Practical Electronics

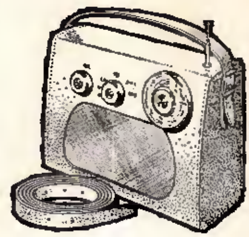
SEPTEMBER 1965

PRICE 2'6

COMMENTARY SYNCHRONISER FOR AUTO PROJECTORS

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS...

BACKED BY OUR SUPER AFTER SALES SERVICE



ROAMER SEVEN Mk III

5 WAVEBAND PORTABLE OR CAR RADIO

Amazing performance and specification ★ ***Now with PHILCO MICRO-ALLOY R.F. TRANSISTORS***

● **9 stages—7 transistors and 2 diodes**

Covers Medium and Long Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room filling volume from rich toned heavy duty "Celestion" speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M & L Waves and telescopic aerial for S Waves. Real leather-look case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere.)

Total cost of parts now only **£5.19.6** P. & P. 5/6
Parts Price List and easy build plans 3/-

NEW TRANSONA FIVE

Home, Light, A.F.N., Lux. all at good volume. *G.P. Durham*

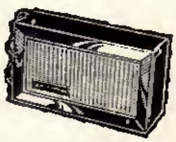
● **7 stages—5 transistors and 2 diodes**

Fully tunable over Medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 2½in. speaker, etc. Attractive case. Size 6½ × 4½ × 1½in. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

POCKET FIVE

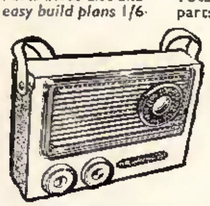
● **7 stages—5 transistors and 2 diodes**



Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite rod aerial and fine tone 2¾in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3½in. (Uses 1289 battery available anywhere.)

Parts Price List and easy build plans 1/6 Total cost of all parts now only **42/6** P. & P. 3/-

SUPER SEVEN



● **9 stages—7 transistors and 2 diodes**

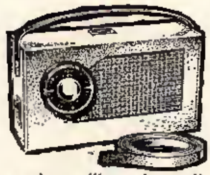
Covers Medium and Long Waves and Trawler Band. The ideal radio for home, car, or can be fitted with carrying strap for outdoor use. Completely portable—has built-in Ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF Stages, push-pull output, 3in. speaker (will drive large speaker). Size 7½ × 5½ × 1½in. (Uses 9v battery, available anywhere.)

Total cost of all parts now only **£3.19.6** P. & P. 3/6 *Parts Price List and easy build plans 2/-*

MELODY SIX

"... amazed at volume and performance. has really come up to my expectations". S.G., Stockton-on-Tees.

● **8 stages—6 transistors and 2 diodes**



Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6½ × 3½ × 1⅞in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.9.6** P. & P. 3/6

TRANSONA SIX

● **8 stages—6 transistors and 2 diodes**

This is a top performance receiver covering full Medium and Long Waves and Trawler Band. Push pull output. High-grade speaker makes listening a pleasure. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1½in. (Uses PP4 battery available anywhere.) Carrying Strap 1/- extra.

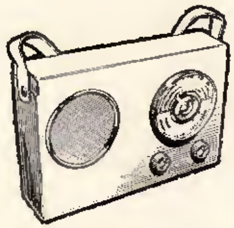
Total cost of all parts now only **59/6** P. & P. 3/6 *Parts Price List and easy build plans 1/6*

ROAMER SIX *NEW!!*

NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS

● **6 WAVEBAND!!**

● **8 stages—6 transistors and 2 diodes**



Listen to stations half a world away with this 6 waveband portable. Tunable on Medium and Long Waves, Trawler band and three Short Waves. Push pull output. Sensitive Ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1½in.

★ Extra band for easier tuning of LUX., etc.

Parts Price List and easy build plans 2/- Total cost of all parts now only **£3.19.6** P. & P. 3/6 (Carrying Strap 1/6 extra.)

COMPONENT BARGAINS

TRANSISTORS

PHILCO MADT Type 2N1727 Maximum frequency of oscillation 150 Mc/s 8/6

PHILCO MADT Type 2N1728 Maximum frequency of oscillation 150 Mc/s 9/6

PHILCO MADT (Micro Alloy Diffused) Type 2N503 Maximum frequency of oscillation over 500 Mc/s 15/-

TUNING CONDENSERS

Air spaced fine quality German manufacture with slow motion drive. 0·0005 with oscillator section .. .. 5/6 Post 1/-

HEADPHONES

High Fidelity miniature magnetic earpieces (2) on slim band with lead and plug. Easily converted to stereo. American manufacture. 100 ohms impedance. Transformers supplied free for higher impedances .. 13/6 P & P 1/6

CYLDON PERMEABILITY TUNERS

Full M.W. coverage. Fitted coupling coil, oscillator coil, ferrite slugs and slow motion tuning with cursor, etc. GIVE AWAY PRICE .. .. 10/- P & P 1/-

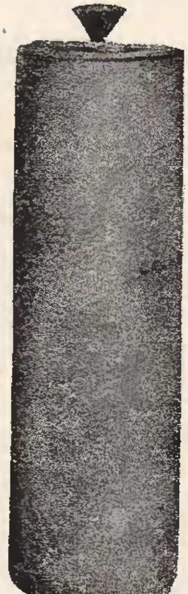
All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans available separately at fixed prices stated.

RADIO EXCHANGE Ltd.
61a, HIGH STREET, BEDFORD. Phone: 2367

Callers side entrance Barratts Shoe Shop Open 9—5 p.m. Sats. 9—12.30 p.m.

UNUSUAL SINGLE SPEAKER SYSTEM

A CONCRETE COLUMN



An inexpensive column speaker constructed from a concrete pipe and fitted with a good 8" or 10" unit, has attracted much interest and admiration because of its clean, open sound.

Complete kits of wooden fixtures are available, including absorbent wadding and diffusing cone.

Price **£3.15.0** for 8" model. Recommended 8" unit —Super 8/RS/DD **£6.14.2** *including purchase tax.* Price **£4.18.0** for 10" model. Recommended 10" units — Super 10/RS/DD **£10.18.8**; Golden 10/RS/DD **£7.17.5**; 10" Bronze/RS/DD **£4.12.9.** *Prices include purchase tax.*

Suitable concrete pipes can be purchased from builders' merchants at about 12/6 and 17/6.

Descriptive leaflet free on request from:

Wharfedale

WHARFEDALE WIRELESS WORKS LTD.
Dept. E
IDLE, BRADFORD, YORKSHIRE
Grams: "Wharfdel" Bradford
Telephone: Bradford 612552/3

BARGAINS for C.C.T.V. Enthusiasts

ALL BRAND NEW!

A FURTHER PURCHASE
E.M.I. 1" VIDICON TUBES

FOR ALL C.C.T.V. VIDICON CAMERAS

Excellent for all Industrial, Commercial, Entertainment, Experimental & Research applications
OUR PRICE ONLY (USUALLY £15) **£8.10** P. & Ins. 16/-

'COSMICAR' 1" f/1.9 LENS

"Click" stop aperture to f/22. C mount (16mm. cine fitting). Full focusing adjustment. Fully bloomed. Complete with lens cap
USUALLY £23 **£9.19.6** P. & Ins. 5/6

HERE'S A BARGAIN — 3 ONLY
'CYCLOP' C.C.T.V. CAMERAS
Mk. III 405 line R.F. Normally selling at £91.5 Genuine Buy at Only . . . **£43** not including Vidicon Tube and Lens (Available as above)

EXPECTED SHORTLY FROM JAPAN!
Semi-Professional 'VIDEO-TAPE RECORDER' AT A PRICE ALL CAN AFFORD! Details will be available shortly— Are You on Our Mailing List?

★ SPECIAL OFFER! 'CIRCUIT DIAGRAMS' of N.E.V. 'Icon' R.F. C.C.T.V. Transistor Cameras—only 24/- inc. p. & p.

HORNTONS ELECTRONICS LTD.
(Next to Pan American Airways)
145 GREAT CHARLES STREET, BIRMINGHAM 3
Tel. MID. 0972 or CEN. 6283

ERSIN Multicore SOLDER

The world-famous copper loaded alloy containing 5 cores of non-corrosive flux, that saves the soldering iron bit. Ersin Multicore Solder is also available in high tin quality alloys. 60/40 in 22 s.w.g. for printed circuits, transistors, etc.

SAVBIT ALLOY *saves wear on soldering iron bits*

SAVBIT SIZE 1 CARTON

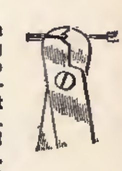
Contains approximately 30 feet of 18 s.w.g. SAVBIT. It is also supplied in 14 s.w.g. and 16 s.w.g. Obtainable from radio and electrical stores.

5/- each

THE HANDY DISPENSER

Easy to find in the tool box—simple to use. Virtually a third hand for tricky soldering jobs. 12 feet 5 core 18 s.w.g. ERSIN MULTICORE SAVBIT alloy in a continuous coil used direct from free-standing dispenser.
2/6 each

BIB WIRE STRIPPER AND CUTTER



Strips insulation without nicking wire, cuts wire cleanly, adjustable to most thicknesses. Splits extruded plastic twin flex.
3/6 each

MULTICORE SOLDERS LTD.
MULTICORE WORKS • HEMEL HEMPSTEAD • HERTS • HEMEL HEMPSTEAD 3636

CMMS 24a

SPACE AGE!

sinclair

P.W.M. AMPLIFIERS
MICRO-RECEIVERS
MICRO-DESIGNS

THE SMALLEST SET ON EARTH!

SINCLAIR MICRO-6
6-STAGE RECEIVER

$1\frac{4}{5}'' \times 1\frac{3}{10}'' \times \frac{1}{2}''$

- Weighs under 1 oz.
- Fantastic power and range
- Plays in cars, trains, buses and difficult areas

ACTUAL SIZE

Build it in an evening!

No transistor set has ever yet compared with the Micro-6 for size, power, performance and design. Thousands upon thousands have been built by enthusiasts from electronic engineers to beginners in transistor construction and are now in use throughout the world. Everything except the lightweight earpiece is contained within the smart minute white gold and black case. With batteries and self-contained aerial, the Micro-6 weighs under one ounce! Unique features which make such wonderful performance possible include bandspread over the higher frequency end of the medium waveband for easy reception of Luxembourg, powerful A.G.C. to counteract fading of distant stations, and vernier type tuning. Quality of reproduction is outstandingly good, so that you derive real pleasure from using this fantastic set. Order your Micro-6 now and prove for yourself why it cannot be too highly recommended as an intriguing design to build and a most practical radio to use. You can build it in an evening and when you have built your first, be certain others are going to want one too, when they see and hear the Micro-6.

All parts including M.A.T.s, case, dial, lightweight earpiece and beautifully detailed easy-to-follow instructions come to **59/6**

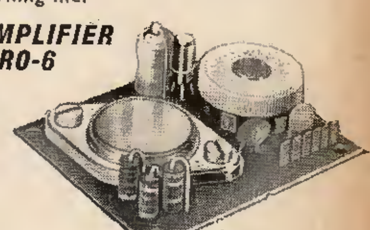
MALLORY MERCURY CELL Type ZM.312 (2 required) each 1/11. Pack of 6 10/6

"Transrista" Black nylon strap for wearing Micro-6 on your wrist 7/6

Amazing circuitry

In the Micro-6, a six stage circuit using 3 special Micro-alloy transistors (Sinclair M.A.T.s) provides two stages of R.F. amplification, double diode detector and high gain 3-stage A.F. amplifier plus A.G.C. and bandspread over the higher frequency end of the tuning to bring in Luxembourg like a local station. Inserting the plug of the earpiece switches the Micro-6 ON; withdrawing switches it OFF. Tuning is by vernier-type dial over the medium wave band. Two self-contained batteries give about 70 hours working life.

A POWERFUL AMPLIFIER FOR YOUR MICRO-6
TR750



SIZE 2" × 2"

This highly original Sinclair amplifier makes a powerful car, portable or domestic loud-speaker radio used with the Micro-6. Can also be used for record reproduction, baby alarm, intercom, etc., 750 milliwatts output for feeding into a standard 25-30Ω l/speaker. Input, 10mV. Response, 30-20,000 c/s ± 1dB. With built-in switch and volume control. For 9V d.c. operation.

Parts and instructions **39/6** *Ready built and tested* **45/-**

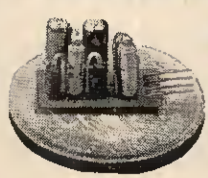
SINCLAIR X-10 P.W.M. AMPLIFIER AND PRE-AMP

Recommended for use where a less powerful amplifier than the X-20 is required. The X-10 offers similar advantages of quality, compactness and price, and it can be battery operated if desired. Tone control system added to choice. For 12-15 volt operation. **FREE X-10 Manual with every amplifier.**

SIZE 6" x 3"

Complete kit and instructions	£5.19.6
Ready built and tested	£6.19.6
X-10 power supply unit	£2.14.0

ANOTHER SINCLAIR SPECIAL
MICRO AMPLIFIER



Smaller than a 3d. piece! Frequency response — 30-50,000 c/s ± 1dB; gain — 60dB (1,000,000 times). The instructions supplied with the set of parts, show how to use this amazing design in many ways including an A.F. amplifier, broadband R.F. amplifier, in a F.M. transmitter, etc., etc. Ideal for modellers and experimenters. Easy to build.

28/-

SINCLAIR MICRO-INJECTOR

Simple to build and use for fault tracing.
Ready built 32/6 *Set of parts 27/6*

GUARANTEE ORDER FORM

NAME...

ADDRESS...

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Please send me

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For which I enclose Cash/Cheque/Money Order value

£..................s..................d.

Guarantee

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full and at once without question. It is important to quote Pr.E 9 should you prefer to write your order instead of cutting out this coupon.

Famous British P.V.C. Recording Tapes

7in. L.P.	1,800ft.	19/6	7in. D.P.	2,400ft.	29/6
5¾in. L.P.	1,200ft.	14/6	5¾in. D.P.	1,800ft.	24/6
5in. L.P.	900ft.	11/6	5in. D.P.	1,200ft.	18/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS: 2, 6 or 12 v. outputs, 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6.

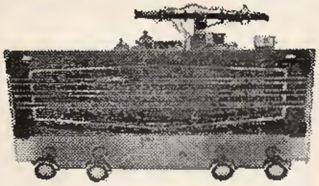
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amps., 15/6; 2 amps., 17/6; 4 amps., 22/6. Circuit included. Amp meter 5 amp, 10/6.

MOVING COIL MULTIMETER TK20A. 0-1,000 v. AC../D.C. ohms. 0 to 100 K., 0-150 mA. Pocket size 2in. scale, 49/6.
EP10K (10K Ω per v.) 1,000 v., 300 K., 250 mA. 79/6

NEW MULLARD TRANSISTORS
OC71 6/-; OC72 7/6; OC81D 7/6; OC81 7/6; AF115 10/6; AF114 11/-; OC44 8/-; OC45 8/-; OC171 9/-; OC170 8/6; AF117 9/6. OC26 12/6; Transistor Holders 1/3. Sub Miniature Condensers. 0.1 mFd., 30 v. 1/3; 1, 2, 4, 5, 8 16, 25, 30, 50, 100 mFd., 15 volt 2/6. Diode OA81 3/-.

VALVE HOLDERS. EA50 6d. MOULDED Int. Oct. 6d. Mazda Oct. 6d.; B7G, B8A, B8G, B9A, 9d.; B7G with can 1/6. B9A with can 1/9. Ceramic Oct., EF50, B7G, B9A, 1/-. Valve base plugs B7G, B9A, Int. Oct., 2/3.

1965 RADIOGRAM CHASSIS



Three Wavebands Long., Med., Short. Five Valves: ECH81, EF89, EBC81, EL84, EZ80. 12-month guarantee. A.C. 200-250 v. Ferrite Aerial A.V.C. Negative Feedback. 5 watts 3 ohm. Chassis 13½in. × 7in. high × 5in. deep. Glass dial size 13in. × 4in. horizontal wording. Two Pilot Lamps. Four Knobs. Aligned calibrated. Chassis isolated from mains.

BRAND NEW £9.15.6 Carr. 4/6.

ARMSTRONG 'GRAM CHASSIS V.H.F. MODEL. 127M. MED. and F.M. £26.10, Stereo £37.10.

GRAM AMPLIFIERS

Valves: UY85 Rectifier and UCL82 Triode/Pentode 3½ watts output. Size (inc. valves) 5 × 5½ × 2in. deep. New and Tested complete 3 ohm output tone and volume on/off controls. **ONLY 37/6** P. & P. 2/6
Ready for use 200-250 v. A.C.

BARGAIN XTAL PICK-UP ARM
Complete with ACOS LP-78 Turnover Head 20/- Stereo 30/-

TRANSISTOR MAINS ELIMINATORS 29/6
PP1-6 volt. PP9-9 volt (All same sizes as batteries)
DOUBLES 42/6. PP1+PP1. PP9+PP9. PP11—4½+4½.

WEYRAD P50 — Transistor Coils

RA2W 6 in. Ferrite Aerial with car aerial coil......12/6
Osc. P50/1AC.............. 5/4
1st and 2nd I.F. P50/2CC 470 kc/s..............each 5/7
3rd I.F. P50/3CC 6/-
Spare Cores..................6d.
Driver Trans. LFDT4......9/6
Printed Circuit, PCA1. Ready drilled and printed 9/6
J.B. Tuning Gang 10/6
Booklet..........................2/-

Volume Controls
Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 4/6.
Stereo L/S 10/6, D.P. 14/6. Linear or Log Tracks.

80 Ohm CABLE Coax
Semi-air spaced 6d. yd. 40 yd. 17/6, 60 yd. 25/-.
Low loss 6dB. per 100ft. at 500 mc/s.
Ideal 625 lines 1/6 yd.

COAXIAL PLUG 1/-. PANEL SOCKETS 1/-. LINE SOCKETS 2/-. OUTLET BOXES, SURFACE OR FLUSH 4/-. BALANCED TWIN FEEDERS 6d. yd., 80 or 300 ohms. TWIN SCREENED FEEDER 1/- yd., 80 ohms. TELESCOPIC CHROME AERIALS. 12in. extends to 33in. 6/6 each. CAR AERIAL PLUGS 1/6. Sockets 1/3.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER, 200/250 v. A.C. 35/-

GARRARD Auto Slim changers	£6.10.
GARRARD AT5 Auto changers	£8.10.
GARRARD AT6 Auto changers	£10.10.

C.R.T. BOOSTER TRANSFORMERS
for heater cathode short circuit or tubes with failing emission. Full instructions supplied, mains input. Optional 25% and 50% boost 2v. or 6.3v. or 12.6v.
State voltage required. PRICE 15/6

BOOKS (Please Add Postage)

"W.W." Radio Valve Data	7/6
High Fidelity Speaker Enclosures	5/-
Transistor Communication Sets	6/-
TV Fault Finding	6/-
Mullard Audio Amplifier Manual	8/6
Radio Valve Guide, Books 1, 2, 3, 4 or 5	5/-
Practical Radio Inside Out	3/6
Transistor Audio Amplifier Manual	6/-
Shortwave Transistor Receivers	5/-
International Radio Stations List	2/6
Modern Transistor Circuits, Beginners	7/6
Sub-Miniature Transistor Receivers	5/-
How to Receive Foreign T.V.	5/-

JACKS. Lead 6/-, Std. open-circuit 2/6, closed-circuit 4/6. Grundig type 3-pin 1/3; Grundig Lead Type 3/6.
Phono Plugs 1/-. Socket 1/-. Banana Plugs 1/-. Sockets 1/-.
JACK PLUGS STANDARD. Screened 3/-. Grundig 3-pin 3/6.
BULGIN NON-REV PLUGS and SOCKETS. P74 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6; P466 6-pin 12/6; P360 4/-.
RESISTORS. Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w., 20% 4d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 2/-. Preferred values. 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg., 9d.

5 watt	0.5 to 8.2 ohm 3 w.	1/6
10 watt	WIRE-WOUND RESISTORS	1/9
15 watt	10 ohms to 6,800 ohms	2/-

10K, 15K, 20K, 25K, 10W. 3/-
MAINS DROPPERS. Midget. With sliders. 0.3 a., 1K., 0.2 a., 1.2 K., 0.15 a., 1.5 K., 0.1 a., 2 K., 6/- each.
LINE CORD 100 ohms ft. 3-way 1/- ft.

WIRE-WOUND Pots. 3 WATT Pre-set Min. T.V. Type. All values 10 ohms to 25 K., 3/- ea.; 30 K. 4/-; Carbon 30 K. to 2 meg., 3/-.

WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE VALUES 50 OHMS to 50 K., 6/6; 100 K. 7/6.

SPEAKER-FRET. Tygan various colours, 52in. wide from 10/-ft.; 26in. wide from 5/- ft. Samples, large, S.A.E.
EXPANDED METAL. Gold 12×12in. 6/-.
ARDENTE TRANSISTOR TRANSFORMERS
D3035, 7.3 CT : 1 Push Pull to 3 ohms for OC72, OC81 .. 11/-
D3034, 1.75 : 1 CT. Push Pull Driver for OC72, OC81 .. 11/-
D3058, 11.5 : 1 Output to 3 ohms for OC72, OC81 .. 11/-
D239, 4.5 : 1 Driver; D240, 8.5 : 1 Driver ...... ea. 11/6
ARDENTE TRANSISTOR POT. 5 K. switched VC1545 5/3
Anti-Parasitic beads (ferrite)................ doz. 3/6.
BLANK ALUMINIUM CHASSIS. 18 s.w.g. 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7×4in., 5/6; 9×7in., 6/6; 11×3in. 6/6; 11×7in. 7/6; 13×9in. 9/6; 14×11in. 12/6; 15×14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12×12in. 5/6; 14×9in. 4/6; 12×8in. 3/6; 10×7in. 2/9; 8×6in. 2/-; 6×4in. 1/6.

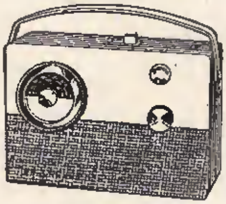
B.T.H. TAPE MOTORS 115 v A.C. 28 w.
12/6 pair, for 200/250 v. (in series)
COLLARO TAPE HEADS 35/- pair

RETURN OF POST DESPATCH *Post 1/6, List 1/-, C.O.D. 2/6 extra. (Export. Send remittance and extra postage, no C.O.D.)* *CALLERS WELCOME*

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, WEST CROYDON Telephone THO 1665

The
SUPER 6
LONG & MEDIUM WAVE TRANSISTOR RADIO



A quality radio available as a kit or ready built. The sparkling performance and superb finish of the completed receiver give you value equivalent to a £12. 12. 0 commercial model.

★ All new parts. ★ 6 transistors and diode. ★ 350mW output. ★ Superhet circuit, Ferrite rod aerial. ★ Weymouth Radio printed circuit board. ★ Component positions and references printed on back of board. ★ Nicely styled wooden cabinet, 11 × 7½ × 3½ in. ★ Vinyl covered in various colours. ★ 6 × 4in. speaker giving good bass and treble response. ★ Full instruction booklet 2/-. Free with kit. ★ I.F. frequency 470 kc/s. ★ Lining up service if required. ★ All parts supplied separately. Write for list. S.A.E. please. ★ 9v. battery required. VT9 or P.P.9. (3/9 with kit).

COMPLETE KIT ONLY £4.17.6
PLUS 5/- POST

OR FULLY BUILT £6.17.6 Tax & Carr. Paid

V.H.F. Pre-amplifier with high signal-noise ratio and gain of at least 3:1 under average fringe area conditions. Metal container 3¼ × 3¼ × 1¾in. high, with strap for eaves, loft or skirting fixing. 9 volt battery operated, using transistor AF114. Covers all British and some Continental stations. 88 to 108 M/cs. Order with confidence of improved reception.

29/6 (2/6 p. & p.)

ELECTRONICS (Camberley) LTD.
15 VICTORIA AVENUE, CAMBERLEY, SURREY
Post Orders Only Please

The foremost name in microphones and sound accessories

LUSTRAPHONE

The many Public Authority and Service users of Lustraphone equipment appreciate the quality and reliability resulting from our extensive experience as specialists in the design and manufacture of microphones and associated equipment.

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Practical Electronics

ANOTHER ASPECT

THERE is an increasing awareness among electronic equipment manufacturers of the importance of good styling and external appearance, whether their products be hi-fi equipments for the home or test instruments for professional engineers. No matter how excellent the basic technical design, the quality of the components, and the craftsmanship embodied in the final product, the visual appeal of the equipment is a key factor in influencing a potential buyer.

★ ★ ★

The amateur designer/builder has (as a general rule) no customer to win and has therefore no compulsion to emulate the professional in matters of external appearance and styling—except only the compulsion engendered by personal pride and taste. We suspect that all too frequently, so far as amateurs are concerned, the technical design is considered the beginning and the end, the physical arrangement of components being somewhat casually evolved during the processes of circuit development. When the circuit is finally completed and functioning satisfactorily, there is a reluctance to interfere with the existing lash-up: the intended "rebuild" is deferred until a more opportune moment—which seldom if ever, materialises.

All this is based on our own experience. It is not therefore in any "holier than thou" attitude that we address our readers on this subject. Rather it is our aim to give those who have yet to get their feet wet the benefit of such experiences.

★ ★ ★

Mechanical design is really quite as important as electronic circuit design. This may not always seem apparent but second thoughts (or regrets) often arise after a piece of equipment has been built!

Such mechanical or physical layout design is especially important where the equipment will be manually operated and a number of controls are involved. Careful attention to the arrangement of controls, meters, sockets and other front panel components is an essential part of good design. There are two major considerations: ergonomics—the best location of controls for ease of operating; and aesthetics—the most pleasing visual effect. Sometimes these two conflict.

In the case of radio, audio, or similar user equipment that is normally on view in domestic surroundings, aesthetics will usually have prior claim to attention. Stylish control knobs to suit practically all tastes and requirements are readily available and these contribute towards that professional finish. Ergonomics is of great significance in the design of test instruments, particularly those having a large number of controls—as for example, an oscilloscope. A well planned front panel will prevent such hazards as confusion between controls or the masking of a meter or such like by the arm when making an adjustment to a knob.

THIS MONTH

Our October issue will be published on Thursday, September 16

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electronics at GOONHILLY

by D. Wray

Post Office Engineering Department

The Post Office satellite communications earth station at Goonhilly Downs, in Cornwall, first came into prominence just over three years ago when it took part in the first live transatlantic transmissions of television via the "Telstar" satellite. In December 1962, a second communications satellite, "Relay", was launched and this, too, was used in many technical experiments and for long-distance television transmissions. Further models of both "Telstar" and "Relay" were launched in 1963. For 2½ years hundreds of experiments were carried out over these satellites to amass the statistics needed for moving from a purely experimental phase to a system that can give worldwide continuous commercial communications.

A major step towards the attainment of such a commercial system was taken in April of this year with the launching of the "Early Bird" satellite. "Early Bird" differs from its predecessors in that it was placed into an orbit having a 24-hour period and so appears to hover over one place on the earth's surface—in this case, over the mid-Atlantic. For the first time *continuous* transmission by satellite between Europe and the United States was possible.

EARTH STATION REQUIREMENTS

Although the earth stations taking part in this project (Andover, in U.S.A.; Plumeur Bodou, in France; Raisting, in Germany; Fucino, in Italy; and Goonhilly, in Britain) differ considerably in their details, the basic requirements of these earth stations must be common to all—as shown in outline in Fig. 1.

The most obvious feature of any earth station is a large steerable aerial. The aerial must necessarily be very large because the received power from the satellite is so small—a fraction of a billionth of a watt—so the aerial must have a large collecting area; in other words, the aerial has a high gain and its radiation pattern evinces a very narrow main beam.

Another factor that must be considered is that the frequencies of transmission between the satellite and the ground must be chosen so that there is as little degradation of the signal as possible by galactic noise (radio noise originating in space) or by absorption in the atmosphere. The frequencies selected as optimum at present are in the region of 4,000 Mc/s for the satellite-to-ground direction, and about 6,000 Mc/s for the reverse direction. As the beam width of a large aerial is not likely to be more than one-sixth of a degree at 6,000 Mc/s, the aerial must be steered towards the satellite with an accuracy of a small fraction of a degree or contact with the satellite will be lost.

The three electronic chains that must meet at the aerial are, therefore, a control system for steering the aerial's movements with considerable accuracy; a transmission chain that will accept either a television signal or multi-channel telephony and convert this into a high-powered radiation at 6,000 Mc/s for transmission to the satellite; and a reception chain to receive the 4,000 Mc/s radio signal from the satellite and reduce it to a television or telephony output. For telephony, of course, transmission and reception must take place simultaneously.

THE PARABOLIC AERIAL

The parabola has the geometric property that straight lines drawn from the focus to the line of the parabola, and then reflected back with equal angles of incidence and reflection, are all reflected in parallel (see Fig. 2). Moreover, the total distance from the focus to any plane drawn at right angles to these reflected lines is always the same no matter what path the incident and reflected paths travel. Thus, if the parabola is rotated about its longitudinal axis to make a paraboloid, and waves emanate from the focus to the paraboloidal surface, they are reflected in phase in a parallel beam Searchlights and car headlights work on this principle, and so do most of the large aerials used at high frequencies. The Goonhilly aerial is a paraboloid 85ft in diameter with a radio feed unit supported at its focus on a slender, but rigid, mechanical tripod.

