL/STEREOGRAM CABINET £25

Polished walnut veneer with elegant glass fronted cocktail compartment, padded. Position for two 10" elliptical speakers. Record storage space. Height 35½", width 52¾", depth 14½". Legs 1 gn. extra.

DUKE & CO. (LONDON) LTD.

621/3 Romford Road, Manor Park, E.12
Phone 01-478 6001-2-3 Stamp for Free List.

PP3 Eliminator. Play your pocket radio from the mains! Save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions. Only 6/6, plus 1/- post.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by fingertip control. Kit includes all parts, case, everything and full instructions. 19/6, plus 2/6 post and insurance. Or available made up 32/6. Plus 2/6 post.

3kW TANGENTICAL BLOWER UNIT

Winter is coming but act today and you won't dismay. This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Units complete, wired ready to fit into cases, i.e. motor, impeller, 3kW heater switching 1, 2 and 3kW, and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need on/off switch. 59/6, postage and insurance 6/6. Don't miss this.

0-1mA FULL VISION MOVING COIL METER

2in sq. full vision 19/6, plus 2/- post.

300pF SILICON TUNING CONDENSER, 2/6 EACH, 24/- DOZ. 0-500mA 3in FLUSH MOUNTING MOVING COIL METER, 10/-.

THE TUBE IS FREE

This month with our 15/20 watt fluorescent kit we give a free 15in tube. Ideal for fish tank, plant growing, or any normal lighting situation. Costs less than 1d per day if left on all the time. Kit comprises Atlas choke, TV suppressed starter, three lampholders and two terry tube clips.

Only 19/6, plus 4/6 post and packing, and the tube is yours for nothing, but you must collect this.

YOU NEVER NEED BUY ANOTHER BATTERY

for your transistor radio if it uses a 9V battery. Stupendous offer this month—a 9V Nickle 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 19/6, plus 3/6 post.

BARGAIN OF THE YEAR

MICRO-SONIC 7 transistor Key chain radio in very pretty case, size 2⅜in × 2⅛in × 1in—complete with soft leather zipped bag. Specification: Circuit: 7 transistor superheterodyne. Frequency range: 530 and 1,600kc/s. Sensitivity: 5mv/m. Intermediate frequency 465kc/s or 455kc/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.

HI-FI BARGAIN

FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of this country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.

Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S.—Cone Moulded fibre—Freq. response 30-10,000c/s—Main resonance 60c/s—Chassis Diam. 12in—12⅜in over mounting lugs—Baffle hole 11in Diam.—Mounting holes 4, holes—¼in diam. on pitch circle 11⅛in diam.—Overall height 5½in. A £6 speaker offered for only £3/9/6, plus 7/6 P. & P. Specify three or fifteen ohms. Don't miss this offer.

THIS MONTH'S SNIP

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 ¼ 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.

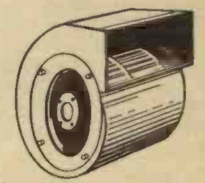
CASSETTE LOADED DICTATING MACHINE

Battery operated and with all accessories. Really fantastic offer a British made £31 outfit for only £6/19/6, brilliantly designed for speed and efficiency—cassette takes normal spools drops in and out for easy loading—all normal functions—accessories include: stethoscopic earpiece—crystal microphone has on/off switch—telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY, £6/19/6 plus 7/6 post and insurance. Footswitch 18/6 extra. Spare Cassettes at 7/6 each, three for £1.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 16/6, plus 3/6 postage.

CENTRIFUGAL FAN



Centrifugal blower or extractor by Torrington, very low noise but large capacity air flow, designed for central heating and air conditioning, ideal also for fume extraction over cooker, duct type outlet, 200/500V 50c/s motor. £3.19.6. Post and insurance 7/6.

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also at **266 LONDON ROAD, CROYDON, SURREY.** *S.A.E. with enquiries please*

HIGH SPEED MAGNETIC COUNTERS (4 × 1 × 1in). 4 digit. 12/24/48V (state which) 6/6 each. P. & P. 1/-.

COPPER LAMINATE BOARD (8½ × 5½ × 1/16in). 2/6 each. 5 for 10/-.

RE-SETTABLE HIGH SPEED COUNTER (3 × 1 × 2in). 3 digit. 12/24/48V (state which) 32/6 each.

BULK COMPONENT OFFERS

100 Capacitors 50pF to 0.5μF.
250 Carbon Resistors ⅛ & ¼W (Transistor types).
250 Carbon Resistors ½ & 1W.
100 Ceramic Capacitors 2—1,000pF.
25 Vitreous W/W Resistors (5%).
12 Precision Resistors (0.1% several standard values included).
25 Close Tolerance Caps. (2%).
12 Silicon Diodes 500 p.i.v. 750 m.a.
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8 Silicon Rects. 100 p.i.v. 3 amp.
50 Silicon Trans. (2N706/708, BSY28/29. BCY41/42 types.) Unmarked, Untested.
50 Silicon Diodes 200 m.a. 100 p.i.v. Sub. Min.

ANY ITEM 10/-. ANY 5 ITEMS £2.

S.C.Rs. (Thyristors) CRS1/20 5/6; CRS1/40 7/6; CRS3/10 7/6; CRS3/30 8/6; CRS3/40 10/-; CRS3/50 12/6 each.

'3000' TYPE RELAYS (ex. new equip.) 10 for 25/- (our choice) P. & P. 5/-.

VENNER LIGHTWEIGHT ACCUMULATORS (1oz 1⅜ × 1⅜ × ⅜in). 1·5 Ahr 12/6 each.

COMPUTER LOGIC BOARDS containing: 14 BCZ11. 2 trimpots, diodes, etc., 20/- each.

LIGHT DIMMER/SPEED CONTROL MODULES: 200 watt, 35/-; 500 watt, 45/-; 1,000 watt, 60/-.

RECORD LEVEL METERS (By Smiths). 1½ × ⅜in, 15/- each. P. & P. 2/6.

MINIATURE RELAYS (½oz, ¾ × ½ × ⅜in), 24V 1 c/o, 7/6 each.

P. C. CONNECTORS (13 way in-line), 4/6 pair.

LARGE CAPACITY ELECTROLYTICS: 100 + 400μF, 275V; 1,000μF, 50V; 2,500μF, 70V; 3,200μF, 16V; 5,000μF, 15V, 4/- each. 4,000μF, 90V; 5,000μF, 25V, 7/6 each. 5,000μF, 50V; 6,300μF, 63V: 10,000μF, 30V; 16,000μF, 15V; 25,000μF, 15V, 10/- each.

SPEAKER BARGAINS (E.M.I. 13 × 8in.) With two Tweeters and x/over, 15 ohm, 65/-; with Dual Cone, 15 ohm, 52/6; Single Cone, 3 or 15 ohm, 45/-, P. & P. 3/-.

FANE, 12in, 20waH (Dual Cone), 95/- P. & P. 5/-.

TWEETER (E.M.I. 3in), 15 ohm, 12/6.

CAR RADIO (3/5 ohm), 7 × 4in, 15/-; 8 × 5in. 17/6.

INVERTER UNIT containing 2 × OC28 and 2 LA5 Pot Cores. 15/-. P. & P. 2/6.

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How would you like to start with a simple amplifier, say, and add to it until it became a fully stereo twenty watt amplifier with FM tuner and facilities to take the most sensitive low output pickups ever made? With **Martin Audiokits** it's easy, for with these superbly engineered all-transistor prefabricated units, success is built in from the start and you build to your own preferred plan. IT'S A MONEY SAVING SCHEME, TOO.

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(Tick as required)

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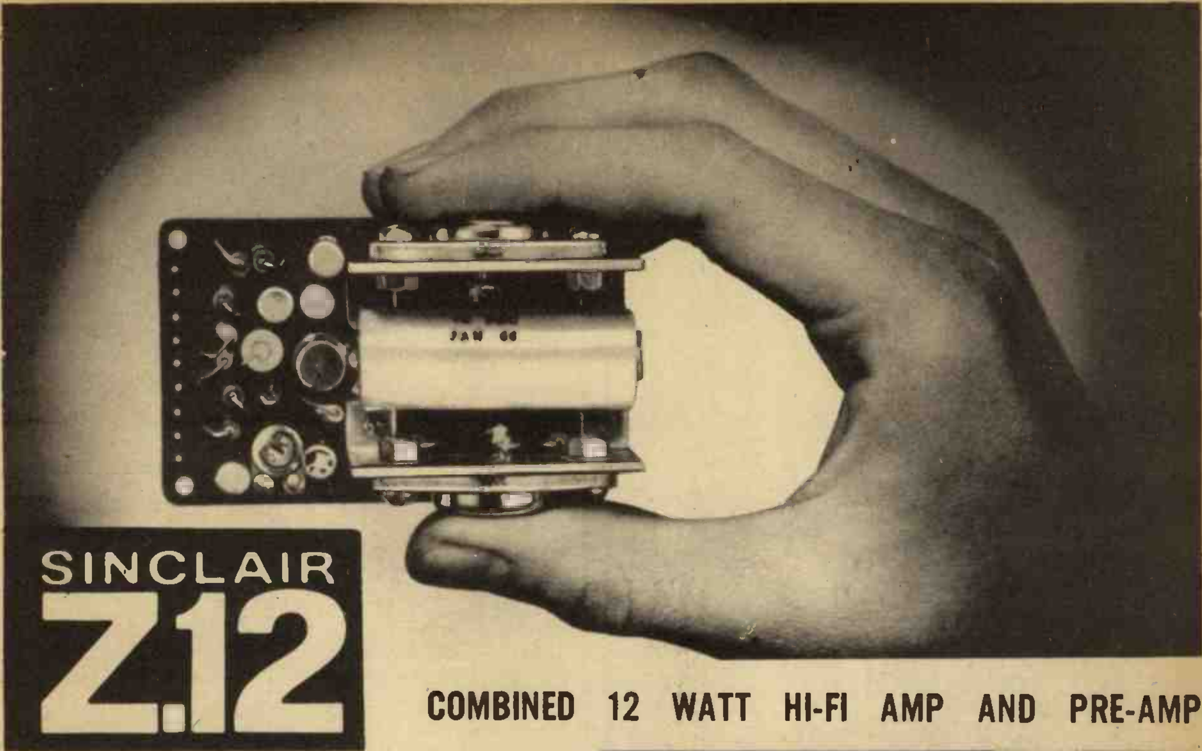

COMBINED 12 WATT HI-FI AMP AND PRE-AMP

The small amplifier with the enormous output

No constructor's amplifier has ever achieved such success as the Sinclair Z.12. It has fantastic power-to-size ratio, and far greater adaptability. It will operate from batteries or mains supply unit PZ.4, and give superb stereo reproduction for a modest outlay. Thousands are in use throughout the world—in hi-fi, electronic music instruments, P.A., intercom systems, etc. This true 12 watt amplifier is supplied ready built, tested and guaranteed together with the Z.12 manual which details control circuits enabling you to match the Z.12 to your precise requirements. For complete listening satisfaction, use your Z.12 system with Q.14 loudspeakers. It assures superb quality with substantial saving in outlay.

★ IDEAL FOR BATTERY OPERATION.

3in × 1¾in × 1¼in. ● Class B Ultralinear output. ● 15–50,000Hz ± 1dB. ● Suitable for 3, 5, 8 or 15Ω speakers. Two 3-ohm speakers may be used in parallel. ● Input—2mV into 2kΩ. ● Output—12 watts R.M.S. continuous sine wave (24W peak). 15 watts music power (30W peak). ● Ready Built, Tested and Guaranteed.

89/6

SINCLAIR PZ.4 STABILISED POWER SUPPLY UNIT

A heavy duty a.c. mains power supply unit delivering 18V d.c. at 1·5A. Designed specially for use with one or more Z.12s. Ready built and tested.

99/6

SINCLAIR STEREO 25 PRE-AMP/CONTROL UNIT

For use with two Z.12's in stereo. With full control and matching facilities. Attractive aluminium front panel and knobs.

£9.19.6

$1\frac{4}{5}$in x $1\frac{3}{10}$in x $\frac{1}{2}$in

BUY IT IN KIT FORM OR READY BUILT

Complete kit including magnetic earpiece and instructions

49/6

Ready built with magnetic earpiece

59/6

Mallory Mercury Cell RM.675 (2 needed) ea. 2/9

This amazingly tiny receiver is the ultimate in personal listening. The Micromatic is as easy to have with you as your wristwatch. It has enormous power and range, and the magnetic earpiece now supplied assures marvellous quality. Hear how Radio I and other stations simply pour in over the whole medium waveband. Build it yourself or buy your Micromatic ready built. This is the set you will never be without once you hear it for yourself.

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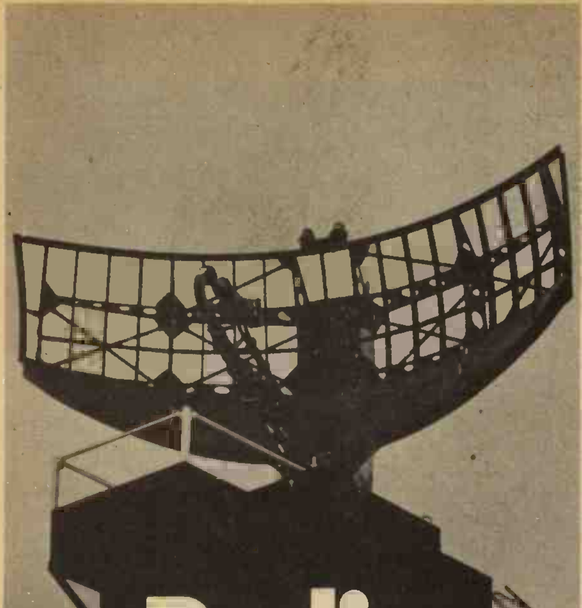

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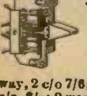

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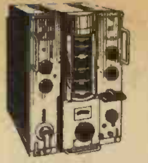

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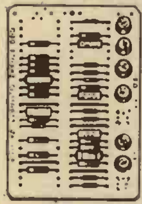

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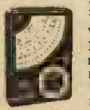

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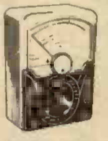

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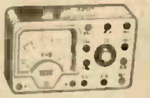

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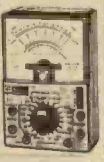

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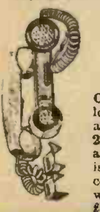

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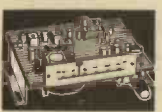

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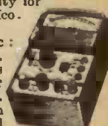

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VOL. 4 No. 8
August 1968

PRACTICAL ELECTRONICS

EXPERIMENTING

How do you prefer your electronics—as cut and dried designs, or as thought-provoking ideas intended to sow a seed or two for individual cultivation? In other words, are you primarily just a constructor, or an experimenter as well?

The building of electronic circuits can be an enjoyable pastime in itself, even if one is throughout just studiously following a point-to-point wiring diagram. And of course, the underlying purpose is generally to produce a piece of equipment of lasting worth, that will perform some function as ably, at least, as a comparable commercial product, and for a more modest financial outlay!

Such building activities are well rewarding and there is no doubt concerning the widespread popularity of the constructional projects published in this magazine. But mere assembly work does not allow one to extract the full benefit from electronics. Much more in addition is offered to those prepared to experiment for themselves on occasion. There are endless possibilities for innovation in electronics, for discovering yet further applications for old and well tried circuits. This is the very reason why electronics is ever expanding, And make no mistake, it is frequently the amateur who comes up with another bright idea in this field!

Apart from "cut and dried (and tried)" designs, many articles appear regularly in these pages which are aimed more specifically at the experimenter. The ideas and design outlines given are usually sufficient to start the enterprising experimenter off on a new path. Complete success may not always reward these individual efforts, but something useful is bound to be learnt in the process. The diligent experimenter will at any rate develop his faculty to think more deeply about electronics, and who knows, one day a bright idea may well and truly click.

Are *you* getting the most out of the hobby?

F. E. Bennett—*Editor*

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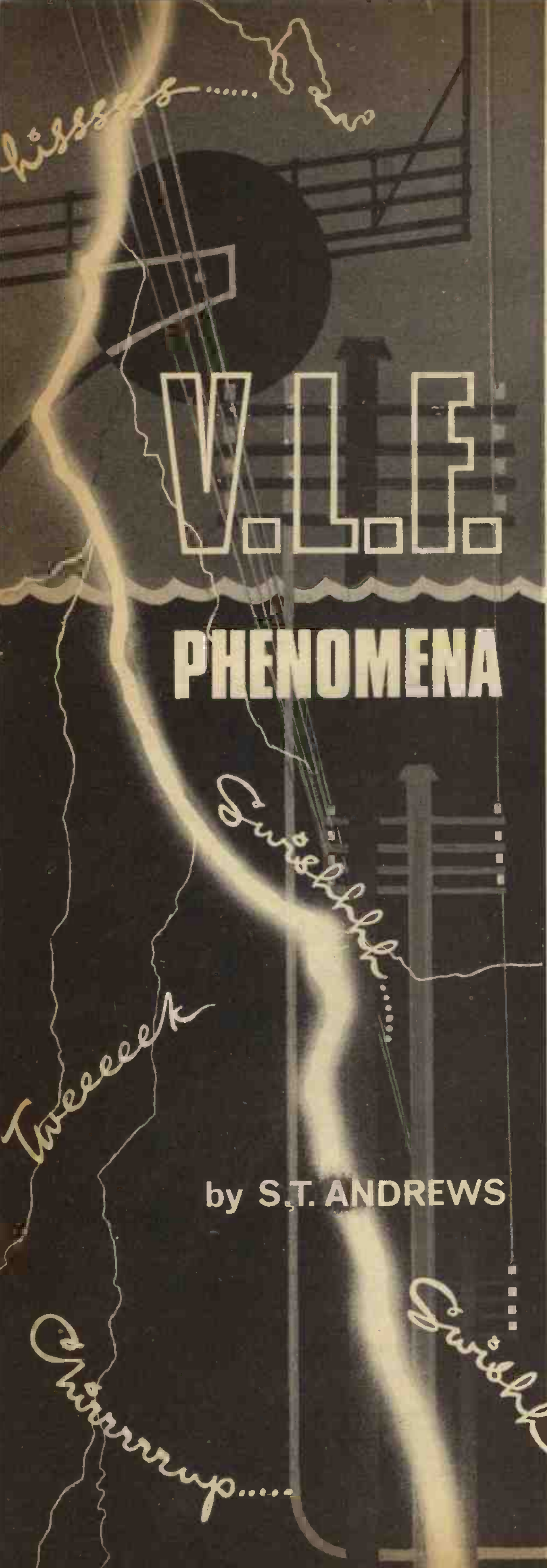
V.L.F. PHENOMENA

by S.T. ANDREWS



WHEN considering radio waves and radio reception it is customary to think in terms of frequencies of megahertz or at least hundreds of kilohertz per second. There are, however, certain radio emissions which do not fall into this category; these are naturally-occurring radio signals of extremely low frequency and correspondingly long wavelength, which are appropriately called Very Low Frequency (v.l.f.) signals.

V.L.F. signals have been the subject of sporadic investigation for a long time, in fact for most of the time during which radio communication has been known and developed. Some problems in this field are still unsolved and, perhaps because of the unusual—and at times quite mysterious—forms which v.l.f. waves take, the subject is extremely interesting.

The purpose of this introductory article is to give a description of some of the types of these signals, together with some theories on their generation. It should be added that v.l.f. waves can be man-made as well, nuclear weapons, and missile and rocket exhausts all producing signals in the same frequency range. However, this article deals only with the naturally-occurring types of v.l.f., so these artificial sources will not be mentioned again.

EARLY HISTORY

The first indication of the existence of v.l.f. signals is to be found in the early part of this century. These were the days when telephones were becoming widespread but the large-scale national electric grid system had not been started and there were far fewer electrical machines of all types. Under these circumstances there was little in the way of man-made interference and in theory long-distance telephone wires should have remained silent when no actual messages were being sent.

In practice, however, the operators soon built up a list of strange and unidentified noises which appeared on their lines and which included chirps, warbling sounds, hiss, whistles of varying pitch and numerous other sounds often known only by suitably-invented onomatopœic names—tweeks, chinks, clicks, etc. Although it was soon realised that the noises were some form of natural radiation no explanations were immediately forthcoming and for a time the causes were quite unknown.

SUBMARINE CABLES

Telephone lines were not the only form of communication to be affected by v.l.f. pick-up, and in 1929 investigations were made into similar phenomena in submarine cables. The signals picked up from such cables were of various types, one common form being a low-frequency, low-amplitude voltage "kick". The occurrence of these kicks was very variable, their frequency being low during daylight, rising progressively as evening passed, and maintaining a high level throughout the night. As soon as dawn broke the kicks rapidly diminished in number to the low daytime level.

Other forms of interference appeared as signals in the range 500 to 1,500Hz, and when applied to a loudspeaker after amplification these came out as roaring or rustling sounds. Also noted were "swishes", signals characterised by a narrow bandwidth, the centre frequency of which rapidly changed, typically from 700 to 2,000Hz over a period of $\frac{1}{4}$ to 1 second. Such swishes were heard both with ascending and descending centre frequencies.

TWEEKS

Another form of v.l.f. phenomena observed from submarine cables were "tweeks". Their waveform was characteristically a damped oscillatory waveform of approximately constant frequency, the whole thing lasting $\frac{1}{8}$ second and being in the frequency range 6 to 20kHz, see Fig. 1. Tweeks were apparently always preceded by a static "kick" and were never heard in daylight. They always appeared at dusk with a low repetition rate and heavy damping. Later in the night the rate often rose to three to 30 tweeks per minute and the damping was greatly reduced. Just before dawn the rate increased briefly before falling to the daytime zero level.

It is reasonable to accept the theory that tweeks are caused by the multiple reflection of a pulse between the earth and the lower levels of the ionosphere, or possibly between layers within the ionosphere (see Fig. 2), and it is also reasonable to assume that a similar explanation may well account for at least some of the sounds heard on the telephone wires.

Tweeks, and also "chinks", had also been heard on telephone wires, again only at night, and they were found to have a duration of $\frac{1}{20}$ to $\frac{1}{5}$ second and a frequency in the range 1·6 to 4kHz. Taking the approximate height of the bottom of the ionosphere as 100km and $c = 3 \times 10^5$km per second, we get about $2{\cdot}5 \times 10^3$ complete bounces per second—so if some signal is reflected by the ionosphere at each bounce we would get a damped waveform of frequency 2·5kHz which is in fair agreement with observation, at least with the telephone wire tweeks.

LIGHTNING DISCHARGES

The ultimate source of energy for a tweek appears to be the static pulse which precedes it. This initiating pulse, or click, is typically radiation from a lightning discharge, and lightning discharges figure very largely in discussions and explanations of v.l.f.

A considerable amount of research has been done into lightning strokes and their effect. Everyone is familiar with the sounds emitted by an ordinary radio receiver when lightning occurs nearby—an initial crack, followed by a sizzling or swishing sound lasting $\frac{1}{2}$ to 1 second. The actual energy dissipated in an average stroke is 1,000 megawatts, all released in 0·1 millisecond or less, so this represents a truly colossal release of energy. It is hardly surprising that some curious effects, for example tweeks, should result from such an energy release and it will soon become apparent that several other phenomena are also the result of energy liberated by thunderstorms.

WHISTLERS

Possibly the commonest, and certainly the most recognisable, type of v.l.f. signal is the whistler. A typical whistler will be heard as a high-pitched audio note, often initially at the upper limit of hearing, which rapidly (0·3 to 5 seconds) falls in pitch and finally dies away at a frequency many octaves lower, see Fig. 3. Sometimes several whistlers will occur in succession, with progressively decreasing amplitudes. Whistlers with frequencies varying from 30kHz to 350Hz have been measured but the spread is usually less in a given instance.

Various theories were put forward to account for the properties of whistlers, in particular their comparatively pure note and the smooth fall in frequency. One suggestion was that whistlers were formed by multiple reflections between the ground and the Heaviside Layer. With a changing angle of reflection a wave would need a different number of bounces to reach a given receiver and since time delay was proportional to the number of bounces, some "sorting out" of frequencies would occur if the maximum angle of reflection was in some way related to frequency.

Another idea was that whistlers were of solar origin and that a group of ionised particles from the sun hit the outer atmosphere and gave rise to a pulse in the shape of an expanding torroidal ring of radiation in the ionosphere with some frequency-selective properties.

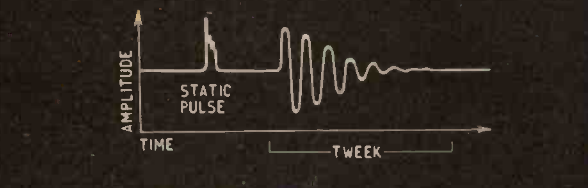


Fig. 1. Idealised diagram of a "tweek" waveform

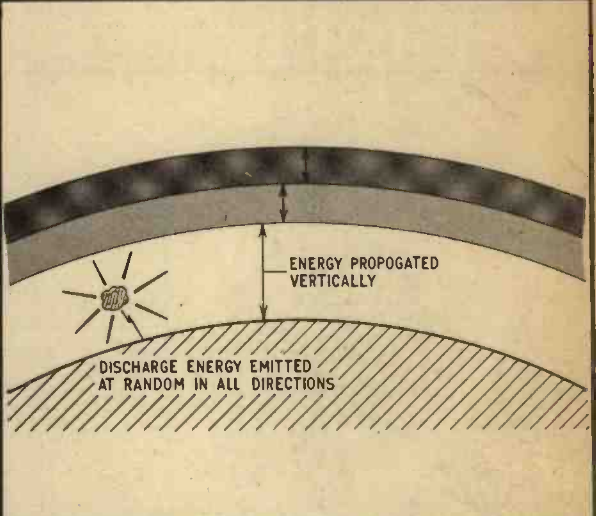


Fig. 2. Formations of "tweeks" (idealised and not to scale)

Fig. 3. Idealised diagram of a "whistler" waveform

The mystery was finally solved by Storey who noted that whistlers could be grouped into two categories depending on the rate of fall of the frequency. One group, with a rate of fall approximately twice that of the other group, generally had the whistler by itself, whistlers in the other group were very often preceded by a pulse of atmospheric noise.

IONOSPHERIC NOISE

Storey showed that this initial pulse came from a lightning discharge and formed his theory that some of the intense energy liberated interacts with free electrons in the ionosphere to give a broad band of radio noise. Some of this noise travels out into space following the lines of force of the earth's magnetic field and ultimately hits the ground again when the line of force goes underground, approaching the other pole. In the case of lightning in Britain this bounce will occur in the neighbourhood of South Africa. After the bounce the waves re-trace their path, following the same lines of force, back to their starting point, see Fig. 4.

A reflective system such as this exhibits dispersion, that is, short wavelengths corresponding to high frequencies are diffracted the most, and so follow a path which is always nearer the surface of the earth than the path taken by a signal of longer wavelength. Since the wave-velocity is constant it follows that shorter wavelengths will arrive back first, followed progressively by longer and longer wavelengths. Thus at a receiving point the effect is a steady lengthening of the received wavelength, hence the regular fall in pitch and the explanation of whistlers.

The degree of dispersion of a whistler will obviously increase with each passage from ground to ground, so whistlers originating from lightning discharges in Britain should have a slower rate of frequency change after two "hops" than those originating from storms in South Africa which have only made one hop, see Fig. 5. Also, one would expect some of the radio noise from the discharge itself to be heard before the whistler in the case of a British-originated whistler. This, of course, is just what is observed, the slower-falling frequency class of whistler generally being preceded by a click.

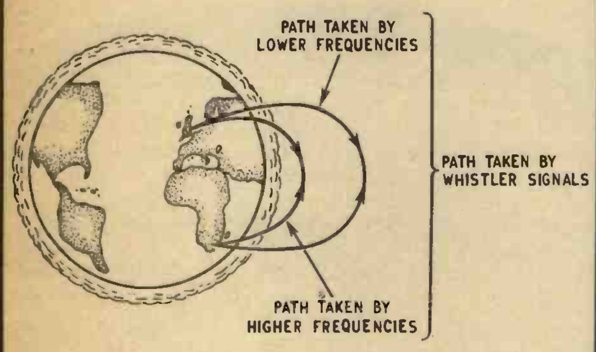


Fig. 4. The formation of "whistlers"

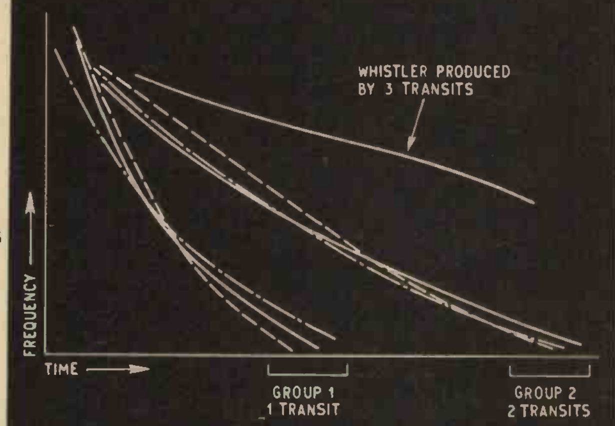


Fig. 5. Graph of fall of whistler rate v. time

THE DAWN CHORUS

If whistlers are the most recognisable part of the v.l.f. repertoire then the upper atmosphere's "dawn chorus" is undoubtedly the weirdest and most unearthly, especially when the observer happens to be on a lonely mountainside in northern Scotland at 5.30 a.m. The dawn chorus is a complex sound and is composed of a mixture of short rising whistles, of duration 0·1–0·2 second, and longer warbling tones; it has been likened to the sound of a distant rookery.

