Practical Electronics

MARCH 1966

PRICE 2'6

SPECIAL ISSUE

* HOW TO MAKE PRINTED CIRCUITS
* BONANZA BOARD PROJECTS

FOR — IMMEDIATE — DESPATCH — PHONE — US — TODAY

DE LUXE RECORD PLAYER KITS

4-Speed Players 2-tone Cabinets 17×15×8½in. High flux loudspeaker and 3 watt Famous Make amplifier ready built. Quality output. Volume and Bass controls. All items fit together perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' guarantee.

TO BUILD YOURSELF

Absolutely complete as above with

B.S.R. GU7 Single Play	£9/19/6	P.P. 7/6
B.S.R. Monarch Autochange	£10/19/6	P.P. 7/6
Garrard "1000" Autochange	£11/19/6	P.P. 7/6
Garrard Model 50 £12.10.0; AT60 £14.15.0.		P.P. 7/6

OR AVAILABLE SEPARATELY

Cabinet with board cut to choice	£3/9/6	P.P. 5/6
Amplifier with speaker	£3/12/6	P.P. 3/6
AUTOCHANGERS (Stereo 10/- extra)		
B.S.R. UA25 or UA14 Mono	£5/19/6	P.P. 3/6
Garrard "1000" Mono	£6/10/-	P.P. 3/6
Garrard AT50 Mono £8.10.0; AT60 Mono	£10.10.0	P.P. 5/6
SINGLE PLAYERS B.S.R. Junior	£3/7/6	P.P. 2/6
B.S.R. GU7 Auto Stop Start	£4/17/6	P.P. 2/6
GARRARD SRP12 Auto Stop Start	£4/17/6	P.P. 2/6
TRANSCRIPTION Garrard SP25	£11/0/0	P.P. 5/6
Garrard A70 £21; LAB80 £25; 401 £30		P.P. 5/6 each

Q MAX CHASSIS CUTTER

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

½in.	14/6	1$\frac{1}{16}$in.	18/-	1¾in.	22/6
⅝in.	14/9	1⅛in.	18/-	2in.	34/3
¾in.	15/6	1¼in.	18/6	2$\frac{3}{32}$in.	37/9
⅞in.	15/9	1⅜in.	20/-	2½in.	44/3
1in.	18/-	1½in.	20/6	1in. sq.	31/6

CRYSTAL MIKE INSERTS

1½ × ⅜in. 6/6; BM3 1 × ⅜in. 7/6; ACOS 1½ × ⅜in. 8/6
TANNOY CARBON MIKE with Switch 5/6
BARGAIN XTAL PICK-UP ARM Complete with ACOS LP-78 Turnover Head and Stylii 20/-; Stereo 30/-.
SPEAKER FRET Tygan various colours, 52in. wide, from 10/- ft.; 26in. wide from 5/- ft. Samples S.A.E.
EXPANDED METAL Gold or Silver 12 × 12 in. 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., 25/-. Circuit included. Amp meter 5 amp, 10/6.

MOVING COIL MULTIMETER TK 20a. 0-1,000v. A.C./D.C., ohms 0 to 100k. etc., 47/6.
MOVING COIL MULTIMETER EP10K. 0-1,000v. A.C./D.C., ohms 0 to 3 meg. etc., 79/6.
MOVING COIL MULTIMETER EP20K. 0-2,500v. D.C. 20,000 ohms per volt. 0-1,000v. A.C. Ohms 0-6 meg. 50 Microamps. 99/6.

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.

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 OCTAL, EF50, B7G, B9A, 1/- Valve base plugs B7G. B9A, Int. Oct., 2/3.

TRANSISTOR MAINS ELIMINATORS 29/6

PP1-6 volt, PP9-9 volt (All same sizes as batteries) 80 mA. DOUBLES 42/6. PP1+PP1, PP9+PP9, PP11—4½+4½. POWER PACK 9v. 300 mA. Full wave. Fully smoothed. Tapped mains input. Chassis size 5 × 4 × 2 in. 45/-.

WEYRAD P50 — Transistor Coils

RA2W 6 in. Ferrite Aerial with car aerial coil	12/6	Spare Cores	6d.
Osc. P50/1AC	5/4	Driver Trans. LFDT4	9/6
1st and 2nd I.F.P50/2CC 470 kc/s	each 5/7	Printed Circuit, PCA1. Ready drilled and printed	9/6
3rd I.F. P50/3CC	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. 5/-. 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 5dB. 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 4/6. BALANCED TWIN FEEDERS 6d. yd., 80 or 300 ohms. TWIN SCREENED FEEDER 1/6 yd., 80 ohms. TELESCOPIC CHROME AERIALS. 12in. extends to 33in. 6/6 each. CAR AERIAL PLUGS 1/6. Sockets 1/3.

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
2/350 v.	2/3	100/25 v.	2/-	8/600 v.	9/-
4/350 v.	2/3	250/25 v.	2/6	16/600 v.	12/-
8/450 v.	2/3	500/15 v.	3/-	16+16/500 v.	7/6
16/450 v.	3/-	8+8/450 v.	3/6	32+32/450 v.	6/-
32/450 v.	3/9	8+16/450 v.	3/9	50+50/350 v.	7/-
25/25 v.	1/9	16+16/450 v.	4/3	64+120/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275 v.	12/6

PAPER TUBULARS
350v.-0.1 9d., 0.5 1/9; 1 mfd. 3/-; 2 mfd. 150v. 3/-. 500v.-0.001 to 0.05 9d; 0.1 1/-; 0.25 1/6; 0.5 2/6. 1,000v.-0.001, 0.0022, 0.0047, 0.01, 0.02, 1/6; 0.047, 0.1 2/-; 0.22, 0.47, 3/-; 2,000v.-0.005, 0.01, 0.02 2/6; 0.05 3/6.
PAPER CONDENSERS. 0.001mfd., 7kV., 6/6; 20kV., 10/6.

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 500, 1,000 mfd. 15v. 2/6; 1,000 mfd. 50v. 7/6; 2,000/50 11/6.
CERAMIC. 500 v. 1 pF. to 0.01 mfd., 9d. DISC CERAMICS 1/-. PULSE CERAMICS 10 pF. to 180 pF., 12 kV., 2/6.
SILVER MICA. Close tolerance (plus or minus ½ pF.), 5 to 47 pF., 1/-; ditto 1% 50 to 800 pF. 1/-; 1,000 to 5,000 pF., 2/-.
TWIN GANG. "0-0" 208 pF.+176 pF., 10/6; 365 pF., miniature 10/-; 500 pF. standard with trimmers, 9/-; midget, 7/6; midget with trimmers, 9/-; 500 pF. slow motion, standard 9/-; small 3-gang 500 pF. 19/9. Single "0" 365 pF. 7/6.
SHORT WAVE. Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged. Couplers 9d. each.
TUNING. Solid dielectric. 100 pF., 300 pF., 500 pF., 3/6 each.
TRIMMERS. Compression ceramic 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF., 750 pF., 1/9.

BEST BRITISH PVC RECORDING TAPES

L.P. 7in. 1800ft.	19/6	D.P. 7in. 2400ft.	29/6
L.P. 5¾in. 1200ft.	14/6	D.P. 5¾in. 1800ft.	24/6
L.P. 5in. 900ft.	11/6	D.P. 5in. 1200ft.	18/6

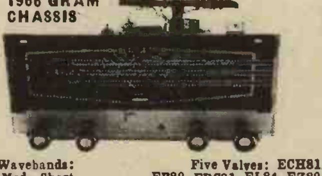
Spare Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Tape Heads: Collaro 2 track 28/6 pair. 4 track 70/- pair.

MAINS TRANSFORMERS Post 2/- each

250-0-250, 80 mA. 6.3 v. 3.5 a. or 4 v. 4 a. Rectifier 6.3 v. 1 a. or 5 v. or 4 v. 2 a. 25/-; Ditto 350-0-350,	29/6
300-0-300 v. 120 mA., 6.3 v. CT 4 a. 0, 5, 6.3 v. 2 a.	33/6
MINIATURE 200 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 300-0-300 v. 70 mA., 6.3 v. 4 a.	19/6
HEATER TRANS. 6.3 v. 1½ a., 7/6; 6.3 v. 4 a.	10/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	8/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	25/-
Ditto, 1 amp., 5, 10, 15, 20, 25, 30, 40, 45, 50, 55, 60	29/6
Sub-Min. Mains to 9 v. 80 mA. 1 × 1½ × 1¼in.	7/6
AUTO TRANS. 150 w., 0, 115 v., 230 v., 25/-; 500 w.	82/6

HIGH GAIN TV. PRE-AMPLIFIER BAND I B.B.C. Tunable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 32/6 or 55/- with power pack. Details 6d. (PCC84 valves if preferred for 0.3a heater chains).
BAND III I.T.A.—same prices. Tunable channels 7 to 13. Gain 17 dB.
Band I or III. Coils and circuit only, 9/6. Chassis 4/9.

1966 GRAM 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 £9.19.6 Post 5/6

Matched speakers 10×6in. 22/6. 13×8in. 45/-.

STEREO RADIOGRAM CHASSIS £14.19.6 Post 5/6 With Long, Med. and Short Wavebands, 15in. x 7in. x 9in.

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.

NEW GARRARD GRAM MOTORS

also suitable for models, tapedecks, etc.
100-130 v. A.C. 15/- pair for 200/250 v. (in series)

THE INSTANT BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER

Leaflet S.A.E.
200/250 v. A.C.

35/-

BAKER LOUDSPEAKERS

NEW HI-FIDELITY MODELS

New Enclosure Plans 3d.

12in., 15w. STALWART 3 or 15 ohms, 45-13,000 c.p.s., 12,000 lines **£5.5**

12in. DE LUXE Foam Suspension, 14,000 lines, 15 w. 25-16,000 c.p.s. **£9**

12in. AUDITORIUM 25 w. 25-15,000 c.p.s. **£12.10**

12in. SUPERB 20 w. 20-17,000 c.p.s. **£15**

GROUP MODELS FOR VOCALS, BASS, LEAD and RHYTHM GUITARS

"Group 25"	12in. dia., 25 watt, 20-10,000 c.p.s.	5gns.
"Group 35"	12in. dia., 35 watt, 20-10,000 c.p.s.	8½gns.
"Group 50"	15in. dia., 50 watt, 20-10,000 c.p.s.	18gns.

LOUDSPEAKERS P.M. 3 OHMS. 2½in., 3in., 4in., 5in., 7in. × 4in., 15/6 each; 8in. 17/6; 6½in. 16/6; 12in. 30/-; (15 ohms 35/-); 10in. × 6in. 22/6; 8in. × 5in. 21/-; 9in. × 6in. 21/-. E.M.I. Double Cone 13½ × 8in., 3 or 15 ohm models, 45/-. Stentorian 10in. HF1012, 92/-; 8in. HF812 76/6. Crossover 30/-. Horn Tweeters 3-16 Kc/s. 10 w 29/6; 20 w 20 Kc/s. 99/6.

T.V. REMOTE CONTROLLER. For Philips 19TG111A, 121A, 125A. 142A, 23TG111A, 113A, 121A, 131A. Stella ST1033A, 39A, 43A. 53A. Cossor CT1910A, 21A, CT2310A. 21A, 31A. Ready to plug in, with 11ft 7 way cable, dual pot Volume and Brightness, OA81 diode, etc., etc. List 3gns. NEW, BOXED, OUR PRICE 12/6 POST FREE.

WAVE-CHANGE SWITCHES WITH LONG SPINDLES. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way or 1 p. 12-way; ea. 3/6. 4 p. 2-way, or 4 p. 3-way, 3/6; 8 p. 4-way, 2 wafer, ... 6/6. Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, spaces. etc., 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-; 4 wafer, 19/6; 5 wafer, 23/-; extra wafers, 2/6.
TOGGLE SWITCHES, s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-.

★ RADIO BOOKS ★ (Postage 9d.)

Radio, T.V. Valves, Diodes, Transistor equivs.	10/6
Mullard Maintenance Manual	16/-
High Fidelity Speaker Enclosures	5/-
Transistor Superhet Commercial Receivers	7/6
Mullard Audio Amplifier Manual	8/6
Radio Valve Guide, Books, 1, 2, 3, 4, or 5 ......each	5/-
Practical Radio Inside Out	4/6
TV Fault-Finding, fully illustrated	6/-
Transistor Audio Amplifier Manual	6/-
Shortwave Transistor Receivers	5/-
Transistor Communication Sets	6/-
International Radio Stations List	2/6
Modern Transistor Circuits, Beginners	7/6
Sub-Miniature Transistor Receivers	5/-
How to Receive Foreign T.V.	5/-

JACK SOCKETS Std. open-circuit 2/6, closed-circuit 4/6. Lead 6/-, Grundig 3-pin 1/3; Lead 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 Miniature 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 or Silver 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
PRINTED CIRCUIT (Copper laminate) board 14½" × 7½"	5/-

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**

RETURN OF POST DESPATCH Minimum P.P. Charge 1/6 per order unless otherwise stated. Full List 1/-, C.O.D. 2/6 extra. CALLERS WELCOME

RADIO COMPONENT SPECIALISTS

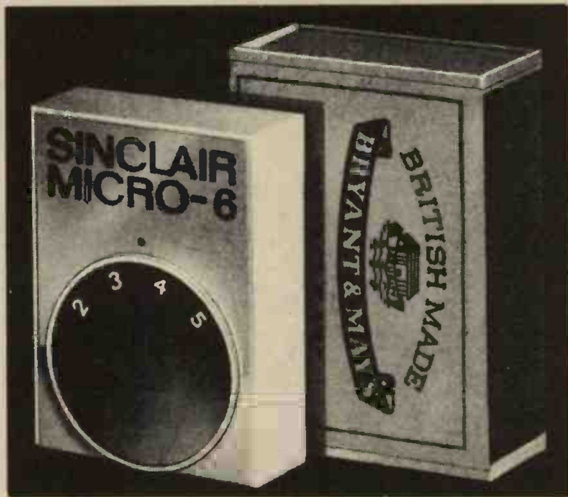
337 WHITEHORSE ROAD, WEST CROYDON Telephone THO 1665

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

YOU ARE ALWAYS AHEAD WITH A SINCLAIR DESIGN

The world's smallest radio

SINCLAIR MICRO-6



No transistor set has ever yet compared in its class with the Micro-6 for size, power performance and design. Everything except the lightweight earpiece is contained within the smart minute white, gold and black case which weighs under one ounce in working order. Quality of reproduction is outstandingly good so you are certain to derive enormous pleasure from this fantastic set. Order your Micro-6 now. See why it cannot be too highly recommended to build and to use. You can easily have it working in an evening!

SIZE: $1\frac{4}{5}'' \times 1\frac{3}{10}'' \times \frac{1}{2}''$
WEIGHT: Under 1 oz.

FANTASTIC RANGE AND POWER

. . and an amazing letter

I have had one of your Micro-6 receivers here in Sydney for about a year and I must say that its performance is very good. The sensitivity is high and the selectivity is quite adequate (it has to separate no less than 8 local stations) and all of them legal too. It is quite a miniature masterpiece!

Congratulations on the release of your F.M. set. You certainly are the leaders in miniature elecctronics. I shall look forward to the release of the Sinclair shirt-pocket colour T.V. receiver with micro-alloy CRT. Thanking you in anticipation and with best wishes for the future.

(signed) P. K. Vaucluse, N.S.Wales

AMAZING CIRCUITRY

The six-stage circuit uses three special transistors to provide two stages of R.F. amplification with double diode detector and high gain 3-stage A.F. amplifier. A.G.C. counteracts fading from distant stations: bandspread brings in Luxembourg like a local station. Plugging in earpiece switches set ON. Tunes over medium waveband by vernier-type dial. Two self-contained batteries give about 70 hours working life.

Complete kit of parts inc. special earpiece and instructions **59/6**

MALLORY MERCURY CELL TYPE ZM.312

(2 required) each	1/11
Pack of six	10/6

NEW SINCLAIR DESIGNS

see next page

THE WORLD'S MOST ADVANCED AMPLIFIER

SIZE: $8\frac{1}{4}'' \times 3\frac{1}{4}'' \times 1''$

OUTPUT:

20 WATTS RMS

SINCLAIR X-20

- 20 WATTS R.M.S. OUTPUT INTO 7.5 ohms
- 20—20,000 c/s ±1dB
- Constant square wave amplitude
- 95% conversion efficiency at output
- Input sensitivity—1mV into 5K ohms
- Power requirements—36V.d.c. at 700 mA

The only amplifier in the world to use Pulse Width Modulation, which, with circuitry developed specially by Sinclair gives power and quality years ahead of anything in its class. You can feed any signal source into the X-20—including modern high quality pick-up, radio tuner, guitar. The X-20 manual shows circuits by which pick-ups, etc. can be matched to the integrated pre-amplifier of the X-20 both in mono and stereo. When you have built this 12-transistor amplifier you use it in the same way as any other top quality hi-fi unit except that it is smaller, costs less and behaves perfectly.

Complete kit of parts including transistors and X-20 manual in sealed carton **£7.19.6**

Built and tested with X-20 manual in sealed carton **£9.19.6**

X-20 Power Pack sufficient to drive two X-20's **£4.19.6**

THE X-20 MANUAL details tone and volume control systems for X-20. Mono and Stereo. **FREE WITH EVERY X-20.** Available separately—2/- post free.

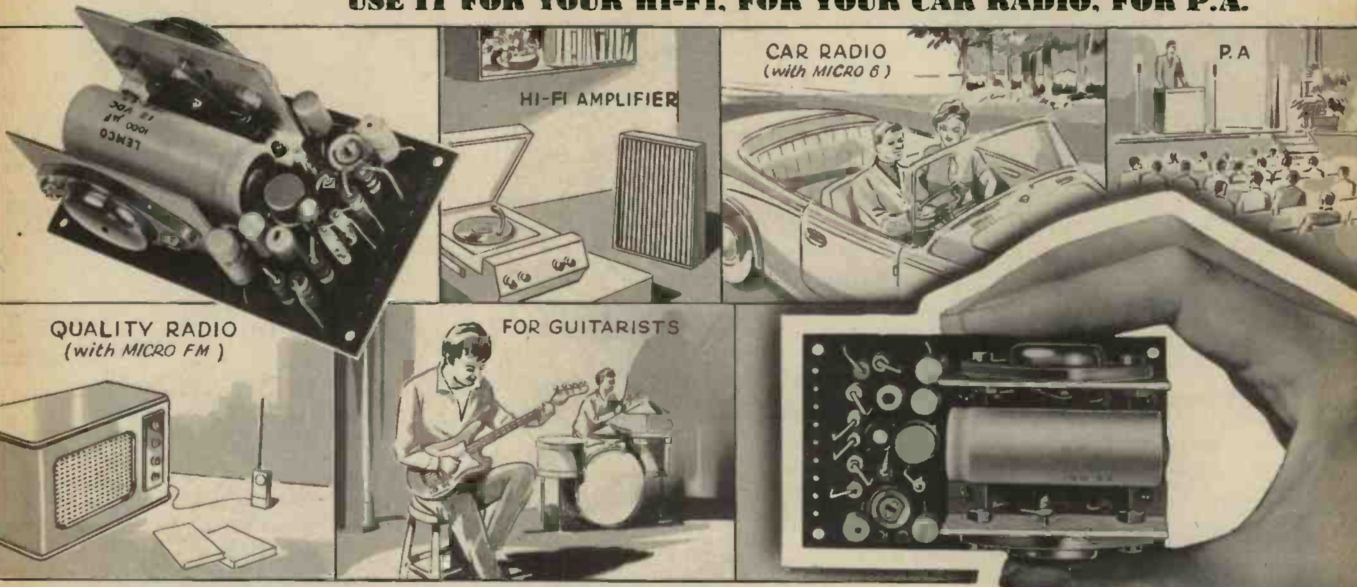
FULL SERVICE FACILITIES AVAILABLE TO ALL SINCLAIR CUSTOMERS

sinclair

SINCLAIR RADIONICS LTD.
COMBERTON, CAMBRIDGE Telephone: COMBERTON 682

A BRILLIANT NEW AMPLIFIER

USE IT FOR YOUR HI-FI, FOR YOUR CAR RADIO, FOR P.A.



WITH YOUR SINCLAIR F.M., FOR MUSIC, ETC.

SINCLAIR Z.12 COMBINED 12 WATT HI-FI AMPLIFIER AND PRE-AMP

THE ULTIMATE IN SIZE, POWER, QUALITY AND PRICE

3″ × 1¾″ × 1⅓″

•

WEIGHS 3 oz.

•

12 WATTS R.M.S. (24 WATTS PEAK)

•

USE IT WITH THE MICRO-6 OR MICRO F.M.

•

IDEAL FOR USE WITH A 12V BATTERY

In the Z.12 manual included with every Sinclair Z.12 integrated 12 watt hi-fi amplifier and pre-amp will be found a number of tone and volume control systems from which you will be able to select one best suited for your requirements. Mono and stereo are shown, and none of these circuits costs more than a few shillings to add.

Here is the hi-fi amplifier you have always dreamed of—very small, very powerful and of the highest possible quality. Sinclair's latest design, the Sinclair Z.12 meets all these requirements AND MORE to give you the most versatile, dependable amplifier system ever. In conformity with original Sinclair design, the Z.12 incorporates its own special pre-amplifier to which you add whichever of the tone and volume control circuits shown in the Z.12 manual suits you best. The Z.12 achieves even greater versatility, since it operates efficiently from any power supply between 6 and 20 volts, D.C. This makes it as attractive for use in car radios, guitars, P.A. systems, etc. as for the very best hi-fi it is designed for. In fact, the Z.12 is the ideal amplifier wherever the need is for great power and quality from the smallest possible unit. The Sinclair Z.12 comes to you ready built, tested and guaranteed. The Z.12 manual included makes simple work of installing and using the unit.

Technical Details: *8 transistor hi-fi amplifier with pre-amp and ultra-linear class B output. Special H.F transistors are used in original circuitry to achieve laboratory standards of performance. Superb quality is assured by generous negative feed back.* **FREQUENCY RESPONSE—15-50,000 c/s ±1dB! OUTPUT—12 watts RMS continuous sine wave (24 watts peak), 15 watts RMS music power (30 watts peak). OUTPUT IMPEDANCE—suitable for 3, 7.5 and 15 ohm speakers. Two 3-ohm speakers can be used in parallel if required. INPUT—2mV into 2K ohms. POWER SUPPLY—6 to 20V d.c. from power unit available or batteries. SIGNAL TO NOISE RATIO—better than 60dB. QUIESCENT CURRENT CONSUMPTION—only 15mA. IDEAL FOR BATTERY OPERATION.**

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SINCLAIR RADIONICS LTD.
COMBERTON, CAMBRIDGE
Telephone: COMBERTON 682

Z.12 Amplifier and pre-amp ready built, tested and guaranteed **89/6**

Sinclair Power Pack for above **£2.14.0**

Recommended for everyone!

"I am extremely pleased with the performance of the Z.12," writes M.H., Bolton, Lancs. "The quality is excellent and is better with one 8" speaker than a hi-fi amplifier which I have complete with 3 speakers. It is far more sensitive and produces a very pleasing tone with a 12V. supply. With no signal input I can detect no noise whatsoever. I shall recommend this little amplifier to everyone."

GUARANTEE ORDER FORM

To: SINCLAIR RADIONICS LTD. COMBERTON CAMBRIDGE

Please send me

....

....

....

....

for which I enclose Cash/Cheque/Money Order value £..............s..............d.

NAME...

ADDRESS...

....

....

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.E36 should you prefer to write your order instead of cutting out this coupon.

MINIATURE METALLIZED POLYESTER CAPACITORS

These small moulded metallized polyester capacitors are ideally suited to the applications of printed wiring panels and transistorised circuits. The use of the new dielectric material and unique construction combine the advantages of small physical size and superior electrical characteristics which meet the requirements of H.5 DEF. 5011 Specification.

CONSTRUCTION

The windings are virtually non-inductive and the wire terminations are soldered direct to the metal electrodes eliminating contact resistance and ensuring the minimum possible inductance.

Cap. Tolerance : ±20%

Voltage Rating :
Peak ripple voltage and D.C. voltage must not exceed rated D.C. voltage.

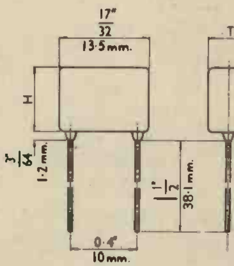
Power Factor :
≤0.01 at 1 Kc/s. at + 20°C.

Temperature Rating :
Suitable for working at + 85°C. without derating.

Insulation Resistance :
10,000 megohms or 2,000 ohm farad whichever is less.

Terminations :
22 SWG solder-coated parallel wires for vertical mounting.

Finish :
Insulated—special non-cracking heat resisting thermosetting compound providing good insulation and good protection against the ingress of moisture.



Cap. µF	Dimensions H	Dimensions T	T.C.C. Type No.
250 V. D.C. at 85°C working			
0.01	11/32in. 9 mm	7/32in. 5.5 mm	PMX1
0.015	11/32in. 9 mm	7/32in. 5.5 mm	PMX7
0.022	11/32in. 9 mm	7/32in. 5.5 mm	PMX2
0.033	11/32in. 9 mm	7/32in. 5.5 mm	PMX5
0.047	11/32in. 9 mm	7/32in. 5.5 mm	PMX3
0.068	7/16in. 11 mm	9/32in. 7.2 mm	PMX8
0.1	7/16in. 11 mm	9/32in. 7.2 mm	PMX4
400 V. D.C. at 85°C working			
0.01	11/32in. 9 mm	7/32in. 5.5 mm	PMX41
0.022	11/32in. 9 mm	7/32in. 5.5 mm	PMX42
0.033	7/16in. 11 mm	9/32in. 7.2 mm	PMX45
0.047	7/16in. 11 mm	9/32in. 7.2 mm	PMX43

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TCC	8	1,000	60°C	10/6	2/6
TCC	8	750	60°C	8/6	2/-
TCC	8	600	60°C	7/6	2/-
TCC	8	400	71°C	6/6	2/-
TCC	2	2,000	60°C	12/6	2/-
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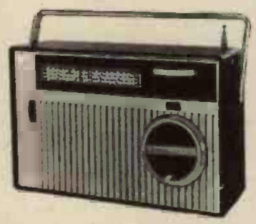

The SKYROVER Mk III.

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Controls: Waveband Selector, Volume Control with on/off Switch, Tuning Control. In plastic cabinet, size 10 × 6½ × 3½in. with metal trim and carrying handle.

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Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11½ × 6½ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

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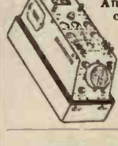

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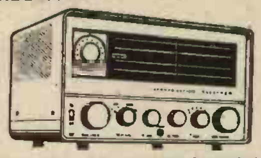

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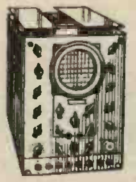

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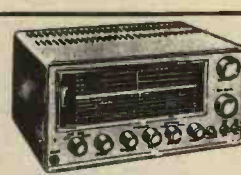

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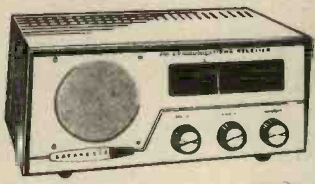

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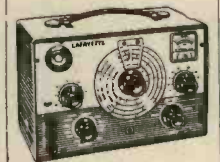

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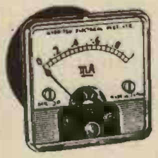

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50-0-50µA	29/6	100mA	22/6	10V D.C.	22/6	50V A.C.	22/6
100-0-100µA	27/6	150mA	22/6	20V D.C.	22/6	150V A.C.	22/6
500-0-500µA	22/6	200mA	22/6	50V D.C.	22/6	300V A.C.	22/6
1-0-1mA	22/6	300mA	22/6	100V D.C.	22/6	500V A.C.	22/6
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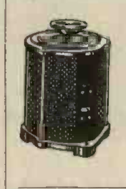

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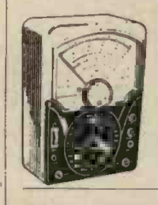

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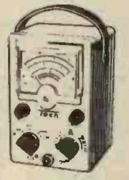

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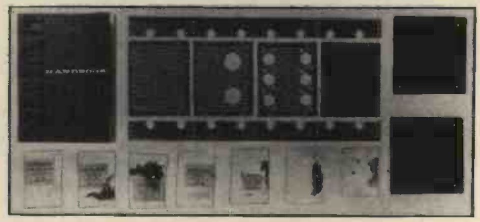
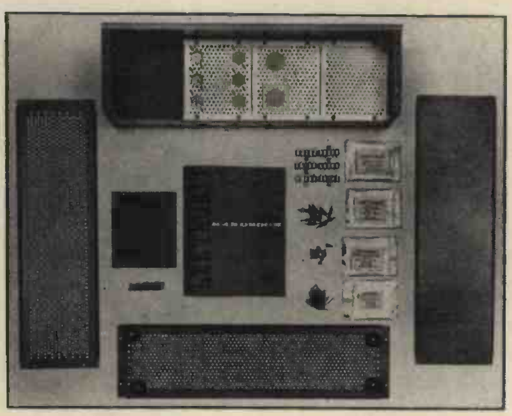
Introductory Kits are supplied to introduce the LEKTROKIT Chassis Construction System to the new user. Kit No. 1 contains sufficient parts to make up an open type experimental chassis. Kit No. 2 contains additional parts to enable the construction of an enclosed permanent unit.

NOTE: The lists of contents are nominal only and the makers reserve the right to vary them as circumstances dictate.



