PRACTICAL WIRELESS

OCTOBER 1969

3/0

AUDIO SIGNAL GENERATOR

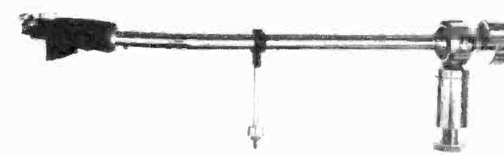
also inside: PRINTED CIRCUIT DESIGN

Lasky's

AMAZING VALUE AD-309K PICK-UP ARM FITTED WITH AD-76K CARTRIDGE

This new AUDIO DEVELOPMENT precision counterbalanced pick-up arm—ready fitted with the outstanding AD-76K magnetic cartridge—offers a truly remarkable breakthrough in quality and value for the Hi-Fi enthusiast. The arm is constructed of brass throughout, heavily chrome plated; uses needle and miniature ball race bearings; both coarse and fine balance adjustment is provided. The fixed head has standard ½in. mounting centres and is finished in black enamel with chrome lifting handle. Tech. details: Overall length 285mm; needle to pivot length 223mm; offset angle 24°; overhang 10mm. Requires single 7/16in. dia. mounting hole. Completely wired, with all fixing nuts and washers. Arm rest also supplied.

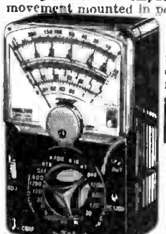
BRIEF DETAILS OF AD-76K. Magnetic cartridges: High compliance with stereo diamond LP stylus/ Output 5mV, frequency response: 20–20KHz, tracking weight 2 grammes.



LASKY'S PRICE £9.19.6 Post 5/-

TMK METER KITS ANOTHER LASKY'S EXCLUSIVE

These two meter kits by TMK offer both the professional, electronics hobbyist and student the unique opportunity of building a really first-class precision multimeter at a worthwhile saving in cost. The impact resistant bakelite cabinets are supplied with the meter scale and movement mounted in position; the model 200 also has the rotary range selector in position. The highest quality components and 1% tolerance resistors are used throughout Both offer professional standards of accuracy. Supplied complete in every detail with full constructional, circuit and operating instructions.



MODEL 200

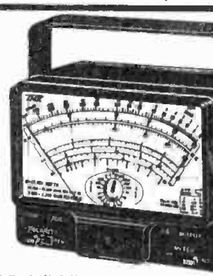
20,000 O.P.V. Multimeter. Features 24 measurement ranges with mirror scale. Large 3 x 2in. meter. Full scale accuracy: DCV and current: ±2%, ACV: ± 3%, resistance ±3%. Special 0·6V DC range for transistor circuit measurements.

SPECIFICATION ● DCV: 0-0·6-6-30-120-600-1200V at 20K/OPV. ● ACV: 0-6-30-120-600 1200V at 10K/OPV. ● DC. Current: 0-0·06-6-60-600mA. ● Resistance: 0-10K-100K-1M-10M ohms (58-580-5·8K-58K at mid-scale). ● Capacitance: 0·002-0·2uF (AC 6V range). ● Decibels —20 to +63dB. ● Output: 0·05uF blocking capacitor. Uses two 1·5V (U.7 type) batteries. Black bakelite cabinet—Size 5¼ x 3⅞ x 1⅞in. Complete with test leads.

LASKY'S PRICE 85/- Post 3/6

MODEL 5025

50,000 O.P.V. FEATURING 57 MEASUREMENT RANGES



A highly reliable instrument using an entirely new range selection mechanism which permits the use of a really large meter in a more compact cabinet. The range selected is clearly indicated on the actual meter face facilitating instant identification without taking your eyes from the meter. High speed rotary range selection knob; also features polarity reversal switch, shielded meter movement with overload protection circuit; Special uA and mA measurement ranges.

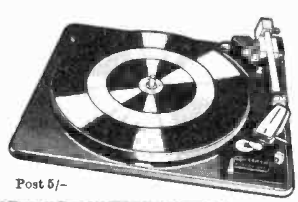
SPECIFICATION ● DCV: 0-0·25-2·5-10-50-250-1,000V at 25K/OPV. 0-0125: 1-25-5·0-25-125-500V at 50K/OPV. ● ACV: 0-3-10-50-250-1,000V at 2·5K/OPV, 0-1·5. 5-25-125-500V at 5K/OPV. ● DCuA: 0-25uA at 125mA: 0-50uA at 250mA. ● DCmA: 0-2·5-25-250mA at 125mV; 0-5-50-500mA at 250mV. ● DC Amps: 0-5A at 125mV; 0-10A at 250mV. ● Resistance: 0-10M/ohms (13, 65, 650, 6·5K and 65K/ohms at centre scale). ● Output: Capacitor (0·1uF, 400VW) in series with ACV ranges. ● Decibels. —20 to +81·5dB in 10 ranges. ● Operates on two 1·5V (U.7 type batteries). Black bakelite cabinet, size 5¼ x 6⅞ x 2⅞in. Strong, resilient plastic handle. Complete with test leads.

LASKY'S PRICE £10.10.0 Post 5/-

ALSO AVAILABLE READY BUILT AND TESTED £13.10.0. Post 5/-.

Garrard

SP25 MkII



LASKY'S PRICE £11.19.6 Post 5/-

AUTOCHANGERS	
1025 less cartridge	£6.9.6
1025 with GCM21 mono cartridge. Stereo compat.	£6.19.6
2025TC with GCM21 mono cartridge. Stereo compat.	£7.19.6
SL55 with J2006 stereo cartridge	£11.19.6
SL65 less cartridge	£14.15.0
SL75 less cartridge	£28.10.0
SL95 less cartridge	£35.0.0
A70 Mk II less cartridge	£13.19.6
AT 60 Mk II	£13.5.0
BSR UA47 less cartridge	£5.9.6
SINGLE PLAYERS	
AP75 with AD.86K magnetic cartridge	£21.10.0
AP75 less cartridge	£18.10.0
SRP22 Mains model less cartridge	£16.12.10
SRP22 Battery model less cartridge	£7.15.3
TRANSCRIPTION DECKS	
401	£28.10.0

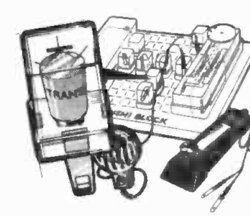
GARRARD BASES
WB1 £3.6.11; WB4 Mk II £5.8.11; WB5 £5.8.11.