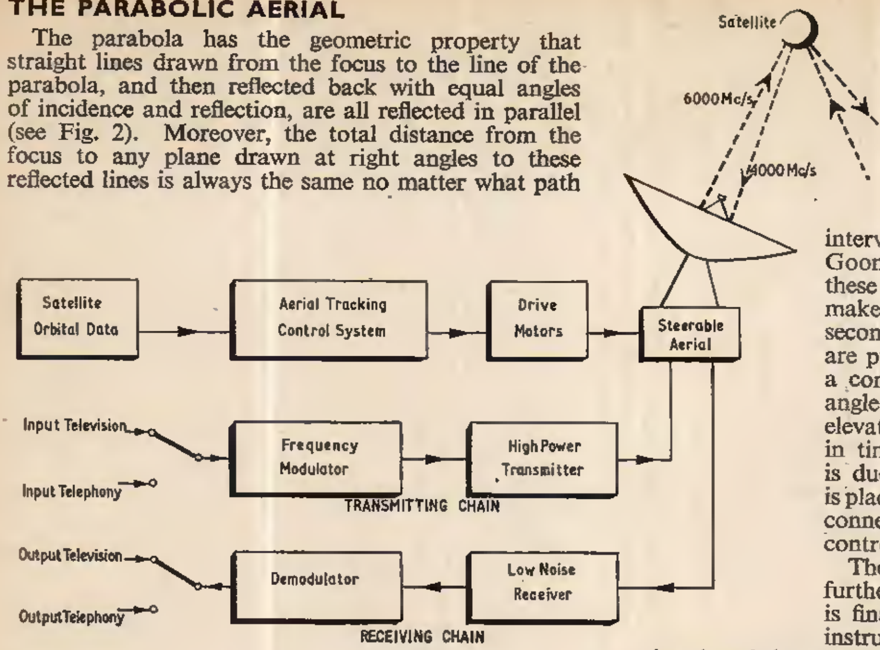


Fig. 1. Essentials of earth station for satellite communications

Referring back to Fig. 2 we can see that if the paraboloid is not geometrically perfect, but has imperfections or discontinuities, then the path lengths to the reference plane will not all be the same; for a radio aerial this means that the reflected beam will not be perfectly parallel, and so the gain of the aerial will not be as high as it could be and some energy will be scattered in unwanted directions. A very high standard of constructional perfection is therefore necessary, for the tolerable imperfections must be related, not to the size of the aerial, but to the radio wavelength being used. The Goonhilly aerial, although 85ft in diameter, is so accurately made that 99 per cent of its area lies within 85 thousandths of an inch of the geometrically ideal.

Since the Goonhilly station is part of an international telecommunications service, it must aim at a very high standard of reliability; the aerial must therefore always track the satellites with an accuracy of at least one-fifteenth of a degree even for the few hours a year in which the mean wind speed is 60 m.p.h. with gusts as high as 85 m.p.h.

PROGRAMMED CONTROL

The method of tracking employed at Goonhilly is that of programmed control with additional automatic correction; the process is shown in Fig. 3. Predictions of the position of the satellite are received from computing centres in the U.S.A. several days in advance of the orbit to which they refer. For "Telstar" and "Relay" these predictions are at one minute intervals in time, and a computer at Goonhilly analyses the way in which these positions vary with time and makes further interpolations to one-second intervals. The predictions are punched out in a 5-unit code into a control tape in which the required angle for both aerial station and elevation are given for each second in time. Before any particular orbit is due, the appropriate control tape is placed into a high-speed tape reader connected to special-purpose digital control equipment.

The digital equipment carries out further interpolations until the aerial is finally receiving no less than 50 instructions per second in both the azimuth and elevation angles. These digital instructions are converted into a corresponding smoothly-varying voltage in the digital-to-analogue converter, and it is this voltage that controls the speed of a variable-speed motor-generator set. Each direction of motion—azimuth and elevation—has a 100 h.p. electric motor for motive power, so the control chain starts with a paper tape and finishes with the motion of 1,000 tons of steel and concrete!

However, gusts of wind may tend to deflect the aerial from its course, so both axes of rotation of the aerial have digital position encoders. These are glass discs on which 16 tracks are printed photographically; they are scanned photo-electrically to give an angular position indication to an accuracy of one two-hundredth of a degree. This information is sent back to the digital control equipment so that the demanded angle and the actual angle can be compared; if there is any difference between them, an error signal is added to the drive voltage to the aerial's motors, and the aerial is driven back on to course again. In other words there is a complete servo loop.

The timing sequence mentioned—one-minute predictions reduced to one-second intervals—applies to

Central Control Console at Goonhilly. Photograph by courtesy of H.M. Postmaster-General

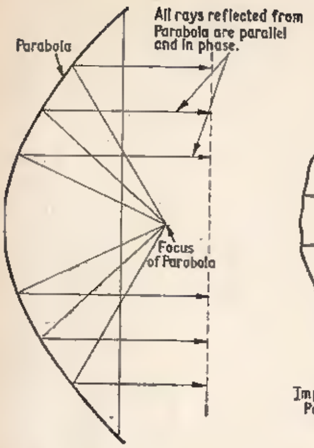


Fig. 2a. Reflection from a perfect parabola

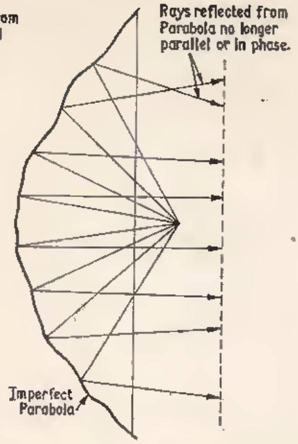


Fig. 2b. Reflection from imperfect parabola

comparatively fast-moving satellites such as "Telstar" and "Relay". For much slower-moving satellites, such as "Early Bird", the predictions are at 10-minute intervals and are reduced to one-minute periods by the computer. In fact, "Early Bird" has been positioned so accurately that once the aerial has been set into position at the beginning of the day there is no need for any further movement during the next 24 hours.

BEACON SIGNAL

But there might be slight errors in the original predictions, or the satellite itself may wobble a little about the geometrically perfect orbit due to the perturbing influence of other planets. Fortunately, the satellites transmit an unmodulated beacon signal and this can help to improve the tracking of the aerial.

At Goonhilly this is accomplished by rapidly moving the radio feed at the focus of the aerial through a circular displacement of very small angle. If the beacon signal picked up by the aerial is strongest when the feed is not along the centre line, then this is an indication that the aerial is not pointing precisely at the satellite. If the error is small or transitory, the feed unit can be moved bodily to counteract it; if the error is persistent, instructions can be fed back with the main aerial control system to bring the aerial back on to course.

With this combination of predicted movement, servo loop correction, the natural stiffness and heaviness of the aerial itself, and the automatic fine trimming action of the aerial feed, satellites can be tracked with an accuracy of two minutes of arc in spite of high winds and rapid acceleration of the aerial.

THE TRANSMITTING CHAIN

Wide deviation frequency modulation has been used by all the active communication satellites that have been launched to date. A wide deviation is necessary to obtain an adequate signal/noise ratio in the received signal when the great losses of the transmission path are taken into account; as a consequence a wide bandwidth is necessary in all the equipment in the transmission chain.

The transmitting (or "up-direction") path is shown in block schematic form in Fig. 4. The input signal—either a television waveform or several hundred telephone channels assembled side by side into a continuous bandwidth—is presented to a modulator which produced a frequency modulated output centred on 70 Mc/s. This is amplified in further amplifiers and

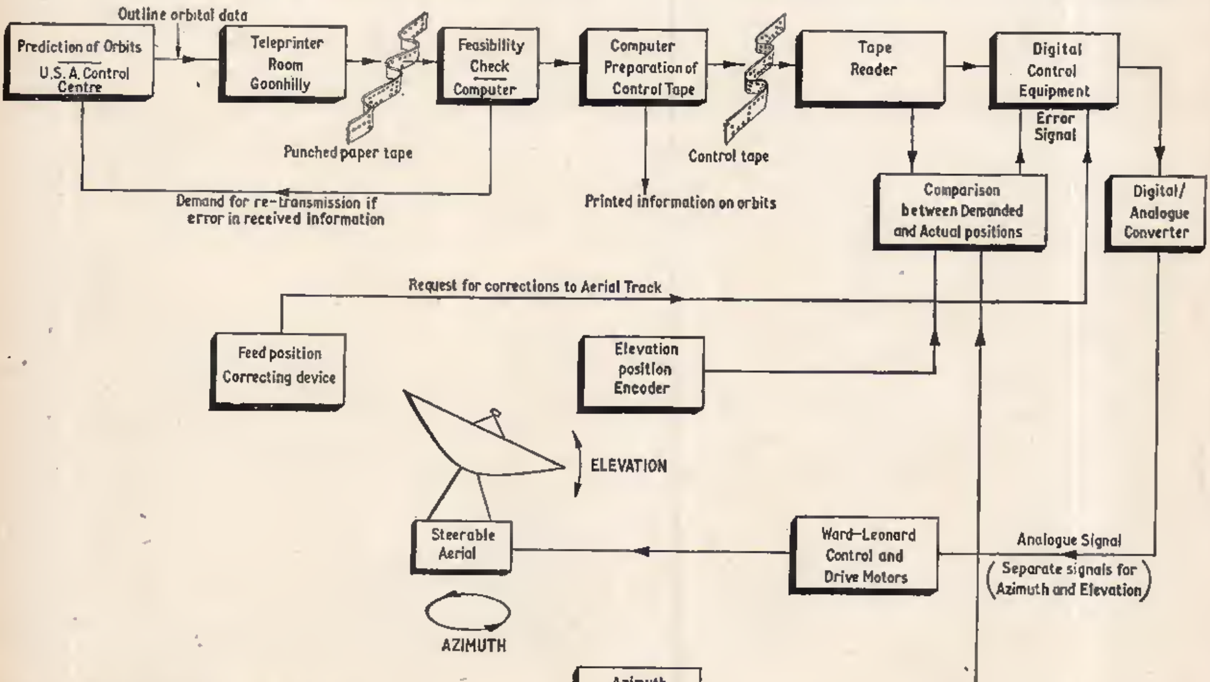


Fig. 3. Block diagram of the aerial control system

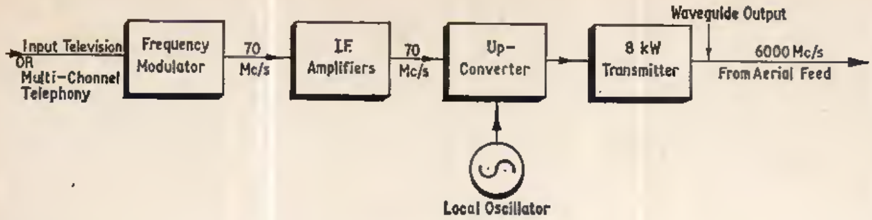


Fig. 4. Block diagram of the transmitting chain

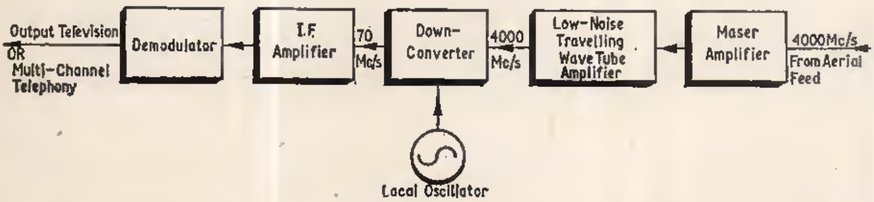


Fig. 5. Block diagram of the receiving chain

applied to the drive stages of a transmitter in which the frequency-modulated 70 Mc/s signal is mixed with a local oscillator to move it up into the 6,000 Mc/s region.

So far, this is all fairly conventional practice. The unique step is in the output stage, which is a specially-developed travelling wave tube. In normal microwave radio systems, a travelling wave tube can be expected to deliver a few watts; at Goonhilly, the output tube delivers 8kW. This is the highest power produced by any earth station in the world.

At these high frequencies, normal cables cannot be used—they are far too lossy; the output from the transmitter is therefore carried to the feed at the focus of the aerial along waveguides—rectangular tubes of copper and brass that carry the radio waves inside them.

Here again, problems arise at Goonhilly that are not encountered in normal microwave radio transmission, because the powers carried by the waveguides are so high that there is real danger of arcs forming if there is the slightest discontinuity or dirt inside the waveguides. It is essential, therefore, for the transmitter to be protected by an arc-detector, for arcs forming in the output waveguide would act as virtual short-circuits across the valuable output tube.

THE RECEIVING CHAIN

One of the fascinating contrasts of a satellite communications earth station is the tremendous difference in power between that transmitted to the satellite and that received from it—a ratio of about one thousand billion to one.

The very low received power is a consequence of the small output power from the satellite itself (usually just a few watts, itself limited by the small battery power supplies charged by solar cells) and the very high path propagation loss entailed in the enormous distance between the satellite and earth. Normal receiving techniques are quite useless when dealing with powers of less than a billionth of a watt; thermal noise produced by the earth, the aerial, and even the sky itself, is comparable with the radio signal that must be snatched from the air.

The first receiving stage must therefore be extremely sensitive, contribute an extremely low noise level, and be able to receive frequencies in the 4,000 Mc/s region with an adequate bandwidth (25-30 Mc/s). All these conditions are met by the maser.

MASER AMPLIFIER

The maser consists, essentially, of a rod of ruby in a waveguide. The atomic structure of ruby is such that its electrons can exist at three different energy levels. By pumping radio power into the ruby at a frequency well above that to be amplified, a substantial proportion of the electrons are lifted to the highest energy level. When a radio signal is received it triggers some of the electrons from the higher energy levels to the lower, and, in doing so, releases energy that represents an amplified version of the input signal. In this way, radio signals of a billionth of a watt or less in power can be amplified by 2,000 times or so. But for this to happen, it is essential that the high energy level electrons should not be dislodged by the normal thermal molecular agitation of the ruby material; the maser must therefore be maintained at an extremely low temperature—about 2 degrees above absolute zero (−271 degrees C).

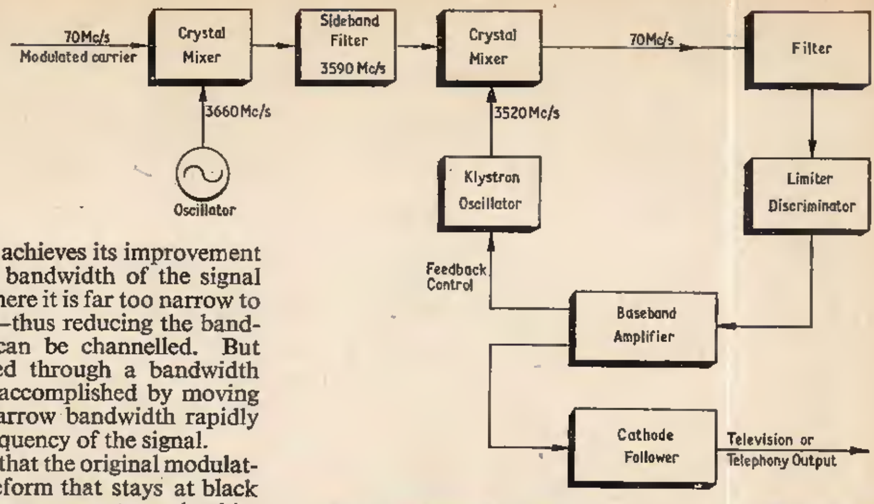
This fantastically low temperature is only attained by immersing the ruby in liquid helium, and one of the most formidable operational problems at Goonhilly is to ensure that constant supplies of liquid helium are available and that the masers are kept immersed as the helium boils off. Masers are tuned to a particular frequency band by varying an external magnetic field, and the presence of the liquid helium coolant is exploited at Goonhilly by obtaining this magnetic field from a superconducting coil.

The received signal level is still very low at the output of the maser and must be further amplified by a low-noise travelling wave tube. A frequency-changer converts the signal down from the microwave region to a 70 Mc/s intermediate frequency, and it is this that is finally demodulated in a f.m. demodulator. A block diagram of the arrangement is shown in Fig. 6.

F.M. NEGATIVE FEEDBACK DEMODULATOR

Even after all these precautions of low-noise amplification, the final i.f. signal that reaches the demodulator can have such a poor signal/noise ratio that the normal type of Foster-Seeley frequency discriminator becomes unusable. To meet this situation, a special device called a frequency-modulated negative-feedback demodulator (often referred to as an f.m.f.b.) is used. This was invented as far back as 1938, but it did not find an application until the coming of satellite communication in the 1960's.

Fig. 6. Block diagram of the frequency-modulated negative-feedback demodulator



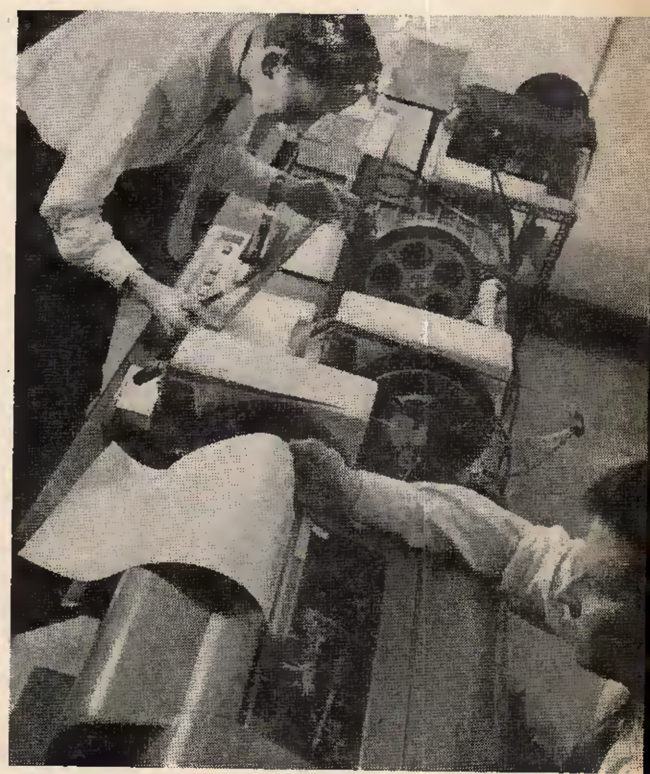
Fundamentally, the f.m.f.b. achieves its improvement by substantially reducing the bandwidth of the signal path—apparently to a point where it is far too narrow to carry the wide deviation f.m.—thus reducing the bandwidth through which noise can be channelled. But how can the signal be carried through a bandwidth that is too narrow? This is accomplished by moving the centre frequency of the narrow bandwidth rapidly to follow the instantaneous frequency of the signal.

Let us imagine, for instance, that the original modulating signal is a television waveform that stays at black level for half the line and then moves up to peak white for the other half; after frequency modulation, this will appear as a certain frequency corresponding to the black level which then swings to another frequency that is equivalent to the white level. Thus, although the television picture needs a wide frequency swing, the *instantaneous* frequency band requirements are quite modest.

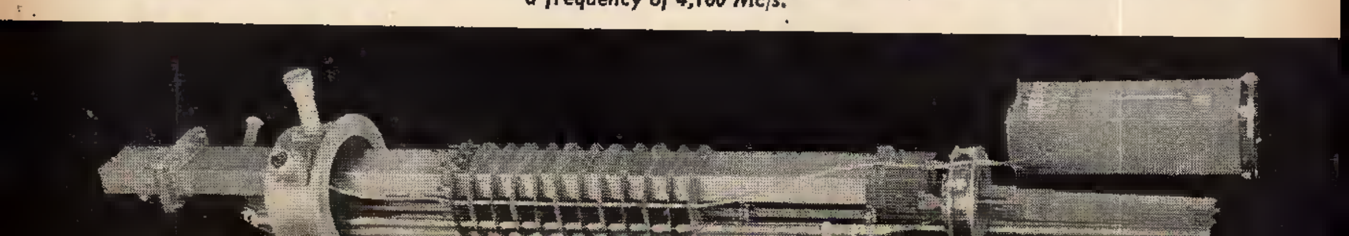
Reference to Fig. 6 shows that the received wide deviation 70 Mc/s f.m. signal is applied to a crystal mixer driven by a 3,660 Mc/s oscillator. The lower sideband, centred on 3,590 Mc/s, is filtered off and applied to a down-converter mixer. This second local oscillator, however, is not fixed but comes from a klystron oscillator, the frequency of which can be shifted by varying the reflector potential. This potential is derived from a discriminator and detector, the discriminator being fed by the down-converted 70 Mc/s signal. Thus the down-converter local oscillator is constantly shifting in frequency according to the instantaneous frequency of the signal and the effective pass-band is moving in sympathy. The f.m.f.b. therefore can demodulate a wide deviation f.m. signal whilst still having a small noise band-width.

This article has described just a few of the novel aspects of the Goonhilly radio station. In addition, there are very many more items of transmission and test equipment that there is no space here to mention. All of these combine to make one of the most fascinating centres of electronic engineering in the country. ★

Making a "print-out" in the computer room. Photograph by courtesy of H.M. Postmaster-General



The down lead assembly with its superconducting magnet alongside one of a pair of travelling masers, designed and built by scientists at the Mullard Research Laboratories, England, for the Goonhilly Earth Station. The masers operate at the temperature of liquid helium (— 217 degrees C) and are capable of amplifying signals of 10^{-13} watts or even less at a frequency of 4,160 Mc/s.



ECHO UNIT

We have all experienced the "Bathroom Effect", that delightfully resonant reverberation added to the voice or an instrument by the hard reflecting surfaces of a sparsely furnished room such as a bathroom. The apparent improvement, particularly to the average human voice, is caused by an echo or repetition of a sound occurring a small but definite time interval after the original sound. Such echoes have of course been from time immemorial a source of fascination and pleasure to man.

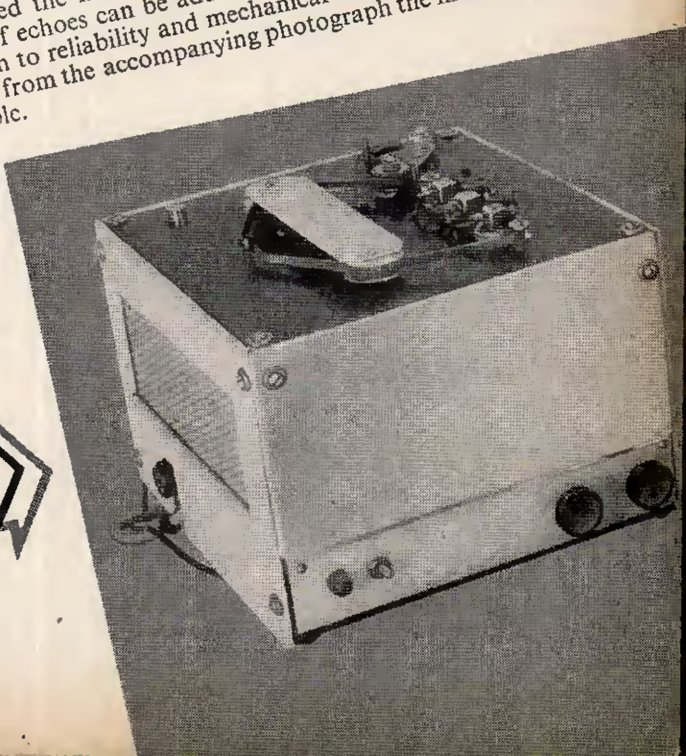
Controlled echoes, which can be produced in a variety of ways, can be put to many uses; for example, adding a new dimension to a solo instrument such as a guitar or saxophone, creating "Radiophonic" or electronic music, adding dramatic sound effects to plays and film sound tracks, or even improving the musical efforts of pop or beat groups.

Since as it is hardly practicable to carry around a portable bathroom or echo chamber, the author designed and constructed the instrument to be described, by means of which a controlled echo or series of echoes can be added to any audio signal.

Emphasis in the design was given to reliability and mechanical simplicity, and ease of construction, and as can be seen from the accompanying photograph the instrument is very compact and easily portable.

by A. T. J. Carrington

This is the completed echo unit. The side and bottom panels can be detached leaving the electronic—mechanical assembly fully exposed.



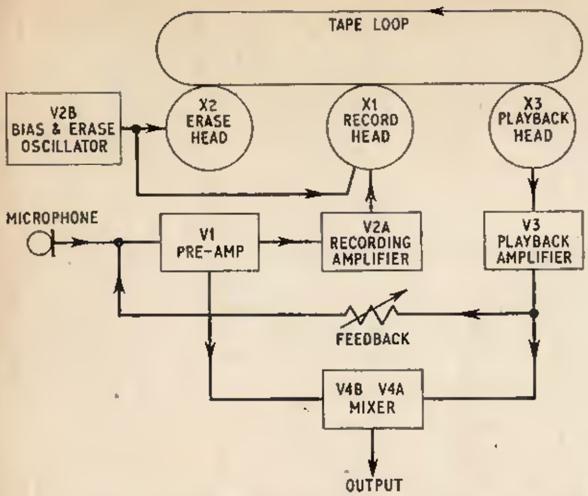


Fig. 1. This block diagram makes clear the system used in the echo unit

This instrument uses the endless tape loop method of producing echoes, and in effect is a specialised form of tape recorder. Reference to Fig. 1 should make the operating principles clear.

The signal, from a microphone or other source, is fed to the pre-amplifier, stage V1, the output from which is split into two parts. Part of the signal is fed to the recording amplifier, V2A and thence to the recording head X1 where it is recorded on the tape loop. The other part of the signal from V1 is fed to a mixer stage, V4B, and thence to the output socket of the unit, so the original signal is amplified and passed straight through the unit and can be applied to the equipment desired.

The recorded signal on the tape is picked up by the playback head X3 and fed into the playback amplifier V3, and thence to the mixer V4A, where it is mixed with the original signal, both signals appearing at the output.

So we now have the original signal plus a single echo, the time lag being dependent on the speed of the tape loop and the distance between the heads. A single echo is not very effective however, and so if we feed back part of the amplified echo from the playback amplifier V3 to the first amplifier V1 the *echo* will go through the whole process again and again and so we will end up with the original signal plus a whole series of echoes, which can, by suitable adjustment of the feedback control, be made to gradually fade away into silence, considerably enhancing the effect.

THE CIRCUIT

Fig. 2 shows the complete circuit diagram of the echo unit.

V1, an EF86 low noise pentode, is the pre-amplifier. Part of the output from V1 anode is fed via C4 and R8 to the preset recording level control VR1 which determines the level of signal fed to the triode grid of V2. The triode section of this valve (V2A) is the recording amplifier, and the pentode section (V2B) is used as the bias and erase oscillator.

V3, another EF86, is the playback amplifier, and the output from this stage is fed via C16 and the playback gain control VR3 to the grid of V4A.

The second triode section of this valve (V4B) is fed from V1 anode via C5, R7 and VR4, gain being adjusted by the latter preset control. The echo feedback is applied via VR2, which controls the amplitude of the amplified echoes from V3 that are fed back to the grid of V1.

The full wave rectifier V5 provides h.t. which is well smoothed and decoupled by C1, C14, C18, C12 and C13 in conjunction with the associated resistors.

TAPE TRANSPORT MECHANISM

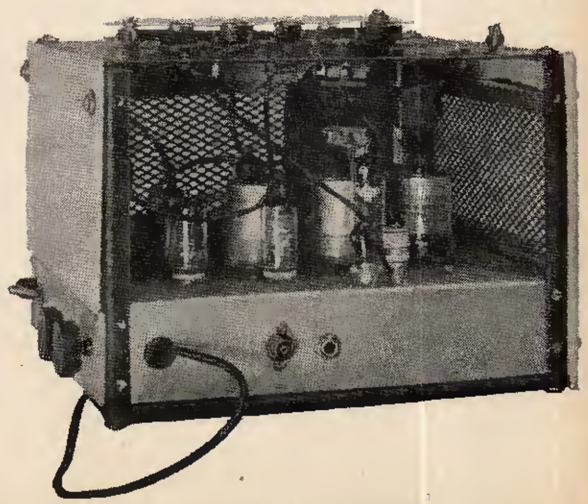
As was mentioned before, emphasis was given to simplicity of construction, and the tape transport mechanism consists simply of a square mild steel plate on which are mounted the three heads (erase, record and playback), the tape guides, and a motor.

The motor is an induction type similar to those used in record players. The shaft of this motor forms the capstan which in conjunction with a rubber faced pinch wheel draws the tape past the heads at a speed of approximately 12·5in/sec. In this way, no pulleys, belts or other mechanical parts are required, and the author found this method entirely satisfactory, wow and flutter being well within tolerable limits. Two spring loaded pressure pads are also mounted to keep the tape in intimate contact with the heads.

AMPLIFIER CONSTRUCTION

The electronics were mounted by conventional methods on an aluminium chassis measuring 10in × 10in × 2·5in, components being mounted directly onto valveholders with insulated anchor tags being used where necessary. The arrangement of the larger components is shown in Fig. 3. Layout is not critical but care must be taken to screen the oscillator stage; this was done in the prototype by making a rectangular box from strip aluminium and bolting this to the chassis, the oscillator components being mounted in the box.

The mains transformer should be mounted as far away from the playback head as possible, but owing to the shielding effect of the mild steel baseplate, the author was not troubled by any problems of induced mains hum.



