PRACTICAL

ELECTRONICS

JUNE 1968

PRICE 2/6

MULTI CHANNEL RADIO CONTROL SYSTEM FOR Model Boat

Also in this issue

DRUMMER'S WHOOSH UNIT * CAMERA TRIGGER

Lasky's Radio

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HAVE YOU GOT YOUR LASKY'S CATALOGUE FREE
Second Great Reprint Issue Now Ready.
Just send your name, address and 1/- for post only.

SPECIAL INTEREST ITEMS!

DESIGNED ESPECIALLY TO REPLAY PHILIPS CASSETTE SYSTEM

THE FANTAVOX TAPE CASSETTE PLAYER

This machine is the first of its type and is designed specifically to replay pre-recorded tape cassettes made for the PHILIPS and other cassette systems. The cassette is simply slipped into the machine and is immediately ready to play. Each cassette gives over 40 minutes play (twin track), no loss of time in rewinding—simply turn cassette over. Constant tape speed 1⅞ i.p.s. Only two controls off/play and vol. Fully transistorised, powerful vol., built in speaker, socket for personal earpiece. Operates on 6 pen-light batteries. Very attractively styled shockproof plastic cabinet size 6½ × 4½ × 2in with wrist strap. Complete with earpiece and batteries. There are now over 200 musi-cassette titles available: jazz, pop, shows and classics. This machine allows you to play the music of your choice anywhere—anytime.

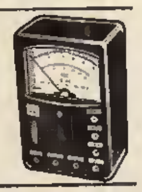
LASKY'S PRICE £7.9.6 Post 5/-

CROWN MODEL TRF-6 AM/FM 9 TRANSISTOR RADIO

Unbelievably small for an AM/FM receiver—the Crown is only 4¼in × 2¾in × 1⅛in. Super sensitive 9 transistor superhet circuit with directionless stabilised reception. AM cover: MW 335–1,605kc/s. FM cover; 88–108Mc/s. Superb tone reproduction. 2¼in PM speaker. Precision tuning. 6 section (14¾in) telescopic aerial—clips into side when not in use. Output 280mW max. Beautifully styled and finished cabinet in black plastic with silver metal trim. Operates on one 9V battery. Complete with leather purse, ear-piece and battery. **List Price 13½ Gns.**

SCOOP Price £7.19.6 Post 2/6

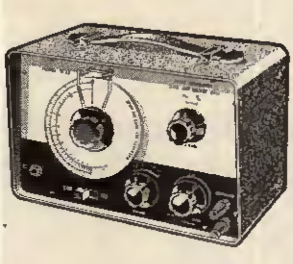
MODEL C-1000 MILI TESTER



A really tiny meter with "big" meter performance. Brief Specification: Movement sensitivity 400µA. D.C. volts ranges: 0–10, 50, 250, 1,000 volts, + 3% fsd at 1K OPV. A.C. volts ranges: 0–10, 50, 250, 1,000 volts + 4% fsd at 1K OPV. D.C current: 0–1,100mA. Resistance range: 0–150kΩ. Size 2¼in × 3⅜in × 1in.

Lasky's Price 39/6 Post 2/6

AUDIO GENERATOR Model TE-22

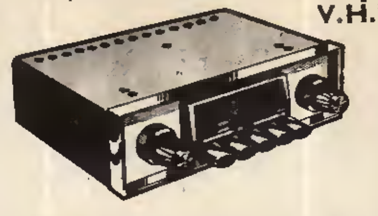


A new factory tested and calibrated low distortion Sine wave and Square wave Audio Generator suitable for use with most oscilloscopes. Brief Specification: frequency range-Sine wave 20c/s to 200kc/s in four switched ranges 20–200c/s, 200c/s to 2kc/s, 2–20kc/s, 20–200kc/s. (Two scales 10–90 and 20–200 on etched circular dial with hair-line cursor.) Square wave range 60c/s to 30kc/s (read on same scales as Sine waves). Frequency response 60c/s to 150kc/s ± 1·5dB. Distortion less than 2%. Output voltage: load impedance 1MΩ, 7V (max.), load impedance 10kΩ, 5V (max.). Variable output amplitude control. Valve line-up: 6BM8, 12AT7, 6X4. Power requirements 105/125V or 220/240V, 50/60c/s a.c. Strong metal cabinet size 7 × 10½ × 5¾in, finished in grey crackle with leather carrying handle. Power "on" pilot light fitted. Complete with test leads and instruction book.

Lasky's Price £15.0.0 Post 5/-

MOTORING PLEASURE

"EASI-TUNE" AM/FM MAJOR V.H.F. CAR RADIO

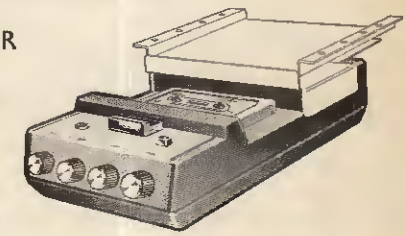


A completely new British made AM/FM car radio that brings the Hi-Fi quality of FM transmissions to your car (ALL the new local stations) PLUS medium waveband cover 185–570m and long waveband cover 1,150–2,000m (FM cover: 8–108Mc/s with automatic. A.F.C.). Features five EASITUNE push buttons for wave change and instant selection of three of your favourite medium wave stations, plus full manual tuning. Nine transistor and four diode circuit gives immediate reception, powerful 3½W output and superior performance at high speed. Other features include illuminated dial, red "on" indicator, tone control. Strong metal case size 7 × 2 × 5½in (fits all standard cut-outs). Very handsome appearance, silver/black/chrome finish. For 12V positive or negative earth operation. Complete with 7 × 4in. speaker, baffle board, universal mounting kit and instruction manual.

LASKY'S PRICE 23 Gns. Post FREE

NEW ANOTHER "EASI-TUNE" CAR ENTERTAINER

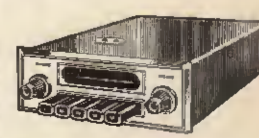
THE STEREO-TONE STEREO TAPE CASSETTE CAR PLAYER



Another British first—right on time, right up-to-date the latest in travelling pleasure. Plays ALL the new great range of PHILIPS Musicassettes with over 250 titles now available—giving YOU the choice of music for your journey (each cassette gives up to 48min continuous play). The Stereo-Tone is compact, easy to fit and styled to enhance any car. Incorporates the well proven Philips tape play mechanism and a specially developed 12 transistor amplifier giving 2½W output per channel with sharp stereo separation. Controls include on/off with indicator, single control for start/stop, fast forward and rewind, sep. volume, bass, treble and stereo balance controls. Tape loading and change are super easy—the Stereo-Tone slides out from its vibration free mounting for inserting or turning cassette over then pushes back for obstruction free operation. The Stereo-Tone cabinet is made from high quality scratch proof CYCOLAC plastic in dark grey with satin silver control panel with black knobs. Size only 9½ × 5½ × 3¼in. Tape speed 1⅞ i.p.s. with transistor motor regulator. Operates on all 12V positive or negative earth systems. Complete with two loudspeakers, baffle boards, leads, etc., simple (four screw fixing) mounting assembly AND one Free Musicassette of your choice.

LASKY'S PRICE £29.0.0 Post FREE

TWO BAND TRANSISTOR CAR RADIO BARGAIN! MODEL CR-62



A new high quality imported all transistor superhet car radio that really breaks the quality/price barrier. A unique feature of this set are the four M/W band station pre-selection buttons which you yourself set to your own four favourite stations—this is in addition to full M/W band cover over 535–1,605kc/s and full L/W band cover over 150–300kc/s (IF frequency 455kc/s). Externally adjustable aerial trimmers ensure maximum output. Six transistor (including one drift type) and one diode circuit provides powerful 2W output. The set is adjustable for use on either positive or negative ground 12V systems (external line fuse fitted). Standard mounting size 6¾ × 5¾ × 2in—front panel ⅜in larger all round—finished in anodised aluminium with black push buttons. Complete with mounting brackets, full installation instructions and two baffle boards (for round or elliptical speaker). Fully guaranteed.

LASKY'S PRICE £9.19.6 Post 5/-

6 × 4in elliptical 8Ω dynamic speaker 17/6 extra—Post FREE.

SPECIAL OFFER—LOCKING CAR AERIAL Model S3003 five section 402 extension heavy chrome telescopic wing mounting type with unique locking device to protect the antenna when closed. Complete with mounting bracket, lead and plug and two "keys". **LASKY'S SPECIAL PRICE 39/6** Post Free with the Royal CR-62. Post Sep. 2/6.

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High Fidelity Audio Centres

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Open all day Thursday, early closing 1 p.m. Saturday

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ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL ST., TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821

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.

MINIATURE WAFER SWITCHES

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

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. **10/-** post free.

A.E.I. FRACTIONAL H.P. MOTOR. 200/250V 50/60 c/s enclosed continuous rating 1/40 h.p. Ex. equip., perfect order. **19/6 plus 4/6.**

A.C. FAN. Powerful mains motor with 6¼in. blade. Ideal blow or extract. **17/6 plus 3/6.**

1·2V NICKEL CADMIUM CELLS. Dia. ¾in. by ¼in. thick (approx.). **3/6** each. Charger for two cells **12/6.**

OIL THERMOSTAT. Teddington type T.B.B. with capillary tube and sensor adjustable by knob (not supplied) controls ¼ h.p. motor or up to 15 amp. resistive load. **9/6.**

5 PUSH SWITCH. One push operates mains on/off switch the other four operate various on/off and change/over switches. **2/6.**

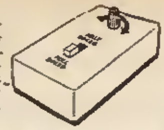
QUICK CUPPA

Mini Immersion Heater, 350W, 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **19/6**, post and insurance 1/6.

NO SOLDERING POCKET 3

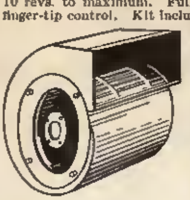
Lots of fun to build and good results when finished. Complete kit with detailed instructions and crystal earpiece. Batteries 1/2 extra—**£5** value only **19/6**, plus 3/- post and ins.

DRILL CONTROLLER



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

CENTRIFUGAL FAN



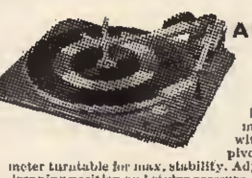
Centrifugal blower or extractor by Torrington, very low noise but large capacity air flow, designed for central heating and air conditioning, ideal also for fume extraction over cooker, duct type outlet. 200/500V 50 c/s motor. **£3.19.6.** Post and insurance 7/6.

THIS MONTH'S SNIP

Full-Fi 12in. 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 30–10,000 c/s; Input Impedance 15 ohms; Main resonance 60 c/s; Chassis Diam. 12in.—12⅜in. over mounting lugs; Baffle hole 11in. diam.; Mounting holes 4—Holes ¼in. diam. on pitch circle 11¾in. diam.; Overall height 5¼in.

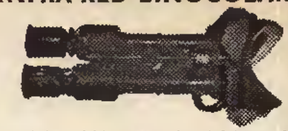
A £6 speaker offered for only **£3.9.6** plus 7/6 post and insurance.

GARRARD AUTO RECORD PLAYER Model 3000



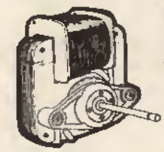
This is one of the latest products of the World's most experienced maker of fine record reproducers. Its superior features include—automatic playing of up to 8 mixed size records—stopping and starting without rejecting—manual playing—pick-up pivots to give low stylus pressure—large diameter turntable for max. stability. Adjustments include pick-up height—pick-up dropping position and stylus pressure. Size is 13¼ × 11¼in. clearance 4¾in. above, 2¼in. below. Fitted with the very superior ceramic stereo cartridge type 9TAHC with diamond stylii which is listed at over £4. Price complete **£10.9.6**, carr. and insurance 7/6.

INFRA-RED BINOCULARS



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

MAINS MOTOR



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

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.

Where postage is not definitely stated as an extra then orders over **£3** are post free. Below **£3** add 2/9. Semiconductors add 1/- post. Over **£1** post free. S.A.E. with enquiries please.

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ADD-ON-ABILITY
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DEPENDABILITY
GENUINE ECONOMY

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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With Bevelled Former Bars

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No. 1.	Capacity 18 gauge mild steel x 36in. wide	£12.10.0
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Also new bench models. Capacities 48in. x 18 gauge £40. 36in. x 18 gauge £25. 24in. x 16 gauge £24. Carriage free.
End folding attachments for radio chassis. Tray and Box making for 36in. model, 5/6 per ft. Other models 3/6. The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals.
One year's guarantee. Money refunded if not satisfied. Send for details.

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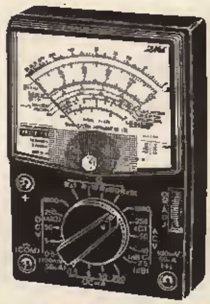

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USED THROUGHOUT THE WORLD, SANWA'S EXPERIENCE OF 30 YEARS ENSURES ACCURACY, RELIABILITY, VERSATILITY. UNSURPASSED TESTER PERFORMANCE COMES WITH EVERY SANWA

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Keenest prices in the country. All Types (and Spares) from ½ to 50 amp. from stock.

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PORTABLE TYPE
1.5 amp. portable fitted metal case, voltmeter, lamp, switch, etc. £9.5.0. Similar to above 2.5 amp. £11.7.6.

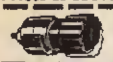
100 WATT POWER RHEOSTATS (NEW)

AVAILABLE IN THE FOLLOWING VALUES
1 ohm, 10 a.; 5 ohm, 4.7 a.; 10 ohm, 3 a.; 25 ohm, 2 a.; 50 ohm, 1.4 a.; 100 ohm, 1 a.; 250 ohm, .7 a.; 500 ohm, .45 a.; 1,000 ohm, 280 mA; **1,500 ohm,** 230 mA; **2,500 ohm,** .2 a. Diameter 3¼in. Shaft length ⅝in., dia. 5/16in. All at 27/6 each. P. & P. 1/6.
50 WATT. 1/5/10/25/50/100/250/500/1,000/1,500/2,500 ohm, 21/-. P. & P. 1/6.
25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 ohm, 14/6. P. & P. 1/6.

VENNER ELECTRIC TIME SWITCH

200-250 v. A.C. 20 amp. contacts twice on, twice off, at any manually pre-set time. Spring reserve (in case of power cut) fully tested £3/9/6. P. & P. 4/6. Or complete in weatherproof metal case (illustrated) £3/19/6, plus 4/6 P. & P. Can be supplied with solar dial, on at dusk—off at dawn. Prices as above.

INSULATED TERMINALS



Available in red, white, yellow, black, blue and green. New 17/- per doz. 2/-. P. & P.

230/250V. A.C. SOLENOID

Heavy duty type, approx. 3 lbs. pull. Price: 17/6 plus 2/6 P. & P.

12/24V. D.C. SOLENOID

Approx. 8 oz. push. Price 8/6 plus 1/6 P. & P.

PRECISION INTERVAL TIMER

From 0-30 seconds (repetitive). Jewelled balanced movement. Lever re-set. Operates 230V. A.C. 5 amp. c/o Micro-switch. New. Price 17/6 plus 2/6 P. & P.

CONDENSERS

2,500 mfd 100v. 12/6 1/6 P. & P. 4,000 mfd 25v. 10/- 1/6 P. & P. 4,000 mfd 50v. 15/- 1/6 P. & P. 10,000 mfd 35v. 15/- 1/6 P. & P.

CONSTANT VOLTAGE TRANSFORMER

Input 185-250 v. A.C. Output 230 v A.C. Capacity 250 watt. Attractive metal case. Fitted red signal lamp. Rubber feet. Weight 17 lb. Price £11/10/0. P. & P. 15/-.

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30 volt 3 amp., 11/-, plus 2/6 P. & P.
30 volt 5 amp., 16/-, plus 2/6 P. & P.

RADIO ALTIMETER

This precision instrument, built to highest Ministry specification, is based on a 24 v. D.C. LOW INERTIA Integrating Motor. The Motor, fitted with gold brushes and drawing only 800 microamp at 24 v. D.C., drives two precision pots with platinum wipers through close tolerance gear-trains, including miniature slipping clutch, combined with two sub-miniature pots for calibrating the electrical bridge circuit. The 3 in. calibrated dial, with a number aperture indicating one rev. per revolution of pointer with maximum of 5 revs. gives an effective scale length of approx. 30 in. Offered at fraction of Manufacturer's price, 32/6. P. & P. 6/-.

LIGHT SENSITIVE SWITCH

Kit of parts, including ORP12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price 25/- plus 2/6 P. & P. ORP 12 including circuit. 10/6 each, plus 1/- P. & P.
A.C. MAINS MODEL Incorporates Mains Transformer, Rectifier and special relay with 3, 5 amp mains c/o contacts. Price inc. circuit 47/6 plus 2/6 P. & P.

LIGHT SOURCE AND PHOTO CELL MOUNTING

Precision engineered light source with focusible-lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair £2.15.0. P. & P. 3/6.

RESETTABLE HIGH SPEED COUNTER.

4 figure, 1,000 ohm coil, 36-48 v. D.C. operation. £3/10/-. P. & P. 1/6. 3 figure, 24 v. D.C. £1/12/6. P. & P. 1/6.

DRY READ SWITCHES.

New special offer of Dry Read Switches half amp. Contact. Size 1¼ × ⅛. 4 for 10/- Post Paid.

MINIATURE UNISELECTOR SWITCH

3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Tested. 22/6, plus 2/6 P. & P.

COMPACT HEAVY DUTY 6v. D.C. RELAY

2 change over, 30 ohm coil. 7/6 each. P. & P. 1/6. 3 for 20/-. Post paid.

NICKEL CADMIUM BATTERY

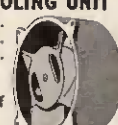
Sintered Cadmium Type 1·2 v. 7AH. Size: height 3½ in., width 2⅜ × 1 5/16 in. Weight: approx. 13 oz. Ex-R.A.F. Tested. 12/6. P. & P. 2/6.

SANWA MULTI RANGE METERS

New Model U50D Multi tester, 20,000 OPV, mirror scaled with overload protection. Ranges—d.c. volts: 100mV, 0·5 v. 5 v., 250 v., 1,000 v.; a.c. volts: 2·5 v., 10 v., 50 v., 250 v., 1,000 v.; D.C. current: 5 μA, 0·5 MA, 5 MA, 50MA, 250 MA. Complete with battery and test probe. £7/5/0 post paid. Three other models available from stock. Descriptive leaflet on request.

THYRISTOR 400 piv, 5 amp., 14/6
THYRISTOR 400 piv, 8 amp., 28/6

220/240 v A.C. COOLING UNIT



2,300 r.p.m. 6" blade size. Smooth powerful motor. All metal construction. Continuously rated. Individually tested. Offered at fraction of maker's price. £2.15.0. P. & P. 7/6

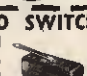
SANGAMO WESTON

Dual range voltmeter. 0–5 and 0–100 v. D.C. FSD 1 m/a. In carrying case with test prods and leads, 32/6, P. & P. 3/6.

A.C. CONTACTOR

2 make + 2 break (or, 2 c/o.). 15 amp. contacts. 230/240V. A.C. operation. Brand new. Price 22/6 plus 1/6 P. & P.

20 Amp LEVER MICRO SWITCH



Brand new lever operated Micro Switch. 20 amp A.C. c/o contacts. Price 4/6 each plus 1/6 P. & P. 5 for £1 Post Paid.

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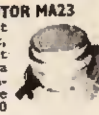
ELECTRONIC BROKERS LIMITED

SYNCHRONOUS TIMING MOTORS BY HAYDON (illus.), a high quality d.c. motor, 40oz torque at 3 r.p.m. 3 r.p.m. 12V, 2 r.p.m. 6V, 1 r.p.m. 28V, 1/12 r.p.m. 12V, 1/12 r.p.m. 30V, 1/15 r.p.m. 24V, 1/60 r.p.m. 28V, 1/120 r.p.m. 28V. List £7. **OUR PRICE £3.3.0.**

HYSTERESIS CLUTCH MOTOR with integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6oz torque at 1 r.p.m. 240V, 50c/s. L = left, R = right. 15 r.p.m. L; 8 r.p.m. R and L; 6 r.p.m. L; 4, ½, ⅓, ¼ r.p.m. L; ⅕, ⅙ r.p.m. R and L, 1/10, 1/12, 1/15 r.p.m. L. Also 120V, 50c/s, 2, ½, 1/12, 1/32, 1/32, 1/60 r.p.m. 25/-.

HIGH TORQUE INDUCTION MOTOR MP 10. Useful for cycle timers. Motorised valves, advertising display unit. 30oz/in at 1 r.p.m. 2·5 watts. 240 volts, 50 cycles. 60 r.p.m., 30 r.p.m., 20 r.p.m. Right, 6 r.p.m., 4 r.p.m., ½ r.p.m., 1/10 r.p.m., 1/15 r.p.m., 1/60 r.p.m.; also 120V, 50 cycles, 20 r.p.m. List 35/-. **OUR PRICE 15/-.**

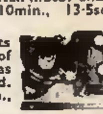
LOW TORQUE HYSTERESIS MOTOR MA23 (illus.). Ideal for instrument chart drives, extremely quiet, useful in areas where ambient noise levels are low. Having a high starting torque a relatively high inertia load can be driven. 6oz/in at 1 r.p.m. 240 volts, 50 cycles. 10 r.p.m. R; 1 r.p.m. R and L; ½ r.p.m. L; ¼ r.p.m. R; ⅙ r.p.m. R; 1/10 r.p.m. R; 1/12 r.p.m. 1/60 r.p.m., 1/20 r.p.m., 1/60 r.p.m., 1/180 r.p.m., 1/360 r.p.m.; ¼ r.p. hour, 1/12 r.p.h., 1/28 r.p.h.; 1 r.p.m. 1½ r.p.m., 2–2 way friction. 25/-.



HYSTERESIS REVERSIBLE MOTOR. Incorporating two coils. Each coil when energised will produce opposite rotation of the output shaft. 240 volt, 50 cycle. 15 r.p.m., 6 r.p.m., ½ r.p.m., ¼ r.p.m., ⅙ r.p.m., 1/10 r.p.m., 120 volt, 60 cycles, 1/10 r.p.m. 80/- reduced to 30/-.

DELAY TIMER BN42 consisting of D.P.D.T. relay, a pilot duty switch, a clutch motor and an actuator, 240 volt, 50c/s 10min., 13·5sec., 120sec. £4.4.0.

CYCLE TIMER (illus.). Repeats a set cycle or sequence of switching operations as long as the motor circuit is energised. 1min., 2min., 3min., 4min., 5min. 35/-.



REPEAT CYCLE TIMERS V3CB. Incorporating a timing motor which drives one or more cams to actuate microswitches in a definite sequence for set periods of time. 8 microswitches. One minute or 2 minutes. £5.5.0.

PROGRAMME TIMERS. 240 volts—50 min., 30 min., £4.4.0.

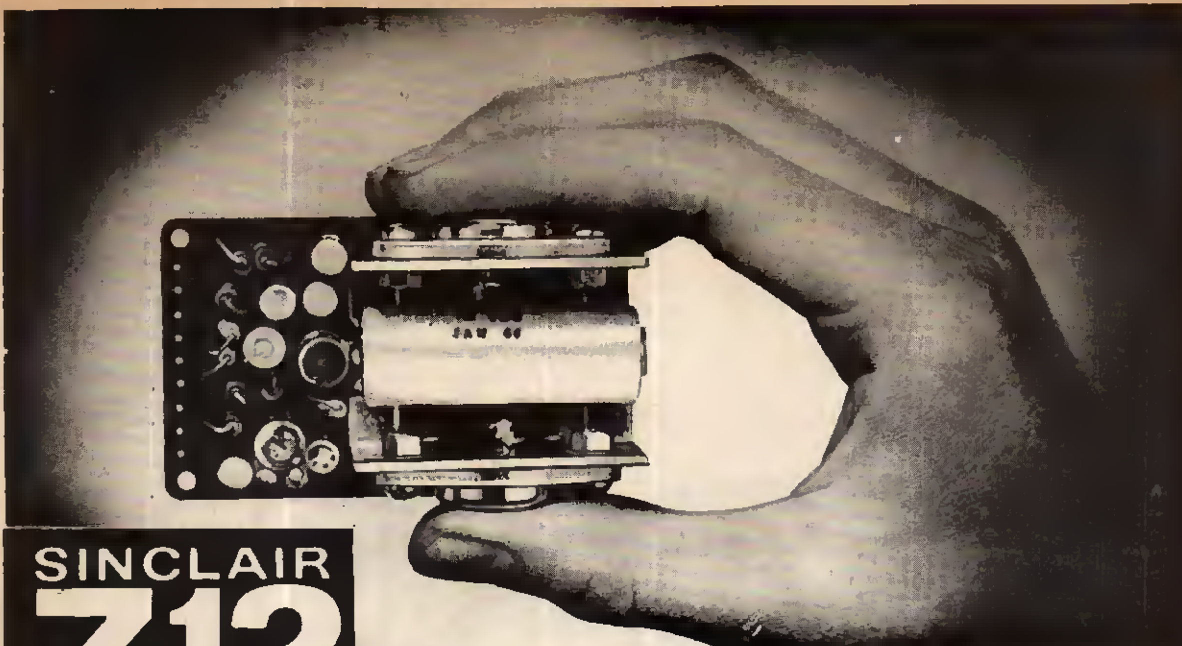
DP11 RESET TIMERS (illust.). 240V, 50 cycles, 6sec., 45/-.

PEN RECORDERS
Elliott Bros. 3-7/8983. A single Pen Recorder. 5mA complete with Sweep and Recording Unit Type 1168A. Voltage range 0–5V, 0–10V, 0–25V. £27.10.0.
Southern Instruments Two Pen Recorder. Complete with Amplifier and 4-speed gearbox, £89.
Kelvin & Hughes Two Pen Recorder, £89. Two pens activated mechanically by 6kΩ S.P.S.T. Relay Deviation 0·1in. Chart width 1·3in. Driven by Synchronour Motor Sangamo Weston 57 Motor ⅓ rev. per hr.* £7.10.0.
* It should be noted a wide range of chart speeds can be achieved by the replacement of the motor.

Portable Single Pen Recorder by Record Electrical (illus.). 3in chart, sensitivity 500mA. Coil res. 1·53kΩ. Fully interchangeable gears available to make a wide range of chart speeds. 200/250V. Size 8 × 11 × 6in. Brand new, comp. with chart and ink. List over £100. **OUR PRICE £49.10.0.**

Elliot Portable Single Pen Recorder. 3½in chart. Sensitivity 500mA. 1 and 6in per hr. £29.10.0.

ELECTRONIC BROKERS LTD.
8 BROADFIELDS AV., EDGWARE
MIDDLESEX
TEL: 01-958 9842



SINCLAIR

Z.12

COMBINED 12 WATT AMPLIFIER AND PRE-AMP

Built, tested and guaranteed.

89/6

No constructor's transistor amplifier has ever achieved such success as the Sinclair Z.12. It favours the user in so many ways—with fantastic power-to-size ratio, with far greater adaptability, with freedom to operate it from batteries or mains power supply unit (the new PZ.4 is ideal for this) and with the opportunity to obtain superb stereo reproduction for very little outlay. Countless thousands of Z.12s are in use throughout the world in hi-fi installations, electronic guitars and organs, P.A. installations, intercom, systems, etc. This true 12-watt amplifier is supplied ready built, tested and guaranteed together with the Z.12 manual which details a number of 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 savings.

SINCLAIR PZ.4 STABILISED MAINS POWER UNIT

A heavy duty stabilised power supply unit of advanced design developed specially for systems using one or more Z.12s. For running from standard A.C. Mains supplies, the PZ.4 delivers 18V. D.C. at 1.5A. Supplied built, tested and guaranteed.

99/6

SINCLAIR STEREO 25

- Input switch in/Treble/Bass/Volume/Balance Controls
- Sensitivity for 10 watts into 1.5 ohms per channel
  Mic.—2mV into 50K ohms
  P.U.—3mV into 50K ohms
  Radio—20mV into 4.7K ohms
- Equalisation correct to within ±1dB, RIAA curve, 50-20,000 Hz.
- $6\frac{1}{4}\times2\frac{3}{8}\times2\frac{1}{2}$ ins. plus knobs. Aluminium front.
  Ready built and tested. **£9.19.6**

SINCLAIR MICROMATIC

the world's smallest radio

No increase in price

Prices for this fantastically tiny, powerful receiver remain the same in spite of increased purchase tax so that the Sinclair micromatic is not only the most original and efficient set of its kind ever produced, it is the best value too. As easy to take with you as your wrist watch. Includes superb magnetic earpiece, tunes over M.W. and plays anywhere.

Complete kit of parts inc. earpiece, case, aluminium front panel, etc. **49/6**

Ready built with earpiece tested and guaranteed. **59/6**

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

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Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question.

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To: SINCLAIR RADIONICS LTD., 22 NEWMARKET ROAD, CAMBRIDGE

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For which I enclose cash/cheque/money order

NAME ....

ADDRESS ....

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PE.6

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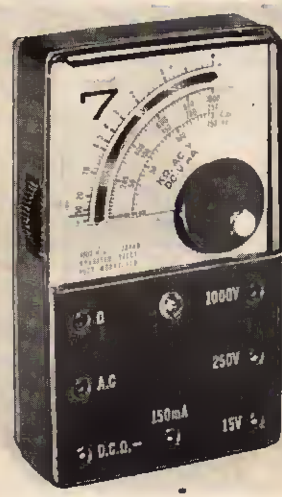

Kew 7 Midget Multi Tester. Eagle's new super midget tester operates on the same principles and provides the same performance as larger meters . . . with the same degree of accuracy. New unitized construction makes the Kew 7 one of the world's smallest pocket multimeters — about the size of a cigarette packet. Mirror scale, "turn around" test leads, battery compartment, printed circuit, voltage, current, and resistance measuring ranges qualify this instrument as a versatile, handy tool that experimenters, students and servicemen will always want to carry with them. Visit your **Eagle dealer** to inspect this exciting new midget meter . . . such good value at 59/6d.