CLEARVIEW PERSPEX COVERS:
SPC1 £3.5.0; SPC4 MK II £4.6.6.
Postage on all above 5/-

DENSHI BOARD KITS

NEW EXPERIMENTAL AND EDUCATIONAL CIRCUIT SYSTEM

The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are incapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. In addition each **DENSHI BOARD KIT** comes complete with an 80 page manual of circuits and data.



THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES:

VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, CONTINUITY TESTER, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE ETC., ETC.

DENSHI BOARD KIT SR-1A *comprises:*

Base board; tuner block; 4 resistors; choke coil; transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces and 80 page manual. **This kit permits the building of 16 basic circuits.**
Post 3/6

LASKY'S PRICE £4.19.6 Post 3/6

DENSHI BOARD KIT SR-2A *as SR-1A but with the following additional parts;* 2SB transistor for AF; 2 resistors; 1 capacitor; crystal microphone; test probes; electrode additional connecting pieces; 9V battery. **This kit permits the building of 30 basic circuits**

LASKY'S PRICE £7.2.6 Post 2/6

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OXFORD ST. 23 TOTTENHAM COURT RD. DOMINION

SPECIAL OFFER OF SHURE STEREO CARTRIDGES

Look at our special prices!

M3D	List £8.10.6.	Premier Price £6.19.6
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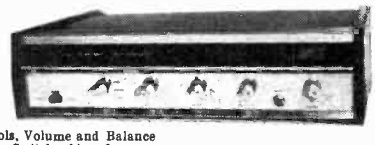
M75-6	List £17.8.4.	Premier Price £13.19.6
M75E	List £25.18.10.	Premier Price £21.0.0

Post and Packing 1/6 each

"NOVA" TRANSISTOR STEREO AMPLIFIER



A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 10 watts per channel. Frequency response 40-20,000 Hz ± 3dB. Inputs for radio, P.U. Ceramic, P.U. Magnetic Tape, Separate bass and treble controls, Volume and Balance controls Mono/Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14½ × 9½ × 3½in. A.C. 200/250V.

WONDERFUL VALUE AT ONLY 25 Gns. Carr. 10/-.

PICK-UP CARTRIDGES

AT MONEY SAVING PRICES!

GOLDRING G800 (Stereo)	£8.19.6
SONOTONE 9TAHC/D (Stereo)	£2.15.0
ACOS GP91/1SC (Mono compatible)	£1.13.5
ACOS GP93-1 (Stereo)	£2. 8.7
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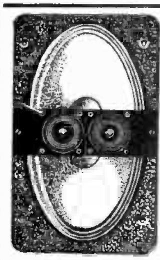
B S R X3M (Mono compatible)	£1.16.5
B S R X3H (Mono compatible)	£1.16.5
RONETTE 105 (Stereo)	£1.15.0
RONETTE 106 (Stereo)	£1.15.0

All complete with mounting brackets and instructions. Post and Packing 1/6 each.

The Premier Stereo System consists of an all transistor stereo amplifier. Garrard Model 2025 auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12 × 5½ × 3½in. high (Amplifier available separately if required £14.19.6. Carr. 7/6.)

WIDE RANGE OF HI-FI STEREO EQUIPMENT ON DEMONSTRATION

All leading makes available including Rogers, Armstrong, Dulci, Wharfedale, Goodmans, Goldring, Shure, etc. etc.

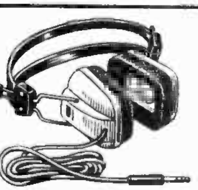


E.M.I. 13×8in. HI-FI SPEAKERS

Fitted two 2½in. tweeters and crossover network. Impedance 3 and 15 ohms. Handling capacity 10 watts. Brand new. 99/6, p.&p. 7/6.

Also available without tweeters 49/6, p. & p. 7/6.

TEAK FINISHED CABINET
Size 17½ × 10 × 7½in. Ideal for above speakers £5.10.0, p. & p. 10/-.



HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2½" speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft. lead and stereo jack plug.

59/6 P. & P. 5/-.

MONO HEADPHONES 2000 ohm 14/6 P. & P. 2/6.
STEREO STETHOSCOPE SET Low imp. 25/- P. & P. 2/-.
MONO STETHOSCOPE SET Low imp. 10/6 P. & P. 2/-.

VERITAS V149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1.5v. Max. output 2.5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

MONO MODEL 59/6 STEREO MODEL 69/6 P. & P. 2/6.

VERITAS V313 TAPE HEAD DEFLUXER

A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds.

34/6 P. & P. 1/6.

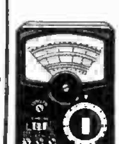
SPECIAL PURCHASE

EKCO "EXPLORER" CAR RADIO

Frustrated Export Order! A truly dependable and selective car radio giving world-wide reception. 8 transistor. 12v. Pos or Neg earth operation. 9 wavebands—MW 185—570 metres and 8 S.W. bands 3.2 Mc/s—17.9 Mc/s (90, 60, 49, 41, 31, 25, 19, 16 Metre Bands). Size 2in. high × 7in. wide × 5½in. deep. Original price £35. **OUR PRICE 21 GNS.** P. & P. 7/6. (Suitable Philips Speaker, baffle and brackets £2.13.0. P. & P. 5/-.)