Interior of the echo unit

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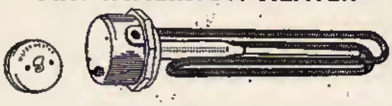

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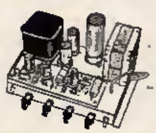

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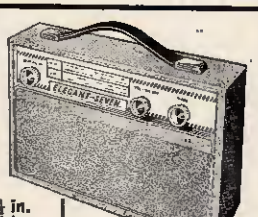

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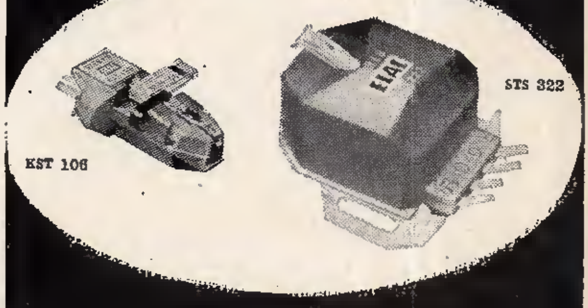

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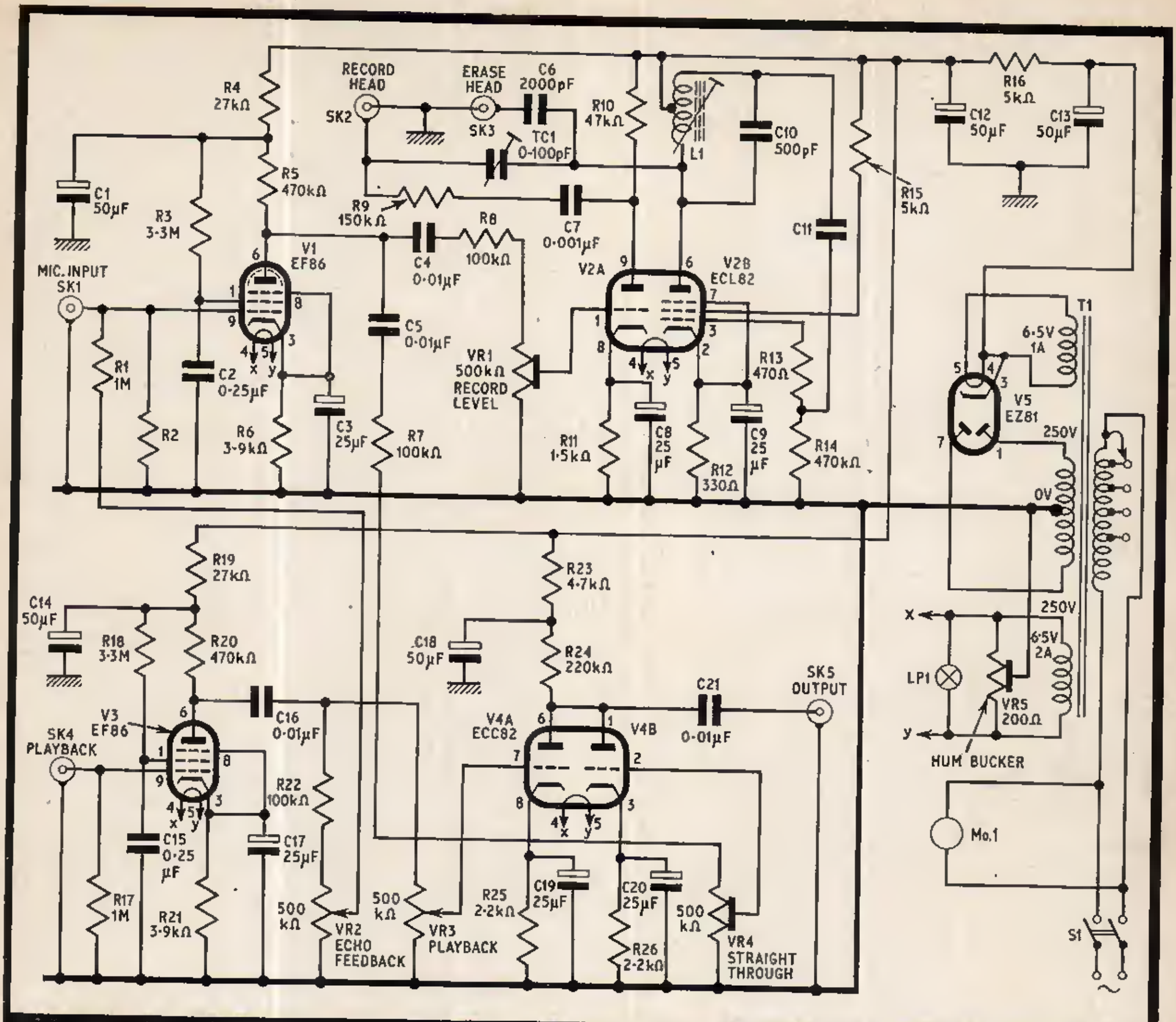


Fig. 2. The complete circuit diagram for the echo unit

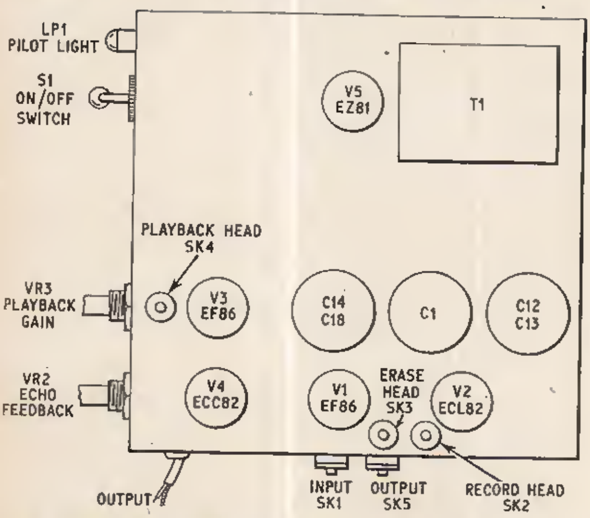


Fig. 3. Top view of the electronic chassis showing the positions of all the major components

The two controls, (playback volume and echo feedback), a pilot light, and a separate on/off switch were mounted on the front of the chassis, a piece of white perspex retained by the control securing nuts forming the front decor.

The input socket was mounted on the side of the chassis as near V1 as possible to minimise the risk of hum.

Ordinary valveholders were used but antimicrophonic valveholders for V1 and V3 could be advantageous. Three chassis mounting coaxial sockets were used to connect the three heads, thus permitting the amplifier to be removed as a separate unit.

TAPE DECK CONSTRUCTION

The tape mechanism was constructed on a piece of 16 s.w.g. mild steel plate, finished in black crackle after drilling. The size of the plate was 10in × 10in and drilling details are given in Fig. 4.

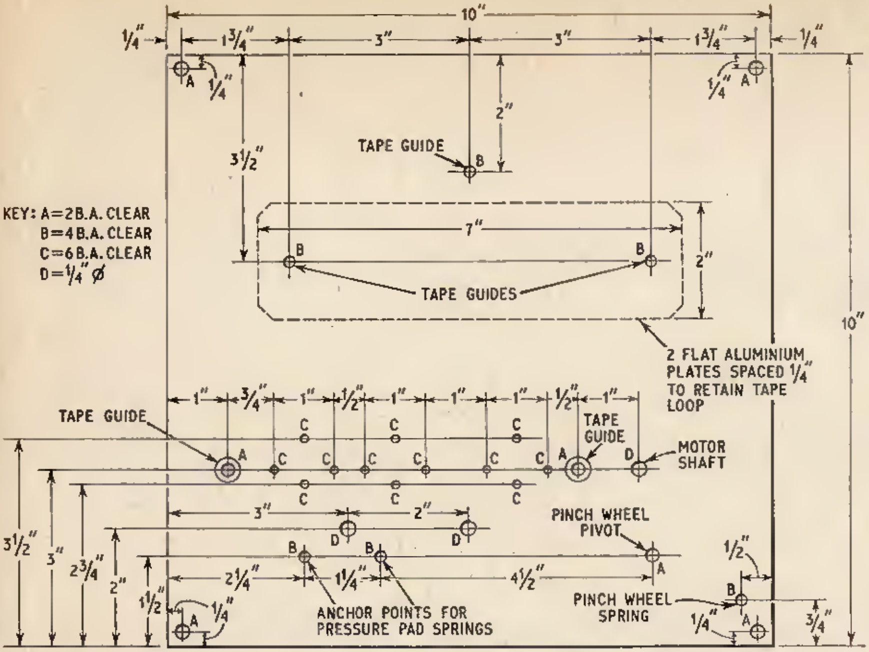
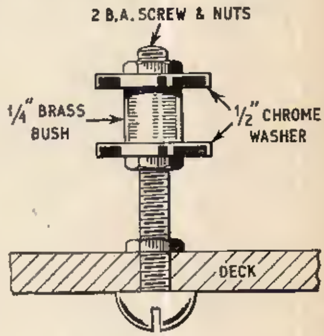


Fig. 4 (left). A plan view of the tape deck showing drilling dimensions

Fig. 5. Details of the tape guides. Five of these are required



The motor was bolted directly to the underside of the plate, the shaft projecting through a hole drilled for the purpose. The three heads, all high impedance, were of the Mariott type as used in the B.S.R. Monardeck, and were mounted on wedge shaped bases so that they could be individually adjusted for azimuth alignment. The distance between the erase and record heads is unimportant, but the playback head should be approximately 2in from the record head in the direction of tape travel.

The tape guides were made from ¼in brass bushes with a chrome washer top and bottom mounted on a 2B.A. stud. See Fig. 5. These guides were screwed into tapped holes in the deck and secured with a locking nut being adjusted so that the tape ran parallel to the deck.

The pinch wheel, which can be of any diameter, was mounted on a pivoted mild steel arm, held firmly against the motor shaft by a 2in × ¼in steel spring. This spring is removed when the instrument is not in use, to prevent "flats" forming on the pinch wheel. Details of the pinch wheel appear in Fig. 6.

The two pressure pads each consist of a piece of thick felt cemented to a piece of ¼in brass strip, the latter being soldered to a $\frac{1}{16}$in shaft which passes through a bush in the deck, see Fig. 7. To the lower end of the shaft is soldered a 2B.A. tag which carries a light tension spring. The other end of this spring is anchored to a 6B.A. bolt in the deck plate. The tension of each spring should be adjusted so that the tape is kept snugly against the heads. Too much tension will cause excessive tape head wear. The erase head, having a much wider gap, needs no pressure pad as long as the tape is in contact with the head.

The tape loop itself was about 20in long but this is not at all critical. In order to keep the loop in position, two flat aluminium plates separated by ¼in bushes were mounted on the deck so that the loop was kept in slight tension. Incidentally, the loop wears extremely well—the author is still using the original, eighteen months after constructing the instrument!

CABINET

The author, not being a particularly good joiner, evolved the following method of housing the instrument. A double decker form of construction was used, the chassis being bolted to four uprights, each 7·5in long and made from ½in angle iron. The top and bottom of each upright were bent over and drilled and tapped to take 2B.A. screws (see Fig. 8).

The tape deck was then screwed to the top of the uprights and a plywood base with four rubber feet fixed to the bottom of the uprights.

The sides of the uprights were again drilled and tapped 2B.A. and hardboard panels covered in white vinyl cloth with a cutout covered by gold anodized fret were screwed to the uprights. This resulted in a neat cabinet with side panels and bottom being easily detached for easy access to the interior. A lid was constructed from hardboard cemented to four 1½in × 1½in battens, the whole being covered with white vinyl.

SETTING UP AND TESTING

The setting up process is made easier by virtue of the fact that the result of any adjustment is immediately audible via the playback amplifier.

First of all it is necessary to adjust the tape guides so that the tape is drawn easily past and parallel with the tape heads. The author used a commercial test tape to make the head azimuth adjustment, but it is quite easy to line them up without. To do this, first align the record head visually so that the head gap is as nearly as possible at right angles to the tape; do this by slackening one screw and tightening the other so the head rocks about the wedge shaped base.

The erase and playback heads cannot be adjusted until the amplifier has been set up. Start by setting all preset controls and the echo feedback control to minimum. Advance the playback control about three quarters towards maximum, and feed a suitable signal into the input socket.

Components . . .

Resistors

R1 1MΩ	R10 47kΩ	R19 27kΩ
R2 1MΩ	R11 1·5kΩ	R20 470kΩ
R3 3·3MΩ	R12 330Ω 1W	R21 3·9kΩ
R4 27kΩ	R13 470Ω	R22 100kΩ
R5 470kΩ	R14 470kΩ	R23 4·7kΩ
R6 3·9kΩ	R15 5k 5W	R24 220kΩ 1W
R7 100kΩ	R16 5kΩ 10W	R25 2·2kΩ
R8 100kΩ	R17 1MΩ	R26 2·2kΩ
R9 150kΩ	R18 3·3MΩ	

All ±10%, ½W carbon, unless otherwise stated.

Valves

V1 EF86 V3 EF86
V2 ECL82 V4 ECC82
V5 EZ81

Inductors

L1 Oscillator coil, 45kc/s.
T1 Mains transformer. Secondaries: 250–0–25V 70mA; 6·5V 2A; 6·3V 1A (Radiospares "Economy" type)

Switch

S1 Double pole on/off switch

Sockets

SK1–5 Coaxial socket, chassis mounting (5 off)

Lamp

LP1 6V lamp

Capacitors

C 1 50μF elect. 350V	C12 50μF elect. 350V
C 2 0·25μF paper 500V	C13 50μF elect. 350V
C 3 25μF elect. 25V	C14 50μF elect. 350V
C 4 0·01μF paper 500V	C15 0·25μF paper 500V
C 5 0·01μF paper 500V	C16 0·01μF paper 500V
C 6 2,000pF ceramic	C17 25μF elect. 25V
C 7 1,000pF ceramic 500V	C18 50μF elect. 350V
C 8 25μF elect. 25V	C19 25μF elect. 25V
C 9 25μF elect. 25V	C20 25μF elect. 25V
C10 500pF silver	C21 0·01μF paper 500V
C11 1,000pF ceramic 500V	TC 1 0–100pF preset trimmer

Potentiometers

VR1 500kΩ carbon, preset
VR2 500kΩ carbon, log
VR3 500kΩ carbon, log
VR4 500kΩ carbon, preset
VR5 200Ω wirewound, preset

TAPE DECK

Record/Playback Head with mounting plate	A102874
Erase Head with mounting plate	A102875
Pinch Wheel Assembly	A102821

The above items are as used in the B.S.R. Monardeck and are obtainable (via retailer) from:
Elstone Electronics, Edward St., Templer St., Leeds 2.
Mo.1. A.C. Induction Motor, obtainable from:
Radio and T.V. Components (Acton) Ltd., 21A High St., Acton, London W.3.
Other parts of the deck are made as described in the text.

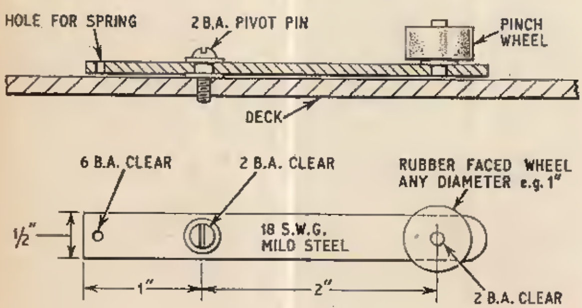


Fig. 6 (left). The pinch wheel mechanism, side and plan views

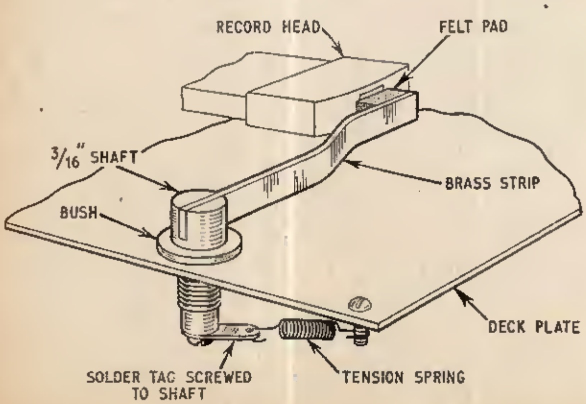


Fig. 7 (left). Detail of the pressure pad assemblies. Two of these are required

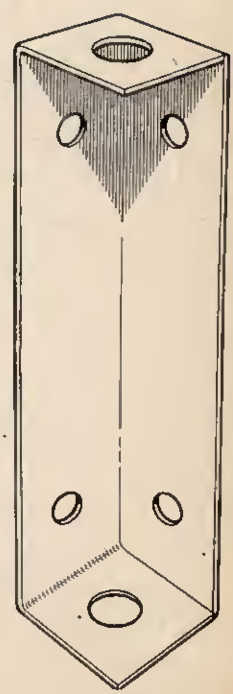


Fig. 8 (right). Detail of cabinet supports. Four are required

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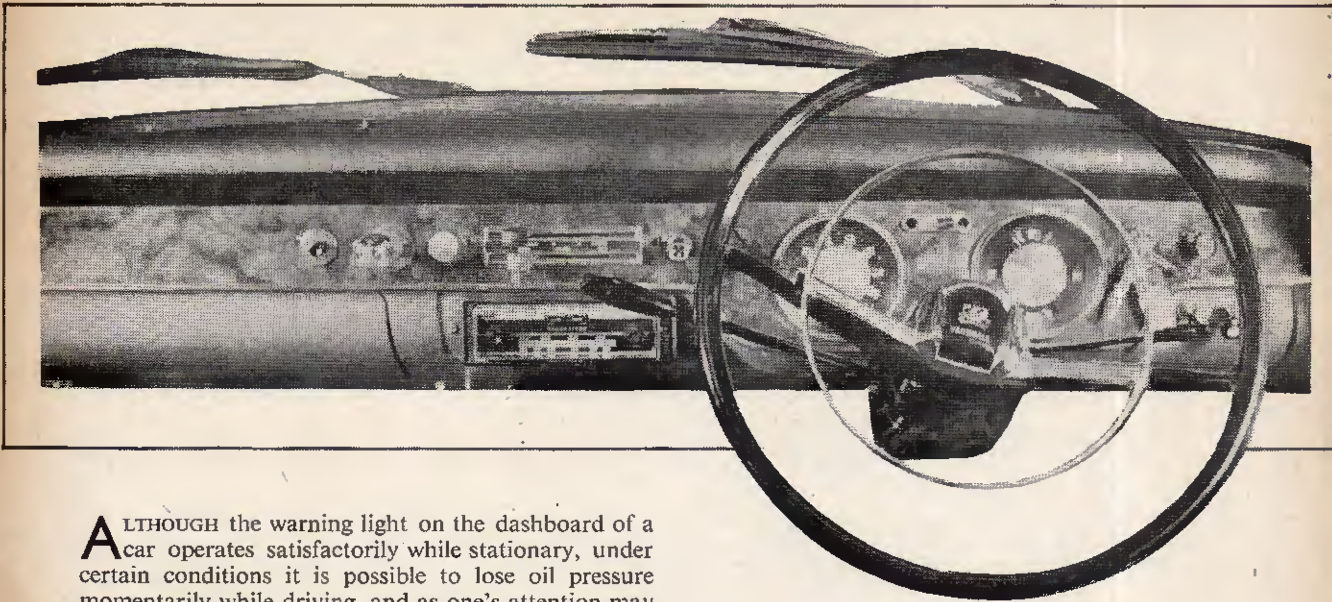


ALTHOUGH the warning light on the dashboard of a car operates satisfactorily while stationary, under certain conditions it is possible to lose oil pressure momentarily while driving, and as one's attention may be otherwise engaged, this may pass unnoticed. The simple unit described in this article will overcome this problem at a very low cost by emitting an audible tone whenever the oil pressure switch operates.

Moreover, the system can be extended, as will be seen later, to give a similar warning when the headlamps and other lamps are left on after the ignition has been switched off. No doubt readers will be able to adapt the unit to give other warnings to suit his own requirements, for example a theft alarm.

OSCILLATOR

The circuit for providing the audible signal is in the form of a modified Hartley oscillator as shown in Fig. 1. A single transistor is connected to a push-pull type output transformer (T1). The resulting fluctuations in collector current produce an oscillatory action which is controlled by the stabilising network, R1 and R2.

The frequency of oscillation is determined by the inductance of the primary winding and the value of C2. Since the transformer remains at constant inductance, the easiest way to alter the frequency would be by changing the value of C2.

The power supply for the oscillator is provided by the car battery; the values of R1, R2, and R3 should be of such a value to suit the battery voltage (see components list). Note that the battery connections to the oscillator should be arranged according to which version is required (see Figs. 2 to 5).

If the comprehensive system (shown in Fig. 5) is used the connector can be wired to provide any of the warnings shown by Figs. 2 to 5 or a combination of any two or more of these. The positive side of the oscillator is earthed to the car body through the multi-way connector only if the car battery positive terminal is "earthed". The device may be used on any car, irrespective of the supply polarity, provided that the oscillator is connected the right way round, i.e. positive to positive.

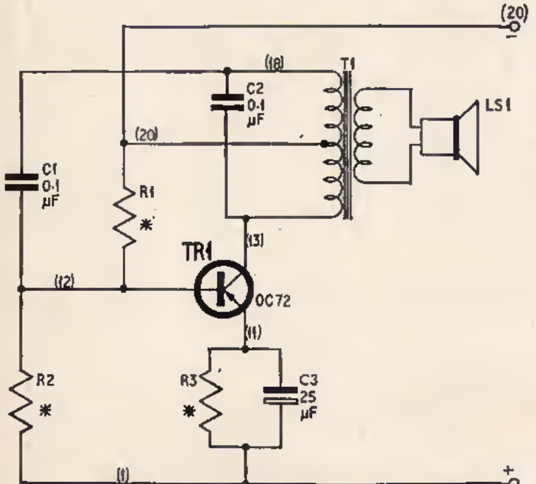


Fig. 1. Circuit diagram of the oscillator. The values of R1, R2, and R3 depend on the car battery used (see the components list.) The reference numbers on Figs. 1 to 5 correspond to the copper strips in Figs. 6 and 7 only

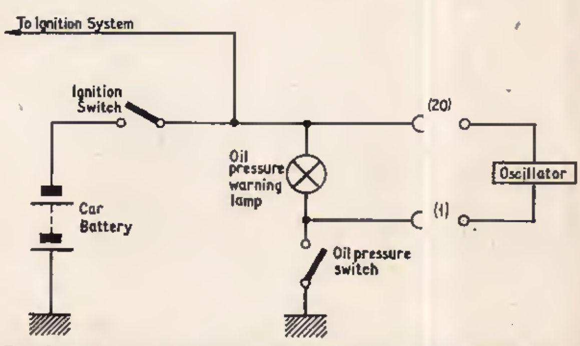
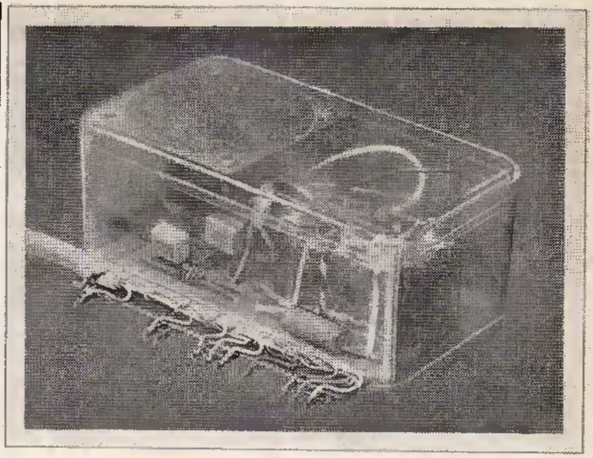


Fig. 2. Basic circuit for giving an audible warning of low oil pressure with the ignition switched on

AUDIBLE WARNING FOR YOUR CAR

BY A. J. HOLMES



OIL PRESSURE

Fig. 2 shows the basic circuit for indicating that the oil pressure is low. The oscillator is connected directly across the oil pressure warning lamp, so that the audible tone can only be switched by the automatic oil pressure switch after the ignition is turned on.

HEADLAMPS

If the driver leaves his car after the ignition is switched off, the circuit shown in Fig. 3 will let him know if he has left the headlamps on.

In this case a relay is used to disconnect the oscillator from the headlamp circuit when the ignition is switched on. When switched off the relay returns to connect the oscillator to the headlamps switch and chassis. The relay should be a type which can be operated on the car battery supply. The type MH2 relay having a resistance of 700Ω as used in the prototype will operate on 12 volts, but for 6 volts a 185 ohm version is necessary.

The dotted lines shown in Fig. 3 indicate wires used in the comprehensive system (see Fig. 5).

OIL PRESSURE AND HEADLAMPS

Fig. 4 shows the circuit combining the functions of oil pressure and headlamp warnings. Two relays are used, and an extra set of contacts (RLB1) are brought into the circuit. Either a direct "chassis" connection to the oscillator for headlamp warning, or connection via the oil pressure switch for oil pressure warning is achieved. The "normal open" contact of RLA2 is connected to the ignition switch via the multi-way connector to supply the battery negative to the oscillator in the "oil pressure" warning system. The "normal open" contact of RLA1 is connected to the oil pressure switch and lamp.

COMPREHENSIVE SYSTEM

The two systems previously described can be combined with any number of extra systems to form an extremely flexible warning system, while the cost is still kept low. The circuit in Fig. 5 and the photograph in the heading to this article shows the prototype unit which was designed on the principles already described.

This unit can be used on comprehensive lines or may be connected to perform any of the previous functions without altering the wiring in the unit. Only the multi-way connector should be wired, according to the reader's requirements from either Figs. 3, 4, or 5.

The circuit shown in Fig. 5a enables three systems to be used to give warnings with two relays additional to the oil pressure system relay. A spare switch and relay can also be incorporated, as shown.

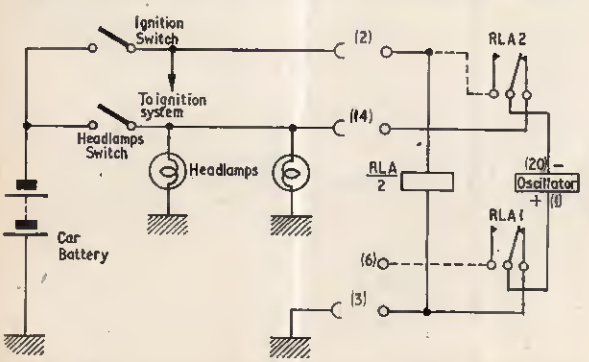


Fig. 3. Basic circuit for giving an audible warning when the headlamps have been left on after the ignition is switched off

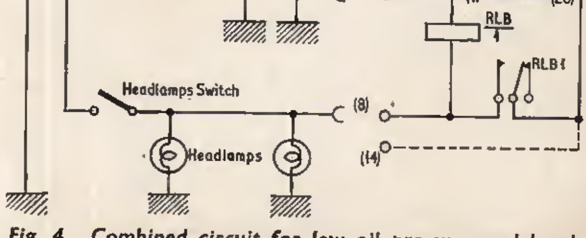


Fig. 4. Combined circuit for low oi! pre sure and headlamps

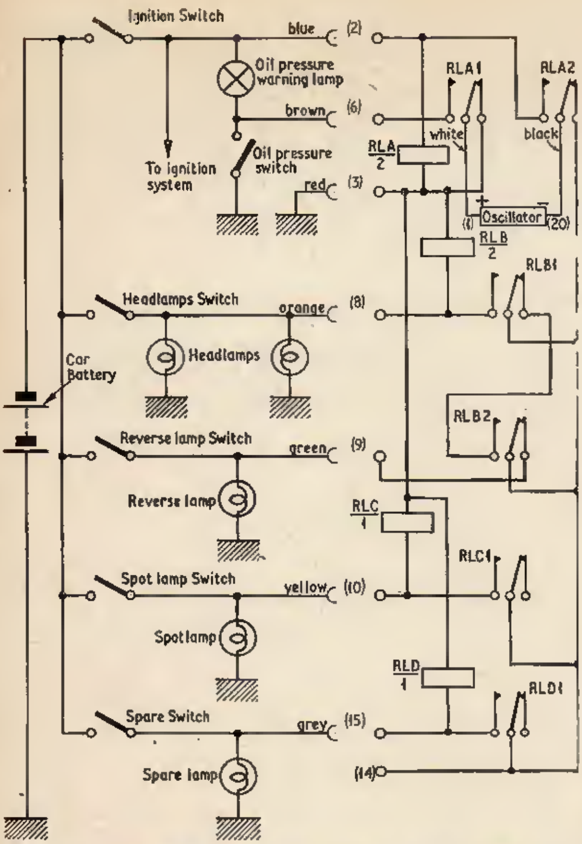


Fig. 5a. Comprehensive system incorporating additional alarms for indicating when either headlamps, reverse lamp or spot lamp are left on after the ignition is switched off. The reference numbers correspond to the copper strip numbers in Figs. 6 and 7 only

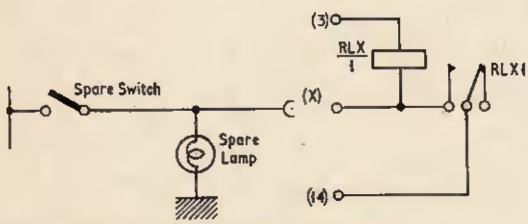


Fig. 5b. Basic circuit of an "add-on" system

The oscillator is switched either to the ignition and oil warning system or the lamps on the car, so that while the ignition is switched on no "warning" sounds can be obtained if the lamps are used in the normal way. However, if any of the lamp switches are left on when the ignition is switched off, the driver is immediately informed.

Provision is made for any extra warning system to be applied by using the lowest part of the circuit where the "spare" position is connected to terminal 15 on the multi-way connector. This can be used, for example, as an anti-theft device. The spare switch can be a microswitch attached to the door, and the spare lamp can be a flashing lamp which is conspicuous to passers-by.

Additional systems can be attached by connecting the basic circuit of Fig. 5b to terminals 3 and 14; the 'x' terminal can be one of the spare *unused* strips on the board or connected direct to an extra switch and lamp.

CONSTRUCTION

The oscillator can be assembled on either a piece of printed wiring board as in the prototype, a piece of Paxolin sheet $\frac{1}{16}$in thick, or on a printed circuit. Details for each method will be given in turn. It would also be possible to assemble it on a circular board to fit closely around the loudspeaker magnet, thus making the oscillator very small and virtually self-contained. The relays would need to be mounted separately if required.

PRINTED WIRING BOARD

The prototype version of the comprehensive system was built on a printed wiring board (available from West Hyde Developments Limited). The complete circuit including the relays can be accommodated on the board, then housed in a suitable case, for example a clear plastics sandwich box 5½in × 3in × 2½in deep. In this way the versatile unit can be used on any of the systems described previously.

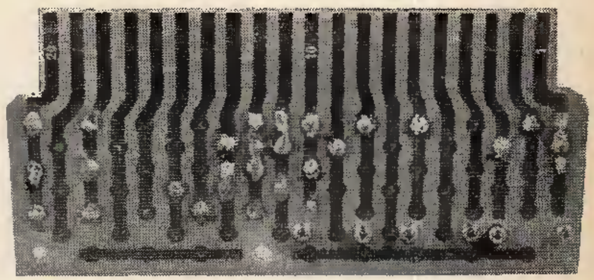


Fig. 6. Underside view of the printed wiring board showing the breaks in the copper strips and additional holes to be drilled. The reference numbers on the strips apply to those in Figs. 1 to 5 inclusive

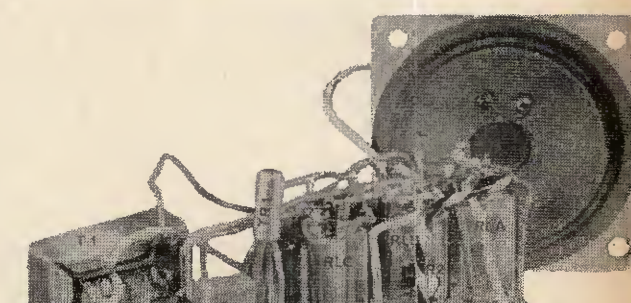


Fig. 7. Top view of the printed wiring board showing the component layout and connections. The transformer can be mounted on the board or in the plastic box

Fig. 6 shows the underside view of the board. It is necessary to drill the board as shown and cut away parts of some strips so that the relays can be mounted on the board. Some additional holes are drilled through the copper strips to take component wires; all soldered connections are shown.

It is probably best to start wiring the components for the oscillator first. The layout of components is shown in Fig. 7. The reference numbers on the strips correspond with those on the circuit diagrams in Figs. 1 to 5, so that any system can be built on this board; conversely the comprehensive system in Fig. 5 can be built for use on any other system required from Figs. 2 to 4. If the diagrams are followed carefully no difficulty should be experienced.