FOR VERSATILITY, RELIABILITY AND SOUND VALUE INSIST ON

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4LD4	13/-
5A	10/6
5AS4	10/6
5T4	10/-
5V4	10/-
5Y4	10/6
6L	14/-
6AB4	8/-
6AC5	12/6
6AF6	13/6
6AG7	8/6
6AJ7	6/6
6AK6	5/-
6AL3	10/6
6AM5	5/6
6AQ4	12/-
6AQ8	8/6
6AR6	8/-
6AS7	17/6
6AU5	25/-
6AV5	13/-
6AX4	10/-
6BD7	9/6
6BF7	14/6
6BJ6	22/6
6BK7	11/-
6BM8	10/-
6BN6	9/6
6BQ7	10/-
6BR8	12/6
6BW7	12/6
6BY6	12/6
6BX7	12/-
6C6	6/-
6C10	11/-
6C31	13/6
6CB6	6/6
6CF8	9/6
6CJ5	11/6
6CK6	8/6
6CM5	10/6
6CQ5	5/-
6CU6	13/-
6CW4	14/6
6CY5	9/-
6D3	9/-
6D8	12/6
6D18	11/6
6DL5	9/-
6DS8	9/6
6E5	10/-
6EJ7	9/6
6ET6	12/-
6F5	10/-
6F8	7/-
6F13	8/6
6F16	11/6
6F19	7/6
6F22	9/6
6F26	7/6
6F30	9/6
6FG6	10/6
6G6	8/6
6GV8	12/6
6H6	5/-
6HU8	15/-
6J6	5/6
6JX8	10/-
6K7	8/-
6K25	30/-
6L6	12/6
6L16	8/6

6LD3	10/6
6LD20	7/-
6N5	8/-
6P1	18/-
6P15	5/6
6Q4	30/-
6R7	8/-
6S7	12/-
6SD7	7/-
6SG7	8/-
6SK7	8/-
6SQ7	9/6
6ST7	8/-
6U5	10/-
6V4	8/6
6X2	9/6
6Y6	13/6
7A4	10/-
7A7	8/-
7AG7	9/-
7B5	12/-
7B8	10/-
7C6	8/6
7D5J	8/-
7DJ8	14/-
7E7	12/-
7F16	11/6
7H7	8/-
7K7	12/-
7R7	14/-
7W7	8/-
7Z4	8/6
8D5	17/6
9AS	12/6
9AQ8	9/6
9D4	9/6
9U8	9/6
10F1	11/-
10F18	9/6
10L14	9/-
10LD13	9/6
10P14	18/-
12A6	12/-
12AU6	10/6
12AE6	9/6
12AL5	9/-
12AT7	5/6
12AV6	7/6
12AW7	22/6
12BA6	8/-
12BL6	10/-
12DT7	8/6
12FB5	12/6
12J7	9/-
12K7	9/-
12S7	11/-
12SF5	11/-
12SH7	7/-
12SL7	9/6
12SR7	7/-
12SY7	8/-
12Y4	4/6
13D3	7/-
13GC8	18/6
14E6	8/-
14L7	9/6
14S7	17/6
15D1	12/-
15E	10/-
16Y9	16/6
17Z3A	7/6
19DB	7/6
19BX6	10/6
19DC8	9/-
19G6	17/6
19SU	7/6
19Y3	7/6
20P1	14/-
20P5	21/6
21B6	9/6
25C5	12/-
25FG6	15/-
25Y5	12/-
25Z6	13/-
28AK8	8/6
30A5	9/-
30C15	15/-
30F5	13/6
30FL13	12/6
30L15	14/6
30P12	15/-
30P19	15/-
30PL14	15/-
35A3	11/-
35C5	8/6
35W4	6/6
35Z5	8/6
41A	8/-
42MP	9/6
45BU	8/6
50BMS	10/6
50L6	10/6
54KU	12/6
62TH	11/-
63TP	8/6
65ME	9/6

84	7/-
141DDT	9/6
150B2	13/-
177	6/-
277	6/-
409A	12/6
879	6/-
1221	8/6
1274	10/6
1638	3/6
1853	6/6
2101	10/6
6488	7/-
38807	12/6
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ARP34	9/6
AU4	8/6
AZ11	10/-
AZ41	9/6
B63	6/6
B152	5/6
B329	8/6
B719	8/6
BF62	11/-
DAF41	12/6
DAF96	7/9
DF92	4/-
DH77	6/6
DH118	9/6
DH147	9/6
DH718	10/-
DK92	11/-
DL91	8/-
DL94	8/6
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EABC80	8/6
EB34	2/6
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ECC40	12/-
ECC83	8/6
ECC86	8/6
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ECF80	9/6
ECF86	12/6
ECH81	8/6
ECL80	8/6
ECL84	13/6
EF37A	10/6
EF41	11/6
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EF89	7/6
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EL33	12/6
EL38	27/6
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EL90	8/-
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EM80	8/6
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HBC90	6/6
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HP6	8/-
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PC86	13/-
PC88	13/-
PC95	9/6
PC97	11/-
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PCC85	9/6
PCC88	14/-
PCC89	14/6
PCC189	14/-
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PCF80	12/6
PCF82	9/6
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PCF801	12/6
PCF802	12/6
PCF805	12/6
PCF806	15/-

PCF808	15/-
PCL80	14/6
PCL82	10/6
PCL83	10/-
PCL84	10/-
PCL85	11/6
PCL86	11/6
PCL88	15/-
PCL800	15/-
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PFL200	16/6
PL36	12/6
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PL81	9/6
PL82	9/-
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PL84	8/6
PL302	11/6
PL500	16/6
PL801	15/-
PY32	11/6
PY33	11/6
PY80	7/6
PY81	7/6
PY82	7/6
PY83	7/6
PY88	9/6
PY301	16/6
PY800	10/6
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PZ30	11/6
R19	10/6
R121	10/6
U26	12/6
U49	12/6
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U78	6/6
U143	10/6
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U154	7/6
U193	10/6
U291	10/6
U319	7/6
U349	10/6
UABC80	8/6
UB41	13/6
UBF80	9/6
UC92	8/6
UCF80	14/-
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UF85	10/6
UL41	10/6
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AF117	5/-
AF125	6/6
AF139	10/-
AF239	12/6
AFZ12	10/-
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NKT228	6/-
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NKT273	4/-
NKT277	5/-
NKT304	8/-
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OAZ210	6/6
OAZ213	6/6
OAZ242	4/6
OAZ247	4/6
OAZ291	9/6
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OC42	5/-
OC44M	5/6
OC46	5/6
OC58	17/6
OC71	4/-
OC75	6/-
OC78	5/-
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OC141	12/6
OC171	6/-
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ST140	4/-
SVC1	15/-
SX62	8/6
SX642	3/6
SX645	15/-
SZ56A	7/6
SZA100F	7/6
TK20	6/-
TK25	5/-
TK36	4/-
TK41	4/6
VA1010	2/-
VA1027	2/6
VA1066	2/-
VR35	6/6
VR9B	8/6
V405A	12/6
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XA103	2/-
XA141	3/-
XA151	3/-
XA162	5/-
XA701	5/-
XD202	2/-
XB113	2/6
XC101A	3/-
XC163	5/-
XC142	9/6
XS101	5/-
XU604	4/6
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ZB22	4/6
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IS5	4/6	6K8	4/-	30L15	15/-	ECF82	7/6	EZ81	5/6	PY88	7/6
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IU4	6/-	6Q7	8/3	30PL1	15/-	ECH42	11/-	GZ34	11/6	PY801	8/-
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2D21	5/-	6SJ7	7/-	35L6	8/-	ECH83	8/6	PABC80	7/6	U26	15/-
3A5	10/-	6SL7	6/-	3524	8/6	ECL80	7/9	PCC84	6/6	U191	14/-
3Q4	7/-	6SN7	5/6	35W4	5/3	ECL82	7/-	PCC85	8/-	U281	8/-
3S4	5/-	6U7	7/-	50B5	6/6	ECL83	10/6	PCC88	11/6	U301	11/-
3V4	6/-	6V6	5/-	50C5	6/6	ECL86	9/-	PCC89	11/6	U801	17/-
5R4	9/-	6X4	4/3	80	7/-	EF37A	8/-	PCC189	12/6	UABC80	6/-
5U4	5/-	6X5	5/-	AZ31	10/-	EF40	10/-	PC86	11/-	UAF42	10/-
5V4	8/6	7B7	7/-	DAF91	4/6	EF41	9/6	PC88	11/-	UBC41	8/-
5Y3	5/9	7C6	6/6	DAF96	7/-	EF42	10/6	PC97	8/6	UBF80	7/-
5Z4	6/-	7Y4	8/6	DF91	3/-	EF80	5/-	PC900	9/6	UBF89	7/-
6/30L2	12/6	10C2	15/-	DF96	7/-	EF85	6/6	PCF80	7/3	UCC84	10/-
6AC7	4/-	10F1	9/-	DK91	6/-	EF86	7/-	PCF82	7/-	UCC85	7/-
6A67	6/-	10P13	15/-	DK92	8/9	EF89	6/3	PCF84	9/-	UCF80	9/6
6AK5	5/-	10P14	16/-	DK96	8/-	BF91	4/-	PCF86	9/-	UCH42	10/-
6AL5	3/-	12AT6	5/-	DL92	5/-	EF92	4/-	PCF800	15/-	UCH81	7/-
6AM6	4/-	12AT7	4/-	DL94	6/-	EF183	7/-	PCF801	10/-	UCL82	8/-
6AQ5	6/-	12AU7	5/-	DL96	8/-	EF184	7/-	PCF802	10/-	UCL83	10/-
6AS6	6/-	12AX7	6/-	DY86	6/6	EL33	12/6	PCF805	14/-	UF41	10/-
6AT6	5/-	12BA6	6/9	E88CC	12/6	EL34	11/-	PCL82	7/6	UF80	7/-
6AU6	5/9	12BE6	6/3	EABC80	7/-	EL41	9/9	PCL83	9/6	UF85	7/6
6BA6	4/9	12BH7	6/6	E180F	15/-	EL42	11/-	PCL84	8/-	UF89	7/6
6BE6	5/3	12Q7	5/6	EAF42	9/6	EL81	9/-	PCL85	9/6	UL41	10/-
6BH6	8/-	12SQ7	7/6	EB91	3/-	EL84	5/-	PCL86	9/-	UL84	7/-
6BJ6	8/-	19AQ5	6/-	EBC41	9/6	EL85	8/6	PFL200	12/6	UY41	7/6
6BE7	11/-	20F2	14/-	EBC81	7/-	EL91	4/-	PL36	10/6	UY85	6/6
6BZ6	7/-	20L1	13/-	EBF80	7/6	EL95	5/3	PL81	7/6	VR105/30	
6C4	3/6	20P1	12/-	EBF83	9/-	EM80	7/6	PL82	7/-		5/6
6C6	4/-	20P3	12/-	EBF89	7/6	EM81	8/-	PL83	7/-	VR150/30	5/-
6CD6	20/-	20P4	19/-	ECC40	11/6	EM84	7/6	PL84	8/9	MANY	
6CH6	6/-	25L6	6/6	ECC81	4/-	EM87	7/6	PL500	14/6	OTHER	
6CL6	10/-	25Z4	8/-	ECC82	5/-	EY51	7/6	PY33	9/9	TYPES IN	
6D6	8/-	30C15	13/6	ECC83	6/-	EY86	7/-	PY80	5/6	STOCK.	

TRANSISTORS

2N753	4/6	BC109	5/6	OC72	4/-	ST141	6/-
2N2160		BSY26	4/6	OC73	5/-	XA104	4/6
	14/11	BSY28	4/6	OC74	5/6	XA124	4/6
2N2926	5/-	BSY65	4/6	OC75	4/6	XA125	4/6
AC107	4/6	BSY95A	5/-	OC76	4/6	XB112	3/-
AC126	4/6	GET106	5/6	OC77	4/6	XC141	7/-
AC127	4/6	GET113	5/6	OC78	5/-	PHOTO	
AC128	4/6	GET873	5/6	OC81	4/-	TRANSIS-	
ACY19	5/-	GET874	4/6	OC81M	2/6	TORS	12/6
ACY21	5/-	MAT100	7/9	OC81D	4/-		
AD140	8/6	MAT101	8/6	OC81DM	2/6		
AD149	16/-	MAT120	7/9	OC82	4/6		
ADT140	15/-	MAT121	8/6	OC83	5/-		
AF114	6/6	OC23	8/6	OC139	8/6		
AF115	4/6	OC26	7/6	OC140	11/-		
AF116	4/6	OC28	8/6	OC169	4/6		
AF117	4/6	OC35	8/6	OC170	4/6		
AF118	4/6	OC41	5/-	OC171	4/6		
AF119	4/6	OC42	5/-	OC200	9/-		
ASY28	7/-	OC44	4/-	OC201	11/-		
BC107	5/6	OC45	4/-	OC203	12/6		
BC108	5/6	OC71	4/-	ST140	4/-		

SIGNAL DIODES

IN34A	4/-
OA5	3/6
OA10	4/6
OA70	2/-
OA79	2/-
OA81	2/-
OA90	2/6
OA95	2/6

SILICON POWER DIODES

60 P.I.V.	290MA	2/-
70 P.I.V.	1amp	3/6
150 P.I.V.	165MA	1/-
150 P.I.V.	25amp	10/-
200 P.I.V.	6amp	5/6
400 P.I.V.	500MA	3/6
400 P.I.V.	6amp	5/6
400 P.I.V.	8amp	7/6
700 P.I.V.	100amp	35/-
800 P.I.V.	500MA	5/6
800 P.I.V.	5amp	7/6
1,000 P.I.V.	6amp	7/6
1,000 P.I.V.	650MA	8/6

ZENER DIODES

OAZ200	12/-	OAZ204	8/6	OAZ208	6/6	OAZ212	6/6
OAZ201	10/-	OAZ205	8/6	OAZ209	6/6	OAZ213	6/6
OAZ202	8/6	OAZ206	8/6	OAZ210	6/6	OAZ223	15/-
OAZ203	8/6	OAZ207	9/8	OAZ211	6/6		

STC 1 WATT SERIES 5%
2·4 / 2·7 / 3 / 3·9 / 4·3 / 13 / 16 / 18 / 20 / 30 / 33V. 5/- each.
Z series. All voltages from 3·9 to 50V. 250MW 2/6 each. 1·5W 4/- each. 7W 5/- each.

PLEASE ADD POSTAGE

THYRISTORS SILICON CONTROL RECTIFIERS

400 P.I.V.	3amp	7/6
100 P.I.V.	7amp	13/6
200 P.I.V.	7amp	15/6
400 P.I.V.	7amp	15/6

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

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

Brand New £15. Carr. 7/6.

ARF-100 COMBINED AF-RF SIGNAL GENERATOR

AF. SINE WAVE 20-200,000c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP.** 21V P/P 600Ω 3·8V P/P.
TF. 100kc/s–300 Mc/s.
Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF. output and % mod. on R.F. 220/240V a.c. **£27.10.0.** Carr. 7/6.

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

10 meg. input 10 ranges: ·01 / ·03 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1.2Mc/s. Decibels—40 to —50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

TE-20RF SIGNAL GENERATOR

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

T.M.C. 1000 SERIES KEY SWITCHES

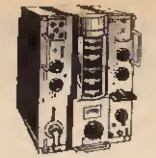
Brand New with knobs as follows.
1 way, 2 c/o 7/6; 1 way, 2 c/o 2b, 7/6; 1 way, 4 c/o. 8/-; 2 way, 3m., 3m. 8/6; 2 way, 2 c/o., 2 c/o. 8/6; 2 way, 2 c/o., 4 c/o. 10/-.
Post extra. Quantities available.

AUTO TRANSFORMERS

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

500 W.	£3.10.0,	P. & P. 6/6
1,000 W.	£5.10.0,	P. & P. 7/6
1,500 W.	£6.10.0,	P. & P. 8/6
3,000 W.	£7.10.0,	P. & P. 12/6
7,500 W.	£15.10.0,	P. & P. 20/-

ADMIRALTY B.40 RECEIVERS



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

SOLARTRON CD711S.2. DOUBLE BEAM OSCILLOSCOPE

An extremely high quality oscilloscope originally costing £400. Switched beam. Identical Y1, Y2 Amplifiers d.c. to 9Mc/s. Sensitivity 3mV/CM to 100V/CM. Time base 10μ/sec. to 10M/secs. Calibrator. X amplifier d.c. to 2·5Mc/s. Z Modulation. 110/220/250V. a.c. Supplied in good working order. **£65,** carriage £2, or available as received from Ministry unserviced **£50,** carriage £2.
(Handbooks **£2** extra.)

AVO CT.38 ELECTRONIC MULTIMETERS

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

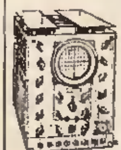
MARCONI TEST EQUIPMENT

EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS, 85Kc/s-25Mc/s, **£25**, carr. 30/-.
TF.885. VIDEO OSCILLATOR. 0-5Mc/s, **£45**, Carr. 30/-.
T.F.195M. BEAT FREQUENCY OSCILLATOR 0-40kc/s, 200/250V a.c. **£20**, carr. 30/-.
All above offered in excellent condition fully tested and checked.
TF. 1100 VALVE VOLTMETER, Brand New, **£50.** TF. 1267 TRANSMISSION TEST SET, Brand New, **£75.**

AM/FM SIGNAL GENERATORS

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

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



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

Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230V 50-60 cycles.
Output full variable from 0-260V. Bulk quantities available.
1 amp.—£5.10.0; 2.5amp.—£6.15.0; 5 amp.—£9.15.0; 8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21; 20 amp.—£37.

PRINTED CIRCUITS

Five assorted printed circuit boards with transistors, diodes, resistors, condensers, etc. Guaranteed minimum 20 transistors. Ideal for experimenters, 5 boards for 10/-. P. & P. 2/-.

AVOMETERS

Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions.
Model 47A £9.19.6.
Model 7 £13.10.0.
Model 8 £18.0.0.
P. & P. 7/6 each.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20c/s to 200kc/s on 4 bands. Square: 20c/s to 30kc/s. Output impedance 5,000 ohms, 200/250V a.c. Supplied brand new and guaranteed with instruction manual and leads, **£15.** Carr. 7/6.

SOLARTRON MONITOR OSCILLOSCOPE TYPE 101

An extremely high quality oscilloscope with time base of 10Ω/sec. to 20m/sec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. **£8.19.6.** Carriage 30/-.

R.C.A. AR88 SPEAKERS

8in. 3 ohm speakers in metal case. Black crackle finish to match our 88 Receivers. Available Brand New and Boxed with leads. **59/6.** Carr. 7/6.

DUBILIER NITROGEL CONDENSERS
Brand new 8 mfd. 800V 8/6, P. & P. 2/-; 2 mfd. 5,000V 42/6, P. & P. 5/-.

LUCAS 20/0/20 AMMETERS
Brand new boxed. Suitable car/motorcycle. **12/6**, P. & P. 2/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS. 0–20Kc/s.
Output 5K or 500 ohms. 200/250V a.c. Offered in excellent condition £12.10.0. Carr. 10/-

HANSEN SWR BRIDGES
52 ohm. **69/6**, P. & P. 3/6.

G. W. SMITH & Co. (Radio) Ltd.
3-34 Lisle St., W.C.2
ALSO SEE OPPOSITE PAGE

MULTIMETERS *for EVERY purpose!*

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

NEW MODEL 500.30,000 O.P.V. with overload protection. Mirror scale. 0 / 0·5 / 2·5 / 10 / 25 / 100 / 250 / 500 / 1,000V. d.c. 0 / 2·5 / 10 / 25 / 100 / 250 / 500 / 1,000V. a.c. 0/50µA / 5 / 50 / 500mA. 12 amp. d.c. 0/60/K6. Meg./60megohm **£8.17.6.** Post paid.

MODEL TE-12. 20,000 O.P.V. 0/0·6/30/120/600/1,200 / 3,000 / 6,000V. d.c. 1/6/30/120/600/1,200V. a.c. 0 / 60µA / 6 / 60 / 600MA. 0 / 6K / 600K / 6meg./60. Megohm 50PF. 2 MFD. **£5.19.6.** P. & P. 3/6.

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

MODEL TE 80. 20,000 O.P.V. 0 / 10 / 50 / 100 / 500 / 1,000V. a.c. 0/5/25/50/250 / 500 / 1,000V. d.c. 0-50µA. 5/50/500mA. 0/6K/60/K/600K/6 Meg. **£4.17.6.** P. & P. 3/-.

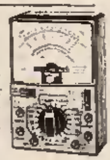
MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V. d.c. 0/6/30 / 120 / 600 / 1,200V. a.c. 0/30µA / 3/30 / 300mA. 0/16K/160K/1·6M / 16megohm. **£5.10.0.** P. & P. 3/-.

MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500V. d.c. 0/10/50/500/2,000V. a.c. 0/2megohm. 0/250 mA. −20 to +36dB. **49/6.** P. & P. 2/6.

TE-51. NEW 20,000Ω/VOLT MULTIMETER. 0/6/60/120, 1,200V. a.c. 0 / 3 / 30 / 60 / 300 / 600 / 3,000V. d.c. 0/60µA/12/300 mA. d.c. 0 / 60K / 6megohm. **85/-.** P. & P. 2/6.

MODEL PT-34. 1,000 O.P.V. 0/10/50 / 250 / 500 / 1,000V. a.c. and d.c. 0/1/100/500 mA. d.c. 0/100 KΩ **39/6.** P. & P. 3/6.

LAFAYETTE 57 Range Super 50,000 O.P.V. Multimeter. D.c. Volts 125V-1000V. A.c. Volts 1.5V-1000V. D.c. Current 25µA-10 Amp. Ohms. 0-15 Meg Ω. dB. −20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.



MODEL AF-105. 50KΩ/Volt. Mirror scale, built-in meter protection. 0/.3/3/12/60/120/300/600/1,200v. d.c. 0/6/30/120/300/600/1,200 v. a.c. 0/30µA/6/60/300MA/12 Amp. 0/10K / 1M / 10M / 100 MΩ −20 to +17 dB. **£8.10.0.** P. & P. 3/6.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7–0·9967. B: 5–200. Ico: 0-50 microamps 0–5mA. Resistance for diode 200Ω-1MΩ. Supplied complete with instructions, battery and leads. **£5.19.6.** P.&P. 2/6.

TE-65 VALVE VOLTMETER.

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

HOSIDEN DH04S 2-WAY STEREO HEADSETS

Each headphone contains a 2½ in woofer and a ⅞in tweeter. Built in individual level controls. 25–18,000c/s. 8Ω imp. with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

GARRARD DECKS

Brand new and guaranteed.

1025 with cartridge	£7.10.0.
LAB80 Mk.11 less cart.	£23.10.0.
LAB80 Mk.11 less cart., with WB2 Base,	£27.10.0.
401 Transcription less cart.	£27.6.0.

Carr. 7/6 each

F.M. WIRELESS MICROPHONES

94–104Mc/s. Transistorised. Operates from 9V battery. Complete with additional secret tie-clip microphone. List £12.10.0 ONLY **£6.15.0.** P. & P. 2/6.
These cannot be operated in U.K.

2-WAY RADIOS

Super quality. Brand new and guaranteed.

3 transistor	£6.15.0 pr.
4 transistor	£6.19.6 pr.
5 transistor	£7.19.6 pr.
6 transistor	£8.12.6 pr.
6 transistor De Luxe	£12.10.0 pr.
10 transistor	£22.10.0 pr.
13 transistor 500mW	£31.10.0 pr.

Post extra *These cannot be operated in U.K.*

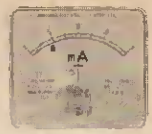
TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

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

SINCLAIR EQUIPMENT

Z12 12 watt amplifier, 89/6.
PZ4 Power Supply Unit 99/6.
Stereo 25 Preamp., £9,19.6.
Q14 Speakers, £7.19.6.
Micromatic Radio Kit, 49/6. Built 59/6.
Micro FM Radio Kit £5.19.6.
ALL POST PAID

CLEAR PLASTIC METERS



First grade quality Moving Coil panel meters available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows: Type MR 38P, 1 21/32 in square fronts.

		100-0-100µA	32/6	200mA	25/-	100V d.c.	25/-
		500-0-500µA	25/-	300mA	25/-	150V d.c.	25/-
		1-0-1mA	25/-	500mA	25/-	300V d.c.	25/-
		1mA	25/-	750mA	25/-	500V d.c.	25/-
		2mA	25/-	1A d.c.	25/-	750V d.c.	25/-
		5mA	25/-	2A d.c.	25/-	15V a.c.	25/-
		10mA	25/-	5A d.c.	25/-	50V a.c.	25/-
50µA	37/6	20mA	25/-	3V d.c.	25/-	150V a.c.	25/-
100µA	35/-	50mA	25/-	10V d.c.	25/-	300V a.c.	25/-
200µA	32/6	100mA	25/-	20V d.c.	25/-	500V a.c.	25/-
500µA	27/6	150mA	25/-	50V d.c.	25/-	'S' Meter 1mA	29/6
50-0-50µA	35/-						

POST EXTRA. Larger sizes available—send for lists.

UNR-30. 4-BAND COMMUNICATION RECEIVER

Covering 550Kc/s—30Mc/s. Incorporates variable BFO for CW/SSB reception. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new guaranteed with instructions. Carr. 7/6. **£12.10.0**

LAFAYETTE MODEL HA700 AM/CWSSB AMATEUR COMMUNICATION RECEIVER

8 valves, 5 bands incorporating 2 MECHANICAL FILTERS for exceptional selectivity and sensitivity. Frequency coverage on 5 bands 150-400Kc/s, 550-1,600Kc/s, 1·6-4·0Mc/s, 4·8-14·5Mc/s, 10-5-30Mc/s. Circuit incorporates R.F. stage, aerial trimmer, noise limiter, B.F.O. product detector, electrical bandspread, S meter, slide rule dial. Output for phones, low to 2KΩ or speaker 4 or 8ohms. Operation 220/240V. a.c. Size 7½ × 15 × 10in. Supplied brand new and guaranteed with handbook. **36 GNS.** Carr. 10/-. S.A.E. for leaflet.

LAFAYETTE MODEL HA-500 SSB/AM/CW 80 THROUGH 6 METER RECEIVER

New outstanding Ham Bands only receiver covering the 80/40/20/15/10/6 metre bands. Incorporates 10 valves, product detector, two mechanical filters, S. Meter, dual conversion on all bands, crystal calibrator, V.F.O. noise limiter, aerial trimmer, IFs 2,608Mc/s. and 455Kc/s. Output 8ohms and 500ohms. Operations 220/240V. a.c. Supplied brand new and guaranteed with handbook **42 Gns.** Carr. 10/-. 100Kc/s. crystal, 35/-.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

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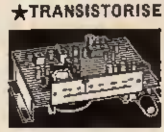

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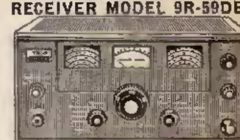

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VOL. 4 No. 6
June 1968

PRACTICAL ELECTRONICS

THE AIR FORCE AND ELECTRONICS

THE fiftieth anniversary of the Royal Air Force is a fitting occasion to recall the close relationship that has always existed between this Service and the branch of technology we now know as electronics. Their histories are closely interwoven. The needs of air defence were chiefly responsible for the sudden growth of electronics.

When the R.A.F. was formed in 1918 wireless communication was already established, but still rather a novelty. Fortunately, government advisers on defence matters anticipated important future developments in the use of electro-magnetic waves, and a Radio Research Board was set up in that very same year. Thus was brought into being the nucleus of the official machinery which later facilitated consultations with persons such as R. Watson-Watt, destined to become the father of radar.

Once the feasibility of locating aircraft by radio had been demonstrated, many of the finest brains from universities, the radio industry, and government scientific departments were harnessed to the task of converting this idea to a practical reality. As is now well known, the first chain of R.D.F. stations was installed around the coasts of Britain well before the outbreak of war in 1939.

Furthermore, as we now realise, the door leading to a future "electronics" era was dramatically pushed open by these heroic backroom efforts of scientists, physicists, and engineers in the late 30's.

In amateur circles there is to be found an especial regard for the Royal Air Force. No other service depends so heavily upon signals and other branches of electronics. In 1939 hundreds of radio amateurs entered the R.A.F., some to perform signal duties, others to be assigned to special training on the secret R.D.F. equipment. Subsequently, thousands of other men and women from all walks of life became initiated into the strange world of radio—or the even stranger one of radar—during those war years.

Many of these ex w/op's and radar mechanics have retained their interest and have applied this fortuitously acquired knowledge to good effect in Civvy Street. The current general awareness of electronics, and the adoption of this subject as a useful and intellectually stimulating recreation by a great many lay persons, are in large measure due to the training and experience provided by the armed forces, and the R.A.F. in particular.

Today the future pattern of the Royal Air Force is the subject of much speculation. The move from manned aircraft to remotely controlled missiles can only mean a greater preponderance of electronic devices and systems. Whatever changes take place, the role of electronics is bound to be pre-eminent.

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

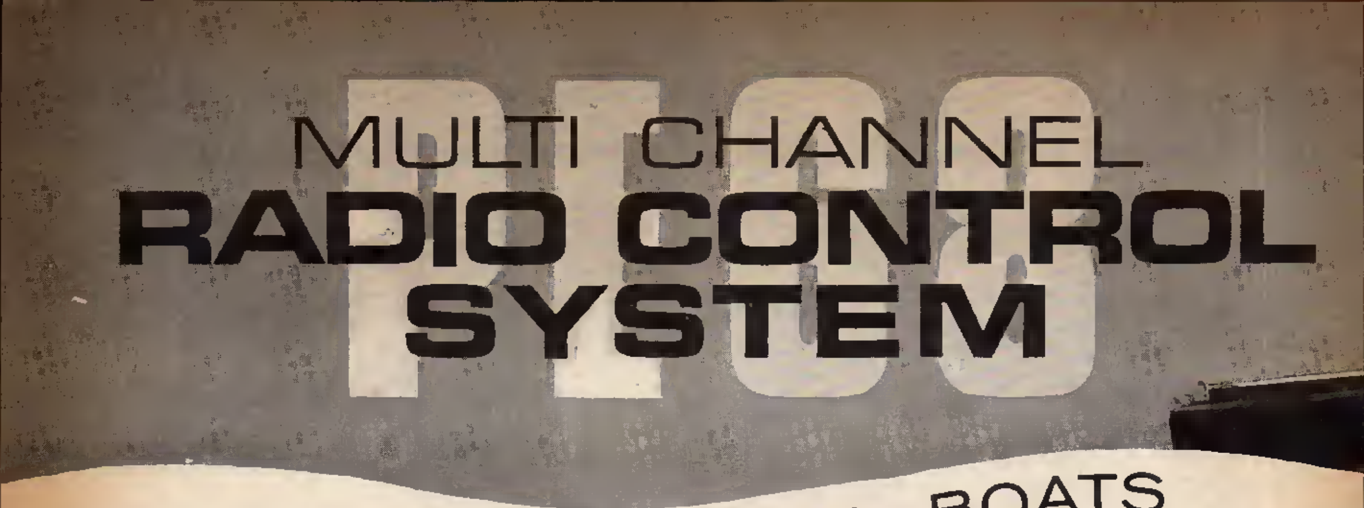
SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our July issue will be published on Friday, June 14

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., 15/17 Long Acre, London, W.C.2. Phone: 01-836 4363. Telegrams: Newnes London. Subscription Rates including postage for one year, to any part of the world, 36s.



MULTI CHANNEL RADIO CONTROL SYSTEM

FOR MODEL BOATS. . . . .

THE relatively simple transistorised multi-channel control system described here was designed specifically for controlling a 34in model diesel powered Vosper R.A.F. Crash Tender. Circuit and constructional details are given for the radio transmitter, receiver and control arrangements, including those for rudder and throttle actuator mechanisms. No special tools are required other than perhaps a power hand drill, although a multi-range meter is desirable and an oscilloscope is an advantage. The overall model with electronics will appeal to the do-it-yourself modeller who has a certain amount of electronics knowledge.

SINGLE OR MULTI-CHANNEL?

Undoubtedly the simplest control arrangement is "single-channel" operation in which only one item of information is transmitted at any one time. This can be quite effective, although special operating techniques may have to be evolved, particularly when high speed models are used, so that function selection is not unduly delayed.

In the case of model aircraft, the flying technique for single channel working differs completely from normal multi-channel practice. Therefore, it would seem to be a very natural progression to the more versatile "multi" techniques, which enable simultaneous movements of various controls to be made, particularly if the cost of such a system could be kept low.

AIRCRAFT OR BOAT?

The scope of "multi" aircraft control can be very rewarding, but the following points were the decisive factors in selecting a boat for using the control system described.

Cost of the installation

A boat or land vehicle control system need not be as complex as its aircraft counterpart, a four-channel system being usually quite adequate for controlling a boat, even at high speed. Surface vehicles are not seriously affected by equipment weight, size, or power consumption restrictions generally imposed by an aircraft of practical proportions.

This gives the home constructor much more scope to use materials and components which are readily available, rather than to have to purchase the relatively expensive, compact, and lightweight items generally required for aircraft control. There is no particular need to miniaturise the circuitry or actuators; with a boat of 34in overall length, lack of space is not a problem to be encountered here.

Loss or damage

In the experimental stages, particularly with home-built equipment in the hands of newcomers to model control, there is a very real risk of damage, or even a complete write-off, in the case of a powered aircraft, as a direct result of some form of loss of control.

Adequate operating facilities

Unless one joins a club it is difficult to find suitable large open spaces for aircraft flying without undue aerial hazards. It must be remembered that a powered aircraft in free flight at speed is potentially a dangerous projectile and serious personal injury has been known to occur to spectators. There are still plenty of smooth stretches of water to be found of quite sufficient size for putting a boat through its paces without risk of annoyance to anyone. Most marine diesels are equipped with silencers to reduce noise.

The effective working range of the transmitter/receiver combination described in this article is about a quarter of a mile. In practice, this was found to be more than adequate, because even at 200 yards distance it becomes difficult for the operator to ascertain the boat's position and attitude in the water.

BASIC ARRANGEMENT

The basic scope for control of a boat is probably less than that for an aircraft, and in order to justify the selection of a "multi" system, a high-speed planing hull was selected, capable of good manœuvrability at speed. Because of the low power/weight ratio achieved with electric propulsion, an ample size of diesel engine was chosen as the power unit. This was installed in an "Aerokits" R.A.F. Crash Tender available in kit form in plywood. The 34in model is used.

This boat is ideal for an installation of this type, the hull being conveniently divided, by bulkheads, into five compartments (see maker's plans). It is very wise if an internal combustion engine is used, to keep one compartment amidships reserved for the engine, fuel tank, and perhaps throttle gear, as these miniature engines tend to become dirty, exuding a mixture of soot and unburnt fuel—the penalty for throttling a diesel engine.

. . PART ONE By E.J. PEPPER C.Eng. M.I.E.E.

The bow compartment (No. 1) (see maker's plans) is sealed off and filled with buoyancy material; No. 2 compartment (wheelhouse) is used as the main electronics area, as this is readily accessible but is well protected and well clear of any spray that might occur at speed. This compartment accommodates the radio receiver, preamplifier, and both control motion panels.

The receiving aerial plugs into a socket fixed to the deck adjacent to No. 2 compartment. No. 3 compartment is the engine room with throttle control and fuel tank. No. 4 houses the battery, relays, and the isolator switches. No. 5 compartment is occupied fully by the steering actuator and the actuator supply battery. It is probably a good idea to mark these compartments on the plans.

If polyurethane foam is inserted ahead of bulkhead B1, holes of about 1in square should be made in the bulkhead.

The second compartment houses the four perforated s.r.b.p. modules: the receiver (aft), the pre-amplifier (port side), rudder control (starboard side), and throttle control (forward). These four modules are easily recognised in the circuit diagram, each being indicated by a hatched line box (see Fig. 2). The complete circuitry in the boat is shown; the transmitter will be described later.

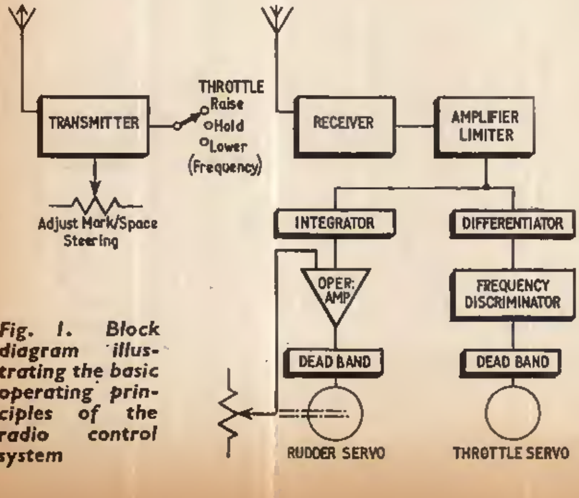


Fig. 1. Block diagram illustrating the basic operating principles of the radio control system

TWO BASIC SYSTEMS

There are two basic systems of control in general use, and there are also two main ways by which the control intelligence can be made to actuate the controlled member (see Fig. 1).