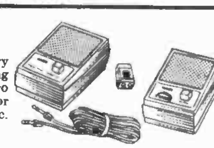
MULTI TESTERS

MODEL D14. A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0–15–150–1000 volts. Resistance 0–100,000 ohms. Current 0–150 mA D.C. Size only: 3⅝" x 2¼" x 1⅛" Complete with battery, test leads and instructions. 49/6 P. & P. 2/6.



POCKET SIZE MODEL. With wide-angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt D.C. 10,000 ohms/volt A.C.
19 Ranges: 0-5-25-50-250-500-2500 volts DC. 0-10-50-100-500-1000 volts AC. 0-50µA-2·5 mA-250 mA DC. 0-6000 ohms-6 megohms, 10µ µf-0·001 mfd-1 mfd. —20 to +22dB. Complete battery, test lead and instructions. £4.19.6 P. & P. 3/6.

TWO STATION TRANSISTOR INTERCOMS.



Complete with battery and 50ft. connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc.

65/- P. & P. 4/-.

FOUR STATION INTERCOM. Master unit and 3 slaves. Ideal for office and home. Complete with battery and connecting wire £7.19.6. P & P. 5/6.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed

LP3	3"	250'	P.V.C.	5/6	LP6	5¾"	1200'	P.V.C.	12/6
TT3	3"	450'	POLYESTER	7/6	DT6	5¾"	1800'	POLYESTER	22/6
DT3	3¼"	600'	POLYESTER	11/6	TT6	5¾"	2400'	POLYESTER	37/6
SP5	5"	600'	P.V.C.	8/6	SP7	7"	1200'	P.V.C	12/6
LP5	5"	900'	P.V.C.	10/-	DT7	7"	2400'	POLYESTER	25/-
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TAPE SPOOLS 3" 1/-, 5", 5¾", 7" 1/9. TAPE CASES 5", 7" 2/6.
Post and Packing 3" 1/-, 5", 5¾" 1/6, 7" 2/-. (3 reels and over Post Free).

"PREMIER" TAPE CASSETTES

C60 (60 min.) 7/6
C90 (90 min.) 12/6
C120 (120 min.) 17/6

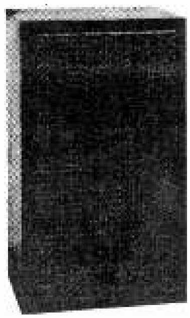
P. & P. 1/-.

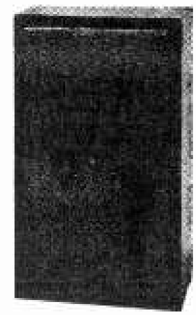
CASSETTE HEAD CLEANER

Removes unwanted deposits from delicate tape heads. Fits all cassette recorders.

11/6 P. & P. 1/-

a complete stereo system for only 28 gns!



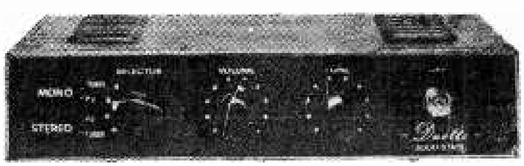


The Duetto 9 Gns.
+ 7/6 p & p

Integrated Transistor Stereo Amplifier

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.

Specification: R.M.S. power output: 3 watts per channel into 10 ohms speakers.
Input Sensitivity: Suitable for medium or high output crystal cartridges and tuners. Crosstalk better than 30dB at 1Kc/s.
Controls: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
Tone Control: Treble lift and cut. Separate on/off switch.
A preset balance control.



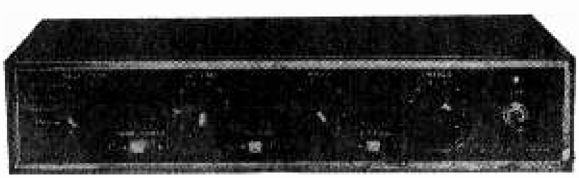
The Duo 4 Gns.
+ 7/6 p & p

The new Duo general purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.

Type 1 Specification: Impedance 10 ohms. It incorporates Goodmans high flux 6" x 4" speaker and 2¼" tweeter. Teak finish. 12" x 6¾" x 5¾", 4 gns each, p & p 7/6.
Type 2 as Type 1. Size 17½" x 10¾" x 6¾". Incorporating Elac 10½" x 6¼", 10,000 lines & 2¼" tweeter. 3 ohms impedance.

5½ gns p & p 7/6

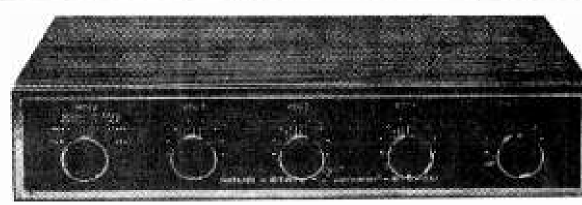
Garrard Changers from £7.19.6 p & p 7/6
Cover & Teak finish Plinth £4.15.0 p & p 7/6



The Classic 8½ Gns. + 7/6 p & p

Controls: Selector switch Tape speed equalisation switch (3¾ and 7½ i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz. *Tape head:* 3mV (at 3¾ i.p.s.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80mV. *Radio:* 100mV. *Aux.:* 100mV. *Tape/Rec. output:* 100mV. Equalisation for each input is correct to within ± 2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ± 13dB at 60 Hz. Treble ± 14dB at 15KHz. *Total distortion:* (for 10 watt output) < 1·5%. *Signal noise:* < –60dB. A.C. mains 200–250v. Built and Tested. Size 12½in. long, 4½in. deep, 2¼in. high. Teak finished case.



The Viscount 13½ Gns. + 7/6 p & p

Integrated High Fidelity Transistor Stereo Amplifier

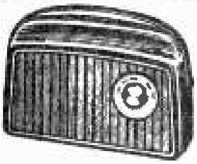
Specification—Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monaural). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo), P.U., Tuner, Tape and Tape Rec. Out. Sensitivities: All inputs 100mV into 1·8M ohm. Frequency Response: 40Hz–20KHz ± 2dB. Tone Controls: Separate bass and treble controls; treble, 13dB lift and cut (at 15KHz); Bass, 15dB lift and 25dB cut (at 60Hz). Volume Controls: Separate for each channel. AC Mains Input: 200–240v. 50–60Hz. Size, 12½" x 6" x 2¾" in teak finished case. Built and tested.