The intensity of these signals varies very greatly during the day and in Britain it is at a maximum around sunrise with, sometimes, a smaller peak at sunset. In Alaska the daily peak comes nearer 2 p.m. and at latitudes nearer the equator the daily peak may be as early as 2 a.m. When plotted graphically the relation between latitudes and time of peak signal is a good approximation to a straight line.

Other properties noted include the apparent similarity between the signals received at stations far apart, implying a widespread source, rather than a localised one, and the absence of any audible precursors. There is certainly no connection between whistlers and the dawn chorus and the lack of any initiating trigger (unlike the click preceding locally-produced whistlers) seems to indicate a source high in the ionosphere.

EXTRA-TERRESTRIAL

Theories on the formation of the dawn chorus all agree that the ultimate source is extra-terrestrial and is in fact ionised particles shot out by the sun. It is possible that the dawn chorus is initiated by the arrival over the geomagnetic equator of positive particles of solar origin, such particles would excite ions already present in the outer atmosphere and these would re-emit excess radiation as electromagnetic radiation at their natural resonant frequency. This frequency would rise as the ionising cloud penetrated to lower levels. Referring momentarily back to the previous paragraph, it was shown that the time of peak dawn chorus activity was progressively later as latitude increased. It is interesting to note that a graph of

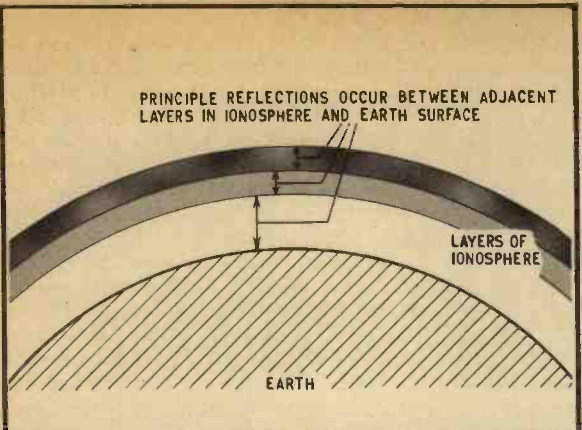


Fig. 6. A possible explanation for the origin of v.l.f. signals in the ionosphere is suggested in this diagram

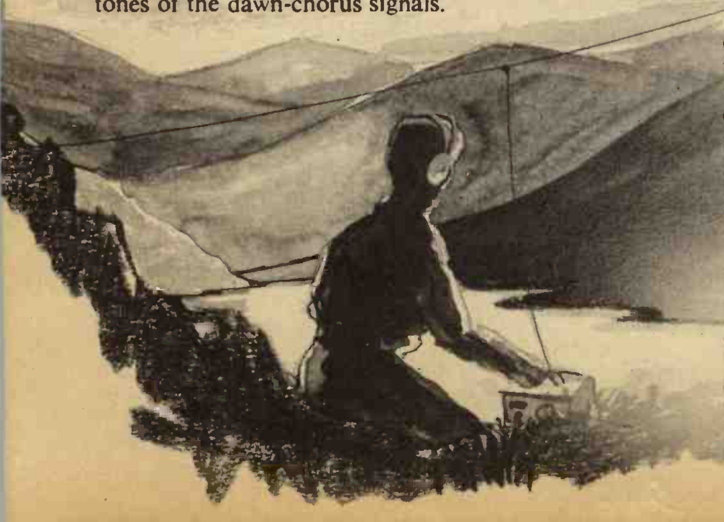
latitude *v.* peak activity time is also the locus of positively charged incoming ions travelling in an equatorial plane and being deflected by the earth's magnetic field.

TRAVELLING-WAVE THEORY

Another theory, due to Gallet and Helliwell, suggests a different action entirely. Their theory is somewhat complex but basically it suggests that in the upper atmosphere an effect occurs similar to that in a travelling-wave tube.

According to this theory the slow-wave circuit (corresponding to the helix in a normal travelling-wave tube) is formed by the ambient ionisation of the outer ionosphere in the presence of the earth's magnetic field. The energy for amplification is provided by the streams of in-coming particles which have velocities in the range 0·1 to 0·01c (c = velocity of light). The particle stream is assumed to travel along the lines of force of the earth's magnetic field and there will be a component of the electric field parallel to this direction. Under these conditions travelling-wave amplification is possible.

According to Gallet and Helliwell the incoming particles arrive in bunches and as these travel along the lines of force of the earth's magnetic field travelling-wave amplification is possible and will occur at a frequency determined by the size and velocity of the bunch. As the bunch loses energy these parameters change so the frequency of amplification, and of the resulting note, change, giving the characteristic rising tones of the dawn-chorus signals.



FINAL THEORETICAL COMMENTS

There is still a lot to be learned about naturally-occurring v.l.f. radio waves and much remains unknown. There is no doubt that some of the strange noises, for example the whistlers, have been successfully explained but the exact method of generation of, for example, the dawn chorus is still controversial.

Some pure research goes on into the nature of v.l.f. and information is also being obtained as a by-product of other work dealing with the propagation of man-made low-frequency transmissions.

Experiments on the nature of the ionosphere are continuing. It is certain that a lot of v.l.f. signals are generated in the ionosphere and the more detailed is the information about it the easier it will be to decide on a mechanism for v.l.f. signal generation.

Ionisation is known to alter greatly in the ionosphere at sunrise and sunset. At sunrise the ionisation and electron density rapidly increase with corresponding changes in the permeability to, and polarisation of, low frequency radio waves. Nuclear explosions at high altitudes also have the effect of increasing electron and ion densities. Another form of v.l.f. radiation, plain hiss, is often heard and this was observed to increase sharply after a heavy cosmic ray shower in 1956.

PRACTICAL NOTES

Theoretically, v.l.f. radio reception is simple, one merely connects an ordinary aerial to an audio amplifier instead of the aerial socket of a radio receiver. In practice, of course, this usually fails due to the pick-up of man-made interference. Fairly high audio gains are required for efficient v.l.f. reception, although whistlers and the dawn chorus are often detectable with quite simple systems.

There are two chief difficulties. The first lies in getting rid of broadcast transmissions which can "break-through" if the v.l.f. receiver has any non-linearity in its amplifying stages. This may be avoided by using a low-pass filter in the aerial circuit and keeping amplifier linearity as high as possible. The second is interference, which comes from almost anything from an electric razor to an electric train, and also the 50Hz hum which is picked up from every power cable.

Since it is not usually possible to reduce the interference at its source v.l.f. experiments frequently have to be performed in open areas away from towns, hence the earlier reference to the lonely mountainside in Scotland.

TYPICAL V.L.F. AERIAL

A typical v.l.f. aerial may consist merely of a hundred or more feet of ordinary wire hung above ground in the traditional "crystal-set" style. One aspect of v.l.f. which is well worth some experimental time is the design of the aerial. Obviously dipoles are quite impractical when dealing in wavelengths measured in terms of miles, and some other criteria must be found which specify the efficiency of the aerial.

A certian amount of "devotion to the subject" is necessary when studying v.l.f. especially for experimenters who live in towns and who wish to study the dawn chorus! However, with a little care both in building the equipment and in laying out a suitable aerial, good results are usually quite obtainable and the audible results alone from a v.l.f. receiver are almost always very interesting.

Next month our Constructional Projects will include a V.L.F. "Whistler" Receiver

MULTI CHANNEL RADIO CONTROL FOR MODEL BOATS

PART THREE – By E. J. PEPPER C.Eng. M.I.E.E.

THIS third and concluding article describes the construction of the transmitter and then covers the complete setting up procedure for the whole system.

TRANSMITTER

The transmitter is a simple low power third overtone crystal controlled M.O.P.A. (master oscillator/power amplifier) arrangement operating at 27·255MHz. The circuit diagram appears in Fig. 13.

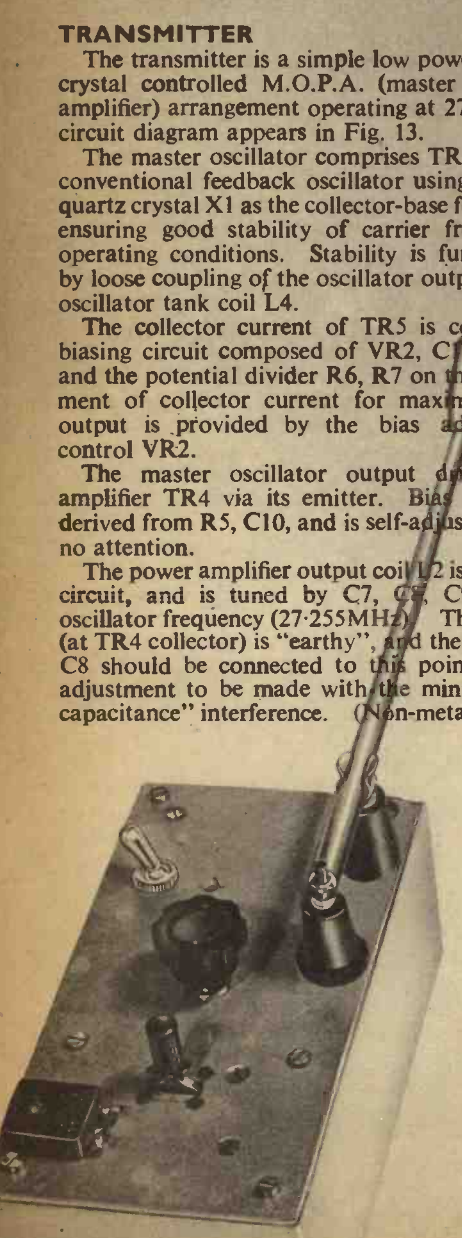
The master oscillator comprises TR5 connected as a conventional feedback oscillator using a subminiature quartz crystal X1 as the collector-base feedback element, ensuring good stability of carrier frequency, for all operating conditions. Stability is further guaranteed by loose coupling of the oscillator output coil L3 to the oscillator tank coil L4.

The collector current of TR5 is controlled by the biasing circuit composed of VR2, C12 in the emitter, and the potential divider R6, R7 on the base. Adjustment of collector current for maximum safe power output is provided by the bias adjustment preset control VR2.

The master oscillator output drives the power amplifier TR4 via its emitter. Bias for this stage is derived from R5, C10, and is self-adjusting and requires no attention.

The power amplifier output coil L2 is in TR4 collector circuit, and is tuned by C7, C8, C9 to the master oscillator frequency (27·255MHz). The common point (at TR4 collector) is "earthy", and the moving vanes of C8 should be connected to this point. This permits adjustment to be made with the minimum of "hand-capacitance" interference. (Non-metallic screw drivers should preferably be used for all adjustments to both transmitter and receiver.)

The aerial couples directly to an effective "tap" on the output coil L2, the "tap" position being determined by the ratio of C7 and the parallel combination of C8, C9. The effective capacitance of the aerial adds to that of C7 and hence final tuning of the output circuit must be done with the aerial connected.



MODULATOR

The collector current of TR4 and hence its resultant radiated output is controlled by TR3, which is connected as an emitter follower with TR4 as its load.

The drive for TR3 is the output of the free-running multivibrator TR1, TR2, which forms the modulator for the transmitter. The multivibrator provides a rectangular voltage waveform varying from zero to the full battery supply voltage.

The multivibrator frequency is set by means of the three position centre-biased P.O. key-switch S1, the throttle control. This selects the relaxation rate capacitors C1–C6, and so provides a frequency of 110Hz, 600Hz, or 400Hz for "increase", "decrease", and "hold" throttle respectively.

The mark/space ratio of the multivibrator is varied by the rudder position control VR1. This potentiometer provides varying degrees of unbalance of the charging resistors, R1, R3; and so determines the on/off time of the multivibrator. In the "rudder amidships" position the multivibrator gives a symmetrical output.

It can be seen that the r.f. carrier is "chopped" or modulated in a manner set by the multivibrator output.

The aerial is a simple centre loaded design 55½in long and is fairly critical in length and wire diameters.

POWER SUPPLY

The most satisfactory power supply for the transmitter is undoubtedly that derived from rechargeable sealed nickel-cadmium cells. A 12V assembly of DEAC 225mAH cells is ideal and will last for 10 hours between charges at an average transmitter load/current of about 20mA.

CONSTRUCTION

The transmitter is of necessity portable and is self-contained in an aluminium box measuring 7½in × 3¾in × 3in.

The electronics circuit is built on a piece of laminated plastics measuring 3in × 4½in which stands off the aluminium front panel on four 4B.A. 2in bolts. The front panel carries the control switches (on/off and throttle), steering potentiometer, and the battery, and also provides support for the aerial.

Details of the circuit board are given in Fig. 14. Holes should be drilled in the material as indicated in Fig. 14b, and tapered pins inserted to provided anchoring points. Perforated "peg board" may of course be used and will eliminate the need to drill holes. The position of the components and the wiring is given in Fig. 14a. Adequate clearance between the output coil L2 and the surrounding case must be provided (say ½in).

The front panel is made from 18 s.w.g. sheet aluminium, as is the transmitter case. See Fig. 16b for dimensions and drilling, and Fig. 16a for arrangement of components and wiring. The "flying leads" are keyed and should be connected up to the similarly coded points on the circuit board (as indicated in Fig. 14a) after the board has been mounted on the four 4B.A. stand-off supports.

INDUCTORS

All inductors used in the transmitter are "home-made". A full specification with winding details for each coil is given in the Components List.

Neosid or Aladdin formers with adjustable dust cores are used for the tuning coils, which are preferably locked against the effects of vibration after adjustment by means of paraffin wax.

The output coil L2 is self-supporting and details are given in Fig. 15.

AERIALS

On the original model the transmitter aerial is of a one-piece rigid design supported by a hardwood mast, but a collapsible unit could be devised, provided that care is taken not to increase the wire diameters too much in an attempt to increase rigidity, otherwise a reduction in antenna efficiency could result. The "free" upper section is best made overlong and then adjusted for optimum results using the receiver as a monitor. See Fig. 18 for details of a suggested design.

Similarly, the receiver aerial is not critical, good results being achieved with a single section whip 14in long. The gain achieved by increasing the length is marginal, and the aerial becomes unwieldy.

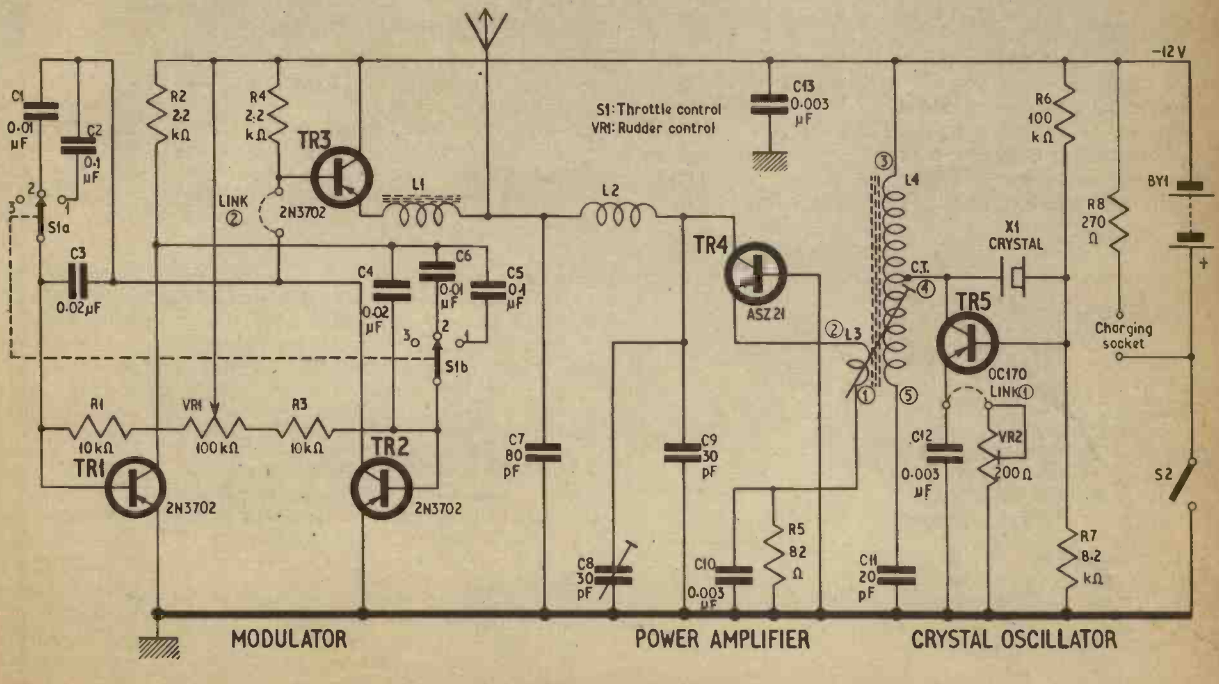


Fig. 13. Circuit diagram of the multi-channel model control transmitter

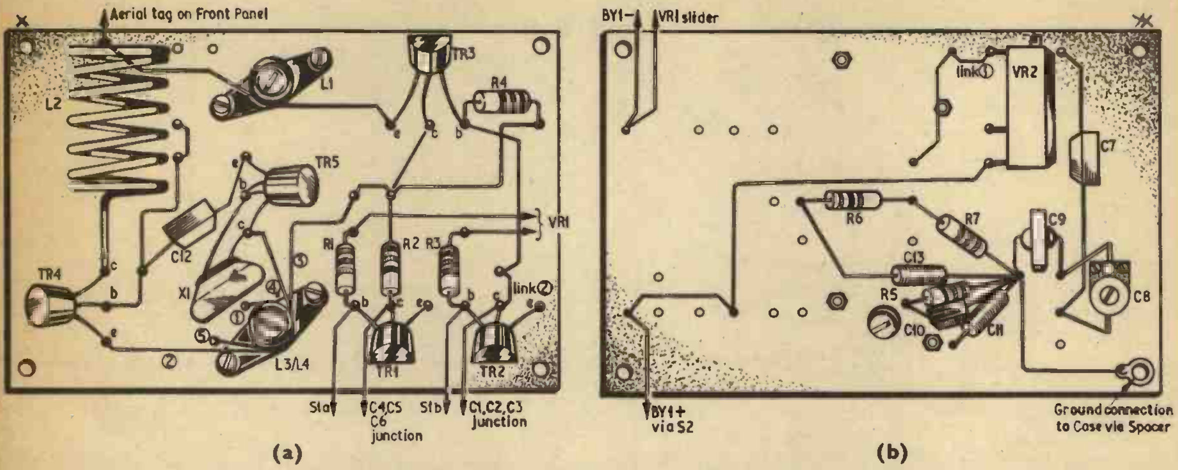


Fig. 14. The transmitter circuit board (a) top view showing arrangement of components; (b) underside view with drilling details, components, and wiring

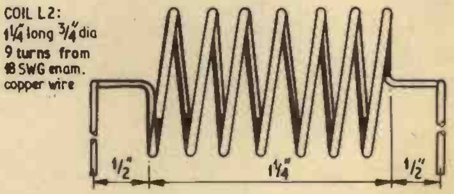


Fig. 15. The transmitter output coil L2

COMPONENTS . . .

Resistors

R1 10kΩ
R2 2·2kΩ
R3 10kΩ
R4 2·2kΩ — All 10%, ¼ watt carbon
R5 82Ω
R6 100kΩ
R7 8·2kΩ
R8 270Ω

Potentiometers

VR1 100kΩ carbon
VR2 200Ω wirewound preset

Capacitors

C1 0·01μF paper
C2 0·1μF paper
C3 0·02μF paper
C4 0·02μF paper
C5 0·1μF paper
C6 0·01μF paper
C7 80pF ceramic
C8 30pF preset trimmer
C9 30pF ceramic
C10 0·003μF polyester
C11 20pF ceramic
C12 0·003μF polyester
C13 0·003μF polyester

Transistors

TR1 2N3702 *or* 2N3703
TR2 2N3702 *or* 2N3703
TR3 2N3702 *or* 2N3703
TR4 ASZ21 *or* AF118
TR5 OC170 *or* OC171

Crystal

X1 27·255MHz type 2MM (Henry's Radio)

Switches

S1 2 pole 3 position Keyswitch, biased to centre position
S2 Single pole on/off toggle

Battery

BY1 12V made up from 10 nickel cadmium cells connected in series (Deac 1·25V, 225mAh) (Henry's Radio)

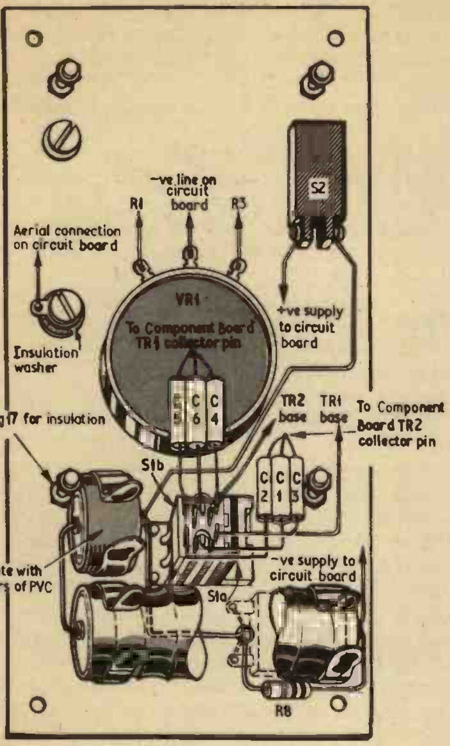
Inductors

L1 ¼in Neosid former with dust core, single layer of 38 s.w.g. enamelled wire wound to full length
L2 9 turns 18 s.w.g. enamelled wire, spaced by one wire diameter and self supporting, see Fig. 15.
L3, L4 ¼in Neosid former with adjustable dust core. L4 wound first—10 turns 30 s.w.g. enamelled wire close wound, then centre tap and wind 10 more turns.
L3 1½ turns 30 s.w.g. enamelled wire wound on top of L4 at bottom (C11) end

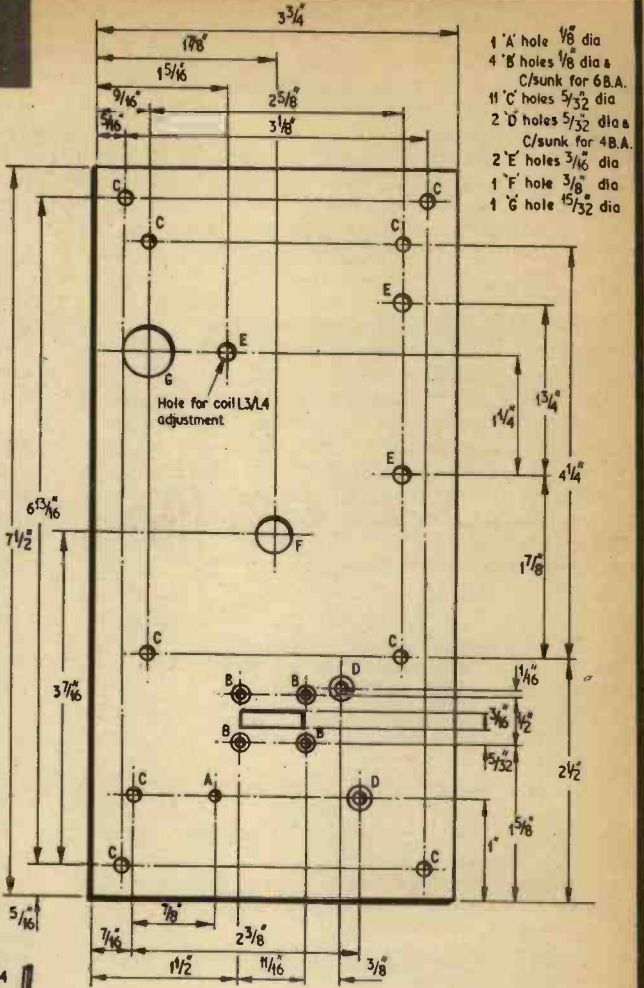
Miscellaneous

Aerial, details given in Fig. 18. Plain or perforated s.r.b.p. board. Pins for board. Aluminium for case and front panel. Four 2in 4B.A. bolts and nuts. Two stand off terminals for aerial

TRANSMITTER DETAILS



(a)



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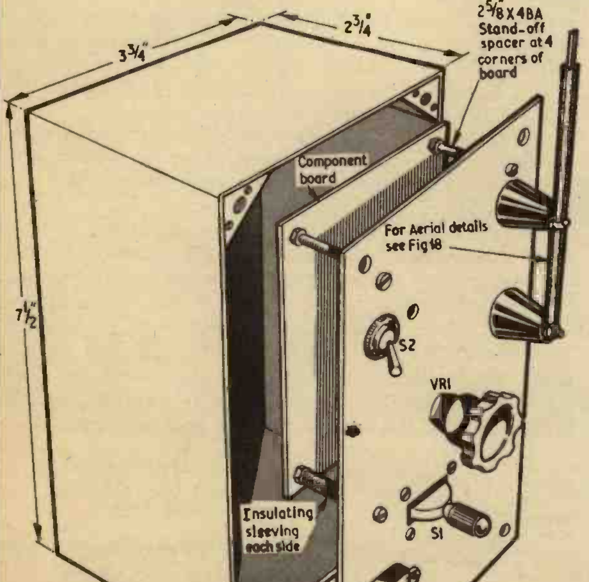


Fig. 16. The transmitter front panel (a) viewed from rear, showing components in position; (b) dimensions and drilling details

Fig. 17. General view of the transmitter with details of the case and aerial fixing

SETTING-UP AND ALIGNMENT

For satisfactory setting-up of the radio control system a multi-range test meter is desirable and, although not essential, a simple oscilloscope can be of enormous assistance.

Monitor points are brought out on the receiver circuit boards to facilitate easy alignment. (Refer to Figs. 2, 4, 5, 6, and 7 June issue.)

The transmitter performance is optimised, using the receiver as a monitor, working at a minimum distance of about 12 feet.

SETTING-UP STEERING MOTION

The steering adjustment is best performed under conditions of artificially reduced signal strength. This can be achieved by disconnecting the receiver aerial, and operating the transmitter at about 10ft distance.

1. Connect supplies to steering panel and monitor square waveform at Monitor Point 2. This should be "clean" and noise-free for all positions of the transmitter steering control, for the three throttle positions.

2. Remove transmitter aerial and increase the distance between the transmitter and receiver until "noise" is apparent and the rectangular waveform at Monitor Point 2 is deteriorating. Adjust VR1 (Set Limiter) for optimum rectangularity at each extreme of the steering control range (this can only be done with the aid of an oscilloscope.)

3. Reconnect transmitter aerial. Set Gain potentiometer VR3 to minimum and switch on rudder motor supply.

4. Unlock Rudder Position potentiometer VR2 from its bracket and rotate body so that the motor MO2 drives to amidships for amidships transmitter setting. Lock potentiometer to bracket.

5. Increase VR3 until motor starts to "hunt" on change of helm setting. Reduce until one overshoot is obtained.

6. Adjust value of R23 if necessary to give correct "lock-to-lock" tracking.

THROTTLE MOTION ADJUSTMENT

1. Switch off rudder motor MO2, and apply supply to throttle panel.

2. Check monostable period at Monitor Point 3 with transmitter "on" in "throttle hold" position. It should be about 1·2ms or so, or approximately 1 : 1 mark/space ratio. Adjust Set Pulse Length potentiometer VR4 as necessary. (Alternatively measure d.c. volts across R40; this should read half the supply volts.)

3. Put transmitter to "throttle close" and helm amidships, and adjust VR4 to give a steady maximum d.c. voltage at TR15 output (across R40). Check at each end of the helm range for a steady output and reduce R40 volts if necessary. (This is the condition of maximum mark/space ratio.)

TRANSMITTER ALIGNMENT

The transmitter can be aligned with the aluminium case cover removed, as the presence of the cover will be found to have little effect on performance. However the final aerial adjustment should be performed with the cover in place. Proceed as follows:

1. Disconnect TR2 collector by removal of link 2. Insert current meter (10mA range) in place of link 1. Set VR2 to maximum.