INTRODUCTORY KIT No. LK-011

		Contents			*Contents*			*Contents*
Chassis Plate No. 1	LK-111	1	Tagstrip 5-way	LK-2231	6	Pin Soldering	LK-3011	25
Chassis Plate No. 2	LK-121	1	Chassis Rail	LK-201	2	Lektrokit Handbook		1
Chassis Plate No. 3	LK-131	1	Side Plate No. 1	LK-301	2	Screws and Nuts for Assembly		
Chassis Plate No. 4	LK-141	1	Bushes Feed Through	LK-2111	12			
Insulators Lead Through	LK-2021	12						



INTRODUCTORY KIT No. LK-021

		Contents
Chassis Plate No. 1	LK-111	1
Chassis Plate No. 2	LK-121	1
Chassis Plate No. 3	LK-131	1
Chassis Plate No. 4	LK-141	2
Insulators, Lead Through	LK-2021	12
Tagstrip 5 way	LK-2231	6
Cover	LK-501	2
Cover	LK-511	1
Chassis Rail	LK-201	2
Side Plate	LK-301	2
Front Panel No. 1	LK-401	1
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VOL. 2 No. 3
MARCH 1966

Practical Electronics

YET ANOTHER VIEW

AS is now customary, the opening weeks of this year saw the publication of the ITV and the BBC annual Handbooks. This same period also witnessed a unique television occasion—one which may possibly make its mark in next year's editions of these handbooks: after many years' discussion, pay television was at last inaugurated, on a trial basis, in the Westminster and Southwark districts of London. Whether this additional television service is needed, only time will tell. It is however an interesting, and maybe significant, development in the field of home entertainment.

The competition between the two broadcasting organisations is real. ITV as a commercial enterprise is naturally concerned with making money for its shareholders, and the size of its audience has a direct bearing on the rates that can be charged for advertising time. Although a non-profit making organisation, the BBC also has every incentive for obtaining a large share of the viewing audience. This body is sensitive to the fact that all viewers, quite regardless of how they divide their viewing time, contribute to the Corporation's funds. The BBC knows it must hold a very substantial part of this audience in order to justify the existing method of raising funds, and in order to present a strong case for further increasing the cost of the broadcast receiving licence, should this be deemed necessary in the future.

In theory, this keen rivalry between the BBC and ITV should be to the viewers' advantage. In practice, we all know it is not altogether so. Certainly there have been improvements since ITV broke the BBC's monopoly 10 years ago. But the "alternative programme" is largely illusory. With both organisations fighting for the maximum number of viewers the same kind of mediocre fare is all too frequently offered on both channels in the peak viewing hours.

After a somewhat abortive start, the BBC's second television service on u.h.f. has now been reorganised. The Corporation makes a great point of the common programme junctions maintained by BBC1 and BBC2. This seems so obvious an arrangement that one is amazed it was not adopted right at the inception of BBC2.

How will pay television fit into this picture? For technical reasons this new service is limited to wired relay systems. It can therefore never become a serious rival to the two existing systems which operate on a national scale. What it can offer is an additional choice in certain centres of population. The present experiment is confined to one area in London, but later this year it will also be tried out in Sheffield. The permanent establishment of Pay TV and any future expansion will depend on the success or otherwise of these two pilot schemes.

The notion that viewers will be prepared to pay cash in advance for each programme they watch is novel; it is quite a new departure so far as broadcast entertainment in this country is concerned. It is conceivable that a successful PAY-TV network would have much influence on general viewing habits. For instance, perhaps the cultivation of a more discriminating use of the on/off switch might be beneficial all round. Not least, would it save artistes that final humiliation of being relegated to mere providers of background scenes for more pressing domestic activities.

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our April issue will be published on Thursday, March 17

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Editorial and Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: Temple Bar 4363. Telegrams: Newnes Rand London. Subscription Rates including postage for one year, to any part of the world, 36s.

Printed Circuit

HOW TO MAKE YOUR OWN PRINTED CIRCUITS

THE days of the bulky metal chassis are now certainly numbered for the majority of exercises. Not all that long past it was general practice to commence operations on almost any electronic device—audio, radio, television and gadget—by making a chassis first. Early constructors favoured copper for this item (probably because of its good electrical conductivity!). Tin plated steel then became popular, followed by aluminium and currently die-cast alloy. This latter material is also used for enclosed boxes to considerable advantage, particularly for the housing and screening of small printed circuit assemblies.

Constructors keen on v.h.f. and u.h.f. devices found that silver-plated copper gave that little margin of increased efficiency over unplated metal, for the reason that v.h.f. and u.h.f. signal currents flow only in the first two or three microns of chassis surface. Later, however, tin-plated steel was found to be almost as good from this aspect.

TAKING OVER

However, as transistors and solid-state circuits are ousting relatively high temperature valves, so the need for the old-style chassis is diminishing and the printed circuit is taking over.

The printed circuit was originally developed as far back as 1945—in connection with a guided missile project. From the commercial aspect, it really started life as an artifice for reducing the cost of manufacturing large numbers of the same electronic assembly. Today, the situation is that almost every commercial radio and television receiver made adopts the printed circuit technique—the chassis as it was known being totally abandoned.

A printed circuit in the context considered here is a piece of insulated board (e.g. plastics laminate), upon which the complete wiring circuit of the assembly appears on one or both sides as a copper pattern. At appropriate points on the board small holes are drilled to accommodate the connecting wires of the components.

The components are thus loaded onto the board and connection to the circuit is made by soldering their shortened wire ends direct to the copper laminate. The printed circuit board therefore serves a similar function as the old-style chassis (since it is upon this that the components are mounted) and also as the wiring.

Printed circuit board assemblies of this nature can be plugged edge-wise into special, multi-contact sockets and thus secured, or they can be supported in metal or wooden frames, depending upon the size of the board and the requirements. Both of these methods are found in commercial equipments.

Printed circuit boards lend themselves admirably, of course, to small, low temperature transistorised equipment. There are now available hosts of components specially developed for printed circuit board techniques including valve holders, controls and so on.

BASIC PRINCIPLES

For rigid-type circuits, the most usual type of board is copper-clad phenolic paper laminate. This comes in various grades and thicknesses. Of recent years, however, it has become possible to bond copper and other metals satisfactorily to other various board materials. These include flexible backings, leading to the film variety of printed circuit.

In its virgin form, the base material has securely bonded to it the copper surface—on one or both sides (Fig. 1). The copper is in the form of a foil, from about 0·0015in to 0·003in thick, and a very important part of the original process is the correct bonding of the foil to the base material to prevent the copper lifting in service.

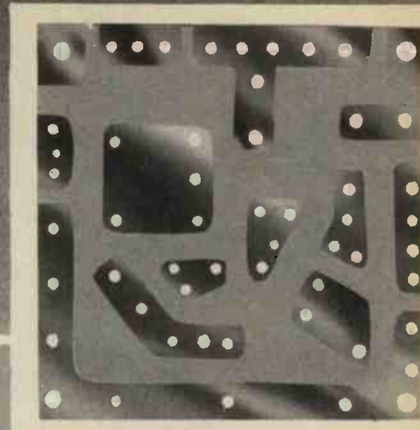
The pattern of the required circuit is formed upon the foil by an etching process, this being first designed and drawn on paper. The design is then transferred onto the surface of the copper, in such a way that the required areas of copper appear on the copper in the form of an acid resistant ink. The whole is then placed in an etching bath containing a solution of iron perchloride, which dissolves the surplus copper and leaves only the "painted" areas of copper bonded on the laminate.

The master drawing of the circuit is usually called the "black and white" in the industry. This is drawn to scale, from full-size down to about 20 : 1, depending upon the circuit size. The "black and white" often shows all the circuit detail, including the component wire holes marked as white circles on the black circuit.

A real size photographic negative of the printed circuit is then made of the black and white original, and it is this which is used to print the circuit on to the copper board surface with an acid resistant sensitised chemical. Finally, the board is drilled at the hole positions indicated on the circuit.

The method above described is, of course, that which is employed by printed circuit board manufacturers, where large numbers of boards of the same circuit are

Techniques...



by GORDON J. KING

required. For the constructor, the same end result can be achieved by a less complex process, and in many cases an individual board can be processed with less trouble than by employing chassis and conventional wiring techniques.

BE CAREFUL!

Copper bonded laminate board is readily available to the constructor from firms such as those dealing in components and specialising in the needs of the constructor. Indeed, some firms advertise complete kits for the production of printed circuit boards, which include a number of copper bonded boards and all the chemicals needed for the exercise (see photograph below).

A suitable etchant can be produced by mixing 4 ounces of ferric chloride and 1 ounce of hydrochloric acid with 6 ounces of water. *This solution is poisonous and can harm the skin.* The use of rubber gloves is recommended.

IF SPLASHED INTO THE EYES, WASH THEM THOROUGHLY WITH CLEAN, WARM WATER AND CONSULT A DOCTOR OR HOSPITAL IMMEDIATELY. Better still—*wear goggles.*

The author has used both coloured shellac and cellulose paint as a resist. If shellac is used, about ½ ounce of the crystals should be dissolved in 3 ounces of methylated spirits overnight, and a little dark-coloured spirit dye introduced to make the solution more visible when applied.

DEVISING A PATTERN

The first thing that the constructor has to do is to translate the circuit diagram of the piece of equipment it is desired to build into printed circuit form. This is by no means as difficult as it may first appear. The printed wiring drawing can follow very closely the actual layout of the circuit diagram. This will be the master pattern to be transferred later on to the copper side of the board (Fig. 2).

The best plan is to make a number of rough translations, doodling with pencil, rubbing out and correcting until a printed circuit drawing which satisfies all the requirements is produced. A certain degree of allowance should be made for the sizes of components used with respect to their positions on board.

The aim should be to keep each inter-component connection as short as possible, a process which will mean orientating the components on the board (or template) until that condition can be attained. The printed wiring must, of course, have hole terminations which will suit the component dimensions, so really, before setting out on the task of translation, the components which are to be used in the equipment must be to hand; or, at least, their dimensions must be available.

Transistors, for example, have various lead-out configurations, so the holes and circuit terminations must match the electrodes in the transistor without the need to cross the wires between the transistor case and the board. Crossed transistor lead-out wires can often result in instability, particularly in v.h.f. and u.h.f. circuitry. The same reasoning applies to other components.

Printed circuit board kit left to right:

etchant, polishing powder, brush, laminated board with copper face, and (standing outside the box) the resist and solvent solution

see over for picture sequence

1 Take a piece of copper-clad laminate and cut it 2 inches square with a fine junior hacksaw. Clean the edges

2 Trace the pattern on to the copper surface using carbon paper and drawing over the master pattern outlines

3 Remove the master pattern and "paint" the areas of copper required with the resist fluid

4 The final pattern of resist on the copper should have clean outlines. No resist should be splashed on any unwanted copper

5 Attach a rubber suction pad to the back of the board so that it can be held and agitated in the etching bath. Avoid splashing the etchant on the fingers

6 The final etched board should be clean and show only the black resist patterns. All unwanted copper has been etched away

7 Remove the resist and polish by using fine abrasive powder. Any surplus chemical left on the board can be washed off

8 Drill small holes (about no. 60 diameter) where required. Be very careful not to tear the copper or lift it

9 The finished printed circuit board drilled ready for mounting the components. This example is used in our special series of articles "Bonanza Boards"

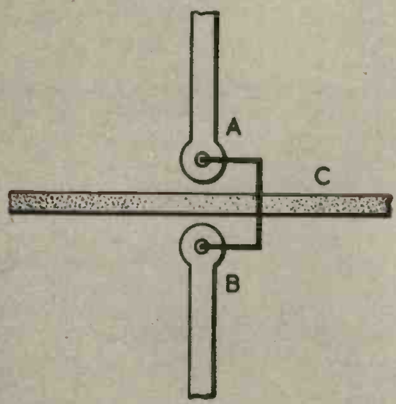


Fig. 10. Method of cross-linking

In cases where it is impossible to complete a translation without one piece of printed wiring crossing another, then the copper strip should have a "break" so that a link wire can be fitted (see Fig. 10).

The example shown here is a perfectly sound design and works quite well. However, quite a large amount of copper has had to be dissolved to leave the copper circuit. While this is not unduly difficult to achieve, it is often advantageous to retain as much copper as possible on, say, the earthed part of the circuit. That is, the parts of the circuit which are considered as being at zero signal potential.

Greater electrical stability is often possible by retaining large areas of "earthed" copper which, of course, are representative of the old-style metal chassis. Such areas are useful for the mounting of, say, transformers, chokes and other similar large components, to ensure a "common earth" throughout the design. Moreover, there is no point in dissolving more copper from the base material than absolutely necessary.

TRANSFER TO COPPER

When a scale drawing of the printed circuit pattern has been finalised, the next step is to transfer this onto the copper foil as a full-size circuit. Unless accurate photographic facilities are available, the best plan is for the constructor to draw the circuit pattern full-size to start with (Fig. 2).

Before transferring the pattern to the copper—or applying the "resist" to the copper it is desirable that the copper surface should be cleaned thoroughly. A *light* abrasive powder (included in the kit) is suitable for this operation, but keep some by for polishing the finished board. The copper must be clean.

Lay the master pattern on the copper surface with a piece of carbon paper between the two. A good impression will be obtained by drawing over the pattern outlines with a ball-point pen. This process is aided if the master is drawn on a good quality tracing paper. The circuit can then be easily lined up correctly on the copper side of the laminate.

Commercially, of course, the master drawing is, in effect, optically projected onto the copper sheet, and special sensitised chemicals provide the acid resistant effect, but this is not necessary for the amateur.

RESIST

When the drawing is transferred onto the copper, the next step is to "paint" all the copper circuit elements that are required with an acid resistant ink (Fig. 3). This is sometimes called the "resist". These parts are protected against acid attack and only the exposed sections of the copper are dissolved or etched away in the acid bath.

The resist must be coloured in some way to make it visible on the copper and it should be very carefully "painted" onto the copper, taking extreme care to avoid spilling any of the resist between the required conductor sections.

The definition at the edges of the finished printed circuit will depend upon just how well the resist is applied. It is difficult to achieve an absolute straight line by hand, but good results are possible by applying the resist with a fine paint brush and employing a ruler to steady the hand and guide the brush. Too great an application of resist should be avoided, but all the required copper must be adequately covered (Fig. 4).

The resist, whatever its nature, must be allowed to dry on the copper before the board is put into the acid bath.

ETCHING

The next stage is to commence the etching process. The acid solution, often called the "etchant", *must not be put into a metallic container;* a plastics dish or box makes an ideal bath, provided it is not too deep.

The board should be placed in the solution (Fig. 5); the process can be speeded up by gently rocking the bath or board so as to agitate the solution without splashing. A rubber suction pad can be very useful if attached to the back of the board. It can then be held with the fingers and occasionally moved about so that the fluid is agitated. Lift the board out of the fluid occasionally to inspect the progress of etching.

The time it will take for the unwanted copper to dissolve will depend upon the thickness of the foil and on the strength of the etchant. The process may take a little longer than expected, and a period in excess of thirty minutes may be necessary to complete the process. Towards the end of that time small particles of copper will be seen between the "painted" conductors on the board. These must all be eliminated by the acid before the board is removed from the solution. The final etched pattern is shown in Fig. 6.

After the etchant has had the desired effect on the board, the board should be removed from the bath and washed thoroughly under running water. The resist can be cleaned off the remaining copper with a cellulose or spirit solvant and finally the copper can be polished again with a domestic abrasive (Fig. 7).

DRILLING

It is now a relatively simple matter to drill the board to take the component wires at the appropriate points on the printed circuit (Fig. 8). The copper left on the board must be sufficiently wide to take a $\frac{1}{32}$in hole or $\frac{1}{16}$in hole, according to the size and number of wires to be inserted in the respective holes. The finished board with all holes drilled for the "Bonanza Boards" series to follow is shown in Fig. 9. ★

PRINTED CIRCUITS with PHOTOGRAPHIC ASSISTANCE

by A. W. COUSINS

For "one-off" circuits a hand drawn pattern transferred on to the copper laminate, followed by the normal etching process, is a quick, simple and cheap method, but if several identical copies of a circuit are required, such as is shown in the "Bonanza Boards" series of articles in this issue, then photographic assistance can cut out the repetition of the drawing stages.

PRINCIPLE OF OPERATION

A pattern of the desired layout is drawn full size on white paper, using black ink to represent the copper required on the finished printed circuit.

The drawing is then photographed to produce a "black and white" negative.

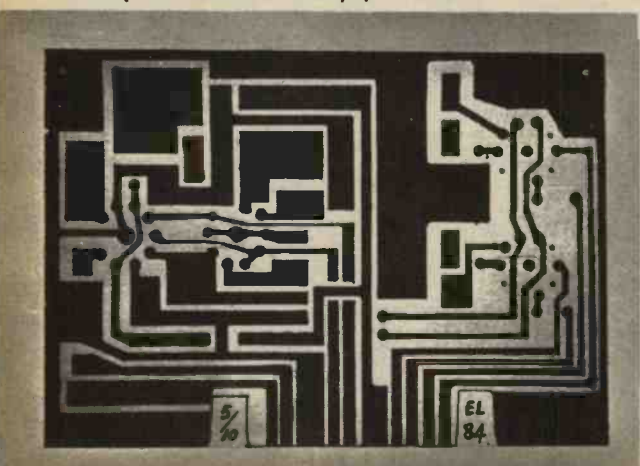
The negative is projected through an ordinary photographic enlarger on to a sheet of copper laminate and the bright lines of the pattern painted over with any normal resistive paint.

The copper laminate is etched in the normal manner.

OPERATION

When drawing out the desired pattern on white card or paper there will be very few critical dimensions—perhaps an edgewise plug connection, valve base pins, or fixed component tags—these will need to be accurately reproduced. To help their accurate photographic reproduction to the correct scale, it has been found convenient to make two white marks on the original drawing (say at two corners) and note the distance between the marks. When projecting the negative later it is only necessary to adjust the picture size so that the distance between the marks is the same as previously measured, and all the other dimensions should be correct too.

Fig. 1. The original drawing on white paper — an adaptation of the Mullard 5-10 amplifier circuit



Any black and white film will provide a negative and a portrait lens or other close-up lens is usually required on an average camera. The photograph can be taken out of doors in daylight, or indoors with the aid of a flash-gun. Aim for slight under-exposure of the negative for best results.

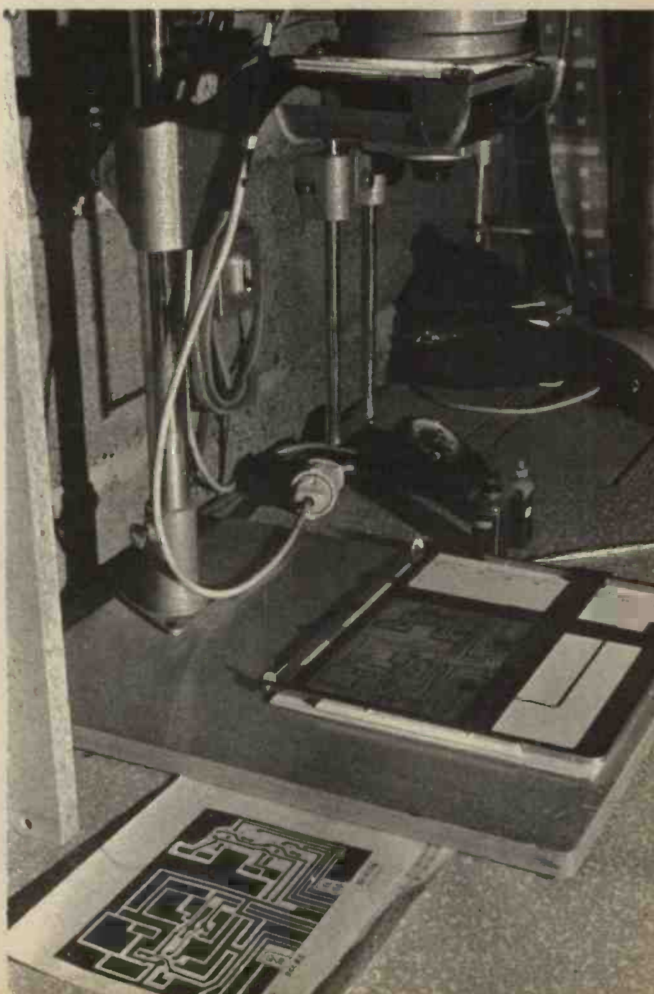
When inking in the projected negative remember that the projector lamp will be in use much longer than for normal photographic work, so ensure it has reasonable air circulation to prevent it getting too hot.

Hold the copper laminate steady in a "masking frame" or between drawing pins on the enlarger base plate, adjust the picture focus so that the correct size is obtained. Ink over the white lines (which were black on the original drawing) until all are covered, using a paint brush or dispenser type plastics ink bottle. The process may be repeated for as many copies as required.

SERVICING

The negative has a further use—make a normal full size print on ordinary photographic paper and ink in component locations and references for future use. Under-expose the print to give a grey and white reproduction so that the ink shows clearly. ★

Fig. 2. The original drawing in the foreground with negative being projected on to the copper laminate held in a masking frame. Note paint brush and dispenser type ink bottle



A BASIC carrier wave (c.w.) transmitter need consist only of a simple valve oscillator, suitably coupled to an aerial of definite length, a typical circuit being shown in Fig. 2. 1. The efficiency of such a circuit is generally fairly low and the tuning has to be carefully "peaked" to obtain maximum output, although with too fine a tuning the circuit may be thrown out of oscillation. Equally, the stability of such a circuit is often suspect, particularly if the air-core tuning coil is unsupported.

The tuning "peak" is readily established for, if a milliammeter is inserted in the h.t. positive line to read the anode current, this current will rise rapidly immediately the transmitter goes out of oscillation due to the loss of bias (generated by the oscillations). For "safe" operation it is necessary to back-off the tuning from this point, although this will result in some loss of signal strength. The latter can be checked with a field strength meter and it will usually be found that maximum signal (indicated by the meter) corresponds roughly with maximum anode current. Further fine tuning in one direction will result in loss of signal strength and a slight rise in anode current. Tuning in the other direction results in a sudden loss of signal and a sharp rise in anode current—e.g. typically jumping from about 15–20 milliamps to 40 milliamps or more.

Field strength will also be dependent on the efficiency of the aerial and aerial coupling. Practical resonant aerial lengths are 8–9ft and 48–50in, the former only being suitable for a ground-standing transmitter. Although this type has certain advantages

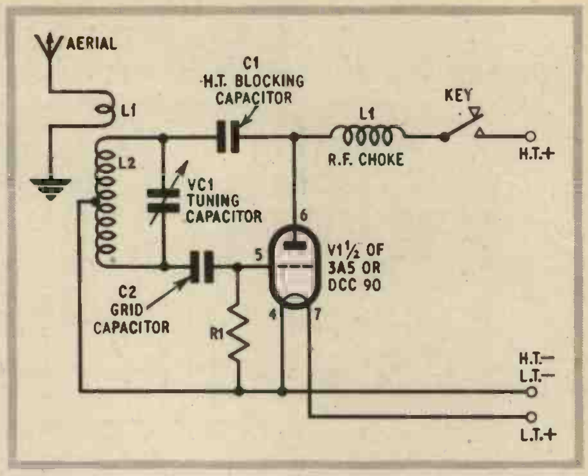


Fig. 2.1. Simple valve oscillator for c.w. transmission. Typical values of components could be as follows: VC1—3 to 30 pF; Coil L2 would have 12 turns of 16 s.w.g. enamelled copper wire, ⅞in inside diameter of coil; C1—0·01µF; C2—100pF; R1—10kΩ for 90 volts h.t.

it is also particularly susceptible to detuning due to changes in position, or the dryness of the ground on which it is resting. It also limits movement of the operator to the distance which the keying lead will stretch (and the lead itself is a mechanical weakness, subject to fraying or damage).

Radio Control of Models

PART TWO

SINGLE CHANNEL TRANSMITTERS

By R.H. WARRING

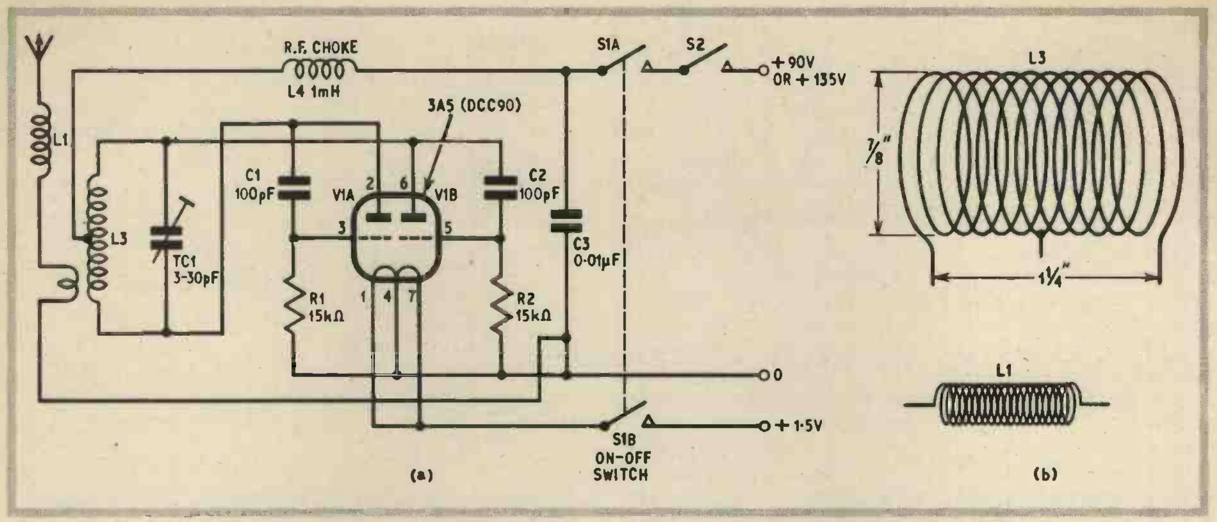


Fig. 2.2 (above). A cross-coupled transmitting circuit is shown in (a). In (b) the winding details for the coils are: L1—20 turns of 20 s.w.g. close wound enamelled copper wire. Adjust the number of turns by experiment. L3—12 turns of 16 s.w.g. enamelled copper wire close wound on ⅞in dia. former

CROSS-COUPLED

A practical and well-proven circuit design is shown in Figs. 2. 2a and 2. 2b, using standard and readily available components. This is also available in kit form[1].

The circuit is of cross-coupled type using a double triode valve (3A5) and can be operated on either 90V or 135V h.t. Filament current is controlled by the values of the grid resistors and, with the recommended 15 kilohm values, is of the order of 12mA and 20mA on 90V and 135V, respectively. Since the valve itself is designed for a filament current of 200mA it is possible to increase the actual filament current substantially (i.e. by reducing the value of the grid resistors) with consequent improvement in range. However, this will markedly reduce the life of the h.t. battery. The values recommended are, therefore, consistent with "optimum" battery performance from a battery of a size suitable for mounting in a hand-held transmitter. The circuit in its recommended form employs a loading coil to improve aerial efficiency, the aerial used being a standard 42in telescopic type. For a ground-standing transmitter where larger batteries can be used and larger current drain tolerated, the grid resistors can be reduced to 10 kilohms with an 8ft aerial; the aerial coupling coil would no longer be required.

Component layout is non-critical and the whole can be accommodated on an s.r.b.p. panel approximately 4in × 2in.

A considerable improvement in performance is realised by employing a master oscillator, power amplifier circuit (MOPA). This relieves the oscillator valve of having to be driven hard, so the circuit can be made that much more stable. This is rather more wasteful of power input since the power absorbed by the first valve is not fed directly to the aerial, but the amplifier stage connected to the aerial is generally more efficient than direct coupling of the oscillator to the aerial. Also, of course, the circuit gains in enabling the oscillator to draw a lower current to operate under more stable conditions, with the final output boosted by the amplifier stage. In practice both the oscillator valve and amplifier valve can be contained within a single envelope (e.g. a 3A5 or DCC 90), offering a compact and simple form of assembly and operation from a single h.t. battery.

Typical single-channel, crystal controlled transmitter with aerial loading coil. The receiver is in the foreground

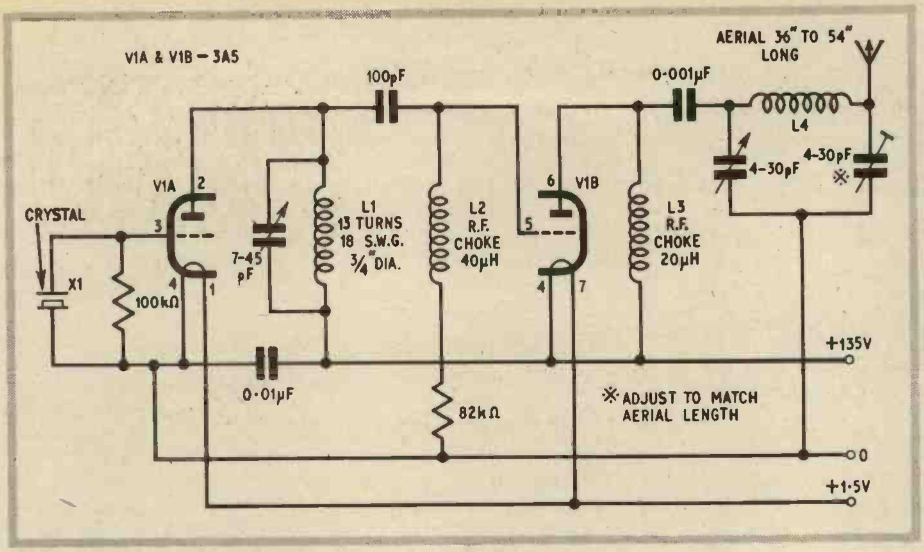


Fig. 2.3a. Two stage crystal controlled transmitter

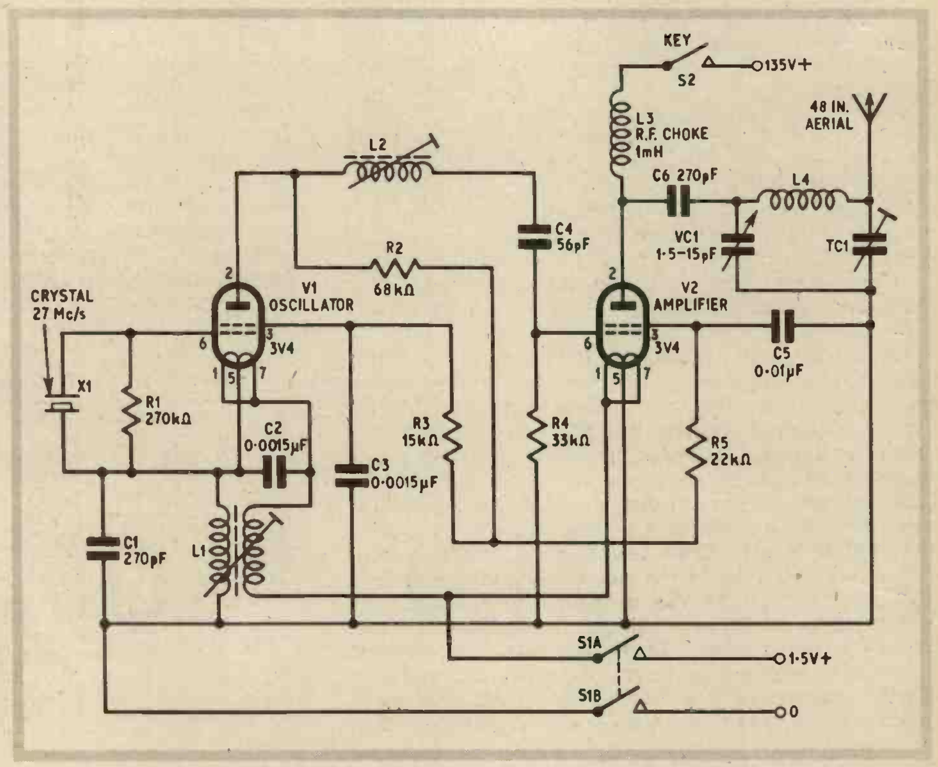
CRYSTAL CONTROL

A typical basic circuit[2] is shown in Fig. 2.3a with crystal control added. Tuning is accomplished in two stages—first the oscillator circuit and then a second trimmer in the amplifier circuit for maximum signal strength as indicated by the field strength meter. This latter adjustment can be peaked out exactly for this will not affect the stability of the oscillator circuit. There may, however, be some reaction between stages calling for a repeat of tuning adjustments. Some transmitter circuits, both single-valve and MOPA, may also have a further trimmer to adjust the aerial coupling. A somewhat more sophisticated circuit is shown in Fig. 2.3b.