SPECIAL OFFER!

Complete stereo system comprising BALFOUR 4-speed autoplayer with stereo head, 2 duo speaker systems, size 12in. x 6¾in. x 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

19 gns. plus 20/- p & p

RADIO & TV COMPONENTS (Acton) LTD
Also see opposite page



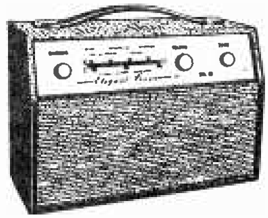
THE DORSET (600mW Output)

7-transistor fully tunable M.W.-L.W. superhet portable —with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques makes this simple to build. Sizes: 12 x 8 x 3in.

MAINS POWER PACK KIT: 9/6 EXTRA.

PRICE 5 GNS. + 7/6 p. & p. CIRCUIT 2/6 FREE WITH PARTS.

THE ELEGANT SEVEN MK III (350mW Output)

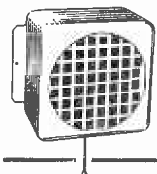


7-transistor fully tunable M.W.-L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.

MAINS POWER PACK KIT: 9/6 extra.

Price £4.9.6 plus 7/6 p. & p.

Circuit 2/6 FREE WITH PARTS.



EXTRACTOR FAN 27/6

plus 7/6 p.p.

AC mains 230/250v. complete with pull switch.

Size 6 x 6 x 4in.

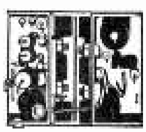
X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP

Specifications: *Power Output* (into 3 ohms speaker) 10 watts. *Sensitivity* (for rated output): 1mV into 3K ohms (0·33 microamp). *Total Distortion at* 1KHz. at 5 watts 0·35%, at rated output 1·5%. *Frequency Response:* Minus 3dB points 20Hz and 40KHz. *Speaker:* 3–4 ohms (3–15 ohms may be used). *Supply voltage:* 24V d.c. at 800mA (6–24V may be used).

Control assembly: including resistors and capacitors.

1. Volume: PRICE 5/-.
2. Treble: PRICE 5/-.
3. Comprehensive bass and treble: PRICE 10/-.

The above 3 items can be purchased for use with the X101.



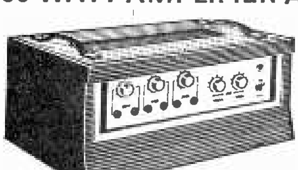
Price 69/6
plus 2/6 p. & p.

Power Supplies for the X101:
P101 M (for mono) **35/-** plus 4/6 p. & p. P101 S (for stereo) **42/6** plus 4/6 p. & p.

CAR TRANSISTOR IGNITION SYSTEM (by famous manufacturer)

For 6 volt or 12 volt positive earth systems. Comprising: special high voltage working hermetically sealed silicon transistor mounted in finned heat-sink, high output ignition coil, ballast resistor and hardwear (screws, washers etc.). PRICE **£4.19.6.** (post and packing 5/- extra).

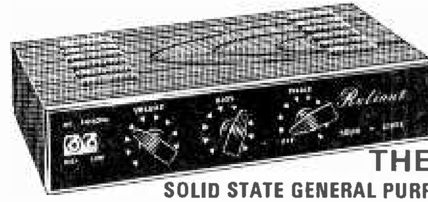
50 WATT AMPLIFIER A.C. MAINS 200-250V



Price 27 gns.
Plus 20/- p & p.

An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.

TECHNICAL SPECIFICATIONS
3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES.** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300 mV at 1m. Suitable for most high output instruments (gram, tuner, organ etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost** +12dB at 60 Hz/s. **Bass Cut** −13dB at 60 Hz/s. **Treble Boost** +11dB at 15 KHz/s. **Treble Cut** −12dB at 15 KHz/s. With bass and treble controls central −3dB points are 30 Hz/s and 20 KHz/s. **POWER OUTPUT.** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sinc wave 38·5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3·2% at 1KHz/s. Total distortion at 20 watts 0·15% at 1KHz/s. Output to match into 8 or 15 ohms speaker system. **NEGATIVE FEED BACK** 20dB at 1KHz/s. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES.** Adjustable from 200–250v. A.C. 50–60 Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.



THE RELIANT
SOLID STATE GENERAL PURPOSE AMPLIFIER

SPECIFICATIONS

Output—10 watts
Output Impedance—3 to 4 ohms
Inputs—1. -xtal mic 10mV
2. -gram/radio 250mV
Tone Controls—Treble control range ± 12dB at 10KH2
Bass control range ± 13dB at 100H2

Frequency Response—(with tone controls central) Minus 3dB points are 20H2 and 40KH2. Signal to Noise Ratio—better than −60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input— −220 −250V. A.C. Size of chassis—10½" × 4½" × 2½". A.C. Mains, 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram. and mike. Built and tested. 8" × 5" speaker to suit price 14/6 plus 1/6 P. & P. Crystal mike to suit 12/6 plus 1/6 P. & P.

Reliant Mark I. 5½ gns. plus 7/6 p. & p.
As above less teak case.

Reliant Mark II. 6½ gns. plus 7/6 p. & p.
In teak finished case.

CYLDON 2 TRANSISTOR U.H.F. TUNER

Brand new. Complete with circuit diagram.

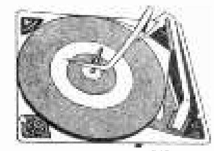
£2.10.0 plus 1/- p. & p.