2. Adjust dust core in L3, L4 for maximum current reading.

3. Adjust C8 for minimum current reading.

4. Adjust VR2 for 5mA on meter; re-check tuning of L3, L4.

The transmitter is now set up and, after removing meter and replacing links 1 and 2, the cover can be fitted.

RECEIVER ALIGNMENT

Alignment should be undertaken with the receiver installed in the boat.

1. Connect an oscilloscope to Monitor Point 1 and earth. With the transmitter "off" several hundred millivolts of noise should be observed at Monitor Point 1 with the receiver supply connected.

2. Switch on transmitter (which will now be modulated) and place it several feet from the receiver. Adjust dust core of L2/L3 for maximum rectangular wave signal at Monitor Point 1. (If no oscilloscope is available the current in the earthy end of R5 should be adjusted for a minimum.) If the optimum appears to be out of range of the core make *small* adjustments to C15 and C5 (this should not really be necessary).

3. Adjust core of L1 for maximum output.

4. The receiver is now aligned, and the transmitter aerial can now be finally adjusted. This is best undertaken when transmitting over a distance of at least 25ft, with the transmitter on the ground and the aerial vertical, away from "earthy" objects. Progressively reduce the length of the aerial upper section an inch at a time until maximum receiver output is obtained.

5. Check the operation of the transmitter modulation controls by monitoring the received signal.

A "kick" on the rudder may be observed when the throttle is actuated. This is in order, and is of such short duration that, in practice, when piloting the boat it will not be perceptible.

CONCLUSION

A reasonably versatile, easy to build, control system has been described, which is not claimed to be able to compete with the most sophisticated commercial equipment, but nevertheless has been shown to give quite creditable results. The actual cost to build complete should only be about £25, two-thirds of which is required for the boat kit, engine and batteries. ★

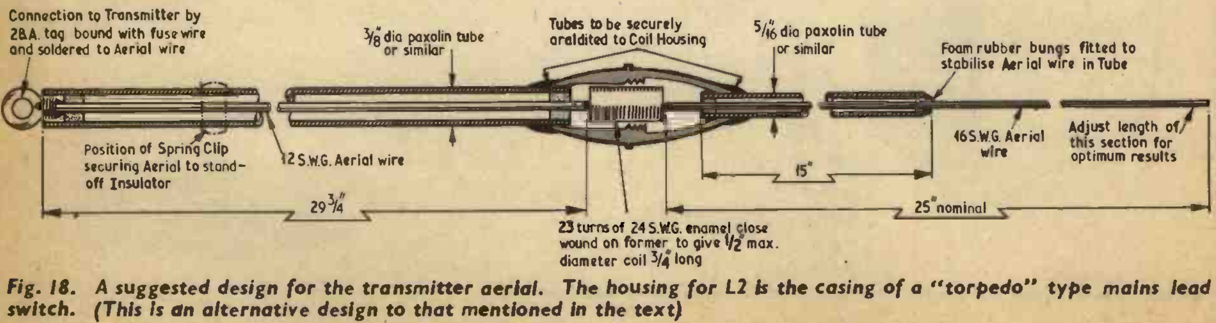


Fig. 18. A suggested design for the transmitter aerial. The housing for L2 is the casing of a "torpedo" type mains lead switch. (This is an alternative design to that mentioned in the text)

IEA EXHIBITION

For anyone prepared to ask a lot of questions and perhaps prise open one or two cabinets, the International Instruments Electronics and Automation Exhibition can provide quite a wealth of ideas for subsequent trial on the kitchen table. Ideas, rather than actual circuits.

For this is a specifically professional event and, as such, many of the interesting gadgets on display contain components that are presumably commonplace inside industry while virtually unobtainable in Tottenham Court Road. Where a familiar component is shown in a new application, the non-professional visitor finds himself mentally adapting the circuit to some project of his own—and wondering whether "surplus" parts will do.

POINTING THE WAY

This year's show was on a record scale, occupying the full 250,000 square feet of Olympia. To quote David Walker, exhibition chairman, "It is something more than the greatest technical show of its kind. It points the way to a future in which technologies represented at Olympia will have resounding repercussions on the social, industrial, and economic structure of the world."

Inevitably his listeners' thoughts turned to Miss Honeywell, the computer company's robot "saleswoman" making her (or its!) first appearance in Britain—of which more later.

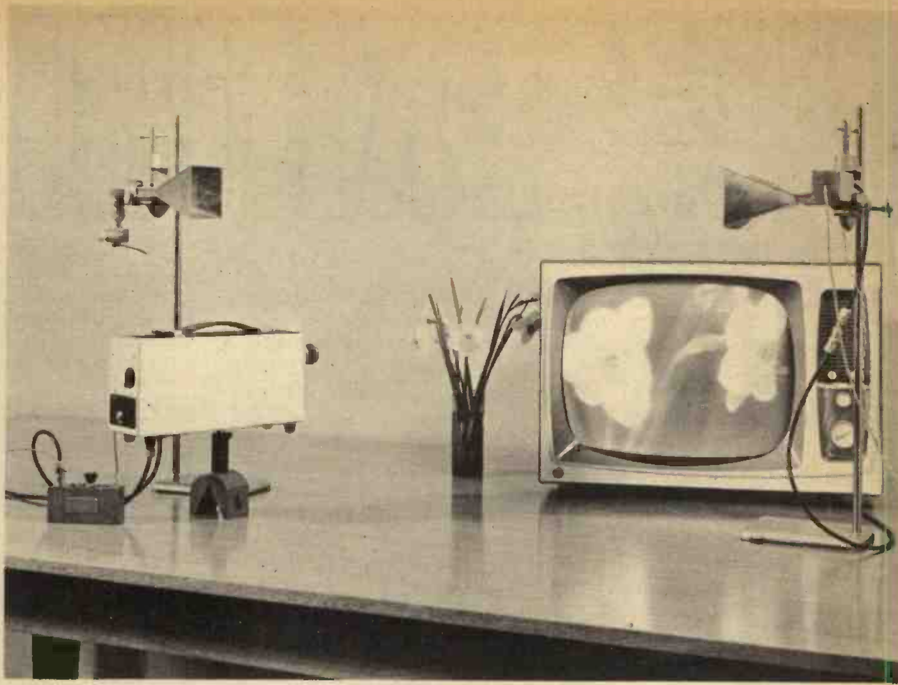
MICROCIRCUIT DEVELOPMENT

Microcircuits were more abundant than ever at this IEA. As prices tumble in the intense battle of production techniques between British and American manufacturers, the devices are edging steadily into the consumer field.

An example of this was the digital car speedometer shown on the General Instrument (UK) stand. This has no needle, the speed appearing on inch-high numerals. It uses a tiny silicon chip carrying the equivalent of 300 transistors and, according to the producers, should compete with the price of mechanical speedometers in a year's time. Such a design would be quite uneconomic if built with discrete components.

Another motoring application was demonstrated by AB Electronic Components who produce microcircuits for use in Lucas alternator equipment, which is expected to replace the conventional car dynamo. AB make a thick-film passive circuit to which Lucas attach their own semiconductors to make a solid state voltage regulator.

Below, Miss Honeywell gave a convincing demonstration of automation capability, but tended to trip over her own flex



Two Gunn diodes and a bunch of narcissi are major components of this desk-top microwave television link exhibited by Plessey Electronics.

On the left is the camera and transmitter horn. Microwave power is supplied by a solid state Gunn oscillator which is frequency modulated by the camera video signal. The transmitted power is 5mW at a frequency of 9.5GHz.

The receiving horn (right) uses a second Gunn oscillator to drive a balanced diode mixer giving an IF output at 30MHz. This is amplified and detected to provide a video input for the picture monitor. The total power consumption of the microwave link is 5W

MECHANICAL MISS

"Miss Honeywell" offered a walking, if not yet talking, glimpse of what microcircuits might come to mean if they can be further scaled down to the size of brain cells and installed in a suitably agile mechanical carcase. Described by Honeywell as a demonstration of the company's "total automation capability", Miss H. strode about the stand indicating computers, memory systems, and logic modules to the accompaniment of a taped soundtrack and under the command of a man at a control panel. Unlike most women, she didn't have a mind of her own . . . in fact she could be switched off altogether by removing her head.

Above, this dual purpose video-instrumentation recorder from the Precision Instrument (UK) stand can be changed from one function to the other by substituting three circuit cards. A stop-scan facility allows continuous viewing of a single picture frame or piece of data

Mullard were showing a new device for measuring very low voltages and currents—a vibrating capacitor. It could be crudely described as a miniature electrostatic loudspeaker mechanically coupled to a capacitor microphone: the d.c. voltage to be measured is applied between two plates, one fixed and the other vibratory. At the same time a driving voltage at about 6kHz is applied to a further pair of plates, the moving half of which is coupled mechanically to the movable plate of the first pair. The resulting swing in capacitance modulates the unknown voltage, and the resulting alternating voltage is easily amplified and measured. The capacitor, type XL7900, is mounted in an evacuated glass encapsulation with a B9D base. It is not yet in full production.

PIEZOELECTRIC SPARKS

The growing use of special piezoelectric crystals to produce high voltage impulses was demonstrated by Smiths Industries. The high voltage spark created on mechanically deflecting the crystal can be used to ignite all the usual industrial and domestic gases.

English Electric ushered visitors into a darkened room to display the extreme sensitivity of their new Image Isocon television camera tubes Types P850 and P880. By using the scattered return beam from the camera target rather than the specularly reflected component, noise in the black areas of the image is considerably reduced. This allows apparently well-lit pictures to be obtained in conditions where even a tom-cat would stumble.

A development of interest to all large-scale manufacturers was the new soldering bit from the Philips organisation, exhibited by Harrison Clark. It has a 500 micron electrolytic coating within the diameter and a protective nickel coating over the top. Although expensive to produce, it is claimed to be capable of

making up to four million joints without undue wear—some 75 times the life of a conventional bit.

On their stand near the main entrance of the exhibition, Racal Research gave the first working demonstration of REDAC—Racal Design and Analysis by Computer—a service now being made available to the whole industry. The computer, an Elliott 4130, is programmed to answer questions on a variety of design problems and to create the analogue equivalent of a "breadboard" to predict filter performance, stray inductance, transistor behaviour, etc.

Another exhibit, the Elliott Automation graphical display, is shortly to be linked with REDAC to streamline the design of printed circuit layouts. According to the literature, "Using the light-pen the designer can communicate the circuit geometry and performance requirements of a circuit board directly to the computer, thus bypassing the conventional data preparation and input stage. A free interchange of information between the computer and the designer can then take place . . ." Could electronics designers be planning their own obsolescence?

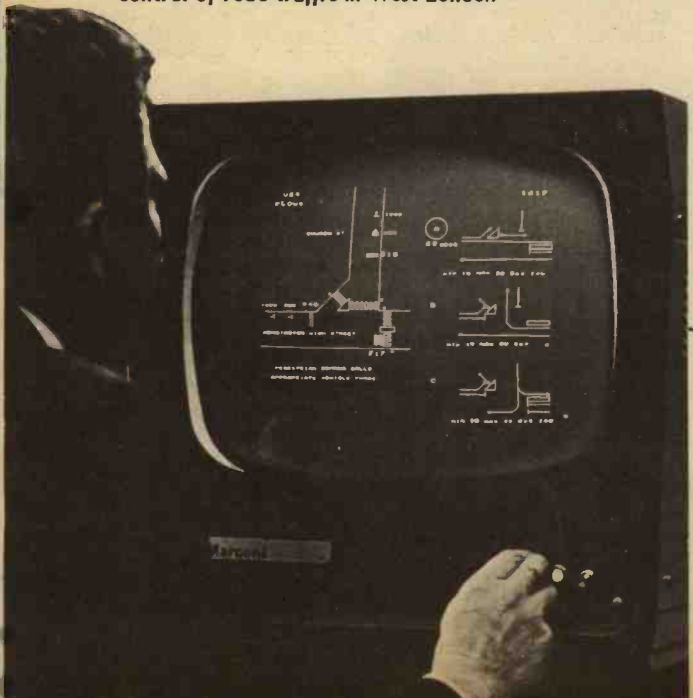
Above, another example of computer graphics, the Elliott CRT display has been adopted by the REDAC electronic design service. Changes to a proposed layout or mathematical shape are made with a photoelectric light pen and shape-generating controls

MINISTRY EXHIBITS

Among a number of interesting items on the Ministry of Technology's stand was a solid state u.h.f. oscillator containing only one active component. Developed by the Royal Radar Establishment at Malvern, the oscillator consists of a platelet of cadmium sulphide to which a steady voltage is applied. This causes the platelet to resonate mechanically at a high harmonic of its fundamental, producing an alternating current. Frequencies of some 800MHz can be achieved and can be finely tuned simply by varying the applied voltage. Power output can be adjusted by illuminating the platelet.

Another RRE design featured a Gunn diode as the heart of a small, low-cost c.w. doppler radar. Variations of this simple hand-held equipment would have applications in security systems, ship docking, vehicle control (and radar speed traps!), and as an obstacle-detector for the blind.

Below, optical display is one of many new ways to achieve intimate communication with computers. This instrument, the Marconi X2000, is to be used by the Ministry of Transport in its current experiments with computer control of road traffic in West London



The Ministry's Explosives Research and Development Establishment based at Waltham Abbey contributed the "ERDEfender", a device which protects explosives workers from the aural effects of their endeavours, but allows them to converse normally between bangs. It consists of a pair of highly-soundproof headphones, each having an integral microphone and amplifier. The amplifiers are designed to saturate at a fixed sound level so that at higher levels (about 95dB) the protective attenuation of the headset becomes effective.

The Royal Aircraft Establishment, Farnborough, provided a good example of heavyweight electronics with a variable speed drive system employing a brushless induction motor supplied at variable voltage and variable frequency by a static inverter. The design has an overall efficiency comparable with d.c. installations, is easier to maintain and has a higher power-to-weight ratio. It has been tested in a 1,000 h.p. diesel locomotive in this country and in a passenger train in the U.S.A.

CANADA'S DEBUT

Canada made her first national appearance at this IEA. The group exhibit, sponsored by a dozen Ontario companies, included products ranging from units for thickness control in steel rolling mills, flaw detection in paper manufacture, monitoring, counting, and digital indication in petro-chemical processing, to aerospace data computers and radio equipment for telemetry, television, and general communications.

The official U.S.A. exhibit covered more than 10,000 sq ft of the National Hall. Of the 42 exhibitors, about a third were showing equipment and tools for electronics manufacture, another third contributed instruments and measuring devices, and the remainder shared automation, data processing, and basic component categories.

A total of 112,393 people visited the six-day IEA, nearly 10,000 of these coming from abroad. The next exhibition will be held at Olympia in May 1970. ★

LOW OHMMETER

By K. RAYMOND

MANY commercial instruments are available that will measure most common resistance values down to about 5 ohms with reasonable accuracy. When it comes to lower values, such as may be found in switch contacts, transformer windings, and radio tuning coils, such an instrument may be of only limited value.

What is required is a low resistance meter. This article sets out to explain the difference between the conventional resistance meter and one that will measure low resistance, and is followed by a practical circuit with constructional information.

It is also possible to measure the resistance of soldered joints so giving an indication of their electrical efficiency. It is well known that "dry" joints, caused by the flux intervening between the terminations, can give rise to mysterious oscillatory effects in some parts of audio and r.f. circuits. Here the low ohmmeter will be an asset in detecting the location of such a fault.

SERIES OHMMETER

Most medium to high resistance meters use a circuit based on that shown in Fig. 1. The zero resistance mark is usually found on the right hand end of the scale as meter current f.s.d. is calibrated with the test clips short circuit. As resistance is increased the current at the meter is reduced, causing the meter pointer to be deflected to a position left of full scale.

From these basic principles it is a simple matter to insert in series with the meter a variable resistance (potentiometer) to control the current to the meter. At a preset value of VR1, with terminals X1 and X2 short-circuited, the voltage across the meter will cause the meter to register full scale deflection. This control is called "set zero".

Having established a given reference zero at f.s.d., the scale can now be calibrated over the resistance range suited to both the battery voltage and the meter coil resistance. The current through the meter varies inversely with the value of resistance in the circuit. If the circuit is broken at some point so that an unknown resistance can be inserted (i.e. at terminals X1 and X2) the current flowing through the meter would be

$$I = \frac{V}{R_1 + R_X + R_M}$$

where V is the battery voltage,

R_1 is the preset value of the set zero control,

R_X is the unknown resistance to be measured, and

R_M is the coil resistance of the meter.

PARALLEL OHMMETER

For low resistance measurements a low value of resistance is shunted across the meter as in the circuit in Fig. 2. This circuit is called a "slide back" ohmmeter in which the meter current is reduced by shunting it with a fixed low resistance and the unknown resistance.

Front view of the ohmmeter clearly showing the new calibration of the dial

The fixed resistance is so much lower than the meter resistance (about 75 ohms) that any small change in the total shunt resistance will show as a well defined deflection on the meter.

This circuit will provide considerable expansion of the low resistance range; in the practical circuit 0 to 1 ohm occupies more than 50 per cent of the scale.

In the case of the series type ohmmeter (Fig. 1) the calibration reference is zero ohms, or meter f.s.d. obtained by varying potentiometer VR1. In the shunt type (Fig. 2) the f.s.d. reference will give the same reading as the fixed shunt—a resistor which will represent the maximum on the scale, in the case of this particular model the value chosen was 5·6 ohms. However, the scale can be extended by increasing the value of the shunt resistor.

PRACTICAL EXAMPLE

The circuit employed is shown in Fig. 3, which includes a ballast series resistor and a push button (*normally open*) to calibrate the meter with R2.

The meter circuit is built into an aluminium chassis, the dimensions and drilling details of which are given in Fig. 4. Wiring is straightforward, but read the calibration notes first as the meter will need re-calibrating before final assembly. To do this remove the cover of the meter and take off the scale plate. On a piece of

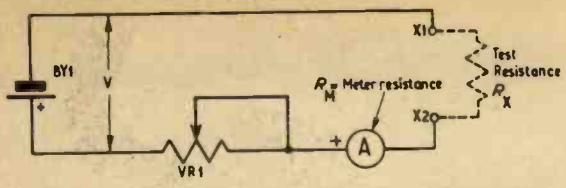


Fig. 1. Basic series ohmmeter for measuring medium and high resistance

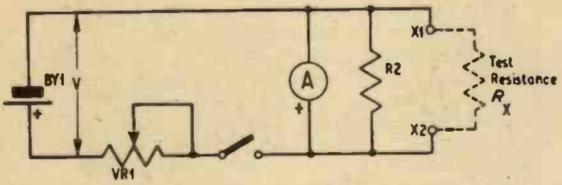


Fig. 2. Basic parallel ohmmeter for measuring low resistance

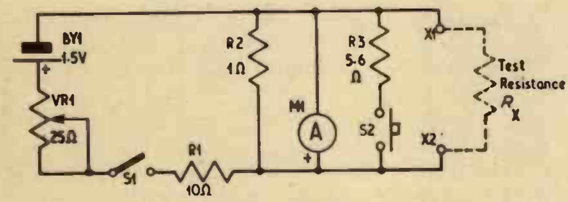


Fig. 3. Practical circuit of the low ohmmeter

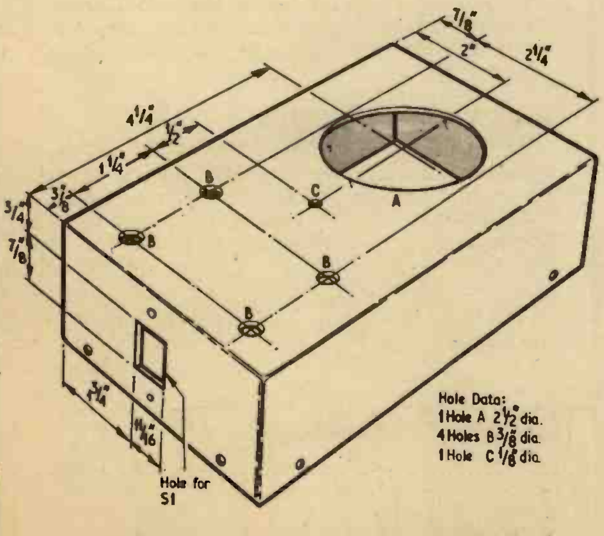


Fig. 4. Drilling details of the chassis

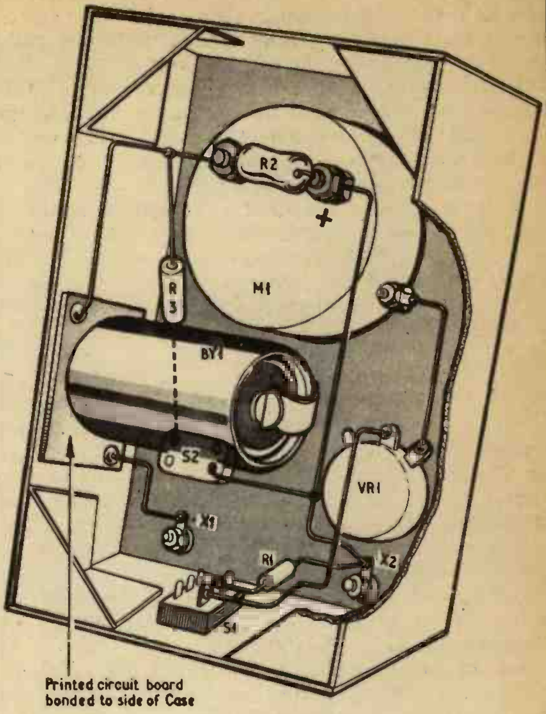


Fig. 5. Wiring of the ohmmeter

COMPONENTS . . .

Resistors
- R1 10Ω, ¼W, 10% carbon
- R2 1Ω 1% wirewound
- R3 5·6Ω, ½W, 1% wirewound

R2 and R3 are selected from 5% types

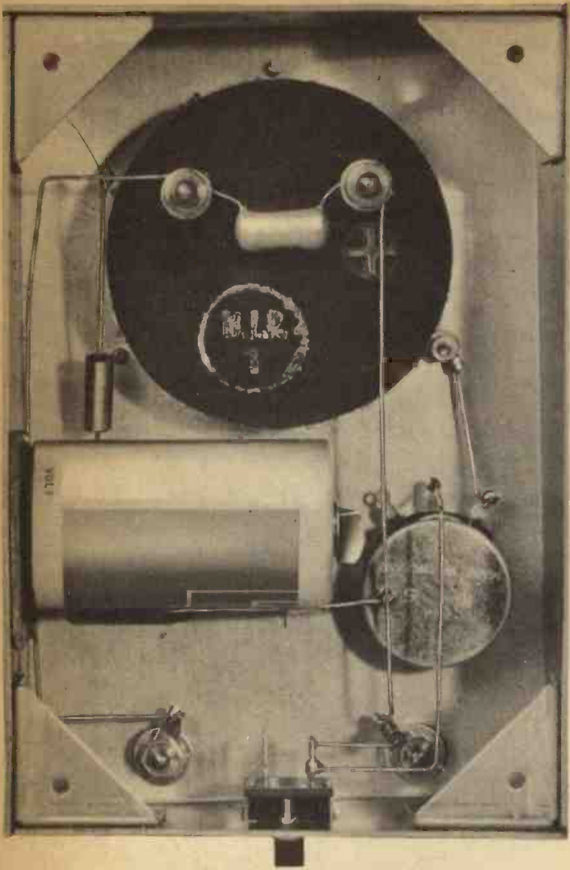
Potentiometer
- VR1 25Ω preset wirewound

Meter
- M1 0–1mA f.s.d.

Switches
- S1 Single-pole, on/off, slide switch
- S2 Single-pole, on/off, push to make release to break

Battery
- BY1 1·5V cell

Miscellaneous
- Tinned copper wire 20 or 18 s.w.g.
- Aluminium chassis 6in × 4in × 2¼in
- Screw terminals (2 off)
- Spring clip for holding battery (see Fig. 5)



Rear view of the finished instrument

white card, mark the curved part of the scale the same size as the scale already on meter dial. Stick the card onto the old scale with an impact adhesive.

No difficulty should be encountered in making the instrument. The components aren't very critical other than the calibrating resistors. All leads however should be as short as possible and of fairly thick copper wire 20 s.w.g. or even thicker. The shunt resistors should be 1 per cent types if possible or selected from 5 per cent resistors.

CALIBRATION

Probably the simplest and most accurate way of calibrating the meter, that is if a precision resistance box is not available, is to use ordinary copper wire. Reference to a table of wire gauges provides the resistance in ohms per nominal length for most standard wire gauges. In this instance 38 s.w.g. wire was chosen, it having a resistance of 0·8503 ohms per yard. With the meter carefully removed from its case, the 5·6 ohm f.s.d. reference is established by applying the press switch and varying the 25 ohm potentiometer until the meter needle reads full scale. The 1 ohm calibration mark is established by connecting a length of wire equal to 36/0·8503in (or approximately 42·5in) plus sufficient to wind round the screw terminals. Now the fractional and multiple values of resistance can be marked by connecting proportional lengths of wire. For example, 4·25in for 0·1 ohm, 21·25in for 0·5 ohm, 85in for 2 ohms, and so on.

Having completed calibration, replace the meter in its case and remove the calibration wire. The instrument is now ready for use. ★

NEWS BRIEFS

Distortion Test—for Yachtsmen

A COMBINATION of electronics and photography is being used by ICI Fibres to measure the distortion that occurs in yacht sails at the time the sails are actually under stress.

In contrast to previous laboratory methods of stretching materials artificially or measuring the permanent results of stress, the new technique is applied in the open air (on dry land) and the immediate effects of a breeze are recorded by precision photogrammetric cameras—similar to the method used for making maps from aerial photographs.

A Honeywell Visicorder provides a continuous trace of conditions as each photograph is taken. Information is fed in from a wind speed and direction indicator and from strain gauges in the mainsheet, together with a marker pulse from the shutters.

Braille by Computer

A METHOD to enable System 4 computers to produce a Braille type of printing almost identical with true Braille has been developed by English Electric Computers.

To convert to Braille, the printing is first copied into magnetic tape which is then read by a special programme. This splits the information into short lengths and prints these in reverse using the full stop on a specially adapted printer. The indentations of the printout can be read by blind programmers when the paper is turned over.

U.S. Builds 9MeV Accelerator

A NINE-MILLION electron volt tandem particle accelerator is being built in the U.S. to assist nuclear research at the Argonne National Laboratories. It uses a pair of 4·5MeV accelerators to produce 9MeV positive ions with a direct current of more than 100 microamps.

An Emmy for Mr Rainger

PETER RAINGER of the BBC Designs Department has received an Emmy, the international award given by the U.S. Academy of Arts and Sciences, for outstanding television engineering achievements. This is the first Emmy award given outside America for technological achievement associated with television. Mr Rainger was the leader of the team which in August last year developed the converter for use between American and British colour television systems.

Computer Masters Russian

SOVIET scientists believe they will have achieved vocal conversation with computers by 1980. The claim follows development of a computer that can understand 50 words and ten numbers, pronounced by any voice. Most of the world's so-called talking computers have difficulty in recognising words in an unfamiliar accent. The Russian machine is to be developed to understand some 2,000 words. It has already been equipped with a fluent answering vocabulary.

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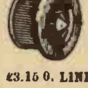
E.M.I. COMBINATION LOUD SPEAKERS. 13¼ x 8½in. Elliptical with 3½in dia. Tweeter. Imp. 8 ohms. Power handling 10 watts. Brand new and guaranteed. List price £8.5.0. LIND-AIR PRICE 99/6. P. & P. 7/6. (Also available without tweeter 59/6. P. & P. 7/6.)



FANE 301 3in TWEETERS Imp. 3-5 ohms. 17,000 gauss. 12 watt. Brand new and guaranteed. List price £3.15.0. LIND-AIR PRICE 59/6. P. & P. 3/6.

GOODMANS SPEAKER BARGAINS! 5in 3 ohms, 15/6; 6in 3 ohm, 29/6; 8in 3 ohm, 32/6; 10in 5 ohm, 65/-; 10in x 6in 3 ohm, 32/6. Tweeter, 19/6. P. & P. 3/6 per Speaker.

STEREO HEADPHONES

Enjoy Stereo Sound as you have never heard it before. MODEL TTC. G1111 as illustrated. Soft padded earphones. Adjustable headband. Impedance 8 ohms per phone. Frequency range 25-13,000c/s. With 5ft. lead. Price 69/6. P. & P. 4/6. Other similar types available. AKAI ASE88. 8 ohms. £7.10.0. CORAL E102 16 ohms. £5.19.6. EAGLE SE1. 16 ohms. 84/-. T.T.C. Stethoscope 8 ohms, 49/6. P. & P. 4/6 each.