For tone operation the carrier is modulated by a low frequency a.f. signal generated by a separate oscillator. This may be applied to either type of basic circuit, although the MOPA circuit is generally much easier to modulate. Because of its other advantages as well, it is the preferred type for all modern transmitters.

Choice of audio frequency is largely arbitrary and

Fig. 2.3b. A somewhat more sophisticated version of the circuit shown in Fig. 2.3a



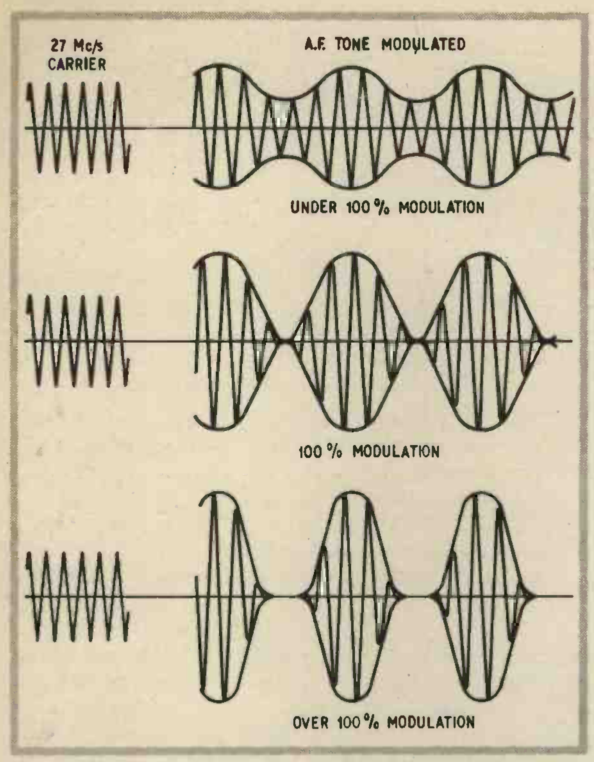


Fig. 2.4. Comparison of modulated signal waveforms

may range from as low as 100c/s to 6,000c/s or more. The range normally favoured for single-channel transmitters is anything between about 500 and 1,000c/s. The degree of modulation usually aimed at is 100 per cent, although some model transmitters produce less and some more than 100 per cent. A possible disadvantage in the latter case is that this produces definite breaks in the carrier which could cause "spatter" (see Fig. 2.4). In practice, the chief effect is that mismatching may occur between different makes of tone transmitter and tone receiver where the design modulation figures differ appreciably. This can also happen where the tone frequency also differs appreciably between the two designs.

Frequency drift can be virtually eliminated with crystal control applied to the oscillator circuit, possible arrangements being shown in Fig. 2.5. In addition to a spot frequency the crystal employed may resonate at a sub-harmonic (one half or one third of the frequency required), or a third overtone. In the latter case, although the crystal has the geometry for 9Mc/s resonance, it will also oscillate at $3 \times 9 = 27$Mc/s in the circuit, and can thus be used directly to control the frequency of the r.f. oscillator. When the crystal frequency is a sub-harmonic equal to one-half of the required output efficiency, then frequency doubling can be introduced either in the anode circuit of the oscillator stage, or in the power amplifier stage.

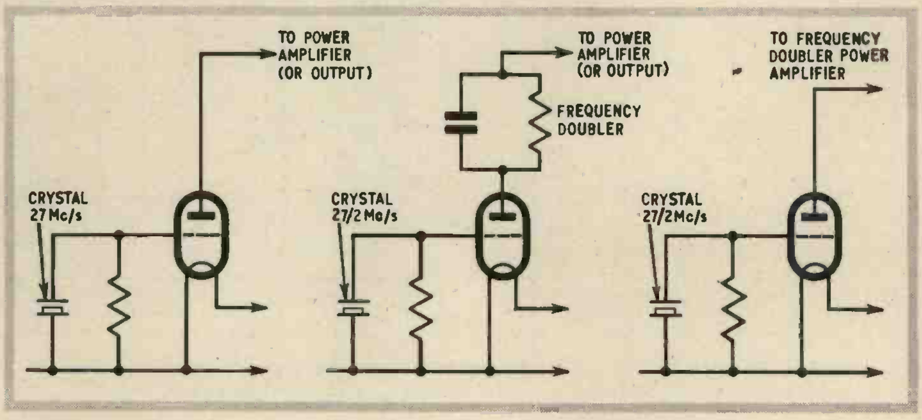
LOADING COIL

A typical straightforward MOPA type single-channel tone transmitter circuit[3] is shown in Fig. 2.6. employing one-half of a 3A5 (DCC 90) valve for the oscillator; the other half of the same valve for the modulator; and a second valve (3D6) for the power amplifier. In modern commercial productions of this type, printed circuit assembly is invariably employed and the aerial coils are usually accommodated on the printed circuit. In this particular example a nominal 48in telescopic aerial is used with inductive coupling and the aerial efficiency improved by the inclusion of a loading coil. This may also be accommodated on the printed circuit panel, although in some cases a wound loading coil is preferred inserted in the centre of the aerial length. In either case, exact matching of the loading coil is essential for optimum results.

A further thoroughly proven single-channel tone transmitter circuit[4] is shown in Fig. 2.7. This employs a paralleled tone oscillator based on a 3A5 (DCC 90) valve; a second 3A5 valve is used for the master (carrier frequency) oscillator and power amplifier, with conventional crystal control of the master oscillator. Further stability is provided on the commercial production by incorporating the aerial coils on the printed circuit board.

Whilst it is readily possible for such circuits to be duplicated from basic components they are normally purchased as ready-made transmitters or kits of components including a pre-drilled printed circuit panel. The latter method is certainly the best proposition for the home constructor rather than starting from scratch both from the point of view of starting with an established circuit layout (as dictated by the printed circuit panel) and in having a complete set of components of the correct type and values. This is of considerable help in the case of inductors. There is also the point that such circuits are generally thoroughly

Fig. 2.5. Application of a crystal to control frequency drift using a 27 Mc/s carrier. The centre and right-hand diagrams use a 13·5 (27/2) Mc/s crystal and frequency doubler



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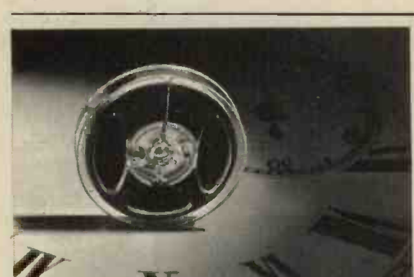

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Review by Alec Tutchings.

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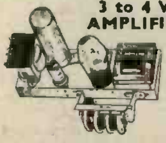

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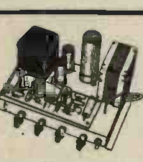

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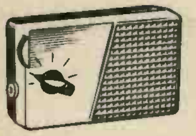

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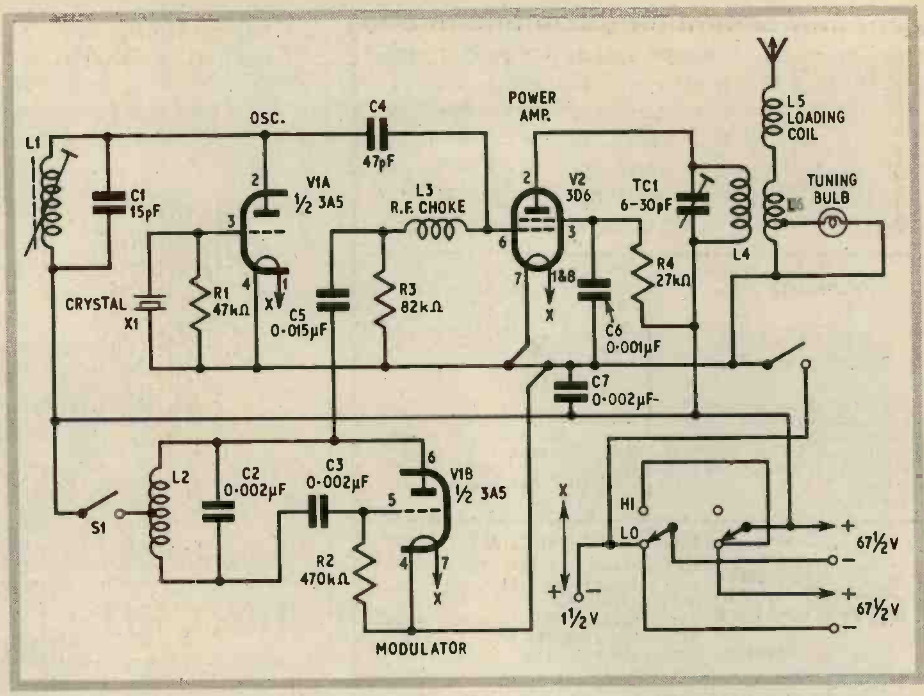


Fig. 2.6. *Typical MOPA single channel tone transmitter circuit*

developed and proven. There is probably little further improvement and development that can be done with simple single-channel transmitters of this type, and original circuits seeking "improvements" will almost certainly show inferior results.

A high capacity h.t. battery is a characteristic of all such conventional designs of valve transmitters with a relatively high current drain. The smaller physical sizes of batteries for reduction in weight, desirable with hand-held transmitters, makes for a relatively short battery life, even though power input may be held to the order of 1·5 to 2 watts, or well below the permitted maximum. In this respect, hand-held transmitters are at a considerable disadvantage compared with ground-standing transmitters, which are not so restricted as regards battery capacity and weight; an

continued on page 198

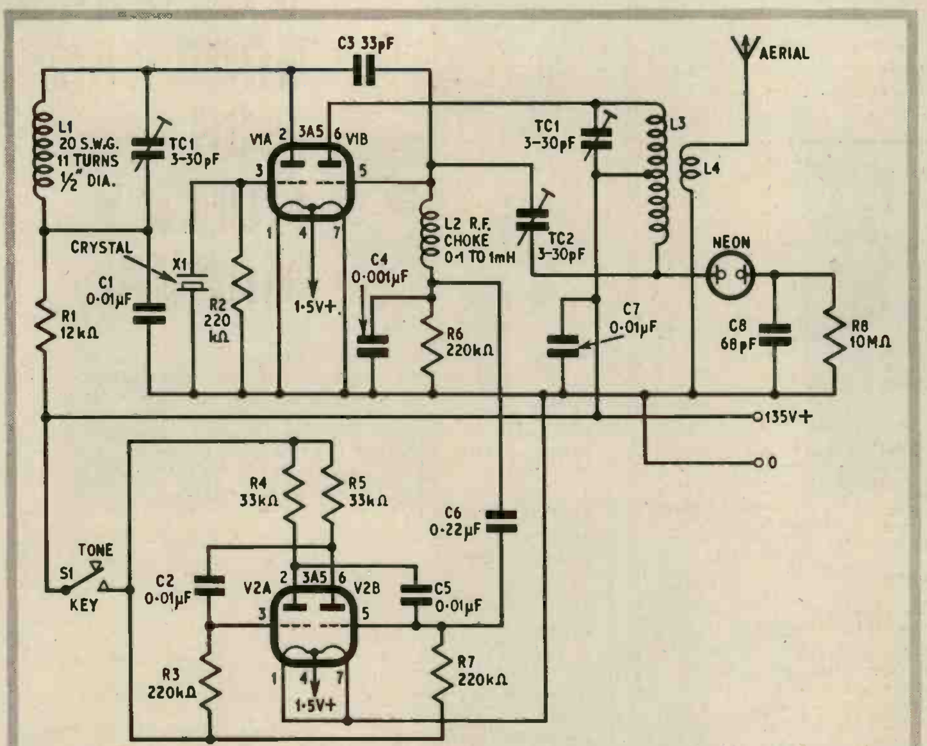
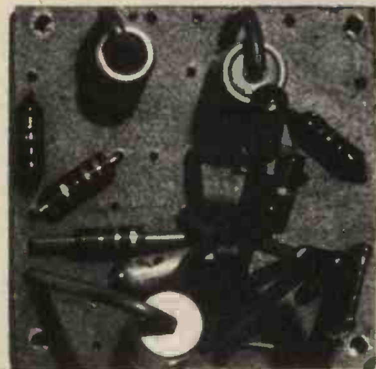


Fig. 2.7. *A comprehensive crystal controlled single channel tone transmitter circuit*

BONANZA



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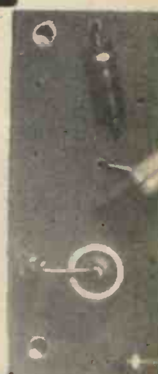

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GUITAR
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BOARDS

by A.J. BASSETT

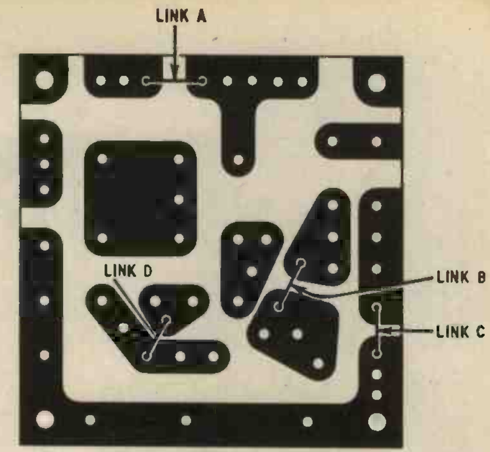


Fig. 2. Printed circuit pattern and link wire connections

THIS is the first of a series of articles which shows how a small simple printed circuit board can be used to build any one of a number of useful circuits. If required, several of the projects can be built and suitably combined to make up a more complex electronic system, as will be seen in subsequent articles.

The projects described can form a foundation of exercises in building simple practical circuits and, as such, is ideal for the home constructor, schools and science clubs.

Each basic circuit is termed an "electronic building brick"; it is made up on a piece of printed circuit board two inches square. The basic pattern of the board in each case is similar and requires very little modification to enable the constructor to build the circuits of his choice.

This month we show how to form the basic circuit, in the article "Printed Circuit Techniques", then go on to build a radio tuner, a guitar practice adaptor, a simple pre-amplifier which can be adapted as a treble booster, and a class "A" driver amplifier.

BASIC CONFIGURATION

Many transistor circuits are based on a similar basic configuration; the components are actually selected to give the required function. Fig. 1 shows an example of this; the actual components are shown in block form but the wiring between them is *basically* the same.

The circuits to be described in this series are all based on this configuration, but in some cases certain minor deviations will become apparent when we describe individual units.

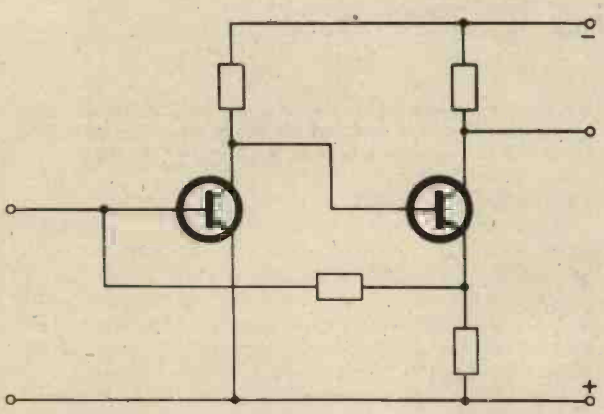


Fig. 1. Basic circuit configuration

PRINTED CIRCUIT BOARD

The basic units described in this series are built on printed circuit boards; a suitable design is shown in Fig. 2 which is the basis of the article showing how to make printed circuits.

A printed circuit kit can be obtained from one of the many component stockists advertising in this journal; the board and chemicals are usually supplied in the kit.

Cut a piece of the board 2in × 2in carefully, using a junior hacksaw. Make sure that you do not let the copper lift or tear as you are cutting.

The pattern of the printed board shown can be transferred direct to the copper laminate by using carbon paper.

After tracing the pattern on the board, paint the area shown in black on Fig. 2, then etch away the unwanted portions with the chemical provided in the kit. The board should then be cleaned so that all the chemical fluid and paint are removed, leaving the required pattern of copper shown in Fig. 2.

The holes to take the component wires should be drilled carefully with a no. 60 diameter drill. Some of these holes are provided to link two or more strips of copper together on some of the units. If an identical board is made for each unit the component connections can be altered to build a different circuit.

SOLDERING

Soldering the components on the board is a simple operation if a hot iron is used and is only allowed to remain in contact with the copper and the component wires for long enough to make good electrical joints.

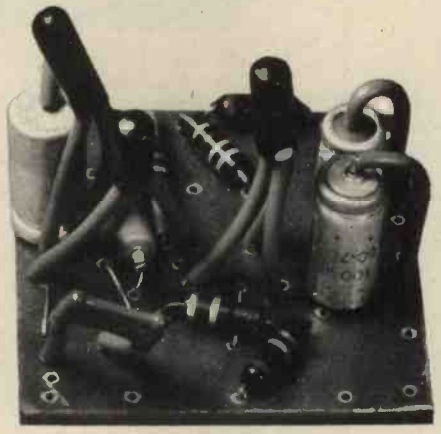
When soldering the wires of transistors, diodes, and small components, it is best to use a heat shunt, for example a pair of pliers or a copper faced "crocodile" clip. The heat shunt is attached to the wire between the soldering iron and the actual component. This will prevent excessive heat damaging the component.

Look for these projects:

THIS MONTH

SIMPLE PRE-AMPLIFIER and TREBLE BOOSTER

BB1



This is one of the most simple circuits but is extremely versatile as will be seen later. All the components are mounted on the printed circuit board with the exception of the volume control. This control is optional and can be dispensed with if the input signal is fed direct into the positive terminal of C1; the circuit is shown in Fig. 1.

The input to the pre-amplifier is medium impedance and could be fed with the signal from a low impedance pick-up. If a higher input impedance is required for connecting to a gramophone pick-up (such as a crystal or ceramic type) a resistor of about 100 kilohms should be connected in series with the input. C1 should then be made as high as possible, 50 or 100μF.

Assemble all components on the board as shown in Fig. 2, making sure that the electrolytic capacitors and diode are connected the right way round. Observe the connections of the transistors; the collector is the wire nearest the spot on the side of the envelope.

Links should be made by soldering short lengths of wire at positions B, C, and D (see Fig. 2).

Output 1 of the pre-amplifier can be connected to an electromagnetic earphone. Alternatively a driver transformer, whose primary impedance is between 600 ohms and 10 kilohms, can be connected between TR2 collector and the junction of R1 and R5; R3 and C5 should be removed.

If the pre-amplifier is to be used to drive a low impedance load (less than 600 ohms), an additional amplifier, such as the "Driver Amplifier" (described elsewhere in this issue) will be necessary.

The function of "Output 2" will be shown in a later article next month; it provides a low impedance output.

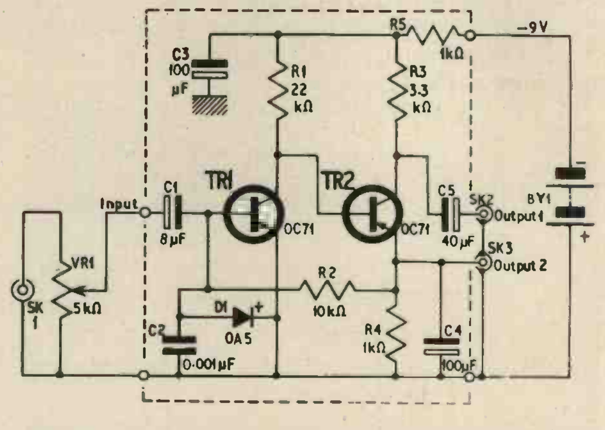


Fig. 1. Circuit of the pre-amplifier. The circuitry enclosed by the dotted line is made up on the printed circuit board. Output 2 will be used in a later article next month

TREBLE BOOSTER

It is a simple matter to convert the pre-amplifier into a treble booster. The value of C4 should be made considerably lower in order to reduce the level of the lower frequencies. A small electrolytic capacitor (8μF is quite suitable) should be connected between TR2 emitter and the common positive strip, in place of the 100μF capacitor (C4) shown in Fig. 1.

The amount of treble boost required is a matter of personal choice and can be reduced by inserting slightly larger values.

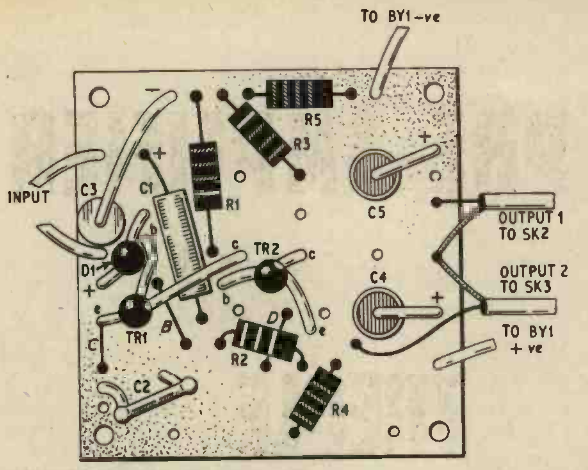


Fig. 2. Layout of components on the board. Note the link wires at B, C, and D

Some readers may prefer to incorporate a stepped variable control by using a switch. The wiper of the switch is connected to TR2 emitter and the "position" tags on the switch to the different value capacitors as shown in Fig. 3. The switch should be a "make-before-break" type otherwise some disturbing noises will be heard when changing positions.

The pre-amplifier and treble booster can be used to amplify the sounds made by the "Electronic Didgeridoo" (described in the November 1964 issue) and the "Electronic Guitar" (described in the January 1965 issue).

USING THE PRE-AMPLIFIER

Being small and at the same time a good matching unit, this pre-amplifier could replace the matching transformer in the "Guitar".

The unit can be mounted in a small box with the volume control and a leakproof battery giving between 3 and 9 volts. Coaxial sockets can be fitted for input and output connections and an on/off toggle switch in series with the battery negative lead. The "sound" lead

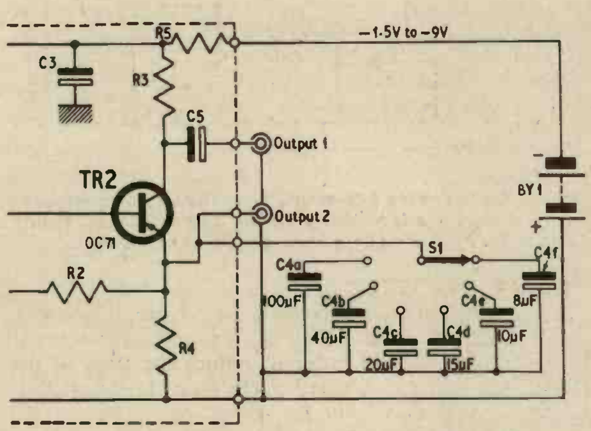


Fig. 3. For the treble booster modification, C4 is replaced by a switch S1 (single-pole, 6-ways) and six alternative capacitance values. These would not be mounted on the printed circuit board

COMPONENTS . . .

Resistors
R1 22kΩ
R2 10kΩ
R3 3·3kΩ
R4 1kΩ
R5 1kΩ
All 10%, ¼ watt carbon

Potentiometer
VR1 5kΩ log. carbon

Capacitors
C1 8µF elect. 15V
C2 0·001µF polyester
C3 100µF elect. 15V
C4 100µF elect. 15V
C5 40µF elect. 12V
In the "treble booster" circuit, C4 is replaced by:
C4a 100µF elect. 15V
C4b 40µF elect. 12V
C4c 20µF elect. 12V
C4d 15µF elect. 12V
C4e 10µF elect. 12V
C4f 8µF elect. 15V
(see text)
S1 single-pole, 6-way rotary switch (make-before-break)

Transistors
TR1, TR2 OC71 (2 off) (Mullard)

Diode
D1 OA5

Battery
BY1 9 volt light duty or leakproof

Plugs and Sockets
PL1 and SK1 coaxial for the input
PL2 and SK2 coaxial for output 1
PL3 and SK3 coaxial for output 2

Miscellaneous
Printed circuit board as described in text;
Switch, single pole, on/off (optional) for battery;
Battery connectors and p.v.c. covered wire.

from the guitar is plugged into the input of the pre-amplifier. Connect the output of the pre-amplifier into the input of the guitar amplifier or some other suitable power amplifier.

Before switching everything on turn all volume controls down low, otherwise extra gain provided by the pre-amplifier will result in excessive output and may lead to damage of the loudspeaker cone.

Other uses for the pre-amplifier are too numerous to mention here, but there are some which would be very popular in the home: gramophone pick-up, radio tuner, or a microphone can all be used with this unit provided that the input impedance is not more than about 5,000 ohms.

..The AUDIODENTAL PHENOMENON

by F.R. Bertrand, B.D.S.

IT HAS been known for centuries that man can hear through his teeth, but this has not been thoroughly investigated until comparatively recent times.

The phenomenon of hearing through the teeth, or more accurately hearing through the mouth, is referred to as the "audiodental phenomenon" or AD. Through AD, man can hear speech, music etc., with clarity and discrimination that exceeds that of the ears. Artificial teeth are as good as natural teeth from the AD point of view.

Probably the most famous application of AD concerned Ludwig von Beethoven who, when stone deaf, was able to compose music by biting on a piece of wood fixed to his piano.

TRANSDUCERS

The middle ear is a natural transducer in that it changes airborne sound signals into waterborne sound signals; and deafness due to defects of the middle ear could be referred to as primary transductive deafness. The inner ear is also a natural transducer, as it changes waterborne sound signals into nerve impulses, and deafness due to defects here could be referred to as secondary transductive deafness.

A series of tests have been carried out on AD using mastoid aids, ear pieces from hearing aids and transistor radio sets. For some of these tests a mastoid aid was firmly attached or pressed against a rod, such as a dental bur. The rod transmitted sound waves to the teeth from a signal source. Such a device is referred to as a sonic probe.

FREQUENCY TESTS

Over 30 volunteers (all male) whose ages ranged from 17 to 50 years, were tested. At least ten volunteers had every single tooth tested.

The results were as follows:

(a) AD tests gave similar results to air conduction tests (AC). The frequency range was found to be 1c/s to 15,200c/s. In only a few cases the range exceeded 15,200c/s and none exceeded 20,000c/s.

(b) Different teeth gave different results, but the overall difference was small. Artificial teeth gave different results from natural teeth, but again the overall difference was small.

(c) The upper frequency limit was difficult to assess due to individual concentration limits.

(d) The sound in all cases was located in the mouth, and in fact to a tooth, by the subjects tested.

(e) Hearing was easier to obtain through the teeth when the ears were occluded. This is because reception of sound through the teeth is masked by reception of sound through the ears, at lower levels of intensity.

(f) There was a level or threshold of intensity of sound below which a subject cannot hear through his teeth.

(g) Pin point contact of the transducer with the tooth, if it is firm, is quite sufficient.

A further series of tests were carried out to compare the sensitivity of hearing through the ears and mouth. Ten volunteers (all male) whose ages ranged from 17 to 42 years were tested. Subjects were asked to determine at what frequencies the sound seemed to change from clicks to a buzz then a continuous tone. This tested the low frequency sensitivity through AD and AC.

Air Conduction

Clicks to buzz—90 to 140c/s; average 109c/s.

Buzz to continuous tone—170 to 400c/s; average 268c/s.

Audiodental Phenomenon

Clicks to buzz—50 to 80c/s; average 68c/s.

Buzz to continuous tone—80 to 210c/s; average 136c/s.

Discrimination with AD was higher than with AC.

OBSERVATIONS

Sound received by AD has the advantage of having no interference from background noise as occurs when sound is received by the ears. The sound received from AD is located to the mouth and, with a good transducer, sound can be heard and located to the mouth at the same time as it is received by the ears.

Several subjects noticed a difference in the reception of a given frequency by the anterior and the posterior teeth. For example, by placing the earpiece of a transistor radio set (connected to the radio and switched on) in the mouth on the tongue, with the lips closed and the ears occluded, sound will be heard. Now lightly holding the earpiece between the posterior teeth, the loudness of the sound will markedly increase. Holding the transducer between the anterior teeth, the quality of the sound will change, as may the loudness.