THREE-IN-ONE HI-FI 10 WATT SPEAKER

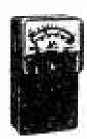
A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross over network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20kc/s. Size 13¼ x 8¹/₁₆ x 4½ inches. By famous manufacturer. List Price £7. Our price **74/6** plus 5/- P. & P.

Similar speaker to the above without tweeters in 3 and 15 ohms **44/6** plus 5/- P. & P.

RECORD PLAYER SNIP A.C. MAINS 240V



The "Princess" 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7" to 10" or 12". Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess, a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only **£5.19.6** complete with cartridge and ready to play. Post and insurance 7/6 extra.

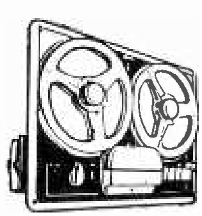


POCKET MULTI-METER

Size 3⅞ x 2½ x 1⅜in. Meter size 2½ x 1⅜in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0–15, 0–150, 0–1000 D.C. current 0–150mA. Resistance 0–100kΩ. Complete with test prods, battery and full instructions, **42/6.** P. & P. 3/6. **FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value **15/-** to every purchaser of the Pocket Multi-Meter.

B.S.R. TD-2 TAPE DECK

takes 5¾in. spools, fitted with B.S.R. ½ Track Heads. Size 13½in. long by 8¾in. wide. **£6 19s. 6d.** plus 7/6 p.p.



MOTEK

3 Speed 2 track Tape Deck complete with heads, takes 7in. spool.

Incorporating 3 motors.

A.C. mains, 240 volts, listed at £21.0.0.

Our Price £9.19.6, plus 10/- P. & P.

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1st I.F. Transformer	P50/2CC (For OC45)	P51/1	(For AF117)	5/7
2nd I.F. Transformer	P50/2CC (For OC45)	P51/2	(For AF117)	5/7
3rd I.F. Transformer	P50/3CC (For OC45)	P50/3V	(For AF117)	6/-

Rod Aerial	RA2W	12/6
Driver Transformer	LFDT4/1	9/6
Output Transformer	OPT1	10/6
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T41/3T	3rd I.F. Transformer	10/6
T41/3T	B.F.O. Coil	10/6

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REVERBERATION AMPLIFIER. Self contained transistorised battery operated. An entirely different approach to sound reproduction. Normally sound reproduction from a single source has a flat one dimensional effect. With this, proper sound delay through reverberation, tones, are created with a truly third dimension for concert hall originality. Two controls adjust volume and reverberation. Simply plug microphone, guitar etc., in and the output into your amplifier. Supplied in a beautiful walnut cabinet 7½ x 3 x 4½in. **£10.4.0**, p.p. & ins. 6/-.

POWER CONTROLLER. Power at your finger tips. Not just half wave control but full wave. One variable control gives zero to full power. Uses latest 15 amp 3kW triac and special triggering device. Complete with box, power socket etc. Ideal for flood-lights, fires, motors, etc. In kit form **£6.9.6**. Ready built **£9.4.6** plus 5/6 p.p.

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MAINS UNITS for all types of TRANSISTOR EQUIPMENT

The ideal, economical and safe way of running Transistor Radios, Record Players, Tape Recorders, Amplifiers etc. from A.C. Mains. All units are completely isolated from mains by double wound transformer ensuring 100% safety.

PLUS-3
MAINS UNIT

Provides three separate switched output voltages 6v., 7½v. and 9v. DC. attractive case with indicator light, mains lead output socket, plug and lead. Size 4½ x 3½ x 2½ in.

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(Extra lead with DIN plug for Cassette Recorders 7/6)

POWER PLUS
MAINS UNIT

for Cassette Tape Recorders using 7½v. Complete with DIN plug for recorder power socket. Can also be supplied for a 6-volt output complete with suitable plug. (Please state make, model and voltage required.)

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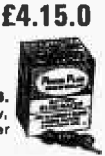
Also available—Unit to run your Cassette Recorder from 12v. Car Battery 32/6. P. & P. 2/6.

MAINS UNIT for FI-CORD 202A TAPE RECORDER P. & P. 5/-. **£4.15.0**



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For single outputs, 6v, 9v, 12v, 18v, 39/6. For two separate outputs, 4½v + 4½v, 6v + 6v., 9v + 9v. 42/6. P. & P. 2/6 per unit. *(Please state outputs reqed).*

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J1007	7"	Standard Play PVC	1200ft.	12/6	P. & P. 2/6.
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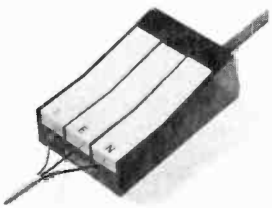
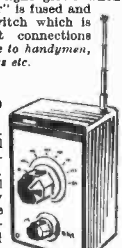
SAVES TIME—SAFELY!



One mains "Keynector" instantly and safely connects electrical appliances to mains supply without the use of a plug. A number of appliances may be used simultaneously up to the full 13 amp rating of this device. A red light glows when "live". The "Keynector" is fused and has its own robust switch which is interlocked to prevent connections when "live". *Invaluable to handymen, servicemen, demonstrators etc.*

39/6 P. & P. 3/-.

VHF AIRCRAFT BAND CONVERTOR.



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

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No. 15RN. Voltage 11·5v. Current 400mA. Torque. 12g-cm. Body size 1¼" long × ⅞" dia. Shaft $^{5}/_{16}$" long × $^{1}/_{16}$" dia. Ideal for small models and toys. 5/6 each. P. & P. 1/3. 3 for 15/-. P. & P. 2/6.

DE-LUXE STEREO HEADPHONES

With soft rubber earpieces. Impedance 8-16 ohms. Frequency response 23-13,000cps. With lead and stereo plug.
Only 59/6. P. & P. 3/6.