EXCITING CASSETTE RECORDER — RADIO

A solid state cassette recorder with a built in MW Band Radio. Listen and record at the same time—play back anytime, anywhere. Uses standard Compact Cassettes. Complete with Dynamic microphone with remote control switch, stand and case, C60 Cassette and carrying strap. Size only 7"×2½"×9½" approx. Weight only 4 lbs. Operates at 1⅞ i.p.s., twin track recording fast rewind built in 2½" dynamic speaker and extension speaker socket, socket for AC adaptor. Fully tunable. Medium wave radio. Lind-Air Special.

Price **30½ gns.** P. & P. 8/6.

GARRARD DECKS

3000 with Sonotone 9TAHC Stereo Cartridge	£9.19.6
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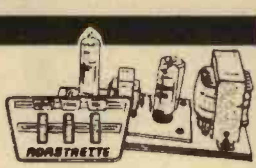
AT60 MKII less cartridge	£13.19.6
AT60 MKII with Decca Deram Stereo Cartridge	£18.14.6
SP. 25 MKII less cartridge	£11.19.6
SP. 25 MKII with Decca Deram Stereo Cartridge	£16.14.0
AP.75 less cartridge	£24.3.11
LAB.80 MKII less cartridge	£24.19.0

All plus P. & P. 12/6

TEAK FINISH PLINTHS with perspex cover 6½ gns. (for LAB80 8½ gns.). P. & P. 12/6 Agents for Thorens, Dual, Goldring, etc.

Mono Cartridge 17/6 extra. Stereo Cartridge 22/6 extra.

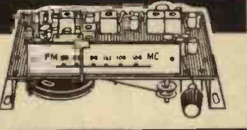
2-3 WATT AMPLIFIER



An ideal basis for building your own portable record player. Just add speaker and turntable, and you will have an above-average model for a mere fraction of the cost. 2-3 watt printed circuit with control panel on flying lead. ON, OFF. TONE CONTROL AND VOLUME. colourful escutcheon. Brimar valves: EZ80, ECL82 and composite installation booklet. Price **85/-** P. & P. 3/6.

TRANSISTOR F.M. TUNER

SAVE £2.2.0 !



6 Transistor FM tuner. Frequency range 88–108Mc/s. Size 6 × 4 × 2½in. Ready built for use with most amplifiers. 9V battery operation. Complete with instructions. LIST PRICE 9 gns.

LIND-AIR PRICE **7 gns.** P. & P. 4/-.

MULTIPLEX ADAPTOR for above for Stereo Radio Reception £5.19.6 extra

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PTA 15 (as illus.). All Transistor, 15 watts Mono. Inputs for Tuner, Gram, Mike, Guitar, Bass, Treble and two volume controls, £15.15.0. Carr. 7/6. Teak case £3.10.0 extra. LT45, 2 Valve 5 watts Mono. Inputs for Tuner, Gram, Bass, Treble and volume controls, £8.19.6. Carr. 7/6. Metal cover 15/- extra. Full details sent on request.

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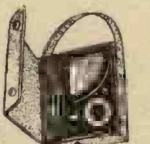


MODEL TTC.1001. 20,000 O.P.V. with overload protection; d.c.volts, 5, 25, 125, 500, 2,500V; a.c. volts, 10, 50, 250, 100V; d.c. mA 250mA-50A. With prods and carrying case. ONLY **85/-** P. & P. 3/6.

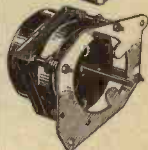
MODEL TTC. 1030. 50,000 O.P.V.; d.c. volts, 0·3, 12, 60, 120, 300, 600, 1,200V; a.c. volts, 6, 30, 120, 600, 1,200V; d.c. mA 0·03–300. With prods and carrying case ONLY £11.19.6. P. & P. 5/-.

MOTOR BARGAINS

Ideal for model makers, record players, tape decks, etc.

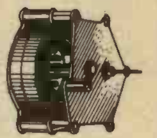
6.3 d.c. Motor. 10,900 r.p.m. at 230mA. 1⅛in × 1in dia. Shaft ½in long × 3/64in dia. 9/6. P. & P. 2/6.

9V d.c. Gram deck replacement motor. 2in × 1½in dia. Shaft ½in long × 3/32in. 17/6. P. & P. 2/-. Two for 30/-. P. & P. 2/-.



R. H. Take up Motor made for Collaro Decks. Many other uses, supplied with suitable resistor for 240V a.c. operation. Spindle 1¼" × ⅛" dia. ONLY 24/6. P. & P. 4/-.

SYNCHRONOUS CLOCK MOTORS



Geared for 40 revolutions per hour 230v 50 cycle, with mounting flanges. Size approximately 1½in deep x 2⅜in diameter. ONLY 22/6. P. & P. 2/6.

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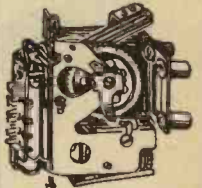

Numerous applications Electro-magnet and brass tooth wheel. A switch wafer and contacts are coupled to this and arranged to be on for 10 pulses and off for 15. An Auxiliary contact is normally on but off 1 in every 25. Complete with suppressor, resistors, plus series contact for continuous operation. Ideal window displays, switching lamps, models, etc. 12V or 24V d.c. Brand new and boxed, 12/6. P. & P. 2/6.

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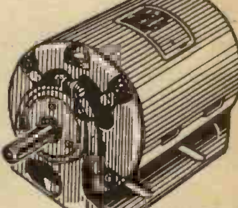
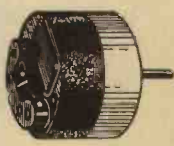


FEW ONLY LEFT

Made by Crompton Parkinson. Single phase ¼ h.p. Motor. 230/250V, 50 cycles. 1·3 amps. 1,425 r.p.m. Continuous rating. Spindle 1⅞ x ½in dia. Overall size less spindle approx. 8 x 6in. Perfect condition. A bargain for the work bench. ONLY 69/6. Carr. 20/-.

DELAY ACTION TIME SWITCH



Made by Smiths. A.c. operation 200 / 250V Double pole. Will give time delays from 0–10 minutes. Size 2⅜in dia. x 2⅜in long inc. ⅜in x 3/16in dia. spindle. BARGAIN PRICE 17/6. P. & P. 2/6.

UNLIMITED!

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

FLUORESCENT CAMPING LIGHT

MANUAL switching of the pre-heating current for the fluorescent tube may be something of a disadvantage. If only to overcome the annoyance of having to wait a second or two before switching on the high voltage to the tube, automatic switching is desirable, see Fig. 1.

When S1 is closed, C5 charges up through R5 and the base of TR2, causing a current of about 20mA to flow through the relay coil for just over one second. The normally open contacts on the relay are thus closed for a moment after switching on, providing the required pre-heating.

The diode D1 is any small silicon or germanium diode, and provides a discharge path for C5 and prevents excessive reverse bias on TR2 when the light is switched off.

If the relay requires more than 20mA or TR2 has a gain much less than 50, R5 may be reduced and C5 increased proportionately, e.g. 3·9 kilohm and 200μF.

The relay is the only component which takes up much space, and this will just fit into the case without too much trouble.

D. A. Pollard, B.A.,
London, W.9.

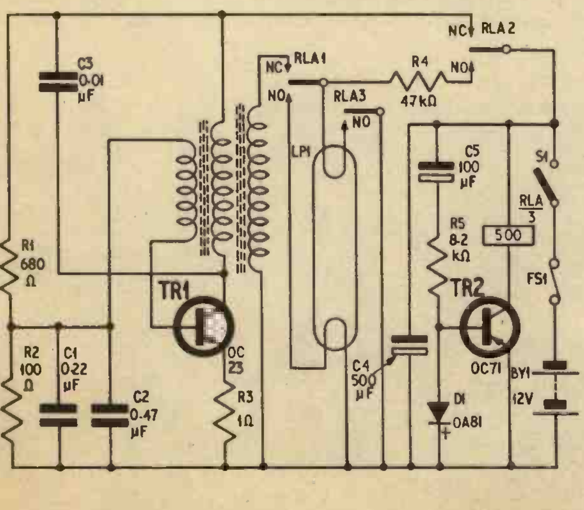


Fig. 1. Circuit diagram for automatic switching of the Fluorescent Camping Light (C2 to be deleted)

UNIJUNCTION WIPER

FURTHER to the correspondence on *Thyristor Screen-wiper Delay* by A. Edge (February 1968 Ingenuity). The circuit Fig. 1 may be of interest.

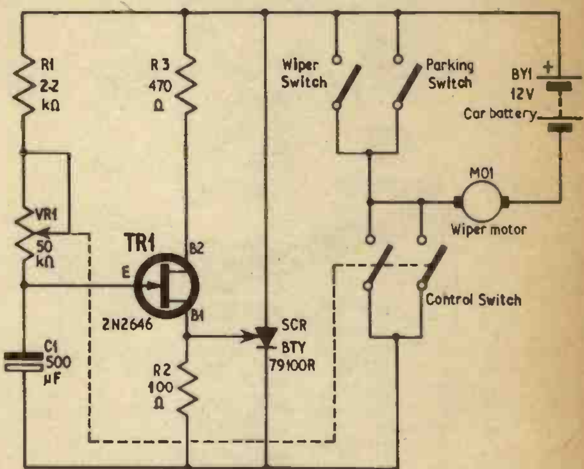


Fig. 1. Circuit diagram of the unijunction motor car screen wiper delay unit

With the availability of unijunction transistors I feel this is a cheaper, simpler, and more elegant way to fire the thyristor.

With the switches in the correct position C1 charges via R1 and VR1 (hence time delay) to a point where emitter current starts to flow. C1 then rapidly discharges through TR1 emitter, base 1 and R2 causing a pulse of sufficient amplitude (i.e. volts drop across R2) to fire the thyristor.

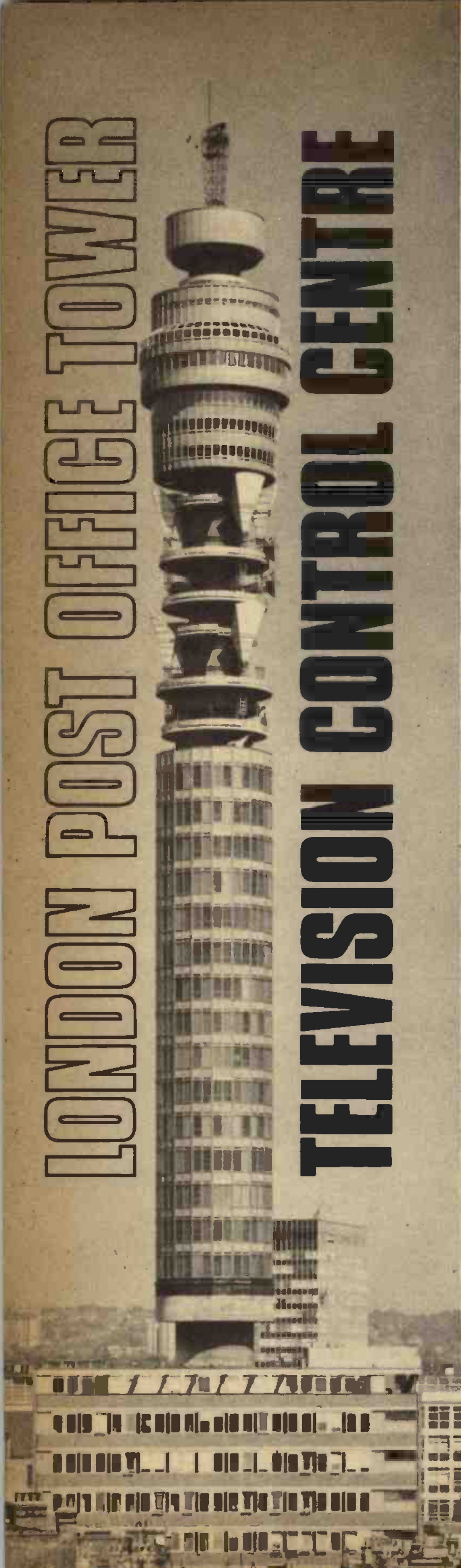
The thyristor remains firing until the wiper motor has moved sufficiently to close the parking switch, the parking switch then takes over the motor supply and removes the supply from the timing circuit. This cycle is repeated each time the motor comes to rest with the parking contacts open.

This timer circuit can be used on various projects and is extremely accurate providing the d.c. supply voltage remains constant.

R. R. Churchett,
Stourport-on-Severn.

LONDON POST OFFICE TOWER

TELEVISION CONTROL CENTRE



It is expected that the ultimate capacity of the Post Office Tower will be about 200,000 telephone circuits, if used entirely for such purposes, or about 140 television links. A likely combination is 150,000 telephone trunk circuits and about 50 TV links. This should meet London's needs for long distance trunk and TV circuits until at least 1980.

At present there are 60 microwave channels working giving 7,200 telephone circuits and 16 television links, and a further 24 channels are being installed.

As this vast complex of telecommunication traffic is intended to cover these islands by way of a network of two way city to city links it is important, particularly with television signals, to provide facilities to test the circuits to be used each day and to monitor programmes being transmitted. This control is maintained at the Tower's TV network switching centre which in addition provides over 5,000 switches a month in the routing of television programmes to fulfil day to day schedules.

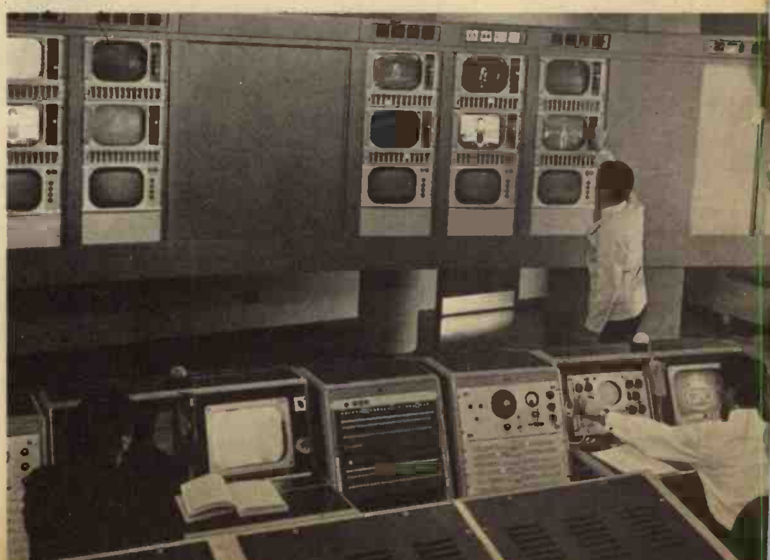
PROGRAMME ROUTES

The Post Office is commissioned to carry TV signals from studio to transmitter via the headquarters of the programme company concerned. Within towns and over distances below 20 miles, underground coaxial cables are used, but for inter-city links the signals are routed over microwave radio channels from the Post Office Tower in the range 2GHz to 7GHz. All the links both local and main line, are routed through the control room on the second floor of the Tower. Here the signals, all at 1 volt into 75 ohms, are terminated on the vision distribution frame which forms a point where the signal can be tested and interconnected to its required destination.

BBC AND ITA

The BBC produce the picture in their own studios where it is transmitted to Broadcasting House and split there into feeds for each transmitter where it is required. These feeds are sent via the control room to the local transmitter and provincial cities. Other programme destinations could be Goonhilly for transmission via *Earlybird* to America, or the Eurovision link.

The ITA rent and control a network of inter-city radio links and programme material is provided by companies such as ABC and Granada. The Post Office, by means of network switching equipment, distribute the pro-



grammes to the transmitters required at times nominated by the ITA and notified to the Post Office daily on schedules, with the result that various patterns of switching are being carried out by Post Office operators on the switching console according to these schedules, with a total capability of switching any or all of 40 destinations to one of 30 sources. The actual switch itself is made by an electronic clock synchronised to the "speaking clock" TIM (now 123). Two switches in advance can be set up by the operator and he can check that the switching function has been correctly performed by reference to the picture monitors provided.

CIRCUIT TESTING

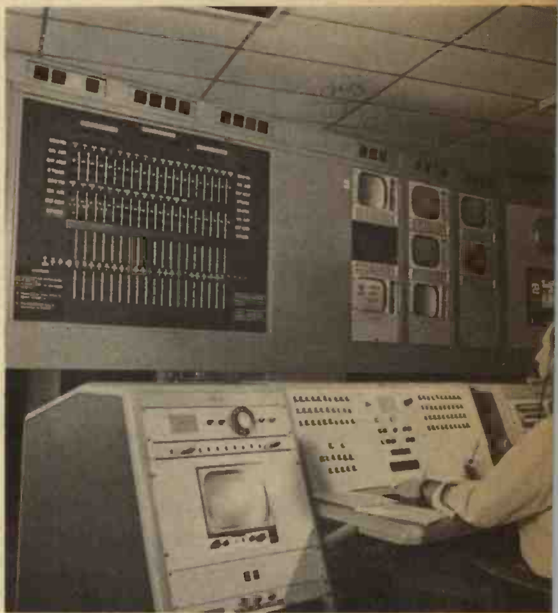
The television signal is electrically very complex and the control room officer must ensure that distortion of the signal over Post Office equipment is kept to a minimum and the links are tested to very exacting standards. The frequency range of the signals is 0 to 3MHz for 405 line pictures and 0 to 5MHz for 625 line pictures, and the control room engineers send special test signals over all circuits to be used each day and, if necessary, provide alternative routes.

The normal test signal is called a "pulse and bar test" which is sent on the links and at the receiving end is inspected visually on an oscilloscope to check that all frequencies in the signal are of the correct amplitude and phase. More sophisticated checks are required for colour signals.

Included on the consoles are high grade picture monitors and associated equipment used in the checking of circuit linearity and noise content. A switchboard provides the engineer with a connection to programme companies, the ITA and the BBC, other Post Office switching centres, and important relay stations. A panel of switches permits a picture from any source to be monitored on the console screens.

OTHER FUNCTIONS

The control room is staffed 24 hours a day and deals with studio programmes and outside broadcasts from anywhere in England. Circuits connect provincial programme companies to their headquarters in London for monitoring purposes. Other functions such as data transmissions, confravision, and closed circuit television programmes for pay television or business organisation all pass through and are tested here. ★

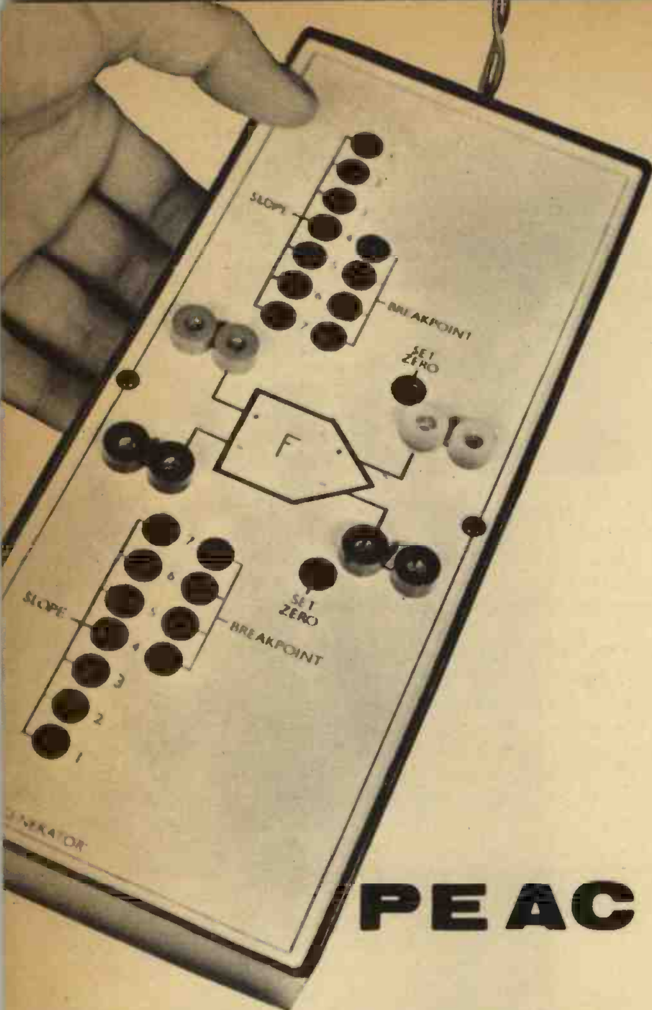


(left) ***General view of control room 405 line monitors and test positions***

(top right) ***Engineers seated at the test consoles where test gear can be connected to any circuit terminating at the control room. The panel in the foreground enables switching of the circuits to the monitor screens***

(center right) ***Programme switching operating position and display panel for ITA switching. Note colour monitor on far right***

(right) ***One of seven of the large horn paraboloid reflector aerials which are fitted on the aerial galleries of the Post Office Tower. This is 27ft high and 14ft wide and weighs one ton. Each horn will ultimately cater for 14 broadband circuits in the 4GHz and 6GHz bands and possibly an additional 11GHz channel and can transmit and receive at the same time***



The natural forward voltage drop of D1 and D2 furnishes self-bias, and bias conditions for D3 are satisfied by a fixed resistor R1. The values of slope adjusters VR1, VR2, VR3, VR4, VR6, VR8 and VR10 were selected to give a parabolic function approximating to $E_0 = E_{in}^2$ when all sliders are at mid-track, and appropriate bias values for that function are provided by mid-track settings of breakpoint adjusters VR5, VR7, VR9 and VR11. The combination VR12 and R3 serves to eliminate offset voltages resulting from diode leakage currents, and VR12 is therefore used for zero-setting.

With so many possible adjustments, including amplifier closed-loop gains determined by R_f or R_{in} computing resistors, it is obviously impossible to catalogue the coverage of the Fig. 8.1 circuit. As a rough indication though, powers of E_{in} ranging from about $E_{in}^{1\cdot1}$ to beyond E_{in}^3 are available. If both branches are cascaded in series with operational amplifiers, the upper limit will extend beyond E_{in}^6. Corresponding root functions $\sqrt[1.1]{E_{in}}$ to $\sqrt[6]{E_{in}}$ may also be generated. It is sometimes possible to use the UNIT "C" function generator for certain trigonometrical functions, and logs to the base 10 or *e*.

UNIT "C" BOX

A wood and plastics laminate box, of small dimensions compared with other PEAC units, will serve to house the two function generator circuit panels. The suggested form of construction is shown in Fig. 8.2. Softwood blocks are glued to a 9½in × 4in × ¼in plywood frame, which has its centre cut out, and white plastics laminate side pieces are then glued to the blocks. The front panel sits on the wooden blocks and is recessed.

PEAC ANALOGUE COMPUTER

By D. BOLLEN

LAST month the Function Generator UNIT "C" was introduced. The principle of operation and some of the uses of the function generator were explained. We are continuing with a description of the practical circuit, constructional details, and application information.

FUNCTION GENERATOR CIRCUIT

The function generator circuit of Fig. 8.1 is designed to display a nominal resistance of 100 kilohm when the input voltage is ±1V. A typical resistance variation with applied voltage is from 500 kilohms at 0·2V to 10 kilohms at 10V. In the Fig. 8.1 circuit, components forming the positive branch are identified by the letter A after a component number, and the letter B is appended to negative branch numbering. As both branches are identical, except for diode and bias polarities, it is not necessary to describe them separately.

D1 is a gold-bonded diode, for a low voltage drop with small input voltages. All other diodes (D2–D7) are of silicon construction to keep reverse leakage low.

UNIT "C" FRONT PANEL

The only items to be mounted on the 9½in × 4in plastics laminate front panel are eight coloured sockets; the layout is given in Fig. 8.3. A series of ¼in holes are drilled in the front panel to allow screwdriver access to slope, breakpoint, and set-zero controls. Panel markings are similar to previous PEAC units.

FUNCTION GENERATOR CONSTRUCTION

Two 3¾in × 3¾in s.r.b.p. panels are drilled and shaped according to the Fig. 8.4a diagram. Before inserting turret tags, lay the prepared panels out as shown in Fig. 8.5, so that one panel is turned over in relation to the other, and components are clearly seen to be mounted on opposite sides. The underside wiring of the positive branch panel is shown in Fig. 8.4b, and the wiring of the negative branch is in Fig. 8.4c.

All diodes are mounted on turret tags to allow them to be disconnected for special purposes, where for

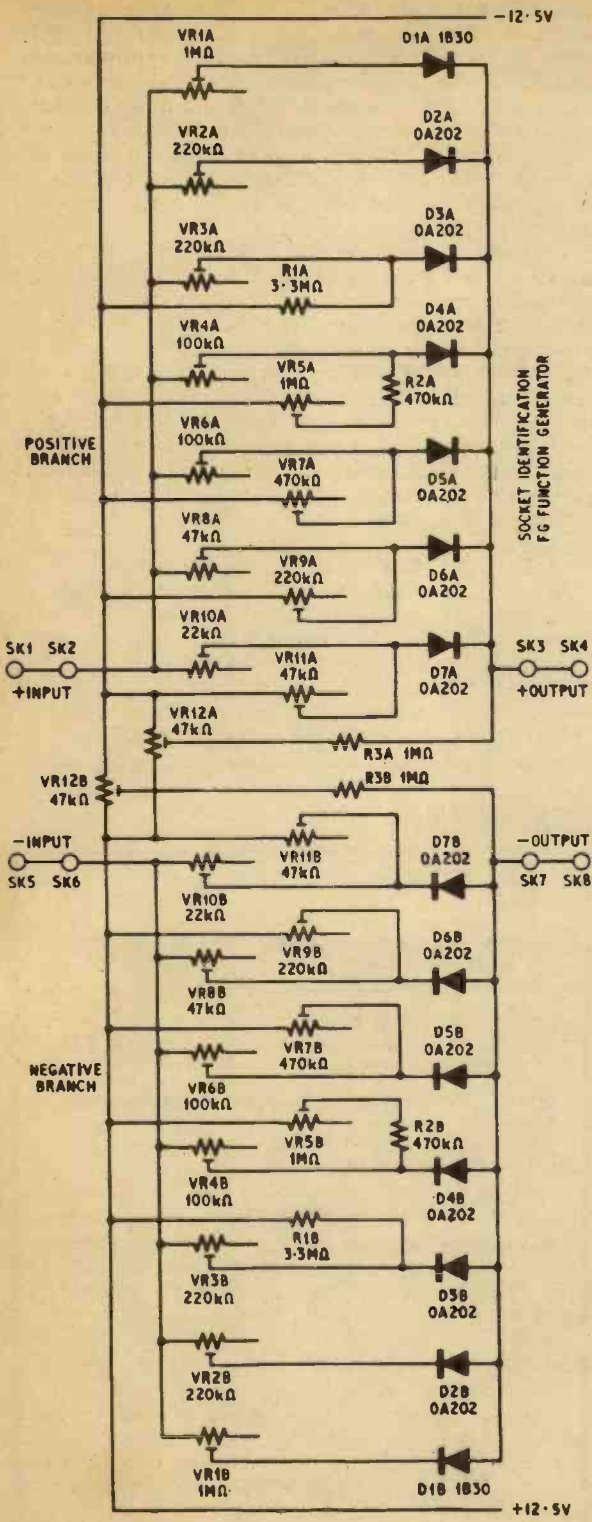
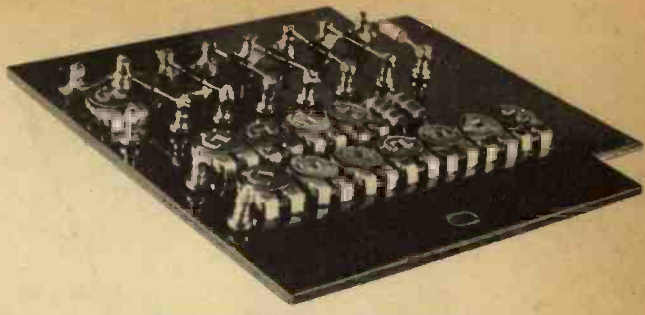


Fig. 8.1. UNIT "C" function generator circuit diagram



Function generator circuit panel

example it is desired to reduce the number of breakpoints, or combine a curved and straight line function. It is advisable to check the polarity of all diodes with a meter before mounting them on the circuit panels.

After completing the underside wiring, bolt the two circuit panels on the plywood frame, as in Fig. 8.5, and make sure that the front panel holes are aligned with the pre-set miniature potentiometer slots.

SETTING UP THE FUNCTION GENERATOR

Patching leads for the function generator should preferably be terminated at one end by miniature plugs, to permit connection to the UNIT "A" computing component sockets. As the generation of powers and roots is the main area of interest, functions related to the square or cube of a number are used in the following setting-up instructions.

To patch the function generator to OA1, join FG/SK5 to S1/I1/SK3, FG/SK8 to S1/I1/SK4, S1/SK5 to OA1/SK8, and link together OA1/SK9, SK10, and SK4. Insert a 100 kilohm computing resistor into OA1/SK11 and SK12. Take a patching lead from S1/I1/SK1 to VS1/SK2, and ensure that S6 is off.