Progressive control

Progressive control is usually simplest, but less precise, being in principle an "open loop" arrangement of integration where the controlled member will move at more or less constant rate in the desired direction until it is checked.

Proportional control

This is a true "closed loop" servo position control.

The simplicity of the system to be described stems from the fact that it permits simultaneous transmission of one progressive system and one proportional system, the former being used to actuate the throttle, i.e. commands "close", "open", and "hold", the latter to steer the boat.

The rudder assumes the angular position corresponding to that set up on the steering "wheel" on the transmitter unit, regardless of the load conditions on the rudder. To achieve this it is necessary to feed back the rudder position to the controller by means of a potentiometer (VR2) ganged to the rudder shaft.

CONTROL PRINCIPLE

The two controls, rudder and throttle, may be operated individually or simultaneously, and the principle of operation may be readily understood from Fig. 3. The transmitted 27MHz carrier is 100 per cent modulated by a square wave of adjustable mark/space ratio to correspond to rudder control, and at three preselected fundamental frequencies to provide throttle control.

The appropriate frequency (110Hz, 600Hz, 400Hz), corresponding to "increase", "decrease", and "hold" throttle respectively, can be selected by a centre biased three-position key on the transmitter, without affecting the pre-set mark/space ratio. The mark/space ratio of the square wave is variable from 1 : 10 to 10 : 1 for

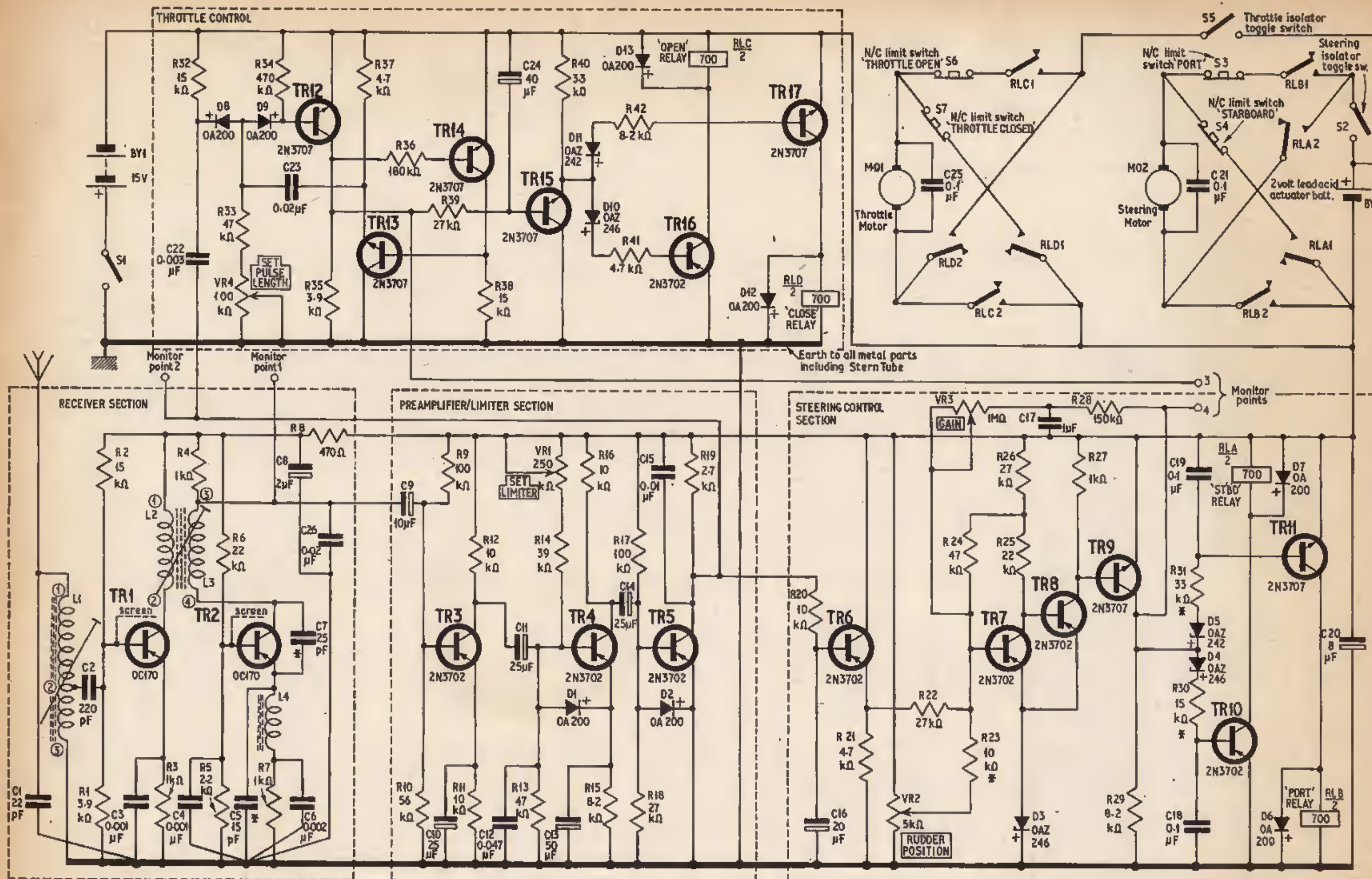
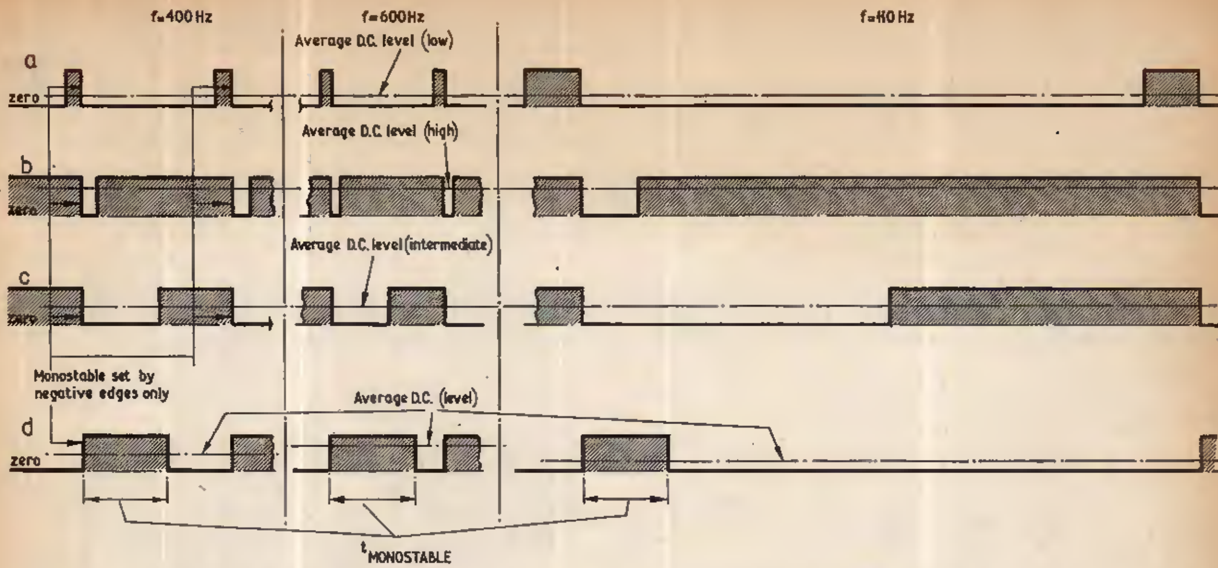


Fig. 2. Complete circuit diagram of the electronics in the boat. Each section is divided into shaded areas to show the individual panels



(a) Steering control waveforms Port Rudder f=400 Hz 'HOLD' throttle (Intermediate D.C. level) (b) Steering control waveforms Starboard Rudder f=600 Hz 'CLOSE' throttle (High D.C. level) (c) Steering control waveforms Rudder Amidships f=110 Hz 'OPEN' throttle (Low D.C. level) (d) Corresponding Throttle control waveforms

NOTES:
(1) The D.C. level of the Rudder waveforms does not change with frequency (2) The Throttle waveform is not affected by change of Rudder Mark/Space ratio

Fig. 3. Steering and throttle control waveforms

any selected frequency and is set by the steering wheel control on the transmitter, a ratio of 1 : 1 corresponding to "rudder straight".

After detection by the receiver, the square wave signals are converted to d.c. levels which in turn actuate relays. These control the d.c. motors which rotate, in the appropriate direction, the actuator lead screws.

The general description of the system will now be followed by a more detailed account of the various functional units. However, it is emphasised at this stage that general information on constructing the boat is excluded since it is outside the scope of this magazine. It is expected that the constructor will acquire the boat kit with instructions through a retailer.

A kit of accessories for this model is available through retailers from Keil Kraft. The electronics are not generally available in complete kit form; constructors will find that all electronic parts are obtainable through the usual retailers.

RADIO RECEIVER

It is an undisputed fact that, because of their selectivity performance, superheterodyne receivers are to be preferred to t.r.f. types; nevertheless super-regenerative receivers can give excellent results and are undeniably simple. If the constructor has no intention of becoming involved in active competition work, where a superhet could offer advantages, he would probably do well to compromise and go for a super-regenerative receiver, which is simple and inexpensive while offering adequate performance.

At the high transmission frequency used, it would have been very difficult to have achieved adequate r.f. amplification with a conventional tuned radio frequency (t.r.f.) receiver, whereas the super-regenerative receiver is capable of providing tremendous amplification, provided that faithful reproduction of the modulation signal is not an important criterion.

As we are dealing with "clipped" rectangular waveforms the effects of signal distortion are of little consequence.

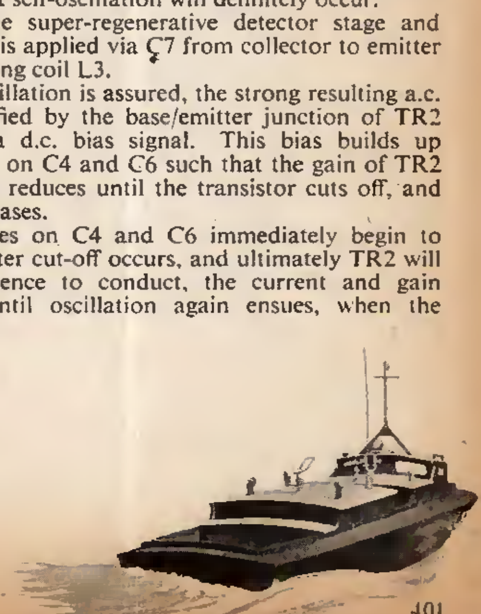
The principle of the super-regenerative receiver is to employ large amounts of positive feedback, to increase the overall gain or sensitivity. This "regeneration", or "reaction" as it was once known, is arranged to render the circuit alternatively oscillatory and non-oscillatory at a fairly rapid rate.

In ordinary t.r.f. receivers, the amount of regeneration possible is limited by the tendency towards instability, leading to continuous oscillation or "howl". The super-regenerative receiver makes full use of this phenomenon, and sufficient positive feedback is applied to ensure that self-oscillation will definitely occur.

TR2 is the super-regenerative detector stage and regeneration is applied via C7 from collector to emitter from the tuning coil L3.

As self-oscillation is assured, the strong resulting a.c. level is rectified by the base/emitter junction of TR2 to provide a d.c. bias signal. This bias builds up progressively on C4 and C6 such that the gain of TR2 progressively reduces until the transistor cuts off, and oscillation ceases.

The charges on C4 and C6 immediately begin to leak away after cut-off occurs, and ultimately TR2 will again commence to conduct, the current and gain increasing until oscillation again ensues, when the

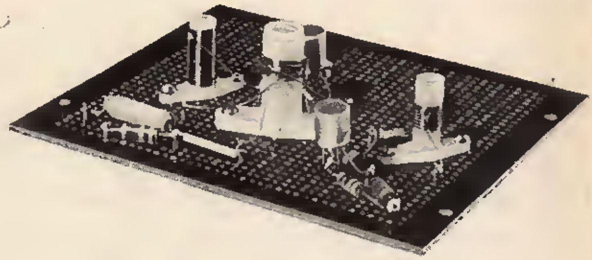


process repeats itself. The time constants C4–R5 and C6–R7 are selected such that the periodic bursts of oscillation (referred to as "squegging") occur at some low radio frequency, which is not particularly critical, and will be found to increase with the antenna signal strength, normally being between about 30–100kHz. This is well out of the signal modulation frequency range, and can be filtered out after detection.

It can be seen, therefore, that there is a substantial portion of time in each period of "squegging" when the gain of the receiver is exceptionally high, but when self-oscillation does not exist. The gain during this period is far higher than could be achieved, with stability, in any single stage "conventional" t.r.f. receiver.

RECEIVER CONSTRUCTIONAL DETAILS

COMPONENTS . . .



Resistors

R1	3·9kΩ	R4	1kΩ	R6	22kΩ
R2	15kΩ	R5	2·2kΩ	R7	1kΩ
R3	1kΩ				

All 10%, ¼ watt carbon

Capacitors

C1	22pF ceramic	*C5	15pF ceramic
C2	220pF mica	C6	0·002μF mica
C3	0·001μF mica	*C7	25pF ceramic
C4	0·001μF mica	C8	2μF elect. 25V
C26	0·02μF polyester (additional squegging filter)		

*C5 and C7 may be altered in value so that the dust core in L2/3 is about mid travel for optimum tuning

Transistors

TR1, TR2 OC170 *or* OC171 (2 off)

Coils

L1 12 turns 28 s.w.g. enam. wire close wound on Neosid ¼in polystyrene former with adjustable core. Tapping is taken 2 turns from the "earthy" end of the winding.

L2/3 ⅜in Aladdin former with dust core. L3 wound first—9½ turns 28 s.w.g. enam. wire close wound. L2 2 turns 28 s.w.g. enam. wire wound on top of L3 at "TR1 collector" end

L4 R.F. choke, 38 s.w.g. enam. wire in single layer on ¼in Neosid former with dust core

Miscellaneous

Aerial, 14 in whip type made from 20 s.w.g. brass or nickel silver wire with wander or banana plug fitted to one end. Socket for aerial. Plain or perforated copper clad s.r.b.p. sheet (see Text) 4in × 4in. Pins for perforated board

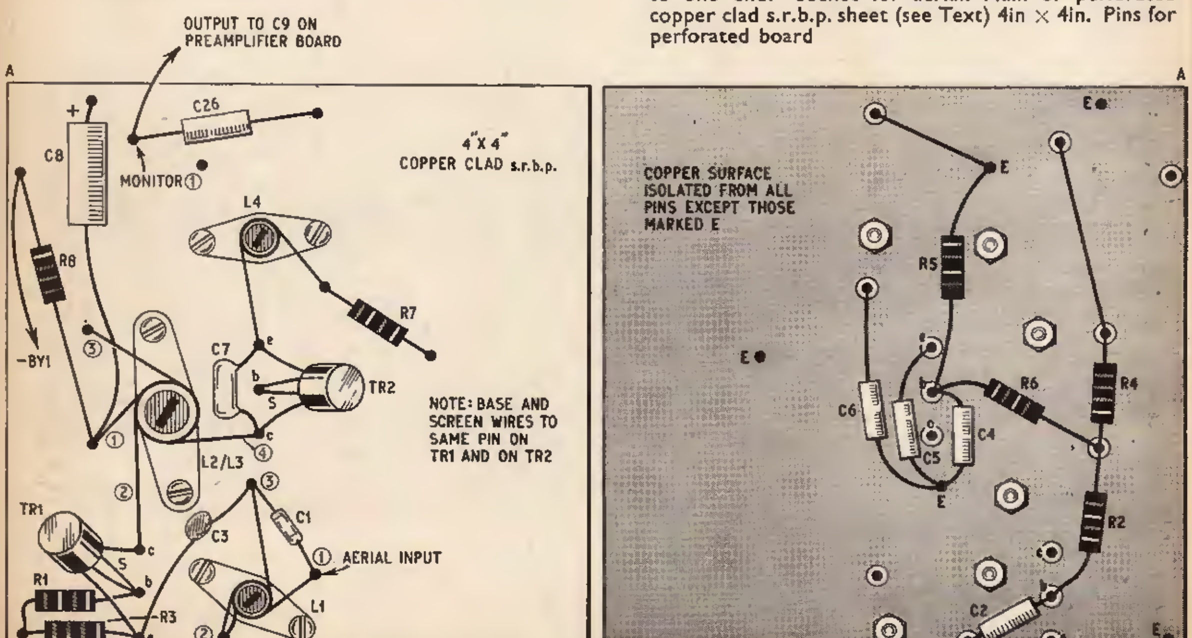


Fig. 4. Component layout and wiring of the receiver panel

Because of the fact that TR2 operates very close to its cut-off point, its characteristic is non-linear, and it is this non-linearity which provides the essential characteristic for detection of the modulation of the carrier. Therefore, TR2 performs the dual role of high gain r.f. amplifier and detector.

If no signal is being received, then self-oscillation is induced at a higher level of collector current, or gain, and hence any circuit noise is greatly amplified in the absence of a carrier. It is because of this inherent characteristic that the super-regenerative receiver is affectionately referred to by some as a "rush-box".

The selectivity of a super-regenerative receiver is inherently poor, and hence is prone to receive simultaneous transmissions, on neighbouring frequencies, from other model control operators in the vicinity. This undesirable feature is to some extent offset by the tendency of the circuit to "latch on" to the strongest signal present, and suppress any weaker signals received.

PREAMPLIFIER CONSTRUCTIONAL DETAILS

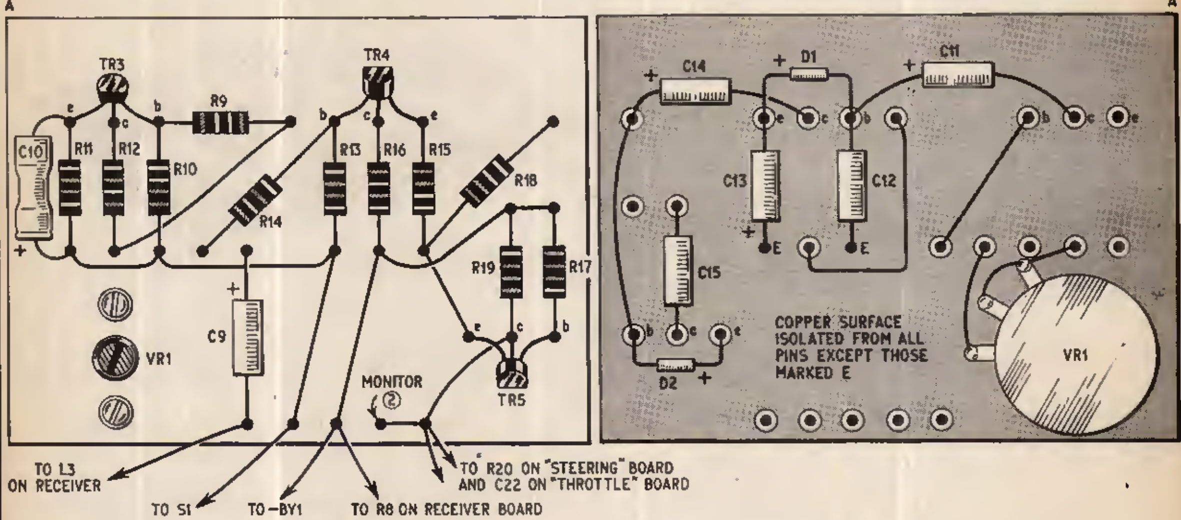


Fig. 5. Component layout and wiring of the preamplifier panel

COMPONENTS . . .

Resistors

R8	470Ω	R12	10kΩ	R16	10kΩ
R9	100kΩ	R13	47kΩ	R17	100kΩ
R10	56kΩ	R14	39kΩ	R18	27kΩ
R11	10kΩ	R15	8·2kΩ	R19	2·7kΩ

All 10%, ¼ watt carbon

Potentiometer

VR1 250kΩ carbon min. preset

Capacitors

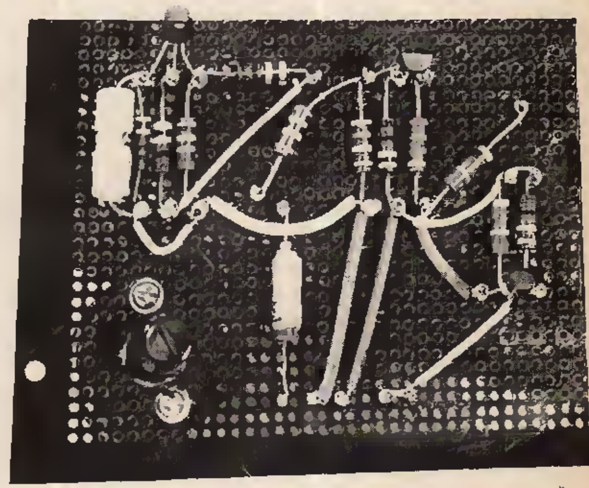
C9	10μF elect. 12V	C13	50μF elect. 6V
C10	25μF elect. 12V	C14	25μF elect. 12V
C11	25μF elect. 12V	C15	0·01μF paper
C12	0·047μF paper		

Transistors and Diodes

TR3, 4, 5 2N3702 *or* 2N3703 (3 off)
D1, 2 1S44 *or* 1S130 *or* OA200

Miscellaneous

Plain or perforated s.r.b.p. sheet (see text) 4in × 3in
Pins for perforated board



The "squegging" action of the receiver can cause unwanted r.f. radiation from a receiving antenna connected directly to the input. Indeed, the initial experiments, performed in an attic workshop, caused considerable interference to television receivers via aerials in the immediate vicinity. This was eliminated and a 6dB gain achieved by fitting an r.f. stage TR1.

This acts as a buffer between the "squegging" detector TR2 and the antenna, and is merely a class A amplifier biased by R1 and R2 in the base, and R3 and C3 in the emitter circuit, for stable operation. The output at the collector is loosely coupled by L2 to L3.

The effect of the antenna loading is reduced on the detector stage, thereby increasing its performance,

STEERING CONTROL CONSTRUCTIONAL DETAILS

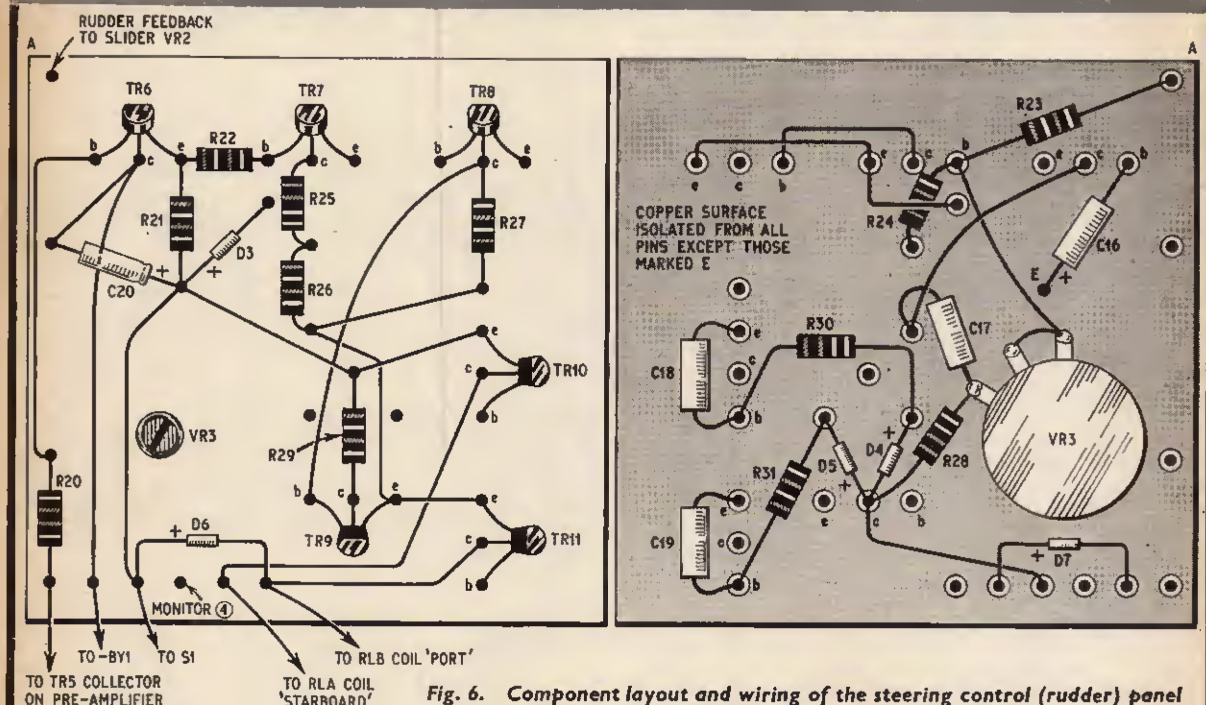
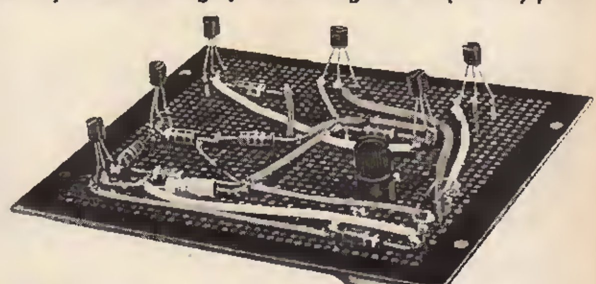


Fig. 6. Component layout and wiring of the steering control (rudder) panel



COMPONENTS . . .

Resistors

R20	10kΩ	R24	47kΩ	R28	150kΩ
R21	4·7kΩ	R25	22kΩ	R29	8·2kΩ
R22	27kΩ	R26	27kΩ	*R30	15kΩ
*R23	10kΩ	R27	1kΩ	*R31	33kΩ

All 10%, ¼ watt carbon
* R23, R30, and R31 may require adjustment on test

Potentiometers

VR2 5kΩ linear carbon or wirewound min.
VR3 1MΩ carbon min. preset

Capacitors

C16	20μF elect. 16V	C19	0·1μF paper
C17	1μF tantalum or paper 12V	C20	8μF elect. 25V
C18	0·1μF paper	C21	0·1μF paper

Transistors and Diodes

TR6, 7, 8, 10	2N3702 *or* 2N3703 (4 off)
TR9, 11	2N3707 (2 off)
D3, 4	Z8·2 (Brush) or OAZ246 (Mullard) Zener diodes (2 off)
D5	Z5·6 *or* OAZ242 Zener diode
D6, 7	1S44, 1S130, *or* OA200 (2 off)

Relays

RLA, RLB 12V 700Ω type MH2 with two changeover sets of 1A contacts (Keyswitch)
or type 4190GD (S.T.C.) (2 off)
(Normal open pair of contacts used)

Switches

S2 Single pole toggle
S3, S4 } Part of Drive System, see Part 2

Miscellaneous

MO2 Motor 3V 6,000–7,000 rev/min (Ripmax Orbit type 505)
Plain or perforated s.r.b.p. sheet 4in × 4in. Pins for perforated board

whilst the antenna loading circuit itself is flatly tuned by L1–C1 prior to amplification by TR1.

The high frequency "squegging" component at TR2 output is filtered out by C26.

PRE-AMPLIFIER

Satisfactory operation of the controls depends entirely on the preservation of a good rectangular waveform after detection by the receiver. This is effected by the use of a high gain pre-amplifier (which is normally saturated), together with a degree of noise rejection filtering. Due to the saturated condition of the amplifier, it is quite stable, and the limiting action is effective in removing the inherent noise generated by the super-regenerative circuit.

The pre-amplifier comprises TR3–TR5 in a circuit which is optimised to clip and square the full range mark/space ratio for minimum signal strength conditions, and provides automatic d.c. restoration of the rectangular wave relative to the zero level for all signals.

Potentiometer VR1 is an optional preset control, which is fitted to the prototype, and can be adjusted to give optimum noise rejection at the limit of the working range of the transmitter. Some degree of noise rejection is provided by C12 and C15.

PROPORTIONAL RUDDER CONTROL

The resultant "clean" rectangular waveform appearing at TR5 collector contains an average d.c. component proportional to the mark/space ratio, but independent of the frequency. This component is extracted by the smoothing circuit R20 and C16 and buffered by emitter follower TR6, prior to being used as a "reference" voltage. This voltage is to be compared with a feedback reset voltage proportional to the actual rudder position as derived by VR2, which is driven mechanically by the rudder shaft, and is some fraction of the battery voltage.

The comparison is made at the input of the d.c. operational amplifier TR7, TR8, TR9, whose closed loop gain is controlled by VR3, the feedback potentiometer, to something around 15.

The quiescent state of the servo is that associated with an amplifier output of about half the battery voltage, when the input currents derived from the reference source and the feedback potentiometer are approximately equal. If, however, the reset voltage differs from that required to obtain this state by about 0·25 volt or so, the amplifier will drive hard to saturation or cut off depending on the polarity of the difference voltage.

A deadband circuit embodying Zener diodes D4 and D5 follows the amplifier, which inhibits operation of succeeding circuits until the "error" voltage exceeds about half that necessary to saturate the amplifier in either direction. This "error" voltage corresponds to about 5 degrees of arc of the steering control at the transmitter (270 degrees helm to helm) and is experienced as lost motion. The deadband, however, creates a definite quiescent state for the control, in which the rudder relays and actuator motor are not energised, and hence once the rudder "homes" to the selected position, current consumption falls to a very low level.

If a signal of more than 5 degrees helm is given then TR10 or TR11, as appropriate, conducts and the associated port or starboard relay is energised which in turn actuates the helm motor. When the rudder nears the selected equilibrium position, the amplifier "zeros" and the relay is released.

Limit switches are fitted at the extremes of lead screw travel which open the motor circuit for the direction selected, should hard helm be given.

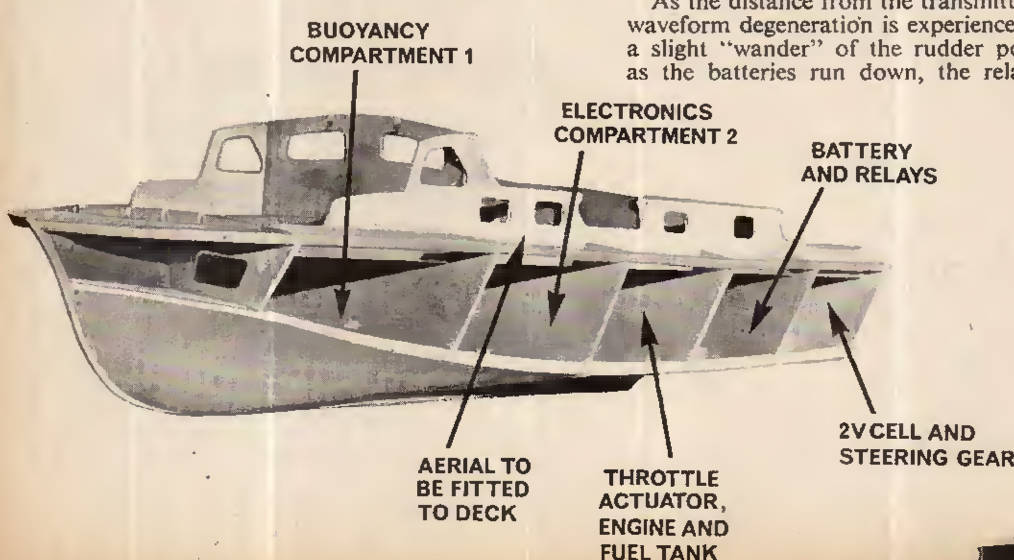
The servo system is simply and effectively stabilised to one overshoot by the phase lead circuit in the feedback path (R28, C17).

Adjustment of the gain control VR3 will optimise the response, corresponding to minimum dead zone without any tendency to oscillate.

As the distance from the transmitter increases, some waveform degeneration is experienced which results in a slight "wander" of the rudder position. Similarly as the batteries run down, the relationship between

IMPORTANT

Readers intending to construct this radio controlled model boat are advised that, before operating in the U.K., the appropriate "model control" licence must be obtained. This licence, which is allocated for model control only at 26·96 to 27·28MHz for a radiated power not exceeding 1·5 watts, can be obtained, upon payment of £1 (sterling), from the Radio Services Branch, G.P.O. Headquarters, St. Martins-le-Grand, London, E.C.1.



helm position and rudder position will be observed to change slightly. In practice these effects were not found to be severe enough to be embarrassing.

If desired, the effect of battery voltage deterioration affecting the rudder control can be easily compensated for by merely rotating the rudder potentiometer body, with respect to its fixing bracket, slightly, say every half hour or so during operation.

PROGRESSIVE THROTTLE CONTROL

The output of TR5 is differentiated by C22 and R32 and fed to the throttle control circuit TR12–TR17.

THROTTLE CONTROL CONSTRUCTIONAL DETAILS

COMPONENTS . . .