The transformer can be mounted on the board or if housed in the plastics box, it can be fixed to the box as shown in the photograph, so that the loudspeaker will fit in the lid.

Fig. 8. Wiring the connector using multi-way cable

When complete the oscillator can be tested by temporarily connecting a dry battery (6V or 12V according to the circuit values used); positive to strip number 1 and negative to 20. If satisfactory the connector can be wired, as shown in Fig. 8, using multi-way cable with at least eight wires. To avoid undue strain on the wires the cable can be laced and anchored to the connector strip as shown.

The board is mounted in the plastics box using the two holes "A" which were drilled for the transformer. It will be necessary to cut a slot in the side of the box about ¼in wide and 4in long so that the copper strip ends protrude.

It is most important to prevent the unit coming into contact with moisture, otherwise serious damage can occur if the copper strips are short-circuited.

PINBOARD VERSION

Cut a piece of s.r.b.p. sheet $\frac{1}{16}$in thick, 2in square, and drill the holes as detailed in the diagram (Fig. 9). The two large holes are made with a number 34 or $\frac{7}{64}$in drill; the other thirteen holes are drilled with a number 56 drill to take short pieces of 18 s.w.g. copper wire. This size of wire will be found to be a fairly tight fit in the holes. It will be necessary to use a pair of pliers to insert the pieces of wire.

The pinholes are numbered in Fig. 10 for reference in the following description of wiring only and do not correspond with those on the circuit diagrams. The side of the board marked out for drilling will be referred to as the front. Cut a number of lengths of the 18 s.w.g. wire about ½in long and push these into place so that about half the wire protrudes from each side of the board; any surplus wire will be trimmed off later. Turning to the back of the board, connect pins 3, 4 and 5 together with thin wire and solder in position. Now connect pins 6 and 7, 8 and 9, and 12 and 13, as shown in Fig. 10. See the photograph in Fig. 11 for appearance at this stage.

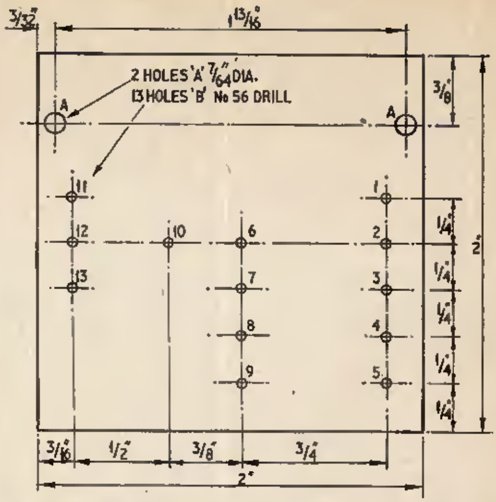


Fig. 9. The oscillator can be built on s.r.b.p. sheet. This drawing shows the drilling details of the sheet. Holes "A" number 34 drill, all others number 56 drill. The hole numbers do not correspond with those in the circuit diagrams, but are only given for the appropriate construction description

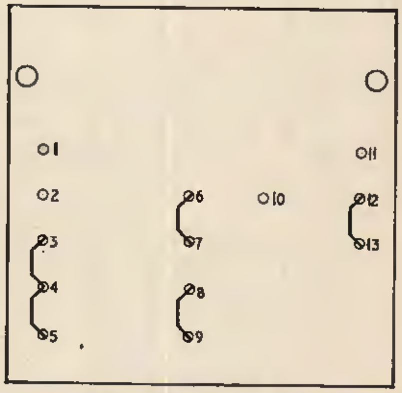


Fig. 10. Wiring the pins on the back of the s.r.b.p. board shown in Fig. 9

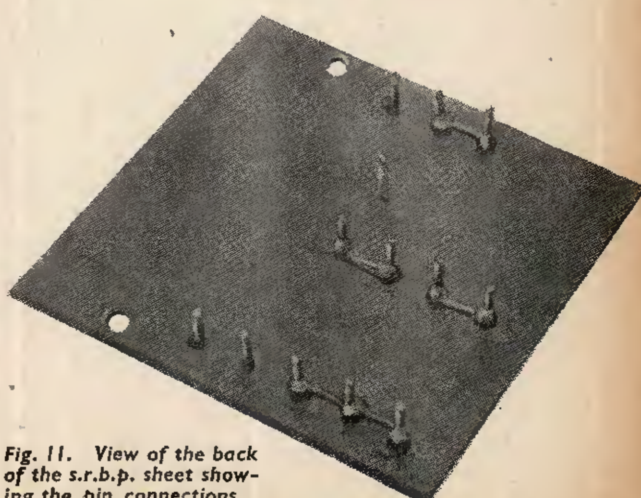


Fig. 11. View of the back of the s.r.b.p. sheet showing the pin connections

Turn the board over to the front side. Fit the transformer in position using holes A–A (see Fig. 9), with the leads on the side nearest to the pins. Solder the leads into place: the loudspeaker winding of the transformer (identified as the pair of thick enamelled wires) to pins 1 and 11; the black flexible wire is connected to pin number 2; the red wire to 10 and the blue wire to 12. These wires should be pushed well down close to the board and soldered to the pins.

Fit the resistors next, R1 to pins 2 and 6, R2 to 3 and 7, and R3 to 4 and 8. Now fit the capacitors; C1 to 10 and 12; C2 to 7 and 13; C3 positive to 5 and negative to 9. Check the circuit over very carefully for any doubtful connections before fitting the transistor. Now fit p.v.c. sleeving to the transistor wires and connect the collector to pin 10, base to 7, and emitter to 8, using a heat shunt on the leads while soldering it in position. The collector lead is the wire nearest the spot on the side of the transistor. The loudspeaker leads are connected to pins 1 and 11 on the back of the board; the battery supply leads—red for positive to 5, and black for negative to 2. Now trim off the surplus wire on the pins. Connect to the supply and check that the oscillator works (6 or 12 volt supply according to the resistors used).

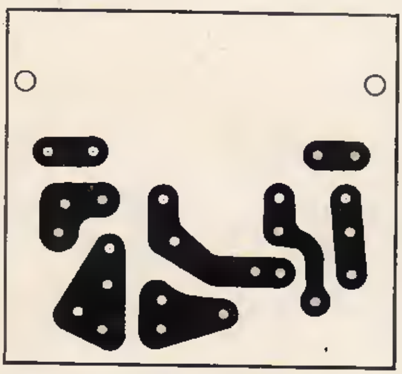


Fig. 12. Pattern for the etched printed circuit which can be used for building the oscillator only

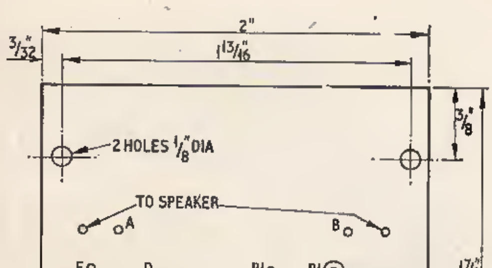


Fig. 13. Connections of the components on the etched printed circuit

COMPONENTS . . .

Resistors
(6 volt version)
R1 3·3kΩ
R2 1kΩ
R3 68Ω
All ½ watt 10% carbon

Resistors
(12 volt version)
R1 18kΩ
R2 4·7kΩ
R3 270Ω

Capacitors (Both versions)
C1 and C2 0·1μF plastic 250V (T.C.C. type PMX4)
C3 25μF elect. 25V (T.C.C. Elkomold type)

Transformer
T1 Push-pull output type TT5 (Repanco)

Transistor
TR1 OC72 or NKT 271

Loudspeaker
LS1 3 ohms 2½in (E.M.I. "square" type or similar)

Relays
(6 volt version)
RLA, RLB, RLC,
Type MH2 185Ω

Relays
(12 volt version)
Type MH2 700Ω

(All relays from Keyswitch Relays Ltd., 120-132 Cricklewood Lane, London, N.W.2)

Component Wiring Board Assemblies
Only one of the following assemblies is needed according to which method of wiring is adopted.

(a) Printed Wiring Board type B (West Hyde Developments Ltd., 30 High Street, Northwood, Middlesex.)
Multi-way connector, with ten clips (Cinch) (available from West Hyde Developments Ltd.)
Multi-core cable "standard" type 8-way (Radiospares)

(b) S.R.B.P. panel, 2in × 2in × 1/16in thick and 18 s.w.g. tinned copper wire.

(c) Printed circuit etching kit (Proops Bros.)

ETCHED PRINTED CIRCUIT

While many constructors will have already had some experience in producing small printed circuits, there are, no doubt, others who perhaps would like to try their hand at it.

A kit containing everything that is needed for the oscillator can be obtained from one of the many advertisers in this journal, for example Proops Bros. of Tottenham Court Road, London. In the kit you will find a piece of copper clad board, some abrasive powder, some paint for covering the areas you wish to keep, and some thinners for cleaning the board when you have finished.

Cut a piece of printed circuit board 2in by 1⅞in, and clean the copper thoroughly with the abrasive powder. Copy the printed circuit diagram given in Fig. 12 by placing carbon paper between the diagram and the copper. Trace the lines through direct from the page. Alternatively trace the diagram on to a piece of tracing paper and then transfer this to the copper. Paint the black areas that you are to keep with the paint supplied, wait until this has dried, and immerse the whole board in the etching fluid. When the etching is completed, and the areas which should be clear are completely free of copper, remove from the etching fluid and wash under running water. Do not let *concentrated* etching fluid go down the sink if you have copper plumbing, or you may find expensive leaks in the waste pipe later on. Clean off the paint with the thinners supplied.

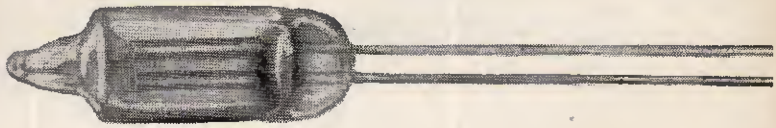
Drill the holes where indicated. The two larger holes are drilled with a number 34 drill to take the 6 B.A. screws for the transformer.

Fit the transformer into position on the plain side of the board, making sure that it is the right way round. Push the leads into the holes in the board; the loudspeaker winding is connected to the holes marked A and B; the black wire into hole C; the red wire into hole D; the blue wire into hole E.

Insert the other components as indicated in Fig. 13, putting the transistor in last. Use a heat shunt on the leads while soldering it into position.

Examine the board carefully to ensure that there are no doubtful joints or pieces of solder bridging the gaps between the copper strips. Fix the loudspeaker leads into their respective holes, as indicated, and fit the supply leads, red for positive to hole F, and black for negative to hole G. Connect to the battery supply, (6 or 12 volts according to the components used). ★

NEON NOVELTIES



THIS is the first of a series of short articles illustrating some of the many uses of neon lamps. The neons employed are all miniature wire-ended types as shown above.

Two examples which are ideally suited to these applications are those supplied by Radiospares (striking voltage 65 volts), and the Hivac type 3L general purpose neons. The latter type requires a striking voltage of 80 volts and maintaining voltage of 60 volts.

Some neon indicators have a resistor wired in series with one of the neon wires to make them suitable for mains voltages. These would normally be unsuitable for the circuits described unless the resistor is removed or short-circuited.

The series is to be divided into groups, the first group dealing with "games"; there will be three of these. Later groups will describe musical devices and instrument applications.

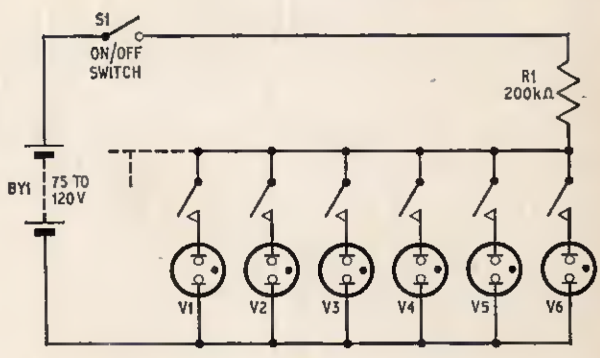
All circuits are simple and require only the minimum of components and technical knowledge in order to make them. Construction is left to the discretion of the readers as this will depend on their individual applications.

ONE PANEL GAME SWITCH by R. Bebbington GRAD.I.E.R.E.

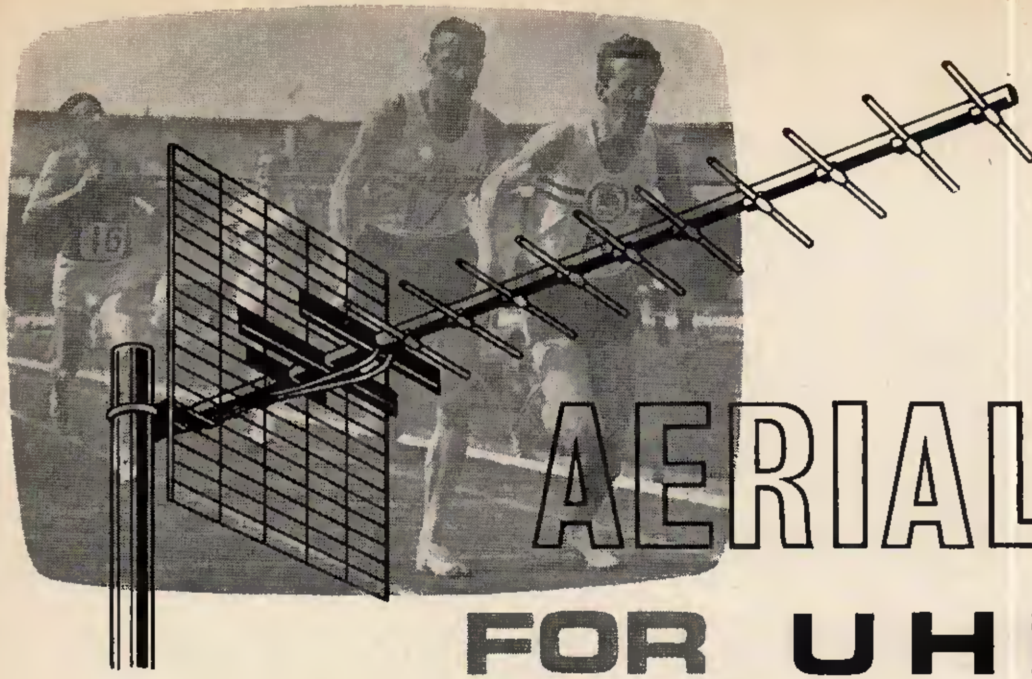
READERS will no doubt be familiar with the device used on television panel games to ensure that the first player ready with the answer is identified. Each member of the panel has a switch and an associated light at his disposal which will glow if he is lucky enough to operate his switch before the other contestants. This can be done with relays but a simpler circuit using miniature neons is described.

The first player to press a switch will cause his neon lamp to glow as it draws current from the battery through the limiting resistor. Any other switch that is "made" even fractionally after this will have no effect because the voltage across the neons is now the maintaining potential of the neon that is struck. For a gas-discharge tube that has a striking voltage of say, 65 volts, this running potential may be around 55 volts, which would be too low for the others to strike. The player must of course release his switch or push-button before the quiz-master poses the next question.

Any number of neons may be used, each of these requiring its own individual switch, which can either be adjacent to it, or identified on a remote display panel.



Several alternative uses for this circuit will probably spring to mind. In miniature car racing a contact situated at the end of each track could be linked up to this circuit and would prove most useful in the event of a close finish. The result could not be in dispute with a neon lit. Perhaps not a photo-finish, but a neon-finish!



AERIALS FOR UHF

By J. D. Benson

In last month's article we discussed the properties of radio waves when transmitted at different frequencies and in particular some of the conditions which must be observed when attempting to receive u.h.f. transmissions. In this article, practical information is given for the construction of aerials for receiving BBC2 within the service area and for more distant reception.

To join the aerial to the receiver, coaxial cable must be used and for u.h.f. reception low-loss cable is a must. The use of inferior cable can completely negate the effectiveness of the signal induced in the aerial.

The construction of three types of aerial will be considered. One is a loft type for use in areas of strong signal and a further two outdoor arrays to cover medium and long distance will be discussed.

The reception of u.h.f. signals is largely conditioned by the position of the aerial relative to the transmitter, i.e. an aerial at long range but situated on a hilltop may give better results than an aerial within the service area, but which is overshadowed by tall buildings.

In weak signal areas little can be gained by increasing the size of the aerial beyond certain limits, but it is possible to amplify weak u.h.f. signals successfully by the use of transistor pre-amplifiers, mainly because man-made interference is almost non-existent in Bands IV and V. Band I signals are very prone to electrical interference. Therefore, if a weak signal is amplified the interference is also amplified, which generally results in a picture covered in "snow" (patterns of white flecks).

OTHER AREAS

The aerial designs, dealt with in this article are specifically designed for Channel 33 which transmits on the frequencies of 567·25Mc/s for vision and 573·25Mc/s for sound. It was felt that in view of the author's location, i.e. some 60 miles from the transmitter, that maximum results should be aimed at from the one channel in operation instead of designing an aerial to cover the four channels allocated to the area.

Many experimenters and constructors may, however, wish to construct aerials which will cover all channels allocated for their areas, or to design an aerial for the particular transmitter currently working. The following design information will enable constructors to build aerials both loft and outdoor, to meet their own specific requirements. The author does not claim that the information given is based on purely theoretical calculations, but it is based mainly on practical results.

LOFT AERIAL

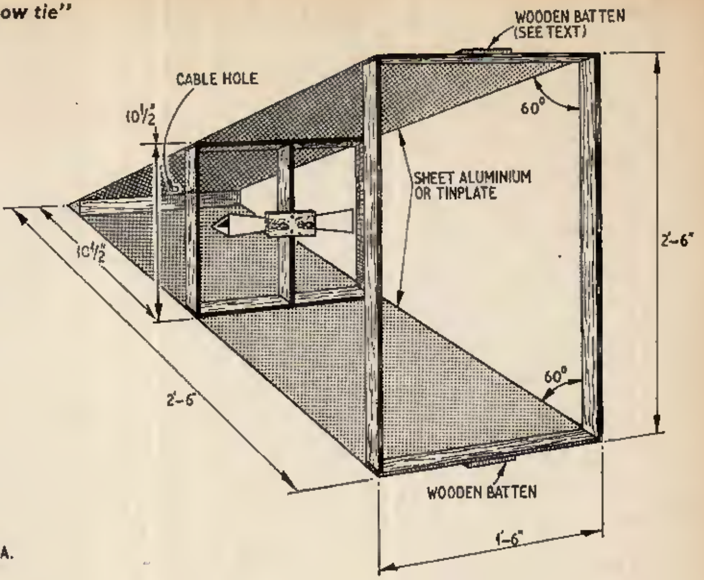
Dealing first with the loft aerial, the reflecting elements are approximately three wavelengths long by one wavelength wide. The "bow tie" overall measurement (4¾in × 2in, Fig. 2b) is half a wavelength calculated on the mean of the vision and sound frequencies for Channel 33.

$$\text{Half a wavelength } \frac{\lambda}{2} = \frac{300 \times 10^6}{2f}$$

If it is required to cover the four channels allocated (i.e. Channels 23, 26, 30, and 33), then the "bow tie" measurement will be based on the mean of the sum of all the four channels vision and sound frequencies. For the London channels this works out at approximately 530Mc/s (see Table 1). The shape of the "bow tie" elements is important as it provides for the correct impedance transfer to the coaxial cable. If the constructor keeps to the proper proportions shown, a very fair match will be obtained.

The distance of the "bow tie" from the apex of the reflectors is also important, with regard to matching; this should be half a wavelength measured from the apex of the "bow tie" triangle.

Fig. 1 (right). The complete loft aerial with the "bow tie" inside the 60 degree reflector



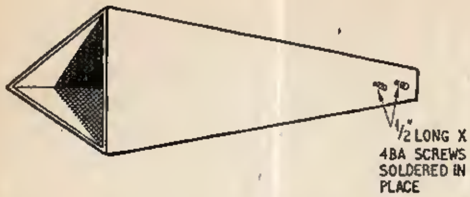


Fig. 2a. Half of the "bow tie" element for the loft aerial. The soldered join is along the back edge or "apex".

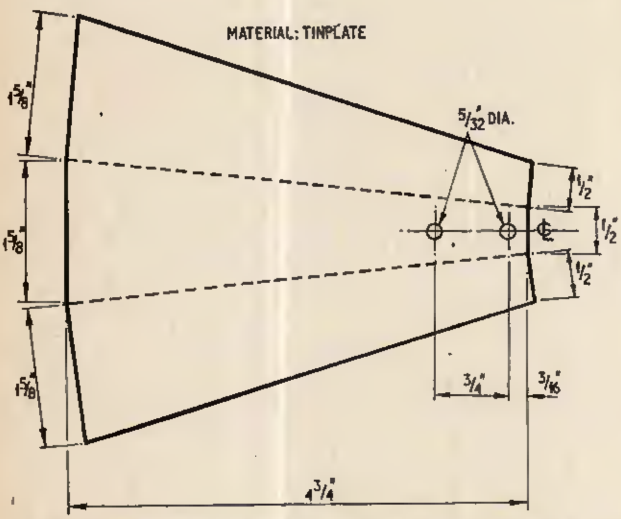


Fig. 2b. Constructional details of the "bow tie". Two are required to be made from sheet tinplate

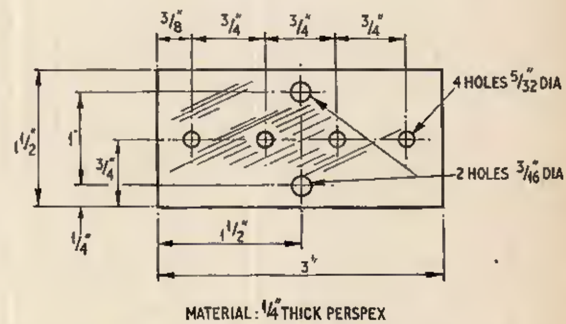


Fig. 2c. Perspex insulator for joining the two halves of the "bow tie" leaving a small air gap between them

The loft type aerial shown in Fig. 1 is of simple construction and has been designed to give best results on Channel 33. The measurements must be adhered to. Wood sizes have been left to the constructor, but the angle of 60 degrees should be accurate, as this contributes largely to the matching of the dipole to cable.

The "bow-tie" dipole elements (Fig. 2) can be made from tinplate and, before bending into shape (Fig. 2a), the 4 B.A. fixing bolts should be soldered in position to prevent turning when mounting on the perspex insulator shown in Fig. 2c. The aerial can be supported by cords attached to the wooden batten which runs along the middle of the reflector surfaces. The "mouth" of the aerial should be directed towards the transmitter and the aerial should be positioned as far away as possible from all metal fixtures (for example, pipes and tanks), which may be in the roof loft.

The gain from this type of aerial is high; it has been successfully used at distances of up to 20 miles from the transmitter. Positioning of the aerial is best carried out by two persons, one moving the aerial in the loft and the other at the receiver to note when best results are obtained.

OUTDOOR YAGI

The construction of the Yagi array calls for careful calculations and measurements. The dipole is half a wavelength overall and is calculated by using the following formula:

$$\text{Length} = \frac{300 \times 10^6}{2 \times 530 \times 10^6} \text{ metres, which resolves to}$$

approximately 28·5 centimetres, which in British units is 11·5 inches. The figure 530 is arrived at by taking the mean of the sum of the vision and sound frequencies of all four channels. In using this formula a correction factor relating to the diameter of the dipole elements should be included, but in practice no ill effects could be observed by its omission. The parasitic element in the centre of the folded dipole is made approximately 15 per cent shorter than the dipole, i.e. approx. 9·5 inches.

The spacing of the Yagi elements from the folded dipole has been based on 0·25 wavelength which gives high gain and good matching. The reflector, which is generally designed at 10 per cent longer than the dipole, is in this case 40 per cent longer to improve the front to back ratio. The vertical overall measurements of the reflector is half a wavelength plus 10 per cent.

Table 1: ALLOCATION OF U.H.F. CHANNELS FOR BBC2

Station	Channels	Frequencies (Mc/s) Vision	Sound	Mean channel frequency (Mc/s)	Mean Station frequency (Mc/s)	in operation
Crystal Palace, London	33	567·25	573·25	570·25	530·25	now
	23	487·25	493·25	490·25		
	26	511·25	517·25	514·25		
	30	543·25	549·25	546·25		
*Sutton Coldfield, Warwickshire	40	623·25	629·25	626·25	664·25	now
	43	647·25	653·25	650·25		
	46	671·25	677·25	674·25		
	50	703·25	709·25	706·25		
Wenvoe, South Wales	44	655·25	661·25	658·25	672·25	12 Sept. 1965
	41	631·25	637·25	634·25		
	47	679·25	685·25	682·25		
	51	711·25	717·25	714·25		
Winter Hill, Lancashire	62	799·25	805·25	802·25	788·25	17 Oct. 1965
	55	743·25	749·25	746·25		
	59	775·25	781·25	778·25		
	65	823·25	829·25	826·25		
Emley Moor, Yorkshire	51	711·25	717·25	714·25	672·25	17 Oct. 1965
	41	631·25	637·25	634·25		
	44	655·25	661·25	658·25		
	47	679·25	685·25	682·25		
Rowridge, I.O.W.	24	495·25	501·25	498·25	540·25	14 Nov. 1965
	21	471·25	477·25	474·25		
	31	551·25	557·25	554·25		
	41	631·25	637·25	634·25		
Black Hill, Lanarkshire	46	671·25	677·25	674·25	664·25	12 Dec. 1965
	40	623·25	629·25	626·25		
	43	647·25	653·25	650·25		
	50	703·25	709·25	706·25		

All of the above stations are horizontally polarised.
The first named channel for each station is, or will be, used initially. The other three channels in each case are for possible future services.
* Sutton Coldfield is, at present, in operation temporarily on low power and becomes permanent on full power 4 October 1965.

Table 2: BBC2 FILL-IN STATIONS FOR THE LONDON REGION

Due to hills obstructing the path of u.h.f. signals to aerials in valley areas, the following fill-in stations are to be brought into service in the near future in the London Region.

Station	Channel	Frequencies (Mc/s) Vision	Sound	Mean channel frequency (Mc/s)	Polarisation
Hertford	64	815·25	821·25	818·25	All these stations will be vertically polarised
Tunbridge Wells	44	655·25	661·25	658·25	
Reigate	63	807·25	813·25	810·25	
Guildford	46	671·25	677·25	674·25	

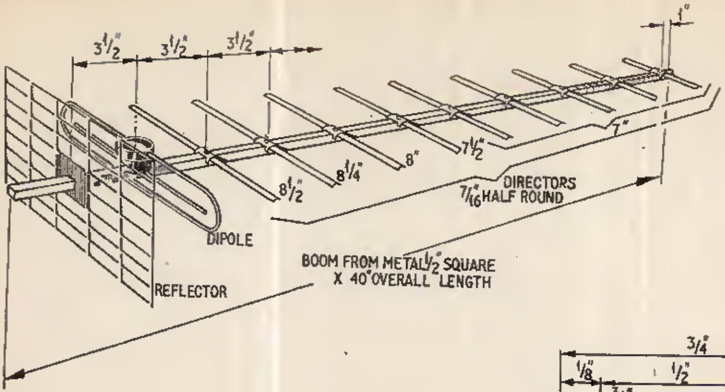


Fig. 3a (left). The outdoor Yagi array for Channel 33 ready for erection. Note the lengths of the directors. The last five directors at the end of the boom are all 7 inches long

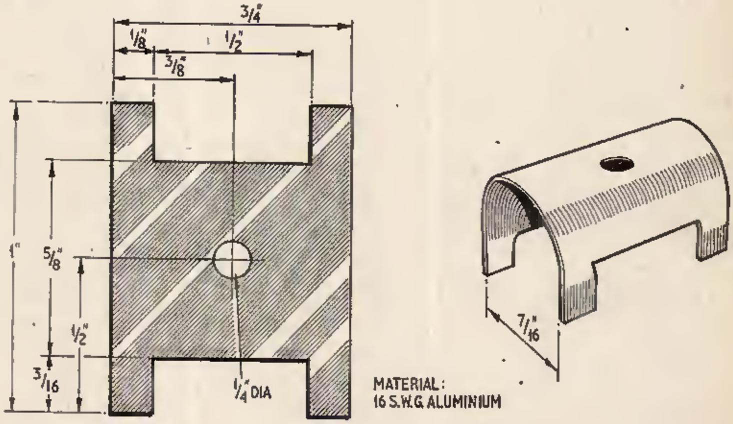


Fig. 3b (right). Constructional details of one of the clamps for fixing a director to the boom

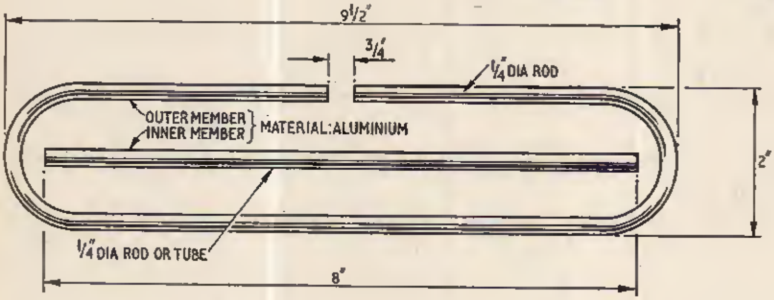


Fig. 4a. (left) The folded dipole. and central parasitic element for reception on Channel 33

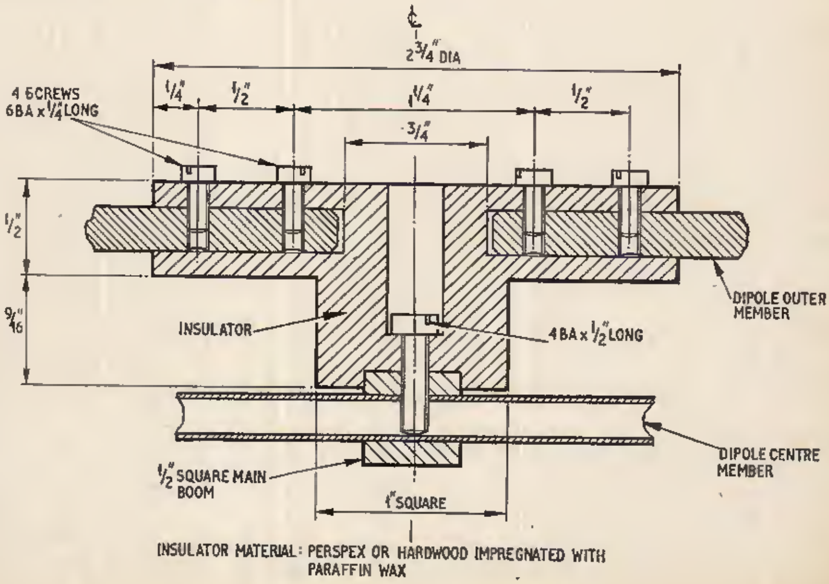


Fig. 4b. Method of mounting the dipole and central parasitic element. The centre member is a tight fit in a hole through the boom. The boom is then drilled and tapped to take the 4 B.A. screw which holds the insulator rigidly in position on top of the boom. The insulators can be made from round or square material as shown, but it must be strong and weather-proof. Connections to the dipole ends can be made by soldering lugs under the 6 B.A. screw heads on the uppermost surface

The director elements are spaced 0·25 wavelength from the folded dipole and from each other. The director nearest the dipole is 10 per cent shorter than the dipole and 10 per cent longer than the next one in front. This can be continued for all the directors. In the aerial design given the last five directors were made the same length; no deterioration could be detected.