NEW STEREO/MONO HEADPHONES

SDH-7. Soft rubber earpieces with slide switch for mono/stereo listening and ind. vol. controls. Impedance 8–16 ohm Freq. response 25–15,000 cps. Withlead and stereo plug.
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SINCLAIR IC-10 INTEGRATED CIRCUIT

10 watt Amplifier. Size only 1 × 0.4 × 0.2in. A true hi-fi amplifier complete with manual giving details of a wide range of applications and instructions. Guaranteed 5 years. ONLY 59/6. P. & P. 1/6.

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AUTO WOUND TRANSFORMERS

All Winding Voltage Ratings and Tapping 0–115–200–220–240v except MT113–0–115–210–240v.

MT113	20W	Size 2¾ × $1^{11}/_{16}$ × 1¾in.	Wgt 11oz	Price 12/6	P&P 2/6
MT64	75W	Size 2¾ × 2½ × 2¾in.	Wgt 1 lb 14oz	Price 21/9	P&P 4/6
MT4	150W	Size 3¼ × 2¾ × 3in.	Wgt 3 lb	Price 33/-	P&P 6/-
MT65	200W	Size 3½ × 4¼ × 4in.	Wgt 4 lb	Price 39/6	P&P 6/-
MT66	300W	Size 4 × 4 × 3¾in.	Wgt 6 lb 7 oz	Price 59/4	P&P 9/-
MT110	400W	Size 4¾ × 4½ × 4in.	Wgt 11 lb	Price 85/-	P&P 10/-
MT67	500W	Size 5¼ × 4 × 4¼in.	Wgt 12 lb 8oz	Price 89/-	P&P 10/6
MT83	750W	Size 4½ × 5¼ × 5¼in.	Wgt 13 lb 4oz	Price 95/7	P&P 10/6
MT84	1000W	Size 4¾ × 5¼ × 5¼in.	Wgt 16 lb	Price 142/2	Carr. ex.
MT93	1500W	Size $5^{5}/_{16}$ × 5¾ × 6½in.	Wgt 28 lb 9oz	Price 170/6	Carr. ex.
MT94	1750W	Size $5^{5}/_{16}$ × 6¾ × 6½in.	Wgt 31 lb	Price 195/-	Carr. ex.
MT95	2000W	Size 7 × 6¼ × 8¼in.	Wgt 40 lb	Price 211/2	Carr. ex.
MT73	3000W	Size 6¾ × 7¼ × 8¾	Wgt 45 lb 8oz	Price 300/-	Carr. ex.

LOW VOLTAGE 12 VOLT RANGE

Primary 200–250v—Secondary 12v

MT111	0·5 Amp	Size 3 × 2½ × 1¾in.	Wgt 12oz	Price 15/3	P&P 2/6
MT71	2 Amp	Size 2¾ × 2½ × 2½in.	Wgt 1 lb	Price 19/-	P&P 3/9
MT69	4 Amp	Size 3½ × 2¾ × 2¾in.	Wgt 2 lb 4oz	Price 28/-	P&P 6/-
MT70	6 Amp	Size 4 × 3 × 3¾in.	Wgt 3 lb 12oz	Price 39/-	P&P 6/-
MT72	10 Amp	Size 3½ × 4¼ × 4in.	Wgt 6 lb 3oz	Price 51/-	P&P 9/-
MT105	20 Amp	Size 4¾ × 4½ × 4in.	Wgt 11 lb 13oz	Price 95/-	P&P 9/-
MT187	30 Amp	Size 5¼ × 4¾ × 4¾in.	Wgt 16 lb 12oz	Price 180/-	P&P 13/6

LOW VOLTAGE 24 VOLT RANGE

Primary 200/250v. Secondary 24v

MT58	1 Amp	Size 2¾ × 2¾ × 2½in.	Wgt 1 lb 7oz	Price 23/9	P&P 4/6
MT114	3 Amp	Size 2½ × 3 × 3in.	Wgt 3 lb 6oz	Price 38/-	P&P 6/-
MT72	5 Amp	Size 4 × 3¾ × 3¾in.	Wgt 5 lb 12oz	Price 53/10	P&P 6/-
MT17	8 Amp	Size 4¾ × 3¾ × 4in.	Wgt 7 lb 8oz	Price 72/7	P&P 9/-
MT115	10 Amp	Size 4¾ × 4½ × 4in.	Wgt 11 lb 13oz	Price 95/-	P&P 11/-

LOW VOLTAGE 30 VOLT RANGE

Primary 200/250v Secondary Tapped 12–15–20–24–30

MT112	0·5 Amp	Size 3½ × $2^{7}/_{16}$ × $1^{15}/_{16}$in.	Wgt 1 lb 4oz	Price 17/4	P&P 3/9
MT79	1 Amp	Size 2¾ × 2½ × 2¾in.	Wgt 2 lb	Price 23/-	P&P 6/-
MT20	3 Amp	Size 4 × 3½ × 3¾in.	Wgt 4 lb 6oz	Price 46/2	P&P 6/-
MT51	5 Amp	Size 4¾ × 3½ × 4in.	Wgt 6 lb 8oz	Price 60/9	P&P 9/-
MT88	8 Amp	Size 5¼ × 3¾ × 4¼in.	Wgt 9 lb 6oz	Price 92/4	P&P 11/-
MT89	10 Amp	Size 5½ × 4 × 4¼in.	Wgt 12 lb 2oz	Price 103/6	P&P 11/-

LOW VOLTAGE 50 VOLT RANGE

Primary 200–250v SECONDARY TAPPED 19–25–33–40–50v

MT102	0·5 Amp	Size 2¾ × 2¾ × 2½in.	Wgt 1 lb 11oz	Price 21/3	P&P 6/-
MT104	2 Amp	Size 4 × 3½ × 3¾in.	Wgt 5 lb	Price 45/8	P&P 6/-
MT106	4 Amp	Size 4¾ × 4½ × 4in.	Wgt 9 lb 4oz	Price 77/-	P&P 9/-
MT118	8 Amp	Size 5½ × 5½ × 4¾in.	Wgt 18 lb 9oz	Price 132/-	P&P 13/6
MT119	10 Amp	Size 6¼ × 4½ × 6½in.	Wgt 19 lb 12oz	Price 165/-	P&P 15/6

LOW VOLTAGE 60 VOLT RANGE

Primary 200/250v. Secondary Tapped 24–30–40–48–60

MT124	0·5 Amp	Size 3½ × 2¾ × 2¾in.	Wgt 2 lb 4oz	Price 24/-	P&P 6/-
MT127	2 Amp	Size 4 × 3½ × 3¾in.	Wgt 5 lb 6oz	Price 52/10	P&P 6/-
MT123	4 Amp	Size 4½ × 3¾ × 4¼in.	Wgt 10 lb 6oz	Price 99/-	P&P 11/-
MT122	10 Amp	Size 6¼ × 5 × 6¼in.	Wgt 23 lb 2oz	Price 152/-	Carr. ex.