Resistors

R32 15kΩ	R35 3·9kΩ	R39 27kΩ	R42 8·2kΩ
R33 47kΩ	R36 180kΩ	R40 3·3kΩ	
R34 470kΩ	R37 4·7kΩ	R41 4·7kΩ	

All 10%, ¼ watt carbon

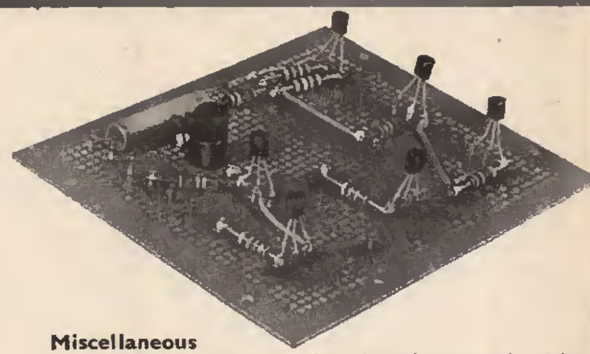
Potentiometer
VR4 100kΩ carbon min. preset

Capacitors
C22 0·003μF paper
C23 0·02μF paper
C24 40μF elect. 16V
C25 0·1μF paper

Switches
S5 Single pole toggle
S6, S7 } Part of Drive System, see Part 2

Transistors and Diodes
TR12, 13, 14, 15, 17 2N3707 (5 off)
TR16 2N3702 *or* 2N3703
D8, 9, 12, 13 1S44 *or* OA200 (4 off)
D10 Z8·2 *or* OAZ246 Zener
D11 Z5·6 *or* OAZ242 Zener

Relays
RLC, RLD 12V 700Ω type MH2 with two changeover sets of 1A contacts (Keyswitch) *or* type 419GD (S.T.C.) (2 off)
Normal open pair of contacts used



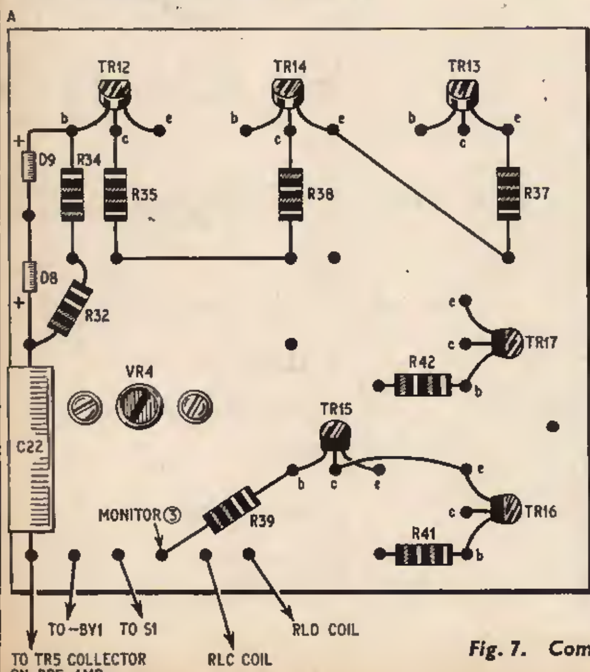
Miscellaneous
M01 Motor, miniature for throttle control with a short shaft (Keil Kraft)
Plain or perforated s.r.b.p. sheet 4in × 4in
Pins for perforated board

OTHER ITEMS FOR ELECTRONICS

Switch
S1 Single pole toggle

Batteries
BY1 15V made up from 12 nickel cadmium cells connected in series (Deac 1·25V, 225mAh)
BY2 2V 1·6Ah lead acid cell

Components for mechanical actuators given next month



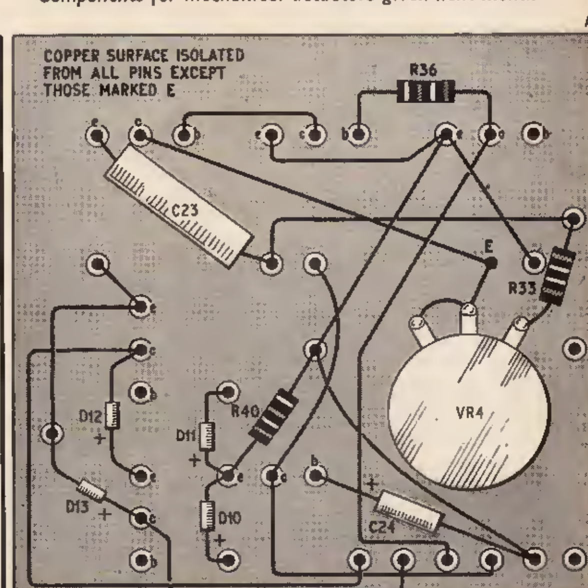


Fig. 7. Component layout and wiring of the throttle control panel

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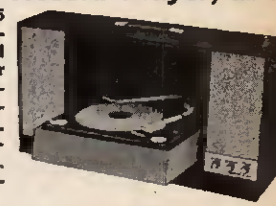

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2N4289 pnp high gain hFE = 100 min. @ Ic = 100μA 160 min. @ Ic = 1mA.
BVcbo over 60V BVceo over 45V fT = 170MHz typ @ Ic = 2mA.
2N4291 pnp large signal high gain hFE = 100 to 300 @ Ic = 100mA Vce = 10V.
BVcbo over 40V, BVceo over 30V, Vce(sat) = 1·5V max @ Ic = 100mA, Ib = 10mA.
2N4292 npn UHF, low noise. fT = 570MHz typ @ Ic = 2mA Vce = 5V. hFE = 50 typ.
BVcbo over 30V, Bvceo over 15V, N.F. 6dB max @ Ic = 1mA, f = 100MHz.
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1/2W 5%	4·7Ω to 10MΩ	E24	2/2	17/-
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500/2·5, 400/4, 320/2·5, 320/6·4, 250/4, 200/6·4, 200/10, 160/2·5, 125/4, 125/10, 125/16, 100/6·4, 80/2·5, 80/16, 80/25, 64/4, 64/10, 50/6·4, 50/25, 50/40, 40/16, 32/10, 32/40, 32/64, 25/25, 20/16, 20/64, 16/40, 12·5/25, 10/64, 8/40, 5/64 .. .. 1/4 each

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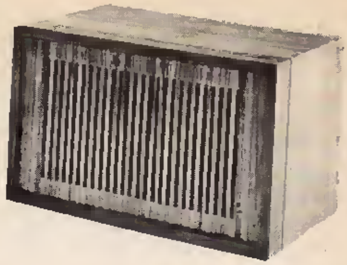

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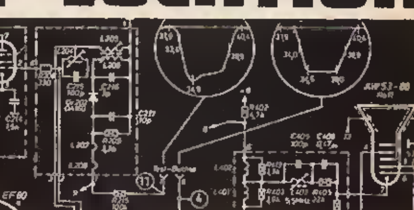

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The negative-going edges are used to set a monostable multivibrator TR12, TR13 and TR14, whose quasi-stable pulse length is preset by VR4 such that it is approximately one half-period of the centre "hold" frequency, 400Hz, equal to 1·25ms.

The monostable output therefore comprises a 1 : 1 mark/space ratio for this condition, and has an average d.c. component after smoothing (R39, C24) of about half the battery voltage (7V). Neither Zener diode (D10, D11) conducts, thereby depriving TR16 and TR17 of drive; hence, neither throttle relay is energised.

It can be seen that as the monostable is only influenced by negative-going edges, and there is only one such pulse per cycle, the output d.c. level will be unchanged as the mark/space ratio of TR5 output varies over its full range.

If, however, the transmitted frequency is raised to 600Hz ("close throttle") the quasi-stable period of the monostable becomes nearly equal to one complete period of the signal frequency and TR12 is not conducting for a high percentage of time. The monostable output average d.c. component assumes a positive voltage, approaching that of the battery, and D11 conducts, operating the "throttle close" motion relay via TR17.

The throttle motor will continue to rotate until the frequency is restored to a lower level, or the limit switch on the lead screw is operated. If the frequency selected is 110Hz then TR12 remains in its stable state (conducting) for relatively long periods of time, with an average d.c. output voltage of about 1 volt to earth. This results in conduction of D10 and operation of the "throttle open" relay RLC via TR16.

The monostable is of a special design which permits rapid recharging of the timing capacitor C23 at the end of a quasi-stable period. This ensures that the monostable is ready to re-enter an accurate quasi-stable period with the minimum delay in the stable state (about 5 per cent), thus guaranteeing good separation between the "hold" and "throttle close" signals.

The "open throttle" discrimination is determined by the cut-off condition of TR15 (about 1·5 volts) as a result of TR16 base current. The "open throttle" frequency need only be low enough to create the cut-off condition, any further frequency reduction only results in unnecessary chatter of RLC.

The frequency allocations for throttle control functions are deliberately made to provide a fail-safe feature. It is obviously desirable that the throttle should be closed to minimum (tick-over) should the transmitter fail or the boat get out of range. Contrary to initial expectation, loss of signal does not produce the effect of frequency reduction to d.c. conditions, i.e. zero frequency.

The noise level of the super-regenerative circuit rises enormously if the carrier is removed, and becomes sufficient to trigger the monostable continuously, giving a high positive output from TR12. It is wise, therefore, to associate this condition with the "throttle close" command.

In a similar manner the random noise pattern generated under weak signal conditions results in an approximately "average" mark/space ratio of unity on the rudder control. As a result the rudder assumes a position roughly amidships. The slow speed straight-ahead attitude adopted by the vessel was very comforting during trials when the transmitter was deliberately switched off.

At this point it will be realised that, had the modulating frequency of the transmitter been made infinitely variable instead of being switched, which could be readily achieved by variation of the charging potentials of the transmitter multivibrator capacitor, the throttle control could have been an independently actuated simultaneous position control, in a manner similar to that used on the rudder. However, it was decided not to do this on the prototype both to preserve simplicity, and to explore the possibilities of both systems.

BOARD CONSTRUCTION

Perforated s.r.b.p. boards were used throughout for the electronic assemblies and layouts were not found to be critical although it is desirable to keep lead lengths as short as possible in the 27MHz portions.

The receiver panel is actually a peg-board manufactured from s.r.b.p. and copper laminate (unetched printed circuit material) the copper acting as an earth plate, being cut away round the plated pegs used for connections to components. This is easily done by countersinking the $\frac{1}{16}$in peg holes with a $\frac{3}{16}$in drill prior to insertion of the pegs.

The entire receiver section is mounted on an unetched s.r.b.p. card 4in × 4in fitted with isolated pegs, and soldering components straight down to the copper ground plane as required. The receiver layout is not particularly critical provided that lead lengths are kept to a minimum and the "earthy" end of certain capacitors are taken to a common point on the ground plane as shown.

So far as the other three assemblies are concerned, there is no special need for using copper clad board (as shown in the diagrams) and a plain type of s.r.b.p. board can be used here if preferred.

Full layout and wiring details for the boards are given in the illustrations (Figs. 4 to 7).

Next month: Actuator construction and installation of drive system and power supply.

POINTS ARISING

PRACTICAL TRANSISTOR CIRCUITS (*April 1968*)
The loudspeaker should be connected between C3+ and the −9V line in the complementary symmetry circuit; R6 should be connected between C3+ and TR2 base; C2 should be connected in parallel with R3.

SOUND EFFECTS: WIND AND RAIN (*April 1968*)
Capacitor numbering in the wiring diagram (Fig. 5) should be amended as follows: C1 to C7 should read C7 to C13 in sequence; likewise C8 to C13 should read C1 to C6. In the components list R1 to R7 inclusive should be 2·7kΩ.

FLUORESCENT CAMPING LIGHT (*March 1968*)
Modification for pre-heating the lamp electrodes was published in the May 1968 issue. It has been found that in this modified circuit (page 375) the capacitor C2 is no longer required and should be deleted. The lamp will then give maximum output when switch S1 is turned to position 3.

EPOXY RESINS

And some of their applications in the electronics industry

By P. A. Dunn, CIBA (A.R.L.) Ltd.

THE technique of protecting components by enveloping them in a "block" or film of moisture-resistant material was in use long before the development of the present-day potting or casting resins. For many years, components such as capacitors have been encapsulated in wax or bitumen, while transformers and other wound components have been impregnated using vacuum or dipping methods.

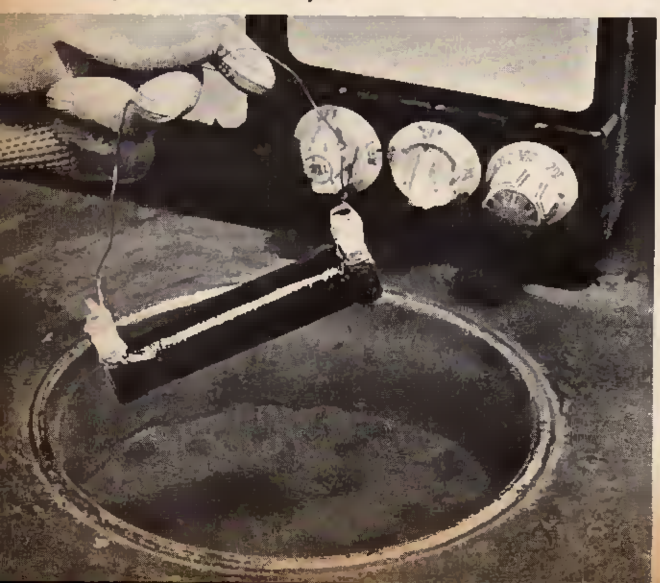
These processes, however, give very little mechanical protection to the components. Moreover, should any local overheating occur, thermoplastic materials such as wax and bitumen will melt and drain away. Another method is to hermetically seal components in a metal can, the leads being made through glass-metal seals, which are subsequently soldered. This method, however, is expensive.

Epoxy resins, introduced to this country about 18 years ago, have brought new concepts of design to the electrical and electronics industries and the ease with which intricate high performance components can now be formed with these resins has given a new freedom to design engineers.

APPLICATIONS

Probably the most well known use of epoxy resins is as adhesives and they are widely used as such in the electronic and electrical industries. Gramophone rotors are bonded to shafts, ceramic insulators are bonded to metal, nickel iron laminations are bonded together to form stators, etc. They are also used to bond the lids of car batteries and to bond iron powder in the manufacture of iron dust cores.

A wirewound resistor receiving a coating of epoxy resin by the fluidised bed technique



CIRCUIT BOARDS

When reinforced with, for example, glass cloth, epoxy resins can be formed into structures having a high strength-to-weight ratio, excellent electrical properties over a wide range of temperatures, great dimensional stability under varying conditions, and good chemical resistance, etc. Pre-impregnated sheets of epoxy glass cloth, pressure moulded to form printed circuit boards, are rapidly supplanting conventional s.r.b.p. ("Paxolin") in high quality equipment.

CHOICE OF INGREDIENTS

Chemically the resins are derived from epichlorhydrin and diphenylol propane. By varying the ingredients and certain phases of the manufacturing process a series of resins may be produced ranging from rather viscous liquids to hard solids. In the uncured state the resins are thermoplastic with poor mechanical strength. They are converted into hard, tough and substantially infusible materials of high molecular weight, by reaction with a suitable hardener. A wide range of chemical hardeners may be employed and since the hardener takes part in the reaction, the properties of the cured product are not only affected by the type of resin selected, but also markedly by the type of hardener employed.

Some epoxy resin and hardener mixtures will cure at room temperature, while others require processing at elevated temperatures. The ratio of hardener to resin in each case is fixed within narrow limits and departure from the optimum ratio entails loss in performance. The choice of hardener can affect the application viscosity of the mixture, the pot-life and the rate of cure. In general, therefore, pot-life and rate of cure can be varied only by choice of hardener, and not by change of resin : hardener ratio. There are, however, some formulations in which a small and variable addition of an accelerator may be used to adjust the pot-life and cure time of a slow acting resin-hardener system.

FILLING AND COLOURING

The many combinations and permutations of the several basic epoxy resins and the greater number of hardeners can be extended by even further modifications. The viscosity may be reduced by solvents, plasticisers, and diluents. Some diluents and plasticisers are reactive and can be combined into the final cured product. Diluents and plasticisers reduce viscosity or impart resilience at the expense of strength at elevated temperatures. Inert fillers may be added to the epoxy resin systems for opacity, cheapness, to improve hardness, wear resistance, thermal conductivity, electrical and mechanical properties, to increase viscosity or reduce the co-efficient of expansion or possible exothermic reaction.

Commonly used fillers are silica, mica, chalk, asbestos, glass, and synthetic fibres, etc. Epoxy resins can be dyed, pigmented and pastes of colouring matter dispersed in liquid epoxy resin are available.

Although the number of possible combinations of resin, hardener, plasticiser, filler, and dyestuff is very great and the number of possible applications is equally large, resin formulations for specific purposes are commercially available. At the same time, the ingredient resins and hardeners are available for those who prefer to exercise wider choice or to derive their own formulations.

EPOXY POWDERS

Although much of the early work with epoxy resins in the electrical and electronic industries involved the use of liquid epoxy resins, more recent techniques make use of the resin systems in powder form.

Epoxy moulding powders consist essentially of a partially cured resin-hardener mixture in powder form. In use they are very free-flowing and may be easily moulded round delicate inserts, while thin sections of resin may be moulded round large metal inserts without difficulty. They cure rapidly on the application of heat and pressure with negligible after-shrinkage. As with other forms of epoxy resin, the absence of volatile matter during the curing operation is of particular value.

The moulding powders have a shelf life of some months and are usually stored at temperatures below 25 degrees C. After processing, they possess high insulation strength, excellent dimensional stability, good heat resistance, low water absorption, and good resistance to tracking. They maintain their dimensional stability at elevated temperatures and in adverse climates.

Epoxy moulding powders have been widely adopted for the fabrication of bobbins, relay bases and connectors, and for the protection and insulation of transformers, silicon diodes, ferrite cores, and metal film resistors.

FLUIDISED BED COATING

In the fluidised bed coating technique the powder, based on an epoxy resin system, is placed in a container with a porous base plate. Air is passed through the plate which causes the powder to become fluid. The component requiring protection is pre-heated and placed in the powder which becomes molten with the heat and adheres to the component. The time of immersion in the powder and the pre-heat temperature of the component determines the thickness of the coating. Subsequent cure may or may not be required depending upon the resin system used. By suitable masking techniques, the protective or insulating film can be placed where required, as for example, in the slots of rotors, eliminating the need for slot liners. The absence of solvents, as may be present in normal coating systems, leads to the elimination of solvent bubbling and solvent entrapment during processing, etc.

Apart from application by the fluidised bed technique, powders can be applied by electrostatic spraying techniques or by processes involving the advantages of both techniques.

"E-PAK" TECHNIQUES

A technique recently introduced to the U.K. and particularly applicable to the packaging of diodes and transistors uses moulded cases and pre-formed pellets of epoxy resin, appropriate in shape and size to the component being protected. As supplied the pellets are dry, non-toxic, and easy to handle. Cure temperature, viscosity, and other physical properties may be varied to meet the requirements of productivity. As in the case of moulding powders and fluidised bed powders, etc., the epoxy pellet in the "E-Pak" process, as it is called, is not fully cured and under the influence of heat it melts, fills the moulded housing containing the components, then sets to form a high strength solid.

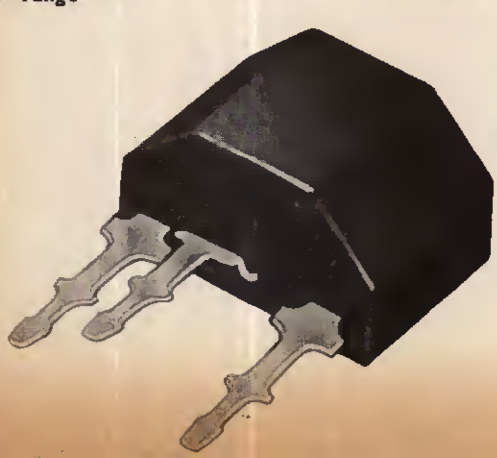
LIQUID RESINS

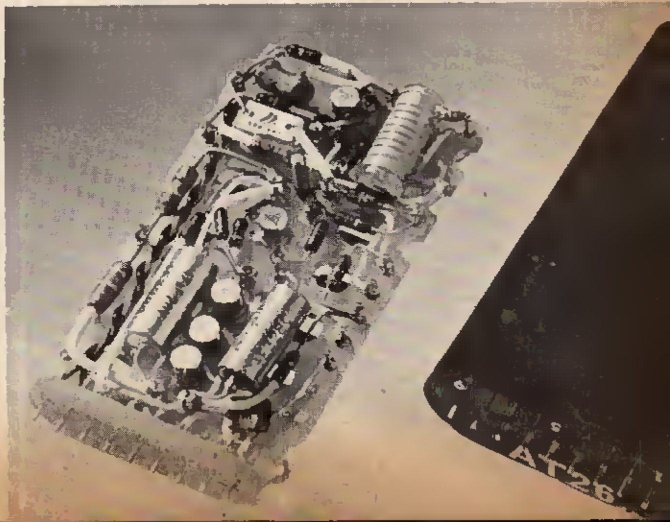
In the same way that an electronic component can be dipped into a fluidised bed powder, it may be protected by dipping into a liquid epoxy resin system. In this case, however, the component is usually at room temperature. The liquid epoxy resin system is formulated to give a thixotropic characteristic so that the resin will not flow from the component during cure. Where the specified requirements are not too high, this system probably offers the cheapest method of encapsulation. It is necessary, however, to take steps to ensure control over the thickness of the coating, since, should this vary, variable performance under high humidity may be obtained and there may also be a tendency for the thinner coatings to crack at low temperatures.

Liquid resin epoxy systems are, however, normally employed by pouring the fluid uncured mixtures into moulds of metal, plaster, plastic or other material by simple gravity casting techniques. Indeed, the term

(right) Rank Pullin amplifier-transmitter units before and after encapsulation

(below) An epoxy cased transistor from the Mullard "Lockfit" range





"casting" is normally employed to describe the general process, although it usually implies the production of an insulating or insulated component where the mechanical as well as the electrical properties of the material are important.

Potting, or encapsulation, implies the complete envelopment and embedment of a component or device in a protective mass of the resin, the object being not only to insulate, but also to protect the article being potted against vibration, shock, dust, ingress of moisture, chemical attack, insects, and other environmental hazards. It will be appreciated that such a technique gives a consistent resin thickness around the component being protected.

The basic casting methods are common to both the electronic and heavy electrical industries, but the products are usually different. Resins used for encapsulating electronic devices are usually designed to cure at low temperatures, for obvious reasons.

MECHANICAL REQUIREMENTS

In the case of magnetic materials, which are highly sensitive to pressure, such as some high permeability steels, it is often necessary to exclude contact with the encapsulation resin by making the core external to the casting, or by means of certain more specialised methods. Metal components can be enclosed within the cured epoxy resins, providing that the differences in thermal co-efficient of expansion are considered.

Both thermal contraction and the curing shrinkage may be further reduced by extending the resin mixtures with inert mineral fillers such as silica, mica, slate, and chalk, etc. The use of fillers also reduces possible exotherm, increases the thermal conductivity and reduces the cost. Fillers are invariably used in the production of large castings.

An automatic dispenser is used by Telegraph Condenser Co. for epoxy sealing of capacitors

Pye of Cambridge use epoxy adhesives to bond the two halves of ferrite pot cores for telephone equipment

Liquid epoxy resin systems may be used to complete the existing closure, made of metal or insulating material, with which a component has been surrounded, by casting the epoxy resin in the container. For example, components may be placed in metal cans and sealed with a layer of epoxy resin and by this technique the need for relatively expensive sealed outlet bushings may be eliminated.

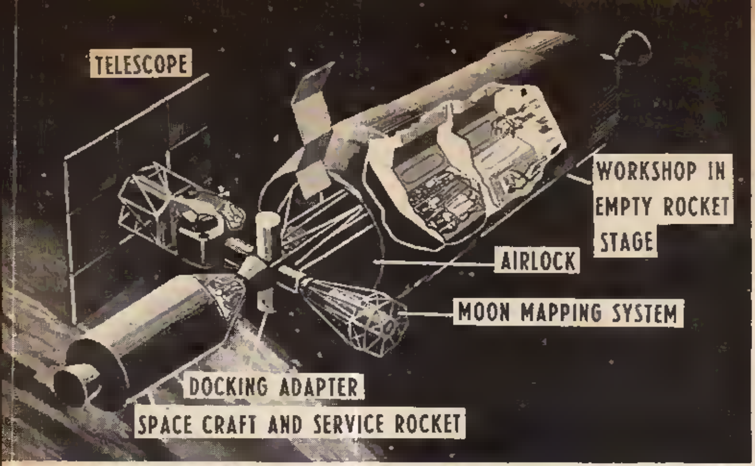
Certain other liquid epoxy resin systems are specially designed for impregnation. The usual technique is the straightforward vacuum impregnation used in industry, although when considered necessary, vacuum may be followed by pressure.

For the impregnation of windings of electrical machines, such as motors, dynamos, and syncros, liquid epoxy resin may be employed in the trickle impregnation process. Here the wound armatures or stators are exposed, while rotating, to a trickle of freshly prepared solvent-free epoxy resin mixture, for a fixed time at a constant temperature and at an appropriate angle. When the winding is completely filled with the epoxy resin, rotation is continued at a controlled temperature in the horizontal plane until the resin has gelled. Heat treatment may follow.

SOLUTIONS

Solutions of epoxy resins are also employed for impregnation and have advantages over more traditional systems. For example, they are used for the impregnation and bonding of "C-cores", where their adhesive properties are valuable.

Another major application of epoxy resins is their use in surface coatings. Epoxy based primers and finishes find wide application for the protection of refrigerators, washing machines, and the housings of many items of electrical and electronic equipment. ★



Impression of United States Apollo space station

SPACEWATCH

By Frank W. Hyde

FIRST ASTRONAUT

At the time of writing the sad news of the death of Yuri Gargarin was announced. He will go down in history as the first man in space and who marked the starting point of manned spaceflight. He was an unassuming and pleasant man who seemed quite unaffected by the publicity that his exploit brought him. He continued to lead the Russian cosmonauts though he did not make other spaceflights. This contrasts with the American "first men" who are no longer connected with spaceflight.

RUSSIAN MOON PROGRAMME

It is perhaps appropriate at this point to look a little more closely at the Russian Moon Programme. It has been thought that the general trend of Russia's efforts would be on the space platform technique. They had indicated this on a number of occasions when they gave small cocktail parties at the Soviet Embassy.

Since the successful remote manoeuvring of space vehicles it must be a possibility that Soviet technology has reached a point where they could be very close to the U.S.A. in point of time. The rumours of a special high thrust booster greater than *Saturn V* were circulating some time ago; such a booster could have a thrust in excess of 10^6lbf.

Possibly this has been once more achieved by the same techniques as in the past, namely the group or cluster method. It could be that a circumlunary project is being prepared in which case, if normal Soviet procedure is followed, there will be a first such attempt using dogs. It is rather significant that nine tracking ships came into operation in various parts of the world, some with large radomes aboard.

Such a network would be essential to any moon attempt which is manned. It is known that the astronauts are having training for water landings, since a circumlunar attempt would probably require a landing somewhere on the equator.

VOICE OPERATED DEVICES

From time to time a certain Hungarian, Lazlo Telcs, has made headlines with his voice operated devices. Though some of these led to rather embarrassing incidents it did not minimise the importance of this development of electronic techniques.

A number of organisations have tackled this problem and now comes news from RCA that under contract for the American Air Force they have under development an advanced project for astronauts. The advantages of such a system are that the astronaut would have his hands free for tools, cameras, control of a personal jet system, etc. while being able to instruct other devices.

The technique of speech recognition has reached a stage where such variations as local dialectal differences can be accepted. There is a name for this type of recognition. The word "Phoneme" indicates the smallest part of speech sound that can be distinguished. The "f' in "fin" for example is one.

GROUND STATIONS

Cable and Wireless Ltd. will be setting up two new ground stations for public service. Scheduled to be in operation by May 1969 they will be constructed at Hong Kong and Bahrain. A contract has been placed with The Marconi Company covering the aerial structure and associated electronic equipment. The cost will be of the order of £2·1 million. The total cost to Cable and Wireless for this service will be about £3·5 million.

These two stations will operate through the *Intelstat 3* satellites. The aerial dishes will be 27 metres in diameter and will be mounted on 18 metre towers. They will be fully steerable in order that they may follow satellites in any orbit.

The Hong Kong station will be concerned with the satellite over the Pacific and will be located on Stanley Peninsular. The Bahrain station situated at Abu Jajur will operate through the other satellite over the Indian Ocean. There will be a direct service from London to Japan, the U.S.A., Hawaii, Australia, Thailand, and the Phillipines.

It is hoped by 1970 that another satellite *UK-4* will be launched. A design study has been completed. There would be a repeat of the experiments performed by *UK-3* with three new additions. Three of the previous experiments need to be repeated for they were spoiled to some extent by mutual radio interference. All three were in the low frequency range of the radio spectrum.

OPTICAL TELESCOPE IMPROVEMENTS

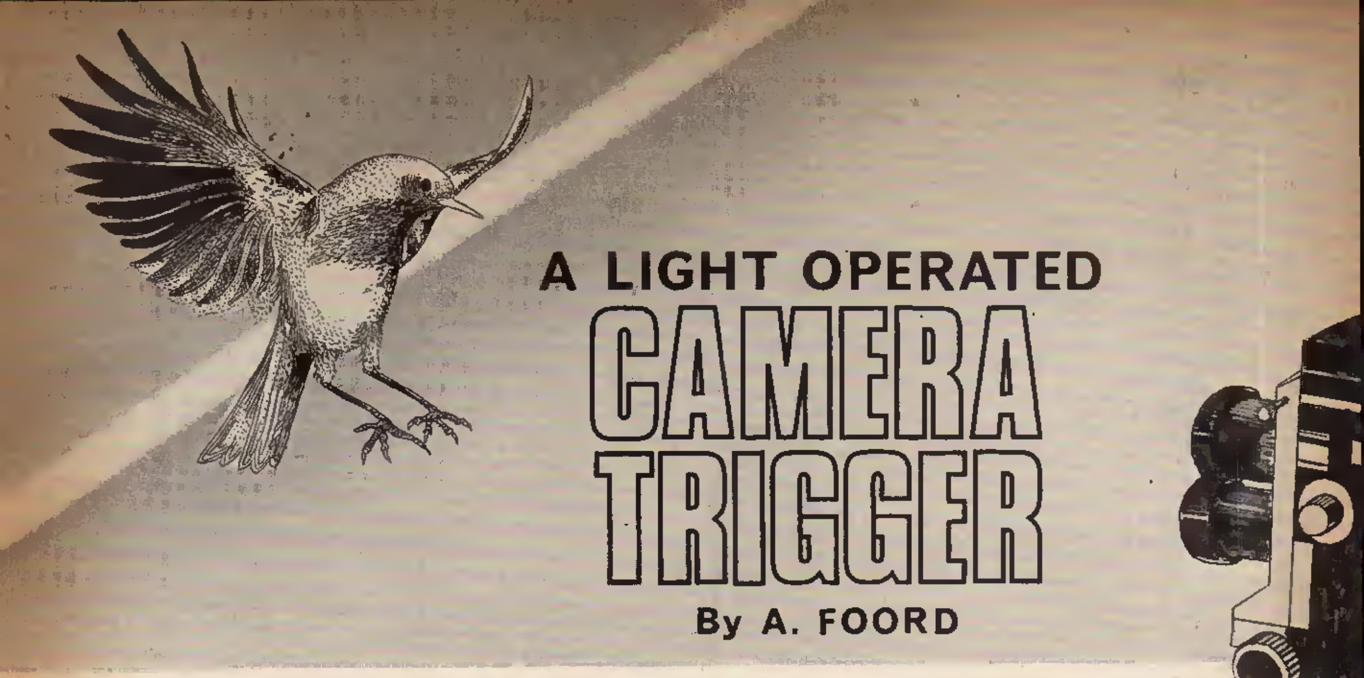
One of the problems in the optical field is getting enough area to gather the maximum amount of light since this determines limits of resolution. A recent successful system has now been developed which virtually makes a mirror ten times larger. This electronic system called the Boyd-Boksenburg Charge Image Reader is to be fitted to the new Isaac Newton Telescope at Herstmonceaux.

The inventors were Prof. R. L. F. Boyd and Dr. A. Boksenburg of the Mullard Space Science Laboratory at University College London. The system has been patented and is on the production line.

Tested on the Isaac Newton Telescope it gave an effective mirror diameter of 2,500cm. The system uses a highly insulated electronic storage plate backed by a conducting plate on which the optical image is directly converted to a charge image by photo-emission. The image is "read" by the proximity of a vibrating probe. The distance between the probe and the plate is of the order of ten microns. The rapid change of capacitance results in an alternating current flow which is directly proportional to the quantity of charge. When amplified it results in a picture when the probe scans the area.

The method differs from ordinary television scanning in that the image is not destroyed during the scan and it is therefore possible to build up the picture element till it reaches a suitable value to be useful.

There are many great advantages to be derived from this device. A photographic image may take hours to expose where this method takes minutes, and in addition there is no grain to mar detail. Moreover the direct readout eliminates the processing of film and the attendant techniques, and not least avoids the uncertainty of the success of the exposure.



A LIGHT OPERATED CAMERA TRIGGER

By A. FOORD

THERE are frequent occasions when one would like to trigger some apparatus into operation without being present to operate it oneself. Examples of some applications are burglar alarms, counting circuits, photography, and so on.

In photography, a birdwatcher is a special case. All too often the bird, or indeed any animal, can be heard, but one has to wait patiently for some time before it will show its face. In the time it takes to set up a camera to photograph the subject, it could have vanished as unexpectedly as it appeared.

What is required, then, is some device that could be set up in the field ready to trigger the camera without undue loss of time. Such a device is described here and was designed to fulfil the following requirements, bearing in mind the use of the photo-electric principle of breaking a light beam.