The design of u.h.f. aerials is a difficult problem and one that even manufacturers differ on. The problems which confront the aerial designer are many and whilst no claim is made that the design figures given are optimum, a very serviceable aerial can be constructed if they are carefully adhered to.

As an outdoor aerial is subjected to wind and rain the construction must be rugged but light in weight and rust resistant. The design is the result of a great deal of experimental work and gives excellent gain under adverse conditions. Used at 50 miles range with a single stage transistor pre-amplifier, excellent results can be obtained. The construction is straight-forward and well within the average experimenter's resources.

Since light weight is essential, aluminium has been used throughout with the exception of the securing clamps which are of steel, plated to prevent rust. Well painted brass or sheet iron clamps would do equally well.

Most of the metal sections used can be obtained from ironmongers or "do-it-yourself" shops, but in case of difficulty all necessary parts cut to size and drilled, can be obtained from Messrs. George Morton (Aerials) Ltd., Shuttleworth Road, Goldington, Bedford, who state that parts or complete sets of parts can be supplied for constructing these outdoor aerials —but not the loft array.

The main boom of the aerial is made of $\frac{1}{2}$in square section aluminium tube. The nine directors are $\frac{7}{16}$in half round section aluminium; each one is held in position by a 4 B.A. screw and clip which is fitted to each director to prevent it twisting out of alignment. Note the differing lengths of these directors in Fig. 3a and clip in Fig. 3b.

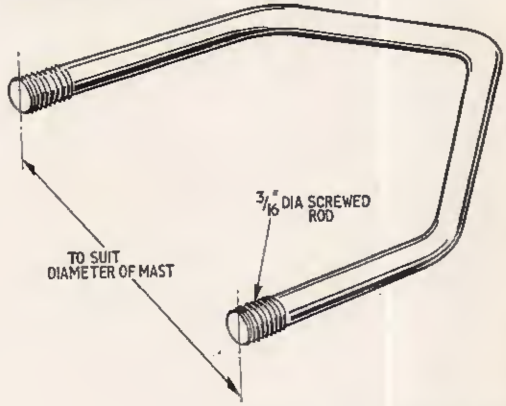


Fig. 5a. This 'U'-shaped cleat is fixed to the upper holes in the bracket (see below) to hold this bracket firmly to a vertical pole

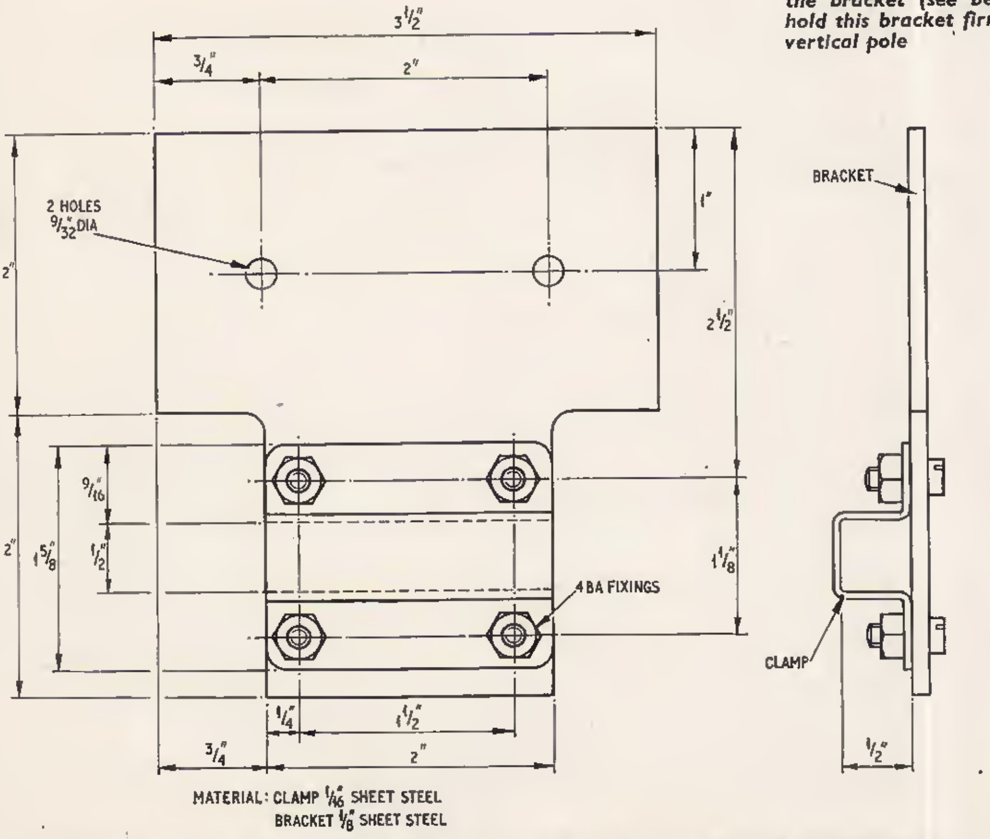


Fig. 5b. Details of the clamping plate and bracket. All parts should be well protected by painting with a primer, undercoat and gloss finish before assembly

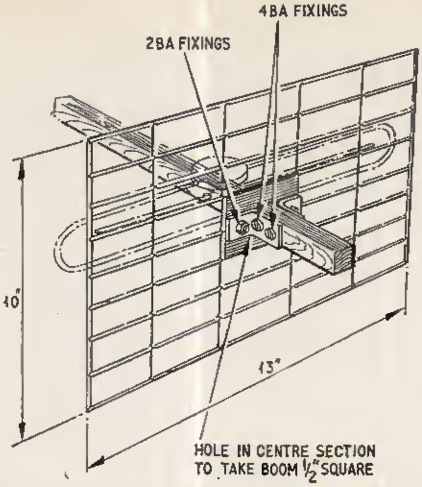


Fig. 6. Constructional details of the reflector fixed to the ½in square aluminium boom

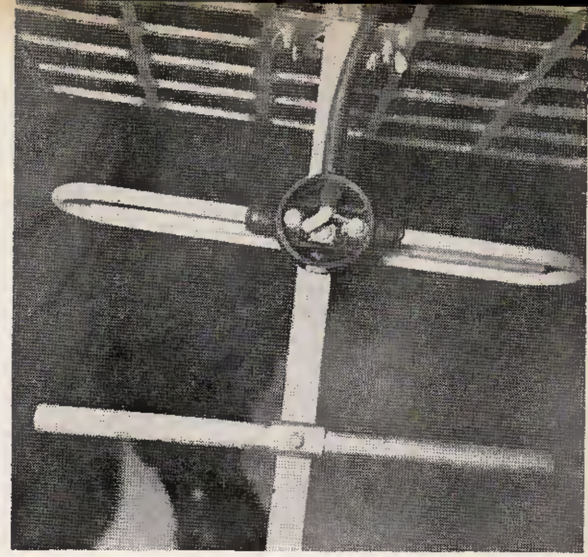


Fig. 7. Close-up view of the dipole showing the coaxial cable connections inside a moulded plastics insulator

The folded dipole is made from a piece of ¼in solid aluminium (this facilitates bending) and the centre element is of the same material (see Fig. 4a). It will be noted that an extra element is positioned in the centre of the dipole. This extra element is of the highest importance and is responsible for matching the dipole to the feeder cable.

The folded dipole calls for special attention. A special insulator (Fig. 4b) and connection has been used which protects the cable joints from the weather. The use of this special insulator is advised but readers may be able to improve on it and devise an alternative. One method of mounting the dipole and central element is shown in detail. A block of perspex or hard wood impregnated with paraffin wax can be used. If this method of construction is used the terminal screws should be varnished or painted to prevent corrosion.

The reflector, behind the dipole, is of cast aluminium or it can be fabricated from stout galvanised wire as in Fig. 6. An alternative would be to cut the grid from hardboard and cover with foil.

Throughout the construction, spring washers should be used to prevent the elements becoming loose through vibration in the wind.

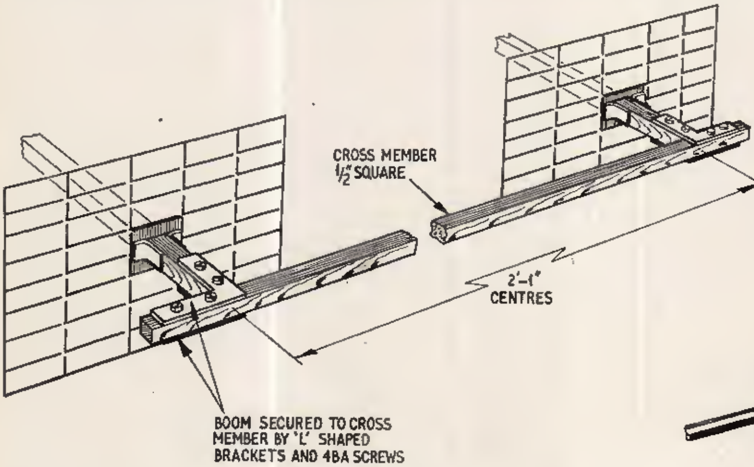
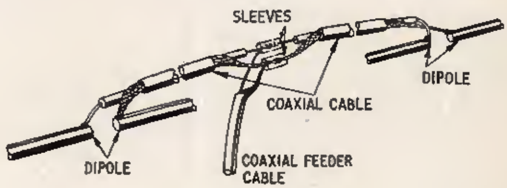


Fig. 8a (left). Details of a twin Yagi arrangement, showing the method of errecting the two arrays on a ½in square aluminium cross boom

Fig. 8b (below). The connections of the coaxial feeder cable to the two dipoles so that they are arranged "core, screen, core, screen"



ERECTION

The completed aerial should be erected in the highest position possible, consistent with the position of surrounding buildings, and accurately aligned on the transmitter with the help of a friend who can report on results from the receiver below. (Note the coaxial cable connections in Figs. 7 and 8b). U.H.F. aerials must be kept in strict alignment with the transmitter for constant results.

Wooden poles should *not* be used for supporting the aerial, as they have been known to twist by as much as 15 degrees due to wet weather conditions.

For distance up to 20 miles, one array is sufficient, provided the site is not overshadowed by tall buildings. Under such conditions two arrays in tandem may be necessary (see Fig. 8 above). For long distance reception two arrays in tandem with a transistor pre-amplifier, preferably mounted at the mast head, will give reliable results. ★

Audio TRENDS...

A Commentary on Sound Reproducing Equipment by Clement Brown

THE SUMMER months are usually rather quiet as far as new audio products are concerned. Therefore it is especially heartening to be able to note that a whole range of high-quality disc equipment, designed and made in the U.K., has been announced by a London firm. Transcriptors Ltd. evidently know how to cater for the increasing numbers of enthusiasts who seek advanced technical features at a less than professional price.

First item on the list is the Transcriptor Arm which, as the illustration shows, is attractive by virtue of its "technical" appearance. There are 10-in and 12-in versions, both of which can be supplied with a head-shell to accept cartridges of normal design. Moreover there are alternative versions with plug-in fittings for E.M.I., Decca Deram and Decca "FFSS" heads.

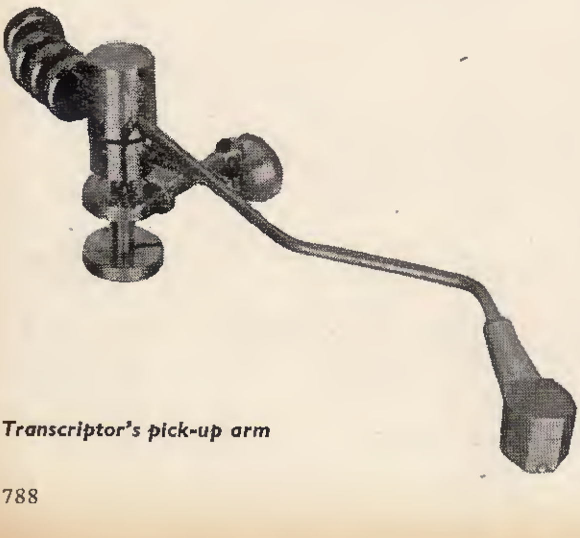
Technical features include a unipivot bearing reckoned to give bearing friction not exceeding 0·08 grammes; a special counterweight system for both planes of movement; and a lifting device for both lateral and vertical positioning of the stylus on the record. A most comprehensive specification is offered in view of the moderate price of £9 7s which applies to all versions. One version of the arm will be converted to another at the works for a charge of £1 9s 3d.

RECORD CARE

Other items in this new range of disc equipment include the Transcriptor Sweep Arm (£2 9s 1d), a cleaning brush which tracks the record; and a stylus brush costing £1 9s 3d. Then there are the Transcriptor Stylus Scales, priced at £2 8s 10d; this gadget is claimed to measure playing weight much more accurately than any competitive device. Full descriptions of these items are available and should prove of special value to those investigating disc equipment for the first time. Write to the firm at 26 Bloomsbury Way, London, W.C.1.

Of course, the availability of cleaning brushes and other "record care" accessories reflects the increased interest in obtaining optimum performance from the more advanced pick-ups. Now that the most costly models track at a gramme in suitable arms, or even less under the most carefully controlled conditions, there must be painstaking care over removal of dust from the record groove. Again, many users wish to clean sticky deposits and fluff from the stylus tip.

Flicking the stylus with a finger does *not* clean it, and one can quite easily damage the stylus-bar or the compliant pivot in the cartridge. A few months ago Metro-Sound introduced a cleaning kit comprising a small brush and a bottle of cleaning fluid, and at the same time they made available an antistatic turntable mat. It is just as important—though for different reasons—to clean tape recorder heads, and Metro-Sound have a kit for this also.



Transcriptor's pick-up arm

TAPE RECORDERS

And so from disc to tape. Although British engineering in this field would take some beating—at least at the professional end of the range—the increasingly international nature of tape recording undoubtedly adds a great deal of interest and variety for the hobbyist and serious amateur. The most notable sources of these machines—specialised heavyweights as well as transistor portables—are Germany and Japan.

Indeed, the Japanese industry offers much to attract the serious enthusiast in the U.K. For instance, there are the Akai machines, marketed here by Pullin Photographic, part of the Rank Organisation. One of the latest models is the ST-1, a two-speed stereo recorder with many advanced features and priced at £129 3s. The frequency response is quoted as 40–15,000 c/s ±3dB, at 7½ inches per second.

There are 3-watt output stages and transistorised pre-amplifier circuits. The ST-1 provides such facilities —now much in demand—as twin VU meters and "sound-on-sound" recording. It weighs nearly 42 lb—a fair guide to the kind of engineering that goes into a recorder of semi-professional calibre. And this is a portable machine: weights of 60 lb or more are common in non-portable models.

FIXED INSTALLATION

Sony recorders are of course among the best known of Japanese designs. It is perhaps less widely realised that the U.K. distributors include in their catalogue a two-speed stereo tape deck, suitable for building into fixed audio installations. Known as the TC-263D, the deck has admirably simple controls; it employs the four-track system and has three heads. It is basically the same as the mechanism used in the Sony TC-200 portable recorder, an excellent stereo model of medium price.

With this deck one can use the SRA-3 stereo pre-amplifier, which provides control facilities and recording and playback circuits intended for linking with the main amplifier of a hi fi system. This is one way to add tape: the other obvious solution is a tape unit, in which mechanical and electronic parts are integrated. The enthusiast's approach must depend on the nature of the audio installation.

Prominent among West German tape specialists are Telefunken and Grundig. Additions to the Telefunken range include the M203 four-track stereo machine. It has a built-in power amplifier and speaker for one channel, and it is intended that the other playback channel for stereo will be provided by an external amplifier or radio set. There are such up-to-date facilities as track-to-track transcription, multiplay recording, and the parallel track feature which enables material on one track to form an accompaniment to a programme on the other track. Price is 79 gns.

In the new Grundig TK400 the recording level is adjusted automatically. This mono recorder, which is in the medium-price category (47 gns.), has the 7½ and 3¾in/sec. speeds and accepts 7-inch spools. Two of the four tracks can be played back simultaneously, headphone monitoring is possible, and synchronised recordings can be made with appropriate accessories.

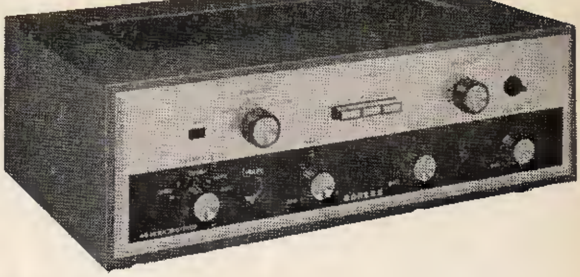
TRANSISTOR AMPLIFIERS

Tuner-amplifiers, with radio and amplifier sections integrated in one housing, are now seen more often. They are of special interest to those who seek to minimise expenditure on cabinet work by assembling a relatively simple and compact shelf mounted outfit. That this trend has emerged is largely due to increased imports from European and Japanese sources. One of the more elaborate Continental examples, the Dualtone Electra 2000, has transistorised input circuits and is rated at 15 watts per channel. The tuner section, adaptable to stereo, covers f.m. and medium-wave bands.

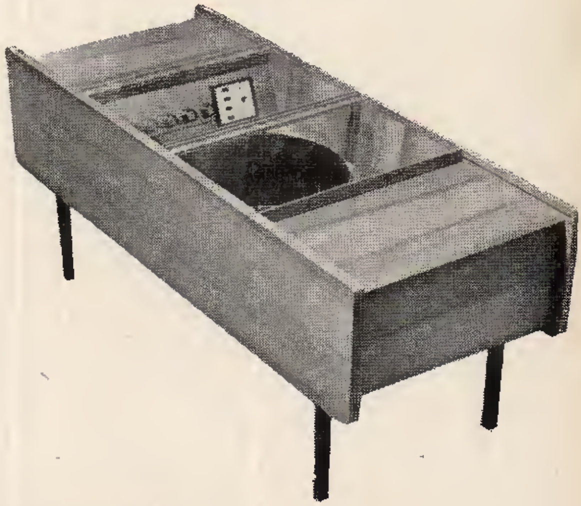
A fully transistorised amplifier for stereo is the MST-15 by Metro-Sound. Again the specification is elaborate and the output is 15 watts per channel. Pick-up input sensitivity is high at 2mV, so that the most advanced types of magnetic pick-up can be used. The controls include one for tape monitoring as well as switched rumble and low-pass filters.

However, at present the majority of high performance amplifiers, especially those rated higher than 10 watts per channel, depend on valves—at least in the output stages. In general, valve output stages give top-quality results at somewhat lower cost. A very nice example is the new Mk 3 version of the Rogers HG88 amplifier. We are, of course, seeing gradual changes in audio electronics, and we can expect a steady though slow fall in the cost of the more elaborate transistor circuits and techniques.

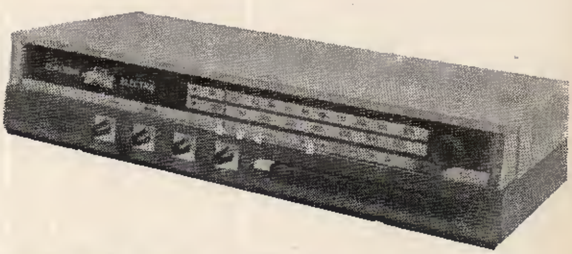
Those who devise their own cabinet-work hardly need reminding to keep an eye on what is done commercially. Pye always come up with pleasing designs for their audio units, and a recent example is model HF1000—the Peri. As the illustration shows, access to controls and pickup is by way of transparent sliding panels. Pye have added a bigger cabinet outfit, the Pammelia, incorporating their transistor amplifier and tuner units.



Rogers HG88 Mk 33 amplifier



Pye Peri HF 1000



Dualtone Electra tuner-amplifier

SLIDE Synchroniser

by E. G. Prentice

No doubt many readers will have taken photographs while on holiday and wish to show them to their friends. Those who take some pride in showing transparencies with a projector may like to add a professional touch to the show by giving a tape recorded commentary.

The adaptor unit described in this article provides a useful link between the tape recorder and projector to synchronise the commentary with the slides. This facility is extremely useful when automatic "slide change" facilities are provided on the projector. The owner can sit back and relax with his audience while the show proceeds automatically.

The prototype synchroniser was made to fit a "Fidelity" tape recorder and is shown here fitted into the microphone compartment

Some projectors have a remote control socket with which the synchroniser can be linked to change the slides for you.

During playback the tape recorder reproduces the accompanying programme. The synchroniser amplifies the signals produced by an oscillator, converts them to d.c. pulses and operates a relay, which completes the remote control circuit of the automatic projector.

LOWER TRACK HEAD

The synchroniser was designed to be used with a two-track tape recorder, the upper track being used for the programme and the lower track for the pulses. The head is a lower-track Collaro head having an approximate resistance of 130 ohms. The tape, of course, is non-reversible.

A four-track recorder could be used, provided that a suitable four-track head is used on the synchroniser. Tracks four or one would be used for the pulses and track two or three for the programme. The tape would then be invertable.

If a lower-track head is not available an upper-track head may be used, but it must be mounted upside down.

The original model, shown in the photographs, was made to fit into the microphone compartment of a "Fidelity" tape recorder, but it could be attached to the side of the recorder with suitable brackets. This is obviously left to the discretion of the constructor. The important point to remember is that it should be firmly held in position so that the tape passes evenly round the head on the synchroniser without upsetting the smooth running of the recorder mechanism. The head should be positioned so that the tape passes it after leaving the capstan and before going on to the take-up spool of the recorder. An even tension is necessary to maintain good contact between head and tape.

CIRCUIT

The circuit of the synchroniser is shown in Fig. 1. In the recording condition, set by the controls on the tape recorder, switch S1 is operated. S1b allows a direct current to flow from the collector of TR1 through the head X1 for erasing purposes on the lower track only.

When switch S2 is operated the erase current is replaced by a signal of approximately 700 cycles per second, derived from a Colpitts oscillator comprising X1, C1, C2 and TR1. The oscillator voltage appearing across R3 is fed via C6 to the base of TR2. The signal is amplified and passed on to the base of TR3 via C8. negative temperature controlled resistor. The original unit, as shown in Fig. 2, used a heatsink for TR3 (see Fig. 3a); this controlled the operating temperature and avoided thermal runaway.

CONSTRUCTION

The actual housing of the synchroniser rather depends on individual requirements and is to a certain extent dictated by the tape recorder model used. A pictorial drawing is shown in Fig. 2 of the author's unit which tted his machine (see photograph). It is not considered necessary to give complete details because of this.

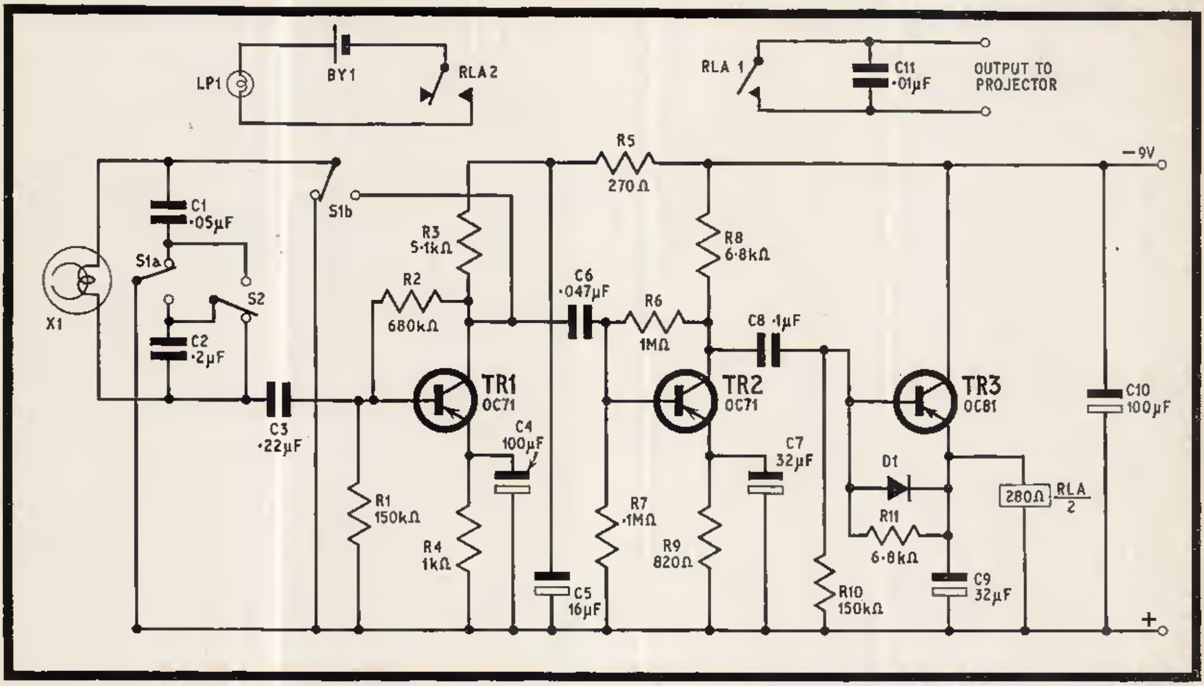


Fig. 1. Circuit diagram of the synchroniser unit. All switches and relay contacts are shown in the "playback" condition

It is rectified by the diode (D1) and appears across the relay coil as a d.c. pulse. The relay contacts are used to operate the projector slide changer.

In the playback condition S1 is released as S2 is depressed. The pulses on the tape are picked up by the head and applied to the base of TR1 via C3.

The amplified signal appears across R3 and is further amplified by TR2. TR3 then operates as before; the relay also operates when pulse signals are provided by the tape, and triggers the "slide change" mechanism in the projector.

Due to the high current passing through TR3, precautions have to be taken to stabilise the operation of this transistor at high temperature by shunting the diode D1 with a resistor R11. The value of R11 is lower than the inverse resistance of D1.

The leads of TR3 should be kept as long as possible, insulated with p.v.c. sleeving, and fitted with a heat shunt during the soldering process. This shunt can be removed after soldering. Although it was not found to be necessary in the prototype, it is possible that further stabilisation may be required; in this case R11 could be replaced by a thermistor of similar value, this being a

However, a few points can be mentioned here as a guide for intending constructors.

The head is mounted on the top of the unit, and a platform, made from thin sheet brass, was fitted in front of the head to guide the tape into position. If tape guides, such as those used on commercial machines, can be obtained these can be fitted on either side of the head, giving a more accurate and stable guide for the tape.

The flat two-pin plug shown in Fig. 2 is fitted to the top of the unit. A matching socket, also the flat type, connects the unit to the remote control lead of the projector. A small two-way socket was also fitted to the top to enable a 9 volt battery to be connected to power the amplifier. Power could have been drawn from the tape recorder amplifier, possibly from the cathode of the output valve, but it would have had to be stabilised since there is an a.c. signal superimposed on it. This would have made the project unnecessarily complex.

The push button switch unit is shown as a three button assembly but only two are used. The important point here is that there should be facilities on each for

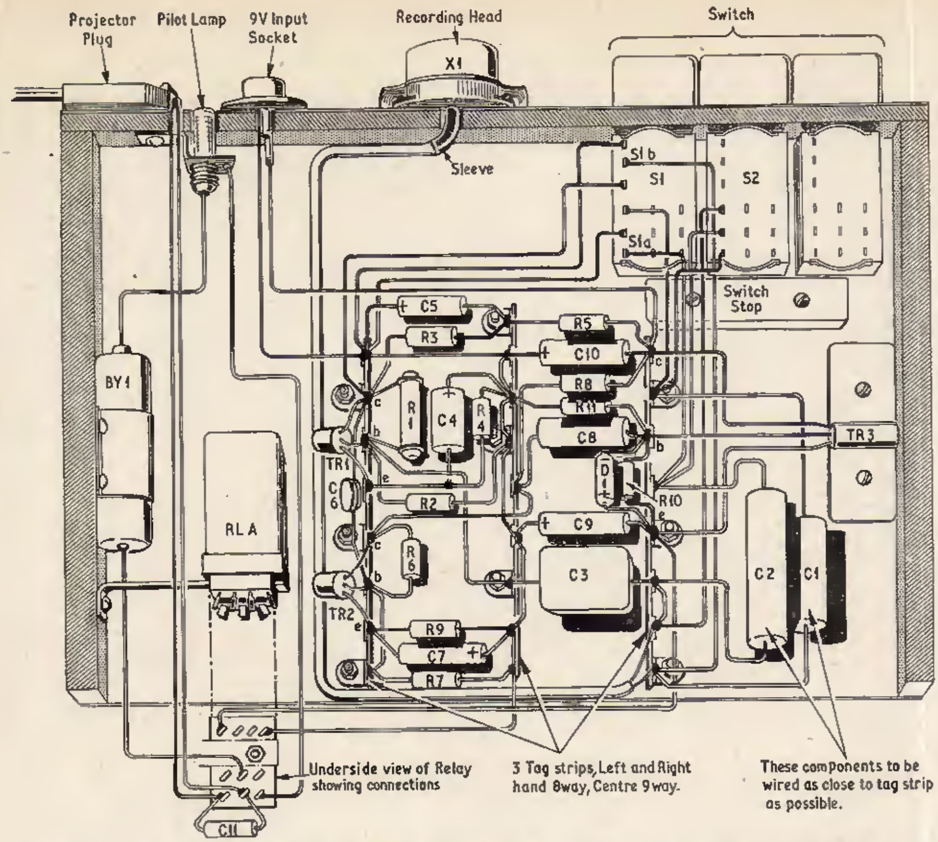


Fig. 2. Layout of components in the synchroniser. The size and shape of individual constructors' units will be determined by the types of tape recorder used

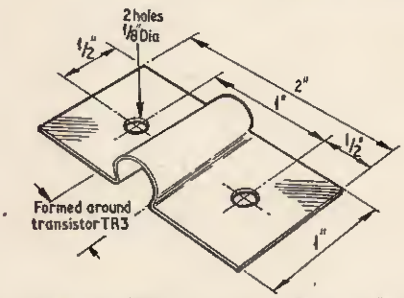


Fig. 3a. Heatsink for TR3. Material can be 20 s.w.g. copper or brass sheet

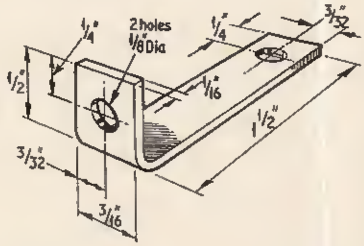


Fig. 3c. Bracket for mounting the relay. The final dimensions depend on the relay used (see text)

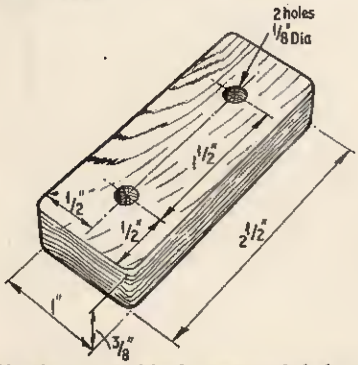


Fig. 3b. Wooden stop block mounted below the push button switches

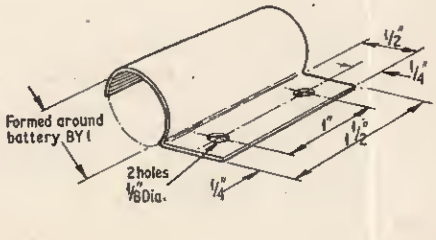


Fig. 3d. Metal clamp for the 1.5 volt cell BY1

two sets of changeover switches. Otherwise the type of switch used is not critical and can even be a rotary type. Fig. 3b shows a wooden stop which is fitted underneath the switch assembly (see Fig. 2).