The task of setting up the function generator is made easier if two voltmeters are used, one for E_{in} connected to S1/I1/SK2, and the other for E_0 to OA1/SK13. The Unit "B" readout meter is ideal for monitoring E_0 because it can indicate voltages down to 0·01V. Switch on the computer power supply and zero OA1 by means of its balance control VR15. Set all function generator slope and breakpoint potentiometer sliders to mid-track, and connect the red and blue wires from the function generator to the power supply terminals on the side of the UNIT "A" box (TL1 and TL2). Adjust VR12B (zero-set) for zero output from OA1.

Because of the interdependence of slope and breakpoint adjustments, a systematic approach is called for when setting up a function. Start with the lowest E_{in} and VR1 and proceed in an orderly fashion towards VR11 and the maximum E_{in} value. It is a help to tabulate specific input and output voltages and relate them to particular slope or breakpoint controls. To assist the reader, two tables have been prepared covering square and cube functions, Table 8.1 and Table 8.2.

If a square function is to be set up on the function generator, switch on S6 (Voltage Source) and set VS1 for an output of −0·2V, then adjust VR1B for an OA1 output of 0·04V. Next set VS1 for −0·5V and adjust VR2B for an output of 0·25V, and so on, according to Table 8.1. After application of $E_{in} = -2{\cdot}0$V, and adjustment of VR4, change the 100 kilohm computing resistor in the feedback loop of OA1 to 10 kilohm, to prevent the amplifier overloading when E_{in} exceeds $\sqrt{10}$.

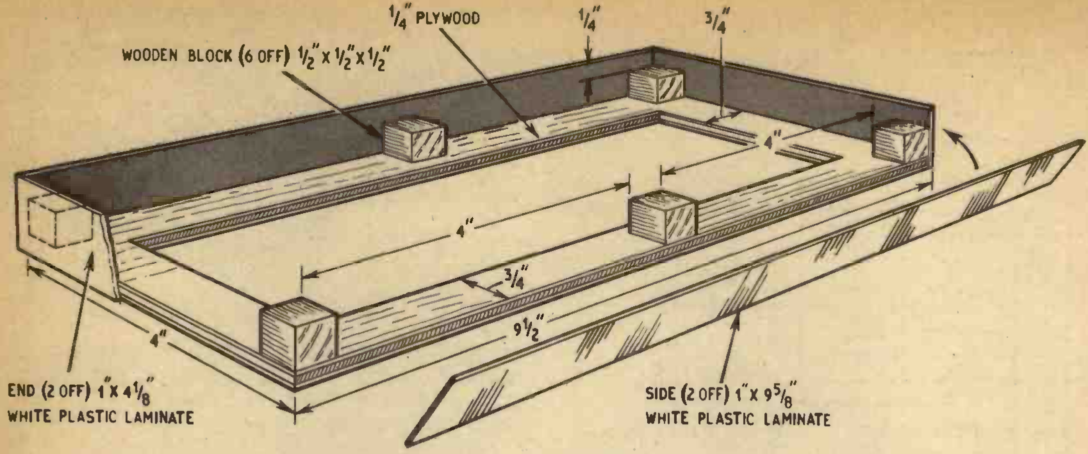


Fig. 8.2. Details and measurements of UNIT "C" function generator case

TABLE 8.1

Diode	E_{in}	Adjust slope	Adjust break-point	E_o	
1	−0·2V	VR1	—	+ 0·04V	$E_o = E_{in}^2$
2	−0·5V	VR2	—	+ 0·25V	$R_f = 100k\Omega$
3	−1·0V	VR3	—	+ 1·0V	
4	−1·5V	—	VR5	+ 2·25V	
	−2·0V	VR4	—	+ 4·0V	
5	−2·5V	—	VR7	+ 0·625V	$E_o = \frac{E_{in}^2}{10}$
	−3·5V	VR6	—	+ 1·225V	$R_f = 10k\Omega$
6	−4·0V	—	VR9	+ 1·6V	
	−6·0V	VR8	—	+ 3·6V	
7	−6·5V	—	VR11	+ 4·225V	
	−9·0V	VR10	—	+ 8·1V	

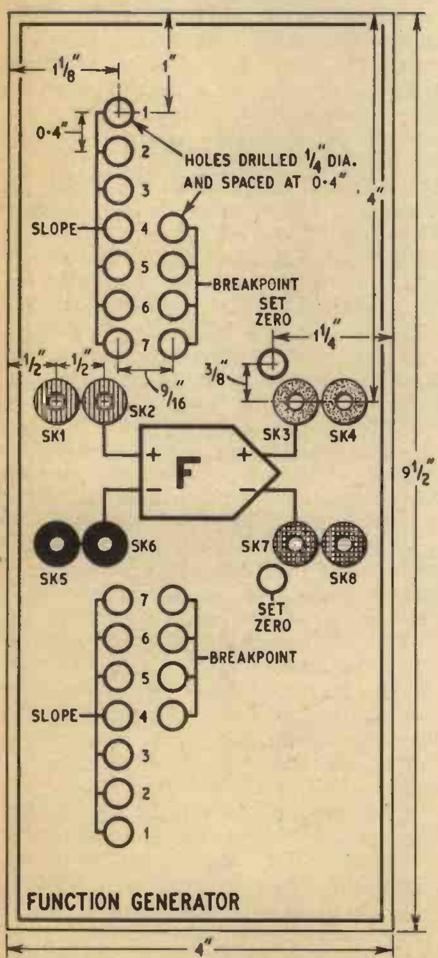


Fig. 8.3. Front panel layout of UNIT "C" function generator

COMPONENTS . . .

UNIT "C" BOX

Plywood 9½in × 4in × ¼in
Softwood ½in × ½in × 3½in
White plastics laminate 9⅝in × 1in (2 off),
4⅛in × 1in (2 off)
Rubber grommet ¼in × 5/32in

UNIT "C" Front Panel

White plastics laminate 9½in × 4in. Sockets: 2 red, 2 yellow, 2 black, 2 blue.

UNIT "C" Function Generator Components

Resistors

R1 3·3MΩ (2 off)
R2 470kΩ (2 off)
R3 1MΩ (2 off)
All 10%, ½W carbon composition

Pre-set Potentiometers

VR1, VR5	1MΩ	(4 off)
VR2, VR3, VR9	220kΩ	(6 off)
VR4, VR6	100kΩ	(4 off)
VR7	470kΩ	(2 off)
VR8	47kΩ	(2 off)
VR10	22kΩ	(2 off)
VR11, VR12	47kΩ	(4 off)

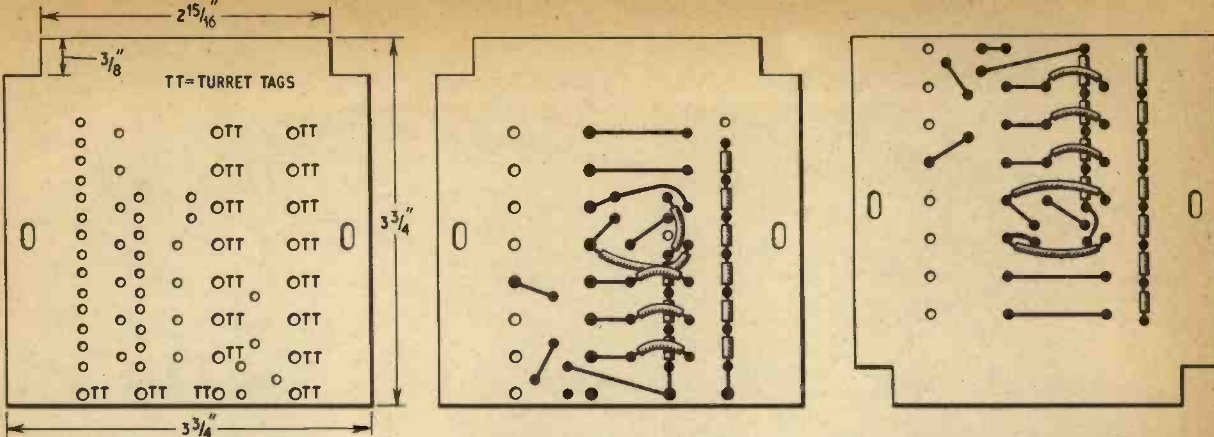
All miniature horizontal mounting

Diodes

D1 1B30 (2 off) (Radiospares)
D2–D7 OA202 (12 off)

Miscellaneous

S.R.B.P. 3¾in × 3¾in (2 off), Small turret tags
4mm stackable plugs, one red, one blue (Radiospares)

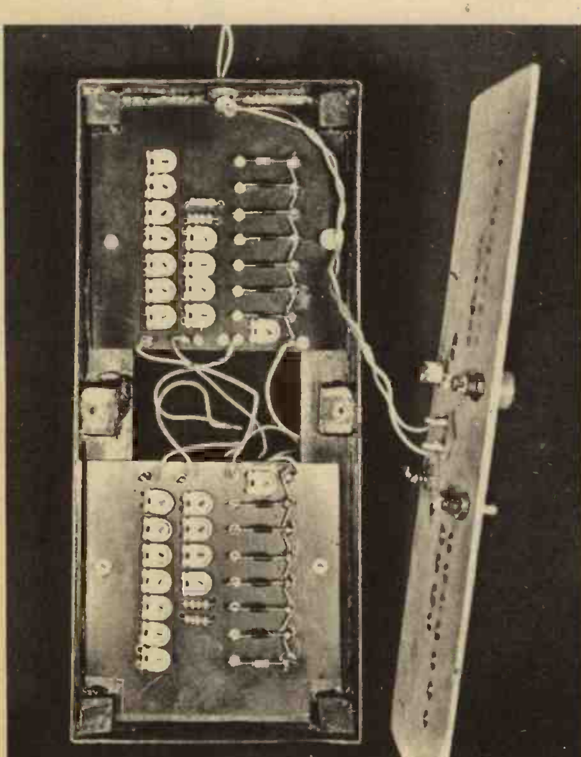


(a) drilling template (2 off) ***(b) positive branch underside wiring*** ***(c) negative branch underside wiring***

Fig. 8.4. Function generator circuit panels (2 off)

TABLE 8.2

Diode	E_{in}	Adjust slope	Adjust break-point	E_o	
1	−0·3V	VR1	—	+ 0·027V	$E_o = E_{in}^3$, $R_f = 100k\Omega$
2	−0·5V	VR2	—	+ 0·125V	
3	−0·75V	VR3	—	+ 0·421V	
4	−1·0V	—	VR5	+ 1·0V	
	−1·25V	VR4	—	+ 1·953V	
5	−1·5V	—	VR7	+ 3·375V	
	−2·0V	VR6	—	+ 8·0V	
6	−2·5V	—	VR9	+ 1·56V	$E_o = \frac{E_{in}^3}{10}$, $R_f = 10k\Omega$
	−3·0V	VR8	—	+ 2·7V	
7	−3·5V	—	VR11	+ 4·287V	
	−4·64V	VR10	—	+ 10·0V	



Interior view of UNIT "C" function generator

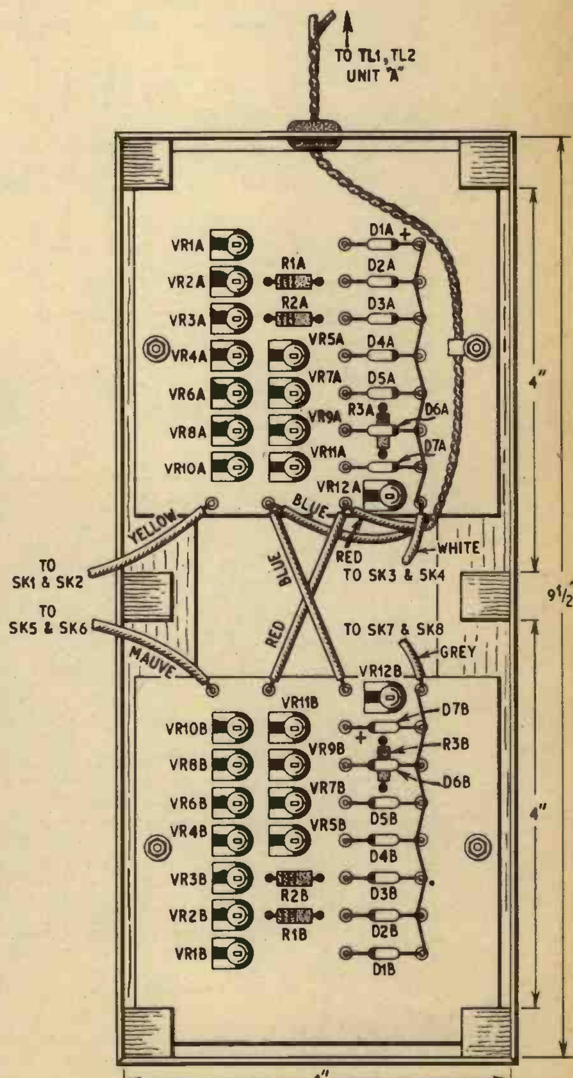


Fig. 8.5. Topside and interconnecting wiring of function generator panels. The circuit boards are shown in position inside the UNIT "C" case

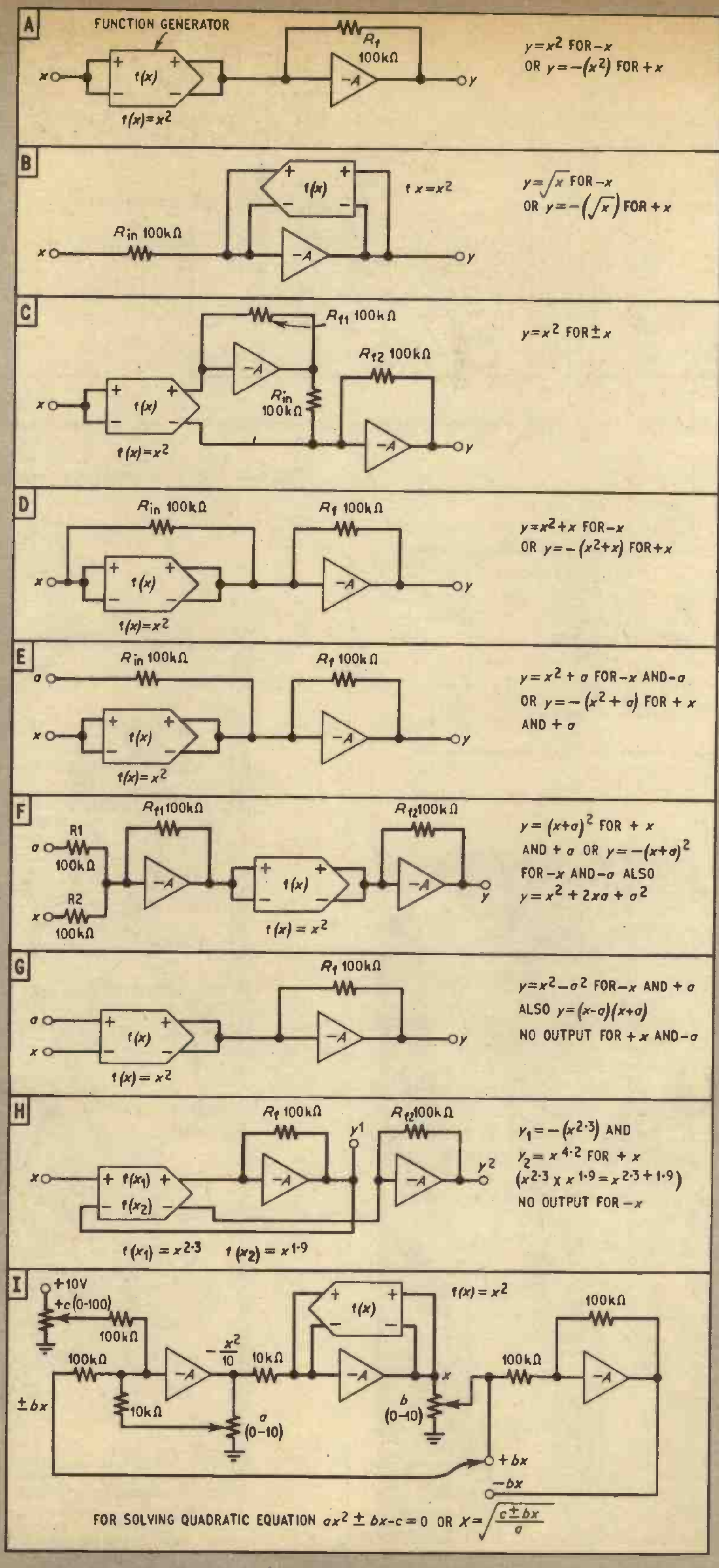
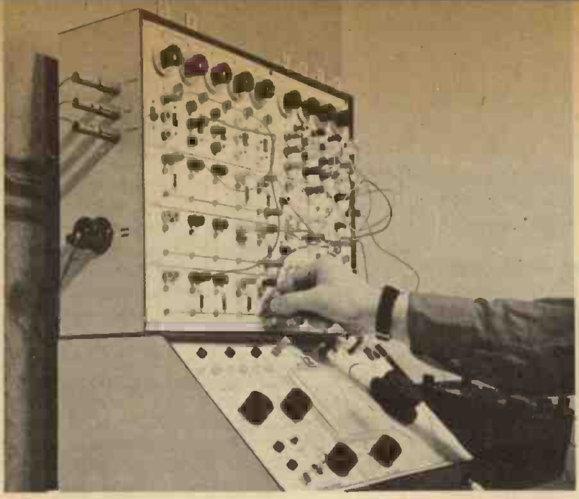


Fig. 8.6. The function generator used for equation solving



This photograph shows PEAC being used to solve simultaneous equations

After the entire range of input voltages listed in Table 8.1 has been covered, return to $E_{in} = -0{\cdot}2$V and go through the procedure again, to achieve optimum accuracy. The positive branch can be set up for the same function as the negative branch by transferring patching leads from FG/SK5 to SK1, and FG/SK8 to SK4, but this time trim VR12A for zero-set, and apply positive values of E_{in}. It may be necessary to slightly re-adjust slope controls VR1–VR3 when the two branches are connected in parallel, if there is some small bias voltage imbalance.

THE FUNCTION GENERATOR IN EQUATION SOLVING

The fact that an analogue computer can produce and handle imaginary numbers will be particularly evident when the function generator is applied to equation solving, see Fig. 8.6. One type of function generator circuit configuration will produce consistant outputs for, say, the cube of a number, but not for its square, or vice versa, because $\pm x^2 = +y$, but $+x^3 = +y$, and $-x^3 = -y$. The computer operator must therefore choose, or devise, the appropriate circuit for a given task.

Output y in Fig. 8.6a will be of the required sign when the input is $-x$, but the sign of y with an input of $+x$ cannot be reconciled with mathematical convention. However, the circuit of Fig. 8.6a does provide a consistant output when the function is x^3, with inputs of $\pm x$. Much the same applies to the Fig. 8.6b circuit, which shows the function generator arranged for square root operations. Circuit Fig. 8.6c reverses the above situation and gives consistent outputs for a square function, but not for a cube function, by employing an extra sign reversing amplifier.

Getting away now from the complexities of square roots of negative numbers and other mathematical anomalies, Fig. 8.6d can be made to give outputs of $y = x^2 + x$, or some other combination such as $y = x^{2.5} - 3x$, depending on the choice of function, voltage polarities, and computing resistor values. The purpose of other circuits E–H will be self-evident in Fig. 8.6. Fig. 8.6i gives the symbolised layout for solving a quadratic equation, where x is unknown and a, b, and c are constants. The function generator can also be introduced into problem set-ups where integrating amplifiers are used, as its frequency response is well in excess of any frequency likely to be encountered.

Next month: The final item of the PEAC equipment, UNIT "D", will be described.

NEWS BRIEFS

All Change at British Rail

PROGRESS of trains over 47 miles of track in the Leeds area is being monitored and controlled with the aid of a computer recently installed at Leeds City station.

The system is unique in that it uses a standard commercial computer (an Elliott 903) which can easily be adapted to new needs. Older systems using Post Office relays and uniselectors have to be extensively rewired when changes are called for.

The Leeds signalmen never see the trains they control. Each locomotive is given a code number which appears on one of 67 cathode ray tube readouts on a large track diagram, and its progress is traced by coloured lights. When the train reaches a new stretch of track, the computer transfers the code number to a fresh readout.

British Rail say future developments could include automatic signal route setting and automatic train announcing.

Lincompex Goes Afloat

LINCOMPEX, a Post Office invention which improves the intelligibility of high-frequency radio telephone services, has gone into service on three Cunard Liners. Lincompex, for "Linked compressor and expander" uses a compressor at the sending end to maintain the caller's voice at maximum level thus preserving a good signal-to-noise ratio, while an expander restores the original dynamics at the receiving end for more natural reproduction. A control signal links the two.

Slow Motion Tube

ENGLISH ELECTRIC VALVE have developed the electronic equivalent of a high-speed cine camera. It consists of an electrostatically-focused triode image-converter tube which can present on its integral fluorescent screen a sequence of frames showing the development of a high-speed event. The shutter action is achieved by deflection of the electron beam over a slit in an aperture plate in the tube. Speeds of 20 million frames per second can be obtained, and, dependent on image size, the number of frames to be recorded can be from eight to 32.

(below) Control panel of the "windowless" signal box at Leeds City station

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.

All amateurs at one time or another like to "dabble" in making printed circuit boards just to see if they can obtain the neat finish, and sometimes time saving associated with this method of construction.

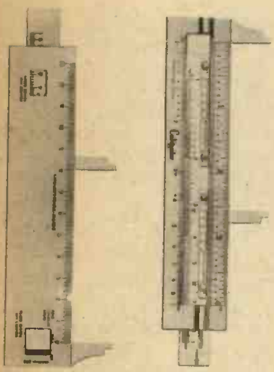
The problem with making your own circuit boards is the time taken to drill all the small holes and the cleaning away of any surplus copper which may not have been etched away from adjacent strips. This time consuming task can be made a lot easier with a Heathcraft Mini-Drill from **Heathcraft Metal Products Ltd.,** 54 Poland Street, London, W.1.

These drills are battery operated (12V) and there are a number of drills, polishing mops, grinding wheels, cutting burrs, and interchangeable chucks (not with standard model) available. The drill measures only 5in long and is relatively easy to handle and drills holes in printed circuit boards in a matter of seconds.

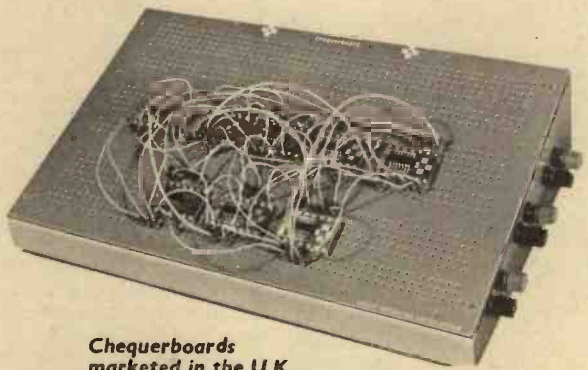
It was found necessary to exercise care when cleaning away copper and solder from adjacent strips due to the very high speed of the drill, which if care was not taken could cut practically through the board before it was realised.

The high speed of the drill also makes it useful for drilling holes in metal chassis as well as polishing finished equipment.

Obviously there are numerous other applications for these drills and further details and price list can be obtained from Heathcraft Metal Products Ltd.

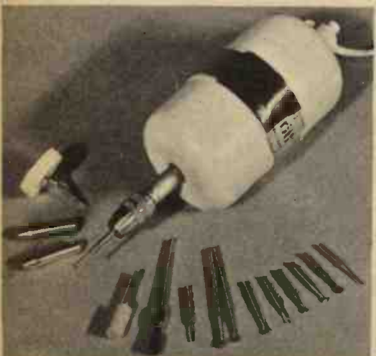


Caliputer slide rule from A. P. Warren



Chequerboards marketed in the U.K. by Radionic Products Ltd.

Henry's catalogue



Heathcraft Metal Products Mini-Drill with various attachments

EDUCATIONAL AIDS

The aids for educational purposes in electronics is always increasing and the latest product for this market is the Chequerboards manufactured by Circuit Integration Ltd., and marketed in the U.K. by **Radionic Products Ltd.,** Stephenson Way, Three Bridges, Crawley, Sussex.

Chequerboards is a system for rapid inter-connection of integrated circuits and other electronic components. Using this system test "lash-ups" can be assembled and tested without soldering expensive components, reducing the danger of damage.

All kinds of integrated circuits, flat packs, TO5 and dual-in-line with 14, 16, 18, and 20 pins are catered for, and in addition provision is made for including special circuits made up from discrete components.

The components are mounted on carriers so that they may be plugged into any one of the range of patchboards. Power supplies are automatically applied to each carrier, and inter-connections between devices is by means of ready-made plug-in wire links.

The system may be used for both digital and analogue system simulation and is particularly suitable for instruction in principles of computation and allied subjects. Plastics covers to fit over any of the carriers are available to enable the logic function of the device to be marked on the top. This enables a library of functions to be stored without reference to data sheets.

Another educational aid is the Caliputer measuring and calculating instrument combining a 4in vernier caliper, depth gauge and slide rule.

The instrument is available in either English or Metric scale. The inch vernier reads to 0·001in, the metric to 0·02mm. Having standard "B", "C", and "D" scales, the slide rule performs multiplication, division, square, and square root calculations.

Made of satin finish stainless steel with the scales deep etched into the instrument, it measures 4¾in long overall and is available from **A. P. Warren Ltd., 37 Sheen Road, Richmond,** Surrey.

LITERATURE

A new 9th edition of Henry's Component catalogue is now available from **Henry's Radio Ltd.,** 303 Edgware Road, London, W.2.

The new edition contains over 280 pages and lists 6,000 stock lines. As before, each edition is supplied with the five 2s discount vouchers for use on purchases. Price of the catalogue remains at 7s 6d plus 1s postage and packing.

Henry's also announce the opening of a new Electronics centre at 309 Edgware Road, London, W.2.

The new centre will be devoted to the sale and demonstration of all the latest high-fidelity equipment, intercoms, public address equipment, microphones, test equipment, etc.

Another very useful component catalogue is the LST 1968 Components Catalogue from **LST Components,** 7 Coptfold Road, Brentwood, Essex.

The catalogue contains 33 pages and lists items from Computer Boards to Heat Sink Compounds.

a new series... By F.C. JUDD, A.Inst.E.

EXPERIMENTS WITH SOUND LIGHT & COLOUR

Currently much interest is being shown in the artistic exploitation of controlled lighting for decorative purposes.

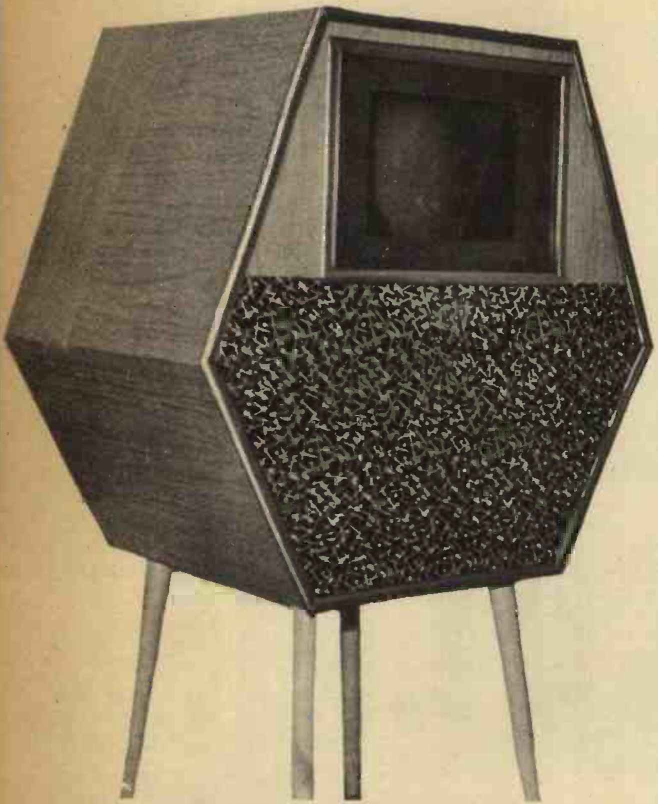
Ever changing levels of light, and different hues, can be blended to create most pleasing and relaxing effects. When the visual display is directly controlled by a sound programme the effect is greatly enhanced. The two media are most satisfactory complements, one to the other. And it hardly needs emphasising that electronically composed music has an obvious and natural place here.

The subject is not new. Modern technology merely makes it more practical and extends the possibilities.

In this series, the author first provides a background by referring to some work carried out in recent years in this field. This first article also provides details of a simple basic colour light display. A more ambitious design involving the modification of a discarded television receiver will be given in the second and third articles. The series will conclude with a discussion about the programming of both displays from audio signals.

Precise "blueprint" details are not given—but there will be adequate information for those keen enough to start experimenting themselves in sound, light, and colour.