1. To respond to the fast or slow movements of birds or animals.
2. To be unaffected by very slowly changing external light, such as daylight.
3. The distance between the light source and the triggering unit had to be as great as possible to avoid the animal scenting the photographer.
4. The unit should be lightweight, portable, and have low power consumption.
5. As most animals are sensitive to white light but not to red, a dark red filter was placed over the light source to render the beam inconspicuous.

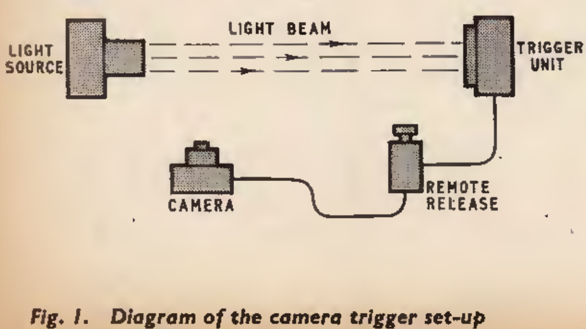


Fig. 1. Diagram of the camera trigger set-up

SHADOW TRIGGER

The system used is illustrated in the block diagram Fig. 1. The complete circuit is given in Fig. 2. The drop in light intensity on the photocell, caused by the shadow of the subject, is used to trigger a monostable multivibrator. A low power lens, such as found in a watchmaker's eyeglass, was found to be suitable for directing the light onto the photocell, in this unit a phototransistor TR1. The eyeglass can be obtained quite easily through large well stocked toolmerchants.

Transistors TR2 and TR3 comprise the multivibrator, and TR4 operates the relay.

Consider at some instant that TR1 is illuminated. When the unit is switched on TR3 will conduct, since its base is returned via R7 to the negative rail. Thus TR3 collector-emitter voltage will be almost zero, and TR2 and TR4 will be cut off. The circuit will remain in this state indefinitely unless compelled to change by an externally applied signal. If the light beam is cut, a negative going pulse will be applied to TR2 base, making TR2 conduct and produce a positive pulse at its collector. This pulse is applied via C2 to the base of TR3, cutting it off. A negative pulse appears at TR3 collector and is applied to TR4 base; TR4 conducts to pull in the relay.

The circuit is now in the second of its two possible states: TR2 conducting, TR3 cut off, but will not remain in this state for long because C2 (which was charged up when it conducted the pulse from TR2 to TR3) immediately begins to discharge through R7 and the output circuit of TR2. As C2 discharges, TR3 base becomes less positive until TR3 conducts again. The circuit is now back in the stable state.

In brief, when the beam is interrupted, the unit changes from its stable state (TR3 conducting; TR2, TR4 cut off) to an unstable state (TR3 cut off; TR2, TR4 conducting) and operates the relay. The duration of the latter condition is given by $t = 0{\cdot}69 R_7 C_2$ seconds.

COMPONENTS . . .

Resistors
R1 18kΩ
R2 3·9kΩ
R3 120kΩ
R4 150kΩ
R5 3·9kΩ
R6 15kΩ
R7 39kΩ
R8 3·9kΩ
R9 4·7kΩ
All 10%, ½ watt carbon

Capacitors
C1 8μ elect. 15V
C2 8μF elect. 15V
C3 0·002μF paper or polyester

Transistors
TR1 OCP71 (phototransistor)
TR2, 3, 4 OC201 (3 off)

Diodes
D1, 2, 3 OA81 (3 off)

Relay
RLA 185Ω 6V type MH2 (Keyswitch Relays)

Miscellaneous
BY1 Battery 6 to 12V
M1 Meter 0–1·5mA f.s.d.
JK1, PL1 Jack with two break contacts and plug
Sockets for wander plugs (2 off)
S1 Single-pole, on/off, toggle switch
Light source (bicycle lamp)
Red filter (Ilford No. 608)
Component tagboard, 10 pairs of tags
Diecast box 6⅞in × 4⅜in × 2¼in or similar
Watchmaker's eyeglass
Battery retainer and clips
Insulation board, s.r.b.p., 4in × 3in

The complete light operated camera trigger control

For the values shown the relay hold-in time is about 0·2 seconds. If this time is not sufficient (in any particular case) it may be increased by increasing the value of C2.

It is usually desirable for the unit to operate with the minimum of time lag, the addition of C3 gives appreciable feedback at high frequencies, and ensures that the rectangular pulses generated at the collectors of TR2 and TR3 are sharp edged, so that the monostable changes state rapidly.

SIMPLE TO MAKE

The diode D1 may be any small signal type, while D3 prevents the high back e.m.f. from the collapsing magnetic field of the relay from damaging TR4. D2 is inserted to prevent damage if the battery connections are accidentally reversed. Relay RLA could be any 6V type requiring up to 30mA to operate it (see components list).

The construction used for the unit would vary according to the needs of the constructor; a diecast box is ideal for this to exclude unwanted light. Fig. 3 shows the tagboard wiring and tagboard component positions. The photograph shows the layout in the box, this will depend to a large extent on the focal length of the lens used. The one in the prototype has a 2in focal length.

For a lens of short focal length the phototransistor can be mounted on the back of the box as shown, with the lens mounted in a hole in the box lid. The trigger unit is connected to one of the remote camera releases available commercially, these usually consist of a solenoid released plunger, operated from a battery when a contact is made.

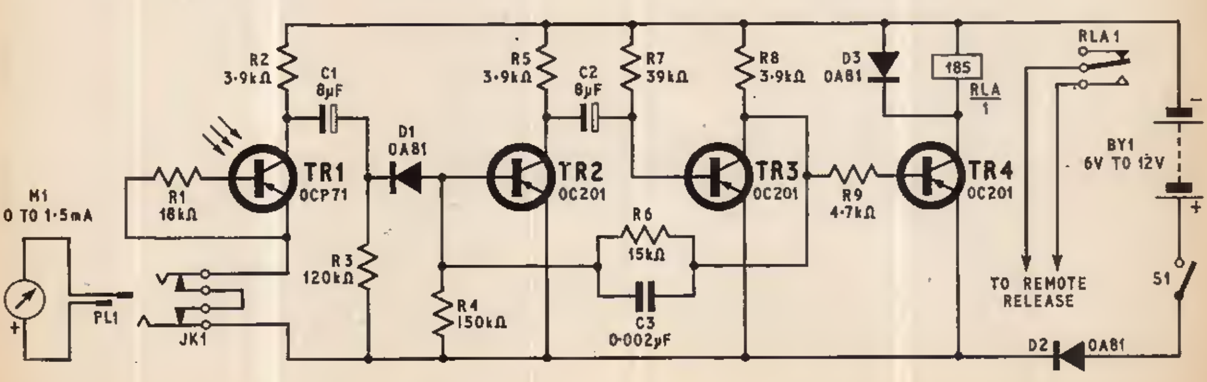


Fig. 2. Complete circuit of the trigger unit

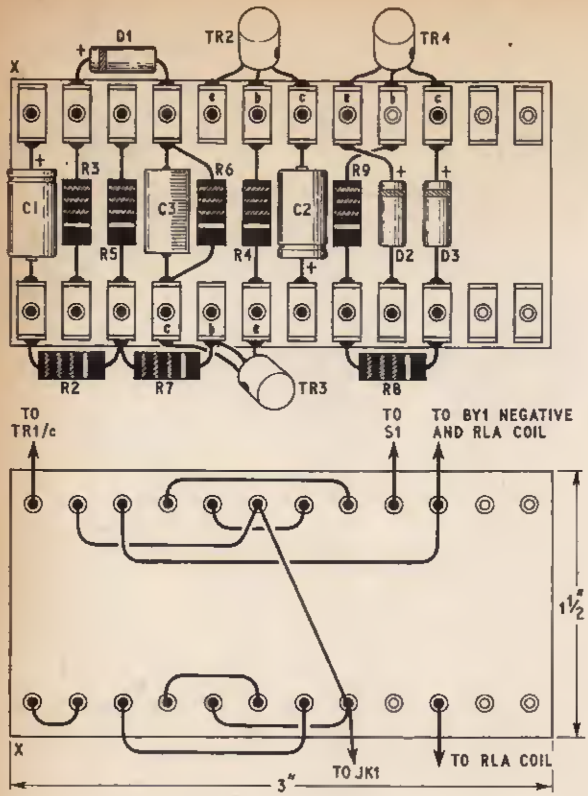


Fig. 3. Component layout and wiring of the tag board in the trigger unit

The meter M1 in series with TR1 is for setting up, and is externally connected via a jack JK1, with break contacts to short the jack when not in use.

The phototransistor is mounted as shown in the photograph so that the emitter junction is facing the lens. This can be seen through the glass envelope and recognised as the side of the base (square piece) with the largest "blob".

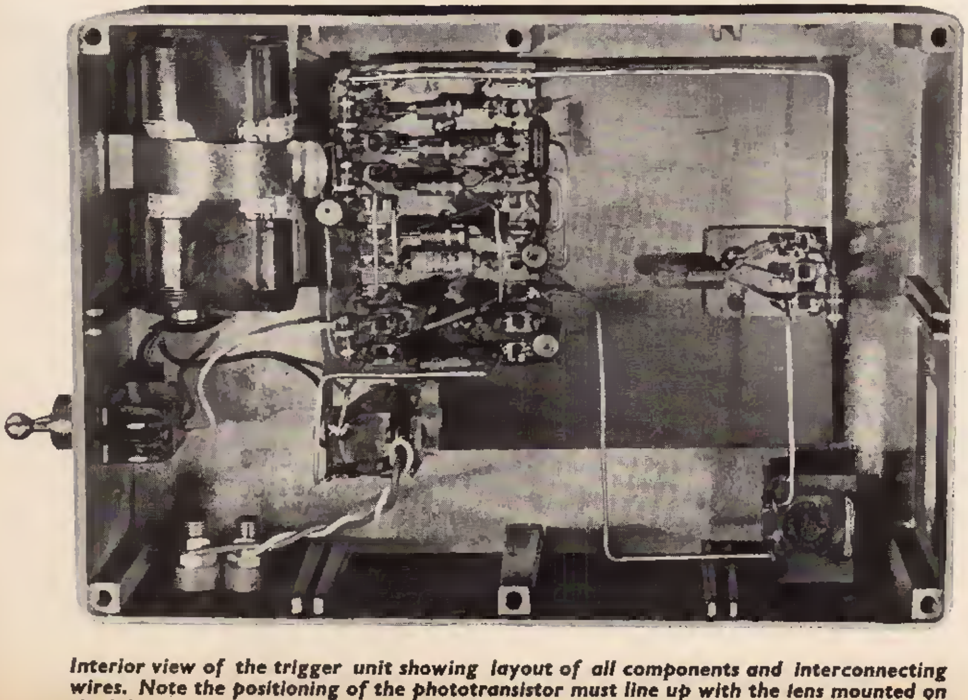
SETTING UP PROCEDURE

Using an ordinary bicycle front lamp, reliable operation can be achieved with a beam length of over 40ft without the filter, and 20ft with the filter. The light source and trigger unit are mounted on camera tripods. The light source should not be run from a.c. supplies, otherwise unreliable operation will result.

Point the light source in the required direction and switch on. Arrange the trigger unit in the path of the light beam and switch on; the leads to the remote release should not be connected at this time.

Swing the trigger unit vertically and horizontally until M1 reads a maximum. Lock the trigger unit in this position; the light is now focused on TR1. For reliable operation M1 should read at least 0·5mA. There is no point in providing enough light to give more than 1mA current, so the intensity of the light source should be adjusted according to the range required.

Remove the meter from JK1. Now, by passing the hand through the light beam you should hear the click of the relay. The output sockets can be temporarily connected to an ohmmeter, or a series bulb and battery, to ascertain that the relay is actually switching. If all is in order, connect the remote release to the trigger unit and all is ready for photographing, provided the camera is aimed at the light beam, where the subject will be. ★



Interior view of the trigger unit showing layout of all components and interconnecting wires. Note the positioning of the phototransistor must line up with the lens mounted on the lid.

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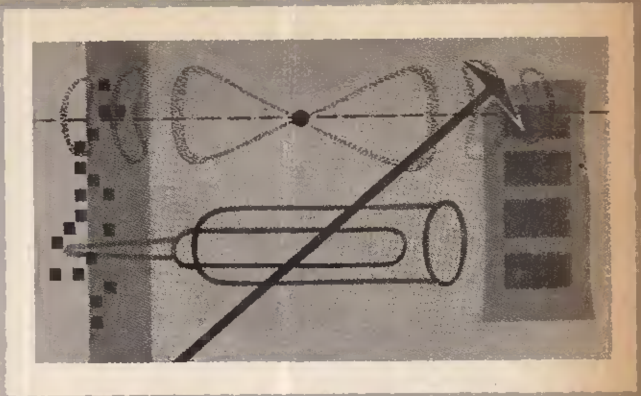


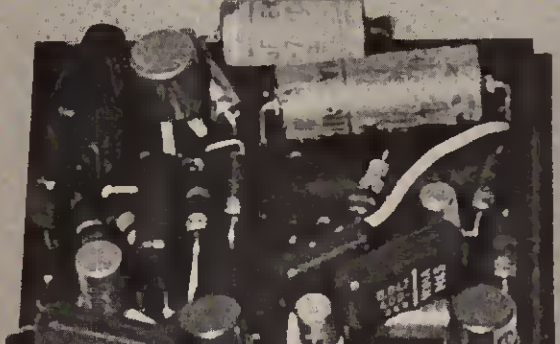
By M.L. Michaelis M.A.

8—STRACE RADIATION METER (Continued)

Last month the ratemeter module of the STRACE radiation meter unit, was described. Before going on to consider the other sub units which make up the complete unit, a few remarks concerning chart recording will be appropriate.

CHART RECORDING

The circuit of Fig. 7.1 illustrates all essential features of a modern ratemeter possessing high efficiency and excellent stability with respect to time and temperature. This circuit is eminently suitable for *chart recording*.



One of the pip generator modules of the STRACE Radiation Meter

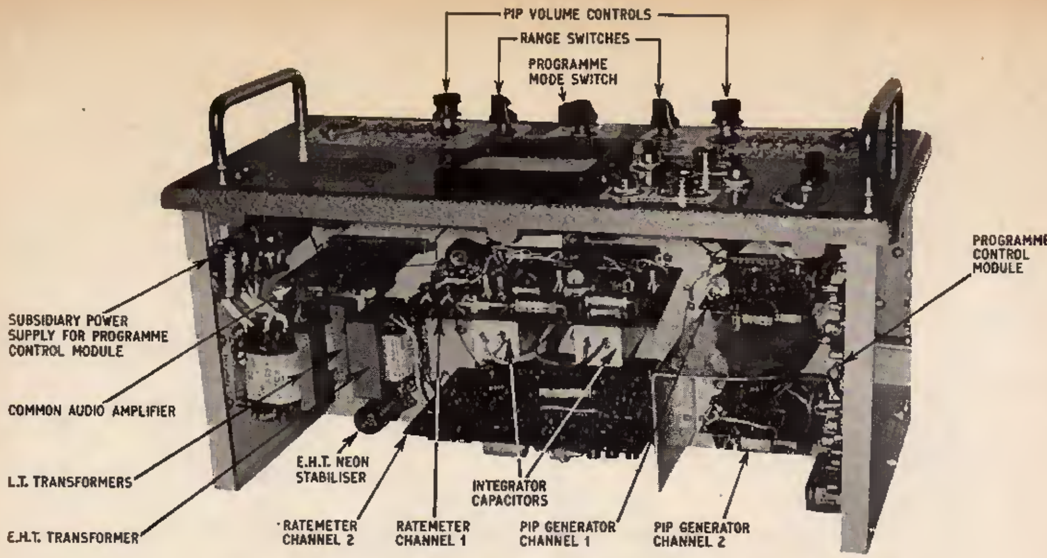
The recommended chart recorder is the model "Metrawatt Multiscript 3" obtainable from Messrs. Smiths Electric Clocks Ltd. This is a precision multimeter, which may also be used as such and possesses a scale and pointer in the usual arrangement. The pointer is a sharp knife-edge type and hovers above special pressure-sensitive waxed paper obtainable in rolls from the same makers. This paper carries the same scales across its width, and is driven forwards by a small mains synchronous motor, at a rate selectable with an internal lever. The motor at the same time drives a strirrup via a cam, causing the stirrup to drop onto the pointer once every two seconds. The knife-edge thereby strikes the waxed paper and makes a black mark. For chart-recording with the STRACE equipment, the Multiscript 3 should be set to the 1mA f.s.d. range, and the paper speed lever to 20mm/hour.

Chart recording enormously enhances the scope of a ratemeter, for two important reasons. Firstly, the gradual decay of the activity of samples with short half-lives is thereby traced directly. It would be most inconvenient to sit and watch the panel meter for such purposes. Secondly, even when measuring long-life samples with insignificant decay over the time of recording, it is readily possible to draw a mean straight line through the residual random fluctuations of the recording. This leads to an effective statistical accuracy considerably better than the nominal design figure of 5 per cent for panel meter readings. In other words, chart recording brings the overall accuracy to a figure at least as good as the read-off accuracy of the chart recorder itself.

The long-term stability of the circuit of Fig. 7.1, when properly adjusted, is so good that the recordings are dead straight lines for days on end with no input pulses, or with a fixed input frequency from a crystal-controlled pulse generator, even if ambient temperatures and mains voltage fluctuate in the meantime. This zero-point stability is of course essential for reliable chart recording in the 2 per cent accuracy class.

ADJUSTMENTS

A source of standard pulse frequencies is required. These may be obtained from a crystal-controlled generator, or from any simple pulse generator (e.g. the Heathkit IG 82) which is tuned accurately to successive harmonics of the 50Hz mains by observing Lissajou figures on an oscilloscope.



The STRACE Radiation Meter

First of all, switch to Range 1 and adjust VR3 for 10 per cent f.s.d. on meter and chart recorder. Then back-off both devices with their mechanical pointer setting screws, to give zero scale readings.

Now switch to range 4 and tune the pulse generator to the third harmonic of the mains (150Hz). Adjust VR5 to obtain meter reading 9,000 c.p.m. Then retune to 50Hz and correct with VR7, if necessary, to read exactly 3,000 c.p.m.

Repeat adjustment of VR5 and VR7 alternately until no further improvement.

Switch to range 3. Adjust VR6 for zero scale reading with no input. Switch to range 1 and connect-up a G.M. counter detector unit without sample, i.e. counting solely the cosmic radiation background of about 40 c.p.m. Determine the true c.p.m. value by counting the pips in the loudspeaker (see below) and timing with a stopclock or watch with seconds hand. Adjust VR4 for correct reading. Wait at least 5 minutes between successive adjustments of VR4. Finally, feed positive pulses of 2V amplitude to PL2, or 5V amplitude to PL3, using pulse generator and oscilloscope. Adjust VR2 such that pulse expander just triggers, i.e. pips just audible in the loudspeaker.

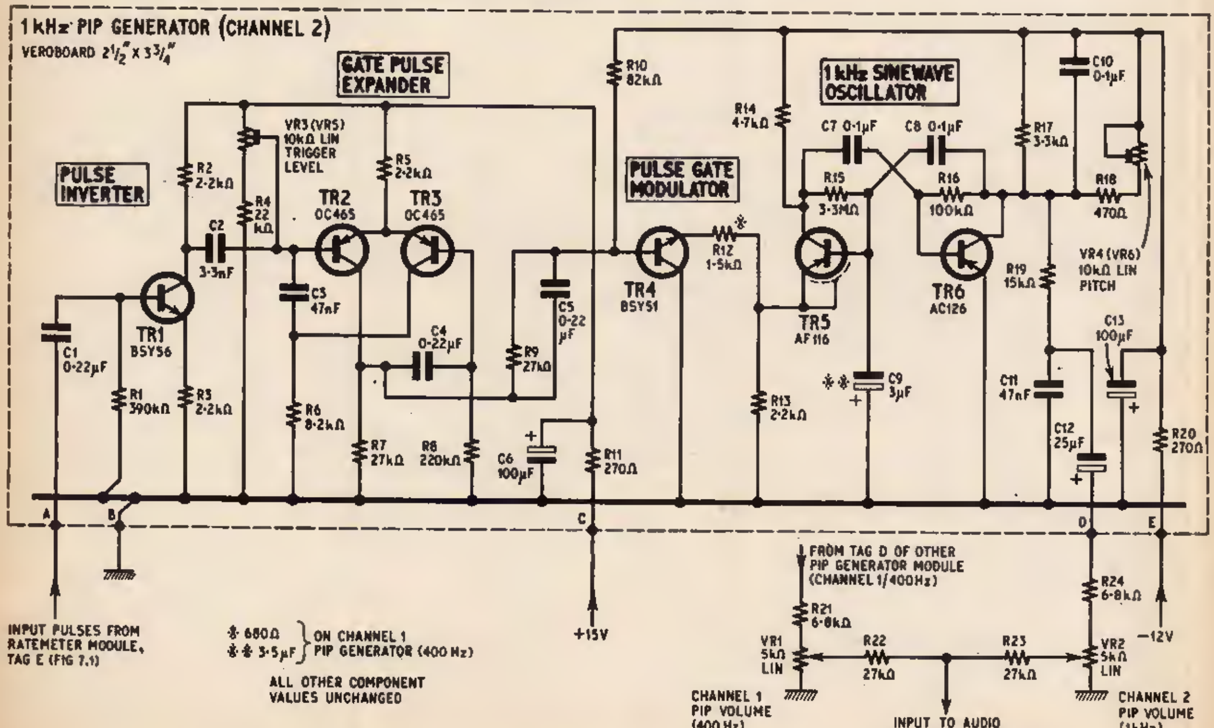


Fig. 8.1. STRACE RADIATION METER: circuit diagram of the pip generator module

The audio amplifier module of the STRACE Radiation Meter

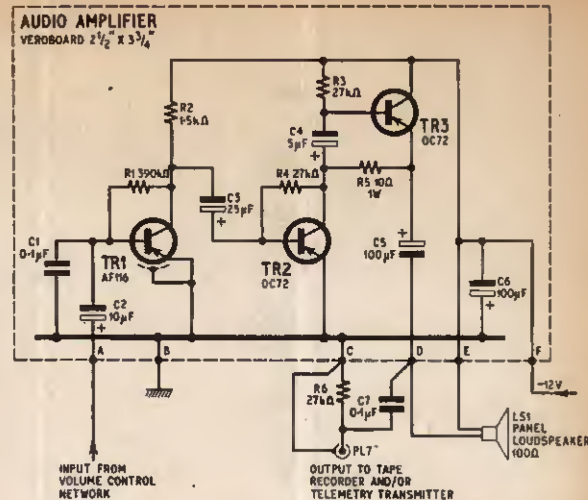


Fig. 8.2. STRACE RADIATION METER: Circuit diagram of the audio amplifier module

Now to resume discussion of the remaining circuitry of the radiation meter.

THE PIP GENERATORS

Fig. 8.1 shows the full circuit of the pip generator module. The layout and semiconductor types are not critical, and it is possible to accommodate this circuit on a 2·5in × 3·75in piece of Veroboard.

We saw that the pulse integration time is 160 seconds (40μF × 4 megohm) on ranges 1 and 2, so that individual pulses produce little or no visible change in the meter reading, and the final meter reading is not reached until about 10 minues have elapsed. Some means of getting a rough immediate idea of the pulse rate is therefore essential, for selecting an appropriate range and for checking that the detectors are working correctly. This function is achieved acoustically, by making each pulse from the detector produce an audible pip in a small loudspeaker.

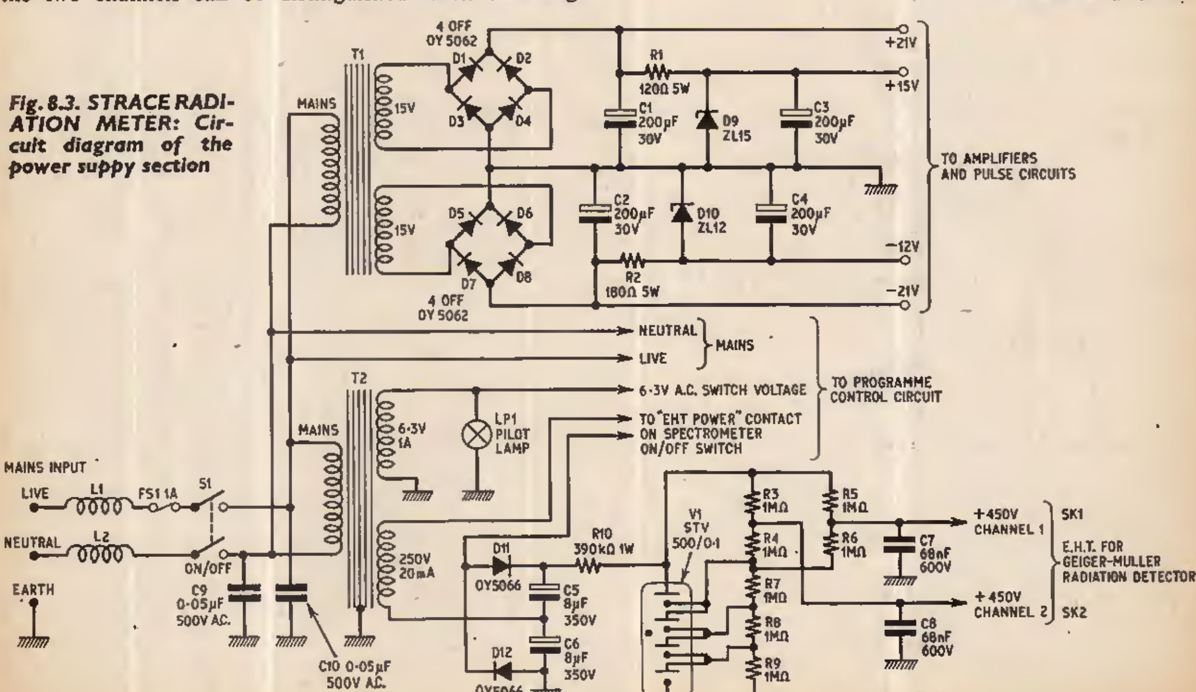
The STRACE radiation meter possesses two identical ratemeter channels according to Fig. 7.1, and thus also two pip generators according to Fig. 8.1. The latter differ only in the pitch of the pips they produce, so that the two channels can be distinguished when sounding simultaneously in the loudspeaker. Channel 1 sounds 400Hz pips, whilst channel 2 sounds 1kHz pips. The components C9 and R12 in the respective pip generators are selected accordingly, and VR4,6 adjusted to give the respective pip pitches.

SINEWAVE OSCILLATOR

The pump pulses from the ratemeter are also fed out via R18 of Fig. 7.1 to the pulse inverter TR1 of Fig. 8.1. This triggers another expander, which produces the much longer gate pulse for generating a pip of audible duration. This gate pulse drives the modulator TR4, which keys an RC sinewave oscillator of the suppressed-harmonic multivibrator type. This circuit keys very neatly to give accurate bursts of sinewave oscillation of about 20 cycles per burst.

continued on page 421

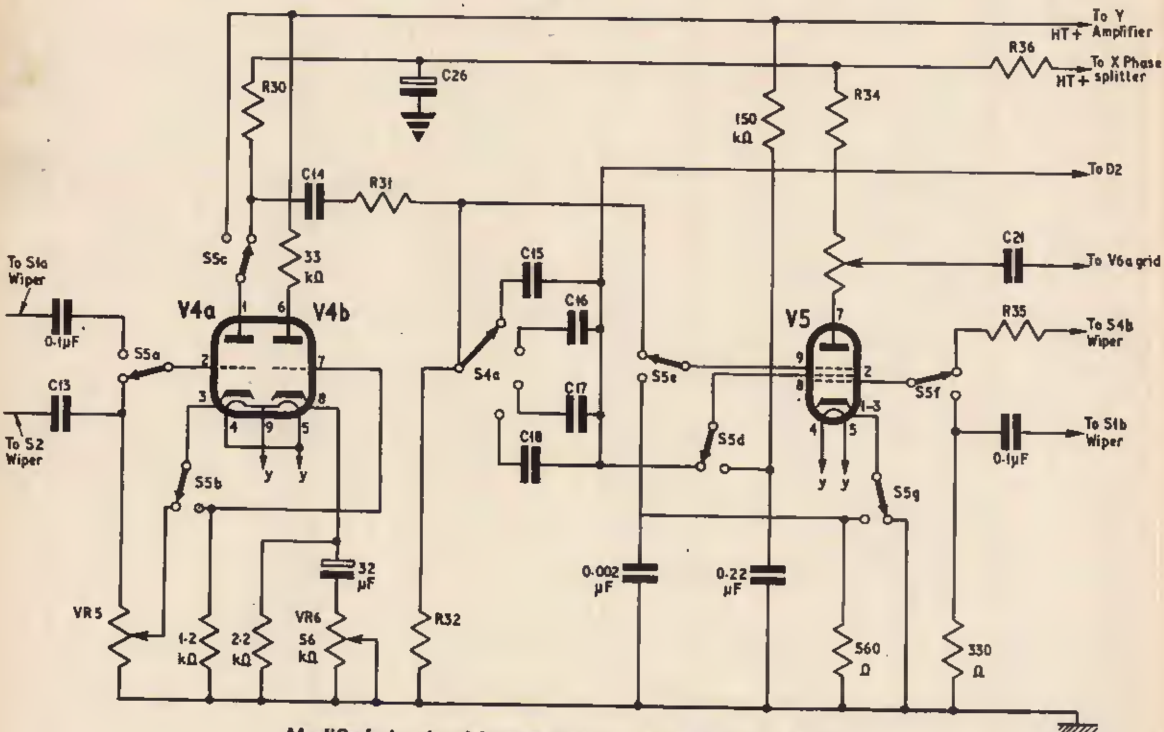
Fig. 8.3. STRACE RADIATION METER: Circuit diagram of the power suppy section



UNLIMITED!

IN THIS feature we hope, from time to time, to be able to publish suggestions submitted by some of our readers on the possible improvement of projects previously described in PRACTICAL ELECTRONICS; short contributions on other subjects may be included. The aim is not to find fault or undermine the abilities or knowledge of our contributors. It may well be that the original article is *par exellence* but it could be improved or adapted to suit individual requirements. The views expressed by readers are not necessarily those of the Editor.

ADDING AN "X" AMPLIFIER AND SCRIBING THE GRATICULE



Modified circuit with additional component values given

HERE is one suggestion for putting the spare valve to good use in the *Investigator Oscilloscope* (July 1967). Rather than add more valves the unused V4b is wired so that the timebase can be switched to bring in an X-amplifier in its place, using a 7-pole 2-way switch.

The circuit is simplified by the omission of the time base range and attenuator switches and several other components. The new X-amplifier is identical to the Y-amplifier and the setting of VR6 should be determined by trial and error.

Constructors wishing to build this unit are referred to *The Oscilloscope and its Applications* (March and April 1967) which covers the measurements that be undertaken using an X-amplifier instead of a timebase circuit.

And now another small addition to the *Investigator Oscilloscope* which might prove useful. When the lines on the perspex graticule are being scribed it will improve the accuracy of the reading taken if lines are scribed on *both* sides of the perspex.

This acts in the same way as the Mirror Scale on some of the more expensive multimeters, that is when the pointer and its image in the mirror coincide, then the eye is directly above the pointer and the reading is the most accurate in this position. The point where the image and pointer coincide is known as the position of no parallax. It is important to be directly above the reading to be taken because if the meter is being read from an extreme angle a considerable error is incurred.

To apply this method to the Oscilloscope the head should be moved about until the lines on the outside of the graticule coincide with those on the inside. Thus more accurate readings can be taken.

It might be found that the lines on the outside of the graticule may lose their layer of black wax with constant use so it may be advantageous to place another piece of perspex in the front of the graticule to preserve the lines.

I. W. Berry,
Huddersfield.

WHITE NOISE GENERATORS

Readers may be interested in the following White Noise Generator circuits, having seen the article published in the January 1968 issue. The circuit in Fig. 1 was derived from the Bonanza Board *Simple Pre-amplifier* and *Treble Booster* described in the March 1966 issue. The components shown in dotted lines are those omitted from the original circuit, also the printed circuit board for the noise generator and the pre-amplifier are identical. All that is necessary to convert the pre-amplifier into a noise generator is the replacement of D1, the base-emitter bias diode, by a device having a poor reverse resistance in the region of 5 to 10 kilohms. Also it is important to omit the original diode bypass capacitor as this attenuates the high frequency output.

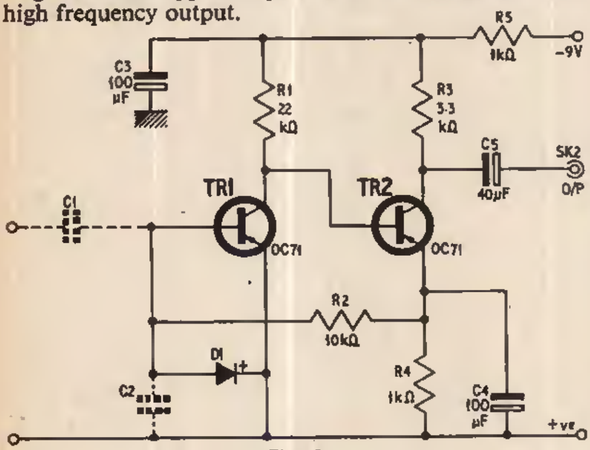


Fig. 1.