MAINS H.T. RANGE

						Size	Price	P&P.
MT1AT	250–0–250v	80MA	6·3v 3·5A	5/6·3v 1A		3½ × 3 × 3in.	33/-	6/-
MT6AT	250–0–250v	100MA	6·3v 3·5A	5/6·3v 1A		4 × 3½ × 3½in.	38/3	6/-
MT110	250–0–250v	120MA	6·3v 3·5A	5/6·3v 1A		4 × 4 × 3½in.	44/9	6/-
MT11AT	300–0–300v	100MA	6·3v 3·5A	5/6·3v 1A		4 × 3½ × 3¾in.	37/9	6/-
MT12AT	300–0–300v	120MA	6·3v 4A	5/6·3v 1A		4 × 3¾ × 3¾in.	46/2	9/-
MT33AT	300–0–300v	150MA	6·3v 4A	5/6·3v 1A		4 × 4 × 3½in.	59/4	9/-
MT2AT	350–0–350v	80MA	6·3v 3·5A	5/6v 1A		4 × 3½ × 3¾in.	38/6	6/-
MT7	350–0–350v	100MA	6·3v 3·5A	5/6·3v 1A		4 × 3½ × 3¾in.	42/4	6/-
MT8	350–0–350	120MA	6·3v 3·5A	5/6·3v 1A		4 × 3¾ × 3¾in.	50/-	6/-

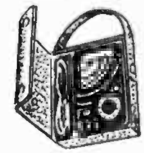
BATTERY CHARGER TYPES

Primary Voltage 200–250v. Secondary 6–12v.

M77	1 Amp	Size 2¾ × 2½ × 2¾in.	Wgt 1 lb 6oz	Price 15/-	P&P 4/6
MT45	1·5 Amp	Size 2¾ × 2¾ × 2¾in.	Wgt 1 lb 9oz	Price 21/9	P&P 4/6
MT46	2 Amp	Size 3½ × 2¾ × 2¾in.	Wgt 2 lb 4oz	Price 25/4	P&P 6/-
MT47	3 Amp	Size 4 × 3 × 3¾in.	Wgt 3 lb 8oz	Price 28/4	P&P 6/-
MT5	4 Amp	Size 4 × 2¾ × 3½in.	Wgt 3 lb 11oz	Price 33/-	P&P 6/-
MT78	5 Amp	Size 4 × 3½ × 3¾in.	Wgt 5 lb 4oz	Price 42/-	P&P 6/-
MT86	6 Amp	Size 4 × 3½ × 3⅞in.	Wgt 5 lb 12oz	Price 48/-	P&P 6/-
MT48	7 Amp	Size 4 × 4 × 3¾in.	Wgt 6 lb	Price 56/7	P&P 9/-
MT146	8 Amp	Size 3½ × 4 × 4in.	Wgt 6 lb 4oz	Price 75/-	P&P 9/-
MT49	9 Amp	Size 4¾ × 3¾ × 4in.	Wgt 7 lb 8oz	Price 99/-	P&P 9/-
MT147	10 Amp	Size 4¾ × 3½ × 4in.	Wgt 9 lb 3oz	Price 105/-	P&P 9/-
MT50	12·5 Amp	Size 5¼ × 4½ × 4¾in.	Wgt 11 lb 14oz	Price 125/-	P&P 11/-

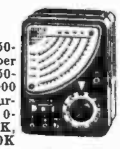
Amperages are D.C. with nominal selenium bridge rectifiers
MAINS ISOLATING RANGE ALSO AVAILABLE

TTC.C1001 MULTITESTER in leather case.



20,000 opv. AC volts 10, 50, 250, 1,000v. DC volts 5-25, 125, 500, 2500v. D.C. Current 0-50µA, 0-250mA Resistance 0-60K, 0-6 Megohm. Decibels –20 to +22dB. Size of meter 4½ × 3¾ × 1in. 85/-. P. & P. 3/6.

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



DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500-1000 volts (10,000 ohms per volt). DC Current: 0-50µA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale.) Capacitance: 10pf. to ·001 mfd, ·001µf to ·1µf. Decibels: —20 to +22dB. Size 4½ × 3½ × 1in. Complete with case 77/-. P. & P. 3/6.

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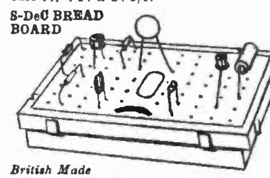

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Solderless breadboard panels, for fast reliable component connections.
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4-DeC KIT. Four S-DeCs with two Control Panels, Jigs and Accessories and the booklet "Projects on S-DeC" all contained in a strong attractive plastic case. Ideal for the professional user. £5.17.6. P. & P. 3/6.

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3000D Stereo/Mono with cart.	£10.19.6
SP25 less cartridge	£11.19.6
SP25 with Decca Deram cart.	£17. 4.6
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SPECIAL OFFER!	
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P. & P. Decks 12/6, Cover 4/6, Base 4/6.
P. & P. Deck/Cover/Base 17/-.