The transducers used in these tests were not designed specifically for AD, but were adapted; they were of the electro-magnetic type.

Many subjects who have been tested for AD have remarked on the quality of the sound reception, and several have referred to it as "pure" sound.

There would appear to be no reason why an AD transducer could not be plugged into a transistor radio in the same way that an earpiece is now used. One could even house a tiny radio in the bowl of a "pipe" so that mechanical sound could be transmitted to the teeth via the stem.

Such instruments may well prove of great value to many deaf people (e.g. people suffering from primary transductive deafness), as well as providing a "pure" source of sound to those of normal hearing. ★

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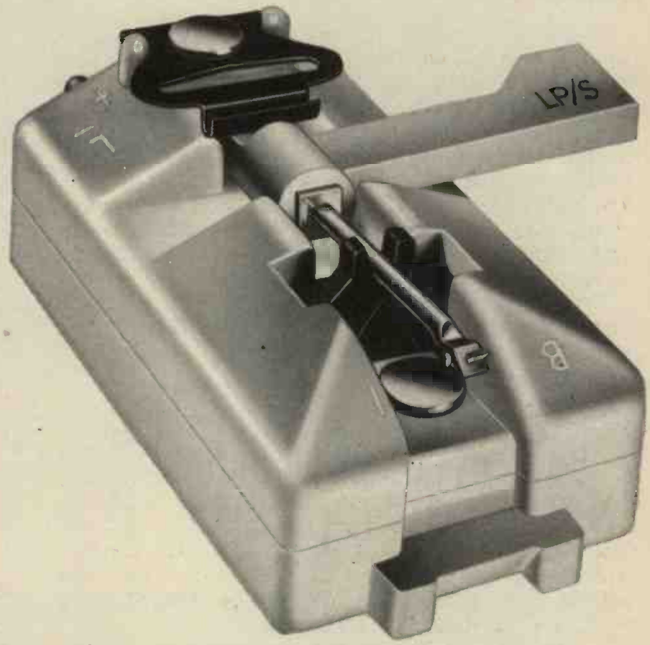

Technical Data

Compliance	5.2 x 10^{-6} cm/dyne
Sensitivity at 1 Kc/s using Decca SXL 2057 record — 1 cm/sec.	0.110 volts ± 2 db
Stylus pressure	2-3 grammes
Equivalent capacity . . .	600 pF
Loading	2 MΩ 100 pF
Channel difference . . .	less than 3 db
Channel separation at 1 Kc/s .	20 db

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Audio TRENDS...

A Commentary on Sound Reproducing Equipment by Clement Brown

THERE are three main ways of adding tape to a domestic audio installation. Perhaps the most obvious is to use a portable recorder and make arrangements for a rapid and convenient hook-up to the hi-fi amplifier. The latter's facilities and controls can be employed for recording and playback. Then there is the advantage that the recorder can be disconnected and carried off for service elsewhere when required.

This approach is perfectly satisfactory (though some times untidy) provided the machine is of adequate quality. But the non-portable recorder, designed to stand on a shelf and be permanently linked to an amplifier, is also very popular nowadays. In some cases the circuits are minus an output stage, so that playback depends on the hi-fi installation. On the other hand, a few manufacturers give the "furniture look" to complete recorders by fitting them in cabinets with handsome wood finishes.

For example, Philips have introduced the EL3556 which, in its teak cabinet, will look well in its permanent living-room niche. Priced at 62 guineas, this machine has four speeds and is designed for mono recording. Stereo playback is possible, however, and there is the multiplay facility and other features demanded by enthusiasts. Output is 4 watts. A smaller model, the EL3558 (42 guineas) is superficially similar but has one speed and different facilities.

SPECIALISED APPROACH

The third approach to tape recording in the home is a more specialised one, though fairly well known to enthusiasts and all who are interested in semi-professional equipment. A tape deck—the mechanical assembly only—is the first requirement, and a separate electronic unit links the deck to the audio installation. The aim is to provide virtually tailor-made characteristics and functions, with a high standard of versatility.

A new electronic unit of this kind is the Brenell Hi-fi Tape Link, introduced at £46. It is intended for use with a stereo deck and meets the basic requirements for recording and playback: that is, the circuits include separate record and playback amplifiers plus the bias and erase oscillator. There is response correction for four speeds, and the user can monitor while he is recording.

PORTABLE RECORDERS

Returning to portable recorders, Wyndsor's latest model, the Vanguard (59 guineas) is a four-track mono machine featuring an 8in Axiette speaker in the detachable lid. With 7½in/sec as the highest of three speeds, the push-button deck has a pause control, a digital counter and three heads. There are separate recording and playback amplifiers, and it is possible to monitor from either the tape or the input signal. Track to track recording is catered for and the output is 4 watts.

Another four-track portable, again priced at 59 guineas, is the Van der Molen model VR4, introduced by H. O. Thomas Electronics. A frequency response of 40–15,000c/s ± 3dB and a wow and flutter figure of 0·15 per cent are quoted for the top speed of 7½in/sec. The output is 5 watts and there are controls for mixing bass, treble and track selection. A useful feature is a direct output from the head at an average level of 2mV. The machine is transistorised. As it happens, both the Wyndsor and Van der Molen recorders offer an unusual advantage—suitability for operation in a vertical position.

Price reductions are not exactly an "audio trend": at least, they are not very common. However, the Telefunken Magnetophon 203 stereo recorder climbs down from 79 guineas to 69 guineas; and a new mains and recharging unit for this firm's M300 and M301 portable recorders, though better than its predecessor, is introduced at the lower price of £9 19s 6d. By the way, the M301 is a four-track version (at 54 guineas) of the M300 twin-track machine, which was made available in the U.K. some time ago.

If the enthusiast intends to make the most of tape recording he must acquire some skill in editing his tapes. Cutting and joining are routine matters; they are not difficult but accuracy is important if strong, noise-free splices are to result.

Perhaps editing will never become a lazy man's speciality, but a new accessory known as Dry-Splice should help towards convenience and speed. It is a prepared length of splicing tape, ready for use and made up in packets of 24 pieces. The unusual feature is a peel-off backing. A card applicator, acting as a guide to tape alignment, is provided.

Thorens TD124 Series 2 turntable unit

DISC EQUIPMENT

A modified and improved version of the celebrated Thorens TD124 turntable, a Metrosound speciality, has been introduced at the same price as the original model. This Series 2 unit has an improved motor suspension, and several points of detail—the controls and finish, for instance—have received fresh attention.

The Thorens TD150 turntable, mentioned in an earlier article (page 955, Nov. 1965), now has a partner—the TP13 arm. This new component, available only as part of the complete turntable unit, has an in-built raising and lowering device, a plug-in head shell and a counterbalance weight arrangement which adjusts for playing weights down to 1 gm.

This arm is very much in line with modern developments in which the aim is to reduce the mass of the arm and head shell so that the lightest and most modern cartridges can be used at low pressures. When supplied for building into a cabinet the Thorens turntable and arm have the model number TD150A and the price is £82 0s 9d.

Similarly the new Transcriptor Fluid Arm is for use with modern high-compliance cartridges. This is an extra product in the firm's range, and the original Transcriptor arm continues unchanged in price and specification. Priced at £14 12s 3d, the new arm has a fluid damping arrangement in the unipivot, designed to improve stability and performance generally. Other features are a lowering and positioning device and a bias compensator to cancel side-thrust.

This arm is for playing weights up to 3gm. It is made as a universal model which accepts most cartridges, though the maximum cartridge weight is stipulated as 16gm. There are also special versions intended for Decca and E.M.I. heads. All these are nominally 9in arms but a 12in model is available to order and at an extra charge of 2 guineas.

EQUIPMENT CABINET

It was remarked on an earlier occasion that would-be cabinet constructors can learn from the experts' methods. A splendid example of a large equipment cabinet, intended to house any combination of high fidelity units, is illustrated this month. It is the Karelia De Luxe (49 guineas), the most recent in the Howland-West range. Length is 5ft and the motor-board depth is 20in. The fittings are of anodised aluminium and the standard wood finishes are rosewood and teak.

TUNER-AMPLIFIER

De-luxe tuner-amplifiers, in wood cabinets and intended for shelf mounting, continue to arrive—mostly from Continental sources. One of the most recent is the Hi-fi Studio II, a transistorised stereo tuner-amplifier from Saba.

This ambitious unit, priced at 115 guineas, includes a stereo decoder. Other special features include switchable automatic frequency control on f.m. and adjustable bandwidth on a.m. On the audio side there are transformerless output stages rated at 8 watts sine wave power per channel. Special speaker systems for this unit sell at 58 guineas a pair. Each comprises two drive units and a crossover filter in a 0·9 cu ft enclosure of the infinite baffle type. More complete details are available from Saba Electronics, Eden Grove, London, N.7.

TURNTABLE MAT

Next an accessory for the record user. This is the Colton Antistatimat which, as the name implies, is a turntable mat designed to disperse the static charges which attract dust. The manufacturer states that the introduction of suitable materials into the rubber used for the mat has the effect of conducting away the static built up on microgroove discs. The mat, which retails at 15s 8d, is 12-in diameter and will fit most turntables. It can, however, be cut if necessary.

SPEAKER UNITS

Inexpensive speaker drive units are always of interest to audio enthusiasts. Several twin-cone models, intended for use in simple reflex (vented) enclosures, have been made available by Reproducers and Amplifiers Ltd. The smallest is the 780 Mk V, an 8in unit priced at £3 18s 6d. There are also 10in and 12in models which sell at £4 13s and £4 18s 6d. A useful leaflet, incorporating guidance on the calculation of enclosure volumes, can be obtained from the firm at Frederick Street, Wolverhampton.

Tripletone's new Series 3 electronic units, offering high quality specifications at very moderate cost, so far include the Hi-fi Major amplifier and a f.m. tuner. The amplifier is a 12-watt mono unit. The mains powered tuner, at £17 15s 10d, covers the range 86–104Mc/s and has a sensitivity of 10 microvolts for 500mV output.

Howland-West Karelia Cabinet

R & A 780 Mark V loudspeaker

ELECTRONIC BUILDING BLOCKS

PART TWELVE

by R. A. DARLEY

FOLLOWING last month's introduction to the binary code and its application in electronics, we continue the discussion with particular reference to its application in timer/counter units.

TIMER/COUNTERS

These dual purpose instruments, which can be used for measuring frequency, counting, or measuring time periods to a high order of accuracy, are widely used in many modern laboratories. The instruments are very simple to use and give a clear direct readout of the measured quantities.

In principle, the timer/counter is a simple device, but in practice it can be quite complex. To understand the principles, it is best to consider the device in each of its individual alternative modes of operation. Fig. 12.1 shows the block diagram of a simple timer/counter set-up for frequency measurement.

Frequency is, of course, referred to in terms of a number of cycles or pulses per second. A frequency measuring instrument can be based on two basic operations: a system that will "count" the pulses, and a "gate" that will pass the input signal that is to be measured into the counter for a pre-determined time only.

The input signal is fed to the amplifier and wave shaper, which converts the input signal to a form that is suitable for the counting process, i.e. a rectangular waveform with a short rise time. This waveform is then passed on to the "gate" circuit. The gate is normally closed, but can be opened for a pre-determined period by the "start/stop" circuit which, in turn, is driven from the timing generator. The timing generator is driven by the crystal oscillator, so the timing periods for which the gate is opened are very closely controlled and highly accurate. Thus, the input frequency can be measured to a high degree of accuracy.

Before dealing with the alternative modes of the timer/counter operation, it is necessary to explain the details of some of the "blocks" shown in Fig. 12.1.

INPUT AMPLIFIER WAVE SHAPER

This "block" usually uses a self-limiting circuit, employing two diodes as a non-linear potential divider network. The signal fed to the first transistor stage of the amplifier is virtually constant in peak value, irrespective of the magnitude of the input signal. The limiter is followed by a wide-band amplifier, the output of which is fed to a "squaring" circuit, usually a Schmitt trigger.

SCHMITT TRIGGER

An example of this circuit is shown in Fig. 12.2. Two transistors are employed, with a common emitter load R4. TR1 uses base-bias network R1 and R2, which have their values selected to ensure that TR1 is

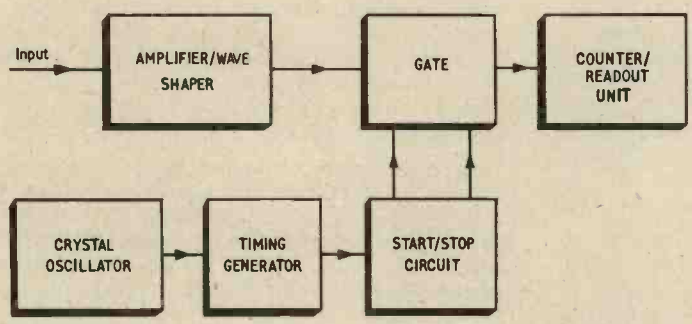


Fig. 12.1. Block diagram of equipment for frequency measurement

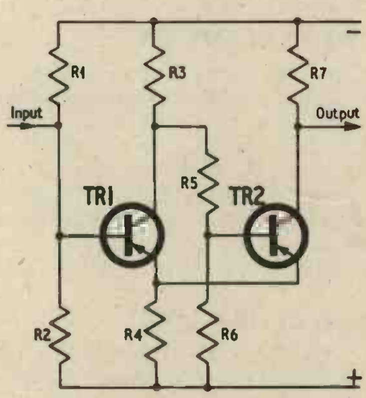


Fig. 12.2. Schmitt trigger

normally biased off. TR2 uses R5 and R6 as its base-bias network, but the top end of R5 is fed from TR1 collector; since TR1 is normally off, its collector is normally at near the full negative rail potential, and TR2 is biased hard on by suitable choice of its base-bias network. If a negative-going input signal is fed to TR1 base of sufficient magnitude to cause that transistor to begin to conduct, its collector will become less negative and so reduce the bias of TR2, thus reducing its emitter current. This results in positive feedback via the common emitter resistor R4, which further increases the emitter current of TR1; cumulative action takes place and TR1 switches hard on and TR2 switches off. When the input signal is removed the circuit reverts to its original condition. The output waveform, which can be taken from either collector, will be rectangular irrespective of the waveform of a.c. signal that is fed to the input of the circuit.

GATE AND START/STOP CIRCUITS

The gate and stop/start circuits take the same form as was shown in Fig. 10.3b in Part 10 of this series.

CRYSTAL OSCILLATOR

This block usually uses a conventional transistorised crystal oscillator, temperature controlled using an oven for the crystal to give high stability. This is followed by a wave shaping circuit, such as a Schmitt trigger, that gives an output suitable for feeding a counter stage.

TIMING GENERATOR

The timing generator consists of a series of binary "decimal" divider units of the type shown in Fig. 11.2 last month. The units are wired in cascade, the input to the generator being taken from the crystal oscillator. Thus if the crystal oscillator is working at 100kc/s, a timing cycle of 10 microseconds is available directly between pulses.

If the output is taken from the first divider stage, the timing cycle will be 100 microseconds, or if the output is taken from the fifth divider the timing cycle will be 1 second, and so on. The required timing cycle can be selected by suitable switching; typically, the following range of timing periods will be available: 10 seconds, 1 second, 100ms, 10ms, 1ms, 100μs, 10μs, and 1μs. A complete timing generator of this kind may use up to 80 transistors.

COUNTER/READOUT

The counter/readout unit consists of a series of divider units complete with decoding networks and readout facilities, similar to those shown in Figs. 11.3b or 11.4b last month. Usually, there are as many counter stages as there are sets of readout displays (between four and eight), and the complete "block" may contain several hundred semiconductors.

Let us now consider the alternative modes of operation of the complete instrument.

TIME MEASUREMENT

Fig. 12.3 shows how the unit is arranged for the measurement of time. In effect, the instrument is used as a precision electronic stop-watch. The timing period is started and stopped and the gate opened and closed manually via the external "start" and "stop" terminals. In this mode of operation the input to the gate is fed from the output of the timing generator. Thus, if the timing generator is set to give pulses at 1 second intervals, and the gate is opened for 47 seconds, the counter/readout unit will register 47 seconds. Typically, the instrument can measure periods of time in the range of 1 microsecond to several days, to an accuracy of 0·0001 per cent.

SINGLE PERIOD MEASUREMENT

The repetition frequency of a signal, as well as being expressed in terms of cycles per second, can be expressed in terms of the period between individual cycles. Quite frequently, it is necessary to know the period between two individual cycles or pulses that are not repetitive; for example, when testing a delay circuit. In this case the timer/counter is set up for single period measurement, as shown in Fig. 12.4.

In this case, the input is fed to the amplifier/wave shaper and then on to the start/stop circuit, which controls the gate. The input of the gate is connected to the output of the timing generator. Thus, the counter/readout displays the period between the two input pulses.

MULTIPLE PERIOD MEASUREMENT

For some purposes it is advantageous to measure the period of, say, every one hundred input pulses, rather than between each individual pulse. In this case the circuit may be arranged as shown in Fig. 12.5. In this case, the input is fed to the amplifier/wave shaper, but is then fed to the input of the timing generator, which is in effect a decade divider unit. The output of the timing generator is then fed on to the start/stop unit, which thus opens and closes the gate for a number of input cycles, depending on the setting of the timing generator. The crystal oscillator is fed directly to the input of the gate circuit, and the counter/readout unit will give a display in terms of microseconds, if a 1Mc/s crystal oscillator is used.

COUNTING

The instrument can be used for straightforward batch counting by arranging the circuitry as shown in Fig. 12.6. The gate is opened and closed, via the start/stop circuit, by operating the external "start" and "stop" terminals manually. The input signal is fed to the amplifier/wave shaper and thence on to the counter/readout unit via the gate.

The input signal can be derived from the objects that are to be counted in a number of ways: the objects may be made to make or break a light beam that is directed to shine on a photo-cell; a metal object may be made to pass through a magnetic field and cause an electric current to be generated.

SELF-CHECK FACILITY

An outstanding attraction of timer/counter units is that a self-checking facility is generally incorporated in the design. This facility enables the functioning of the complete instrument to be checked at the turn of a switch. Fig. 12.7 shows the block diagram of the unit for this particular function.

Two outputs are made available from the timing generator, one at, say, 10kc/s, which is fed to the input of the gate, and the other at 10 seconds between pulses, which opens and closes the gate via the start/stop circuit. Thus, if the unit is operating correctly, the counter/readout unit will register a count of 100,000.

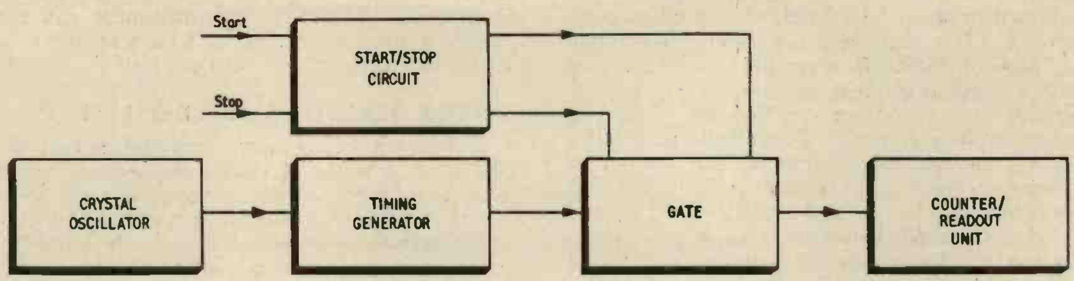


Fig. 12.3. Block diagram of equipment set up for time measurement using a counter/readout unit. Triggering is done manually through the start/stop circuit.

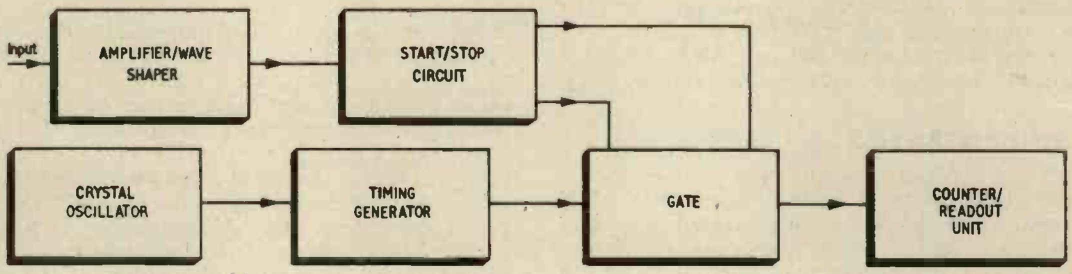


Fig. 12.4. Block diagram of single period measurement using an amplifier/wave shaper circuit

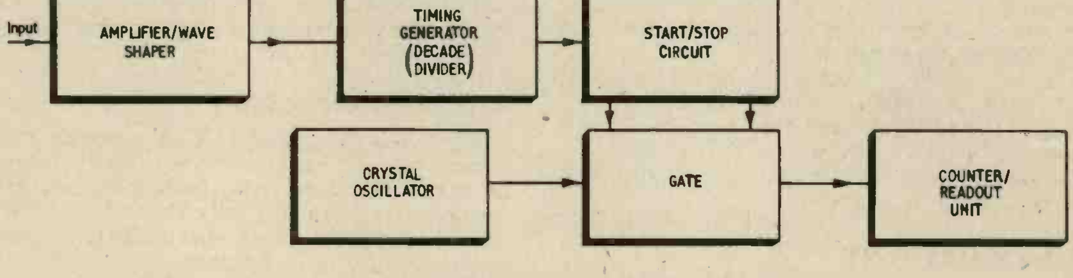


Fig. 12.5. Block diagram of multiple period measurement using a decade dividing circuit

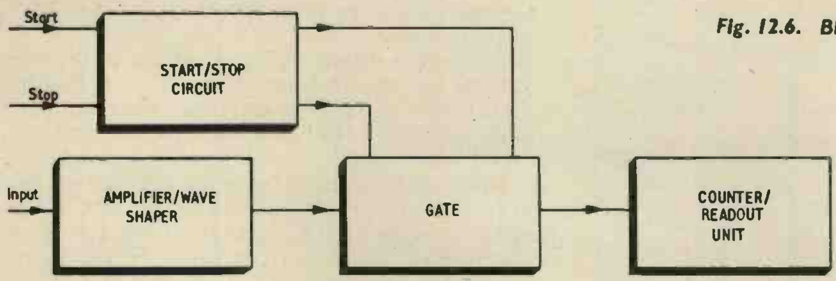


Fig. 12.6. Block diagram of a counter

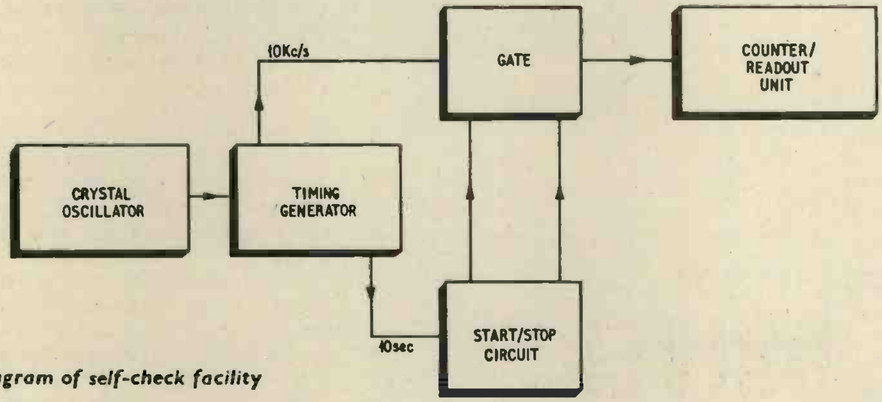


Fig. 12.7. Block diagram of self-check facility

Note that this count should be registered irrespective of the accuracy of the crystal oscillator, and that the crystal accuracy is the only detail of the instrument that is not checked automatically.

Although the impression may have been given in this article that the timer/counter requires some degree of skill to operate, needing to have its circuitry re-arranged for making different types of measurement, virtually no skill is necessary; the required mode of operation can be selected at the turn of a switch.

The instrument can be used for many applications additional to those already mentioned. It can be used to measure phase shift, speed, acceleration, distance, torque, viscosity of fluids, wind resistance, or any other properties that can be represented by an electrical signal.

READOUT METHODS

The method of readout is of considerable practical importance. One widely used system, and probably one of the easiest to read, has 10 small bulbs per readout unit, the bulbs being incorporated in a "block" with a system of lenses and numerals cut into a series of screens. Each lighted bulb projects a particular numeral onto a translucent screen on the front of the instrument.

Some instruments use a system of moving coil meters to give the readout. Each meter represents one decade and has ten calibration points, marked 0 to 9. This system is quite expensive but has the advantage that the total power consumption is considerably less than in other readout systems.

Almost all modern timer/counters have provision for feeding an output to a pen recorder, which is about the most practical system that there is for checking long term frequency drift.

Many of the old valve powered timer/counters used cold cathode tubes to give their readout displays; this system is rapidly being incorporated in transistorised equipment. Transistor inverters can be used in battery powered instruments to provide the necessary operating voltages, and the system has the great advantage that negligible power is needed to operate the tubes.

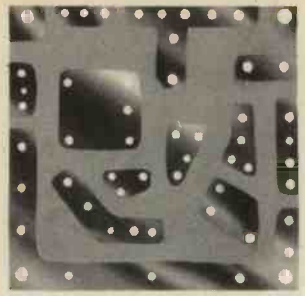
INCREASING THE FREQUENCY RANGE

Timer/counter units vary considerably in price and performance; the lower cost instruments will measure frequencies of up to 300kc/s and have only four readout units. The more expensive units may have as many as seven readout units and measure frequencies up to as high as 30Mc/s directly.

The frequency ranges of most instruments can be increased up to about 100Mc/s by the use of add-on decade divider units placed between the input signal and the timer-counter.

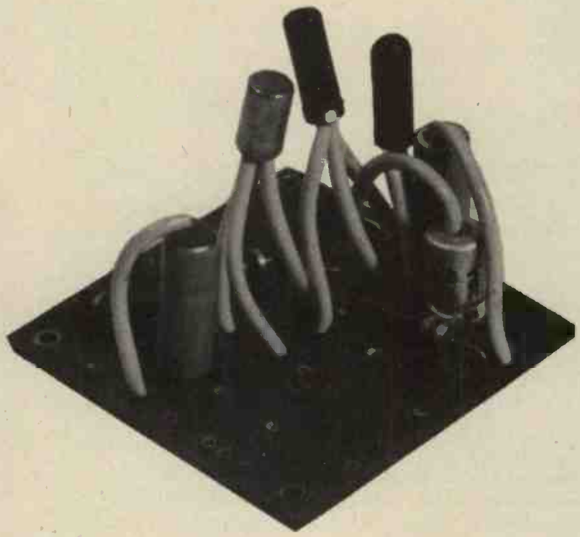
If frequencies greater than about 100Mc/s are to be measured, mixer type add-on units can be used, working on the "beat frequency oscillator" principle, and extending the operating frequencies up to a few thousand megacycles per second.

Next month: Mathematical circuits, both passive and active



BB2

DRIVER AMPLIFIER



HAVING become accustomed to the general procedure of making up a unit, it is a simple matter to proceed with building any of the other circuits described on the printed circuit pattern described in the "Bonanza Boards" article.

The circuit diagram (Fig. 1) of the driver amplifier and the component layout (Fig. 2) are very similar to those of the "Simple Pre-amplifier" described elsewhere in this issue. It will be seen that the component values are different.

The output is more powerful and can be used to drive a loudspeaker of 80 ohms impedance direct, or a lower impedance type through a suitable matching transformer. It can also be used to drive a push-pull output pair of transistors via a suitable driver transformer; a quality power output can then be obtained from this output pair.

Note that all links A, B, C, and D (see Fig. 2) are used. The load, whether it is a loudspeaker or transformer, should be connected between TR2 collector and battery negative via SK2. The input should be about 1 kilohm impedance and fed via SK1.

COMBINED

The unit as it stands is not a great deal of use on its own, but when used in conjunction with a pre-amplifier, or some other small signal source, it will provide that added boost which will give enough power to drive a loudspeaker.

Fig. 3 shows how this driver amplifier can be connected to the "Pre-amplifier" (described elsewhere in this issue) to form a high gain amplifier. It is not necessary to use two volume controls as will be seen from the alternative configurations in Figs. 3a and 3b.

Now both units are combined and will give good results from a low impedance dynamic microphone or pick-up. The "treble boost" facility can be incorporated, if required, by adopting the modification to the pre-amplifier unit as before. If a higher impedance input is required a resistor (about 100 kilohms) should be connected in series with the input.

COMPONENTS . . .