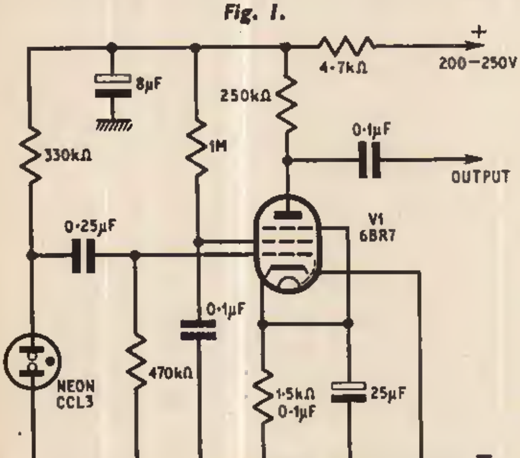


Fig. 2.

The circuit in Fig. 2 relies on the movement of heavy particles due to the ionised gas in a miniature neon indicator to produce white noise. The neon used may be of the type used as mains warning indicators provided that it has no integral series resistor. If construction of this circuit is contemplated it must be remembered that neons tend to be susceptible to mechanical shock when used in this application, and thus the unit gives best results if fitted with anti-vibration mountings.

S. A. Hardy,
Chippenham, Wiltshire.

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Adjust VR3,5 such that triggering is secure. Then adjust VR4,6 to give correct pitch of the pips. If the oscillator bursts into continuous oscillation before correct pitch can be reached with VR4,6, judiciously increase the value of C9. Continuous oscillation also results if VR3,5 is turned too far towards R4, but this can be distinguished by its staccato form, as compared to a pure sinewave squeak if too low a value of C9 is the cause.

THE AUDIO AMPLIFIER

Fig. 8.2 shows the circuit of the common audio amplifier, using three readily available germanium transistors. TR1 is a driver stage for the series-push-pull output stage TR2, 3.

This simple circuit develops about 75mW output power and is thoroughly recommendable for monitoring purposes in general electronic equipment. Layout is again quite uncritical, and accommodation on a piece of 2·5in × 3·75in Veroboard, or even smaller, is a simple matter.

If a 100 ohm speaker is unobtainable, any other impedance may be fed from a suitable matching transformer (e.g. about 4·5 : 1 ratio step-down for a 5 ohm speaker). The exact ratio for the transformer is not critical, and a sub-miniature component is satisfactory.

Returning to Fig. 8.1, it is seen that the outputs of the pip generators are fed via respective front panel volume controls to the common audio amplifier. Either channel may thus be sounded alone at any desired volume, or both may be sounded together, whereby distinction is still possible by virtue of the different pitches. Both volume controls may be turned to zero when running the equipment on automatic chart recordings overnight, and noise is thereby undesirable.

It is of course equally possible to construct a radiation meter with only one ratemeter module, with or without a pip generator and audio amplifier. Or a single pip generator may be provided, which can be switched to either ratemeter module at will.

POWER SUPPLIES

Fig. 8·3 shows the power supply circuit providing all voltages for the circuits of Figs. 7.1, 8.1, and 8.2. The bridge rectifier and smoothing circuits with Zener diode stabilisation associated with TR1 are conventional.

D9 is a 15V power Zener diode and D10 a 12V power Zener diode. Both are rated for at least 750mW dissipation without cooling fin. The 250V winding of TR2 feeds a voltage doubler circuit for the e.h.t. supply for the specified G.M. counter detectors (450V stabilised). D11 and D12 may be any standard television silicon h.t. rectifier or other mains type.

V1 is a Noval-based Telefunken valve containing four miniature neon stabiliser sections of 125V running voltage each. Four separate neons or Zener diodes of equivalent rating may be used in series as alternatives.

The a.c. input to the e.h.t. rectifier circuit is switched via an extra contact on the scintillation spectrometer switch. Thus the G.M. counter detectors are automatically switched off when power is switched on to the scintillation detector/kick-sorter amplifier unit, and vice versa. The pulse cables of both types of detector units may be left connected to the radiation meter.

This completes our survey of the pulse processing circuits employed in a very typical analogue radiation meter. We have seen that two parallel channels are here provided. Professional equipments may use much greater numbers of parallel channels. These can be run on entirely independent experiments, but more commonly some form of coordination for a single composite experiment is required, since this is the only real justification for including more than one counting channel in a single equipment. The channel coordinating circuits are known as the *programme control section* of nucleonic equipment.

Next month: Programme control circuits.

Transistor Amplifier DESIGN

5 NEGATIVE FEEDBACK

By A. Foord

LAST month's article gave an outline of the theory of negative feedback principles. Continuing now with this subject, the virtual earth amplifier is described in relation to feedback; later on, negative feedback will be shown to have an influence in designing tone control networks.

VIRTUAL EARTH AMPLIFIER

For a "virtual earth" amplifier, an inverting amplifier is used and the output taken directly back to the input (see Fig. 5.1) via the feedback resistor R2. The open loop gain of the amplifier is $\bar{A}$ where the bar indicates phase shift of 180 degrees. R3 represents the input impedance of the amplifier; R2 and R1 determine the gain with feedback.

In the analysis we assume that R2 and R_L do not load the output of the amplifier. Since the gain A is large, the voltage V at point A will be small (V_o/A) for practical values of V_o, so this point is often called a "virtual earth". The larger is A the smaller will be V. Taking into account the shunting effect of R3 and the finite gain for A, the overall actual closed loop gain

$$G' = \frac{V_o}{V_i} = -\frac{R_2}{R_1} \times \frac{1}{1 + \frac{R + R_2}{AR}}$$

where R is R_3 and R_1 in parallel

$$R = \frac{R_1 R_3}{R_1 + R_3}$$

If A is large this simplifies to

$$\text{Ideal closed loop gain } G = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

Provided A is large the gain is determined by the feedback resistors; taking a practical example we can compare the results between the actual and ideal formulae.

If $R_1 = 1\,\text{k}\Omega \quad R_2 = 10\,\text{k}\Omega \quad R_3 = 10\,\text{k}\Omega \quad A = 50$

(a) Using the accurate formula:

$$R = \frac{R_1 R_3}{R_1 + R_3} = \frac{10}{11} = 0{\cdot}91 \text{ kilohms}$$

$$G' = -10 \times \frac{1}{1 + \frac{10{\cdot}91}{50 \times 0{\cdot}91}} = -8 \text{ times}$$

$$= 18 \text{ dB}$$

(b) Using the ideal formula:

$$G = -10 \text{ times} \qquad = 20\text{dB}$$

We aimed for a gain of 20dB and obtained 18dB, so that when A is only 5 times the required closed loop gain and R_3 is only ten times R_1, the error in using the ideal formula is small, 2dB in this case. If A had been larger (say 100) the error would have been smaller, as we would expect from our theory on feedback in general.

It can be shown that the impedance at the virtual earth point A is given by:

$$Z_A = \frac{R_2}{A}$$

If $R_2 = 10$ kilohms and $A = 50$

$$Z_A = \frac{10^4}{50} = 200 \text{ ohms}$$

This low impedance at this point is another reason for calling this a "virtual earth". If we consider the complete amplifier including R1, then

$$Z_i \simeq R_1$$

The output impedance of the amplifier (Fig. 5.2) without feedback is represented by Z'_o and could be of the order of 100 ohms if the last stage of the amplifier is an emitter follower. The output impedance with feedback is given by

$$Z_o = \frac{Z_o'}{A} \times \frac{R_2}{R_1} = 20 \text{ ohms}$$

The output impedance is reduced. The frequency response is improved by a factor of AR_1/R_2 at each end.

If the amplifier had its upper 3dB point at 6kHz then, if as before, $A = 50$, $R_1 = 1{,}000$, $R_2 = 10{,}000$ the 3dB down point is improved by $(50 \times 1)/10$ or 5 times, to become 30kHz. Similarly at the low end, the lower 3dB down point might be extended from 200Hz to 40Hz (Fig. 5.3).

SHUNT LOCAL FEEDBACK

The simplest method of applying this feedback is around a single common emitter stage, see Fig. 5.4. As one might expect, the effect of decreasing R_2 is to decrease the gain and increase the bandwidth of the overall response (Fig. 5.5).

It is desirable to make R_L high in order to increase the open loop gain of the amplifier, but unfortunately this means that R_L will be loaded by the next stage, so that it is not possible to predict closed loop gain by the above formula. By feeding R_L into an emitter follower, a better arrangement is possible, see Fig. 5.6a.

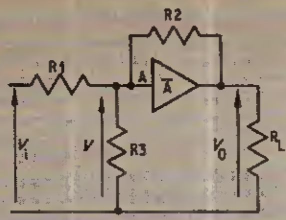


Fig. 5.1. Basic configuration to illustrate the "virtual earth" amplifier

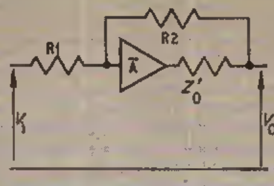


Fig. 5.2. Output impedance without feedback is Z'_0

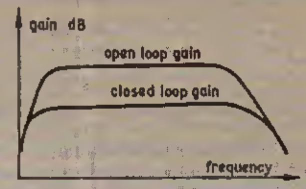


Fig. 5.3. Extended frequency response by using negative feedback

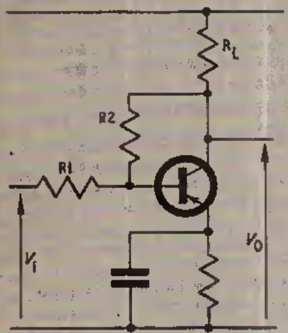


Fig. 5.4. Simplest form of negative feedback through R2, which is also used to bias the base

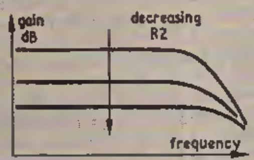


Fig. 5.5. Effect of decreasing the value of R2 in Fig. 5.4 to increase bandwidth

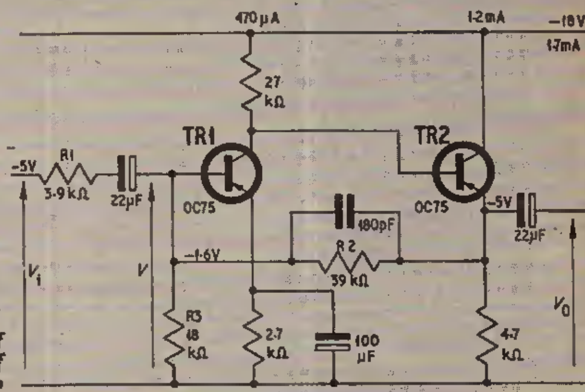


Fig. 5.6a. To avoid heavy loading of the amplifier stage an emitter follower is used

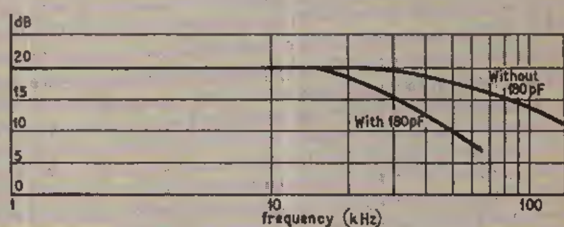


Fig. 5.6b. The feedback resistor R2 can be shunted by a capacitor to reduce bandwidth

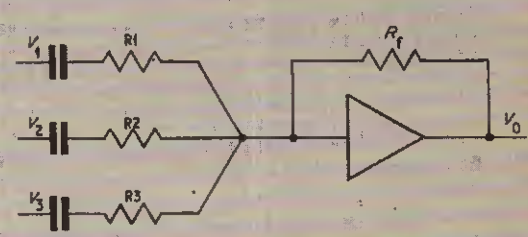


Fig. 5.7. Three inputs are mixed into the "virtual earth" point of the amplifier

The collector load of TR1 is no longer loaded by R2, the output impedance of the amplifier is already low and is further decreased by the feedback, and R3 will not shunt the virtual earth point to any extent. The open loop gain V_o/V was about 300 times, which agrees with the similar figure obtained when using this amplifier previously for series local feedback.

$$\text{Closed loop gain} = \frac{R_2}{R_1} = \frac{39}{3{\cdot}9} = 10 \text{ times} = 20\text{dB}$$

$$Z_i = 3{,}900$$
$$Z_o = 10 \text{ ohms}$$
Maximum output = 500mV r.m.s. into 1kΩ

Without the capacitor across R2, the amplifier has a bandwidth of 60kHz; with 180pF across R2 the bandwidth is restricted to about 22kHz (see Fig. 5.6b).

Since this amplifier needs to be fed from a source impedance low in comparison with R1, it can be fed either from an emitter follower or from the output of a similar circuit. These amplifiers can therefore be cascaded without interaction, the maximum output of 500mV into 1 kilohm is governed by the emitter current of TR2.

For a similar stage which presented a load of 3·9 kilohms a larger signal could be handled. If this amplifier needed to feed 500mV r.m.s. into a power amplifier which actually had a low impedance of the order of 1 kilohm, it might be better to reduce the emitter resistor of TR2 from 4·7kΩ to, say, 2·2kΩ so that there was no danger of the amplifier limiting.

The polarity of the input capacitor assumes that the amplifier is fed from a similar amplifier or an emitter follower.

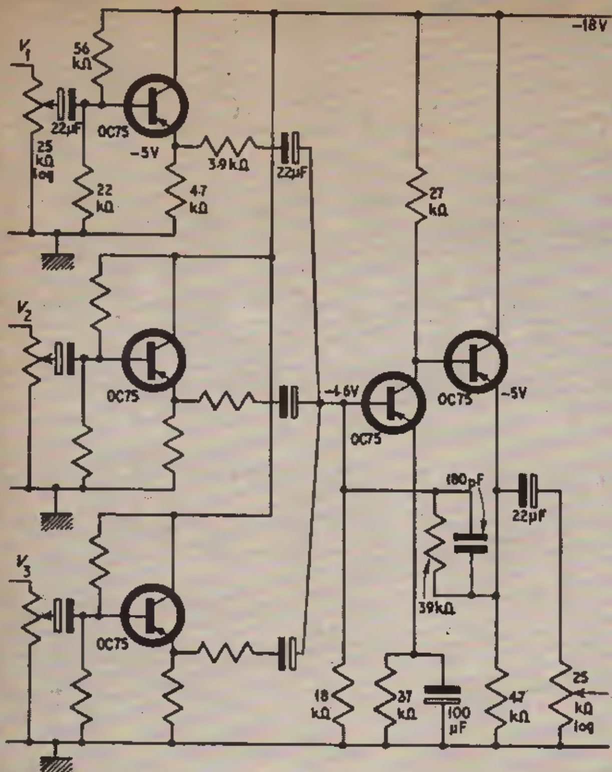


Fig. 5.8. A detailed circuit of the 3-channel mixer, each input being "buffered" from the others by an emitter follower

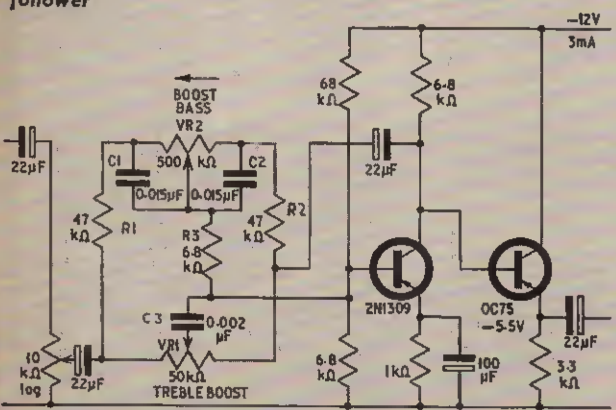


Fig. 5.9. A typical example of the Baxandall type of feedback tone control circuit for treble and bass boost and cut

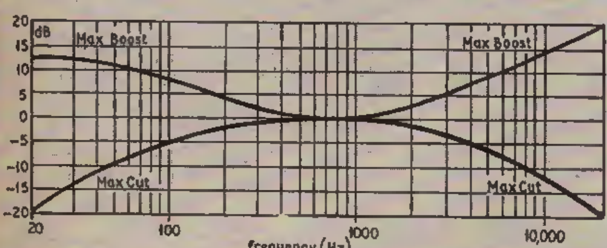


Fig. 5.10. Upper and lower limits of frequency response given by the Baxandall circuit

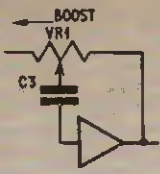


Fig. 5.11. Treble control

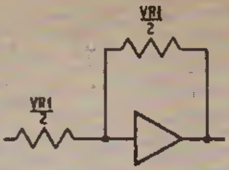


Fig. 5.12. Treble flat

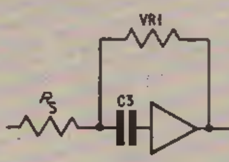


Fig. 5.13. Treble boost

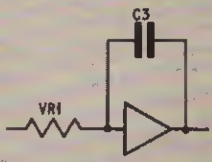


Fig. 5.14. Treble cut

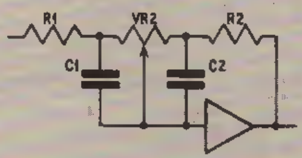


Fig. 5.15. Bass control

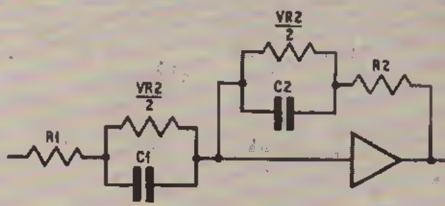


Fig. 5.16. Bass flat

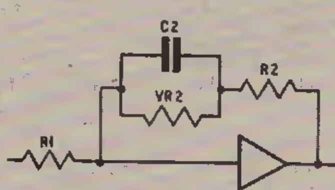


Fig. 5.17. Bass boost

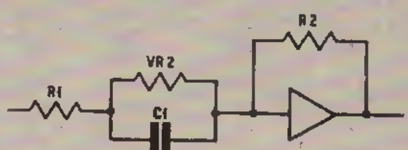


Fig. 5.18. Bass cut

Figs. 5.11 to 5.18. This series of diagrams shows the maximum, minimum and "flat" conditions of the Baxandall circuit

MIXING

Mixing can be achieved by adding extra inputs at the "virtual earth" point, Fig. 5.7.

$$V_0 = R_f \times \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \text{----}\right)$$

If R1 = R2 = R3 = R. This becomes

$$V_0 = \frac{R_f}{R} \times (V_1 + V_2 + V_3)$$

A practical audio mixing unit could be made up in this fashion (Fig. 5.8) for three or more inputs.

Input impedance = 8kΩ
Maximum gain = 10 times = 20dB
Maximum output = 500mV
Frequency response 20Hz to 20kHz, ±3dB.

Each parallel input stage is identical.

FEEDBACK TONE CONTROLS

The virtual earth arrangement can be used with feedback and input networks that are frequency selective, providing tone controls of the well known Baxandall type (see Fig. 5.9). The performance of this circuit is given in Fig. 5.10, and was measured with the gain control at maximum, so that the tone controls were effectively fed directly from the previous stage, which had an output impedance of 250 ohms.

With the volume control at a lower level, the source impedance would be slightly higher (up to a maximum of 5kΩ) but this would not effect the response curves by more than a couple of dB or so, since the tone control network is made a high impedance network.

The 2N1309 was used here so that the open loop gain without feedback extended well outside the audio band. An OC75 (which has a lower cut-off frequency) could be used here, but the response on maximum treble boost might not be as great.

Slightly more bass boost can be obtained by reducing the 47 kilohm resistors to 22 kilohms. Performance: When no boost or cut is applied ±3dB, 20Hz–20kHz. Bass boost 12dB at 20Hz; cut 19dB at 20Hz. Treble boost 19dB at 20kHz; cut 19dB at 20kHz.

The overall gain is about unity at mid-band and will give a maximum output of 500mV into 1 kilohm. The circuit has been broken down into eight configurations in Figs. 5.11 to 5.18. Taking the treble section (Fig. 5.11) this can be divided into three conditions: flat (Fig. 5.12); boost (Fig. 5.13); cut (Fig. 5.14).

Secondly, the bass control in Fig. 5.15 gives equal source and feedback impedances (and hence unity gain) in the flat condition, Fig. 5.16. Feedback is reduced at low frequencies to give bass boost, Fig. 5.17. In the bass cut condition the input network increases in impedance from 1kHz towards 20Hz, and overall gain is reduced below unity, Fig. 5.18.

To ensure that the tone controls are not overloaded on peaks, it is preferable to place the volume control as early in the circuit as possible, so that the tone controls are operated at a low level, see Fig. 5.19.

VOLTAGE OUTPUT, SERIES INPUT NEGATIVE FEEDBACK

Apart from the virtual earth arrangement, there is another method of applying negative feedback over two stages: the voltage output, series input arrangement.

In this case (Fig. 5.20) the resistor R2 enables a signal proportional to load voltage to be fed back,

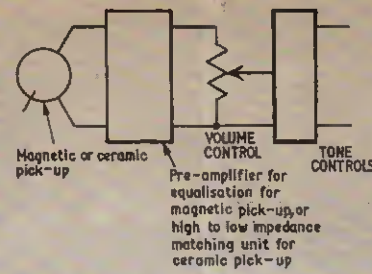


Fig. 5.19. Volume control is inserted before tone controls so that boost condition is not distorted

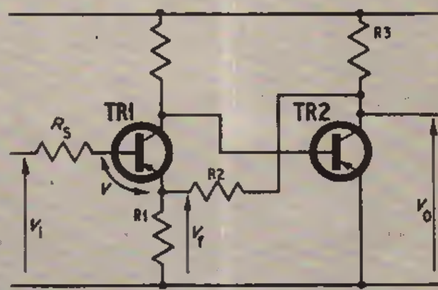


Fig. 5.20. Voltage output, series input negative feedback

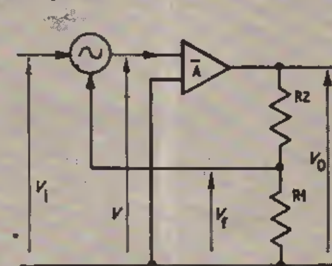


Fig. 5.21. Theoretical equivalent of Fig. 5.20

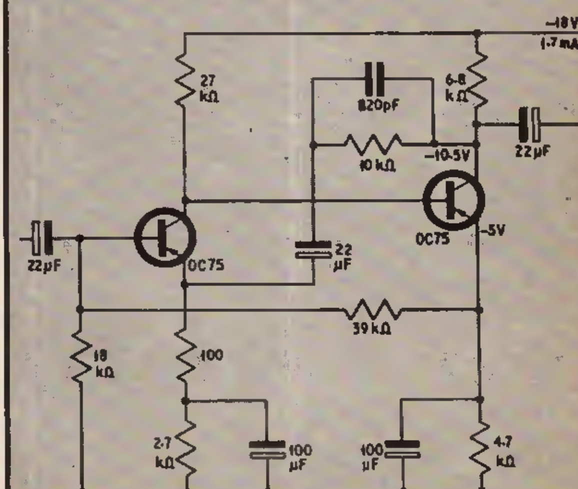


Fig. 5.22. Practical circuit of amplifier with voltage output, series input negative feedback

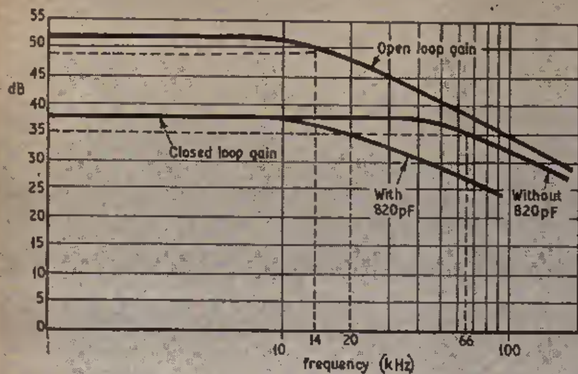


Fig. 5.23. Frequency response of circuit in Fig. 5.22 with and without shunt capacitor

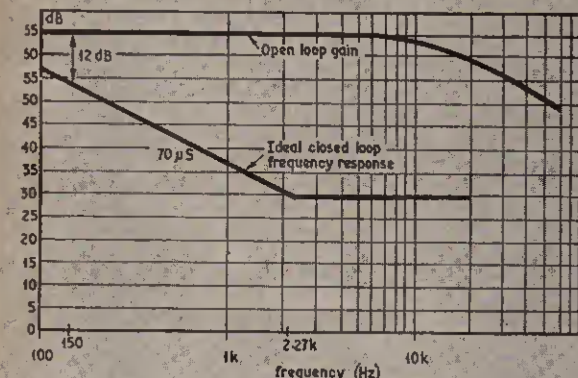


Fig. 5.25. Ideal tape replay characteristic compared with open loop gain response for 7½in/second

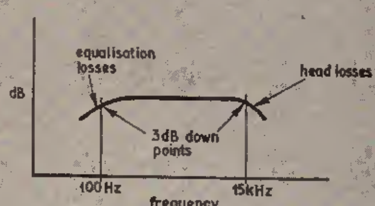


Fig. 5.26. Overall frequency response from tape replay head and amplifier

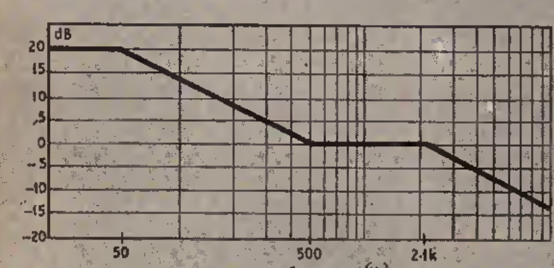


Fig. 5.27. R.I.A.A. microgroove replay characteristic

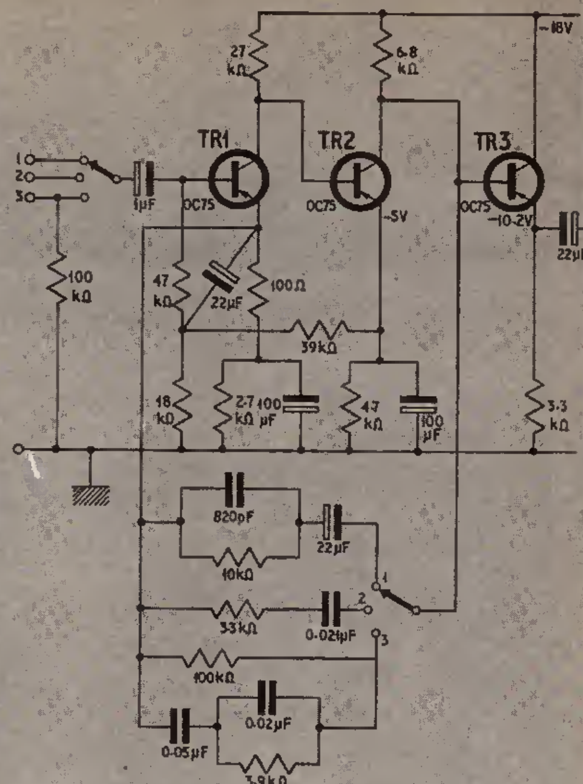


Fig. 5.24. Various tone correction characteristics are obtained with switched feedback paths. Position 1 for microphone, 2 for tape head replay, 3 for magnetic pick-up

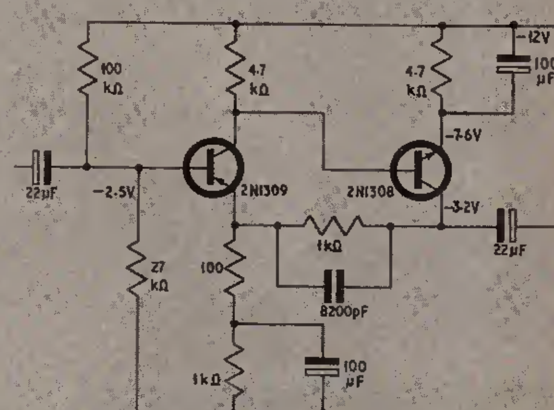


Fig. 5.28. Using an npn, pnp pair with fixed feedback

while R1 enables this feedback voltage to be applied in series with the input, Fig. 5.21.

This applied feedback increases the input impedance and decreases the output impedance. R1 should be kept low (less than 1 kilohm) since this applies local feedback to the first stage. The amount of output fed back = $B = R_1/(R_1 + R_2)$. Then gain with feedback

$$G = \frac{1}{B} = \frac{R_1 + R_2}{R_1} = 1 + \frac{R_2}{R_1}$$

provided $1 + (R_2/R_1)$ is much less than A in the usual way for negative feedback formulae.

If the gain with feedback is such that R_2/R_1 is much greater than unity, then $G = R_2/R_1$.

Input impedance is given by

$$Z_i = \beta_1\beta_2 \times \frac{R_1 . R_3}{R_2 + R_3}$$

this is shunted by the bias resistors at TR1 base.

Output impedance is given by

$$Z_o = \frac{G}{\beta_1 . \beta_2} \times [R_s + \beta_1 . R_1]$$

$$Z_o = \frac{R_2}{\beta_2}$$

for a low source impedance R_s.

A typical circuit of this type is shown in Fig. 5.22, which has a frequency response as shown in Fig. 5.23.

Without feedback the input impedance Z_i = 5 kilohms. Output impedance Z_o = 6·8 kilohms. Mid-band gain is 52dB and bandwidth 14kHz.

With feedback the gain is 38dB, which is what one might expect since the open loop gain is 52dB = 400 times, while the closed loop gain

$$G' = \frac{400}{1 + \frac{400}{100}} = \frac{400}{5} = 80 \text{ times} = 38\text{dB}.$$

Ideal closed loop gain = 100 times = 40dB
Amount of feedback = 52 − 38 = 14dB
Input Impedance Z_i = 8·2 kilohms
Output Impedance Z_o = 200 ohms
Maximum output is 150mV r.m.s. into 1kΩ, and 250mV r.m.s. for open circuit output.

Noise referred to input = 5μV r.m.s. for a 600 ohm source. Bandwidth is 66kHz, reducing to 20kHz with the 820pF capacitor in circuit. The response is 3dB down when the impedance of the capacitor is equal to 10 kilohms, in this case 19·4kHz.

The feedback must be operative until a frequency lower than the low frequency 3dB down point of the amplifier, otherwise we could obtain a peak in the closed loop response. This is deliberately done for tape equalisation, where a rising l.f. response is required. This feedback arrangement is widely used in pre-amplifiers since, by switching the feedback network, a wide variety of frequency selective characteristics can be obtained.

At the moment, the load is fed directly from the collector of TR2, which reduces the open loop gain. Feeding the load via an emitter follower increases the open loop gain to 65dB. For a tape head or magnetic pick-up input we require a high input impedance, but the high input impedance given by the negative feedback is masked by the shunting effect of the resistors biasing TR1.

Bootstrapping these resistors enables us to take full advantage of the high input impedance provided by negative feedback. The modified amplifier suitable for use with switched feedback is now as shown in Fig. 5.24.

Microphone Amplifier

As previously shown this will have a gain of about 40dB and a bandwidth of 20kHz. Input impedance is greater than 100 kilohms over the audio band.

Tape Amplifier

This has a gain of about 61 times (30dB) at 1kHz and an input impedance of 100 kilohms over most of the audio band, but the input impedance will drop at the low frequency end where it runs out of loop gain.

The ideal response for 7½in/second (70μs time constant) is shown in Fig. 5.25. Below 150Hz the amount of negative feedback is less than 12dB, so the equalisation is not going to be exact. This, coupled with the drop in input impedance would give an overall response out of the tape head, similar to that shown in Fig. 5.26

Magnetic pick-up

Here the mid-band gain is about 35dB, with R.I.A.A. equalisation. The input impedance is about 47 kilohms, which is recommended for most magnetic pick-ups, this falls to 30 kilohms at 20Hz, which is acceptable. The equalisation is within ±2dB of the required characteristic between 20Hz and 20kHz.

The straight line approximation of the theoretical curve is given in Fig. 5.27, which is referenced to 0dB at 1kHz. The 100 kilohm impedance has been increased from the theoretical value (about 47 kilohms) to allow for the finite open loop gain at low frequencies (65dB).

Summary

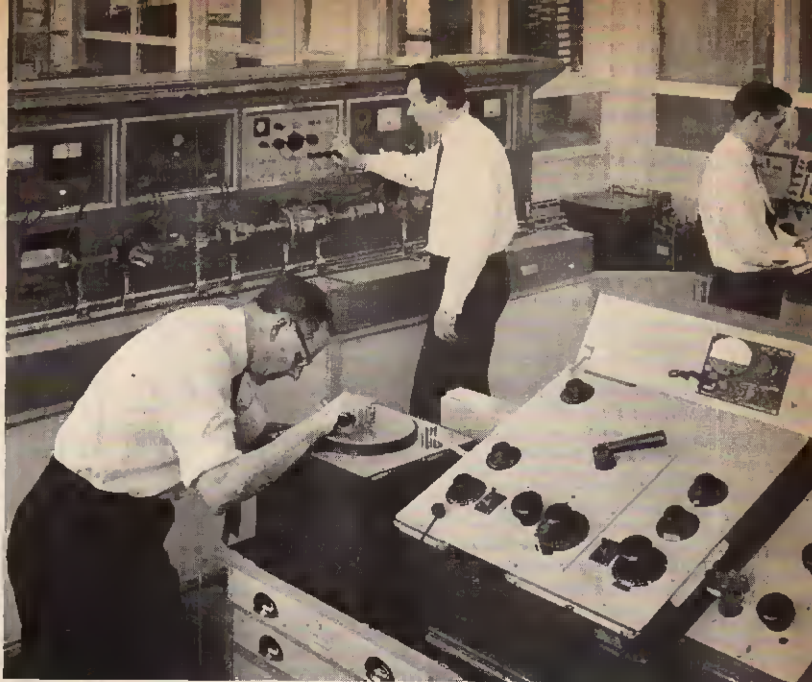
Inputs at 1kHz for an output of 250mV
Microphone. 2·5mV 100kΩ
Pick-up. 4·5mV 47kΩ
Tape. 4·0mV 100kΩ (7½in/sec and 70μs)
Maximum output: 250mV into 1kΩ

For a simple amplifier of fixed feedback, it can be advantageous to use an *npn, pnp* pair, as in Fig. 5.28. In this case

Maximum output = 250mV r.m.s.
Frequency response ±3dB 20Hz — 20kHz
Gain 10 times = 20dB
Input Impedance = 20kΩ
Output Impedance = 150Ω

Next month: High input, low output impedance amplifiers and active filters

Official O.K. for Calibration Lab.