IN music and audio and indeed in moving films, experiments have been made at one time or another with the co-ordination of sound, light and colour. A classic example in movie films was Walt Disney's *Fantasia.* Aside from films there have been applications such as coloured lighting controlled and synchronised by sound. Some experimenters have even tried to present sound in terms of colour, whereby each colour displayed as light on a screen represented a particular band of frequencies or specific sounds. The various combinations and methods are quite intriguing and perhaps attractive to experimenters who would like to try something different.



This is the original c.r. colour pattern display as demonstrated at the 1962 Audio Festival in London

The author's own particular interest in sound and colour came about as the result of research in the techniques of electronic music. Here the need for a visual element seemed obvious since most electronic music is of an abstract form. A search for information on such an unusual subject revealed that little had been written but that various methods had been used; for instance, at one exhibition in London a computer had been employed to analyse music and present its findings on a large screen in terms of colour illumination. Electronic organs have been used to control coloured lighting via the organ keys and coloured lighting has been combined with music as in *Son et Lumiere* programmes.

CATHODE RAY DISPLAY

It seemed, however, that the cathode ray tube had been overlooked as a controllable means of displaying images of sound in abstract form. Multi-colour effects might also be produced by using colour tubes similar to those used in colour television receivers. These are of course expensive items, so the possibilities of a standard blue/white trace television c.r.t. combined with a colour "scanner" were investigated.

As a result, a complete display as shown in the photograph was devised and constructed by the writer and demonstrated at the London Audio Festival of 1962. The display featured a 10in × 8in screen and employed a standard 12in television c.r.t. and a colour scanner. The audio signals for producing the colour patterns were recorded on tape and synchronised with electronic music, also on tape. The programme could therefore be repeated as often as desired.

Such a display can be produced, as was the original version shown here, from an old television receiver with a 12 or 14in tube. The usual a.c./d.c. circuitry must be modified and all the normal r.f. and video sections removed. The experiment should in fact begin with no more than the c.r.t. and its e.h.t. supply. A separate power pack capable of delivering approximately 300V at 100mA is needed to cover all h.t. requirements. This should include a 6·3V heater winding suitable for about half a dozen 0·3A valves.

LISSAJOUS PATTERNS

The basic function of the c.r.t is to display what are really complex Lissajous patterns derived from various audio frequency signals with different waveforms. Signals can also be taken from accompanying music as well. Auxiliary equipment therefore consists of audio signal generators with sine and square-wave outputs and a signal mixer. By tape recording the control signals, the editing techniques of magnetic tape can be applied, i.e. the pattern signals can be juxtaposed to a desired order.

The original experimental display consisted of the c.r.t. and e.h.t. supply together with X and Y deflection coil amplifiers and pulse generators. The colour scanner was made up from pieces of coloured (transparent) Cinemoid. A normal television tube produces a brilliant blue/white trace which when covered by Cinemoid transparency will change to whatever colour is being used. The scanner was made to rotate at about ten times per second whilst the c.r.t. grid was pulsed at around the same rate. Patterns displayed on the screen changed colour according to the rate of the scanner rotation and the frequency of the c.r.t. grid pulses. By varying the grid pulse rate as well as the repetition rate of the patterns themselves, quite beautiful and brilliant "psychedelic" effects can be produced.

Details and circuits for constructing a new and improved version of this c.r. display unit will be given in the next two articles. *This month's cover incorporates three colour photographs taken directly from the screen of this c.r. colour pattern display unit.*

For the reader eager to start experimenting in this field, we now give some practical details of a coloured light display using banks of small lamps. Less sophisticated than the c.r.t. device, this is relatively simple to construct, and is certainly very effective in operation.

A COLOURED LIGHT DISPLAY

The idea of controlling coloured lights by audio signals is by no means new. Almost any audio power transistor can be made to pass enough collector current to light small flashlight bulbs connected in parallel or series-parallel in the collector circuit.

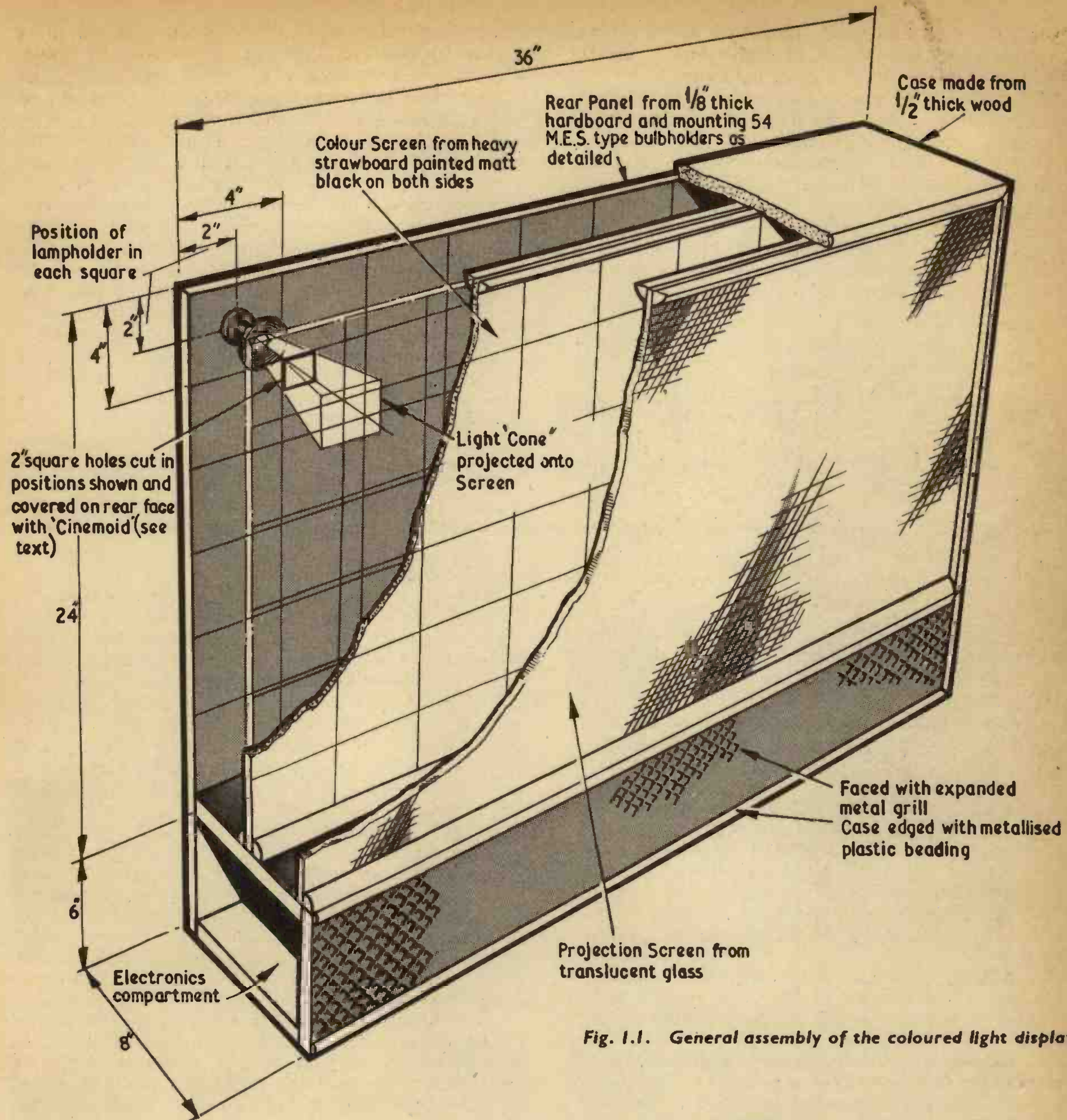


Fig. 1.1. General assembly of the coloured light display

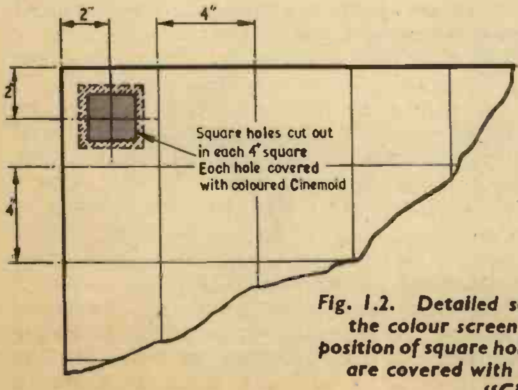


Fig. 1.2. Detailed section of the colour screen showing position of square holes which are covered with coloured "Cinemoid"

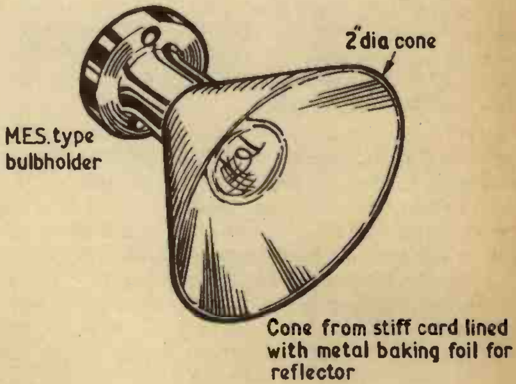


Fig. 1.3. Lampholder and reflector

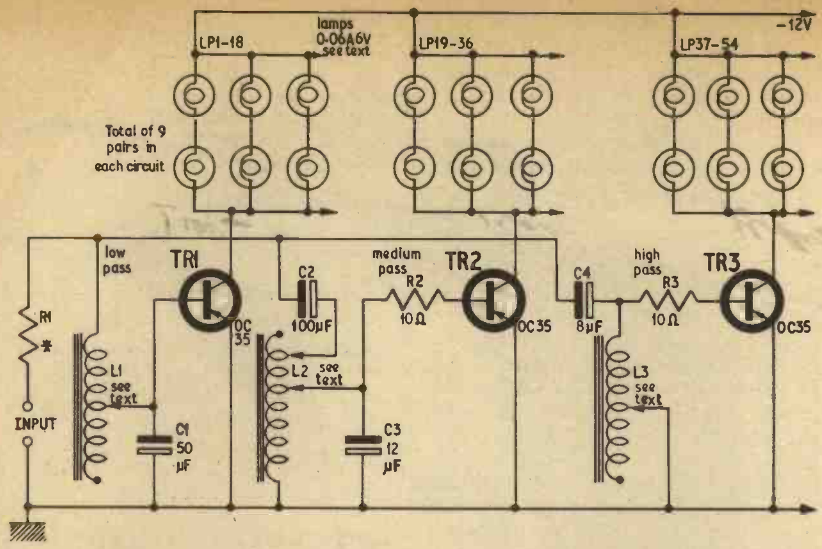


Fig. 1.4. Filter amplifier circuit for the coloured light display. R1, nominally 10Ω, is selected to suit input source

The basic principle is to drive the transistor from cut-off up to full collector current (no more) by applying signals at the base. As the collector current increases so also will the brilliance of the lamps. With a 12V supply and a maximum collector current of say 500 to 600mA, approximately eighteen 0·06A (6V) lamps in series–parallel in the collector circuit will light to full brilliance.

The display as shown in the photograph (right) has a screen 3ft × 2ft and fifty-four 6V 0·06A lamps are used to display colour blocks measuring approximately 4in × 4in on the frosted screen. Three transistor amplifiers with audio filters are employed to divide the audio frequency spectrum into bands covering approximately 50–100Hz, 200–1,000Hz, and 1,000–5,000Hz—and higher.

In a display of this kind, the original of which was demonstrated in London in 1963, the colours can be arranged in various ways, e.g. at random or geometrically. The effect was found to be more interesting when the colours and lamps were distributed at random. The display can be almost any size, i.e. smaller or larger than the one shown and described in this article. If a larger number of lamps are used the power transistors must of course be capable of passing the necessary current. Alternatively, more than three transistor amplifiers and filters could be used—together with extra lamps, accordingly.

A colour display using small lamps. Constructional information is included in this article

DISPLAY SCREEN AND LAMPS

The recommended size of the display is 3ft wide, 2ft 6in high and 8in deep, see Fig. 1.1. This allows a front screen of translucent or frosted glass of 3ft × 2ft. The lower part of the case contains the 12V h.t. supply and transistor filter/amplifiers.

The 54 lamps are mounted on the back inside of the case as shown in Fig. 1.1. The colour screen is mounted approximately halfway between the lamps and the front glass screen so that squares of light approximately 4in square are projected onto the front screen. With three filter amplifiers 18 lamps per transistor can be used. This calls for audio power transistors such as the OC35 capable of passing a collector current of around 600mA. Each transistor must of course be mounted on a suitable heat sink.

Every lamp is fitted with a small circular reflector to increase the brilliance and to focus the light forward. The reflectors are made from 2in squares of "food foil" pressed into shape by wrapping round a small rubber ball or similar spherical object. Make a hole in the centre (before pressing into shape) just large enough for the cap of the bulb to go through (see Fig. 1.3). The reflectors are fixed to the bases of the lamp holders with a spot of adhesive.

Those desirous of experimenting with a display of this nature are advised to carry out a few bench tests first of all with the transistors and lamps and the filter circuits. In this way adjustments to the circuits and the tuning of the filters with the help of an audio signal generator will facilitate final operation.

THE FILTER AMPLIFIER

The filter amplifier of Fig. 1.4 consists of three sections —each controlling a group of lamps. Each transistor is normally cut off and collector current will flow only when signals are applied to the base via the requisite filter. The inductances for the filters have to be determined experimentally but in the original circuits Mullard type LA11 or Vinkor LA2002 pot cores each with a full winding of 30 s.w.g. enamelled wire were used. The windings were tapped every 50 to 60 turns so that each coil could be adjusted to the desired frequency cut-off in conjunction with the tuning capacitors.

The input signal required to drive the transistors into the fully conducting state can be taken directly from the low impedance output of the amplifier employed for the reproduction of music (extension speaker sockets of a radio or record player, etc.). It may be found that less audio power can be used if the base of each transistor is biased a little toward the negative h.t. rail, but not sufficiently to cause the lamps to light.

This photograph shows the new version c.r. colour pattern display based upon a discarded television receiver and which will be described in subsequent articles

Instead of inductances consisting of wound pot cores as mentioned above and which are expensive, it should be possible to use the primary windings of small valve type audio output transformers. If these have tappings, so much the better. Each circuit can be checked with the aid of an audio signal generator and "tuned" experimentally for bandwidth by adjusting (a) tappings on the inductance or by using alternatives and (b) varying the value of the capacitors of the filter circuit.

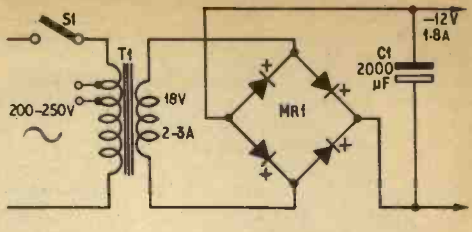


Fig. 1.5. Power supply circuit for the colour display

A circuit suitable for a power supply is given in Fig. 1.5. Smoothing other than that provided by the 2000μF capacitor C1 is not essential. There is ample room in the bottom section of the case for the filter amplifiers and the power supply. The power supply transformer T1 and the bridge rectifier MR1 together must be capable of supplying 12V at a peak d.c. current of 1·8A.

DISTRIBUTION OF LAMPS AND COLOURS

The lamps are wired in series-parallel, 18 to each transistor circuit, as in Fig. 1.4. It has been found that random distribution over the backboard produces the best effect. Much the same applies to the colour screen, i.e. the colours are placed at random (see Fig. 1.1).

The final position of the colour screen relative to the lamps and the front screen is best found by experiment. The ultimate position is when squares of light approximately 4in square are projected on to the opaque front screen (see Fig. 1.1). The coloured "Cinemoid" from which pieces approximately 2½in × 2½in are cut is obtainable from Strand Electric and Engineering Company Limited, 250 Kennington Lane, London, S.E.11. Pieces 12in × 12in cost 2s 9d each and are known as "reference 61". Colours available include red, green, blue, yellow, orange, purple.

COMPONENTS FOR THE DISPLAY

Most of the components used in this display are standard, i.e. resistors are ½ watt and the electrolytics are minimum 12V working. The transistors are Mullard OC35 or nearest equivalent. Pot cores are also available from Electroniques (S.T.C.) Limited, Edinburgh Way, Harlow, Essex, who can also supply all other components including a suitable transformer and rectifier for the power pack. The lamps are M.E.S. 6V 0·06A types.

IN OPERATION

When connected to the loudspeaker output of a record player, radio or hi-fi system, the lamps will light at random but relative to the level of sounds and the frequencies. In consequence the colour blocks will actually appear to change position and at times several may even appear to move in one direction. The room lighting should be low since the power of the lamps is small.

There is no reason of course why such a system should not be developed so that higher power lamps could be employed, particularly as transistors capable of passing 5A to 10A at 24V are now available. The writer makes no claim for originality in the basic idea, but only for the display method and circuitry as described in this article.

Next month: Details of a c.r. colour pattern display unit

DEATH OF A MOON

Another milestone in satellite history was marked on May 24, 1968 when *Echo One* re-entered the earth's atmosphere to die unobserved so far as is known at the moment.

The satellite, a wrinkled plastic balloon after nearly eight years in orbit, entered the earth's atmosphere soon after 0100 GMT over the Pacific Ocean near the west coast of South America. It passed over Guadalajara, Mexico, before striking the atmosphere but the final minutes were unobserved. It is not, therefore, possible to say at this time whether it burned on re-entry or whether any part of it survived.

The satellite was originally a 30 metre diameter sphere when launched on August 12, 1960. It was the world's first passive communications satellite. The brightest of the man-made satellites, its aluminised skin reflected radio signals and enabled distant points to be connected by radio thus paving the way for the Intelsat communications satellites that today link the world by television and telephone.

Echo One might have remained circling the earth for a thousand years had it not been for the pressure of the sun's radiation which by perturbing the satellite's orbit caused its early death.

SPACEWATCH

By Frank W. Hyde

RADIO ASTRONOMY EXPLORER

The first of the radio astronomy satellites has been through its tests at the Goddard Space Flight Centre in Greenbank, Maryland, U.S.A. It is due to be launched in June or July this year. The frequency range of operation will be from 0·3 to 10MHz (100 metres to 3 metres).

The choice of frequency was determined by the fact that in this band there is maximum absorption by the ionosphere preventing the ground based radio telescopes from obtaining information of value. With the telescope outside the ionosphere it will be possible to study the sources in the galaxy and determine details of the magnetic fields existing there.

Study of the relativistic electron spectrum may throw light on the way in which cosmic rays are formed within the galaxy. Important data will be gathered about the effect of the sun's activity out to some 100 solar radii. This aspect is of great importance since ground stations are only able to plot the progress of disturbances to about a twentieth of the distance. More data may become available about the decametric radiation of Jupiter, greater information will be available about the interplanetary medium than can be obtained by ground stations alone.

UNIQUE AERIALS

The aerial systems are of unique design. They will consist of booms which will extend some 250 metres to form two V-shaped aerials. They are of flat tape which will curl round to form a hollow tube. The material used is silver plated beryllium–copper 0·005cm thick. The whole unit will be gravity stabilised so that the aerials will have a fixed directivity.

The V-aerials may not always be pointing in the required direction to monitor solar or Jovian bursts of radiation. To overcome this a 40 metre dipole aerial will be oriented at right angles to the V-aerials. The operation of the systems will be such that the noise levels are monitored every few seconds at a number of selected frequencies. The data returned to earth will require something like 30 hours of computer time per week to reduce them to readable form.

The success of this project will almost certainly lead to the launching of telescopes of higher resolution to study the more distant sources such as exploding galaxies and quasars. Pairs of such units could provide interferometer complexes with still more extensive observations. The projected height for the first telescope is 6,000km, the orbit will therefore precess and in about a year the whole of the celestial sphere would be scanned.

LARGE RADIO TELESCOPE

West Germany is to have a radio-telescope of 100 metres diameter. It is being built for the Max Planck Institute for Radio Astronomy. It will be erected in the Effelsberger Valley.

The parabolic reflector will be built on the Teller principle. The whole reflector is supported only at points on the axis. As the dish is moved from the zenith position there are deformations of the original parabolic form.

Construction is such that the reflector will always take up another parabolic form. The new forms will have different focal lengths and different axial inclinations. These can be corrected with the aid of a computer and corresponding displacements of the aerial feed made. The deviation from the true parabolic form will be only 0·7mm.

The dish is made of aluminium plates for 80 metres of the diameter; the remaining 20 metres is made up of perforated plates forming an annular ring. The perforations help to reduce the wind resistance. A large cabin at the focus of the dish will house the helium cooled receiver. There will be an elliptical reflector behind the focal point for wavelengths from 10 to 30 centimetres. A maser will be used at the 3cm band and a parametric amplifier for the 20cm band.

The telescope is expected to be in operation by the end of 1969. It is hoped that it will be able to detect objects with low emission of the order of 10–30 watts/sq.m.

A NUCLEAR REACTOR IN A GALLON CAN

West Germany has produced a nuclear reactor small enough to go into a one gallon measure. Known as an Incore Thermionic Reactor, it uses highly enriched uranium as fissile material and the coolant is liquid sodium. The operation is distinguished from most other methods of producing electrical power by the fact that there are no moving parts. Current is produced directly by thermionic effects.

The uranium is contained in small tubes of molybdenum which are thinly coated with tungsten. These are each surrounded by an insulated cylinder cooled by liquid sodium to a temperature of 650 degrees centigrade. During fission the interior temperature rises to 1,400 degrees centigrade and the thermionic electrons jump across the gap of 0·17mm between the two cylinders thereby producing an electrical current.

Thermionic cells about 6cm in length each produce about 250A at 0·65V. The cells are connected in groups of seven to each fuel rod. There are some 19 rods in all. These rods do not have enough fuel to start a chain reaction so further rods which do not produce current are packed round them.

A reactor of this size produces about 20kW. Thus one more step is taken toward the sort of power supply required by space vehicles. It may well be that this will provide a cheaper method than that of solar cells when high powers are required.

SATELLITE TRACKING

Many amateurs have become a little blasé about the reception of satellite signals. Perhaps it is not generally realised that there are a number of useful observations to be made using the satellite transmissions as a tool.

Now that the sun is very active again there are opportunities to measure the changing density of the ionosphere by monitoring satellites at different frequencies simultaneously, a great field for the ingenuity of the amateur.

MUSICAL DOORBELL

By E.G. PRENTICE

THIS circuit provides a novel doorbell giving a musical tune. Unlike most doorbells it has the added advantage that a number of loudspeakers can be connected to announce callers in any room in the house.

The cheerful sound triggered off by the caller originates in a clockwork musical box mechanism. The output from this mechanism is converted into an electrical signal which is then amplified. An ingenious but simple contact transducer is made from a crystal pickup cartridge.

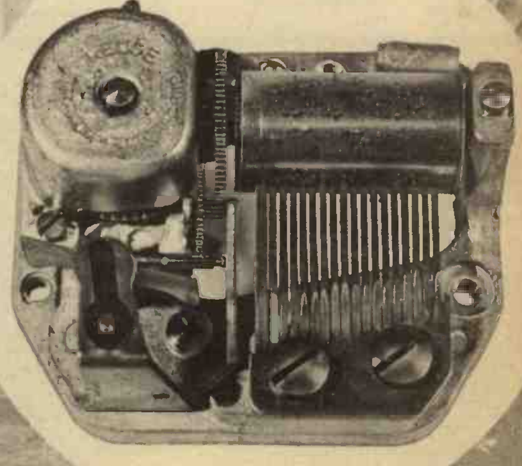
CIRCUIT DESCRIPTION

Transistor TR1, relay RLA, and associated components (see Fig. 1) form a timing circuit which allows the doorbell to "play" for a preset period (about seven seconds) irrespective of the length of time the caller has his thumb on the bell push. The relay is additionally responsible for the mechanical start and stop of the musical box mechanism.

The remainder of the circuit is a conventional push-pull audio amplifier which raises the transducer output to loudspeaker level.

On pushing the bell push S1, a negative voltage is applied to the base of TR1, via the normally closed relay contact RLA1, causing a rise in collector current. This energises the relay, which closes RLA2 (the speaker muting contact) and RLA3 (the main power contact), and opens RLA1. The large capacitor C1 starts to charge, and the charging current keeps TR1 biased on. As C1 continues to charge, the bias current progressively falls until the point is reached where the corresponding collector current is insufficient to sustain the relay, which then drops out and switches off the whole assembly. The charge remaining in C1 is now discharged through RLA1 and R2.

When the relay is energised, a lever attached to its armature (see Fig. 4) releases the clockwork musical box mechanism and the resulting sound is picked up and converted by the crystal transducer to an electrical signal.



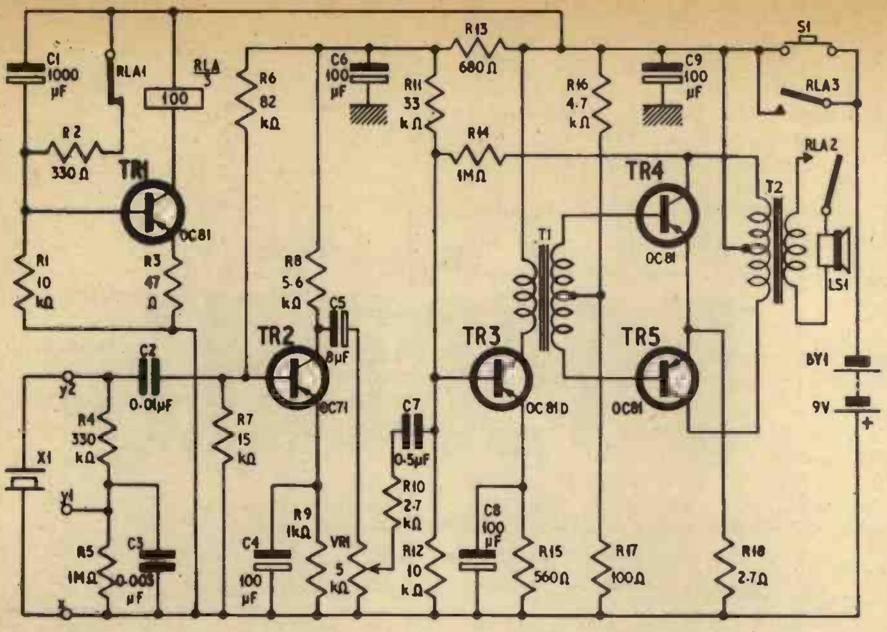


Fig. 1. Circuit diagram of the amplifier and timer

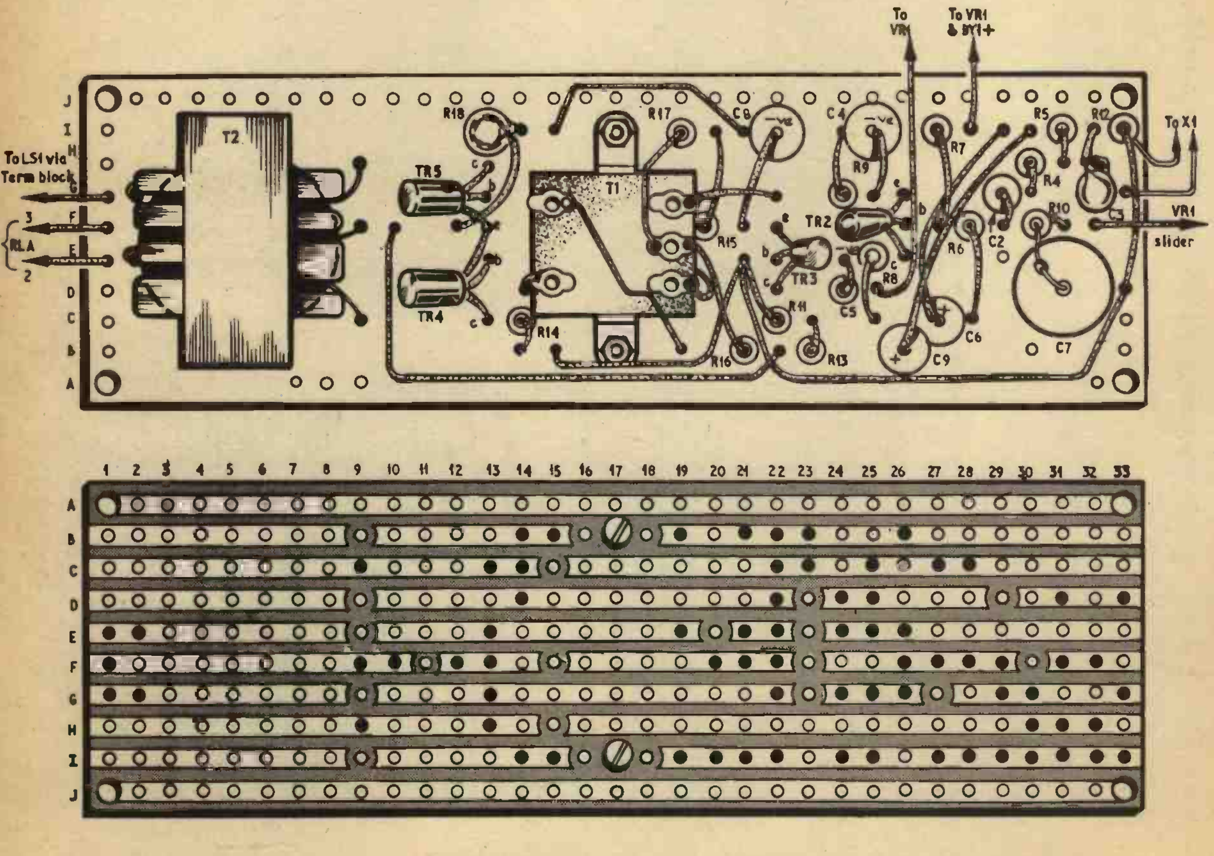


Fig. 2. Amplifier layout and wiring with (below) the underside of the Veroboard

This signal is applied to the base of TR2, the amplifier input stage, and is thus amplified and applied to the volume control VR1 via the d.c. blocking capacitor C5. The appropriate level of signal is tapped off by the slider of VR1 and applied to the base of the driver transistor TR3. The resulting amplified signal at the collector of TR3 is conveyed by T1 to the base of the push-pull output transistors TR4 and TR5 in opposite phase, and after further amplification is recombined by the output transformer T2.