The relay was mounted on a bracket fixed to the side of the box (see Fig. 3c). The remainder of the components were mounted on tag strips as shown in Fig. 2; the layout is not critical. The small pilot lamp, powered by a 1·5 volt cell clamped to the side of the box (Figs. 2 and 3d), indicates when the relay contacts are closed due to the pulses. This relay has two sets of changeover contacts; the actual type is not important provided the coil resistance is as close to 280 ohms as possible.

COMPONENTS . . .

Resistors

R1	150kΩ	All 10%, ½W carbon
R2	680kΩ	
R3	5·1kΩ	
R4	1kΩ	
R5	270Ω	
R6	1MΩ	
R7	100kΩ	
R8	6·8kΩ	
R9	820Ω	
R10	150kΩ	
R11	6·8kΩ	

Capacitors

C1	0·05μF	paper 150V
C2	0·2μF	paper 150V
C3	0·22μF	paper 150V
C4	100μF	elect. 12V
C5	16μF	elect. 12V
C6	0·047μF	paper 150V
C7	32μF	elect. 12V
C8	0·1μF	paper 150V
C9	32μF	elect. 12V
C10	100μF	elect. 12V
C11	0·01μF	paper 500V

Transistors

TR1, TR2 OC71
TR3 OC81

Diode

D1 OA85 or OA81

Relay

RLA 280Ω two-pole changeover (S.T.C. type 24)

Recording Head

X1 130Ω Collaro or similar for lower-track recording (see text)

CONSUMPTION

The battery consumption is very low except when the relay is operated. The following are guides to the currents which you can expect to be drawn under certain conditions:

(a) Playback—0·5mA
(b) Erase—2·0mA
(c) Pulse (relay operated)—35mA

As conditions (b) and (c) are only in operation for very short periods the life of the battery is very good. In fact, it was found that, after 2,000 operations of the slide changer, the battery voltage had dropped only about ½ volt. ★

ECHO UNIT

continued from page 775

A cheap alarm clock with a loud tick will make a splendid source of signal if stood in front of a microphone. It is important to keep the microphone as far from the speaker of the external amplifier being used as possible. Earphones connected directly to the output of the echo unit are recommended for setting up purposes to prevent the possibility of acoustic feedback.

Advance the record level preset control VR1 until a delayed tick is apparent at the output. Now adjust the playback head until the high frequency response is at a maximum.

The recording level can now be set at a position such that no distortion is apparent even on loud signals. The erase head is adjusted so that all traces of previous recording are erased. The preset VR4 is now adjusted, with the playback control VR3 at minimum, until the straight-through portion of the signal is at the desired level. On turning up the playback volume a single echo will now be obtained. On turning up the echo feedback control it will be found that multiple echoes are produced giving a very pleasing effect. The feedback control must be handled carefully, or the whole system will go into oscillation. It is a good idea to use a microphone with a switch, then if the echo feedback control is turned too high the resulting oscillation can be rapidly quenched.

Incidentally, if a variable speed motor is used, many further interesting effects may be obtained. ★

ELECTRONORAMA

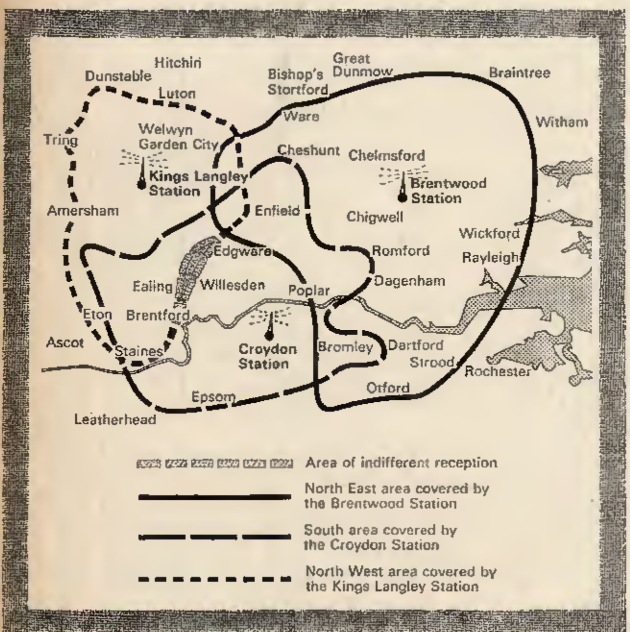
HIGHLIGHTS FROM THE CONTEMPORARY SCENE

FIRST!

Car-to-Car Phone Call Across the Atlantic

THE first car-to-car telephone call was made on 5 July between London and Montreal. The link was made from a car installed with the new G.P.O. Radiophone manufactured by Pye Telecommunications Limited. Managing Director Mr. John Brinkley spoke to Pye's Canadian Managing Director in a taxi cab in Montreal, via the Bell Telephone Network. The handset was then passed to a reporter who chatted to the taxi driver, Mr. Marx Kaufman.

A few minutes earlier, the Postmaster-General, Mr. Anthony Wedgwood Benn, M.P., declared the Radiophone Service open to London subscribers by telephoning from the G.P.O. Headquarters in London to Richard Dimbleby in a car on Vauxhall Bridge.



The new service covers an area of up to 30 miles in a rough circle round the centre of London and will, at the start, cater for about 350 subscribers. Provided they are in the service area, subscribers can make and receive calls to any part of the country and to other cars connected to the service. The service area is divided into three sectors, each of which is served by a radio station. These are at Beulah Hill, near Croydon; Kelvedon Hatch, near Brentwood; and Bedmond, near King's Langley. Calls are centrally controlled by operators at the Tate Gallery Exchange, Victoria.

Storno Limited are also manufacturing the radio transmitting-receiving equipment for installation in cars.

Brrr!

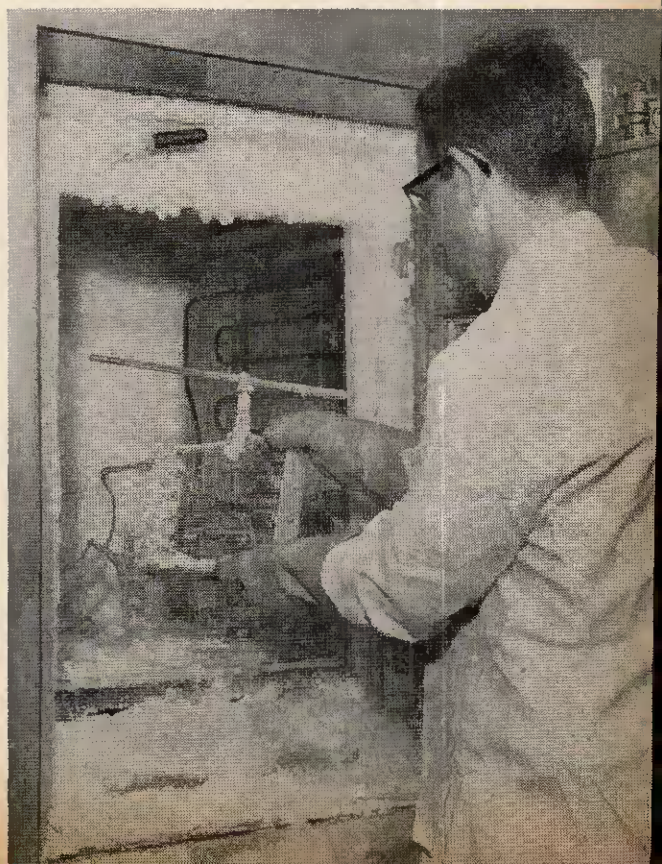
D.C. MOTORS, manufactured by Rank Pullin Controls, have to undertake vigorous testing for twelve months before being certified by the Ministry of Aviation.

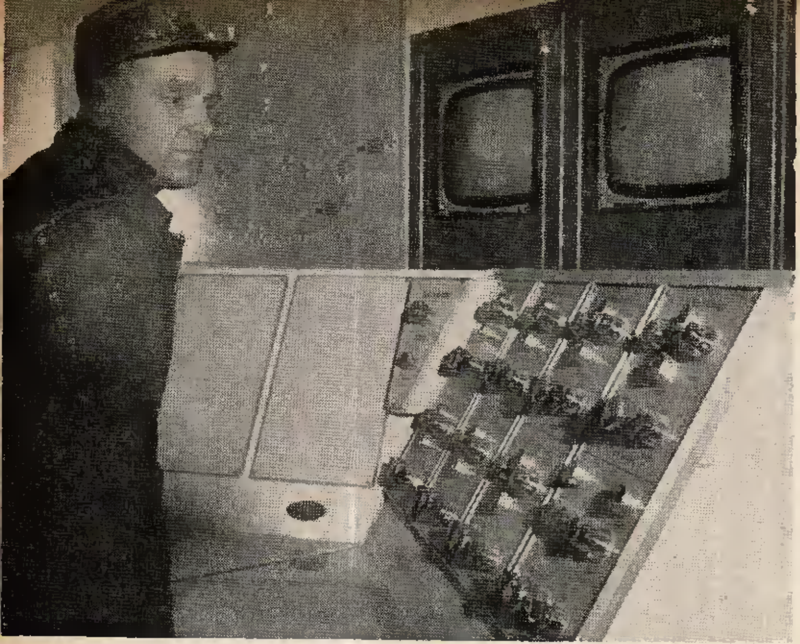
The photograph below shows the mounting frame, with the motors attached, being withdrawn from a refrigerator after ten days of environmental tests, during which the temperature was varied between −65 degrees and +85 degrees centigrade. They are further subjected to changes in pressure and humidity.

Later, the motors are placed in close proximity with tropical fungi to ensure that they would not support fungi growths.

They also have acceleration tests up to 100g and vibrations tests at frequencies up to 500 cycles per second at 30g. During vibration testing the motors complete $22\frac{1}{2}$ million cycles.

The motors are expected to have a life of 1,000 hours of continuous running on full rated load. They are used in aircraft flight systems, missiles and industrial control systems.





FIRST AGAIN!

Electronic Controlled Colliery

Bevercotes Colliery in Nottinghamshire is the "Mine of the Future". Equipped with an extensive electronic control scheme, this is the most advanced colliery in the world.

Electronic control is provided for the mechanised longwall faces (coal cutting machinery), all underground transport, shaft winding, and for the coal preparation plant on the surface. The consoles which control these operations are linked to a central control room at the pithead from where they receive information and instructions. The comprehensive communications system includes closed circuit television with cameras located at vital positions below ground. It is expected that a computer will be added shortly, so that the mine can be run entirely automatically, producing a pre-determined coal output programmed at the commencement of each shift.

Coal production will start later this year. It is anticipated that by 1968 1·5 million tons of power station coal will be produced from five remotely operated coal faces with a labour force of only 770 men, compared with a force of 2,000 men required for a similar mine using conventional mechanisation.

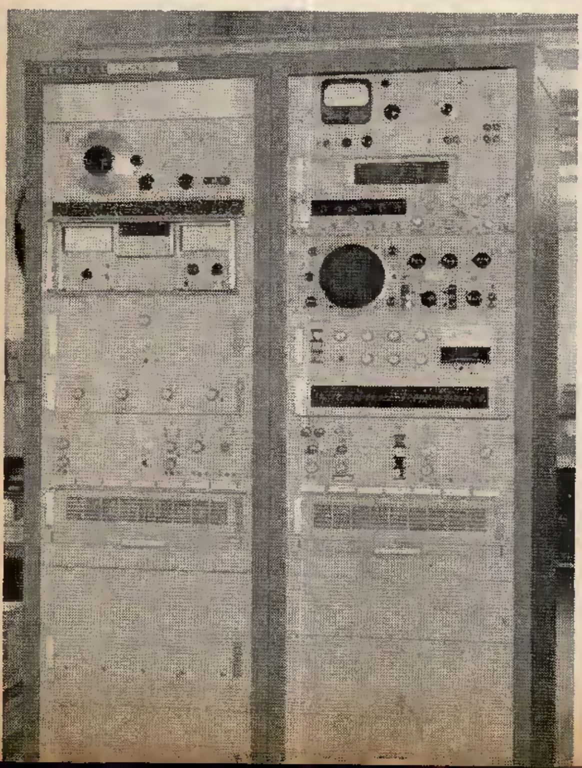
The photograph on the left shows part of the underground control room. Cendrex ash analysis in the coal preparation plant is undertaken by the x-ray equipment shown below.

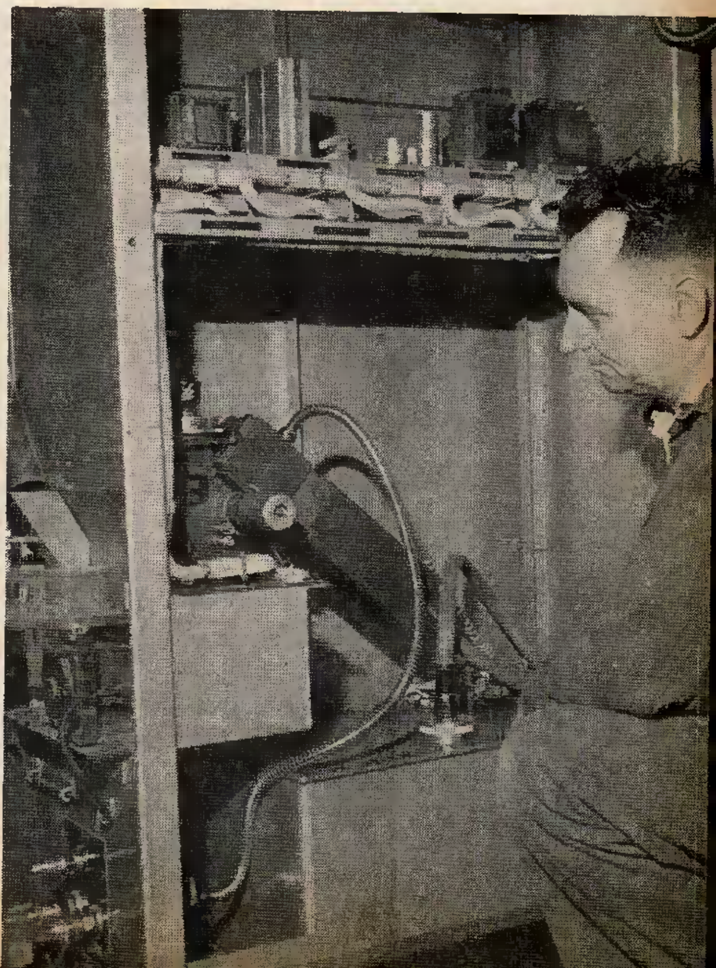
All this . . .

The new Honeywell Series 9300 Analysis System shown below can compute and plot amplitude versus frequency, power spectral density, peak versus frequency, amplitude ratio versus frequency, cross power spectra, complex transfer function, and amplitude or amplitude-squared versus time.

The output can be presented as an X – Y plot in which the r.m.s. value, or mean square value, is plotted against the log. frequency. It is also available for digitising.

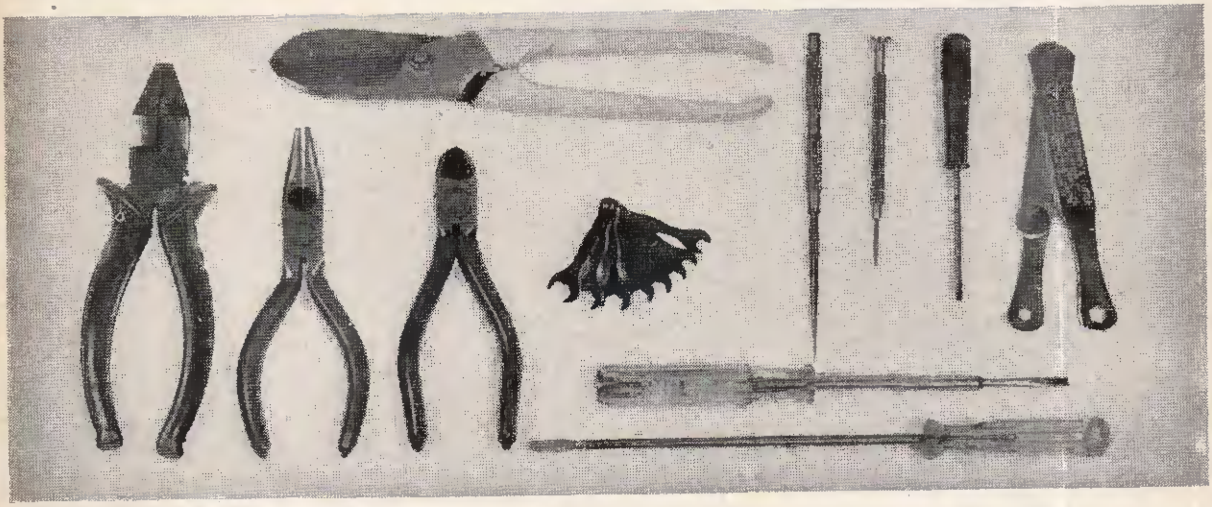
Now we can get down to work!





BEGINNERS start here... 11

An Instructional Series for the Newcomer to Electronics



Here are displayed the essential tools for general constructional work. Other more specialised items can be added as the demand arises. In our photograph we show (left to right) square nosed ("electricians") pliers with insulated grips; long nose, side cutting pliers; round nose ("diagonal") wire cutters; set of B.A. spanners (0 to 8); scriber; watchmaker's screwdriver; grub screwdriver; "Bib" wire cutters and strippers. In the top centre is a pair of tinsnips. Finally, the picture is completed with a medium and large screwdriver—one having an insulated shank

When we launched our present series of articles for the newcomer to electronics, we made it clear that both the theoretical and the practical aspects of this hobby would be dealt with. Some of our readers may be thinking, perhaps ruefully, that theory has stolen the stage in our last few instalments. But they may rest assured that the balance will be restored!

Before tackling a.c. theory, we will direct our attention to the other side and talk about materials, tools and workshop practice.

IN YOUR WORKSHOP

If you are a regular reader of our series, there is probably a corner somewhere which is already serving as the "centre of operations" for your constructional work. Our young readers might have a drawer and tabletop in the bedroom (with mum grumbling now and then about "all those bits of wire!"), or perhaps the kitchen table serves as a workbench when the domestic situation permits. Some readers may be fortunate enough to have a separate room or outbuilding already equipped with workbenches and tools.

Like any practical subject, electronics has certain techniques attached to the constructional work enabling successful results to be obtained with the minimum effort. How about the tool kit for this work in our subject? There are many opinions possible concerning the kind of tools needed. In spite of this, however, the following ideas are probably universal, and should help you to see the way.

CONSTRUCTIONAL METHODS

The methods of construction are now more or less governed by the component makers, whose parts generally have become standardised. Thus an international octal valveholder has a diameter of 1⅛in and the fixing holes are 1½in apart.

Most valve apparatus is built on metal plates (usually aluminium) with side panels, this kind of assembly being called a *chassis*. Very early in the radio construction art, wooden baseboards were used, the components being fixed down with woodscrews. This method is still sometimes used for experimental *lash-ups* and is called, naturally enough, the *breadboard method*.

There has been a rapid development of special techniques to fit in with the modern trend towards miniaturisation, especially in the case of circuits employing transistors and other semiconductors.

The most obvious and well-known of these techniques is the *printed wiring board*. Here one starts with a piece of laminated plastics board which is clad with copper on one side. A special etching process is used to produce a suitable pattern of copper, the unwanted portion of the copper skin being dissolved away by chemicals. This method is best suited for fairly complex circuit designs, and has most definite advantages when a number of identical units have to be made.

Another form of "printed wiring" is available pre-made in a standardised style. One well-known brand is called *Veroboard* and consists of a perforated plastics board with strips of copper attached to one side. This material has figured prominently in PRACTICAL ELECTRONICS designs, and can be used for a great variety of projects. And of course, there is no need for chemicals and the somewhat involved preparation required when making an orthodox printed wiring board.

Ordinary, plain plastics board ("Paxolin") can also be used for mounting components, the connections being made by pieces of wire running along the reverse side of the board. To save the labour of drilling holes, the perforated type of board can be purchased. Terminal posts for securing the components can be improvised from short lengths of fairly thick tinned copper wire (16 or 18 s.w.g.). Alternatively, it is possible to buy packets of prepared terminal pins. These are tapered and are of a suitable diameter for the standard type perforated board.

In the course of your practical work in electronics, it is likely that you will make use of all these methods—plus other variations! Plenty of scope here for private enterprise. And after all, part of the fun of a hobby is making good use of seemingly worthless odds and ends.

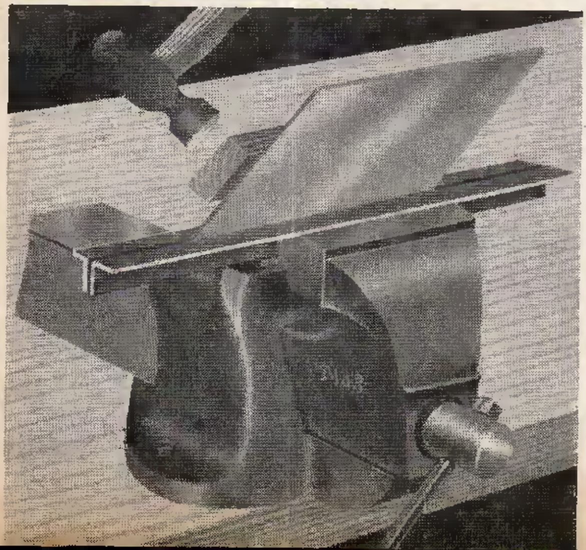
BASIC TOOL KIT

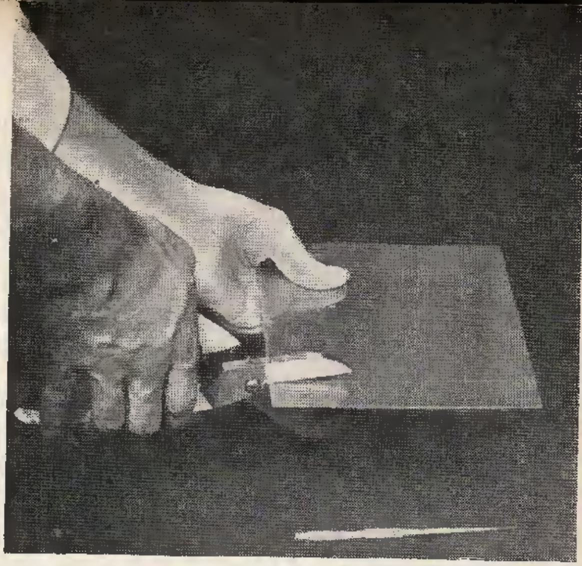
Before we get down to discussing the above mentioned constructional methods in detail, we must deal with the question of tools. All constructional methods involve soldering, so some skill in this art is a necessity. So important in fact that we will be devoting the major part of our next article to soldering.

In the meanwhile, all methods except printed circuitry require work with wire—and even with printed wiring methods the component leads still have to be trimmed to the correct length. All this indicates that a pair of wire snippers is a "must". The most convenient type are round nose cutters (diagonal cutters). Wire strippers are also useful, but the insulation, usually plastic these days, *can* be stripped with the cutters, if it is knicked each side of the point required, then pulled off—but it requires some skill not to cut the wire!

A couple of screwdrivers are needed: one to fit the 2, 4, and 6 B.A. screws so common in our work; the other, smaller, and often called a grubdriver, to fix control knobs onto their spindles.

This illustrates the method of bending sheet metal





Cutting a piece of aluminium. The scriber is in the foreground

Closely following on the screwdrivers are pliers. A long nose, side cutting pair of pliers is indispensable. A useful size for general work is 5½ or 6in. Longer, and more finely tapered pliers are most desirable tools—but they are more expensive. A pair of round nose pliers will come in very handy if loops and bends are to be made in wires.

PREPARING THE MATERIAL

Of course, for accurate and neat jobs, the parts involved should be carefully laid out before the cutting and drilling starts. In fact, a simple drawing helps greatly at this stage. It doesn't have to be an honours grade technical drawing effort, but just a sketch showing dimensions, hole positions, and so on. With a preliminary sketch, perhaps drawn up from juggling around the actual components relative to each other on a piece of wood or paper, any fouling of parts is usually noticed straight away. It is most annoying to find a valve won't plug into its holder because a mains transformer is in the way!

Now the cutting out. The metal or plastics sheet should be marked out carefully along the line of cut: for this operation a scriber is needed. You can obtain one of the proper ones, or sharpen a point onto the blade of a broken screwdriver or steel knitting needle.

When cutting, keep the progress of the hacksaw blade or tinsnips slightly on the waste side of the line, then you will have a tiny excess which can be filed down to smooth off the edge.

BENDING SHEET METAL

Bending sheet metal presents a bit of a problem without a vice, so if you are thinking of some fairly ambitious cabinet or chassis work it might be an idea to fix yourself up with one somewhere. Even then, a vice alone isn't much use—the jaws are too short, and have serrations on them which will make ugly marks on soft metals like aluminium.

For fairly long bends, a pair of angle irons are useful. These can be clamped in the vice and the work gripped between them so that the bend can be made along the whole length. The bend can be started by hand, then finished by means of a hammer and a block of wood: to hit the metal directly would, of course, result in serious dents and marks.

DETACHED PARTICLES

By John Valence

TRIGGER PULSE

It is quite fascinating how an odd item of news can act as a trigger pulse and set up a train of thought or revive memories of some happening or experience of long long ago.

Take that exciting (or to the insularly minded, disturbing) project the Channel Tunnel, which has been in the news again just recently. Mention of this subject always evokes memories of one of my earliest visits to the cinema, and in particular of a (then) greatly imaginative and futuristic film dealing with international skullduggery. Most details of the plot escape me, but two things remain as vivid impressions: a highly dramatic episode when a time bomb planted on a cross channel train explodes in mid tunnel (or mid channel, as you will); and the appearance of the television phone which seemed to be part of the normal domestic scene. As I recall, images of callers appeared on a picture frame type of screen which retracted into a cabinet when not in use. The script writer had unconsciously leapfrogged the cathode ray tube era and transported us even further ahead into the world of the solid state screen!

Spectacular progress notwithstanding, it is going to take us quite a while yet to catch up with this! Seems a safe bet that the Channel Tunnel will be in existence before the c.r.t. is pensioned off, or even, for that matter, before vision is added to our public telephone service.

By the way, maybe someone will recognise this old film (*circa* 1930) and remember the title. Needn't be afraid of thus revealing your age—you can always say you saw it on B.B.C. television (1965 variety).

NEW BROOMS

Young members of Parliament are reported to be chaffing at the bit and impatient of the traditional ways of the Mother of Parliaments. And who can blame them? Typical and yet pathetic, I thought, was the offhanded manner in which one older MP dismissed all this agitation in a television interview: "always happens with new members—want to have a clean sweep—but soon will settle down to the traditional ways"—or words of a similar kind.

What a dreadful thought! Let's hope some of the new blood will not succumb too rapidly to the cosy pedestrian ways of the "best club in the country". It is just this fresh outlook that is required and a new wind to blow some of the dust from the multitudinous nooks and crannies down Westminster way.

Seemingly, one of the revolutionary ideas being put forward concerns the use of electronic apparatus for counting and recording votes in the House. Gad, Sir! What will they think of next?

BLAST OFF

There are of course good and bad traditions. I will not be alone in regretting that the jet aircraft's ability to blast the eardrums of all those within a mile or two of a major airport seems to be accepted by the authorities as a traditional right. While the aircraft industry is strangely enough absolved from responsibility in this matter, it falls to the lot of other technologies to provide a palliative to this sometimes quite unendurable racket.

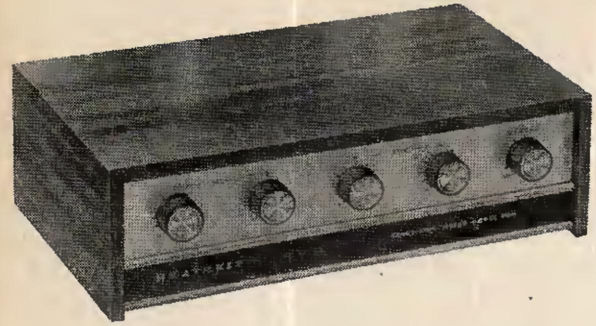
"Jones Minor will relieve you after second period of maths..."

Soundproofing of buildings is a very expensive business. Apart from the additional structural materials needed, the use of double glazed windows makes an air-conditioning system mandatory if the desired result is to be achieved.