THE overworked National Physical Laboratory expects to be relieved of some time-consuming routine tasks following BCS (British Calibration Service) approval of the Ferranti Calibration Laboratory.

"Outsiders" can now obtain help in a wide range of measurements covering frequency, d.c. resistance, inductance, capacitance, a.c. and d.c. voltage, current, and power.

The calibration laboratory started at Ferranti's Moston works in 1940 and was transferred to its present site at Wythenshawe, Lancs., in 1954 to provide a service to the company's factories engaged in design and production of guided weapons.

It was later made available to all Ferranti factories in the Manchester area, and in 1963 was extended to other manufacturers and organisations engaged on government contracts by obtaining EID part III test house approval, which covers a variety of electrical and physical measurements.

The service was extended to all industries when the new BCS granted approval for d.c. and low frequency measurements.

Type from Tape

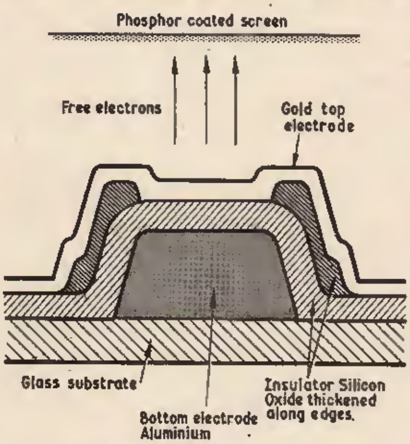
A LANCASHIRE printing company, the Tinling Printing Group, has ordered an Elliott-Automation computer typesetting system for its Prescot works.

The computer will automatically justify text (punched on special keyboards) and will produce complete pages in the form of punched paper tape. It also makes a record on magnetic tape for storage in case reprints are required.

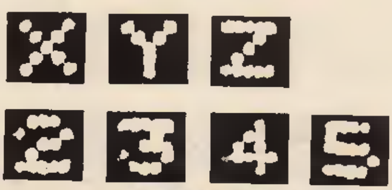
The completed paper tape is fed to a Photon typesetting machine which produces a positive of each page for making litho printing plates.

Editing the book, and author's corrections, will also be easier and quicker because the computer adjusts the page make-up automatically to allow for alterations to the text during the proof-reading stage.

(below) the magnetic and paper tape units



The point-source electron gun (above) can be matrixed to produce a detailed display



Semiconductor Picture Display

WHAT could be the beginning of a semiconductor version of a television tube was demonstrated at the Physics Exhibition by STL Research. The principle used relies on the electron tunnelling effect, already to be found in tunnel diodes.

The significant difference, though, is that electrons, after excitation in aluminium, are channelled through silicon oxide to a gold electrode.

Free electrons are then released into a vacuum to strike the phosphorescent coating on the display screen. The matrix (or raster) on the screen is made up from a series of tiny dots, each dot being related to its own semiconductor "gun".

Current experiments by STL have shown that good alpha-numeric displays using 10 sq mm dots of activity are quite feasible and, in fact, could be developed on a commercial scale more economically than conventional methods.

The size of the dot can be made very much smaller (about 0·002in) to make up a fine screen matrix with a large regular pattern of dots. Reproduction by photo-optic and electronic systems of live or photographic pictures becomes a possibility. The major hurdle to be jumped here, of course, is the vastly increased numbers of lead-out wires, but sequential display of each "dot" would reduce this number to practical proportions.

ANALOGUE COMPUTER

PEAC

By D. BOLLEN

The PEAC basic equipment has now been dealt with and this month we commence a detailed description of the chief ancillary unit. Subsequent articles will cover the remaining two ancillary units.

Perhaps it should be repeated at this stage that the three ancillary units are purely optional add-on items. The additional facilities they each provide, are indicated in the PEAC Specification (January 1968, page 38).

PEAC UNIT "B"

UNIT "B" reinforces the facilities of UNIT "A", but does not introduce new computing circuit elements. A master potentiometer and a suitably scaled readout meter improve the accuracy and ease of handling of UNIT "A", while the integrator mode switching circuit opens up further possibilities in the solution of Calculus problems.

UNIT "B" FRONT PANEL

It may not be necessary to use hardboard for the front panel if a thick grade of plastic laminate is used, since the wooden surround in the box front gives plenty of support.

Prepare a 17¾in × 8¾in white laminate panel and establish hole centres with a sharp spike, from the drawings Fig. 6.1 and Fig. 6.2. Next, drill only the holes for all sockets, S7, S8, the meter mounting studs, and cut out a hole for the meter body with a fretsaw.

Beginning with the master potentiometer dial, draw a 300 degree arc of radius 2$\frac{11}{16}$in with a pencil compass (refer to Fig. 6.2). Divide the arc into 3-degree divisions with protractor and pencil. The accuracy of the master potentiometer will benefit from careful preparation of the dial. Draw in the dial arc and divisions with Indian ink.

Rub-on transfers are suitable for the dials of VR18 and VR19, and will save time, but make sure that the transfer gives main divisions spaced at 30-degree intervals, for a 1–10 calibration.

When dials are complete, drill holes to take the spindles of VR18–VR20, S9 and S10. Draw in all ink lines, add transfer numerals, and varnish.

BOX CONSTRUCTION

Commence building the UNIT "B" box by cutting out two side panels from hardboard; they are shown in Fig 6.3. Fix ½in square softwood lengths *A*, *B*, *C*, and *D* to the inside of the side panels. Join the side panels together by means of horizontal lengths *E*, and *F*, using countersunk woodscrews and glue. Square up with the assembly placed on a flat surface.

Cover the box framework with hardboard top, bottom, and front strip panels, and, when firm, reduce overlapping edges with a rasp and sandpaper. Finish off the box with a layer of white plastic laminate, and paint exposed hardboard edges to match the UNIT "B" box.

MASTER POTENTIOMETER AND NULL METER

A d.c. voltmeter connected to the slider of a computing potentiometer will impose a small load, and when the voltmeter is removed the measured coefficient will increase slightly, to the extent of about 1½ per cent in the case of a 10V 20,000 ohms/volt meter, and a 10 kilohm potentiometer set with its slider near mid-track. One way of avoiding the error is to leave the voltmeter connected to the potentiometer after a coefficient reading has been taken, but this is seldom convenient.

Ideally, the instrument used to measure coefficients or computer voltages should impose no load at all, and this condition can be satisfied fairly easily by employing an accurately calibrated master potentiometer.

In Fig 6.4, a permanent load is placed on the coefficient potentiometer CP by the computing resistor R_{in}, thus causing a significant dial setting error. To find the true coefficient of CP, both potentiometers are supplied with a reference voltage of +10V, so that potentiometer coefficients of 0–1 will be multiplied by 10 to conform to a 0–10 dial calibration. When

COMPONENTS . . .

UNIT "B" FRONT PANEL

NOTE: All front panel controls are numbered consecutively, following on from UNIT "A", but internal sub-assemblies have individual component numbering.

Potentiometers
VR18 100kΩ carbon linear
VR19 100kΩ carbon linear
VR20 25kΩ wirewound, 3in, 25W instrument potentiometer. (G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2)

Switches
S7 Miniature push button, push to make, one pole
S8 Toggle, single pole changeover
S9 4 pole, 3 way rotary
S10 2 pole, 6 way rotary

Sockets
5 red, 3 black, 5 blue, 4 yellow, 4 white, and 2 green

Knobs
One Bulgin K403, 2⅜in knob with 3in skirt. Three Radiospares type PK 1⅛in knobs with pointers

Meter
M1 "Sew" MR85P, 100–0–100μA, internal resistance 1,000Ω

Miscellaneous
Plastic laminate (thick) for front panel, 1 off, 17⅜in × 8¾in. Rub-on dial transfers and letters, black (Radiospares)

UNIT "B" MASTER POTENTIOMETER

Resistors

R1 200Ω	R3 47Ω	R5 820Ω
R2 820Ω	R4 47Ω	R6 200Ω

All 5%, ½W carbon film or metal oxide

Pre-set potentiometers
VR1—VR4 100Ω wirewound (4 off) panel mounting type

Miscellaneous
16 s.w.g. aluminium sheet 6in × 4in. Tag strip with three tags.

UNIT "B" READOUT METER

Resistors

R1 82kΩ 10%	R3 7·5kΩ 5%	All ½W, carbon composition
R2 22kΩ 10%	R4 1·2kΩ 10%	

Pre-set potentiometers
VR1 22kΩ
VR2 10kΩ
VR3 2·2kΩ
VR4 1kΩ
All miniature horizontal mounting skeleton construction

Meter protection diodes
D1, D2 OC71 or similar "inverted" germanium transistor (2 off)

Miscellaneous
S.R.B.P. panel 2⅛in × 2in.

UNIT "B" INTEGRATOR MODE SWITCH

Resistors

R1 10kΩ	R4 4·7kΩ	R7 27kΩ
R2 10kΩ	R5 27kΩ	R8 4·7kΩ
R3 1kΩ	R6 1kΩ	R9 10kΩ

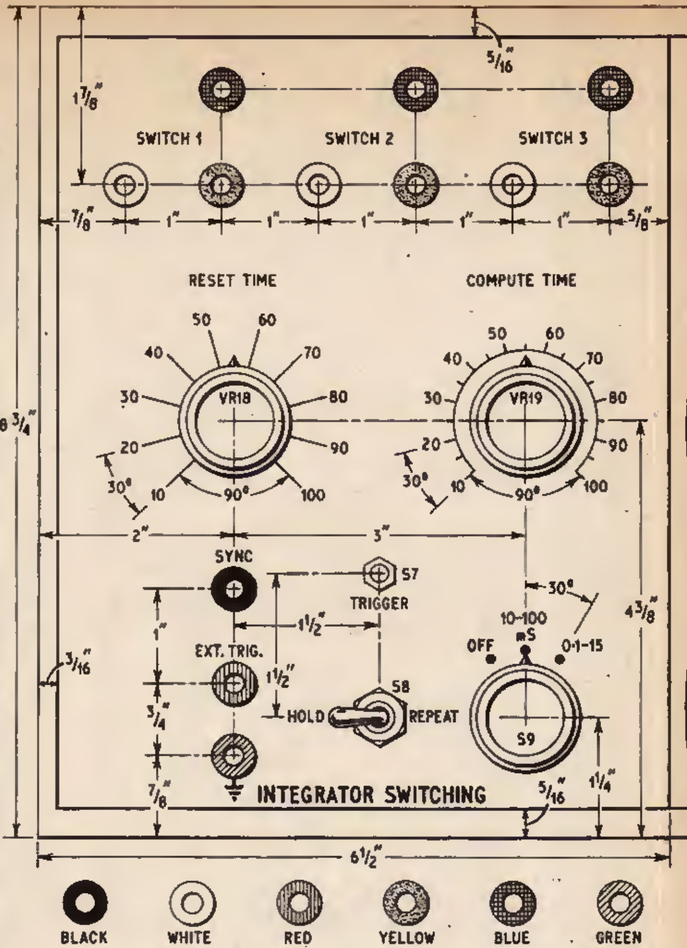


Fig. 6.1. UNIT "B" front panel, integrator switching section

R10 10kΩ	R12 3·3kΩ	R14 1kΩ
R11 1kΩ	R13 10kΩ	R15 560kΩ

All 10%, ½W carbon composition

Pre-set Potentiometers
VR1 10kΩ
VR2 5kΩ Both vertical mounting

Capacitors
C1 1,000μF elec. 15V
C2 1μF polyester 250V d.c.
C3 1·4μF polyester 250V d.c.
C4 14μF elec. 25V
C5 0·1μF polyester 250V d.c.
C6 1μF polyester 250V d.c.
C7 1·4μF polyester 250V d.c.
C8 14μF elec. 25V working.
C9 0·068μF polyester 250V d.c.
(The values of C3, C4, C7, and C8 are approximate—see text)

Transistors
TR1–TR6 ACY28 or AC126.

Diodes
D1, D2 OA95 (2 off)
D3–D14 1B30 (Radiospares) (12 off)

Reed Coils
RLA, RLB Miniature triple 12V Osmor type MT12V (2 off)

Reed Switches
RLA1—RLA3, RLB1—RLB3 Hamlin MRG2, 20-40AT (R.T.S. Ltd., P.O. Box 11, Gloucester St. Cambridge) (6 off.)

Miscellaneous
S.R.B.P. panels: 1 off 6¼in × 2¼in; 1 off 3in × 2in. Small turret tags.

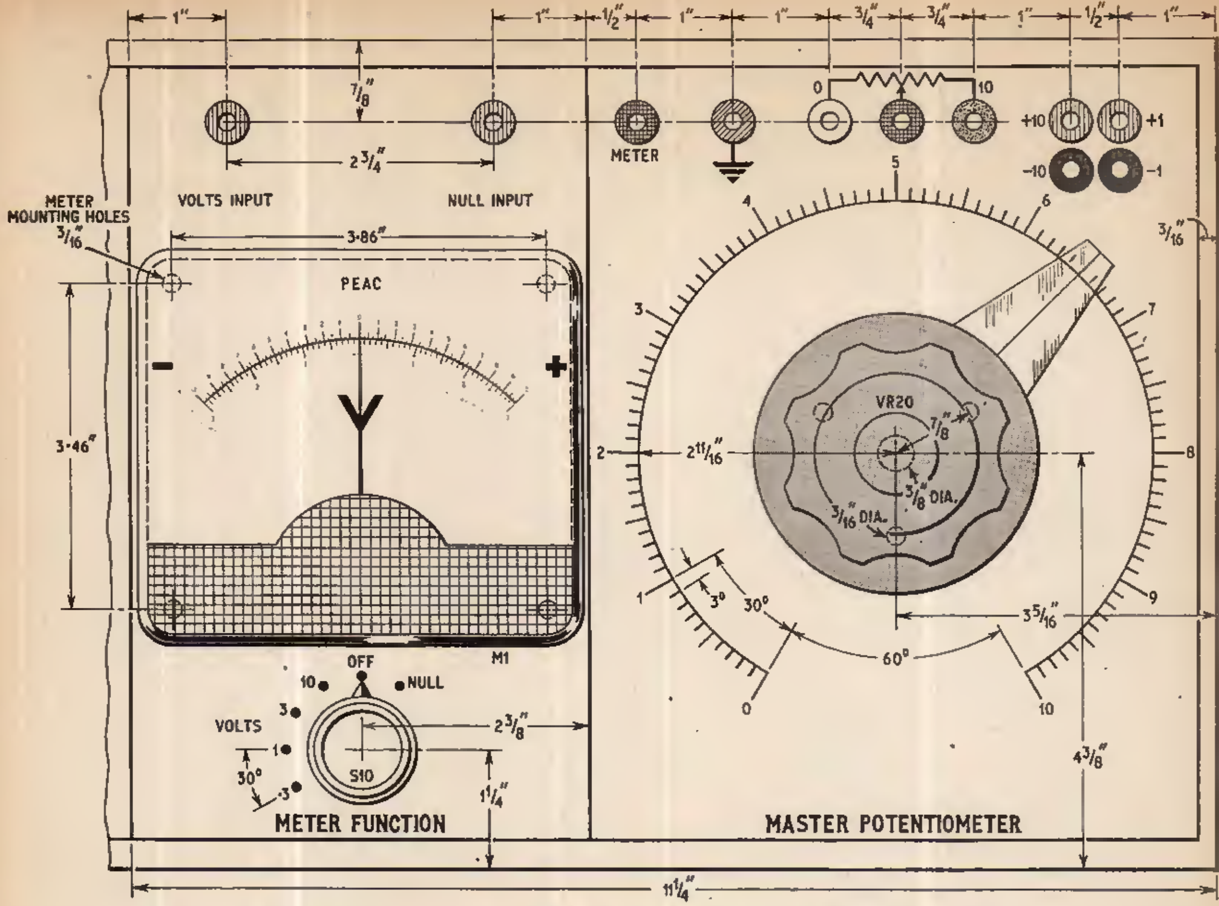


Fig. 6.2. UNIT "B" front panel, readout meter and master potentiometer

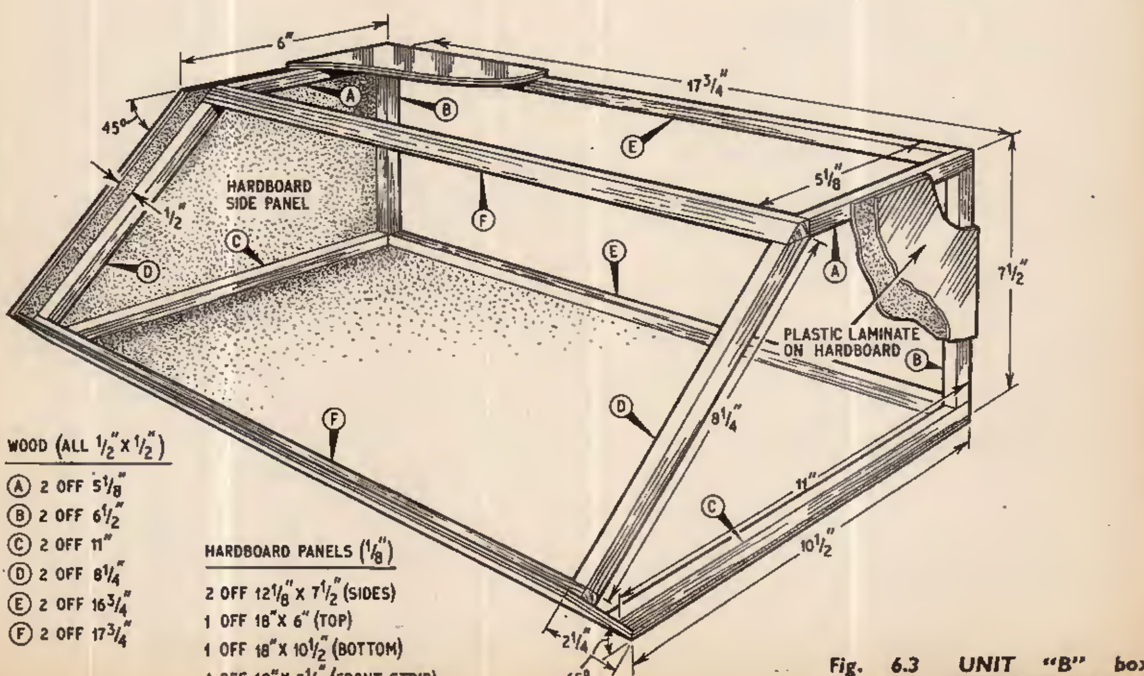


Fig. 6.3 UNIT "B" box constructional details

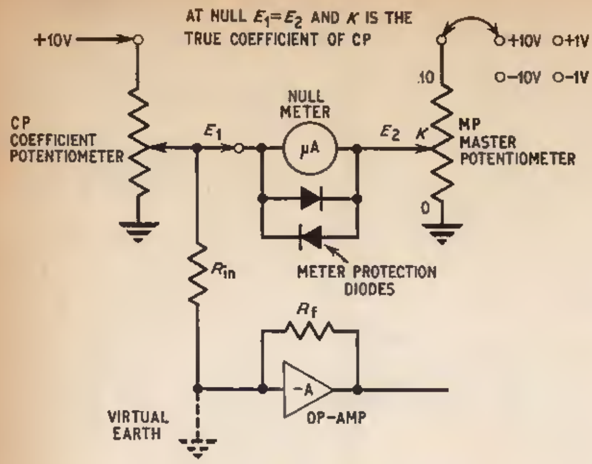


Fig. 6.4. Master potentiometer circuit for measuring coefficients

Fig. 6.5 (below). Circuit diagram of readout meter and master potentiometer

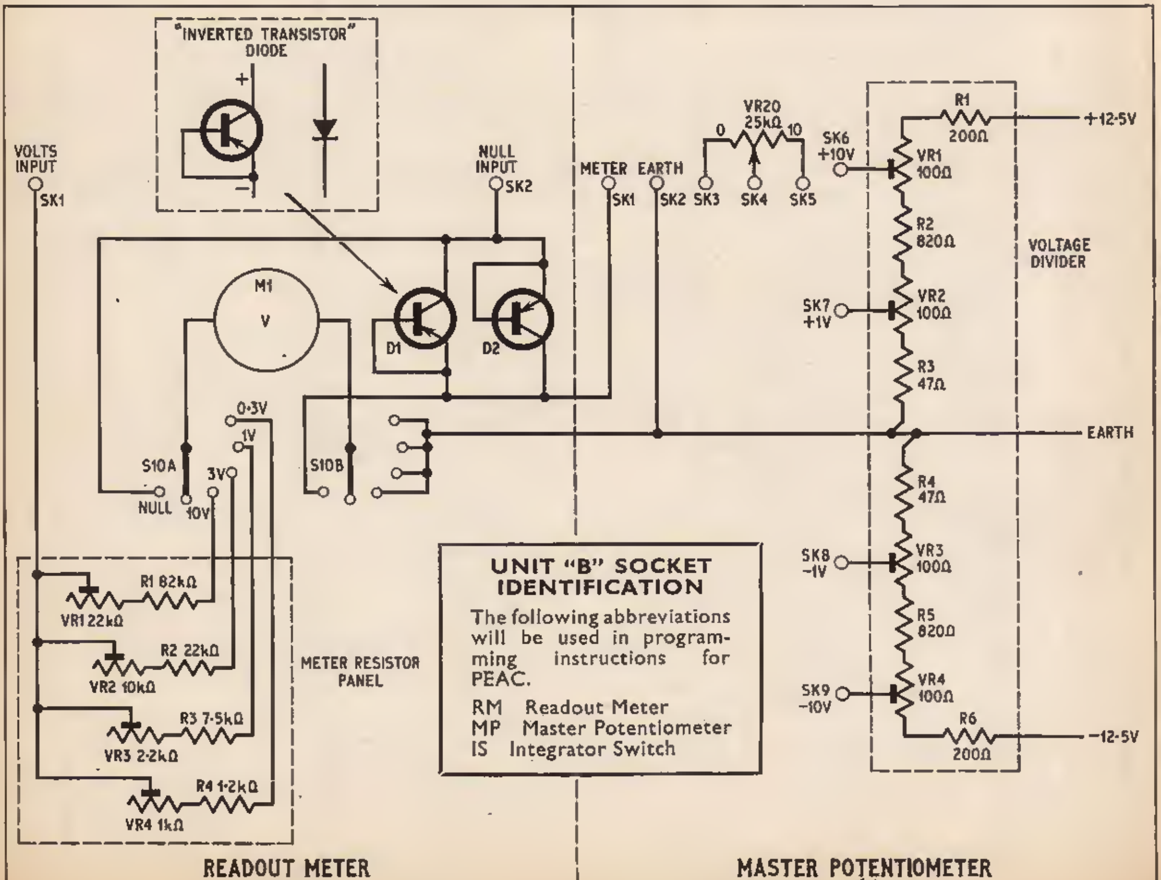
the voltage at the slider of CP is identical to the slider voltage of MP, no current flows through the null meter, and the true coefficient of CP can be read straight off the dial of MP.

Since no current flows at null point, no load is imposed, and the input resistance of the measuring circuit is virtually infinite. Meter protection diodes are included to preserve good meter sensitivity without allowing damaging currents to flow through the meter when the circuit is off balance.

READOUT METER AND MASTER POTENTIOMETER CIRCUITS

One meter movement serves for null indication and voltage measurement. Considering first the readout meter circuit Fig 6.5a, miniature pre-set resistors VR1–VR4 will permit calibration of each meter range to an external voltage standard, and also help to eliminate discrepancies between ranges.

The way in which meter protection diodes D1 and D2 are wired may be unfamiliar to the reader, so some explanation is called for. If a transistor is operated "inverted", that is with collector-emitter polarities reversed, it will exhibit a very low "on" resistance when the base is near emitter potential. With base connected straight to emitter, the transistor therefore becomes a diode with lower than normal forward resistance, and yet will still offer a high resistance



UNIT "B" SOCKET IDENTIFICATION

The following abbreviations will be used in programming instructions for PEAC.

RM Readout Meter
MP Master Potentiometer
IS Integrator Switch

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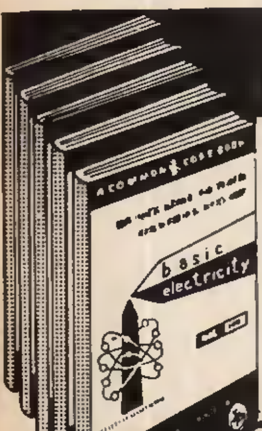

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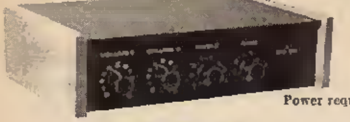

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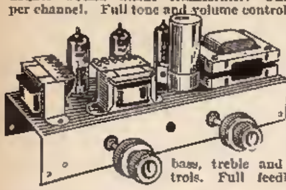

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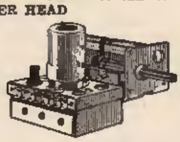

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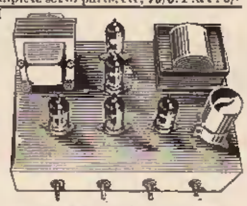

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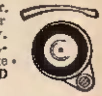

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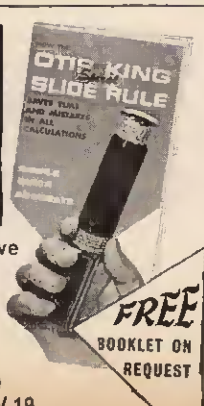

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5¾in.	1,800ft.	19/6	7in.	3,600ft.	44/-
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			3in.	600ft.	8/6

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reverse characteristic. The arrangement eliminates the need for a meter series resistor while still giving adequate protection.

In Fig. 6.5b, VR20 is a 3in instrument potentiometer of good linearity. The voltage divider network, composed of R1–R6 and VR1–VR4, taps off four standard voltages from the computer power supply, so that the master potentiometer will measure inputs of 0 to + 1V, 0 to − 1V, 0 to + 10V, and 0 to − 10V on its 0–10 scale. The accuracy of the master potentiometer, bearing in mind the 14in scale length, approaches that of a laboratory voltmeter.

FRONT PANEL AND MASTER POTENTIOMETER ASSEMBLY

Mount all sockets, potentiometers VR18–VR20, switches S7–S10, and meter, on the UNIT "B" front panel. Make up an aluminium bracket from the measurements given in Fig. 6.6, and glue it to the front panel, along with the small tag strip, in the position shown in Fig. 6.7. A hot soldering iron applied to the aluminium bracket will solidify the epoxy resin glue in a matter of minutes, sufficient to hold the bracket in place until the joint sets hard.

Rest the front panel inside-out on the UNIT "B" box front, to protect panel markings during assembly. Mount pre-set voltage divider potentiometers VR1–VR4 to the aluminium bracket, and then proceed with the

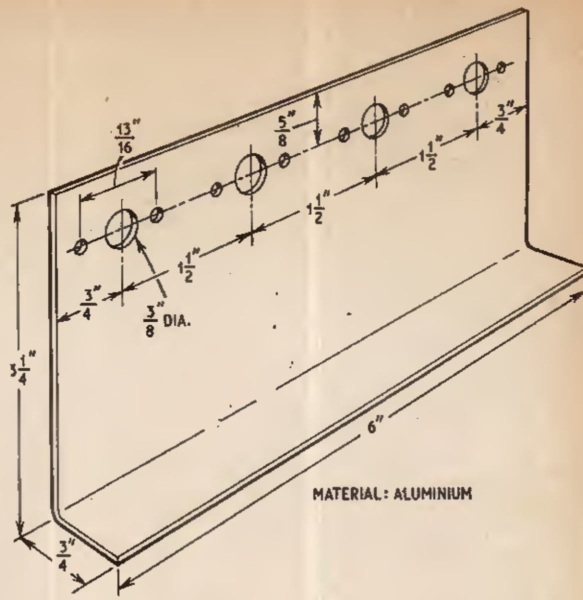

Fig. 6·6. Mounting bracket for pre-set potentiometers

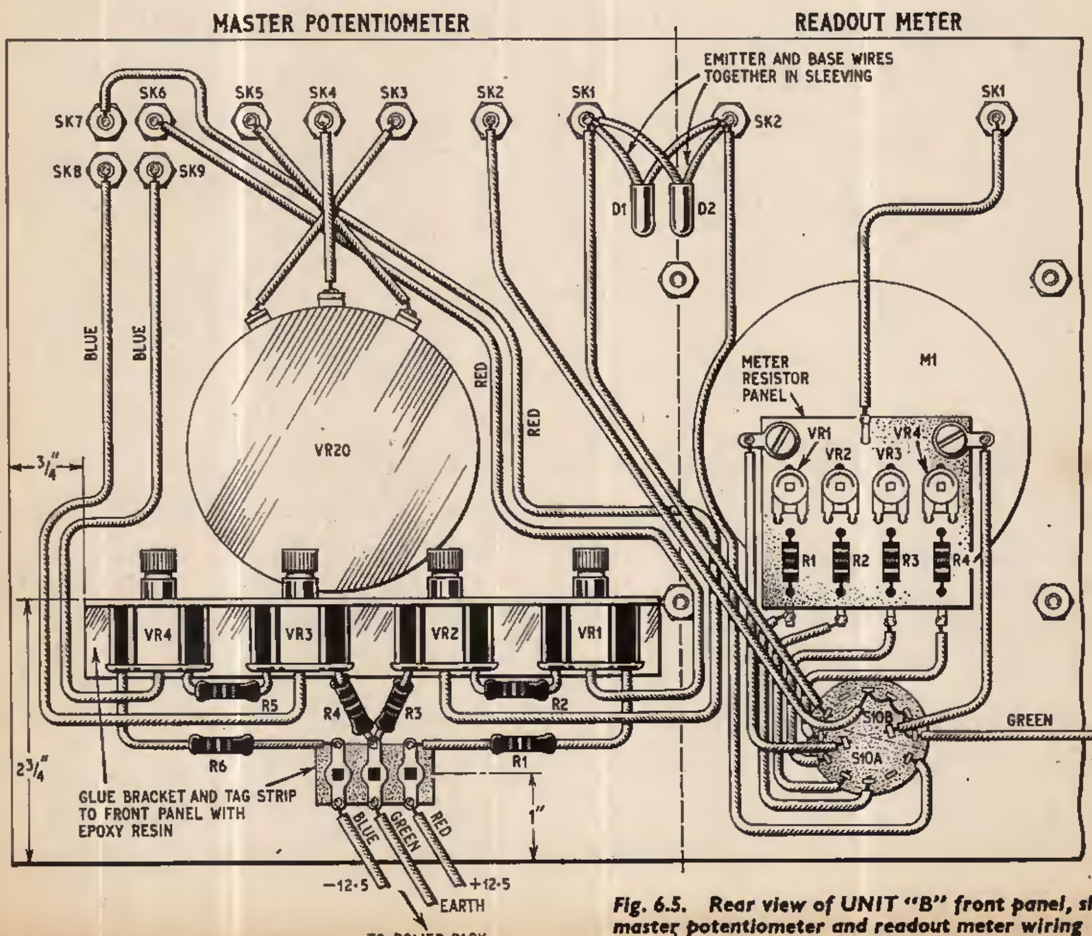

Fig. 6.5. Rear view of UNIT "B" front panel, showing master potentiometer and readout meter wiring

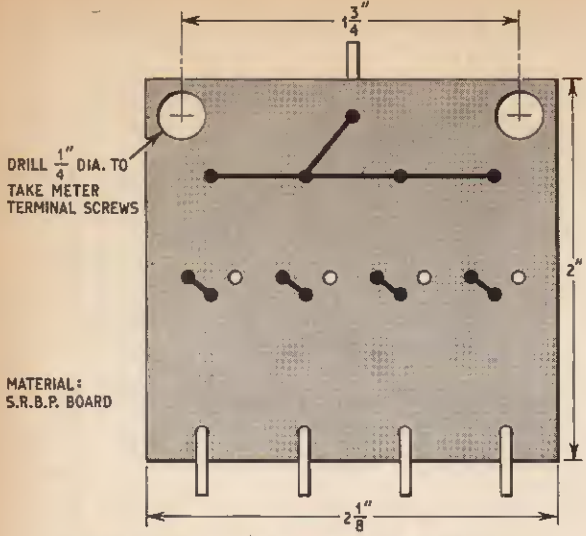

Fig. 6.8. Meter resistor panel, underside view

wiring of master potentiometer components, using 20 s.w.g. tinned copper wire and sleeving.

READOUT METER ASSEMBLY

Make up the meter resistor panel shown in Figs 6.7 and 6.8, and attach to the meter terminals. Solder D1 and D2 to MP/SK1 and RM/SK2, then complete S10 and resistor panel wiring.