Resistors
R1 10kΩ   R3 220Ω
R2 10kΩ
All ±10%, ½ watt carbon

Potentiometer
VR1 5kΩ log. carbon

Capacitors
C1 40μF elect. 12V   C3 100μF elect. 15V
C2 100μF elect. 15V

Transistors
TR1 OC71 TR2 OC81 *or* GET104 (Mullard)

Diode
D1 OA5

Battery
BY1 9 volt light duty

Plugs and sockets
PL1 and SK1 coaxial for the input
PL2 and SK2 two-way for the output

Miscellaneous
Printed circuit board (see text)
Switch, single pole, on/off (optional) for battery
Battery connectors and p.v.c. covered wire

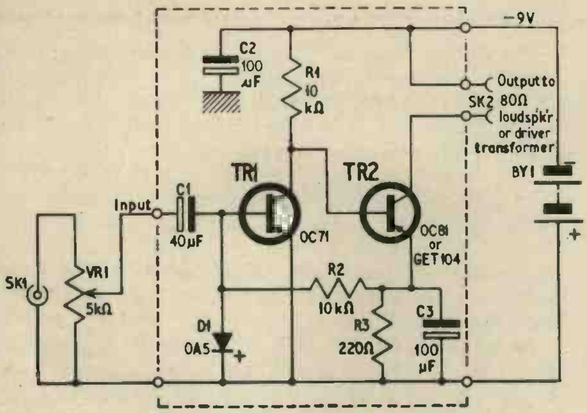


Fig. 1. Circuit of the driver amplifier. The circuitry enclosed by the dotted line is made up on the printed circuit board

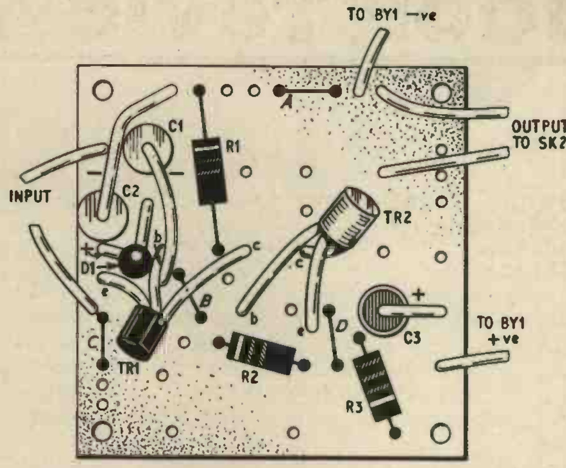


Fig. 2. Layout of components on the board. Note the link wires at A, B, C, and D

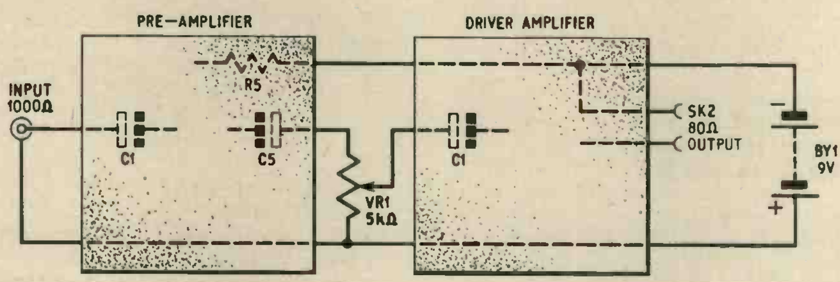


Fig. 3a. The pre-amplifier unit and the driver amplifier unit linked together to make a high gain audio amplifier with an output impedance of 80 ohms. The volume control VR1 is connected between the two boards and the input is fed direct into C1 of the pre-amplifier

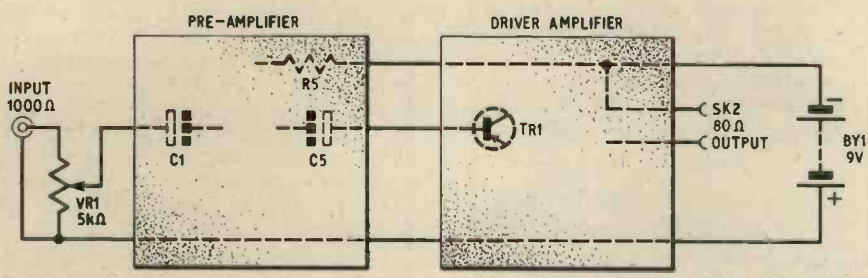


Fig. 3b. This set-up will give the same facilities as those of the circuit shown in Fig. 3a, except that VR1 is connected to the input end of the system to reduce the possibility of overloading the first stage. Notice that C5 of the pre-amplifier is connected directly to the base of the first driver stage transistor

Book reviews

MUSICAL INSTRUMENTS AND AUDIO

By G. A. Briggs
Published by Wharfedale Wireless Works Ltd.
238 pages, 8½in × 5½in. Price 32s 6d

In this, the sixteenth Briggs-Wharfedale book, the emphasis is on musical instruments as the basis of audio. In other words it is mainly about sound production—not reproduction. It is not a text-book but a readable and liberally illustrated round-up of facts and figures about instruments and the sounds they make.

Several expert collaborators have helped with such topics as organs, pianos and formants in speech and music. Mr. K. F. Russell has acted as technical sub-editor. The result is a wide-ranging text running to 238 pages including the index.

First there are notes on basic matters such as the behaviour of vibrating strings, reeds and air columns. Contrasted with traditional "mechanical" instruments are those which employ electrical and electronic techniques.

After "Various Sounds—Cause and Effect" we come to a particularly important part of the book—two linked chapters on musical instruments (which are all illustrated) and their characteristics. Then we learn about formants in speech and music. Distortion is tackled in two parts: a very brief note on distortion of the live sound is followed by comments on distortion in reproduction.

There are chapters on pipe organs, electronic organs, pianos and tuning. A final chapter on music in schools contributes much charm—and some lovely pictures—but adds little on the subject of musical instruments.

Once or twice I thought the author's humorous touches were getting too subtle for me. The heading "psycho-acoustics" might have heralded a choice contribution from Professor Colin Cherry, but instead it concerns an American who has hidden his speakers behind a decorative screen (sensible fellow).

This is a fairly expensive publication and it is surely reasonable to expect more imaginative typographical design than is displayed here. But the book is fascinating and demands the attention of those who would like an easy-going account of a complex subject.

C.B.

ITV 1966

Published by the Independent Television Authority
224 pages, 9in. × 7in. Price 7s 6d

This new edition of the ITA handbook covers the whole field of Independent Television from the work of the authority and the programme companies to the advertising and the transmitters.

The major portion of the handbook is devoted to programme matters. The technically minded viewer will find some interesting reading in the chapter describing technical operations and in the particulars of the individual transmitters. Over 300 photographs are included.

PRACTICAL STEREOPHONY

By H. Burrell Hadden
Published by Iliffe Books Ltd.
155 pages, 8½in × 5½in. Price 37s 6d

"Stereophony was born out of the desire to create in the mind of a person listening to a broadcast or a recording, the illusion that he was actually present at the live performance. . . ."

The note on the jacket of this book summarises the whole essence of H. Burrell Hadden's profound description of all aspects of stereo. Yet at the same time his writing is lucid enough for amateurs to grasp the full implications of the subject.

Beginning with the theories of hearing and methods of creating a stereophonic effect, through the history of stereo development, to the techniques involved in recording, broadcasting and reproduction, practically all that one needs to know for achieving stereophonic bliss in the home is packed into these 155 pages.

Incidentally, mono enthusiasts who cannot afford stereo can learn a great deal from this book, too!

M.A.C.

THE TAPE RECORDER

By C. G. Njisen
Translated from the original Dutch book by J. B. Wright
Published by N.V. Philips Gloeilampenfabrieken
Distributed in the U.K. by Iliffe Books Ltd.
142 pages, 8½in × 5½in. Price 13s 6d

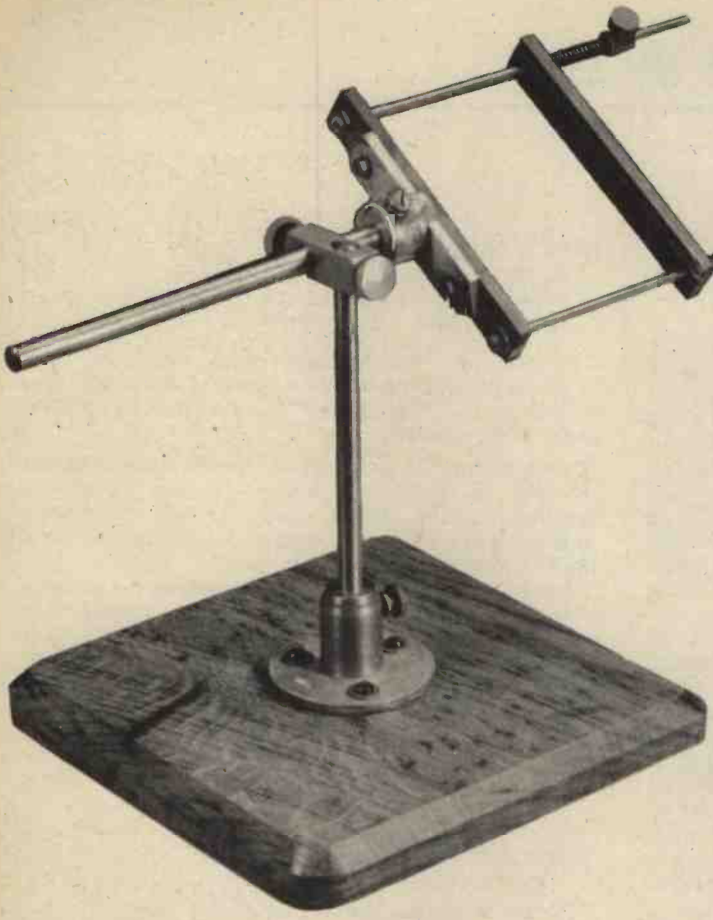
As long ago as 500 B.C., we are told, a Greek philosopher, none other than Pythagoras, carried out investigations into the nature of sound. He produced high and low tones by causing pieces of gut to vibrate. But only in recent times has the science of sound been so intimately exploited. In fact the tape recorder, or the "telegraphon" as it was then called, was patented in 1900 by the Danish engineer Poulsen. It seems rather strange, therefore, that another 50 years should pass before the tape recorder caught the eyes and ears of domestic users on a large scale.

Today tape recording in the home, in schools and clubs is a booming hobby. Amateur, as well as professional tape recordists will find this paperback book a valuable asset and, no doubt, will find a great deal of both technical and practical advice to help with their hobby.

Explanations are included of what sound is; how it can be recorded; how the tape recorder works; its practical uses; getting the best from your recorder; about ancillary equipment; maintenance and fault finding; acoustics and their effects; stereophony in practice; choosing a recorder; practical advice on making recordings; microphone techniques; copying and editing . . . You name it, this book is very likely to explain it!

Tape recording has much to offer as a hobby; this book has much to offer the hobbyist.

M.A.C.



WIRING BOARD HOLDER

by M.E.FRANCIS

THE WIRING of the printed circuit boards and similar wiring boards by amateurs for electronic designs and equipment, presents a problem when trying to hold them in a convenient position and height whilst working on them. The clamp stand described here solves this problem and need not cost more than a few shillings. Most of the material can be found in the experimenter's odds and ends box, or in a shop dealing in second-hand articles.

The board is held by spring pressure between two s.r.b.p. strips supported on two rods, carried on an adjustable stand similar to a clamp stand used in science laboratories. It can be held at a convenient height and position by the adjustable clamps and thumb screws.

To set the board in the clamp the sliding s.r.b.p. strip is set to the width of the printed board by loosening the thumb screws on the spring retaining collars. The board is then inserted in the grooves. The spring retaining collars are slid along and tightened until the board is held firmly by pressure from the springs.

To remove the board, pull the sliding s.r.b.p. strip back against the springs and slip the board out of the grooves.

The board is placed in the clamps with the copper strips uppermost. This gives free access for soldering components to the strips. This clamp stand will hold wiring boards of any width up to about 6 inches, and any length.

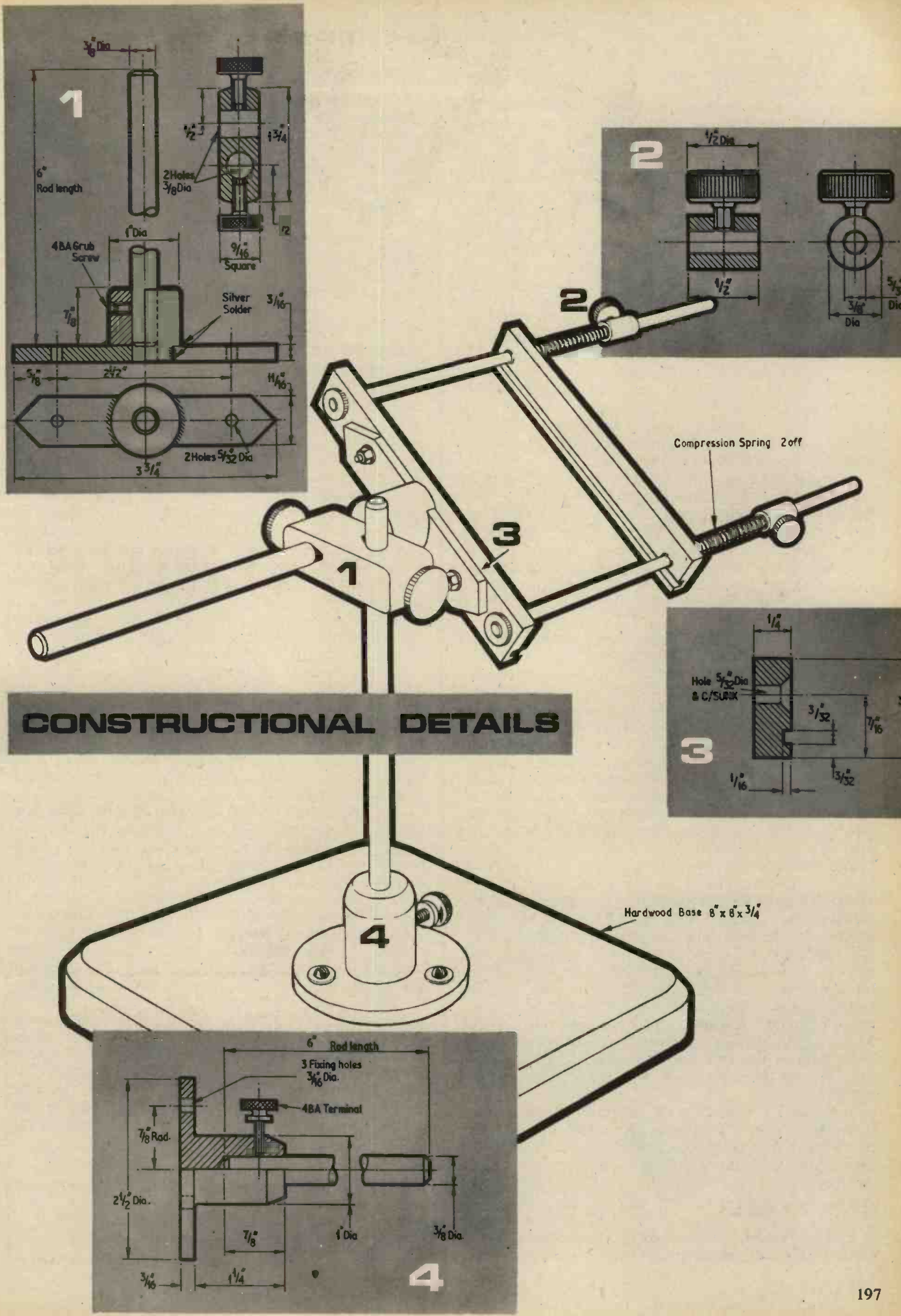
HOW TO MAKE

Two pole pieces from discarded loudspeakers are used and drilled $\frac{3}{8}$in diameter in the centre of each pole piece to take the $\frac{3}{8}$in diameter rods. Next drill and tap a 4B.A. hole (no. 32 or $\frac{5}{32}$in drill) through the side of each pole-piece to take the grub and thumb screws. Use tapping grease when cutting screw threads with a tap or die. This will give a smooth clean thread.

One pole piece is used to fix the clamp to the base and uses a 4B.A. thumb screw (see detail 4). The other pole-piece will need to have its plate shaped. Alternatively this plate can be made separately and fixed to the 1in diameter boss by silver soldering, brazing, or welding (see detail 1).

YOU WILL NEED . . .

- Hard wood plate 8in × 8in × $\frac{3}{4}$in
- Pole pieces from old p.m. loudspeakers (2 off)
- Steel rod $\frac{3}{8}$in diameter—6in long (2 off)
- S.R.B.P. strip $\frac{3}{4}$in × $\frac{1}{4}$in × 5in (2 off)
- Square strip steel, brass, or duralumin, $\frac{5}{8}$in × $\frac{5}{8}$in × $1\frac{3}{4}$in
- Collars—$\frac{3}{8}$in o.d. × $\frac{1}{2}$in long with $\frac{5}{32}$in dia. hole (2 off)
- Silver steel rod $\frac{5}{32}$in diameter, 8in long (2 off)
- Compression springs $\frac{3}{16}$in inside diameter 2in long (2 off)
- Screws 4B.A. $\frac{1}{2}$in long with large knurled head (3 off)
- Screws 2B.A. $\frac{1}{2}$in long with large knurled head (2 off)
- Lock nuts for silver steel rod, 4B.A. steel (4 off)
- Nuts and bolts 4B.A. (2 off each)
- Grub screw 4B.A. (1 off)
- Wood screws $\frac{3}{4}$in No. 8 round head steel (3 off)


1
3/8" Dia
6" Rod length
1/2"
1 3/4"
2 Holes 3/8 Dia
9/16" Square
1" Dia
4 BA Grub Screw
7/8"
Silver Solder
3/16"
5/8"
2 1/2"
11/16"
2 Holes 5/32 Dia
3 3/4"
2
1/2" Dia
1/2"
3/8" Dia
Compression Spring 2 off
3
1/4"
Hole 5/32" Dia & C/SUNK
3/32"
7/16"
1/16"
3/32"
CONSTRUCTIONAL DETAILS
4
Hardwood Base 8" x 8" x 3/4"
6" Rod length
3 Fixing holes 3/16" Dia.
4BA Terminal
7/8" Rad.
2 1/2" Dia.
7/8"
1" Dia
3/8" Dia
3/16"
1 1/4"
4

On the plate of one pole-piece two holes are drilled (across the diameter) to bolt one of the s.r.b.p. strips to it with countersunk head 4B.A. screws. One of the original holes can be used for one of them (detail 1).

A piece of ⅜in square steel, brass, or duralumin, 1¾in long is drilled with two ⅜in diameter holes at right angles to each other (see detail 1) with a 2B.A. tapped hole (no. 24 drill) in each end for the thumb screws.

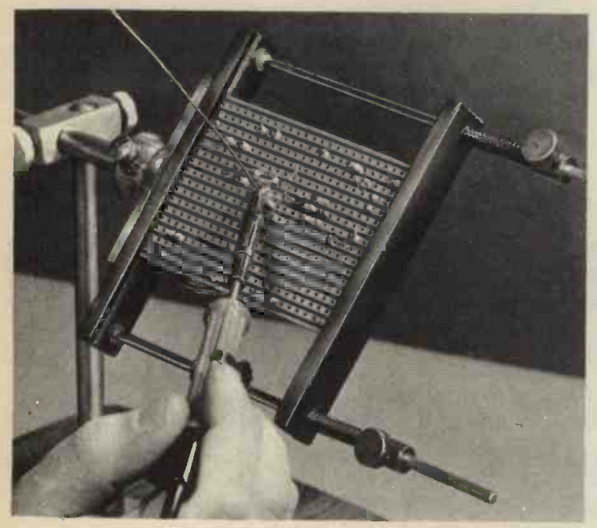
The cutting of the groove in the s.r.b.p. strip may present a little difficulty, and should be done carefully. Mark out the groove with a scriber; then clamp a piece of wood on top of the strip with the edge of the wood in line with the scribed line. With the side of a tenon saw pressed against the piece of wood, carefully saw a slot 1/16in deep in the s.r.b.p. strip. Move the wood to the other scribed line and repeat the procedure. Do the same for the other piece of s.r.b.p. strip. The small piece of s.r.b.p. left between the saw cuts can be scraped out with a small sharp chisel or knife.

Next drill the holes for the 3/32in diameter rods at the end of each s.r.b.p. strip; at the same time drill the holes in one piece for the 4B.A. bolts to hold it to the "pole-piece" plate. If the holes for the 3/32in rods are drilled in both s.r.b.p. strips while clamped together, it will ensure that they are in line when assembled.

The 3/32in rods can either be silver steel or "Meccano" axles; the spring retaining collars can be "Meccano" bosses or bored pillars (see detail 2). One end of each rod is threaded 4B.A. and bolted to the fixed s.r.b.p. strip. Place one 4B.A. nut on each rod and pass the screwed portion through the end holes in the fixed strip; lock in position with the other nuts. Bolt the s.r.b.p. strip to the pole-piece plate with the 4B.A. countersunk head screws (see detail 3).

Next place the other strip on the 3/32in rods and fit the two springs, one on each rod. Place the spring retaining collars, one on each. A 4B.A. tapping hole is drilled (no. 32 drill) and tapped through the side of each for the thumb screws. If the holes in the sliding strip are a bit too tight to allow it to slide freely they can be enlarged carefully with a small round file or reamer.

The baseplate is prepared from a piece of 8in square hard wood about ¾in thick; this large size gives some degree of stability. The edges can be chamfered and the corners rounded for a neat appearance. The other pole piece is screwed to the centre of this board using round head screws through the holes in the plate of the pole piece (see detail 4). ★



RADIO CONTROL OF MODELS

continued from page 179

additional disadvantage is that the shorter aerial (usually 48in telescopic) further reduces overall efficiency and hence power output.

Fortunately, however, with "tone" equipment signal strength is not so important as with carrier wave operation. Thus a suitable tone transmitter-receiver combination can operate over a satisfactory range with much less signal power. The hand-held carrier wave transmitter, however, shows distinct limitations as regards range, unless particular attention is given to realising a high circuit efficiency and good aerial coupling and aerial efficiency.

USING TRANSISTORS

Restrictions on the power output available from existing transistors delayed the appearance of the satisfactory all-transistor transmitter. With types now available, however, sufficient power can be fed into the aerial for satisfactory operation at comparable ranges, although the actual power output is normally considerably lower than that realisable with valve transmitters. To compensate for the lower power into the aerial it may be necessary to increase aerial efficiency with a centre loading coil (equivalent to increasing the effective length of the aerial); with refinements in receiver circuit design increasing sensitivity without sacrificing stability and thus enabling the range to be maintained at much lower signal strengths. The superhet receiver is particularly attractive in this respect; but many conventional super-regenerative receivers may have "marginal" performances allied to an all-transistor transmitter.

Range, as such, is largely an arbitrary figure and becomes specific only when applied to a particular transmitter-receiver combination. Thus with the same transmitter, one receiver may continue to respond up to, say, two miles and another receiver only to a hundred yards or so, although both may be properly tuned, simply because of the difference in receiver sensitivities involved.

Working range is also affected by operating conditions. For model aircraft control, ground-to-air range is considerably greater than measured range ground-to-ground established by a practical check. In such cases a ground-to-ground range is usually more than adequate. With other applications it may be the ground-to-ground range which counts, and the range involved may be relatively short (e.g. 100 yards or less). In such cases transmitter power becomes even less significant and simplified transistor circuits may be satisfactory with small capacity batteries and lower power input.

The particular attraction of the all-transistor transmitter is its compactness, allied to low input voltage demands and consequently low battery costs. Circuit stability, however, may be more critical, especially in working the output transistor to its limit. In such cases a change in loading, such as produced by operating with a retracted aerial, can result in damage to the output transistor in some circuits.

REFERENCES

1. Ivy-AM transmitter, produced in kit form by Macgregor Industries
2. Kraft
3. Min-X "Powermaster" single-channel transmitter
4. Orbit single-channel transmitter

Next month: Single channel receivers

NEXT MONTH!

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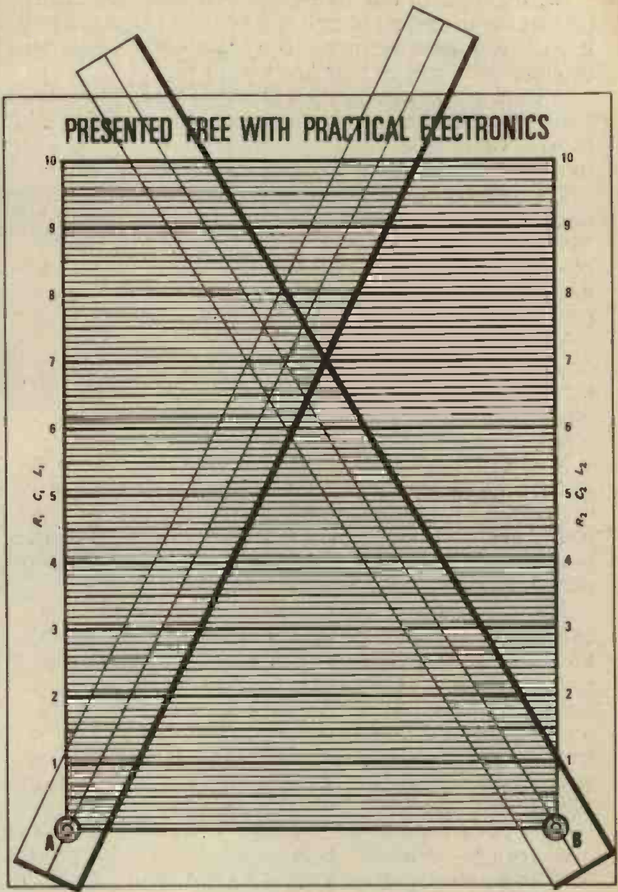

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ELECTRONORAMA

HIGHLIGHTS FROM THE CONTEMPORARY SCENE

Fighting the Crime Wave

WHAT HAS a van such as this got to do with electronics? It is one of a number of vehicles armed with electronic devices aimed at out-witting the potential thief.

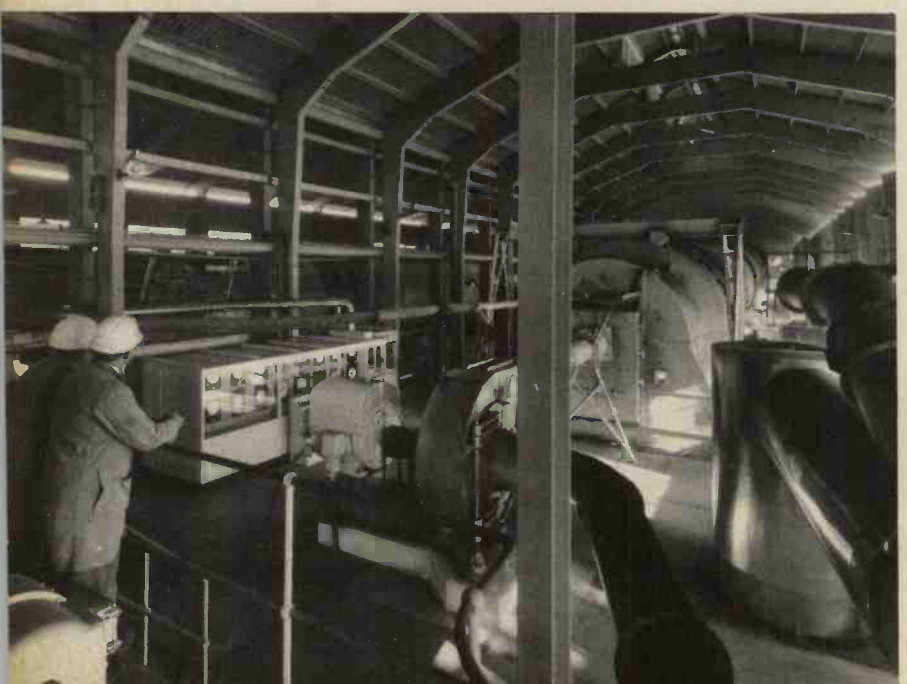
The Keyless Key Company of Walworth, London, is mounting a battle of brains against car thieves, pay-roll bandits, and hi-jackers by using ingenious electronic systems. The basic "Keyless Key" is designed to be fitted in addition to, or in place of, existing starter switches and operates on a combination system.

The "Securelay" has an added refinement. If a would-be thief manages to get under the bonnet and tries to start the car by bridging the coil, battery or fuses, the horn will sound and the ignition stay dead.

One device designed to beat the lorry thief is a manual alarm with diesel immobilisation. On arrival at his destination, the driver turns a key which immediately locks the fuel by an electric solenoid in the fuel line.

A special anti-hi-jacking system can be fitted to heavy vehicles. To enter the vehicle the driver operates a key switch and has 30 seconds to get into his cab. If the driver is attacked and the door opened by attackers, the alarm will sound and the engine will be immobilised. A similar condition operates when he leaves the cab.

Of course, we cannot divulge the appearance or circuitry of these units.



Cement Kiln

A NEW electronic controlled 500ft kiln, one of the largest in Europe, is now fully operational in the Blue Circle works of Associated Portland Cement Manufacturers Limited. Our picture shows the firing end with the electronic equipment, developed by Honeywell Controls, to provide means of recording, indicating, and controlling at optimum values, variables necessary to ensure continuous production at minimum fuel costs.

TV Pictures are Kept Clean

HAVE YOU ever stopped to think that the quality of your television picture depends to a large extent on the cleanliness of the camera tube. Here is a picture to show just how clean they have to be. A copper mesh (as used in a 4½in image orthicon tube) is being inspected by using oblique illumination from a projector.

The mesh provides a conducting surface but allows a high proportion of electrons to pass through. A dust particle on the mesh would stop some electrons and create a blemish on the television picture produced by the tube.

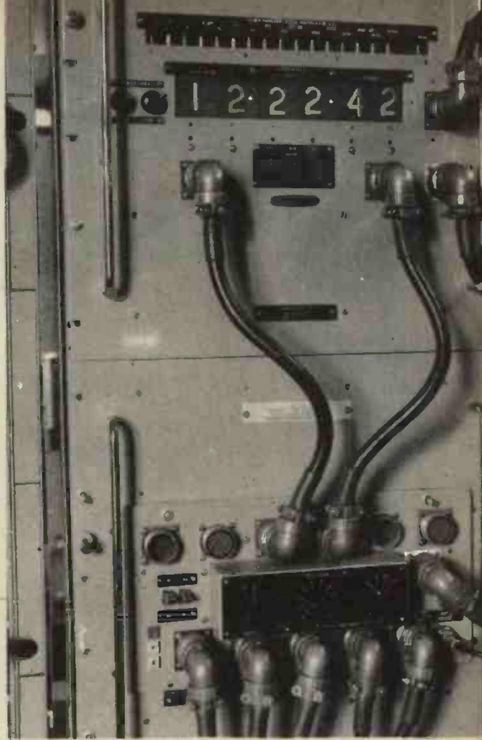
These particular meshes are made by E.M.I. at Hayes, Middlesex.

Microwave Repeater

THIS IS one of the six repeater station towers on the Post Office microwave link between London, Birmingham, and Manchester.

It is fitted with flexible waveguide rather than the conventional rigid type to simplify installation and reduce planning time. The waveguide is manufactured by a West German firm—Hackethal-Draht-und-Kabel-Werke Aktiengesellschaft and supplied by Livingstone Laboratories.