PLAYING TIME

The length of playing time is of course governed by the charging time of C1. This can be varied to suit requirements: raising the capacitance of C1 and/or the resistance of R1 lengthens the playing time, and vice versa.

The mechanical noise of the lever hitting the butterfly on cutting out is prevented from reaching the speaker by the relay contact RLA2, which is adjusted by careful bending to break the speaker connection before the lever actually comes into contact with the butterfly.

MECHANICAL CONSTRUCTION

The unit is assembled on a ⅜in thick plywood baseboard measuring approximately 8in by 4½in, to which is screwed a vertical panel of similar size and material.

On the baseboard is mounted the amplifier board, the battery BY1, and the terminal block for the loudspeaker and bell push. The front panel carries the musical movement and transducer, as well as the relay and the volume control VR1. A 1¾in diameter hole in the panel gives access to the winding key of the movement.

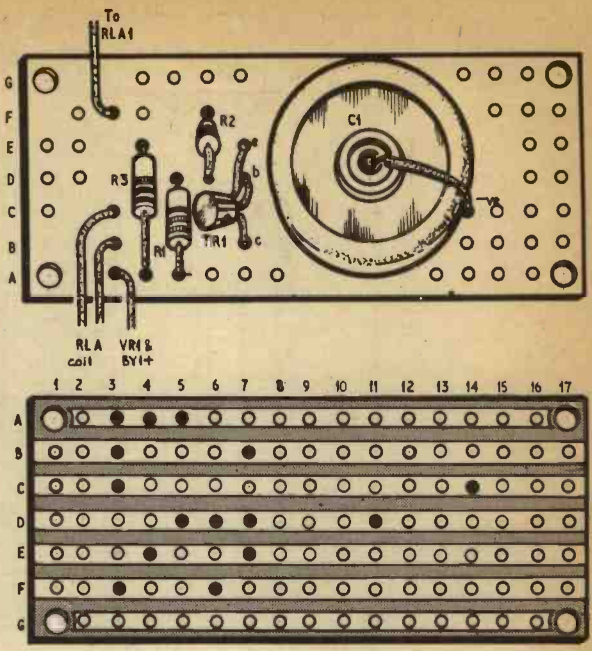
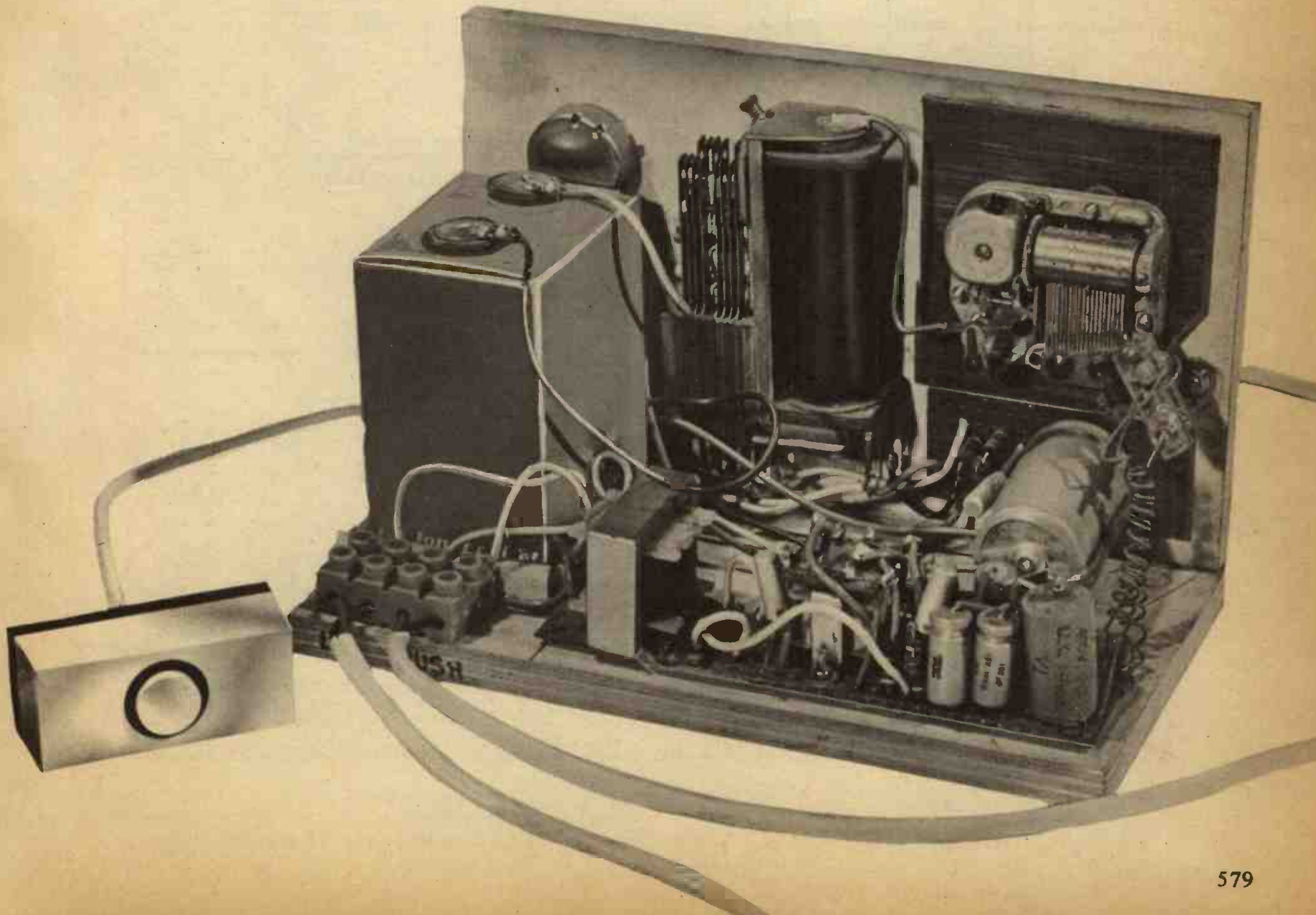


Fig. 3. Layout of the timing module



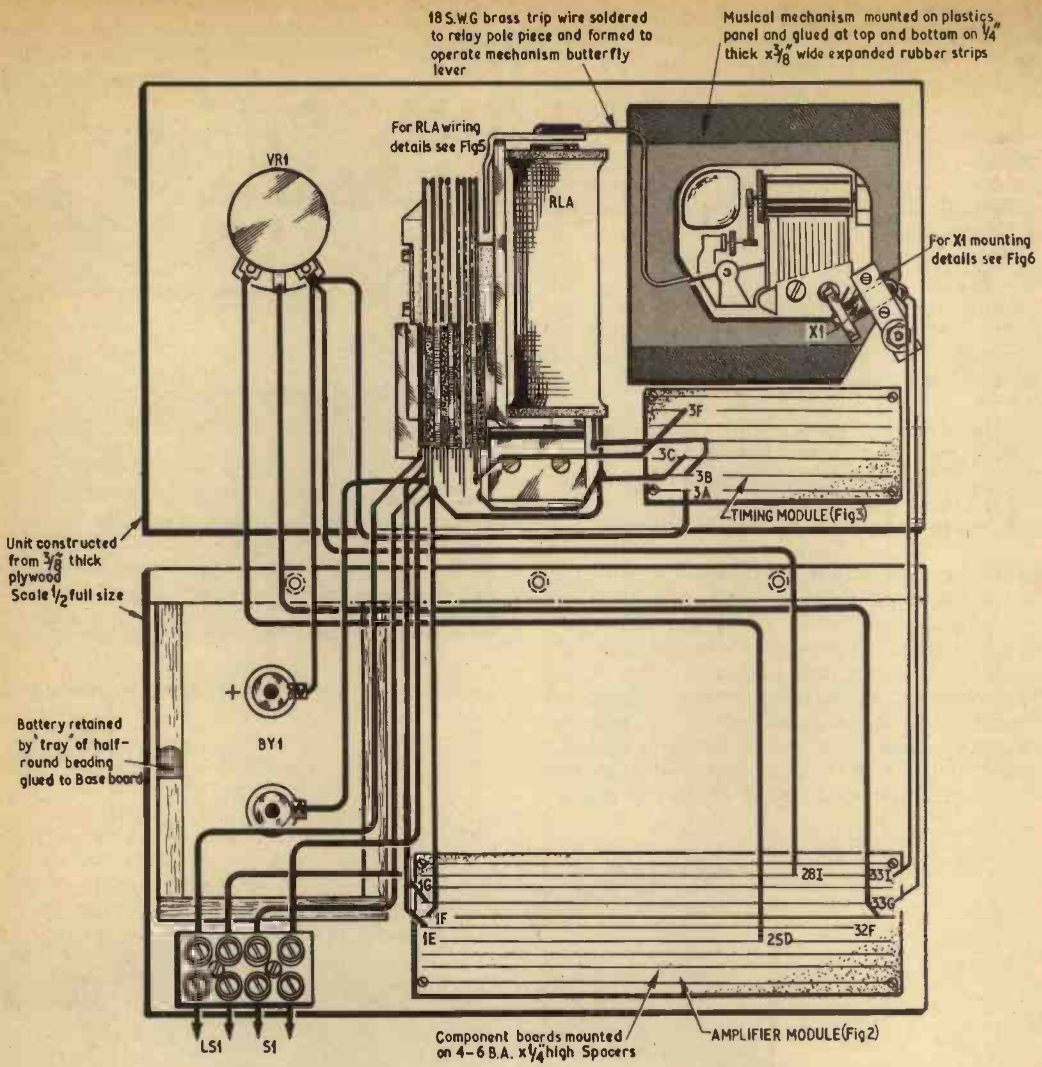


Fig. 4. Flattened-out view of the front panel and baseboard, showing interconnections. The crystal transducer, X1, is positioned to make light mechanical contact with one of the comb-fixing screws of the musical movement

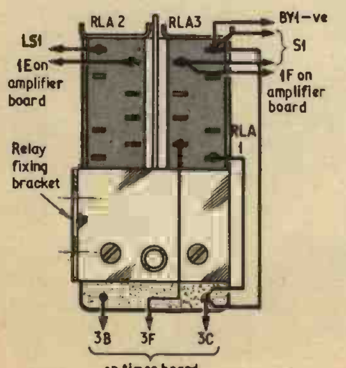


Fig. 5. Relay wiring details

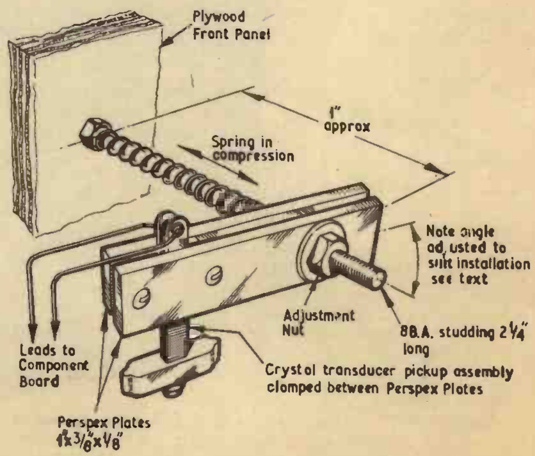


Fig. 6. Construction of the transducer. Electrical connection to the foils of the crystal is made by sandwiching two metal shims between it and the Perspex plates

COMPONENTS . . .

Resistors
R1 10kΩ
R2 330Ω
R3 47Ω
R4 330kΩ
R5 1MΩ
R6 82kΩ
R7 15kΩ
R8 5·6kΩ
R9 1kΩ
R10 2·7kΩ
R11 33kΩ
R12 10kΩ
R13 680Ω
R14 1MΩ
R15 560Ω
R16 4·7kΩ
R17 100Ω
R18 2·7Ω wirewound 3 watt
All 10%, ¼ watt carbon, except R18

Potentiometer
VR1 5kΩ log.

Capacitors
C1 1,000μF elect. 12V
C2 0·01μF 15V
C3 0·003μF 15V
C4 100μF elect. 12V
C5 8μF elect. 12V
C6 100μF elect. 12V
C7 0·5μF 15V
C8 100μF elect. 12V
C9 100μF elect. 12V

Transistors
TR1 OC81
TR2 OC71
TR3 OC81D
TR4 OC81
TR5 OC81

Transformers
T1 (driver) Radiospares type T/T6
T2 (output) Radiospares type T/T7

Relay
RLA Post Office type 3000. 100Ω coil with minimum of two make and one break

Switches
S1 Bell push

Loudspeaker
LS1 Any p.m. type of about 5in diameter or larger, and having a 3Ω coil

Battery
BY1 9 volt (PP9 or equivalent)

Transducer
X1 Crystal element removed from BSR cartridge type TC8M or TC8H (see text)

Musical box mechanism
Hobbies' Swiss Musical Movement No. 1 (tune as selected)

Miscellaneous
Battery clips. Four-way terminal block. Rubber strip. Cellulose cement and contact adhesive. Materials for transducer (see text and Fig. 6)

To minimise microphony and mechanical noise, the movement is mounted on to a piece of laminated plastics, the screws passing through rubber grommets, which is then attached with adhesive and ¼in thick strip rubber spacers to the front panel, as in Fig. 4. Ensure that the heads of the mounting screws cannot touch the panel.

Before installing the relay, a 3in length of 16 s.w.g. brass wire is soldered to the armature and bent in the form of an elongated L (see Fig. 4). The relay is then mounted on the panel by means of a small bracket made from 1/32in sheet brass, and so positioned that the wire comes into contact with the butterfly governor of the musical movement when the armature is open, and releases it when the armature is closed.

THE TRANSDUCER

Construction of the transducer is rather a delicate task. It uses the element from a crystal gramophone pickup cartridge type TC8M or TC8H.

Remove the cartridge from its cradle and pull out the two styli. The cartridge is held together by two rivets: when these are carefully drilled away, the two plastic halves can be parted and the crystal removed. Two small "Perspex" sideplates are cut and drilled to take 8 B.A. screws, as in Fig. 6, and a small metal shim is glued to each plate with contact adhesive so that when the two sideplates are screwed together they form a clamp across the crystal and make contact with its connecting foils.

The completed assembly is mounted on a 2¾in length of 8 B.A. screwed studding at an angle of about 45 degrees and held in place by a nut compressing the assembly against a spring.

The transducer is then screwed to the wooden panel in such a position that the plastic bridge at the end of the crystal comes into contact with one of the comb-attaching screws of the musical movement. Final adjustment for best tone and volume is made when the amplifier is completed. The nut can then be locked into position with a little cellulose cement. Beeswax applied to the junction of the transducer and comb screw will remove chatter.

AMPLIFIER CONSTRUCTION

Building the amplifier and timer circuits is quite straightforward and layout is not critical. The prototype used Veroboard (wiring and interconnection details in Figs. 2, 3, and 4), but a chassis or tag board approach is equally suitable. Connections for the bell push and loudspeaker should be taken to a terminal strip.

When connecting the transducer to the input of the amplifier, very thin wires, previously coiled, should be used to avoid microphony. The soldering must be done very quickly to prevent damage to the crystal. A safer alternative would be to attach the leads to the metal shims already described, before assembling the transducer.

Crystals from TC8M cartridges should be connected between points X and Y2 in the circuit diagram, and TC8H types between X and Y1.

SETTING UP

Connection of the battery, speaker, and bell push completes the general construction. On turning up the volume and pressing the push, the relay should energise and release the movement. The amplified tune should issue from the speaker for about seven seconds and then cut off automatically.

If a loud howl is produced, reverse the connections to the primary of T1.

If the unit shows no signs of life, check first the battery polarity and then the relay connections. The amplifier can be tested by manually holding down the armature of the relay to apply power, and then feeding in a signal to the transducer terminals (X and Y1 or Y2 in Fig. 1) from a crystal set, a gramophone pickup, or a microphone. The speaker muting contact (RLA2) is a possible source of intermittent operation—it should be cleaned carefully with a proprietary fluid or with fine emery paper. Failure of the timing circuit to switch off after the appropriate period may be caused by a "leaky" C1.

FINAL INSTALLATION

The movement will need winding about once a week—dependent on how popular you are—so the unit should be accessible. It should also, if possible, be protected from dust and the products of cooking (if installed in the kitchen) since these could in time contaminate the relay contacts.

Connection to the speaker and bell push can be via ordinary twin bell wire, but if very long leads to the speaker are involved, 5 amp lighting flex is preferable to avoid loss of volume. It is possible to mount the speaker and "electronics" in one box, but microphony caused by mechanical feedback from speaker to transducer may limit the maximum useable output.

In conclusion the author finds that component values are not critical and can be varied somewhat to suit available parts, with the exception of the relay and timing components C1 and R1.

Current consumption averages 45mA and battery life should be about a year. ★

nucleonics for the EXPERIMENTER

By M.L. Michaelis M.A.

10—PROGRAMME CONTROL CIRCUIT; OPERATING STRACE

A WELL-DESIGNED programme control circuit should not lead to unnecessary increase of the number of manual controls. This rule is rigidly applied in the STRACE design.

Thus the reset contacts are combined with the chart recorder on/off switch, so that programme control is reset to the start of a sequence quite automatically when the chart recorder is first set running. Again, the e.h.t. supply for the G.M. counter detectors is not required when the scintillation detector and spectrometer is in operation, so extra contacts are used on the spectrometer mains switch on the front panel of the radiation meter, in order that G.M. counter e.h.t. is switched-on only when the scintillation detector is switched off, and vice versa. Furthermore, the programme logic circuit card is required only for spectroscopy with the scintillation detector; for work with the G.M. counter detectors, the 50 second master timebase is used alone (as explained below), and so both these switching functions are combined with the spectrometer on/off switch. In this manner, the programme control section as shown in Fig. 10.1 actually leads to no additional manual controls, apart from the mode switch, S4.

AUTOMATIC INTERLOCK

More complicated professional equipments often do have some additional manual controls solely for the programme functions, especially if mechanical devices for automatically changing samples at predetermined intervals, or according to measured activities, are to be included. Nevertheless, a good nucleonic equipment design is always characterised by maximum possible automatic interlock with the already existing controls for the basic functions.

We already met an example of this principle in the ratemeter sections of STRACE. Here we effected the range switching in such a manner as to preserve the design statistical accuracy for all ranges, instead of providing separate controls for range and statistical accuracy.

SPECTRUM COORDINATION

Nevertheless, some attention is required to the question of allowing sufficient time for the correct meter reading to be established. If the integration time (product of integrating capacitor and discharge resistor in the ratemeter) is t seconds, then at least $2t$ seconds of recording are needed before the reading has risen close enough to its final value for practical purposes.

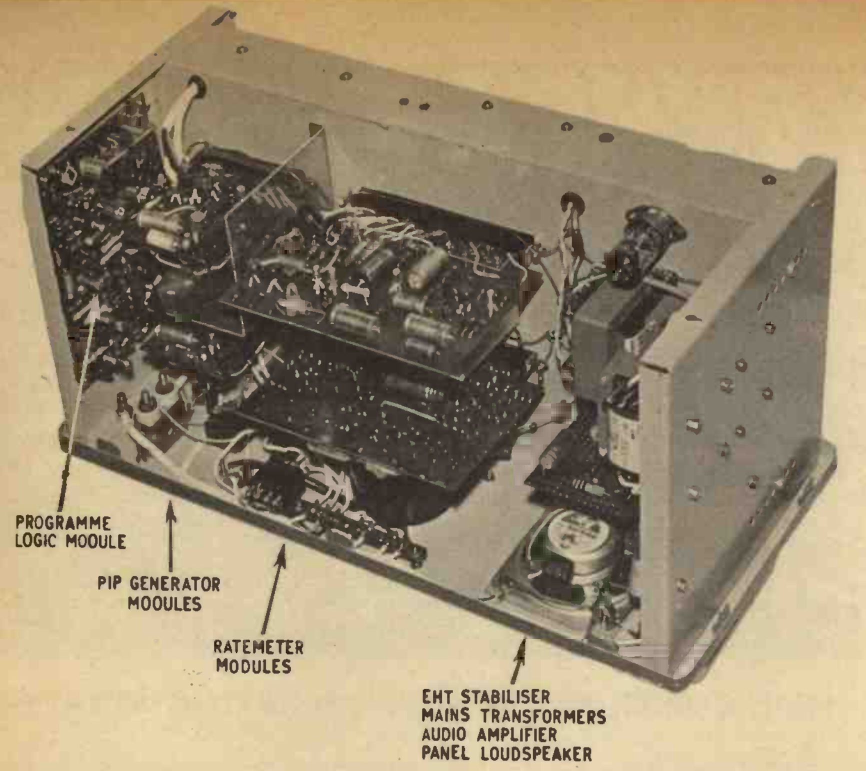
The scanner of the kick-sorter amplifier in the scintillation spectrometer must therefore be left operating for a sufficient time in each step. If we choose this "step time" to be of adequate length in relation to the lowest ratemeter range which possesses the longest integration time, then the same "step time" is more than ample for all other ranges.

In the STRACE equipment, the integration time for the 100 c.p.m. range is 160 seconds, so that the reading is sensibly established after 400 seconds, which period has thus been chosen as the spectrometer step time. We saw that the programme logic circuit derives the 400 second intervals by scaling-down the 50 second master timebase by a factor of eight, using three binary counter stages. The differential output of the kick-sorter amplifier is fed to channel 1 of the radiation meter, and the integral top output to channel 2. Each channel is recorded for 400 seconds before the scanner is moved to the next one of the 12 spectrum steps. The scanner is thus fed with a shift pulse only once every 800 seconds. We saw that this interval is derived in the programme logic circuit by counting-down from the 400-second intervals by a further factor of two, using a fourth binary counter stage.

Now the differential output of the spectrometer encompasses only a narrow range of detector pulse amplitudes, so that the counting rate may well be small on many occasions, requiring the 100 c.p.m. range. We saw that the reading here takes some 400 seconds to be established, so that a streak instead of a clean spot would be recorded on the chart, if the differential channel (channel 1) were to be recorded first of all in each 800 second scanner period. On the other hand, the integral top output of the spectrometer covers a larger pulse amplitude range and thus gives higher counting rates. The 100 c.p.m. range is here seldom if ever required, the 1,000 c.p.m. one normally being the lowest. This has an integration time of only 40 seconds, so that the reading is already established for most of a 400 second recording period.

Thus there is no objection to recording the integral top channel (channel 2) first of all in each 800 second scanner period. Consequently, the programme logic circuit ensures that the channel relay is set to channel 2 for the first 400 seconds, and to channel 1 for the last 400 seconds—not vice versa—of each 800 second period during which the scanner remains in the same spectrum step.

This type of spectrum coordination, at least as far as the principles are concerned, is quite typical of sequential analogue spectrometer systems in general.



STRACE Radiation Meter looking into the top of the chassis

Having understood the basic functions of the programme control section and why these are required, we may now consider the details of the actual circuit for STRACE, shown in Fig. 10.1.

WORKING WITH G.M. COUNTERS

The spectrometer switch S4 will be set to "OFF" for working with the G.M. counter detectors. Contact 1 of S4 then completes the a.c. input to the internal e.h.t. circuit for the G.M. counter tubes, whilst contact 2 switches the 50 second output from contact 1 of the master timebase relay RLC straight through to wafer S5A of the mode switch S5. Mains input for the scintillation detector spectrometer unit and for the programme logic subsidiary power pack is broken at contact 3 of S4. Provided the mode switch S5 is set to position 2 or 4, the pulse switch RLE receives a brief pulse of current from the timebase relay RLC once every 50 seconds.

The contact of the pulse switch RLE closes and opens on alternate current pulses, so that the channel relay RLD is alternatively energised and de-energised for 50 second periods. With the mode switch S5 in positions 2 or 4, the channel relay RLD thus connects channel 1 and channel 2 ratemeter outputs alternately through to the meter and chart recorder, for periods of 50 seconds. Channel 1 is always connected to the meter and recorder when the RLD is energised, and channel 2 when it is de-energised.

RECORDING MODES

In position 4 of the mode switch S5, no d.c. backing voltage is fed to the meter and recorder, so that the electrical zero points for both channels lie at scale zero. In position 2 of the mode switch S5, an adjustable (preset) stabilised backing voltage from VR1 is added in series with channel 2 only. The electrical zero for channel 1 is thus still at scale zero, but the electrical zero for channel 2 is then at 40 per cent or 50 per cent scale deflection, according to the setting of VR1. Forty per cent is convenient. The recordings for the two channels are then definitely separated on the chart paper, but a smaller width is available for each channel.

Whether the separated or the coincident mode is more convenient, will depend upon the ranges and relative counting rates involved in a given experiment. The aim is always to avoid confusion between the two simultaneous recordings which would result from unintelligible intersections in the wrong mode.

In position 3 of the mode switch S5, the channel switching pulses may be derived from any external timebase, instead of from the built-in master timebase. This is necessary when coordinating with other equipments.

The remaining two positions, 1 and 5, of the mode switch S5 respectively switch-through channel 1 or channel 2 *permanently* to the meter and chart recorder. This is useful for quick read-offs to select suitable ranges before starting a twin recording run, and for numerous other purposes. It satisfies the essential need to be able to read-off either channel at will without disturbing the two ratemeters and without having to wait for a corresponding timebase step.

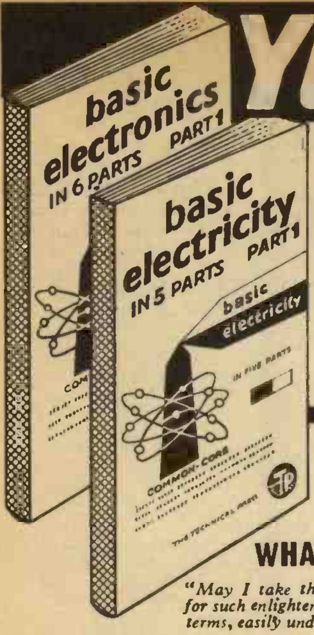
PAPER FEED SPEED

The paper feed speed found to be most suitable for the "Multiscript 3" chart recorder for all types of work is 20mm/hour. The paper movement during each 50 second timebase period is then barely visible, so that the two traces for the respective channels appear essentially continuous, with no visible breaks. Yet the area between the two traces remains clear, because the recording is made by jerking the knife-edge pointer against the pressure sensitive paper only once every 2 seconds, with the help of the synchronous cam-driven stirrup of the recorder unit. Even at the channel switch-over points, the pointer thus has ample time to move to the other trace without striking the paper on the way.

A conventional pen-recorder would black-out the entire paper area between the two traces on moving back and forth between the channels, unless pen-lifting complications synchronised to the master timebase were introduced. The dropping-stirrup type of recorder is thus much more suitable for twin-channel recording with a single-channel unit. The *Metrawatt "Multiscript 3"* recorder is obtainable from Messrs. Smiths Electric Clocks Ltd. It is also much cheaper than a conventional pen recorder, and quite free from ink dry-out and similar troubles.