As centre-zero voltmeters with 10–0–10 and 3–0–3 scale calibrations are not readily available, a scale will have to be made. Perhaps the most satisfactory way of fabricating a new and really accurate meter scale is to draw it two to four times full size, photograph it, and then have the resulting negative enlarged back to the original size on glossy photographic paper. The enlarging can be done commercially if the oversize drawing carries a thick black line to represent a length of 1in on the finished scale, just outside the scale perimeter.

When taking the photograph, ensure that the camera lens is in line with the centre of the scale card, and that the film plane is parallel to the surface of the oversize drawing, to prevent optical distortion.

Another tip, use white Formica for the drawing, as then mistakes in ink can be erased without leaving unsightly grey areas.

To remove the existing scale from the meter, prise off the transparent meter front, and carefully remove the scale card by undoing the two holding screws. Measurements can then be taken for preparing the oversize drawing.

To fit the new scale, cut out the photographic reproduction and paste it over the old scale, with edges and mounting holes of both scales properly registered.

SETTING UP MASTER POTENTIOMETER AND READOUT METER

With red, green, and blue p.v.c. covered wires, connect the master potentiometer tag strip (Fig 6.7) to the solder tags on the power pack output terminals. Also, temporarily link the rear of MP/SK2 to the green earth wire. Rotate VR20 spindle fully clockwise and patch MP/SK2 to SK3, MP/SK5 to SK6, MP/SK1 to SK4, and link RM/SK2 to VS1/SK1. Switch on the computer and S6, and adjust VS1 for an exact +10V. Now obtain a null on the readout meter by setting VR1 on the voltage divider bracket, from the back of UNIT "B" box.

Repeat for VR2 with an input of +1V by transferring the patching lead plug from MP/SK6 to SK7, and again for VR3, SK8, with an input of −1V, and VR4, SK9, with an input of −10V.

After that, while still nulling with a −10V input, rotate VR20 spindle slightly clockwise, until the meter pointer just begins to move away from zero. Place the large knob on VR20 spindle, with the transparent plastic cursor aligned with the "10" division, and tighten the grub screw. Set VR20 cursor to the "5" division and check for null with an input of —5V. It may be necessary to slightly re-position VR20 knob on the spindle, and trim VR1–VR4 again to minimise errors.

Calibration of the readout meter is straightforward. Apply a selection of known voltages to RM/SK1 and

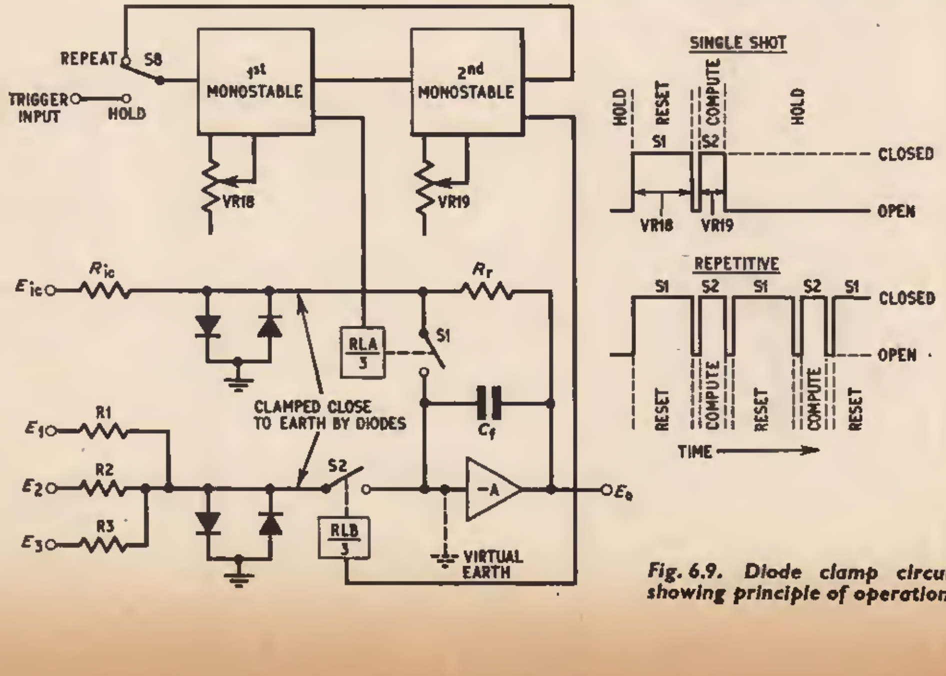

Fig. 6.9. Diode clamp circuit, showing principle of operation

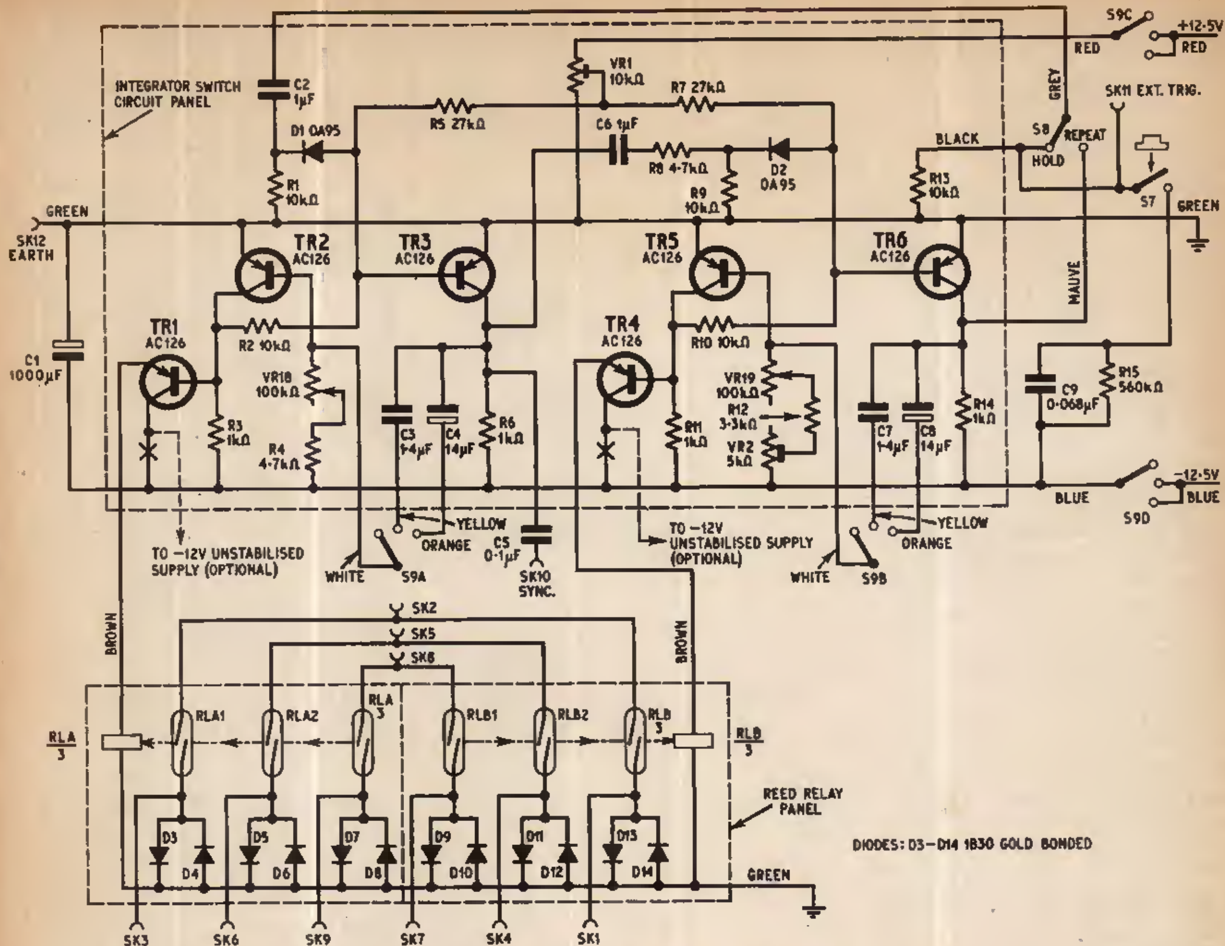

Fig. 6.10. The complete circuit diagram of the integrator switch

adjust VR1–VR4 on the resistor panel for optimum accuracy on each range.

INTEGRATOR MODE SWITCHING

The simplest type of integrator switch employs a mechanical relay with several sets of contacts, driven by an astable multivibrator, and this system is used for small demonstration and educational analogue computers. The relay is arranged to "gate" the inputs of several amplifiers simultaneously.

The PEAC integrator switch goes a stage further, with reed relays for a "clean" switching action at high speeds, full initial condition facilities, and a circuit based on two independently timed monostable multivibrators.

Referring back to the basic integrator switch shown in Fig 1.2c, two changeover switches S1 and S2 are opened and closed in a pre-determined sequence, governed by an external timing circuit. It is important to ensure that integrating amplifier input resistors are not left floating when they are disconnected from the virtual earth summing junction, as this could seriously disturb input and other computer voltages, hence the presence of S1 and S2 earthed contacts.

DIODE CLAMPS

To eliminate the need for expensive reed switches with changeover contacts, diode clamps can be used instead of an earthed contact, see the alternative amplifier circuit of Fig 6.9. The diodes do not interfere with the normal working of the integrator, but will nevertheless hold resistor junctions close enough to earth to prevent load variations when S1 and S2 are open, and this modification more than halves the cost of switching components.

In the block diagram of Fig 6.9, the 1st monostable—controlled by VR18—determines the period of closure of S1. When S1 opens after a timed interval, a pulse is delivered to the input of the 2nd monostable, thus closing S2. S2 will remain closed for an interval controlled solely by VR19.

For "single shot" operation, a trigger pulse applied to the 1st monostable input, when S8 is switched to "hold", will initiate the closure of S1 (reset) and bring the integrating amplifier to its initial condition.

As soon as S1 opens, S2 closes (compute) and connects input resistors to the summing junction. At the end of the compute period, S1 and S2 are both open (hold), the monostables are quiescent, and the amplifier output voltage is held steady by the action of capacitor C_t. The next computer run is started by another trigger pulse applied to the 1st monostable input.

Repetitive operation is achieved by passing the output pulse from the 2nd monostable back to the input of the 1st monostable, when S8 is switched to "repeat". S1 and S2 are then made to open and close alternately, and the "hold" facility is deleted.

The method of inserting an inital condition voltage is as follows. When S1 is closed the reset resistor R_r is connected between the amplifier output and summing junction, and can therefore be regarded as a feedback resistor in parallel with C_f.

As long as S1 remains closed, R_{ic} will be acting as an input resistor, so that

$$E_o = -E_{ic}\frac{R_r}{R_{ic}}$$

and $E_o = -E_{ic}$ when $R_r = R_{ic}$. R_{ic} and R_r are disconnected from the amplifier summing junction when S1 opens, but C_f will "remember" the initial condition voltage and hold the amplifier output steady prior to the application of compute voltages when S2 closes.

INTEGRATOR SWITCH CIRCUIT

The complete circuit of the integrator switch is shown in Fig 6.10. The 1st monostable consists of TR2 and TR3, with RLA actuated by emitter follower TR1. VR18 continuously covers two ranges given by C3 (10–100ms), and C4 (0·1–1s). Components associated with the 1st monostable input are C2, R1, and D1.

The 2nd monostable is almost identical to the 1st. TR4 drives RLB, C7 and C8 offer the same timing range coverage as C3 and C4, and input components are C6, R8, R9, and D2. However, more care is taken to establish the correct values for 2nd monostable timing capacitors C7 and C8, and VR2 allows precise calibration of the "fast end" of the VR19 timing scale, so that compute intervals can be determined by a reasonably accurate dial setting.

VR1 establishes the working point of both monostables, to achieve reliable operation at all dial settings. S7 is a push button on the front panel for starting a "single shot" computer run. Full control of an oscilloscope trace, from UNIT "B" front panel, can be realised by suitable connection to the integrator switch circuit. With S8 switched to "hold", the mode sequence can be triggered repetitively, with a variable hold interval, by the oscilloscope timebase output or by a separate oscillator. Consistant syncronisation of the trace, with continuous or single-sweep timebases, is made possible by linking IS/SK10 to an appropriate oscilloscope input

A SEPARATE SUPPLY

The load capacity of the existing stabilised power supply can be improved by wiring the collectors of TR1 and TR4 (shown dotted in Fig. 6.10) to a separate −12V unregulated supply, which can be housed inside the UNIT "B" box, and in this event C1 could be omitted from the Fig. 6.10 circuit, as it merely serves to prevent current pulses from flowing in the negative stabilised supply line during relay switching.

RLA and RLB consist of two triple-switch coils, catering for the needs of three integrating amplifiers. A duplicate relay panel could be added later, by wiring relay coils in parallel, to increase the switching capacity to six amplifiers.

CORRECTION

In Fig. 5.7, the captions for the first and second oscillographs (top row, left and centre) should be transposed.

Next month: Assembly and setting up of the Integrator Switch; practical examples in the use of this section. Introduction of UNIT "C" Function Generator.

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1µF	50 volt	8µF	3 volt	64µF	2·5 volt
1µF	350 volt	8µF	6 volt	64µF	9 volt
1·25µF	16 volt	8µF	350 volt	100µF	3 volt
2µF	3 volt	8µF	450 volt	100µF	6 volt
2µF	9 volt	8µF	50 volt	100µF	9 volt
2µF	70 volt	8µF	275 volt	150µF	12 volt
2µF	150 volt	10µF	25 volt	200µF	3 volt
2µF	350 volt	16µF	150 volt	200µF	4 volt
2·5µF	16 volt	20µF	3 volt	250µF	2·5 volt
2·5µF	25 volt	20µF	6 volt	250µF	9 volt
3µF	3 volt	20µF	9 volt	320µF	2·5 volt
3µF	25 volt	20µF	15 volt	350µF	9 volt
3·2µF	6·4 volt	25µF	6 volt	350µF	10 volt
3·2µF	64 volt	25µF	12 volt	400µF	2·5 volt
4µF	4 volt	25µF	15 volt	400µF	15 volt
4µF	12 volt	25µF	25 volt	500µF	4 volt
4µF	25 volt	30µF	6 volt	500µF	6 volt
4µF	64 volt	30µF	10 volt	640µF	2·5 volt
4µF	100 volt	40µF	3 volt		
5µF	6 volt	40µF	6·4 volt		
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DRUMMER'S Whoosh..Sh..Sh

By A. J. BASSETT

THE "cymbals" circuit with the white noise generator, described last month, can be adapted to give a "whoosh" effect to the sound of drum beats. A microphone is placed in close proximity to the drums; the signal from the microphone is passed through the "whoosh" unit. The effect produced can be tuned or filtered to give different pitches for each drum beat.

WHOOSH TRIGGER

The unit described incorporates its own microphone amplifier to give sufficient drive to trigger the whoosh into action. Referring to the circuit in last month's cymbals effects article, the signal is fed into C7 from the heavily driven amplifier shown in Fig. 1.

This amplifier cannot be used as an ordinary audio amplifier or pre-amplifier for normal listening purposes, as its output would be pulsed and highly distorted; however, it is very suitable in this case for providing a pulse drive to the cymbals circuit. This latter circuit is triggered to pass white noise from the P.E. White Noise Generator.

Refer to the block diagram on Fig. 2. The sound of the drum is picked up by the microphone, which is placed close to the drum skin. The signal passes to the high-output-swing amplifier via a volume-control VR2.

The output pulses from the amplifier then operate the cymbal circuit, whose output can be heard as a "whoosh" by connecting to a power amplifier. A single-pole push/push switch may be connected from the junction of D2, D3 to chassis, in order to mute the unit when effects are not required.

The cymbals filter circuit is altered to give a lower "whoosh" sound rather than a cymbal effect. This alteration consists merely of increasing the values of C5 and C10 to 0·05μF; C7 and C8 become 0·01μF, and R10 is decreased to 1 megohm. Different values may be tried, thus altering the effect to your own personal preference. It is necessary to adjust the volume controls (both the sensitivity control VR2 and the volume control on your audio amplifier) after changing the capacitors, as they have a considerable effect on the output amplitude of the unit.

If VR2 is set too high, acoustic feedback can occur, resulting in a continuous "whoosh" effect from the loudspeakers. Therefore, VR2 is set a little lower, so that a tap on the drum is necessary before the "whoosh" effect is produced. Other sounds, for example, from an electric guitar or organ, should not be allowed to trigger the whoosh unit. Another measure, which may be necessary in order to avoid this continuous "whooshing" feedback is to position the loudspeakers well away from the drums.

MAKING THE MODS

To make this effects unit you will need the basic white noise generator and cymbals filter boards (see last month's article). Carry out the modifications to the cymbals filter board as detailed earlier; fit these two units into a chassis or other box 12in × 4in × 2½in, leaving space for the new microphone amplifiers and possibly the 18V power supply.

The "manual pulse" push-button S1 and resistor R7 are not necessary and can be omitted if desired. The "pulse input" jack JK1 is not necessary either and can be transferred for use as the microphone input jack.

A muting push-button is fitted to the chassis and connected in parallel with D2 on the filter board.

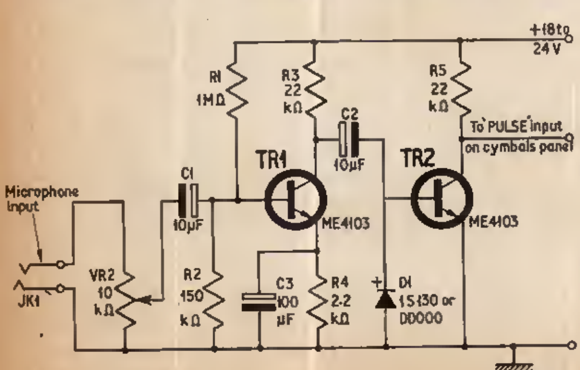

Fig. 1. Circuit diagram of the microphone amplifier

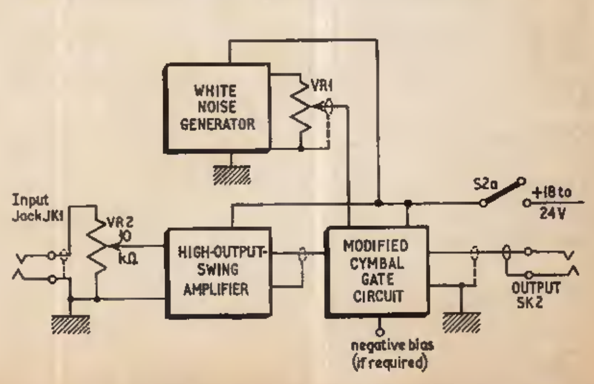

Fig. 2. Block diagram showing the interconnection of panels with jacks and controls

COMPONENTS . . .

MICROPHONE AMPLIFIER

Resistors
R1 1MΩ R3 22kΩ R5 22kΩ
R2 150kΩ R4 2·2kΩ
All 10% ¼W carbon

Potentiometer
VR2 10kΩ log. carbon

Capacitors
C1 10μF elect. 15V
C2 10μF elect. 15V
C3 100μF elect. 10V

Transistors and Diode
TR1, TR2 ME4103 *or* C424
D1 1S130 *or* DD000

Miscellaneous
Printed circuit board 2in × 1½in

Other components are as given in the Cymbals Effects Unit article last month except:

Change C5 to 0·05μF, C10 to 0·05μF, R10 to 1MΩ, C7 to 0·01μF, C8 to 0·01μF

Delete S1 and R7

Add Single pole on/off switch in parallel with D2 (push on/push off)

Fig. 3. Printed circuit pattern (full size) for the microphone amplifier

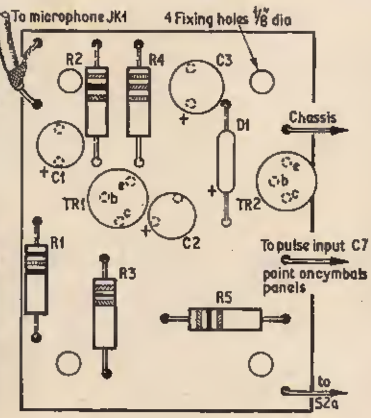

Fig. 4. Component layout on the printed circuit board

Next, the new panel incorporating components for amplifying the microphone signal is made up. The printed circuit pattern is shown full size in Fig. 3, while component layout is given in Fig. 4. Terminal points on the board can be either pins or direct connections to the copper through holes in the board.

All printed circuit boards can be glued on to foam rubber or plastics pads in the box so that the copper does not touch the metallic chassis; plain s.r.b.p. boards can be used here to separate the printed circuit boards from the metal.

TESTING THE EFFECTS UNIT

Connect the unit to a power supply of 18 to 24 volts, also a negative bias supply for the cymbal circuit. The power source may consist of either batteries or a mains power unit with smoothed output (as shown in last month's article). Connect also a power amplifier with loudspeakers (a guitar amplifier or public-address amplifier is suitable). All variable controls should be set initially to a low level. Temporarily connect the junction of R8, C8 (cymbals filter) to the positive supply and switch on.

By adjusting VR1 and the volume control of the audio amplifier, the sound of the white noise generator should come through in a filtered form; the controls should now be adjusted to give a fairly loud, continuous low-pitched hissing effect. Remove the positive supply connection from the junction of R8, C8, and this sound should die away.

By adjusting VR2, you will find that sounds received by the microphone are transformed to give a whooshing effect from the loudspeaker. VR2 can be set so that only the loudest sounds have this effect, and if the microphone is mounted near to, and facing, the skin of a drum, only a tap on this drum will produce an output from the unit.

USING THE UNIT

The unit may be used with just one particular drum, which is the simplest arrangement. Alternatively, several different drums may be used, each with its own microphone. If a number of identical microphones are used, these may be simply connected in parallel using screened wire. Alternatively, an audio mixer unit may be used in place of VR2, to feed signals from a number of different sources to the input of the amplifier. The microphones used may be an inexpensive crystal type, or a moving-iron diaphragm unit.

In order to obtain a different "whoosh" sound from each drum, you may wish to build a separate "whoosh unit" for each drum, and feed the output from each unit to the power amplifier by way of a mixer unit. ★

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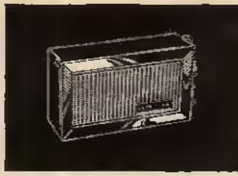

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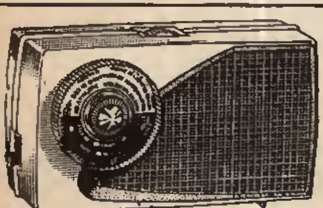

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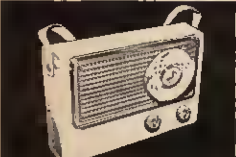

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MARKET PLACE

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.

COMPONENTS

The "Apollo" subminiature mercury switch available from **Photain Controls Ltd.**, should prove very useful for trip or alarm circuits, and in a variety of other circuits such as communications, measuring and control equipment.

Very similar in appearance and size to a transistor, the switch consists of a robust metal housing and contains high purity mercury. One electrode is the metal outer casing and the other the centre lead. The contacts are sealed in glass and filled with gas. The load current is 0.3A at 110V.

When the switch is tilted at a minimum of 30 degrees from horizontal position the mercury moves and closes or opens the contacts, switching the supply on or off as required. When operating there is no clicking noise. Further details are available from Photain Controls Ltd., Randalls Road, Leatherhead, Surrey.

Now to lighting, the Mark-A-Lite is a small halfpenny size disc which glows continuously in the dark, yet needs no electricity, mains, battery or recharging. The back of the disc is self-adhesive and is useful for marking the position of any small item that could be a hazard, or for locating objects in darkness. Light switches, keyholes, car ignition switches and front panel controls, are just a few of the applications that come to mind.

The Mark-A-Lite costs 11s 4d and is available from **Wrights Aviation Co. Ltd.**, 4 Melbourne Close, Morton, Middlesbrough, Yorkshire.

A new range of battery holders have just been announced by **A. F. Bulgin & Co. Ltd.**, Bye Pass Road, Barking, Essex. These holders take U2 cells and equivalents. They are designed for front panel mounting, making it easy to replace exhausted batteries; all contacts are heavily plated to prevent corrosion.

The holder is fixed to a panel by four 6B.A. bolts, the front cap or contact being a push and twist type.

An r.f. microminiature coaxial connector by **Thorn Special Products** is available for matched impedance coupling of 50 ohm screened cables. It is made of gold plated copper alloy, with crimped connections, the connector being insulated with p.t.f.e. The contact resistance is claimed to be less than 4 milli-ohms. This connector is supplied as a complete cable assembly, the pin and socket each being assembled with a 12in length of 50 ohm cable. Alternative lengths are available to order.

EQUIPMENT

Newmarket Transistors Ltd., have recently added a preamplifier to their range of "packaged circuit" modules. The PC10 is intended mainly for tape head amplification and is powered from a 9V supply. It has an input impedance of 150 ohms and output impedance of 3,300 ohms. The sensitivity is given as 150mV out at 1kHz for a 15mV input.

Readers thinking of purchasing a new multimeter may be interested in the Sanwa range available through **Household Electrix Ltd.**, 47-49 High Street, Kingston-upon-Thames, Surrey.

The price of the Sanwa range of meters varies from £3 7s 6d to £13 5s.

One item not shown at this year's Audio Fair is the Dewtron New Dimensions sound effects amplifier. Marketed at 8 guineas, plus 4s postage, by **D.E.W. Ltd.**, Ringwood Road, Ferndown, Dorset, the unit provides adjustable echo, vibrato, spacial (reverberation) and tonal effects. The unit can be used with any domestic radio, record player, electronic musical instrument, or tape recorder having provision for an external speaker.

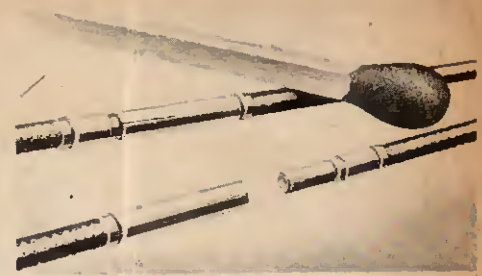
The effects amplifier creates a pseudo "stereo" effect if an extra speaker is used together with the existing appliance speaker. The power output is approximately 1 watt. Another version is obtainable for car radio use and is wired directly to the car battery.

AGENTS

Home Radio (Components) Ltd., 187 London Road, Mitcham, Surrey, have been appointed retail stockists of all Lektrokit components.

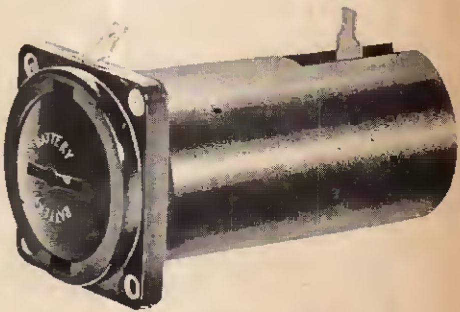
Over 150 individual items in the Lektrokit ranges are now available "off the shelf" and are all obtainable through the postal delivery service run by Home Radio.

Single cell or small quantities of Voltabloc rechargeable nickel-cadmium battery cells can now be purchased through **Electroniques**, Edinburgh Way, Harlow, Essex.



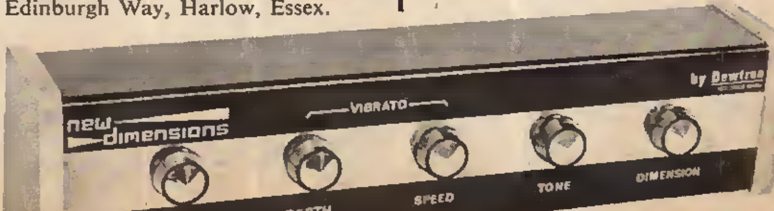
Microminiature coaxial connector produced by Thorn Special Products

Apollo mercury switches from Photain Controls



Panel mounting battery holder by A. F. Bulgin

Wrights Aviation Mark-A-Lite



Dewtron New Dimensions sound effects unit maufactured by D.E.W. Ltd.

Readout—
A SELECTION FROM OUR POSTBAG

Thriving and active

Sir—About a year ago, a letter was published in your magazine, announcing the intention of forming a radio club in South London. The Addiscombe Amateur Radio Club was formed, having as its hard core several young people who wrote to us as a result of reading about us in P.E. Since those early days we have had many more members and visitors attracted by the publicity you have given us. The members have asked me, as secretary, to write to you with our thanks for the help and encouragement you have given to us, and doubtless to many other clubs who are struggling to get firmly established.

Thanks to P.E. the Addiscombe Club is now a thriving and active club.

S. V. Knowles, Hon. Sec.,
West Croydon,
Surrey.

Unsociable or mere handmaiden?

Sir—I wonder how many readers have stopped to think how Electronics, as an activity for Amateur enthusiasts, has never produced a social movement for the advancement of its aims and interests in a similar way, for instance, to the Amateur Radio Movement. It might be said that this lack of an effective Club or Society movement is due to the lack of incentive to co-operate with other fellow enthusiasts, which is essential in such activities as Amateur Radio.

It must mean that thousands of Electronics enthusiasts are working away on lonely projects, and that Electronics has no collective voice or recognisable unity as a hobby movement.

But, a closer look at my statement about lack of incentive above, shows that it does not hold water. There are a great number of Amateur Movements with strong collective organisations, the Amateur Astronomers, Model Engineers and Aeromodellers, to name just a few. None of these activities can claim an essential social element, like that necessary for Amateur Radio, yet they have strong society movements.

There might be more serious reasons for the lack I have been discussing. Is it possible that, on the average, Electronics enthusiasts are an unsociable type of person anyway, rather dealing with gadgets and things than with people? They may have had a strong desire to retreat into their gadgetry world, over which they can keep a sense of power.

There is one further explanation, and that is the one that says Electronics has no separate existence. This means that the activities of the people engaged in electronics are catered for by other firmly established bodies. Therefore, Radio Amateurs constitute a vast number of electronics men. There is a large pool in the model control field. The Radio Astronomers make up another quite advanced group. The Photographer would build his timers and gadgets, without the need to go to an Electronics Club.

It would seem that Electronics is a handmaiden to other interests, in other words it has come too late and the prospects for any representative Society arising is bleak . . . or is it? There may be readers with other views, but the evidence would have to be strong!

R. F. Marchant,
Leyton, E.10.

"Phial"-ed

Sir—I would like to congratulate A. J. Nicholls on his approach to Electronic and Mechanical car protection (see Readout April issue). I feel though that his car is still dangerously vulnerable to theft.

The modern thief, having beaten the electronics and entered the car, thinks nothing of breaking or unlocking any mechanical device linking steering to a pedal.

I have made my car safer by arranging in addition, that the release of the handbrake, as the thief goes to drive away, breaks a glass phial and fills the car with tear gas. At this stage I felt my car was fairly secure until I realised that the thief might have a gas mask with him.

I have therefore arranged things further so that as soon as the car moves forward small bursting charges in the hubs blow off all four wheels.

Dr. R. Parfitt,
London, S.E.19.

You must have a thriving practice. We hope you don't charge a consulting fee?

Simplicity is the key

Sir—I have read your Editorial in the April issue of PRACTICAL ELECTRONICS with great interest.

As the Design Engineer of a small firm of Instrument Engineers I too have found that some of the circuits given in your magazine tend to be a little too sophisticated. Of course, if the aim is to generate an increased interest in electronic circuitry this is very fine. If, on the other hand, usefulness is the aim I would suggest that simplicity is the best policy.

Many manufacturers of instrumentation have the tendency to make their products with many "frills" built into them as sales gimmicks. For instance, I know of one s.c.r. control circuit containing no less than ten transistors. Compared with another (fool-proof and accurate) circuit produced by another firm that only employs three transistors.

There are numerous examples of this kind to be found in the industrial field. Believe me, the simpler a circuit can be made the less trouble in maintenance and reliability is to be expected.

Trusting that these remarks may interest your readers.

D. H. Heppell,
Warley.

Any square wire?

Sir—Can any reader suggest a source of SQUARE connecting-up wire, as used in the early 1920's?

This is urgently wanted by members of the Peterborough Radio and Electronic Society, in the making of "genuine 1922" wireless receivers for their "Radio Museum". Plenty of old components have been collected—but not a bit of SQUARE wire.

D. Byrne G3KPO,
Jersey House,
Eye, Peterborough.

Come and join us

Sir—We are writing to enquire if any of your readers in the Paddington area would be interested in visiting the Paddington and District Amateur Radio Society which meets every Thursday at 7.30 p.m.

The club promotes an interest in amateur radio and allied subjects. Lectures and film shows are amongst the itinerary together with a constructional evening, held on Wednesdays.

The Clubroom is in the Beauchamp Lodge Settlement, 2a Warwick Crescent, W.2.

The Club intends to hold several field days during the year and provide demonstration stations for local events.

M. M. Pawley G8AWV,
London, W.2.

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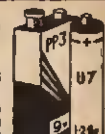

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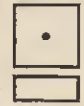

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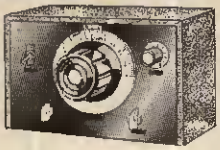

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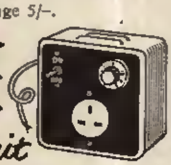

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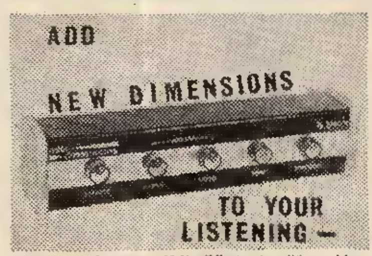

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