The microwave reflectors at the top of the tower are similar to those used on the London P.O. radio tower.



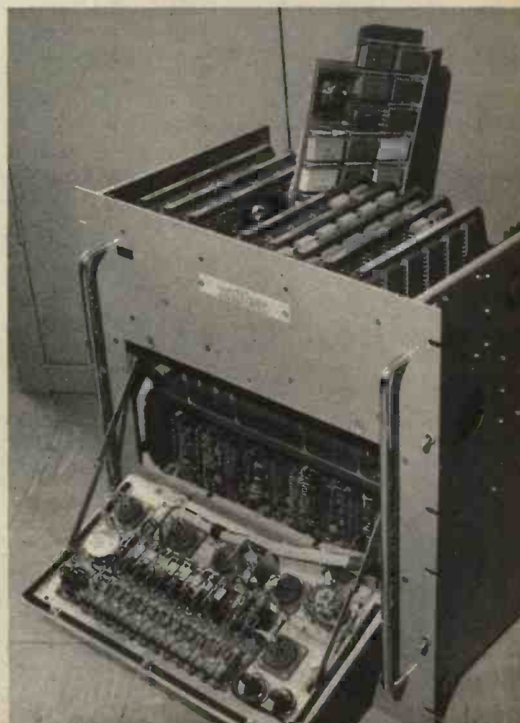
Pay As You View

BRITAIN'S first pay television was inaugurated by Mrs. Harold Wilson, wife of the Prime Minister, and the Rt. Hon. Anthony Wedgwood Benn, M.P., Postmaster-General, at the Hilton Hotel, London, on 7 January.

The service is open to subscribers to Pay-TV and British Relay in Westminster and Southwark over closed circuit land lines, and is on trial for three years. The service will be extended later to Sheffield.

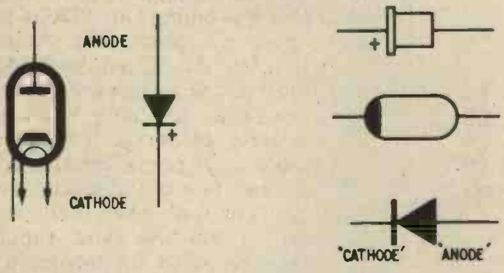
The master rack of equipment (above) at British Relay's London control centre shows (top to bottom) the viewer popularity gauge, the time check indicator and its controls, and the device used to set the price charged for the programme.

Each slave rack (shown below) comprises electronic calculators like this, each of which caters for 4,000 pay-television subscribers. It measures continuously the number of subscribers watching a programme and relays this information to the master rack. It also sends out the programme price pulses which operate the individual subscriber's meter.



BEGINNERS start here... 17

An Instructional Series for the Newcomer to Electronics



(a) (b)

Fig. 17.1 (a). Circuit symbols for (left) a thermionic valve diode and (right) a semiconductor or "solid state" diode

Fig. 17.1 (b). The outline shapes of two types of semiconductor diode. The "cathode" (see symbol below) is usually identified by a "+" or coloured mark on the body of the component

TO follow up the two filter units described in last month's article, we now consider a pair of suitable rectifier units. But, before we discuss the construction of these units, it may be a good idea to revise what we are doing with such devices as the filters and rectifiers, and why pairs of each type of unit are required. We have really put the cart before the horse, because the filters *follow* the rectifier units to produce a smooth, steady d.c. supply from them. The rectifiers will produce d.c., from the a.c. coming in via the transformer, but it is pulsating d.c. The filters smooth out these pulses.

DIFFERENT REQUIREMENTS

We require two different kinds of smooth d.c. according to whether we are using valves or transistors.

COMPONENTS . . .

LOW VOLTAGE RECTIFIER

D1–D4 Silicon diodes 200V peak inverse voltage (p.i.v.) 500mA. Lucas DD003 or Texas IS113 (Henrys Radio) 4 off.

T1 Filament transformer. Primary tapped at 0, 210, 230 and 250V. Secondary 13V 0·5A Radiospares "Standard" type.

Wooden baseboard 5in × 3in × $\frac{1}{2}$in.

HIGH VOLTAGE RECTIFIER

D1–D4 Silicon diodes 800V peak inverse voltage (p.i.v.) 500mA. Mullard BY100 4 off.

T1 Mains transformer. Primary tapped at 0, 200/220, and 230/250V. Secondaries: 0–250V 60mA; 6·3V 2A. R.S.C. Ltd. "Midget" type.

Wooden baseboard 6in × 4$\frac{1}{2}$in × $\frac{1}{2}$in.

Miscellaneous Items for Both Units

Three-way terminal block. Tag-strip—four tags plus two fixing tags. Brass wood screws. Plastic covered wire. Material for cover. Three core mains lead and plug.

Valves require a high voltage, with usually small currents only. Transistors, on the other hand, draw quite heavy currents at a low voltage. We can say valves are *high impedance* devices, while transistors are *low impedance*. Hence we have a high impedance filter/rectifier supplying 200 volts at about 50 mA for small valve units, and the other (low impedance) filter/rectifier set supplies around 12 volts at up to an ampere for transistor work. These differences account for the differences in the component values in the two filters.

There are two methods of changing the mains a.c. supply into pulsating d.c. One, the *half-wave* system, allows only one half cycle of the a.c. waveform (on, say, the positive half) to reach the output. There is quite a long wait while the other half cycle is occurring before the next pulse. The other method uses *both* half cycles, and is therefore called a *full-wave* rectifier system. This method cleverly switches both half cycles appropriately to produce pulses of output with the same polarity. The pulses follow each other without any delay.

Because the full-wave method is more efficient we have used it here, and although a few more rectifiers (or diodes) are required, the investment is well worthwhile because of this efficiency. Either *valve* diodes or *semiconductor* diodes can be used. (We will discuss how these devices work at a later date.) Semiconductor diodes are much smaller than valves, they require no heating, and they are essential for the low voltage unit anyway, so we will specify them for both units. The symbols used for diodes are shown in Fig. 17.1.

HOW THE CIRCUITS OPERATE

The circuit diagram of the low voltage rectifier unit appears in Fig. 17.2. The high voltage rectifier circuit is given in Fig. 17.4.

The action of both circuits used in our units is roughly as follows. The diodes (D1–D4) offer a low resistance to current in one direction, but offer an extremely high resistance in the reverse direction. In effect, they conduct only in the direction of low resistance; this is referred to as the *forward* direction. The diodes can be considered as polarity operated switches.

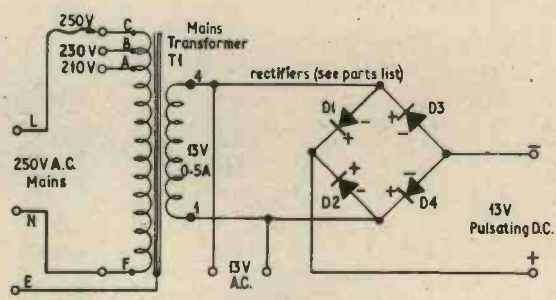


Fig. 17.2. Circuit diagram of low voltage rectifier unit

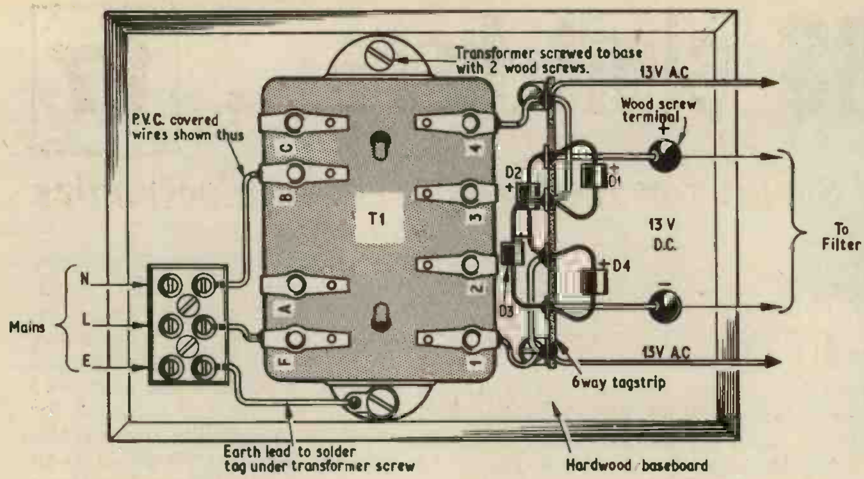


Fig. 17.3. Top view of the low voltage rectifier unit

The four diodes D1–D4 can be mounted on the tag strip, with the appropriate leads already coming out. Quite an important point you should bear in mind, is that the diodes must be the correct way round, otherwise the unit will not operate, of course. Furthermore it is pretty certain that at least two of the diodes will be destroyed when switching on for the first time, should they be wired up incorrectly. The positive end of these diodes is marked either by red paint or by a "+". See Fig. 17.1.

When a.c. is applied to the diodes, they alternately switch on and off in step with the alternations of polarity of the supply voltage. For example, when the top end of the transformer secondary ("4" in Fig. 17.2) is positive, the diodes D1 and D4 conduct. When this point swings negative on the following half cycle, these two diodes cease to conduct and a path for the current is now provided via D3 and D2. In our two circuits, the four diodes form what is known as a *full-wave bridge* rectifier.

Apart from the d.c. outputs, we arrange on both units to have available a low voltage a.c. supply. This is obtained directly from the 13V secondary of T1 in Fig. 17.2. In the case of the high voltage unit, the midget mains transformer in Fig. 17.4 has an additional secondary winding which provides 6·3V.

CONSTRUCTION DETAILS

Once again, the parts are mounted onto a standard wood base as in the case of the other units in our constructional series. The a.c. mains should not be connected into the units by the "woodscrew" method, this is not really safe enough. A plastic terminal block is therefore specified for this purpose.

All wiring for the low voltage unit is clearly shown in Fig. 17.3. The arrangement of the high voltage rectifier unit is very similar, but in this case the mains transformer has flying leads, instead of tags. These leads are colour coded and should be connected up as indicated in the circuit diagram (Fig. 17.4). Also, this mains transformer is larger than the component used in Fig. 17.2 and so a larger baseboard is required. Mount the transformer so that the side the leads emerge is adjacent to the diode tag strip.

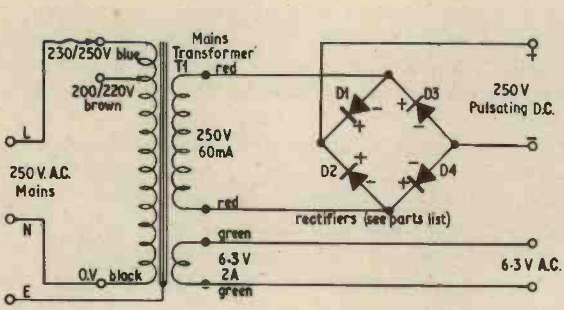


Fig. 17.4. Circuit diagram of the high voltage rectifier unit

A PROTECTIVE COVER

A cover should be made which will box in the bare tags which have large voltages across them. *Once again we must state the need to respect the mains and take precautions when using mains operated equipment.* Perhaps an insulating cover of hardboard or plywood could be made this time. If a perforated zinc cover is constructed as described for the filter units, then internal pieces of insulating material should be used, adjacent to high voltage points. This metal screen should be securely connected to the third (earth) lead on the mains cable. It goes without saying that a "three-pin" system should always be used with such apparatus as we are discussing.

When everything is completed, the units are ready for initial operation. Carefully check all lead positions and rectifier directions, and see that earth connections are intact, then plug in to the mains supply and switch on. A small 6 volt lamp connected across the 6·3 volt a.c. terminals of the high voltage unit will provide an indication as to whether current is available or not. Avoid the h.t. output terminals of the high voltage unit, as up to 300 volts is developed across them when the unit is operating.

Two similar lamps connected in series can be used to check the 13 volt output of the low voltage unit.

CONNECTING UP THE FILTER

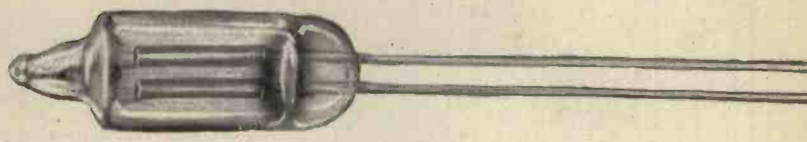
Connect terminal *A* on the filter unit (refer back to Fig. 16.1) to the positive (+) terminal on the rectifier unit. Connect terminal *B* to the negative terminal on the rectifier unit.

With the appropriate filter connected in place on the rectifier output, the set of voltage supplies available to you is as follows:

(*a*) 13 volts smooth d.c. and 13 volts a.c.
(*b*) 250 volts smooth d.c. and 6·3 volts a.c.

Remember to avoid these two small hazards: Do not mix up the filter units, and always connect the units the correct way round regarding polarity. No switch is incorporated in either unit because the three-pin system with which these units are meant to be used has switched plug/socket units, which are also fused. If you require a switch, then one of the excellent lead switches can be fixed into the mains cable.

NEON NOVELTIES



THIS is the seventh 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.

SEVEN NEON TIMER

by R. Bebbington
GRAD.I.E.R.E.

THIS device is equally useful in kitchen or darkroom or wherever there is a need to measure small intervals of time. Simply select the time interval required and switch S1 to "start". When the period of time selected has elapsed the neon indicator will glow. As a refinement, an audio indication may also be obtained by connecting the output to an audio amplifier and loudspeaker.

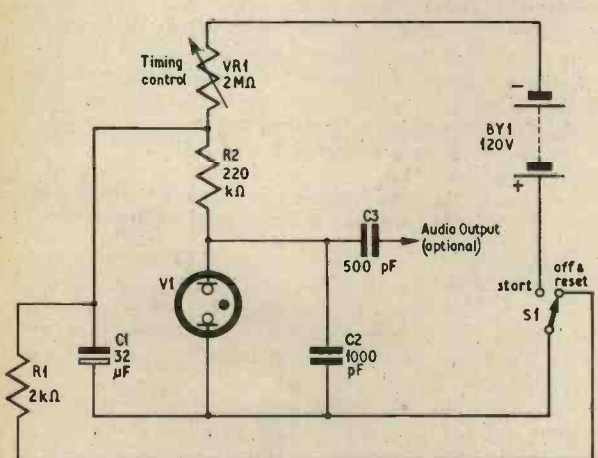


Fig. 1. Circuit diagram of the neon timer

Basically the circuit consists of a neon in parallel with an electrolytic capacitor (C1) which charges through a variable resistor VR1. The neon glows when C1 has charged to a potential in excess of the striking potential. The time taken depends upon the *RC* time-constant and, since it is easier to vary the resistance, a 2 megohm potentiometer (VR1) is used. If long time intervals are required however, a parallel network of switched capacitors may be employed.

It is an easy matter to calibrate the timing control using the seconds hand of a watch. Table 7.1 shows the time-constants for different *RC* combinations.

TABLE 7.1 TIME CONSTANTS

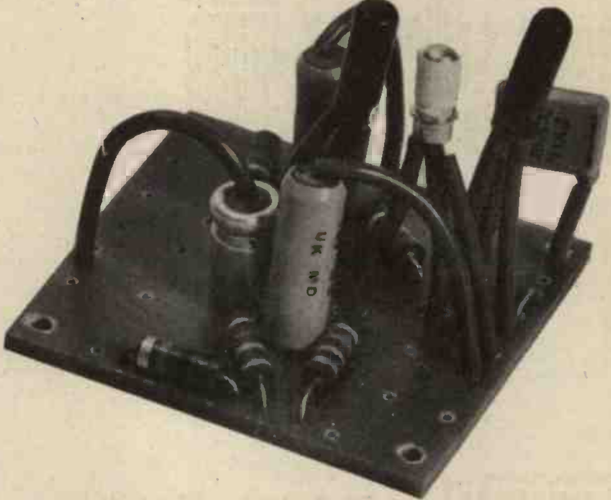
R	*C*	*Time Interval* (seconds)
220kΩ	12µF	4
220kΩ	32µF	10
1MΩ	12µF	16
1MΩ	32µF	40
2MΩ	12µF	45
2MΩ	32µF	120

For longer intervals it is more desirable to increase the capacitance of C1 rather than increase the resistance of VR1. If too high a series resistor is chosen then leakage problems may be encountered and inaccuracies result.

The reset position of the start switch S1 is also the "off" position. It is a single-pole change-over switch which disconnects the battery and discharges C1 in the "off and reset" position. In the "start" position R1 is disconnected, the battery contact is made, and the chosen time interval commences. All one has to do now is to sit back and wait for the neon to glow, indicating the required time delay.

A.M. RADIO TUNER

BB3



THE same printed circuit board (described in the "Bonanza Boards" article) can be used to construct a simple radio tuner for personal listening with an earphone. It can be coupled to the driver amplifier to provide a higher output for loudspeaker listening, as will be seen later.

Fig. 1 shows the circuit diagram of the tuner using a ferrite rod aerial, tuning capacitor and earpiece in addition to the printed circuit board components.

Fig. 2 shows the component layout. The only links required are C and D. If you wish to use a crystal earphone as shown in Fig. 1, C4 can be left without any connection or omitted altogether.

The ferrite rod aerial and tuning capacitor VC1 are types which are commonly used for medium and long waves. Those who wish to make their own tuning coils can use a piece of ⅜in diameter ferrite rod and wind 50 turns of 28 s.w.g. enamelled copper wire in a single layer for L1. This will tune with VC1 for medium wave stations. If long wave stations are required L1 should have 160 turns of the same wire layer wound. L2 is wound either on top of or close to L1 and consists of 5 turns of 28 s.w.g. enamelled copper wire.

It is a desirable precaution, although not strictly necessary, to wrap a thin sheet of paper round the ferrite rod before winding. This will help to prevent short-circuited turns, which could arise if the enamel is chafed.

The tuning capacitor is 350pF; a mica dielectric type is suitable here. If reception is difficult by reason of locality or screening when used in a car, L1 can be "tapped" one-third of the number turns from the "earthy" end and an aerial wire attached. Alternatively an extra coil with one-third of the number of turns as on L1 can be wound on the same ferrite rod. One end of this winding is earthed; the other end is connected to the external aerial.

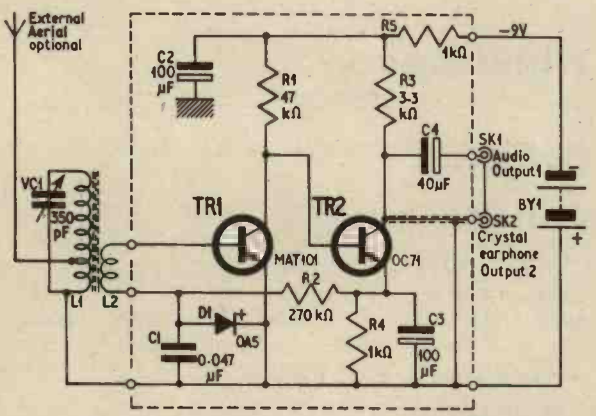


Fig. 1. Circuit of the a.m. radio tuner. The components outside the dotted line are mounted on a suitable metal box which houses the whole tuner (see text). Components inside the dotted line are assembled on the printed circuit board

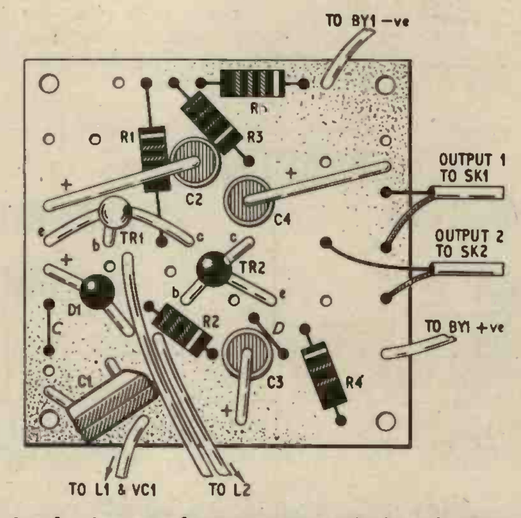


Fig. 2. Layout of components on the board. Notice the link wires C and D and the leads to the coils L1 and L2. Output 1 can be fed into an audio amplifier such as the driver amplifier described elsewhere in this issue. Output 2 will provide a low level signal for a crystal earpiece.

COMPONENTS . . .

Resistors
R1 47kΩ
R2 270kΩ
R3 3·3kΩ
R4 1kΩ
All ±10%, ½ watt carbon

Capacitors
C1 0·047μF mica
C2 100μF elect. 15V
C3 100μF elect. 15V
C4 40μF elect. 12V
VC1 350pF mica or air dielectric, variable

Transistors
TR1 MAT101 (Sinclair)
TR2 OC71 (Mullard)

Diode
D1 OA5

Inductors
L1 and L2 made by winding 28 s.w.g. enamelled copper wire on ⅜in diameter ferrite rod (see text)

Battery
BY1 9 volt light duty

Plugs and sockets
PL1 and SK1 coaxial for output 1
PL2 and SK2 coaxial for output 2

Miscellaneous
Printed circuit board (see text)
Switch, single pole, on/off (optional) for battery
Battery connectors and p.v.c. covered wire
Crystal earphone (if required)

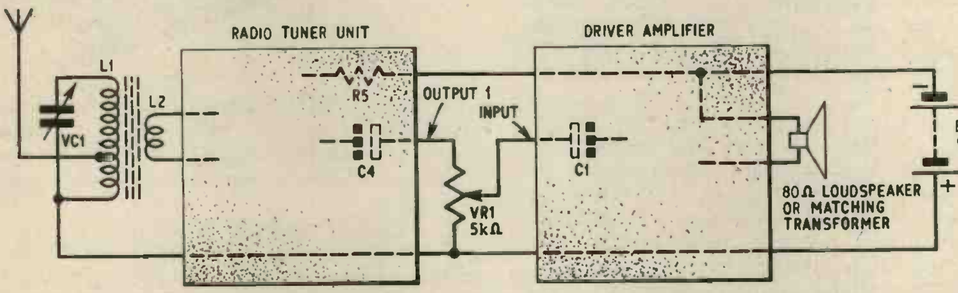


Fig. 3. The radio tuner can be combined with the Driver Amplifier to form a small pocket receiver using an 80 ohm output to a small loudspeaker or phone (not crystal). The dotted components refer to those described in the "Radio Tuner" and "Driver Amplifier" articles respectively.

POCKET RECEIVER

It is possible to combine the radio tuner unit with the "Driver Amplifier", described elsewhere in this issue, to provide a personal pocket receiver. Fig. 3 shows how the two units should be linked together.

Only one battery is needed; the common positive strips should be joined together, and the battery end of R5 on the tuner should be connected to the junction of R1, C2, and SK2 on the driver amplifier. SK1 on the tuner is linked with SK1 on the driver; the plugs and sockets can be eliminated if desired.

Meetings . . .

SOCIETY OF ELECTRONIC & RADIO TECHNICIANS

SOUTHAMPTON

Date: February 23
Title: Flight Simulation (General Precision Systems)
Time: 7.30 p.m.
Address: College of Technology, East Park Terrace, Southampton.

STOKE-ON-TRENT

Date: February 22
Title: Television Studio Equipment
B. Yates A.S.E.R.T.
(ATV (Birmingham) Ltd.)
Time: 7.30 p.m.
Address: Room 215, Physics Block, College of Technology, Stoke-on-Trent.

"Bighead" Bonding Fastener

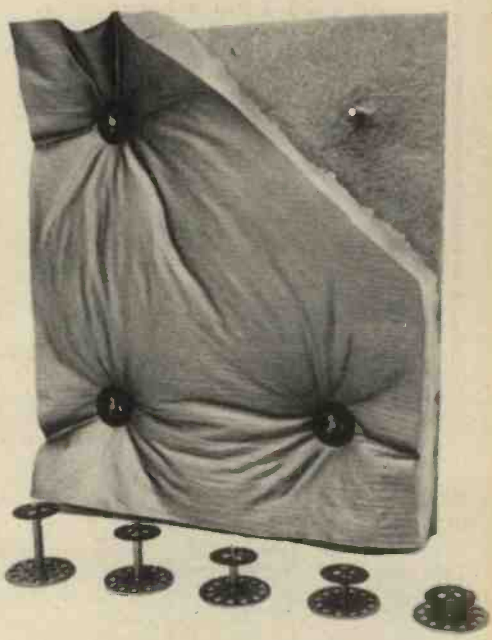
Metal Ventures Ltd., Southern Road, Aylesbury, Bucks.

These new fasteners enable thermal and acoustic insulation materials to be fixed quickly to laminates of all kinds. They are particularly suitable for fixing linings to loudspeaker enclosures.

The lagging studs can also be bonded on to surfaces such as acrylic sheet, plywood, steel, decorative laminates and chipboard. They can be hot pressed into polythene.

Once the perforated portion of the fastener has been fixed, the insulant can be easily impaled on the protruding studs and firmly secured with the barbed cap supplied.

Five standard lagging studs are produced, ½in, ¾in, 1in, 1¼in and 1½in in length, to suit various thicknesses of insulants.



Sine/Square Wave Generator

Daystrom Ltd., Gloucester, England.

The Heathkit Model IG-82U sine/square wave generator is designed for servicing and testing audio, radio, television, and recording equipment.

The sine wave frequency range extends from 20c/s to 1Mc/s $\pm$ 1·5dB into a high impedance load. Distortion is better than 0·5 per cent from 20 to 20,000c/s. The output voltage, peak-to-peak, is available in four ranges: 0–0·01, 0–0·1, 0–1, and 0–10.

The square wave frequency coverage is 20c/s to 1Mc/s. The output voltage peak-to-peak is in three ranges: 0–0·1, 0–1 and 0–10. The rise time is less than 0·15 microsecond.

Both the sine and square wave outputs can be used simultaneously, as well as independently. The frequency of these two output signals is identical but the output signal levels are individually variable.

The generator has many applications which include the design and development of filter or compensating/equalisation networks, checking loudspeakers and enclosures, and square wave tests for high and low frequency attenuation, phase shift, ringing, etc.

The model IG-82U weighs 16lb and is available in kit form for £24 10s, with constructional and operating manual. The generator assembled and tested costs £36 10s.

New Workbench Tool Rack

Henri Picard & Frere Ltd., 34/35, Furnival Street, London, E.C.4.

Our photograph below shows a new workbench tool rack, which holds 26 miniature hand tools. The tools are held in position by rubber grommets arranged in three stepped rows at the back of the rack. These grommets are easily replaceable and there are 34 different sizes for holding tools with body diameters ranging from 1mm to 10mm. By mounting in this method the workbench is kept clear and the working ends of the tools are protected from damage. The risk of loss is also minimised.

There are two shallow troughs below the first row of grommets and deeper storage trays, divided into 10 compartments, project from the front. These compartments have transparent lids and are ideal for storing small components. The price of the tool rack is 95s 8d.

PORTABLE RATEMETER

By D.V. SMITH

Part Two

It was stated in last month's article that the sub-units of the ratemeter may be used in various combinations to suit individual requirements. As such arrangements are identical to the internally switched facilities in the complete instrument, it is felt that some further descriptions of the possible "set-ups" would be useful to those intending to construct either the complete comprehensive instrument or only certain sections.

G.M. TUBE ALONE

The first of these arrangements for using the G.M. tube only is shown in Fig. 7. (Note: in this and the following "set-up" descriptions the choice of either battery or mains power is taken for granted.)

The circuits needed are the G.M. amplifier (Fig. 2), the ratemeter (Fig. 5), and the e.h.t. generator (Fig. 6). This set-up will enable an experimenter to explore the characteristics of a large number of G.M. tubes whose operating voltages fall within the range of the e.h.t. generator (0–800V). In addition, the various well-known radiation experiments included in most modern physics syllabi are within the capabilities of the circuits.

To the newcomer, the range of G.M. tubes available is a good indication of the specialised nature of most types and careful consideration of the application one has in mind is, of course, a basic step towards achieving the best results with a given instrument.

The physical layout of the above arrangement as used on its own is not critical and could be tailored to meet most requirements.

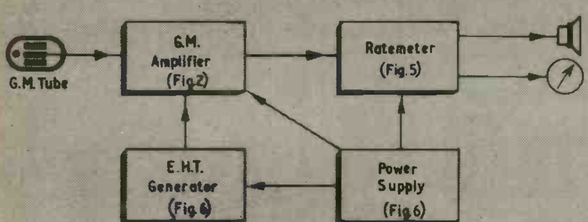


Fig. 7. Arrangement of units when using G.M. tube alone

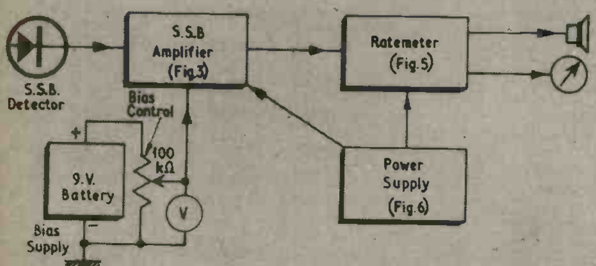


Fig. 8. Set-up for the detection of alpha particles using the s.s.b. detector. Output link on s.s.b. amplifier (Fig. 3) to be connected between B and C

S.S.B. DETECTOR FOR ALPHA PARTICLES

The simplest arrangement for using the s.s.b. detector is shown in Fig. 8 and will make possible the detection of alpha particles.

This amplifier is also capable of being used in conjunction with pulse height analysers for energy spectrometry of alpha particles.

The circuits indicated are the s.s.b. amplifier (Fig. 3) and the ratemeter (Fig. 5). A nine volt battery is all that is needed to provide sufficient detector bias. This should be possible, with the variable metered supply, to demonstrate the ability of the device to detect alpha particles at bias levels down to zero and the effect of various bias levels on the count rate observed.

At this point it might be prudent to look at one of the few problems involved with the s.s.b. detector. This is associated with the measurement of the actual bias appearing across the device.