An interesting way around this dilemma has been tried out in a school close to London Airport. Instead of a costly air conditioning system, certain windows are allowed to be opened for normal ventilation purposes. These windows are coupled to an automatic device which in turn is connected to a sound detector mounted on the roof. When the sound picked up (as from an approaching jet) exceeds a predetermined level, this amplified sound operates a solenoid and the window is quickly closed. Subsidence of the noise results in the reopening of the window.

One possible snag I can see arises from the fact that the warmer days coincide with peak holiday traffic on the airlines. With a steady stream of aircraft passing overhead at one minute intervals, I feel the atmosphere inside the classrooms will become a trifle heavy—if quiet. *Wake up there, Jones!*

NEW PRODUCTS



Audio Mixer Kit

Daystrom Ltd., Gloucester, England.

The mixer type TM-1 in our photograph is designed for use with a variety of amplifiers, radio tuners, tape recorders, and dynamic and crystal microphones. Four channels are provided, two of high sensitivity and high impedance and two channels of lower sensitivity and impedance. Each channel is controlled by its own volume control and is automatically earthed when the input plugs are removed.

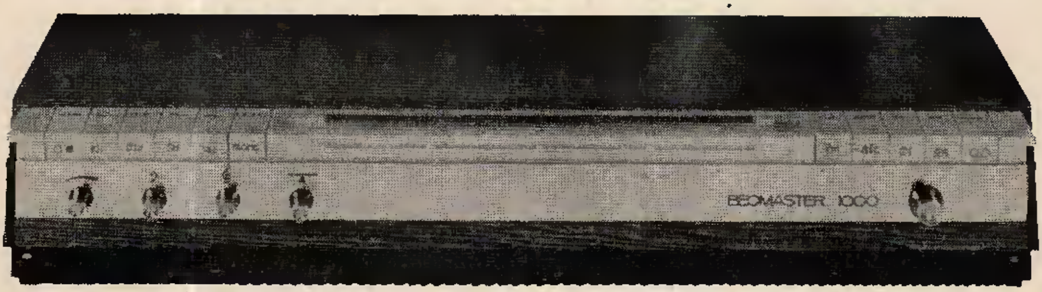
The technical specifications are as follows: sensitivities (for an output of 200mV r.m.s.), channel one 1·5mV (1 megohm nominal input impedance in "High Z" position); 4·5mV (2·5 megohm nominal input in "Xtal" position); channel two 1·5mV (1 megohm nominal input impedance); channel three and four 180mV (250 kilohm nominal input impedance). The output (for rated input in one channel) is 200mV (600 ohm nominal output impedance). The noise (referred to 200mV r.m.s. output) is −50dB (all channels) in "High Z" position.

The frequency response (ref. 1 kilocycle at full output) is 15 cycles per second to 30 kilocycles per second at ±3dB, with a distortion of less than 0·2 per cent at full output. The mixer is powered by a 9 volt battery at 6mA current consumption and has seven transistors mounted on a roller-tinned printed circuit board.

The mixer has individual volume controls for each channel, a master volume control, and on/off switch. A useful facility in the TM-1 is the inclusion of a "music/speech" switch which in the music position gives a linear response. In the "speech" position the response is cut by 3dB at frequencies below 150 cycles per second. By attenuating the low speech frequencies it is possible to minimise the boom effect particularly noticeable in public address systems.

The TM-1 is housed in an attractive oil-finished walnut cabinet which is supplied factory assembled. The front panel is extruded aluminium with a brushed, gold anodised finish. The matching knobs have spun-gold inlays. The "High Z/Xtal" and "Music/Speech" switches are concealed behind the hinged lower front panel. The TM-1 mixer is available in kit form with full constructional details for £11 16s 6d or assembled and tested for £16 17s 6d.

Stereo Amplifier and F.M. Tuner



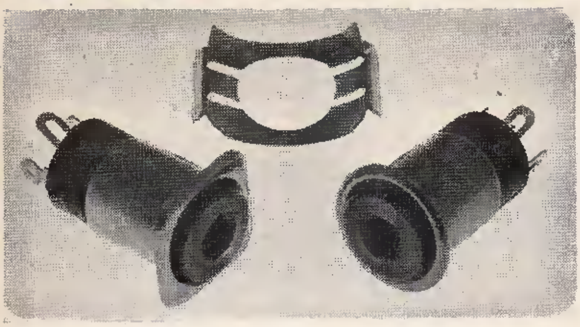
Bang & Olufsen U.K. Sales Division, Eastbrook Road, Gloucester.

Bang & Olufsen announce the U.K. introduction of the all-transistor Beomaster 1,000 stereo amplifier and f.m. tuner. The amplifier gives an output of 15 watts per channel. The f.m. band is extended up to 108Mc/s and incorporates an automatic frequency control circuit.

Other features include: push-button speaker change-over switches which control two sets of stereophonic speaker systems; separate bass and treble controls; balance control for correct stereo sound distribution; separate treble and rumble filters; push-button switching between monaural and stereophonic reproduction, and push-button function selector for switching between f.m., tape recorder, "gram 1" and "gram 2".

The Beomaster 1,000 is styled in a teak or Brazilian rosewood "slim line" cabinet $3\frac{7}{16}$in high by $19\frac{7}{8}$in wide by 10in deep with stainless steel control knobs, and "piano-key" selector switches. It retails at 79 guineas.

Miniature Jack Socket



Carr Fastener Co. Ltd., Stapleford, Nottingham.

A new moulded miniature jack socket designed to accept all miniature jack plugs has just been announced by Carr Fasteners Co. Ltd.

The sockets are designed for insertion into a prepunched or drilled hole of 0·438in ($\frac{7}{16}$in) diameter where they are secured firmly by a ratchet plate. Two types of nickel plated bezels are available presenting either a circular or square face.

The contacts which have a tinned finish for easy soldering and long storage life, are fully enclosed within the moulding thus protecting them from damage in handling.

High Intensity Neons

West Hyde Developments Ltd., 30 High Street, Northwood, Middlesex.

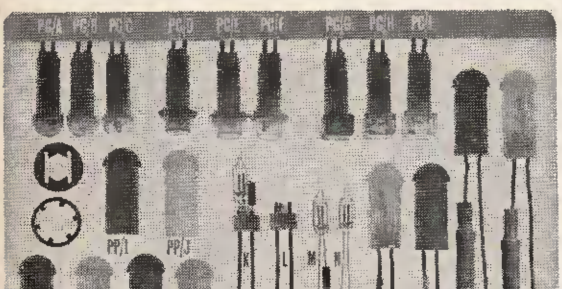
The above firm have recently increased their range of high intensity neons from two to twenty. They now include 115 volt and 400 volt versions.

Marketed under the trade name of "Brightlife" the neons give greater brightness than their existing models and have 25,000 hours average life. They can be operated at 120 degrees centigrade (panel temperature) and 75 degrees centigrade at the leads.

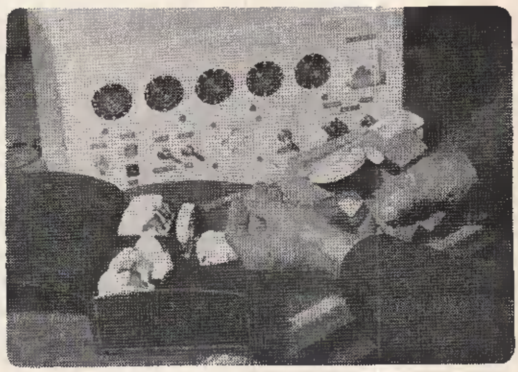
The neons come in two fixing sizes $\frac{1}{2}$in diameter and $\frac{3}{8}$in diameter with one hole fixing; a thin protrusion prevents rotation. The $\frac{1}{2}$in diameter types are moulded in polypropylene which diffuses the light and are available in white or red housings. The high density polythene bases, with the leads moulded in them, have a high resistance to splashes from chemicals.

The $\frac{3}{8}$in diameter type are moulded in polycarbonate which gives higher light transmission; these are available in three cap shapes and three colours, red, amber, or clear, dome, top-hat, or square.

Both types give a glow behind the panel which serves as a warning when any servicing is carried out with the apparatus switched on.



M4 Labelmaker



Dymo Ltd., Browells Lane, Feltham, Middlesex.

The unit in our photograph is the Dymo M4 Labelmarker which is proving a very useful gadget in our workshop. The photograph shows the added professional appearance obtained by using the labels on the General Purpose Counter or Scaler to be described in next month's PRACTICAL ELECTRONICS.

The labels are produced by "dialling" the required letter or number on the gun and squeezing the large embossing trigger. Once the label is completed the tape is cut by squeezing the small cut-off trigger.

The tapes for the M4 are available in nine different colours and one transparent version. The self-adhesive tape is $\frac{1}{4}$in wide and is prepacked in a plastics magazine, which provides easy loading and quick change of colours. The range of colours enables any equipment to be labelled under a coding system.

The M4 Labelmarker costs £3 19s 6d supplied with one roll of tape free. Tape for the M4 is available at 6s 3d per magazine and the colour required must be given when ordering.

ELECTRONIC BUILDING BLOCKS

PART SIX

by R. A. DARLEY

LAST MONTH we discussed a simplified method of designing basic stages of a transistor amplifier and described its use in providing phase-splitting circuits. Before going on to the various impedance matching devices, it is probably worth looking at two basic circuits for providing feedback equalisation.

INTEGRATORS AND DIFFERENTIATORS

The circuit of the integrator is shown in Fig. 6.1a, together with its block diagram in Fig. 6.1b. A resistor (R_s) is connected in series with the input and a capacitor (C_f) provides feedback between collector and base. A time constant is thus deliberately introduced in the circuit, so that the degree of feedback that is applied over the complete circuit is made a function of frequency.

If a square-wave is fed into the input, the output will be as shown in the Fig. 6.1c, the degree of change in wave shape being dictated by the effective time constant of R_s and C_f. The effective value of C_f is increased over the nominal value by a factor β (the current gain of the circuit), i.e. $C_{effective} = \beta \times C_f$.

The capacitive coupling between collector and base results in a substantial reduction in the input impedance at operational frequencies.

The circuit of the differentiator is shown in Fig. 6.2a, together with its block diagram in Fig. 6.2b. In this case a capacitor, C_s, is in series with the input, and feedback between collector and base is obtained via resistor R_f. A time constant is again introduced, and the output amplitude again depends on frequency. The effect of the circuit on a square-wave is shown in Fig. 6.2c.

These two circuits are often used in applications where a non-linear frequency response is required, such as in equalisation networks.

IMPEDANCE AND CURRENT TRANSFER

The main part of this article will discuss the inherent impedance characteristics of transistors and their application to practical circuits.

Certain basic details should be remembered in order to understand these characteristics. The transistors can be used in any one of three configurations, each one making use of the current transfer characteristics in a different way. These three configurations were mentioned in last month's article and are expanded here to show the different ways in which an impedance match may be obtained between two other circuits.

It should be realised that both α and β represent current gains in the transistor, but they are the gains between different parts of the semiconductor. Either term may be used to indicate current gain, as the values of the two gains are interdependent. β denotes the current gain from base to collector while α denotes the current gain from emitter to collector. For example, if the value of α is known then β can be calculated from the following formula:

$$\beta = \frac{1}{1-\alpha}$$

It will be noted that α can never be greater than 1, but that the nearer it approaches to 1 the greater will be the value of β.

COMMON EMITTER CONFIGURATION

The practical circuit diagram of a common emitter amplifier is shown in Fig. 6.3. The input impedance of this circuit is generally fairly low, in the order of 1,000 ohms, and is not greatly effected by variations in the collector load. Typical values of input impedance with collector loads of zero and infinity, for example, are 750 ohms and 1,500 ohms respectively.

The output impedance is of medium value and likewise is not subject to undue variation of collector load values. With loads of zero and infinity, the output impedance can be expected to be in the order of 25,000 ohms and 50,000 ohms respectively. Ratios of input to output impedances are typically in the order of 35:1.

High orders of current, voltage and power gain are obtained with this configuration although the frequency response of the circuit is not very good; in an amplifier using an OC71, for example, the upper 3dB-down point will normally be at about 11kc/s. The output of the amplifier is 180 degrees out of phase with the input.

COMMON BASE CONFIGURATION

The circuit diagram of a typical common base circuit is shown in Fig. 6.4. The input impedance in this mode of operation is generally low, typically in the order of 35 to 700 ohms, depending on the collector load. It should be noted that the input impedance is greatly effected by variations in the collector load.

The output impedance is generally high, in the order of hundreds of thousands of ohms. Ratios of input to output impedance are very high, frequently in the order of 1,500:1.

The circuit gives high voltage gains, but only medium power gains, while the current gain is invariably very nearly 1.

The frequency response of the circuit is very good; in an amplifier using an OC71, for example, the upper 3dB-down point will be at about 600kc/s.

The output of the amplifier is in phase with the input.

The low input and high output impedances of this circuit make it ideal for matching a low impedance circuit or component into a high impedance one; in this type of application, the circuit is used like a step-down impedance matching transformer. The circuit may also be used purely to take advantage of its very good frequency response characteristics.

COMMON COLLECTOR CONFIGURATION

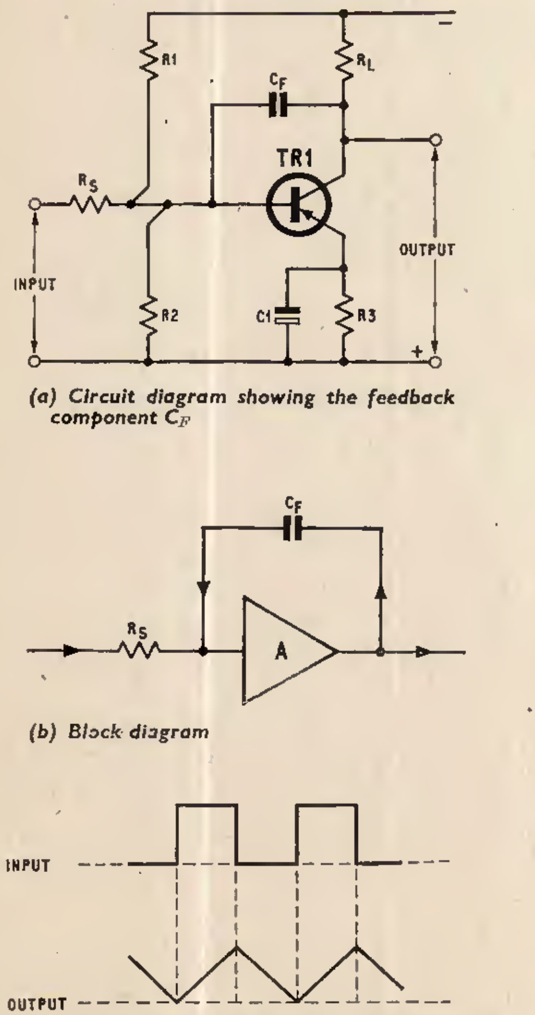
The input impedance of the common collector circuit, (see Fig. 6.5), is generally high, values of 500 kilohms being obtained with little difficulty.

Output impedances are low, typically in the order of 500 to 1,000 ohms.

The current gain of the circuit is high, but the power gain is low, while the voltage gain is always slightly less than one.

The frequency response of the circuit depends to a large degree on the value of the emitter load, but can, for general purposes, be considered to be about the same as is obtained with a common emitter circuit.

The output of the amplifier, taken from the emitter, is in phase with the input. Thus, the emitter "follows" the base signal and, for this reason, the circuit is generally referred to as the "emitter follower". This is a very important circuit in electronics.

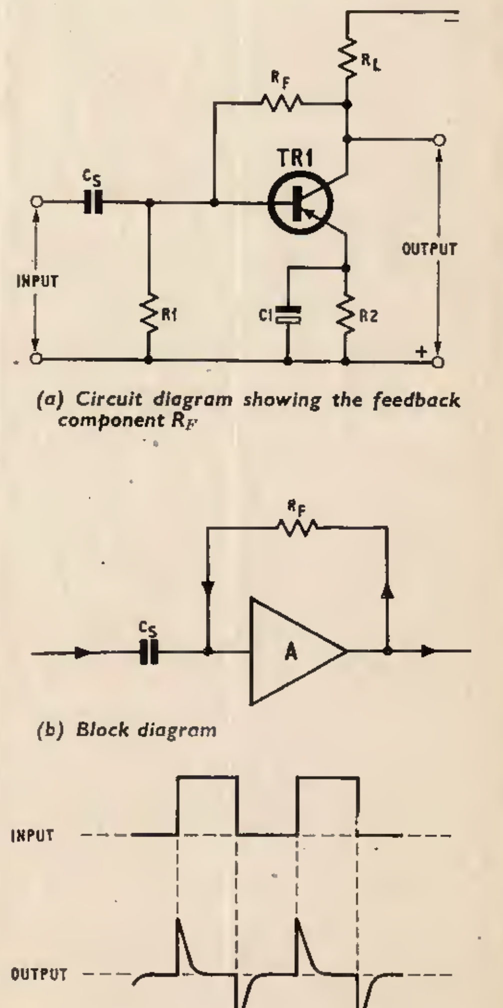


(a) Circuit diagram showing the feedback component C_F

(b) Block diagram

(c) Output waveform from a square wave input.

Fig. 6.1. Single stage integrator



(a) Circuit diagram showing the feedback component R_F

(b) Block diagram

(c) Output waveform from a square wave input.

Fig. 6.2. Single stage differentiator.

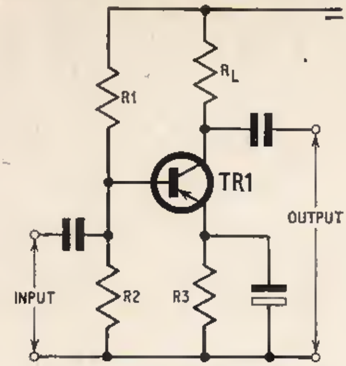


Fig. 6.3. Common emitter circuit giving medium impedance input and output

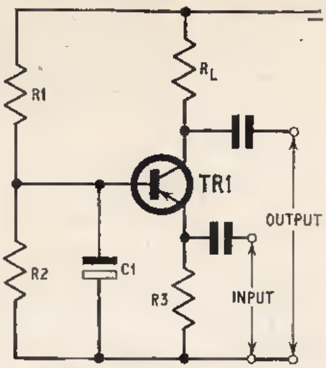


Fig. 6.4. Common base circuit giving low impedance input and high impedance output

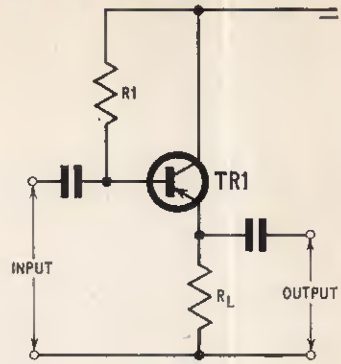


Fig. 6.5. Common collector circuit giving high impedance input and low impedance output

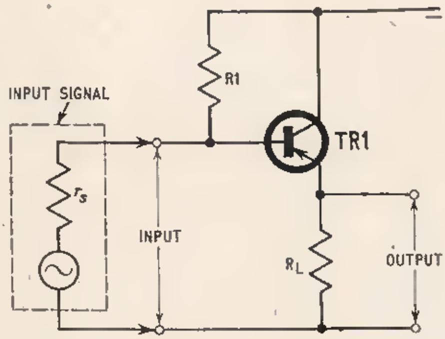


Fig. 6.6. Emitter follower circuit where $Z_{in} \simeq \beta R_L$ *and* $Z_{out} \simeq r_s/\beta$

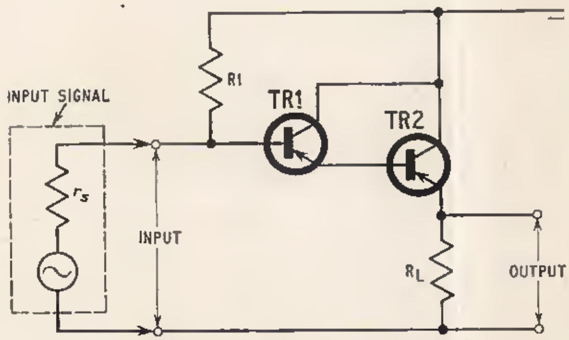
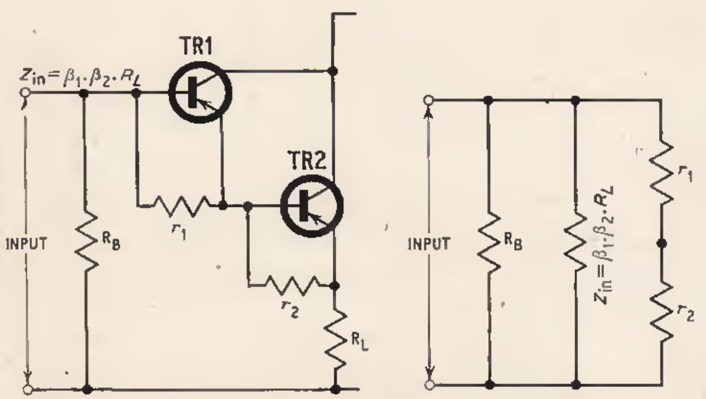


Fig. 6.7. Darlington or super-alpha pair provides a higher input impedance. $Z_{in} \simeq \beta_1 . \beta_2 . R_L$*, and lower output impedance* $Z_{out} \simeq r_s/\beta_1 . \beta_2$



(a) (b)

Fig. 6.8. Theoretical circuits of the Darlington pair. (a) and (b) Resistances r_1 *and* r_2 *represent the internal resistances between base and emitter of each transistor*

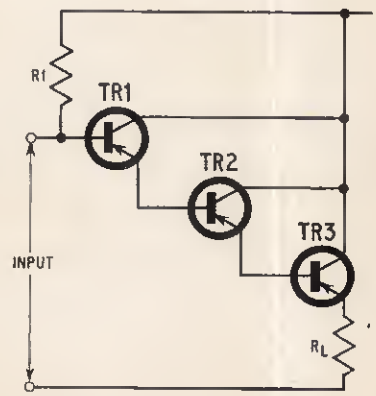


Fig. 6.8c. Darlington pair type of circuit using three transistors. $Z_{in} \simeq \beta_1 . \beta_2 . \beta_3 . R_L$

EMITTER FOLLOWER CIRCUIT

The input impedance of the emitter follower circuit can be calculated approximately as the product of the emitter load resistor, R_L, and the β of the transistor. Thus, if an OC71 transistor, which has a typical β of 50, is connected as an emitter follower with an R_L of 5,000 ohms, the input impedance of the circuit will be $50 \times 5{,}000 = 250$ kilohms.

The output impedance of the emitter follower circuit is given approximately as the source impedance of the input signal divided by the β of the transistor. This is made a little clearer from Fig. 6.6, where the input signal is shown as coming from a signal generator with an internal source resistance, r_s. This internal resistance is effectively in parallel with the input impedance (Z_{in}) of the transistor. It follows, therefore, that if the source impedance of the input signal is infinitely high, the effective source resistance of the input signal will be the same as the input impedance of the emitter follower, and the output impedance of the emitter follower will therefore equal R_L.

It can be seen that, within reason, any desired combination of input and output impedances can be obtained using the emitter follower circuit. The circuit is thus ideal for use as a "buffer" or matching stage in an amplifier circuit.

The voltage gain of the emitter follower circuit is always less than 1. Generally speaking, however, the higher the output impedance of the circuit, the nearer will the voltage gain approach to unity. In practice, the voltage gain of a conventional emitter follower circuit will be in the order of 0·9.

"DARLINGTON" OR "SUPER-ALPHA" PAIR CIRCUIT

One of the main disadvantages of the transistor compared with the valve is that comparatively low input impedances are involved. For many applications this low impedance is of little importance, but occasions do arise when a very high input impedance, in the order of megohms, is necessary for satisfactory operation, a typical example being matching a high-impedance crystal pick-up into a fairly low impedance common emitter amplifier, without appreciably loading the crystal.

Let us suppose, for example, that an input impedance of 2 megohms is required. If an attempt is made to use an emitter follower circuit to obtain this impedance it is found that, using a transistor with a β of 50, the emitter load resistance (R_L) has to be in the order of 40 kilohms. If a transistor such as an OC71 is to be used in this circuit, such a high value of R_L will necessitate a supply voltage of at least 45 volts, remembering that this transistor is required to operate at a mean collector current of about 1mA if excessive distortion is to be avoided. Even ignoring this fact, the 40kilohm emitter resistor will give too high an output impedance for feeding into the common emitter amplifier circuit.

To overcome this problem the effective current gain can be increased, rather than increasing the value of R_L. A circuit that does this is shown in Fig. 6.7, and is known as the "Darlington" or "Super-alpha" pair.

Transistor TR2 is connected as a conventional emitter follower circuit, with a β of (say) 50; R_L is the emitter load. An amplifier (TR1) preceeds the emitter follower, but is connected so that the emitter current of TR1 flows directly in the base of TR2.

If the current gain of TR1 is also 50, the current flowing in the emitter of TR1, and therefore in the base of TR2, will be 50 times greater than that in the base of TR1, and the current flowing in the emitter of TR2 will be 50 times greater again. If we call the current gains of TR1 and TR2 β_1 and β_2 respectively, the overall gain between the base of TR1 and the emitter of TR2 can be seen to be $\beta_1 \times \beta_2$; the input impedance of the circuit is therefore $\beta_1 \times \beta_2 \times R_L$, which in this case gives $2{,}500 \times R_L$.

The output impedance of this circuit is given approximately as the source impedance of the input signal divided by ($\beta_1 \times \beta_2$).

Returning to the case in which an input impedance of 2 megohms is required, using transistors having a β of 50, it can be seen that if a Darlington pair is used, the required value of R_L is given from the simple formula

$$R_L = \frac{Z_{in}}{\beta_1\beta_2} = \frac{2{,}000{,}000}{2{,}500} = 800 \text{ ohms}$$

In practice, it is unlikely that this value of R_L will suffice to give the value of input impedance required. The reason for this is explained by referring to Fig. 6.8.

Fig. 6.8a shows a conventional Darlington pair circuit redrawn to show the true effective circuit. R_B represents the base bias resistors of the circuit and, remembering that the negative supply line is effectively shorted to chassis as far as a.c. is concerned, can represent either the single resistor (R1) shown in Fig. 6.7, or the two resistors of a voltage divider network in parallel, depending on the type of base bias circuit that is used. R_B is in parallel with the input impedance (Z_{in}) of the main circuit.

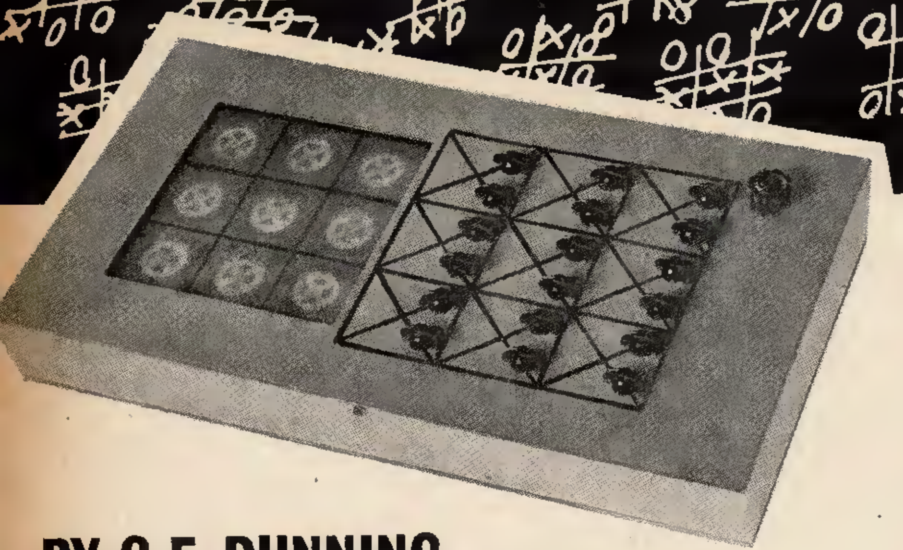
In a transistor, leakage currents flow between base and emitter, base and collector, and emitter and collector. For our present theoretical purpose, these leakage paths can be represented as a single resistance between the base and emitter, external to the actual transistor. In a germanium transistor this leakage resistance has a value of about 2 megohms, while a silicon transistor has one of about 10 megohms. Thus, in all normal transistor circuits, this leakage resistance is in parallel with the input; in the Darlington pair, however, the leakage resistances of the two transistors are effectively in series with each other, and the combination is in parallel with the input circuit. These two resistances are shown as r_1 and r_2 in the circuit diagram (Fig. 6.8a).

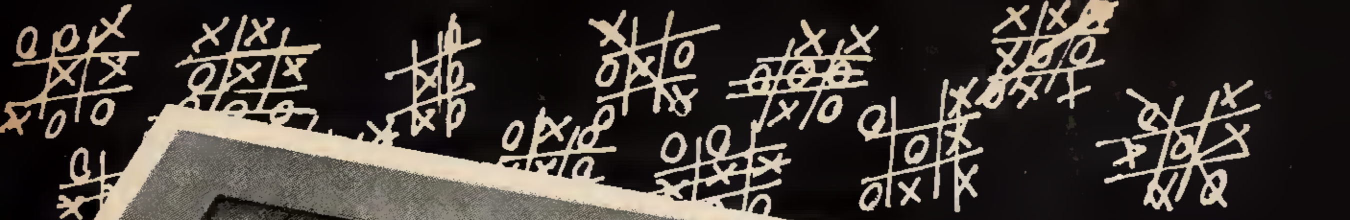
Fig. 6.8b shows the effective input circuit that results from the above. The maximum input impedance that can be obtained with this circuit is limited by the values of leakage and bias resistance.

In practice, the maximum value of input impedance that can be obtained using germanium transistors is in the order of 2 megohms, using the Darlington pair circuit.

If an additional transistor stage is wired in front of TR1 in Fig. 6.8a, the input impedance will be raised and can be determined by $Z_{in} = \beta_1 \times \beta_2 \times \beta_3 \times R_L$. The new circuit is shown in Fig. 6.8c. The same limitations are still imposed by the leakage and base bias resistances. It is not practical to use more than three transistors in the Darlington pair type of circuit.

Next month: Applications of the Darlington pair, the "bootstrap" amplifier, and ultra high impedance amplifiers.





NOUGHTS and CROSSES MACHINE

BY G.E. DUNNING

For a modest outlay the Noughts and Crosses Electropponent Machine provides an item of considerable attraction for a Fete, Club or small Exhibition, etc. It is also of some educational value in the sense of logical acuteness, and no doubt could be developed much further into a game of greater depth and sophistication.