WORKING WITH THE SCINTILLATION SPECTROMETER

When the spectrometer on/off switch S4 is switched on, contact 3 feeds the mains voltage to the scintillation spectrometer unit and to the mains transformer T1 of the programme logic subsidiary power supply, so that all these circuits can now operate. At the same time, contacts 1 and 2 of S4 are broken, so that the G.M. counter e.h.t. circuit is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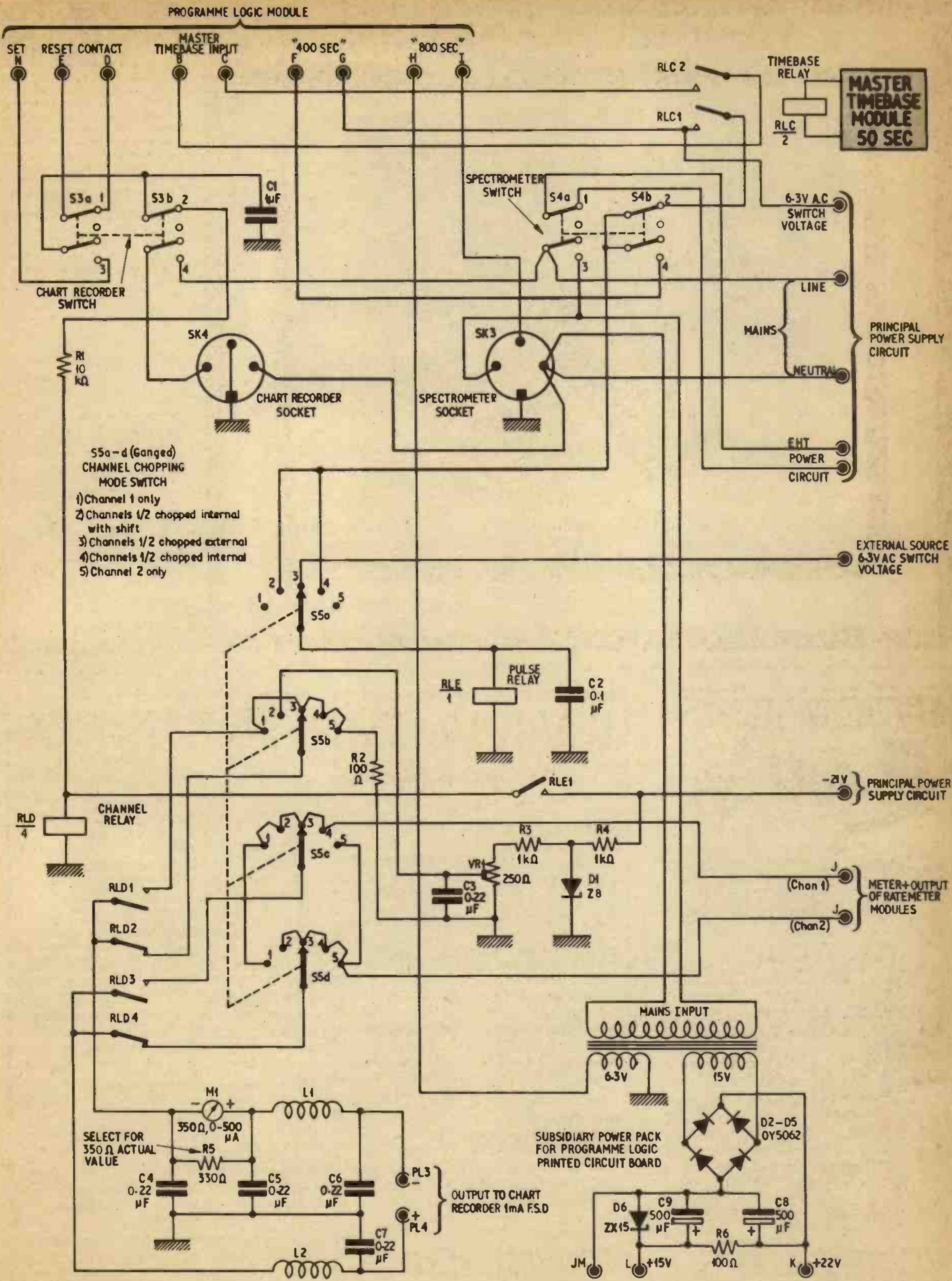
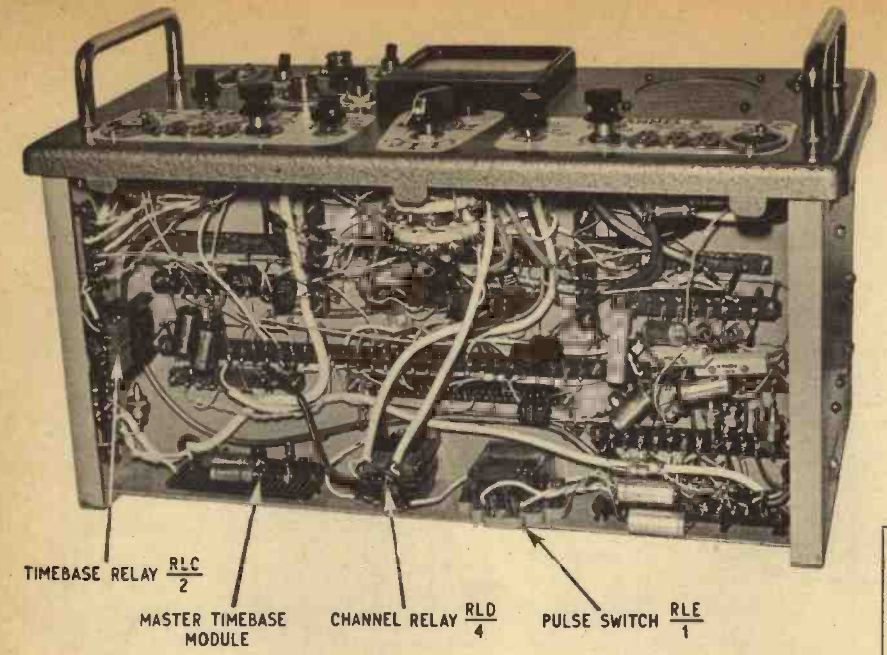


Fig. 10.1. **STRACE RADIATION METER:** *circuit diagram of the programme control*



STRACE Radiation Meter, under sideview

> *CORRECTION*
>
> **Fig. 9.2**
>
> C5, C9 should be 1nF (=1,000pF) each

switched off and the direct 50 second interval feed from the master timebase to the pulse switch is broken. Instead, contact 4 of the spectrometer switch S4 now feeds the 400 second output pulses from the programme logic to the pulse switch RLE, via the mode switch S5. The function of the mode switch has not been changed in any way.

The 50 second master timebase pulses are now fed from contact 2 of the timebase relay RLC, as input to the programme logic circuit for counting-down. But as long as the chart recorder switch S3 is still off, the programme logic can not respond to the master timebase, because contact 1 of S1 holds the binary stages fast in the zero state. At the same time, contact 2 of S3 holds C1 charged to −21V via R1, if the channel relay RLD is energised, i.e. if the meter and recorder are connected to channel 1.

Now comes the moment when all is ready, and the chart recorder motor switch S3 is switched on. Contact 1 opens, and the programme logic can then commence to count-down the master timebase pulses. If and only if C1 was charged, the set line N receives a negative pulse via contact 3 of S3 and causes a 400 second pulse to appear at once from the programme logic, throwing the meter and recorder onto channel 2, for the reasons already explained above. Contact 4 of S3 connects the mains voltage to the chart recorder motor.

At the recommended paper feed speed of 20mm/hour, each 400 second interval corresponds to about 2mm paper movement. The statistical fluctuations of the trace also amount to roughly 2mm trace width. Thus each spectrum point appears as a black blob about 2mm in diameter on the chart. The centre-point can easily be assessed by the eye, as the true mean reading. The sequence of successive blobs for each spectrum trace is spaced with 2mm gaps, corresponding to the blobs of the other trace. The 12 points of each spectrum run are thus clearly resolved, and the integral top for each spectrum step falls against the gap *preceding* the differential blob, since we have already explained that the integral top must be recorded for the first, and the differential for the second 400 seconds of each 800 second step.

CONTINUOUS RECORDINGS

If it is desired to make continuous recordings for particular energy levels, instead of scanning complete spectra, then the scintillation spectrometer mode switch must be set to the "SIM" mode, the limit potentiometers set to the energy limits of interest, and the mode switch S5 on the radiation meter unit set to position 1 "channel 1 continuous". A single continuous recording is then traced for the differential channel, e.g. to study the rate of increase or decay of the sample activity in the tuned-in energy range. The programme logic is running, but without effect, in this setting.

INTERFERENCE SUPPRESSION

The chokes L1, L2 and capacitors C6, C7 in Fig. 10.1 prevent the entry of r.f. interference picked-up by the chart recorder cable. Strong shortwave broadcast transmitters could cause trouble without the suppressor components, so that they should always be included.

The chokes and capacitors behind the principal mains input socket (see Fig. 8.3) serve the same purpose for the mains cable. A fully enclosed metal cabinet is essential for all units. All pulse cables must be coaxial, but mains and recorder current cables may be ordinary unscreened types. The r.f. chokes each consist of a single layer of about 100 turns of 30 s.w.g. enamelled copper wire wound onto a long 2·2 megohm 2W carbon resistor, with the wire ends soldered tightly to the resistor leads.

The correlation between the channels and the 400 second pulses is thrown into the correct phase only at the moment when the chart recorder motor switch S3 (Fig. 10.1) is switched-on. If the logic were to get out of step at some later time, self-correction is impossible. High counting stability is thus demanded for the count-down system in the programme logic circuit. This is achieved by ample threshold margins in the binary stages used, driver stages between successive binary stages and the Schmitt trigger at the input to the programme logic, which prevents multiple responses to contact rebounds of the timebase relay.

The circuit has in practice never got out of step during many weeks of continuous running, except just once when somebody accidentally turned off a mains master switch, and on again at once upon seeing all pilot lamps extinguish!

Such disturbances of course make any computer forget what it has calculated so far, so it is no reproach when the programme thereby gets out of step.

This concludes the present series in which we have surveyed nucleonic equipment in general, and have described in some detail a comprehensive equipment suitable for amateur construction. Schools and colleges will find this equipment valuable for teaching purposes as well as for pure research.

In order that the possibilities of STRACE may be fully exploited, it is proposed to commence in a few months time a short series of articles describing practical experiments using this equipment. In the meanwhile comments are invited from those who have been following the present series of articles. ★

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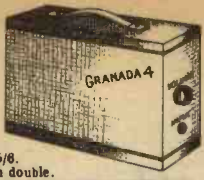

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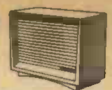

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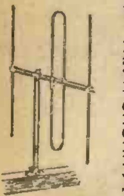

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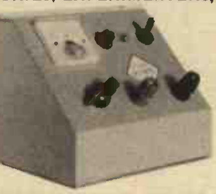

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LOW CURRENT STANDBY SWITCH...

By A. THOMAS

OFTEN a situation arises where an amplifier or other electronic device can be switched on fully at the instant an input signal appears, but in the absence of such a signal, it is on "standby" and consumes very little current.

This is a factor of considerable importance in battery powered equipment; not only is the battery power important, but the amount of power that may be taken for a relatively short time. An instance where this may occur is an amplifier that has a standby current of, say, 20mA and a current of 100mA when delivering an output. In this case the battery has to stand the long term current of 20mA as well as the short term current of 100mA, and consequently has to be quite large physically in order to get a reasonable life out of it. If the standby current is very low then the peak current may be obtained when required from a much smaller battery.

Typical instances where this idea can be applied are a baby alarm amplifier or a loud speaking telephone; such devices need not be switched on manually when required, since the incoming signal can be made to perform this operation. Another possibility is radio control of models, where the battery life is very important indeed. Radio control is beyond the scope of this article, but the idea may be seeded in the minds of the enthusiast.

BASIS OF THE SWITCH

The basis of the low current standby switch is a high gain low current amplifier which feeds an electronic switch. The switch then turns on the power to the main circuit, which carries out whatever function that is required in the normal manner.

To enable the required low leakage current to be obtained, silicon transistors are essential in a design of this type. The low cost epoxy transistor type 2N2926 has been used in this instance.

The signal input to the switch is fed in parallel with the signal input to the amplifier or other apparatus it is intended to control.

PERFORMANCE SPECIFICATION

The minimum signal which may be fed into the unit to ensure reliable switching is 1mV. If a higher level of voltage input is required at a higher input impedance, then a series resistor may be put at the input, the value being calculated to provide an input current of 10μA.

The frequency range over which the unit will switch reliably is 100Hz to 100kHz. Tests have not been carried out at a higher frequency than 100kHz, but there is no reason why the unit should not handle frequencies up to about 30MHz. Modification will be suggested later for high frequency use. If a higher input level is available, then the lower frequency limit may be reduced to 10Hz. The wave form is not critical as long as the duty ratio is less than 10 to 1; that is, if impulses are applied at the input at 1kHz then the pulse width must be greater than 100μs.

The drain from the power supply is in the order of 100μA in the no-signal condition; when a signal is received, the current taken by the amplifier part of the switch is in the order of 5mA. The total current taken by the switch depends on the load applied to it.

The output current from the switch depends on the output transistors used and can be up to 10A. Table 1 gives a list of output currents and suitable transistors. (The model illustrated in this article has an output rating of 50mA or 500mA, depending upon which type of transistor is used in TR5 stage.) The output voltage will be the full battery voltage less the V_{ce} saturation of the output transistor, and this can range between 300 and 700mV.

The signal modulation of the switched battery voltage is approximately 1mV at 100Hz, and this decreases as the input frequency increases and may be attenuated by the addition of a suitable capacitor at the output.

The leakage current into the load with no signal input will be very low, the measured current for a BFY50 transistor was 75nA.

Table 1

Output current	TR4	TR5	TR6
20mA	2N2926	—	—
50mA	2N2926	2N2926	—
500mA	2N2926	BFY40	—
5A	2N2926	2N2926	2N2697, 2N2811, or 2N2877
7A	2N2926	BFY50	2N3230 or 2N3231

General view of the complete signal operated switch

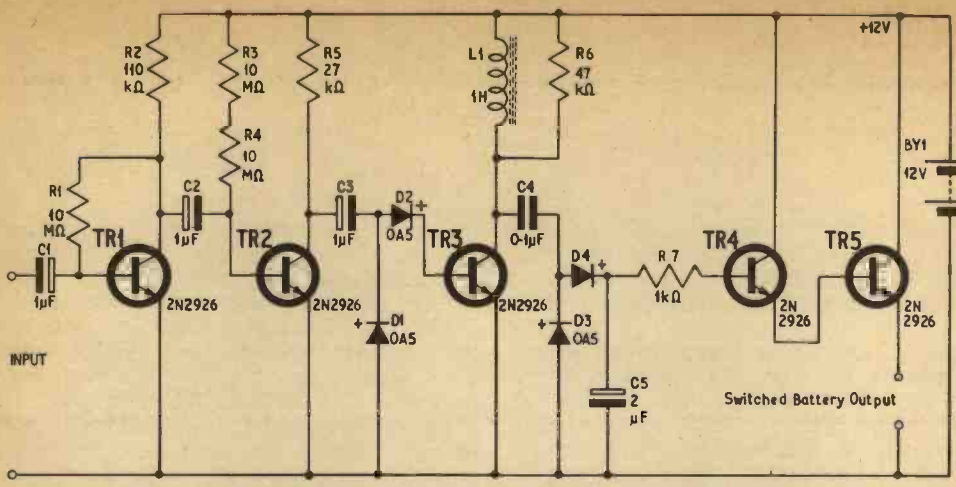


Fig. 1. Circuit diagram of signal operated switch. This arrangement is suitable for switching currents of up to 50mA. With different output transistors and an additional stage, currents of up to 7A can be switched—see Table 1 and Fig. 4

The threshold time of the switch is 75ms and the hold time, after the cessation of the signal, is 1·5 seconds.

CIRCUIT DESCRIPTION

Fig. 1 shows the complete circuit of the switch. The input signal is applied to C1 via a resistor if required as discussed earlier. TR1 is a common emitter low current high gain amplifier, the output of which is fed via C2 to TR2. The resistors R3 and R4 make-up a 20 megohm resistance feeding 500nA of base current to TR2. This small current helps overcome the V_{BE} of TR2 and puts TR2 into a partially conducting state. The signal from C2 turns the stage on with the positive half cycle, and hard off with a portion of the negative half cycle.

The output from TR2 collector is fed via C3 to a pair of diodes D1 and D2. These diodes form a voltage doubler rectifier and feed the full voltage swing from TR2 collector as a positive going signal at TR3 base.

The collector circuit of TR3 consists of an inductor of 1H with a parallel damping resistor of 47 kilohm. The input to TR3 base causes the collector to swing the full battery voltage, then, due to the inductance in the collector, to overswing the same amount, so producing a 24V peak to peak signal at C4. The damping resistor value has been chosen to suit the inductance at 100Hz to prevent ringing.

The output from TR3 collector is fed via C4 to a voltage doubler rectifier, D3, D4, and thence to a reservoir capacitor C5, which tends to charge to the peak value of the signal, 24V. This level is clamped by the base collector junction of TR4 to the battery voltage. Thus, maximum driving voltage is applied to the Darlington emitter follower TR4 and TR5. The voltage on C5 is fed via R7 current limiting resistor. The collector breakdown voltage BV_{CEO} of the 2N2926 is 18V, but in the position of TR3 the collector swings 24 volts. Six transistors have been tried in this position with no ill effects.

CONSTRUCTION

L1, the inductor in TR3 collector circuit, has an inductance of 1H. In the prototype a Mullard Vinkor core type LA2416 has been employed. This coil former is wound with 1,180 turns of 42 s.w.g. enamelled copper wire. The d.c. resistance of this winding is 110 ohms. Other forms of inductors may be used as long as they have a high Q.

The unit is built up on a piece of Veroboard as shown in Fig. 2 and Fig. 3.

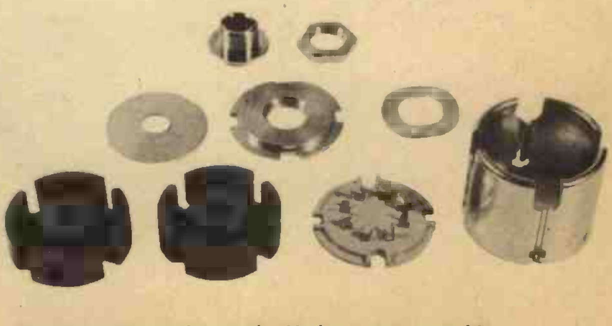
Any power transistors that are used must be mounted on a heat sink of minimum dimensions 3in × 2in made from aluminium. The heat sink may be mounted by means of spacers to the Veroboard. Fig. 4 gives the additional circuit for the power transistors referred to in Table 1.

TESTING THE UNIT

With no load on the output of the unit, and no signal input, connect the battery via an ammeter. The meter should read something in the order of 100μA.

Disconnect the ammeter and connect a voltmeter across C5. Apply a signal in the order of 1mV at a frequency greater than 100Hz. The output from a radio receiver speaker would be ideal, and should be connected via a potential divider consisting of a 120 kilohm resistor in series with a 100 ohm resistor. The 100 ohm resistor goes down to the negative battery, the 120 kilohm resistor to the speaker, and the junction to the amplifier input. The other side of the speaker also goes to the negative side of the battery.

With the radio tuned into any station with a continuous output, and the volume control set for a moderate level, approximately 1mV of suitable signal will be fed to the switch.



The items that make up the Vinkor core assembly

COMPONENTS . . .

Resistors
R1 10MΩ
R2 110kΩ
R3 10MΩ
R4 10MΩ
R5 27kΩ
R6 47kΩ
R7 1kΩ
All ½W, "Hystab" (Radiospares)

Capacitors
C1 1μF, C2 1μF, C3 1μF elect. 15V sub. min.
C4 0·1μF polyester
C5 2μF polyester

Diodes
D1–4 OA5 germanium diode (4 off)

Transistors
TR1–4 2N2926 (4 off)
TR5, TR6 see Table 1 and text

Miscellaneous
L1 1H inductor, high Q (see text)
BY1 12V layer type battery
Vinkor core LA2416, housing DT2418, and former DT2074 (Mullard); 42 s.w.g. enamelled wire for L1. Veroboard. Terminal pins.

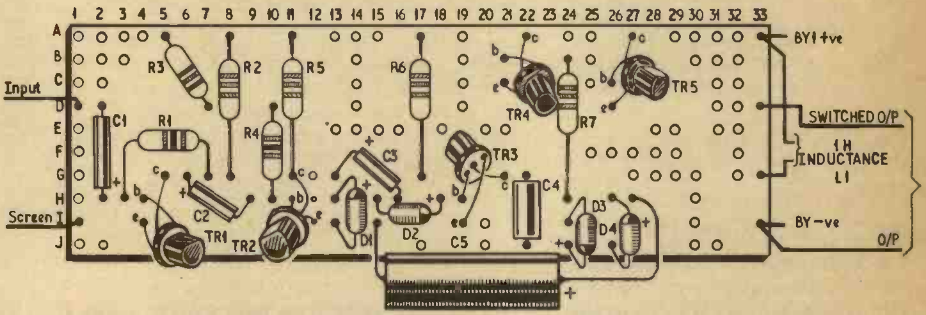


Fig. 2. Component arrangement on the Veroboard

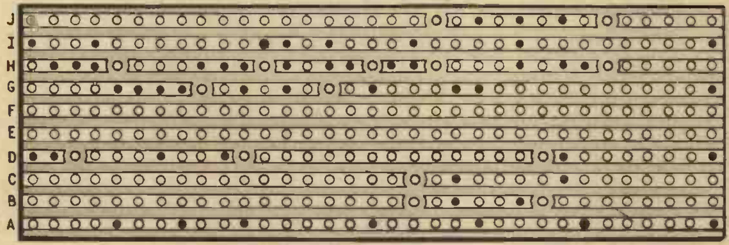


Fig. 3. Underside of the Veroboard showing breaks in the copper strips and connection points

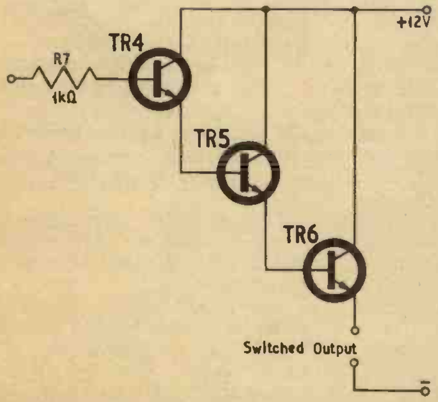


Fig. 4. Additional stage for high current operation. Transistor types are given in Table 1

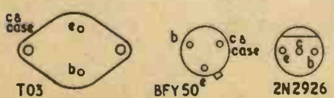


Fig. 5. Transistor base details

The voltage across C5 should be 12V when the signal is present and virtually zero two seconds after the signal has been removed. Connect the necessary load, depending on the output transistor used, and move the voltmeter connection from the top end of C5 across to the switch output. Approximately 11·5V should be present when a signal appears and zero volts when it is removed. If the unit works as above, it is now ready for use.

If a switch-on pulse is apparent in the apparatus, then the threshold time may be increased by inserting a resistor experimentally in between D4 and C5. Any instability may be removed by connecting a suitable capacitor across the output from the switch. *Warning: the output impedance of the last stage is very small, therefore the output transistor may be destroyed if a short circuit is placed across the output terminals.*

MODIFICATIONS FOR H.F. USE

For use as a high frequency switch, the bandwidth will be from 100kHz to 30MHz. The capacitor and inductor values may be reduced by a factor of 100. The germanium diodes should be of a type designed for h.f. use. The input sensitivity level may be required to be increased from 1mV to 10mV. ★

Readout—

A SELECTION FROM OUR POSTBAG

United effort

Sir—In reply to Mr R. F. Marchant's letter, published in the June 1968 issue of P.E., I should like to point out that instead of complaining, a group of enterprising electronics amateurs in South Wales have formed the British Amateur Electronics Club. This is a rapidly growing club and with even more support from the electronics amateurs of this country it will undoubtedly become a very successful national club.

The B.A.E.C., although only 18 months old, has united many amateurs who now work on a single project of considerable size together—rather than each on his own personal small project. Through the B.A.E.C. it is also possible to solve any problem in the field of electronics with the help of the committee and of the many professional members who are invariably willing to give advice.

I will admit that electronics is the handmaiden to many other activities, but it is now about time that we amateurs united to help other individual societies instead of being "loners". This will not only be an advantage to the individual members but also to other societies who utilise electronics in their activities.

I am certain that the present members of B.A.E.C. would like to see Mr Marchant's name along with those of many other electronics amateurs among the ever increasing membership of the B.A.E.C.

John G. Owen, GW8BFT,
Llangefni, Anglesey.

NATIONAL GRID LEEK

"Jones the Fuze will now demonstrate the instability of certain power supplies"

"Frilly" sophistication?

Sir—The remarks made by D. H. Heppell in Readout (June issue) were indeed interesting, but are they valid? Comparison between honest-to-goodness simplicity, and "frilly" sophistication in electronic circuits tends to reveal a double standard of thinking, with a marked disparity between the circuit most people prefer to build and the equipment they would most like to own.

If Mr Heppell—as an instrument design engineer—was offered a choice between a free gift of a £500 oscilloscope and a £30 oscilloscope, there can be little doubt which he would choose despite considerations of reliability and maintenance.

It seems to me that the whole argument in favour of simplicity boils down to wanting something for nothing, the ultimate in performance for a minimum time and effort. Is the hobby of electronics a utilitarian means to an end, a short cut to some higher purpose, or is it a source of self-education and pleasure?

D. Bollen,
Devon.

Guarding the home

Sir—Of far more importance than car-theft preventers are house-theft foilers. Anything from half an hour to a fortnight's absence leaves one's home open to quick looting by yobboes. Surely alarms set off by mere approach of a human body, concealed in rooms, set and de-set by coded transmission, could be devised by ingenious readers, which would save many homes this summer from raiding during holidays by these idle, vicious pests. I have certainly fitted my own maisonette with an unstoppable alarm—and booby-traps which would give an unpleasant reception to any unauthorised entrant!

P. Benn,
Somewhere in England.

Transistor curve tracer

Sir—The uniselector for the *Transistor Curve Tracer* in the May 1968 issue will not step round automatically if its coil is connected as shown in the circuit diagram, Fig. 3, page 337. To achieve self-drive the coil should be connected in series with the interrupter contacts located alongside the coil.

It is also necessary to connect a spark-quench across the interrupter contacts as I have shown in Fig. 1, otherwise there will be heavy sparking at the contacts and they will quickly burn out. This also prevents diode D4 having high back e.m.f. pulses applied to it, and the quench circuit also reduces radio interference. Suitable values are shown in the diagram. The resistor should be a 1W carbon, and the capacitor a 250V working paper type.

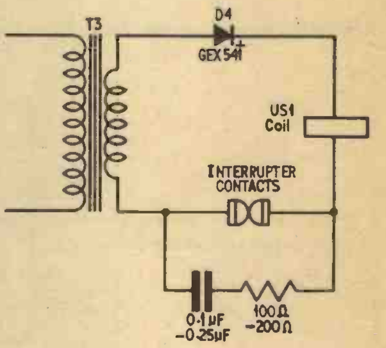


Fig. 1

The speed at which the uniselector rotates can be adjusted by turning the two screws each side of the coil, to alter the tension of the armature-return coil springs. It may also be necessary to alter, by careful bending, the setting of the interrupter operating lever (the extension arm on the armature) and the tension of the long interrupter contact spring. These adjustments are likely to be interdependent, and the settings should be such that there is smooth and regular stepping at the desired speed of rotation. Too much bending of the interrupter operating lever could break or crack it.

W. E. Thompson, G3MQT,
St. Leonards-on-Sea, Sussex.

The uniselector used was already partially wired to include the interrupter contacts and I should have shown these in my circuit diagram.

I did not find the spark quench circuit necessary but it is a wise precaution to include this across the contacts as suggested.

With regard to uniselector adjustment I would hesitate to suggest that the constructor should adjust the interrupter arm by bending it. The manufacturer has generally adjusted this before leaving the factory and the tension screws are sufficient to vary the stepping period.

If bending is attempted then the use of a standard GPO relay adjustment tool is preferable to a pair of long-nosed pliers that the constructor would normally use. This is because a movement at right-angles to the lever is required which is difficult to achieve without damage when using pliers.—GKF

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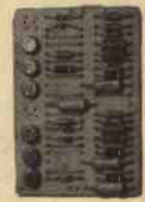

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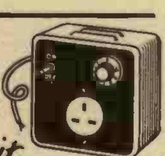
HEAT LIGHT SPEED CONTROL Unit



Mk. V 3000 watt Model. Fingertip control of all a.c./d.c. electrical equipment. Suitable for all types of lighting arrangements. Incandescent lamps. Spot lamps. Arc lamps. Floodlights. Makes an ideal dimming unit. Ideal for controlling all types of electric drills and all a.c./d.c. electric motors for all applications. Ideal for all types of electric heaters. Suitable for lathes and power tools. Contains the latest electronic switching devices and associated thyristor circuitry. Size 6 × 5 × 2in. Louvred metal case in pleasing hammer finish. Attractive front panel with matching socket and controls. Recommended price 25 gns. Huge purchase enables us to offer them at £8.19.6, carriage and insurance 10/-. C.O.D. if required.

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