Due to the finite reverse resistance, some leakage current will flow and its magnitude will vary from unit to unit within the manufacturer's limits. The leakage characteristic for all these devices will be approximately of the form shown in Fig. 9 where it can be seen that for most values of bias the leakage is fairly constant.

Some figures for high grade 20th Century units are given in the table below.

TABLE 1

Detector type	Working voltage	Leakage at w. voltage
SSNO3K	25	$<\frac{1}{2}\mu A$
SSNO5K	25	$<1\mu A$
SSNO3K	300	$<1\mu A$
SSNO5K	100	$<2\mu A$

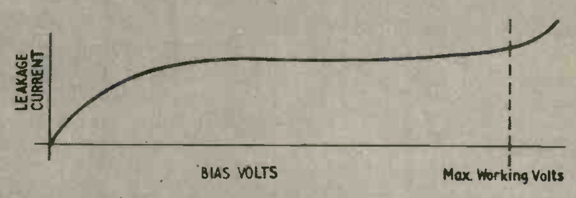


Fig. 9. Leakage current characteristic of the s.s.b. detector

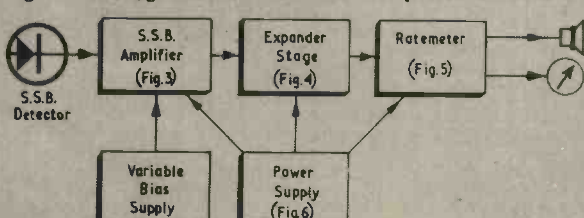


Fig. 10. Set-up for the detection of beta and gama radiation. Output link on s.s.b. amplifier (Fig. 3) to be connected between A and B

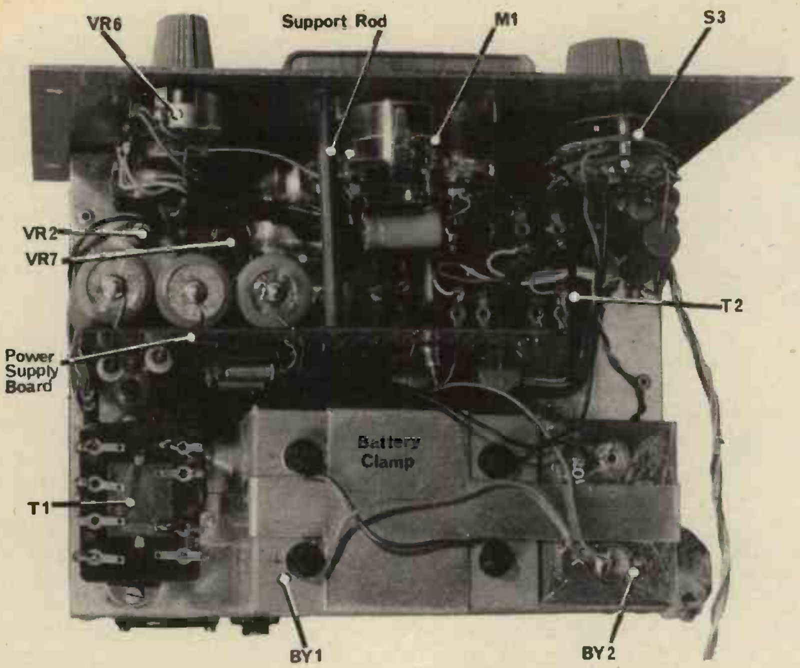


Fig. 11. Top view of the completed ratemeter

the most commonly used (and cheapest), while at the other end of the scale (and more expensive) 300 volts is the present limit.

As a general rule only low voltage working detectors are required for alpha particle detection while for beta and gamma detection better results are obtained at higher voltages.

The problems with the complete instrument in this respect was how best to portray the s.s.b. detector facility and in fact the most awkward case was chosen, this being for the 300 volt variety where use of the e.h.t. generator rather than batteries was called for.

S.S.B. BIAS PROBLEMS

Here again the problem of the bias calibration arises. At first sight it might only appear necessary to arrange the bias supply in much the same way as in Fig. 7 and use the calibrated e.h.t. control as the means of obtaining variation.

The problem is, of course, to ascertain by how much the bias is reduced by the leakage current flowing through the load. Probably the most practical approach is to plot leakage versus bias for the particular detector and make allowance for the voltage drop in the megohm load resistor at the various bias levels.

Too great a stress ought not to be laid on this aspect for, as can be seen, the difference made by the leakage is unlikely to create great difficulty.

A suitable source of alpha particles is a luminous dial, but care should be taken to avoid fingering the characters for any deposit will reduce by absorption the available counts. Most important, however, is the presence in the luminous paint of radio-active materials which are selectively accumulated *permanently* in various sites in the body, particularly in this case the bones, and any risk of bodily uptake, however small, should be avoided.

S.S.B. FOR BETA & GAMMA

Detection of beta and gamma in addition to alpha radiations is made possible with the arrangement of Fig. 10 to which the addition of the expander stage (Fig. 4) gives the added gain required together with the necessary facility to discriminate against unwanted noise. Some care should be taken with layout and screening of circuits to avoid both noise pick-up and oscillation.

The bias supply is not specified in this case because the maximum voltage which can be applied to the device will depend on its rated voltage and this will vary from unit to unit.

The 25 volt working detector is

This will work to a certain extent but it has one serious drawback in that the e.h.t. generator will cease to function at outputs of about 10 volts or lower.

While this is of no consequence as far as the G.M. tube is concerned, because no operation of the tube is to be expected at this voltage, from zero to 10 volts is a region of great interest in the case of the s.s.b. detector regardless of its maximum voltage.

The answer was to operate the e.h.t. generator at a fixed voltage using a preset control and to "pot" down the output to a variable potentiometer from which the bias voltage was obtained. It was also necessary to ensure that the total resistance of the potentiometer chain was sufficiently high enough not to over-load the

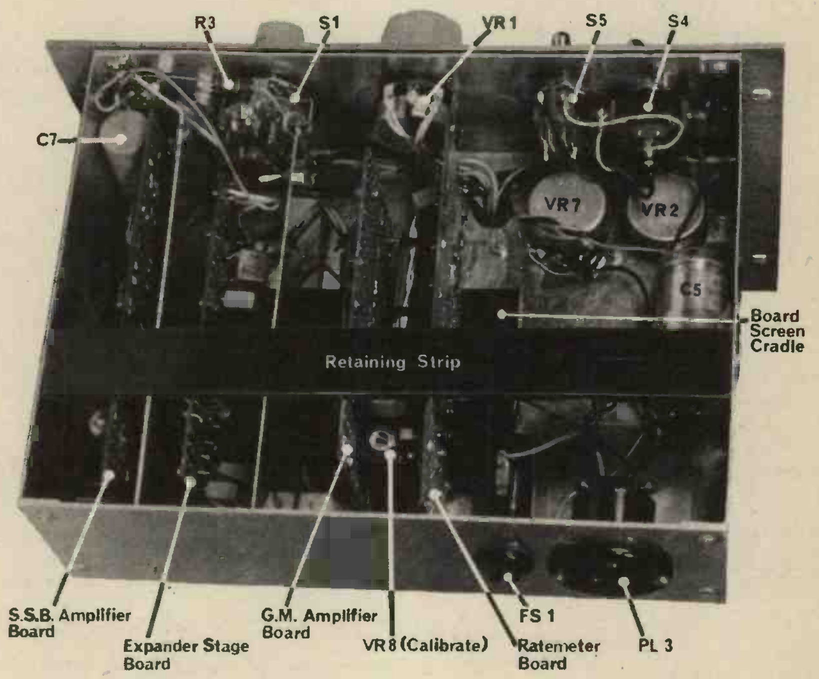


Fig. 12. Underside view of the ratemeter chassis

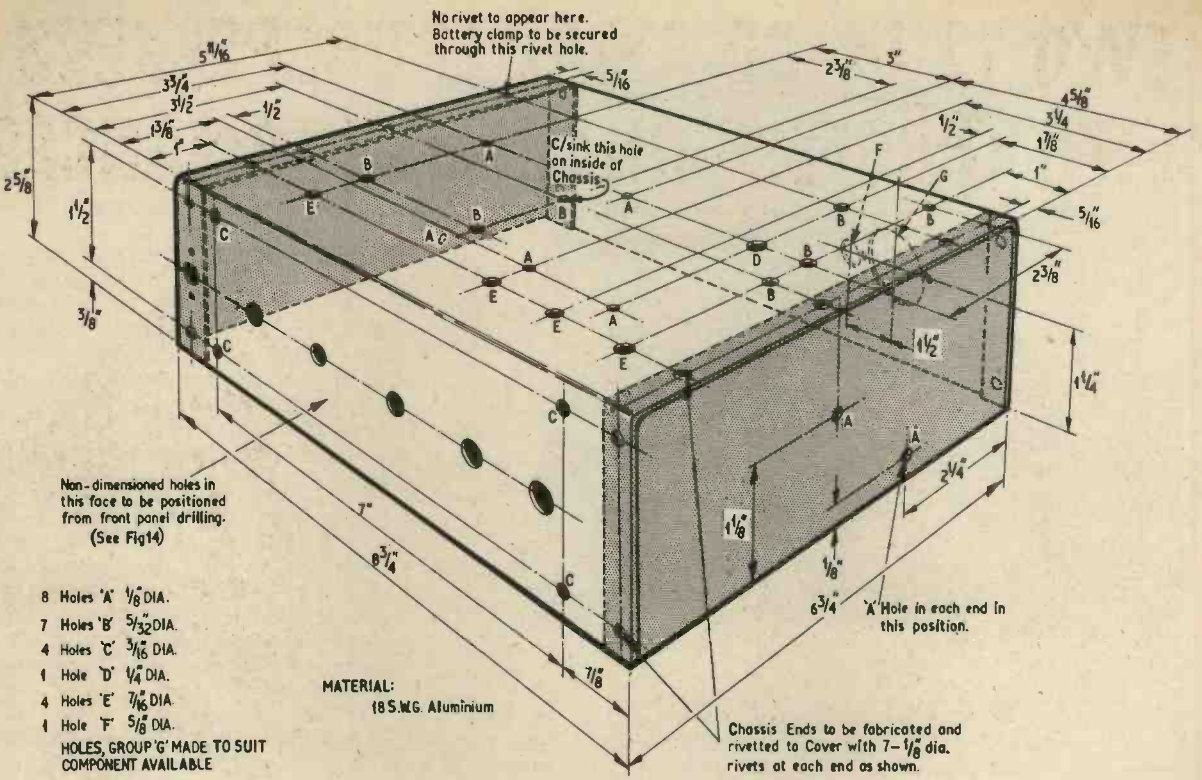


Fig. 13. Dimensions and drilling details for the chassis

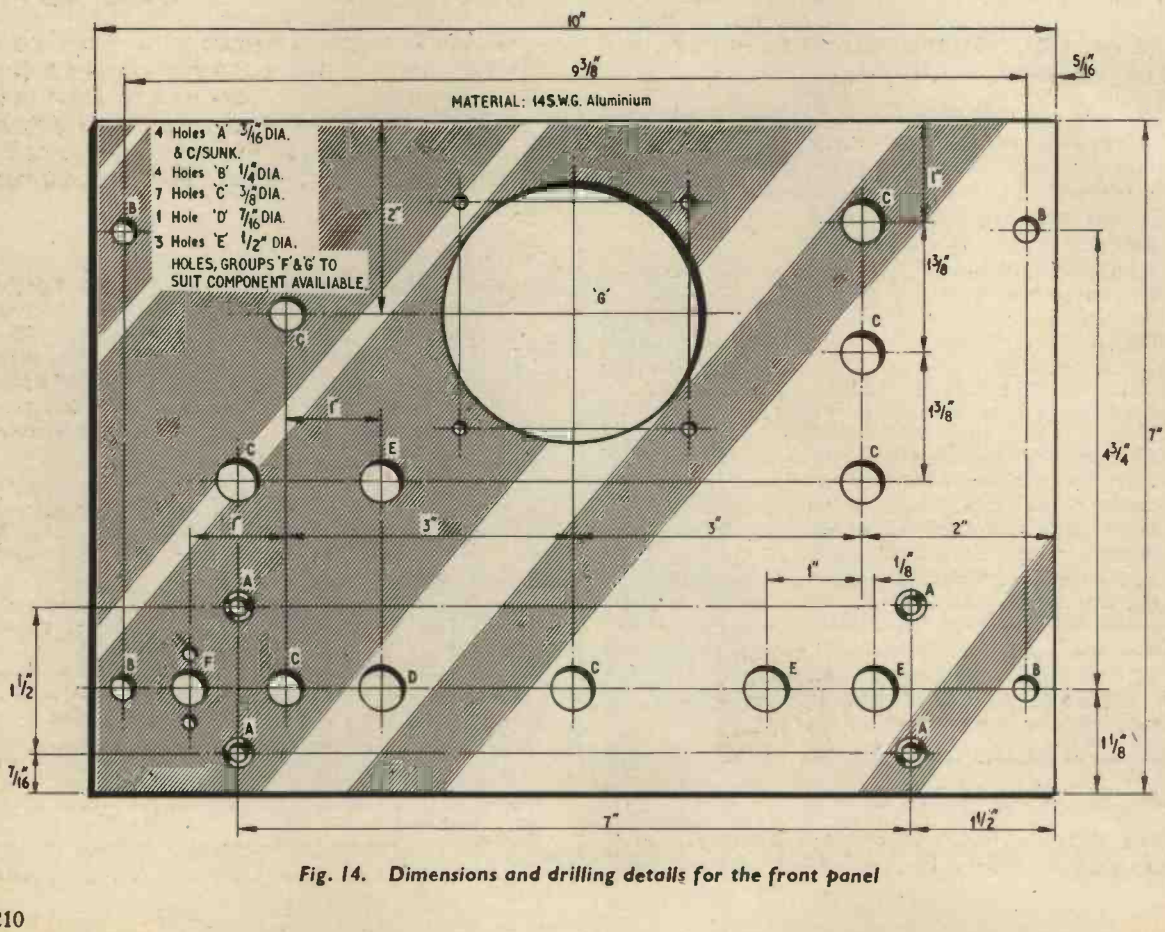


Fig. 14. Dimensions and drilling details for the front panel

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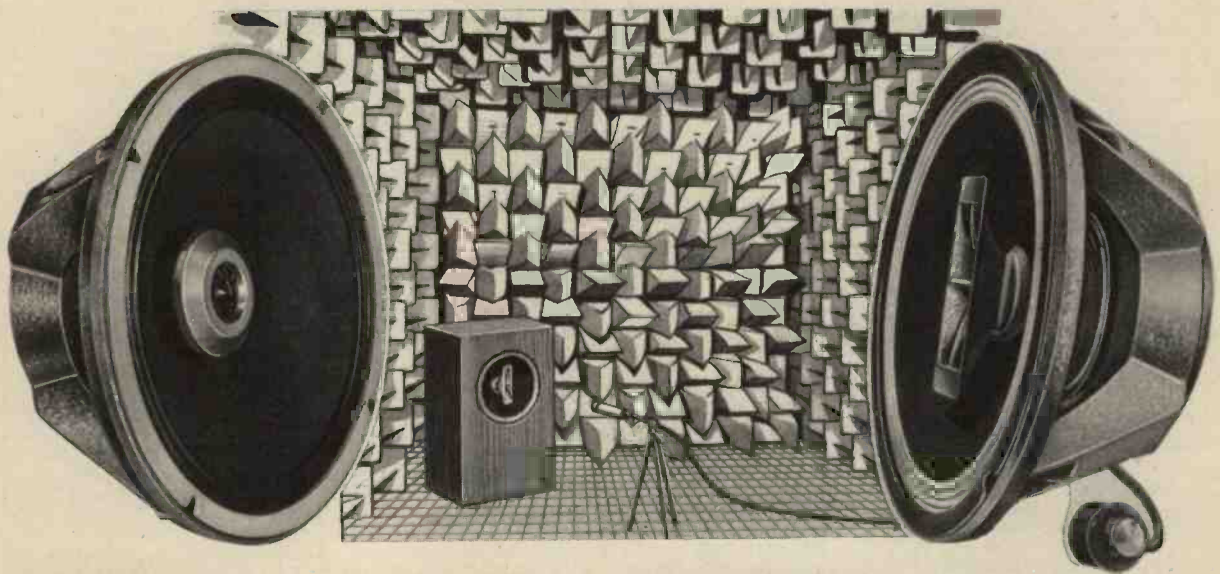

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Impedance	15/16 ohms
Flux Density	13,000 gauss
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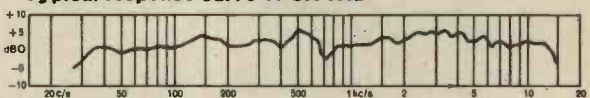
Flux Density	17,000 gauss
Total Flux	180,000 Maxwells

Typical response curve of CX 1512



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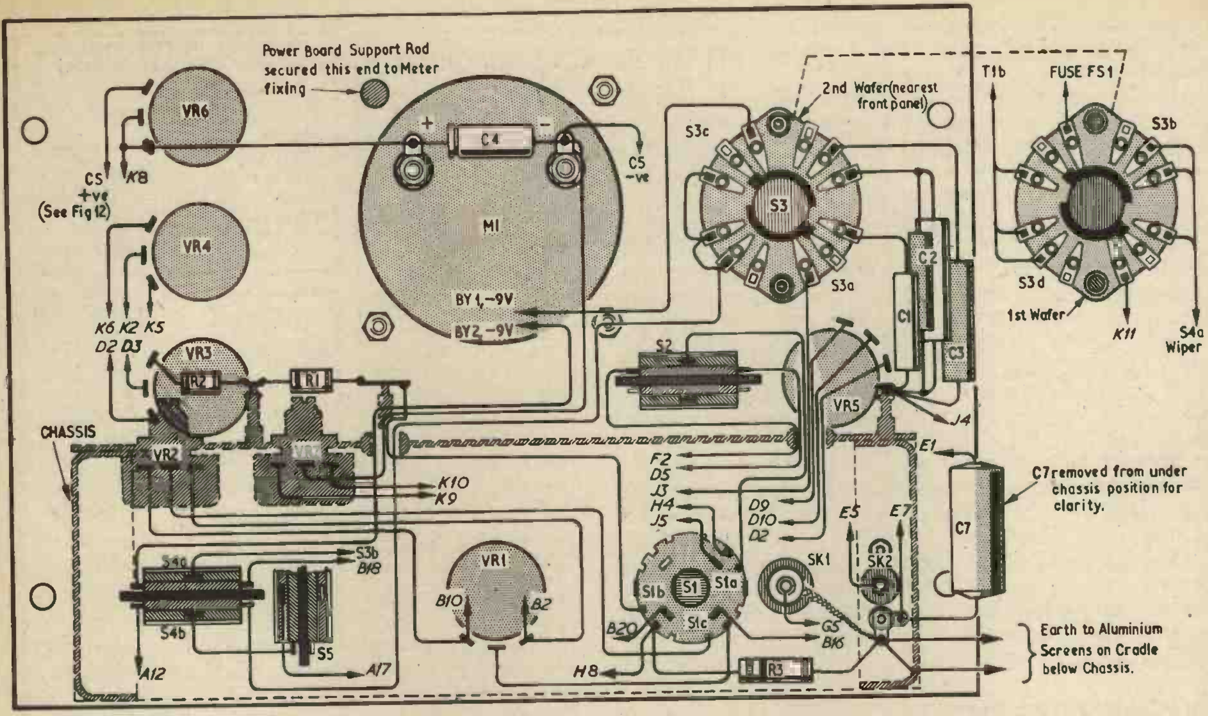

Fig. 15. Front panel components and wiring. Key to the coding of the external connections is given in Fig. 1. (last month)

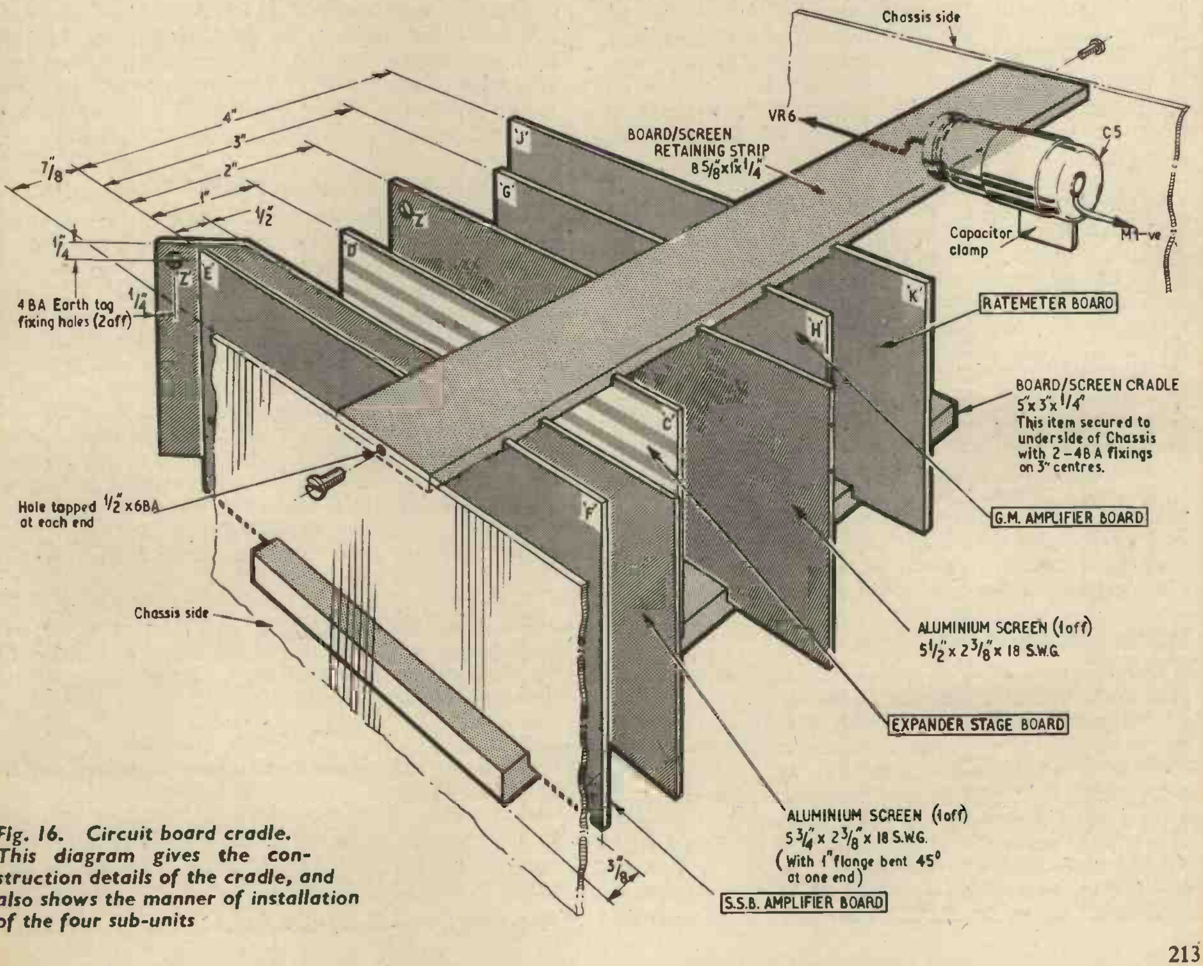

Fig. 16. Circuit board cradle. This diagram gives the construction details of the cradle, and also shows the manner of installation of the four sub-units

e.h.t. generator. A value of 20 megohms was used in the prototype.

It is necessary, therefore, to take into account the impedance of the supply when calibrating the "s.s.b. volts" (VR3) for a particular detector whose leakage is known.

To put the problem in its proper perspective it should be said that not many experimenters are likely to need 300 volts bias for, in practice, 9 volts bias will still enable one to detect even quite low energy beta and gamma radiations with a good 25 volt working detector using the circuits of Fig. 10. The described arrangement using the e.h.t. generator was incorporated in the instrument to show that it could be done if needed and this should be borne in mind when choosing the bias supply, as obviously a 25 volt working detector can be very easily operated from a small battery.

Once again a source of beta and gamma radiations is the luminous dial—provided that the alpha particles are absorbed by a thin sheet of paper placed between the source and the detector.

The luminous watch face may not be the most perfect source by laboratory standards, but it is undeniably the most easily obtainable and can readily be used in a number of experiments involving the three types of radiation discussed.

MECHANICAL DESIGN

The mechanical design of the prototype instrument naturally raised questions regarding the best method of arrangement, the Veroboard sub-units being the foremost consideration in this respect. A commercial instrument built for the same applications would almost certainly employ plug-in circuit boards making a very convenient unit. It was felt however that this sort of refinement would unnecessarily add to the cost and be of little or no benefit to the constructor building this instrument as described.

The top and underside views of the finished ratemeter (see Fig. 11 and Fig. 12) show the compromise method by which the sub-unit boards can be mounted in a roughly similar manner to the conventional plug-in modular form of construction. The important difference in this case is that although the boards are moveable they are not strictly removeable unless the wire connections are broken.

Adherence to this "modular" system was considered necessary as far as the complete instrument was concerned in order to keep it as small as possible while, at the same time, still clearly made up of separately useable sub-units.

Of course there is no reason why individual constructors should not employ good alternative systems better tailored to their own requirements, if they prefer. This is particularly so if only sections of the instrument are required and space is not at a premium.

MAIN CHASSIS ASSEMBLY

Details now follow of the construction of the comprehensive instrument shown in the illustrations.

Construction commences with preparation of the metal work for the main chassis assembly. This consists of the chassis proper, Fig. 13, and the front panel, Fig. 14. Both these items are made from 18 s.w.g. sheet aluminium. Drilling positions on the front edge of the chassis should be obtained by offering up the completed front panel to the chassis.

When the front panel has been bolted to the chassis, the main assembly circuit components should be

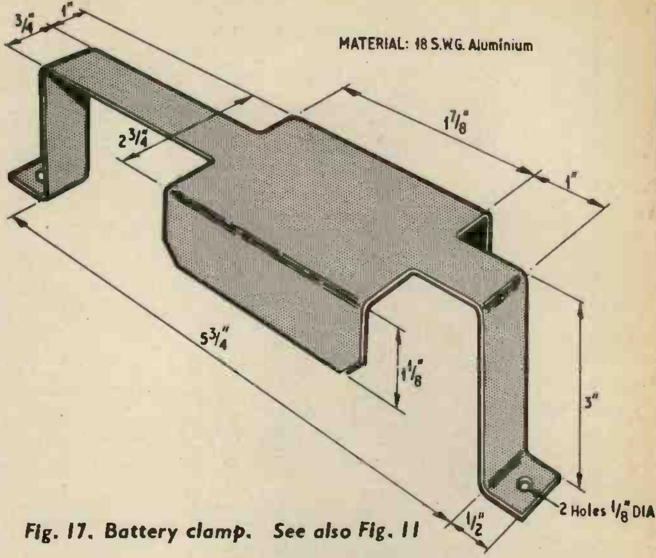

Fig. 17. Battery clamp. See also Fig. 11

mounted in position and the wiring completed so far as is practical at this stage. Fig. 15 shows all the front panel components *in situ*; also included in this diagram are two potentiometers (VR2, VR7) which are mounted on the deck of the chassis, close to the front panel. The "external" wiring, i.e. the flying leads *A12*, *H4*, etc. are best omitted at this stage;. they can be added when the sub-units have been incorporated in the chassis.

The two transformers (T1, T2) are bolted to the top of the chassis as shown in the photograph, Fig. 11. The mains connector PL1 and the fuseholder are fitted to the rear edge of the chassis. The capacitor C5 is clamped to the side of the chassis, see Fig. 12. Fixing holes for all these items are included in Fig. 13.

CRADLE FOR CIRCUIT BOARDS

The cradle which holds four sub-unit boards can be seen in the underside view of the chassis, Fig. 12. Constructional details are given in Fig. 16. The cradle is made from ¼in thick × 3in wide s.r.p.b. with ⅛in deep slots cut crosswise. Two hacksaw blades mounted side-by-side in the saw will cut slots of the correct width for the Veroboards. A 1in wide strip of the same material with corresponding slots and fixed at each end to the chassis forms the board retaining strip. (If an extra conductor is left at both edges of the eleven-way Veroboards, making a total of thirteen ways in all, this will allow them to be mounted in the slots without fouling the components wires on the "*1*" and "*11*" conductors—see Part Three).

Two holes are drilled in the cradle for fixing this to the chassis as mentioned in Fig. 16.

Details of the battery clamp are given in Fig. 17.

The third and concluding part of this article will cover the construction of the individual circuit boards, the final assembly and wiring, and the setting up and operation of the ratemeter.

ERRATA

The following small amendments should be made to diagrams included in Part I.

- Fig. 1. Value of C5 should be 5,000μ*F*. Common side C1, C2 and C3 goes to *J4*.
- Fig. 3. Output to ratemeter at *F2* is NEGATIVE (link between B and C).
- Fig. 5. Input at *J5* is NEGATIVE.

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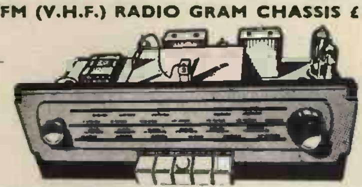

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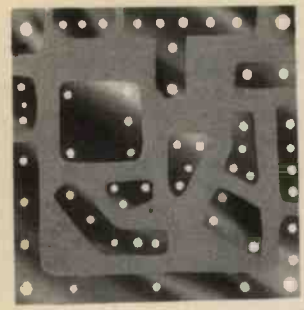

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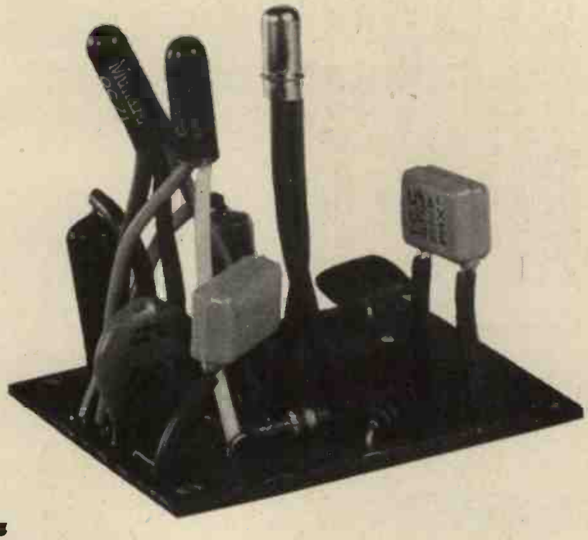

Use this simple device to play an electric guitar or a microphone through your radio

GUITAR PRACTICE ADAPTOR

This adaptor is a simple device to enable an electric guitar to be used with a domestic a.m. radio receiver. The guitar output leads are connected to the input of this unit; the output of the adaptor is connected to the "aerial" and "earth" input sockets of a medium or long wave receiver according to the type of coil used.