Noughts and Crosses is a "perfect information" game because no simultaneous moves are made and every previous move is at all times during play known to both players. According to the theory of games[1] this form of game is always "strictly determined"—which means that if the best strategy is employed by both players then the game will inevitably result in a draw.

Incidentally, Draughts and Chess are also "perfect information" games. In practice, however, because of the enormously large scope of possible strategy which may be employed in these games, one or both players is very likely to make an error of judgement and then chance enters the game, often allowing one player to beat the other.

Unfortunately in the game of Noughts and Crosses the scope for strategy is very limited and moves are easily anticipated by opponents so that the game invariably ends in a draw. The Noughts and Crosses Machine may be arranged to illustrate this fact, causing the best strategy of all contestants always resulting in a draw.

Under these conditions the game becomes trivial, resulting as the machine proves, in no win to any player; so in order to remedy this state of affairs it has been decided to introduce an element of chance into the working of the machine. This element may be introduced at will and just how this is applied will be described later in the text.

STRATEGY OF THE GAME

The nine possible positions of Noughts and Crosses shown in Fig. 1 may be considered as being: Corner, Middle or Centre. Of these three the middle positions are strategically the weakest.

1	2	3
4	5	6
7	8	9

crn	mid	crn
mid	ctr	mid
crn	mid	crn

Fig. 1

The main strategy of Noughts and Crosses may be considered as being divided into two classes as follows:

(a) Primary Strategy

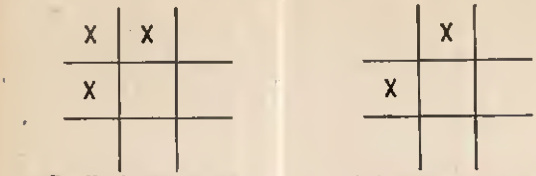
The player's objective here being simply to produce a pair of, say, Xs whenever and wherever possible. For example:

X	X	

Fig. 2

b) Secondary Strategy

Here the player's objective is to position his preliminary moves so that a subsequent move will yield two alternative pairs. For example:

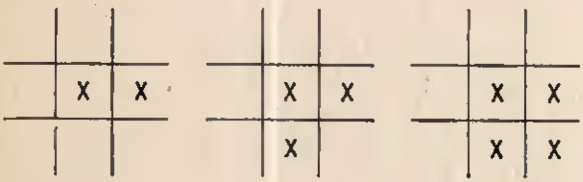


Preliminary moves Subsequent moves

Fig. 3

(c) Combined Primary and Secondary Strategy

This is a more subtle strategy in which two apparent moves of primary strategy result in a second strategy position yielding three alternative pairs.



First Second Third

Fig. 4

In designing the Noughts and Crosses Machine the significance of these points was taken into consideration. First of all it was decided that if either the middle or corner positions were taken in the opening move, then the machine would reply by taking the centre position. Alternatively, if the centre position was taken in the opening move then the machine would take a corner position (actually the No. 3 position).

Obviously the machine must defeat primary strategy by causing any adjacent pair of Xs to be automatically blocked by a 0. But clearly this leads to cheating through moving twice in a turn, on the part of the machine, when it is dealing with secondary strategy. Therefore in such cases it was decided that the switching should be so arranged that one of the two or three alternatives, when blocked by a nought, should always result in a winning line for the machine. In practice it is found that the contestant foresees this outcome and detracts from his strategy in an effort to prevent the machine from winning.

AN EXTRA VARIABLE

In order to economise in switch contacts and also to introduce a certain amount of randomness into the game, if so desired, an extra switch is included.

This switch (S19) will provide a nought in any of the nine positions, unless that position is already occupied by a cross, and it is turned by the contestant to cause the machine to make its move whenever the machine fails to respond automatically. Such a condition arises when the opposition is of a non-strategic nature; moreover the order of the numerical positions around this switch are arranged so as to cause a possible win for the machine by means of secondary strategy.

As a further economy in switch contacts, S19 is utilised by the machine in defence against secondary strategy involving the No. 1 position.

S19 has three symmetrically arranged blank positions. If it is originally positioned so that on rotation in a clockwise direction the No. 1 position will be the first taken, then it is impossible to beat the machine (provided the extra switch knob is rotated in a clockwise direction).

If S19 is positioned originally on either of the remaining blank positions or is rotated anticlockwise, then it is possible to beat the machine (by secondary strategy). No coding is provided on the top panel and the contestant cannot tell upon which blank S19 is originally positioned. This switch may also be used to cause the machine to start the game.

CONSTRUCTION

The actual noughts and crosses are displayed upon a ground-glass screen. The ground-glass side is placed uppermost and the plain side is blacked out with black self-adhesive plastic, such as *Fablon*. Nine cutouts are made in the plastic, each consisting of an X surrounded by an exposed 0 as shown in Fig.5.

Fig. 5. ***Rear view of ground-glass screen with plastics material in position.***

COMPONENTS . . .

S1–18	Single wafer 4-pole 2-way switch (18 off)
S19	Two wafers, each 1 pole 12-way. Make-switch assembly (Radiospares)
LP1–18	Pilot lamps bulbs (MES) 6V 0·06A (18 off)
T1	Heater transformer 6·3V 1·5A secondary

Eighteen pointer knobs. Nine batten lampholders. Nine clip-on lamp holders. Material for case (see text).

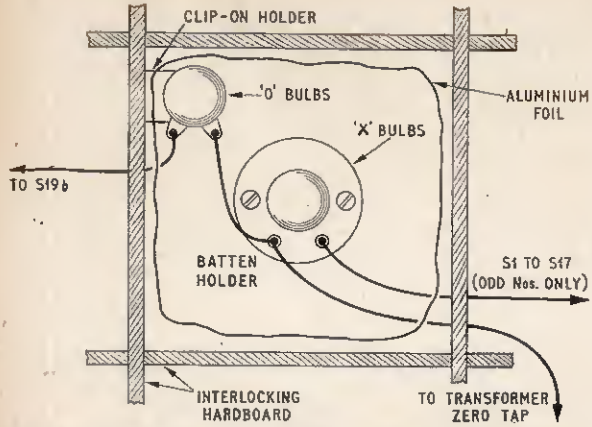


Fig. 6. Detailed view of lamps installed in hardboard "square"

The positions of the 0s is first marked out on the paper backing of the *Fablon.* These are cut out and then the plastic is stuck onto the glass. Small squares of plastic are then stuck inside these 0s and these are trimmed by a razor blade around a suitable round object such as a halfpenny. The cross is then marked using a rule and razor blade and the centre strips lifted out.

The nine squares are fabricated from four interlocking strips of hardboard, the outer squares being open on one side. These noughts and crosses are lit by separate pilot lamps, the light from the nought bulb being separated from that of the cross bulb by a thin cardboard tube which is stuck to the plain side of the glass in a position which forms the inner circle of the nought. Light from the nought bulb is reflected around this cardboard tube by means of a surrounding lining of aluminium foil.

The "squares" are fitted inside the case as shown in Fig. 7. A detailed drawing showing the lamps and their wiring connections is given in Fig. 6.

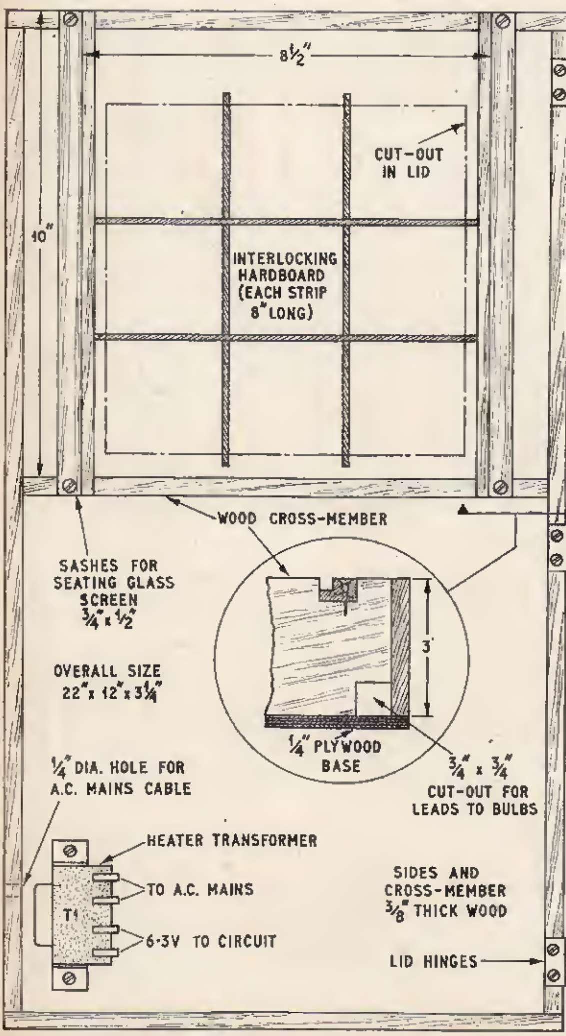


Fig. 7. Construction of the case

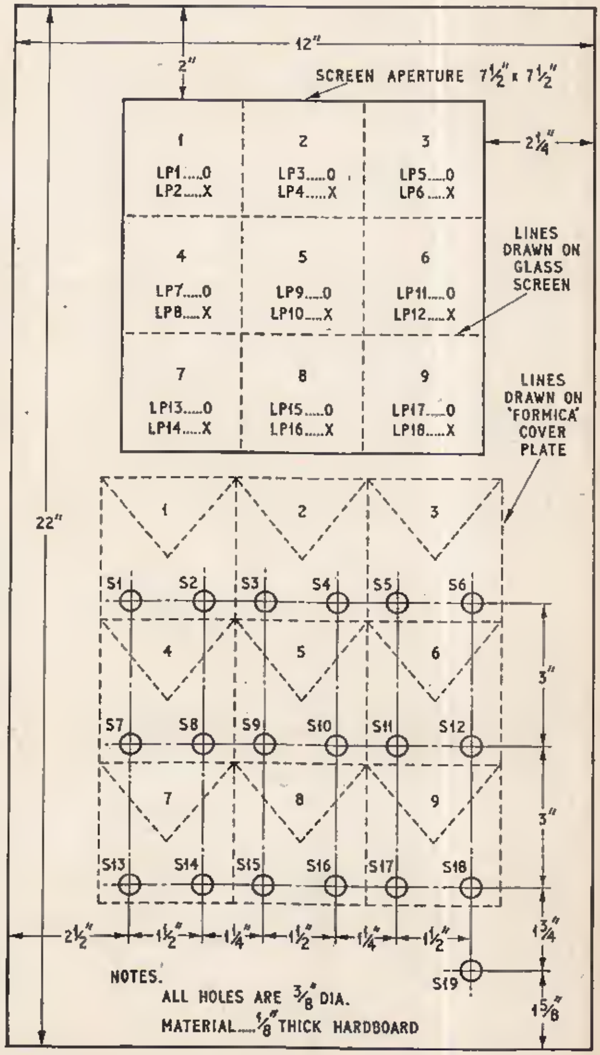


Fig. 8. The lid and control panel

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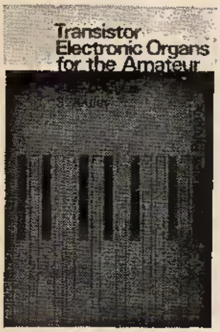

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Dispelling an old theory

Pick-Ups (The Key to Hi-Fi)

By J. Walton

For many years it has been the assumption that the loudspeaker is the weakest link in the record reproducing chain. This book challenges that theory. The author, after many years of research into the subject, concludes that it is the pick-up that causes most distortion. It is no exaggeration to say that, by following its advice, the owner of an ordinary gramophone or record player or the hi-fi enthusiast will not only achieve a superior standard of record reproduction, but will ensure that his records will last many times as long.

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The case dimensions are 22in × 12in × 3in. The sides are built up from 3in × ⅜in timber and the base is a piece of ¼in plywood. See Fig. 7.

Within the case is a cross member of 3in × ⅜in; this is pinned to the sides and supports the two sashes which hold the glass screen in place. The bottom corners of the cross member are cut away to allow connecting wires to pass through.

The size of the piece of ground-glass is 8½in × 8½in, but the size of the seen screen is 7½in × 7½in.

THE CONTROL PANEL

Below this screen is positioned the control panel. This consists of eighteen 4-pole 2-way switches grouped in pairs within a noughts and crosses former. The remaining control, S19, which is a 1-pole 12-way rotary switch is located below the lower right hand corner.

It would, of course, be possible to employ just one switch in each of the nine positions. However, this would necessitate the case of double wafer switches, which are not always easy to obtain and, furthermore, would undoubtedly prove far more costly than the present arrangement.

The switches are located in position on a sheet of hardboard of slightly larger overall dimensions than that of the case. This board is hinged to the case and its top surface covered by a sheet of *Formica* laminated plastic. This plastic surface can be marked in the manner shown in Fig. 8 by means of a felt tipped marking pen which can also be used to mark the noughts and crosses former on the top surface of the ground-glass screen.

The switches are positioned within a rectangle 9in × 8½in; it was found necessary to lengthen the side so as to narrow the shape of the X formed by the switches when turned inwards, as the switches used only turned through an angle of 30 degrees.

WIRING UP THE SWITCHES

The switch wiring is fairly complex, and is best performed in two distinct stages as indicated in Fig. 9. and Fig. 10.

First complete all the wiring shown in Fig. 9. This comprises most of the interconnections between the switches S1 to S18. It will be noticed that one pair of switches is associated with each of the nine squares.

These switches should be mounted so that the knob is pointing upwards when the rotors are against contact number 1. The odd numbered switches (i.e. left handed as viewed from front of machine) will then rotate clockwise to the second position, while the right hand switches will rotate anticlockwise.

Next, proceed to add the additional wiring shown in Fig. 10. This second stage brings in the extra switch S19.

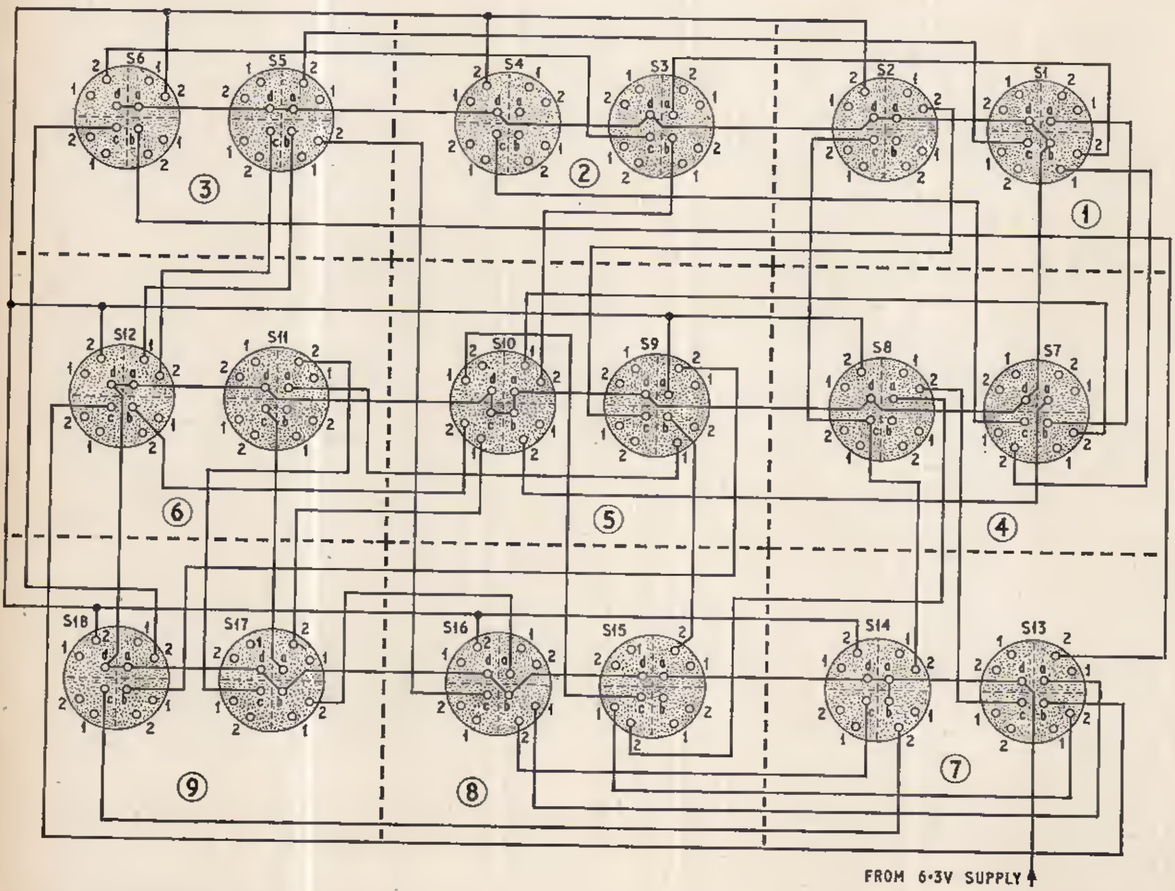

Fig. 9. First stage wiring

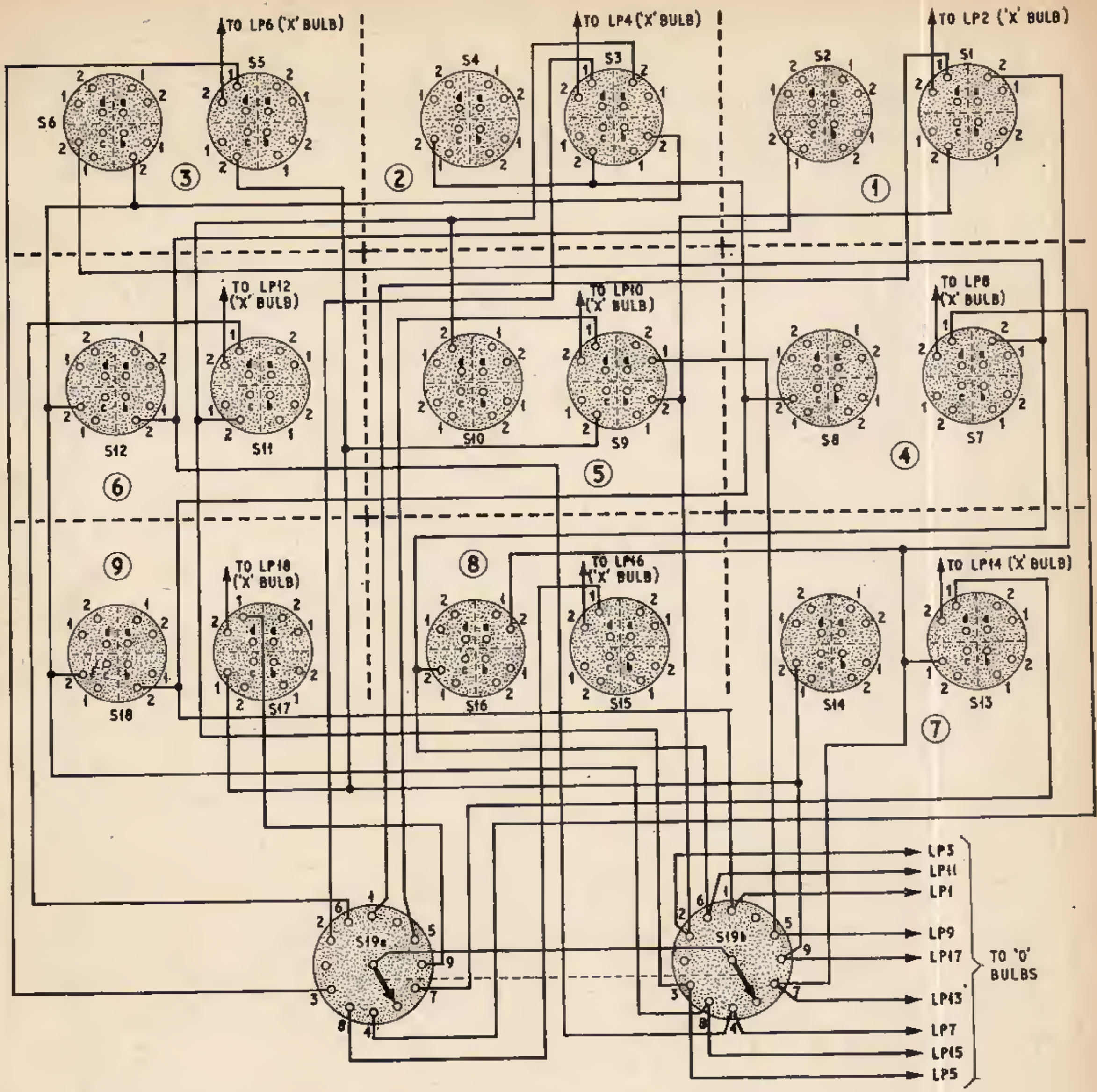

Fig. 10. Second stage wiring

POWER SUPPLY

The power supply is provided by a 6·3V heater transformer. It is, however, quite practical to use a bell battery in place of the transformer if similar low rating bulbs are used.

PLAYING THE GAME

The contestant is intended to turn each of the pairs of pointer knobs inwards in the square desired, as seen on the screen. The position of the pointer knobs then forms the bottom half of an X, which is lit upon the screen in the corresponding position.

Turning the left hand pointer knob inwards in the desired square will light the players X and turning the right hand pointer knob of the pair inwards will usually provide the machines answering 0. If, however, on turning the left hand knob inwards the machine answers immediately then there is no need to turn the right hand pointer knob inwards also.

If on turning both pointer knobs inwards the machine fails to answer, then the extra knob (S19) must be rotated until the machine does answer. The machine will always play a rational game, provided these instructions are complied with and the switches are wired as shown in Figs. 9 and 10.

REFERENCE

1. **Vatsda, S.** An introduction to linear programming and theory of games.

★

NEWS BRIEFS

Early Bird Now Commercial

THE WORLD'S first satellite for public telephone service is now fulfilling its intended task of supplementing existing cable circuits between the U.K. and North America.

Individuals making Transatlantic telephone calls will be unaware of the type of circuit over which they are speaking, since it is Post Office policy not to divulge this. Speech transmission by satellite does not seem to be at all distinguishable from similar transmissions made by cable.

This latter point was confirmed by the Editor of PRACTICAL ELECTRONICS, who through the courtesy of the G.P.O., spoke to the Editor of *Radio-TV Experimenter* in New York via "Early Bird" shortly after the International Inaugural Ceremony on 28 June. No delay in speech transmission was detectable at either end of the circuit during this two minute conversation.

Guest of Honour

ADMIRAL of the Fleet the Earl Mountbatten of Burma, K.G., was the Guest of Honour at a Dinner held in June to mark the 40th Anniversary of the founding of the Institution of Electronic and Radio Engineers.

Lord Mountbatten has played a significant part in the promotion of electronics research. Only a year ago, his desirability to co-ordinate electronics research programmes culminated in the founding of the National Electronics Research Council, of which he is Chairman.

New International Telephone Exchange

A NEW EXCHANGE, standing in the shadows of St. Paul's Cathedral, London, and aptly named Wren House, was opened by the Postmaster-General, the Rt. Hon. Anthony Wedgewood Benn, M.P., on 29 June. The opening of this exchange is but one step in the tremendous task of coping with the ever increasing demand for overseas telephone services. Mechanised processes, expanding operator and subscriber dialling and the provision of more submarine cables—and of course "Early Bird"—will help in dealing with this traffic.

There are 198 manual switchboards in this new building. Outgoing services to North America will operate from Wren House together with most of the radio telephone services from London including those to India, Pakistan and South America, and many of the services to Africa and the Middle East. The service to ships at sea will also operate from this new exchange.

Automatic Shopping

PUNCHED-CARD shopping has arrived at Wallasey, Cheshire. Britain's first automated supermarket provides a wide range of goods, from which the shopper selects her choice by picking up the appropriate punched card. She then presents the cards to the checkout desk where a tabulator prints the bill. The bill is passed to the stock room where the order is packed.

The system, which was installed by De La Rue Bull Machines Ltd., is similar to one used in Caen, France.

Computer Research at Stevenage

THE Minister of Technology, Mr Frank Cousins, M.P., recently opened the new Research and Development Laboratories of International Computers and Tabulators, at Stevenage, Hertfordshire.

Mr Cousins is seen here looking at a new punched card reader which will be used with small computer installations of the 1900 series.

Readout—

A SELECTION FROM OUR POSTBAG

Transistor quality

Sir—Are transistor amplifiers, as described in the first issue of PRACTICAL ELECTRONICS as clear n tone as valve amplifiers?

The reason I ask is that if you compare a transistor radio with a valve one, the latter always sounds clearer and is not "tinny" as is the case with transistors.

T. Crisp,
London, E.17.

Modern transistors are capable of providing high quality reproduction—equal to the performance obtained from valves.

The reason why transistor radios often sound tinny is the fact that they are built on a very small scale and use miniature loudspeakers. You will notice that amongst the high-class commercial equipment, transistors are coming more and more into favour.

Semiconductor coding

Sir—I cannot agree with your view in your July editorial that British semiconductor firms had "a perfect model to follow in the American Numbering System."

The American system tells only one thing, whether a device is a transistor or a diode and the resulting mess in America is one to be pitied. They have a system in which devices are referred to purely by numbers, which by themselves are meaningless.

In this country however, the big firms like S.T.C., S.G.S.-Fairchild, and Mullard are now adopting the standard European code for their non-military devices, such as the ASY67 or BSX28.

Thus I feel sure that in a few years' time, the Americans, of whom you spoke so highly, will be looking to Europe for the "perfect model of the numbering system."

D. J. Taylor,
Dudley,
Worcs.

The American numbering system was not put forward as being an ideal model in all respects—but as an illustration of the fact that a large number of manufacturers in one country could get together and agree to use a unified system.

That this is possible is further demonstrated by the British Services and governmental departments who use a CV system; there are also several other "standard systems" in use in various parts of the world.

Our criticism was aimed at the many house numbering systems created by individual manufacturers of transistors.

Listen here!

Sir—I note with despair, the perpetration in your columns of a hopelessly incorrect nomenclature (and this in an issue in which the editorial is concerned with nomenclature—admittedly of a somewhat different type). I refer of course to the use of the term "monaural" in the Portable Stereo Record Player article.

The tag *monaural* may be applied only where a single ear is concerned, as, for instance, when using a normal telephone handset. I quote the following interesting sentence from the article: "When using the two amplifiers for monaural (one-ear) listening an interesting *pseudo-stereo* effect is obtained by switching one earpiece out of phase". Which is a bit pointless since it's only necessary to use *one* amplifier and *one* earpiece for *monaural* listening. Let's get it right, 99 times out of 100, the word to use is MONOPHONIC.

R. McCarson,
London, N.W.10.

The rigorous definitions accepted by the professional engineers who look into the matter closely are those given by the famous American musical engineer, Mr. H. F. Olsen, in an article "Sound Reproducing Systems" in the American journal Audio, *September, 1959. p. 28. In effect his definitions restrict* aural *to headphone systems and* phonic *to loudspeaker systems.*

Whatever the "correct" usage of aural and phonic, the fact of the matter is that many engineers (as I) tend nowadays to use the terms as completely interchangeable.—D. J. R. Bowers.

Novice licences

Sir—I am in complete accordance with the views set out by your correspondent, Mr. Kirk, G3JDK (July issue), except that I feel the issue of an Amateur licence should be taken a step further.

I would like to see the nouveau licensee serve a probationary period for the first six months. He would have a distinguishing prefix to his call-sign, and would only be allowed to operate in selected segments of certain bands. At the end of this period, the G.P.O. monitoring stations (or an R.S.G.B. Committee set up for this purpose) could weed out the poor transmissions and bad operators, convene a meeting, and gently read them the "riot act". They would then continue for another six months and if they failed to reach a normal standard at the end of the year, the renewal of their licence could be declined.

Rex J. Toby, G2CDN, EI5B,
SUICX, etc.,
Isleworth,
Middlesex.

Pulse counter

Sir—With reference to your April issue, I would like to build the pulse counter which you describe. The counter would be used on my motor cycle and another on my friend's car; however, both use magneto ignition.

We imagine that the output would simply connect to the contact breaker, the negative line to the battery and the positive to earth, as we both use 6 volt and earth systems.

Also, could I use an illuminated "S" type meter if one was available in the correct impedance?

G. Ball,
Harrow,
Middlesex.

The transistor limiter should be run from the motor cycle battery and the pulses occurring across the contact breaker should be fed into the limiter, as you suggest. There is no reason why an illuminated "S-meter" could not be used as the indicator, provided it has a suitable sensitivity. This type of meter, of course, is really nothing more than a milliameter, anyway.—G.J.K.

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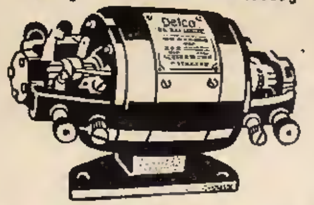

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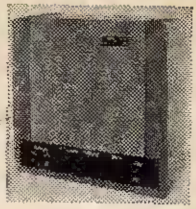

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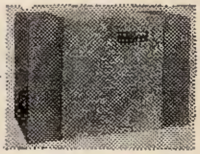

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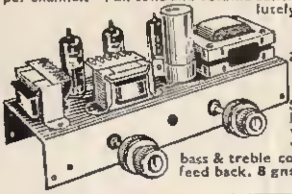

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HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
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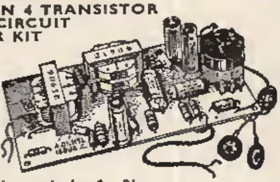

● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE** 45/-. P. & P. 3/-. Also ready built and tested, 52/6. P. & P. 3/-. A pair of TAIs are ideal for stereo.

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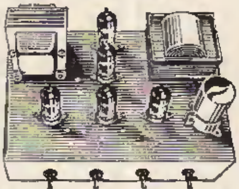

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★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate Bass, Treble and Volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player ★ Provision for remote mounting of controls or direct on chassis. ★ Chassis size only 7½in. wide x 4in. deep. Overall height 4¾in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) PRICE 79/6. P. & P. 6/-.
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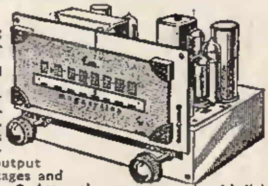

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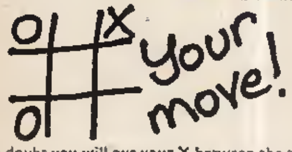

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