The signal from the guitar (or microphone) modulates an r.f. signal produced by the oscillator circuit tuned by L1, L2 and VC1. The circuit diagram is shown in Fig. 1. These tuning components are the same as those described in the "A.M Radio Tuner" article elsewhere in this issue. The output is taken from the collector of TR2 via a 2·2pF capacitor.

This capacitor can be replaced by a home-made capacitance consisting of two short lengths of wire (about 2in) with thin insulation, which are twisted together. The collector of TR2 is connected to one wire and the output terminal to the other. The two wires must not touch each other (electrically) but must be close together.

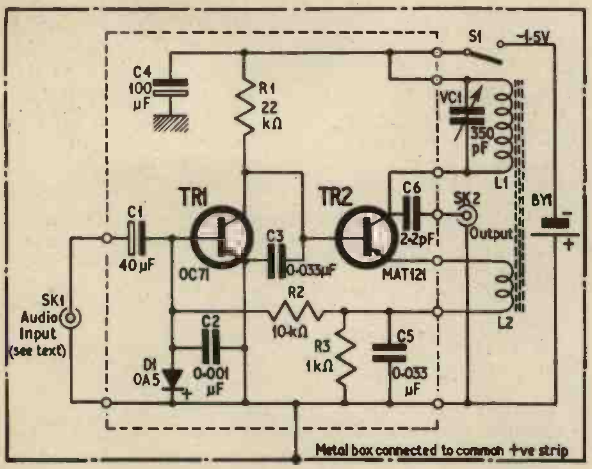

Fig. 1. Circuit diagram of the adaptor. The circuitry within the inner dotted line is made up on the printed circuit board. The outer chain dotted line indicates a metallic screen, such as an aluminium box, in which the complete circuit is assembled

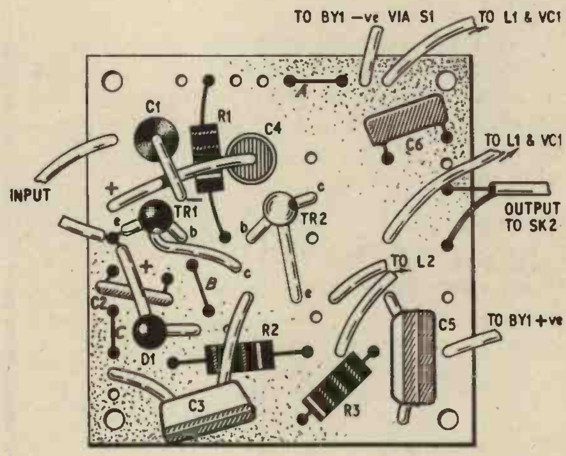

Fig. 2. Layout of components on the board. The coils L1 and L2 and tuning capacitor TC1 are the same as those used in the a.m. radio tuner described elsewhere in this issue. Notice the link wires at A, B, and C

Yet another method of coupling the output is by means of an extra winding on the ferrite rod. Only one complete turn of wire is needed and should not be too close to either of the other two windings. One end of this winding is connected to the metal screen round the whole unit; the other end is connected to the r.f. output terminal (SK2) for subsequent connection to the radio receiver.

METAL SCREEN

The metal screen is advised to prevent interference or interaction with nearby receivers. The simplest is a small tin, aluminium, or copper box with the input and output sockets SK1 and SK2 (coaxial types) screwed to the box on opposite sides. Although the r.f. output may be only a few millionths of a watt (a small fraction of a milliwatt), without the screen the interaction (possibly via nearby metallic objects) can be most disturbing.

COMPONENTS . . .

Resistors
R1 22kΩ
R2 10kΩ
R3 1kΩ
All resistors 10% ½ watt carbon

Capacitors
C1 40μF elect. 12V
C2 0·001μF mica or polyester
C3 0·033μF mica or polyester
C4 100μF elect. 15V
C5 0·033μF mica or ceramic
C6 2·2pF ceramic (see text)
VC1 350pF mica or air dielectric, variable

Transistors
TR1 OC71 (Mullard)
TR2 MAT121 (Sinclair)

Diode
D1 OA5

Inductors
L1 and L2 made by winding 28 s.w.g. enamelled copper wire on ⅜in diameter ferrite rod (details as in "Radio Tuner")

Battery
BY1 1½ volt cell, leakproof

Switch
S1 Single pole on/off

Plugs and sockets
PL1 and SK1 coaxial for the input
PL2 and SK2 coaxial for the output

Miscellaneous
Printed circuit board (see text)
Insulating board 2in × 2in (see text)
Battery connectors (if required)
Metal box to house whole unit

The layout of components, using the same printed circuit board pattern as before, is shown in Fig. 2. Link wires are required at A, B, and C (see Fig. 2).

A backing plate of thin plain s.r.b.p. or other insulating material can be attached to the underside of the board to insulate the copper strips from the metal box. This plate can be cut 2in square with four ⅛in diameter holes drilled to match the fixing holes in the four corners of the printed circuit board. Alternatively, it can be made a bit larger according to the size of the metal box, so that both the printed circuit board and the ferrite rod can be mounted on it.

The two boards are screwed together on wooden mounting blocks glued to the inside of the metal box. Allow sufficient space to house the tuning capacitor VC1, the leakproof battery BY1, the on/off switch S1, and the two sockets SK1 and SK2. The box should be connected to the common "positive" copper strip from BY1.

TEST THE ADAPTOR

When the complete adaptor has been constructed and wiring checked, it can be tested. Connect the output from SK2 to the aerial and earth sockets of a domestic a.m. radio, making sure that the screen is connected to the "earth" terminal and the centre conductor to the "aerial" terminal. If the receiver has no "aerial" and "earth" sockets (it may use a ferrite rod or frame aerial), a single loop of wire round the internal aerial may be connected to the adaptor. A.C./D.C. receivers should not be used.

Switch on the receiver and tune to a "quiet" spot. Switch on the adaptor and rotate the tuning capacitor knob. This should produce a series of whistles from the receiver due to passing heterodynes and will indicate that the adaptor is oscillating correctly. If these heterodyne whistles are not heard, even with the receiver volume control turned up, the connections to L2 in the adaptor should be interchanged. The adaptor may fail to oscillate if these connections are incorrect.

Now connect an electric guitar, or other low level audio signal source, to the input socket SK1. Tune the adaptor with VC1 until the audio signal can be heard through the receiver loudspeaker.

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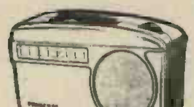


PRINCESS 2 wave

Its circuit features all the latest refinements:— A.V.C. Push-pull output, Feedback, etc., etc., includes efficient ready wound aerial and 2½in. P.M. speaker. Transistors—case—everything supplied except battery. Instructions supplied but if required separately 1/6.

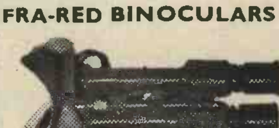
TRANSISTOR BARGAIN

Transistor set case with carrying handle size 10×8×3in. Strongly made from best plywood and covered Two tone fabric—looks very smart—suitable for receiver—amplifier—extension speaker, etc. Originally listed at 29/6 but offered this month at only 15/- plus 5/- post and insurance also given free with it is a printed circuit board to suit it and building instructions for fine two wave radios.—Don't miss this grand offer.

CAPSTAN DRIVEN TAPE RECORDER

Although some well made spool driven machines give remarkably good results, there is no doubt that to achieve anything like perfection and to have versatility a Capstan Driven Tape is essential. Now at last we can offer you a Capstain Driven, completely portable battery operated instrument at a remarkably low price. So low in fact that you can easily afford to have a second machine for use in your car, office, home, etc., or to give to reps. or relations to exchange tapes.
SPECIFICATION: 200/7000 c.p.s. 400 mW. output—double track—twin speed (3¾ and 7½) fast rewind time—5in. spool gives one hour playing with standard tape, weight 7 lb. Size 8×11×3¾. Complete with batteries, microphone—tape spool and instruction manual. Nothing to go wrong if you use a good tape and keep heads clean. Demonstration gladly given at our Croydon shop.
Special Snip Price This Month, £11/11/0, post and insurance 6/6.

See in the Dark INFRA-RED BINOCULARS



These infra red from a high-voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lens for T.V. cameras—light cell, etc. (details supplied).
The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order, but sold without a guarantee. Price £2/17/6 plus 10/- carriage and insurance. Handbook 2/6.

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.-9 to 12 volts for up to 500 mA (class B working). Takes the place of any of the following batteries: PR1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. Condenser, Zener diode and instructions. Real snip at only 14/6 plus 3/- post.

BATTERY ELIMINATOR

With this you can operate your pocket radio from the mains. You can also re-charge PP3 batteries five or six times. Only 18/6 plus 3/- post and insurance. Will save its cost in no time

TWO-WAY RADIOS

Give communication over ½ mile. FULLY transistorised—crystal controlled, built-in telescopic aerial—press button operation—PP3 batteries—pair instruments complete and ready to use. £7/9/6 plus 5/- post and insurance. G.P.O. licence required

FOUR-STATION INTERCOM.

Will save time and improve efficiency. Ideal in home—office—shop—surgery, etc. Complete outfit comprises Master unit and three substations each of which can call the master and have full two-way working. No wiring problems as subs fitted with 60ft. twin flex and they plug into sockets. Also included is packet of staples—and battery. Nothing else to buy—£7/15/- plus 4/0 post and insurance.

13 AMP. SOCKETS

Change all those old-fashioned ones to these modern fused types or install a new ring main. White sockets for surface mounting or for letting into wall or skirting—best make (G.E.C.), 5/6 with switch or 3/9 less switch. Six or more post free, otherwise add 2/-.

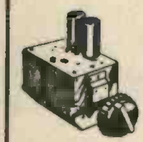
HEAT AND LIGHT UNIT

Gives 300 watts of heat with approx. 150 watts of light and simply fits in place of lamp, 29/6 plus 3/6 carriage and insurance.

SEED & PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame, 12/6 plus 2/6 post and insurance.

TURRET TUNERS



By the famour Cyldon or Brayhead firms complete with coils, but less coil cover, valves and knobs—all 35 Mc/s — wonderful bargain at 6/6 each plus 2/9 post.

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50 pf with long spindle as illustrated, 1/6 or 12/- doz. Twin 50 pf not quite such long spindle, 2/6 or 24/- doz.

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Suitable to control elements, heater, soldering iron and boiling rings up to 2,500 watts. Complete, adjustable, normal price 55/- each, special snip price 12/6 plus 2/- postage and insurance.
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JOHN VALENCE

THE WRECKERS

During the last few weeks it has been impossible to open a newspaper without reading of telephone vandalism. Each day it seems there are further reports of damage to public telephone kiosks up and down the country. This plague of senseless destruction is alas just another sign of these lawless times. There appear to be two quite different categories of wreckers: the petty crooks who raid the coin boxes for greed, and the young irresponsibles with time on their hands and nothing in their heads who get "kicks" from wrecking other people's property.

It is appalling that these individuals are so completely lacking in feeling for their fellows. Do they never come in contact with people who have to use the telephone for urgent business — perhaps life or death matters? Is thought for other people altogether beyond their capabilities, or are they just downright callous?

The G.P.O. is trying out a number of secret devices in an effort to trap these vandals. What a pity all this engineering effort has to be diverted from normal work of catching up on the backlog of telephone installations.

The introduction of the "dial-a-disc" service may be seen as another but quite different and clever method of discouraging some vandalism. What irony if, in the future, public telephone call boxes owe their continued existence to the fact that pop records are an important amenity. Strange world.

I wish the G.P.O. luck, but feel that the remedy rests largely with the police.

ON THE BEAT

The equipping of police officers with two-way radios seems an obvious and urgent task. We hear a lot about new types of radio equipment being designed for the man-on-the-beat and enthusiastic remarks about this soon replacing the P.C.'s whistle. But all this has been going on for such a long time that it sounds like ancient history. Two-way walkie-talkies are not a startling new discovery, heaven knows. It makes one wonder who has been dragging their feet over this matter: is it the equipment manufacturers, or is it the authorities responsible for running the police?

It might be significant that the first police forces to be operatively equipped with specially designed individual radios are run by county authorities. The metropolitan force is of course run directly by the Home Office.

With a new boss in this government department, perhaps things will start moving. The new Home Secretary Roy Jenkins seems to be in sync with these times. Some little while ago I remember hearing him in his then capacity as Aviation Minister pointing out the impressive part electronics plays in aeronautics. About one third of the total cost of a modern aircraft is accounted for in installed electronic equipment, he said.

Coming from this kind of environment where all the latest technological aids are exploited, the minister surely can but be staggered by the inadequacy of electronic aids employed in the detection and prevention of crime. Let us hope he will rapidly redress this deficiency. If successful in his war on crime, I am sure his hard pressed colleague the P.M.G. will be at the top of the queue of those offering their grateful thanks.

HOLIDAY HOUR

Now to a more pleasant topic.

A popular pastime in the winter time is the study of holiday advertisements. And what better way of dispelling the wintry gloom than to indulge in flights of fancy from your own armchair? The alluring descriptions of sun drenched holiday resorts do indeed provide a temporary balm to our more immediate surroundings.

This large and ever-growing holiday industry has now attracted the attention of the computer makers. It has been suggested that hotels using computers instead of clerical staff to reserve rooms, write guests' bills, and keep accounts, could show a handsome profit over and above the initial cost of the computer.

Well, everyone likes to make money, and I have no doubt that the managers of the more progressive hotels are already poring over computer specifications and measuring up the available space behind the reception desk with an eye on vital statistics—technical ones, naturally.

Bearing in mind the not infrequent news of rebellious computers at work in breweries, rating offices, etc., I admit to being a trifle apprehensive about this latest venture. Just imagine; hot, dusty, and tired on arrival—how *do* you argue with a computer about a disputed booking? And whom do you demand to see, the *manager* or the *electrician*?

Readout—
A SELECTION FROM OUR POSTBAG

Crookes radiometer

Sir—Please could you publish or pass on this letter with reference to Mr. M. J. Bunce's enquiry about where he could acquire a "Crookes Radiometer": Proops Bros. Ltd., of 52 Tottenham Court Road, London, W.1. can help. In their catalogue it is called a "Solar Engine" and is numbered—Cat S-168. It is five inches high and three inches in diameter and costs 12s 6d plus 1s 6d postage and packing.

C. Fosbury,
Hove, 3,
Sussex.

Many thanks to all those readers who have kindly sent similar information.

More power please !

Sir—I have been most interested in the "S.C.R. Light Dimmer" described on page 987 (December issue). Can you tell me if any changes would be necessary to the circuit to enable it to control a 300 watt lamp?

I have in mind using such a dimmer on a transparency projector to control the brilliance of the lamp relative to the density of any particular transparency, and to prevent surge current in the lamp when first switching on the projector.

J. Cannam, B.Sc., A.R.P.S.
Chesterfield,
Derbys.

Sir—Would it be possible, by substituting larger diodes for D1–D4 and/or using a larger s.c.r. (or more than one in parallel) to increase the load carrying capacity of the bridge circuit from 120 watts to say, 2kW (240V a.c. Unity Power factor)?

C. J. Knight,
Great Barr,
Birmingham, 22a.

In the actual power circuit, the s.c.r. is well capable of handling greater currents than those demanded by the load specified in the article. The diodes, however, are capable of passing only 0·5 ampere and would need replacement.

Naturally the larger the diodes used, the greater the space required. Also, as the desired current rating approaches the maximum limits of the s.c.r. and diode consideration must be paid to heatsink dimensions. Another limit to be observed to increase power is the type of load to be supplied. Reactive loads such as inductors and capacitors automatically limit the maximum ratings quite severely according to the amount of reactance present in relation to the resistance of the load. Inductive loads such as motors are fitted with capacitive power factor correction but even so, careful consideration must be paid to the rating of the s.c.r. and diodes used.

The trigger circuit is relatively independent of the power rating of the power control circuit, and should require little alteration for increased power. Any alteration for increased trigger voltage would be carried out by either increasing the emitter resistance of TR2 or decreasing the resistance of the 68 kilohm resistor. But these can only be varied within narrow limits.

To increase the power to some high value (above 2kW) then careful design is required according to the load requirements and this is going further than just altering the circuit in the published article. —*E. Barnett.*

"Light" amplifier

Sir—I am constructing a fairly sensitive counting device using a 2·5V lens ended bulb and an OCP71 phototransistor. I find that a single stage amplifier circuit (which I took from your article on "Light Operated Switches" in the December 1964 issue) does not give sufficient light-to-dark current ratio. I wish to increase the amplification stages to possibly four. I would be grateful if you could advise me where I could obtain such a circuit. The output is required to operate a relay which in turn operates a simple electro-magnetic counter.

J. M. Scott,
Isle of Cumbrae,
Scotland.

A second transistor (also OC72) d.c. coupled would give a considerable rise in sensitivity. —*G.J.K.*

What's all the "fuzz"!

Sir—I am a keen guitarist interested in sound effects. I wondered if you could supply me with a circuit diagram of a "Fuzz Box" or "Tone Bender"?

C. J. Gatton,
Crawley,
Sussex.

Can you help ?

Sir—Could any of your readers sell, lend or give me a circuit diagram for an oscilloscope using a G.E.C. type E4504/B/16 tube or its equivalent, any information on this tube would be appreciated.

Further to this, could anyone sell me the first five copies of PRACTICAL ELECTRONICS, which are missing from my collection.

G. M. Davis,
St. Helens,
Lancs.

Sir—I should be obliged if you could insert an enquiry in P.E. for a loan of the January 1965 issue or to purchase a copy. The article I am interested in is the article on the "Darkroom Timer".

A. Whitefield,
Glasgow, W.3.

New recruits welcome

Sir—I am sure that readers in this neighbourhood will be interested to know that the St. Cyres Electronic Group will be showing Mullard films on February 18 and 25 at the County Secondary School, St. Cyres Road (off Redlands Road), Penarth, Glam., starting at approximately 7.15 p.m. Anyone interested in joining the Group should contact me as soon as possible, as numbers must be limited.

I organised this Group so that others like me who are interested in electronics as a hobby could get together and discuss and, I hope, make, various electronic projects of general interest and, in particular, those which are normally considered "not practical" for amateurs. I am hoping that regular meetings will be arranged for discussions and the organisation of projects and visits to places of interest.

Members include engineers from the BBC, ITA and IBM at present. I also hope that those members who know very little about electronics but are interested in the subject will join.

C. Bogod,
" Dickens ",
26 Forrest Road,
Penarth, Glam.

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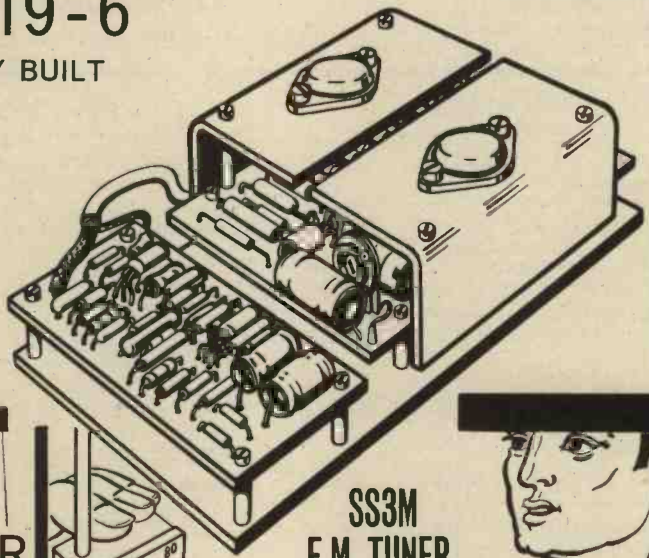

SPECIFICATION—20 watts output max. Distortion less than 0.1%. Frequency response flat from 16c/s to 20kc/s. Noise 80dB down on max. output.

* quiescent

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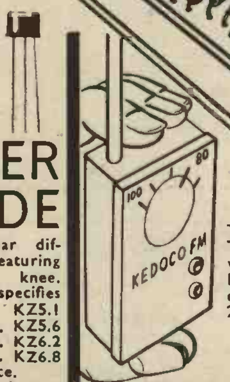
3/11 EACH



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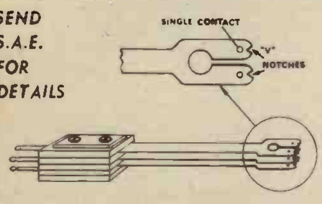

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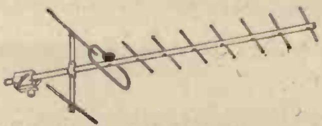

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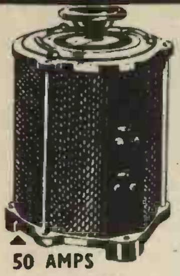

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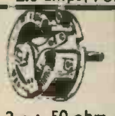

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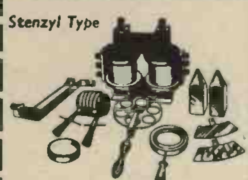

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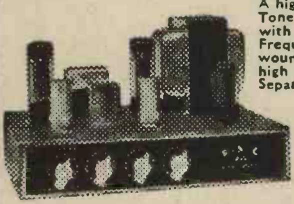

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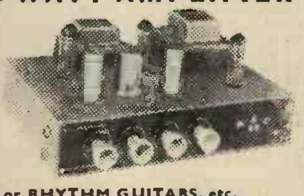

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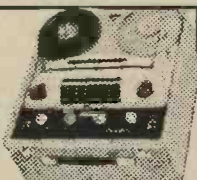

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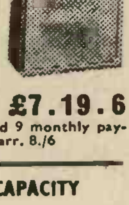
Type BMI. An all-dry battery eliminator. Size $5\frac{1}{2}$ × $4\frac{1}{2}$ × 2in. approx. Completely replaces batteries supply 1.4v. and 90v. where A.C. mains 200–250v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4v. and 90v. Complete kit with diagram 39/9 or ready for use 49/9

12 in. 10 WATT HIGH QUALITY LOUDSPEAKER



In walnut veneered cabinets. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/6. Terms: Deposit 11/3 and 9 monthly payments of 11/3 (Total £5.12.6). 12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 × 18 × 10in. Finish as above. **£7.19.6** Terms: Deposit 17/9 and 9 monthly payments of 17/9 (Total £8.17.6). Carr. 8./6

FANE 122/10 20 WATT HEAVY DUTY LOUDSPEAKER
12in. 15 ohm. With exceptionally robust 2 in. diameter voice coil assembly. Post 5/6 **5 gns.**

AUDIO FIDELITY HF 100D. 10" 15 WATT HI-FI SPEAKER. Heavy cast construction, dual tone, smooth frequency response. 40-15,000 c.p.s. Speech coil 3 ohm or 15 ohm. Exceptional value at **£5.15.0**

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3 watts. output. Negative feedback. Controls Vol., Tone and Switch. Mains operation 200–250v. A.C. Fully isolated chassis. Circuit, etc. supplied. Only Carr. 3/9 **39/9**

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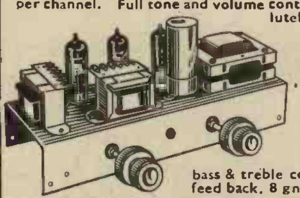
STEREO AMPLIFIER

Incorporating 2 ECL82s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

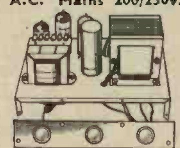


ONLY **£4.19.6** P. & P. 6/6

Super De-luxe version with ECL86 valves, sep. bass & treble controls, full feed back. 8 gns. P. & P. 6/6

HSL 'FOUR' AMPLIFIER KIT.

A.C. Mains 200/250v., 4 watt, using ECC83, EL84, EZ80 valves.



★ 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/-.
Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).
This kit although similar in appearance to HA34 it employs entirely different and advanced circuitry.

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Semi shrouded drop thro' type. Pri. 200, 220, 240v. Sec. 250v. ½ wave at 70mA and 6·3v. at 2 amp. c/t. Stack size 3" × 2½" × 1½". PRICE 11/-. P. & P. 3/-.

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A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d. x 5½in. h. Ready built and tested. PRICE 69/6. P. & P. 4/9.
ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. PRICE 89/6. P. & P. 5/9.

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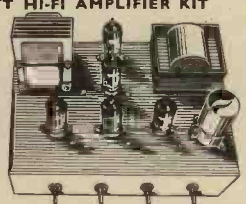
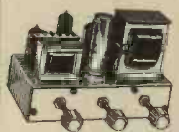
10/14 WATT HI-FI AMPLIFIER KIT



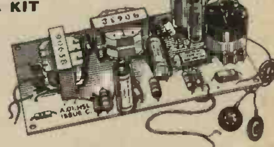
A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.) All parts sold separately. ONLY £6/19/6. P. & P. 8/6. Also available ready built and tested complete with std. input sockets. £8/15/-. P. & P. 8/6.

3-VALVE AUDIO AMPLIFIER MODEL HA34



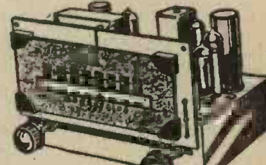
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. x 4in. d. x 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.
The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4.5.0** P. & P. 6/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



● 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 SI 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 TA1s are ideal for stereo.

HARVERSON'S F.M. TUNER Mk. I



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning ● Frequency coverage 88-100Mc/s ● Balanced diode output ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier) ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5½in. ● All parts sold separately. Set of parts if purchased at one time £5/19/6, plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version** as above but complete with magic eye, front panel and brackets, £6/12/6. P. & P. 8/6.
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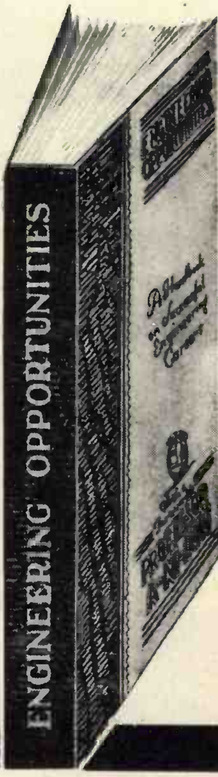

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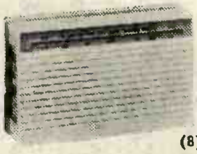

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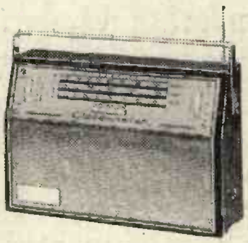

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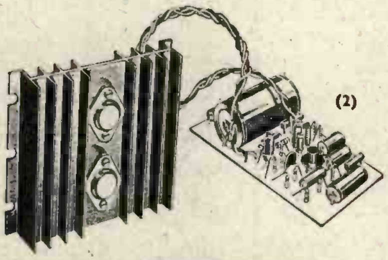

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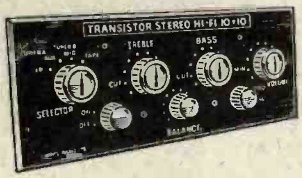

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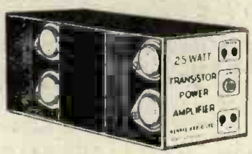

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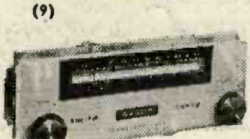

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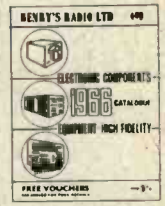

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ITI-2	20kV	89/6	EP100k	100kV	£10.10.0
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(9) 25 WATT AMPLIFIER

New 8-Transistor design. Push-pull output for 7½ to 16ohm speaker. 150mV input. 30c/s to 20kc/s ± 1dB. For use with valve or transistor preamplifiers as item (3) above. Size 2⅜×2⅞×6¼in.

PRICE BUILT AND TESTED £8.19.6 P.P. 3/-

(Mains unit 79/6, p.p. 2/6)

(10) ROADSTER MW/LW CAR RADIO

Supplied as Preassembled Panels. Permeability tuned superhet. Push-button wave-changer. Push-pull output. Fits any car. 7×4×2in. 12 volt (+) earth.

ASSEMBLY TOTAL COST £8.19.6 P.P. 3/6

(Speaker/Baffle/Car Fixing Kit, 20/-)

(11) GARRARD DECKS

(p.p. 5/- any type)

1000 mono	£6.10.0.	stereo £6.19.6
2000 mono	£6.19.6.	stereo £7.10.0
*SP25 mono	£10.19.6.	stereo £11.10.0
Autoslim mono	£5.19.6.	stereo £6.10.0
*AT6 mono	£8.19.6.	stereo £9.10.0
*AT60 mono	£11.19.6.	stereo £11.19.6
3000LM stereo £8.19.6		

(*Deram cartridge add 60/- to mono price). All autochange (except SP25), complete with cartridge. Brand new.

(12) TRANSMITTER/RECEIVERS

*Up to ½ mile range. Price per pair £7.19.6, p.p. 2/6.

*Up to 5 miles range. Price per pair £22.10.0, p.p. 3/6.

*FM wireless microphone £16.

G.P.O. Licence required

(13) VHF FM TUNER

Supplied as 2 Preassembled Panels, plus metal work Superhet design, 88-108 Mc/s, 9 volt operated.

Total cost £12.17.6, p.p. 2/6.

(14) NEW MW/LW TUNER TO BUILD

Fully tunable superhet with excellent sensitivity and selectivity. Output up to ½ volt peak. Complete with front panel, etc. 9 volt operated.

TOTAL COST TO BUILD 79/6 P.P. 2/6

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