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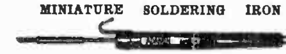

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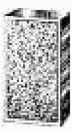

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Highly sensitive. Push-Pull high output, with Pre-amp./Tone Control Stages. Performance figures of factory built units: Hum level —70dB. Frequency response ±3dB 30-20,000c/s. Sectionally wound output transformer. All high grade components. Valves EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 mV. Suitable for high impedance microphones, Crystal or Ceramic P.U's. Designed for **Clubs, Schools, Theatres, Dance Halls** or **Outdoor Functions**, etc. For use with **Electronic Organ, Guitar, String Bass,** etc. Gram, Radio or Tape. Reserve L.T. and H.T. for **Radio Tuner.** Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250v. 50c/s A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts with point-to-point wiring diagrams and instructions. Carr. 12/6 **15 Gns.**

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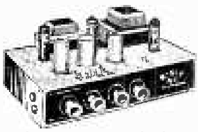

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP. Two input sockets with associated controls allowing mixing of "mike" and gram, etc. etc. High sensitivity. 5 valves—ECC83 (2), EL84 (2), EZ81. High quality sectionally wound output transformer. IND. BASS AND TREBLE CONTROLS. Frequency response ±3dB 30-20,000 c/s. Hum level —60dB. SENSITIVITY 40 millivolts. For Crystal or Ceramic PUs. High Impedance "mikes". For Musical Instruments such as String Bass, Electronic Guitars etc. Size approx. 12 x 9 x 7in. For AC mains 200-250v. 50 cps Output for 3 and 15 ohm spkrs. SAE for leaflet. Complete kit. **9½ Gns.** Full instructions and point-to-point wiring diagrams. Carr 11/6 (or factory built 12½ gns.) Twin handled metal cover 27/6. TERMS ON ASSEMBLED UNITS. Deposit 99/6 and 9 monthly payments of 23/- (Total £15.6.6)

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★ Four Jack inputs and two Volume Controls for simultaneous use of up to four pick-ups or "mikes". Bass and Treble controls.

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250-0-250v. 100mA, 6·3v. 2a, 6·3v. 1a.	26/9
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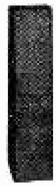

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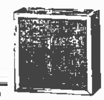

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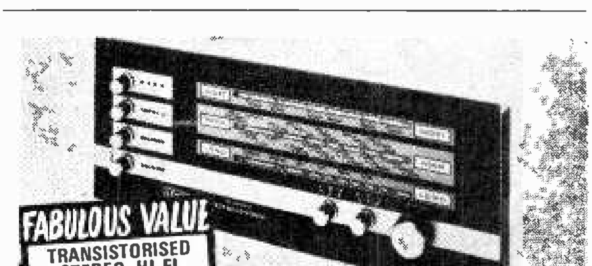

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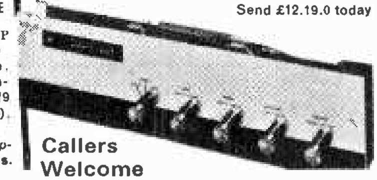

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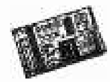

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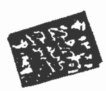

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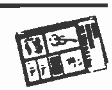

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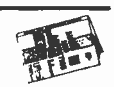

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Feb., 1969

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Extract of letter from Mr. R. G. Bernaldez of Madrid, Spain.
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P & P 7/6.

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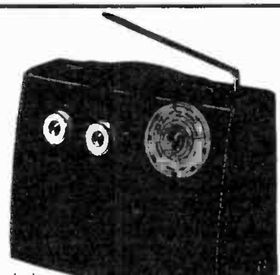

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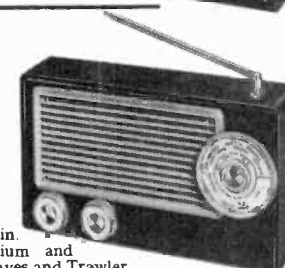


SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

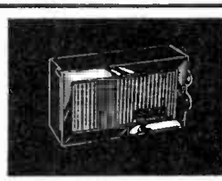
Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 x 5½ x 2¾in. approx. Tunable on Medium and Long Waves, three Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. Eight improved type transistors plus 3 diodes. All top grade components. Push pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts) Earpiece with switched socket for private listening 5/- extra.

Total building costs **89/6** P & P 5/6

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5¼ x 1¼ x 3¼in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. All first grade components—7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

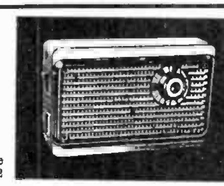


Total building costs **44/6** P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6¼ x 4¼ x 1½in. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. All first grade components. Easy build plans and parts price list 1/6 (FREE with parts.)

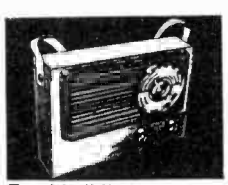


Total building costs **47/6** P. & P. 3/9

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings. Size 7½ x 5¼ x 1½in. Tunable on Medium and Long waves, two short waves, Trawler Band Plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short waves. All top grade components. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/-.



Total building costs **79/6** P. & P. 4/6

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ROAMER EIGHT	☐	ROAMER SEVEN	☐
TRANSONA FIVE	☐	TRANS EIGHT	☐
POCKET FIVE	☐	ROAMER SIX	☐

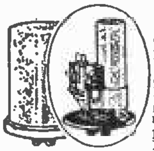
Parts price list and plans for ....

Name ....

Address ....

.... PW10

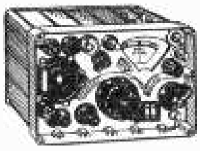
CAR LIGHT FLASHERS



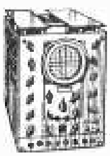
Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset). Housed in strong plastic case. Flashing rate between 60-120 per minute. 12V DC operation. Maximum load 6 amps. Size 2-11/16in. dia. x 4in. Supplied brand new at a fraction of original cost. 6/6 each P. P. 2/6. (3 for 17/6 P. P. 4/6).

R209 MK II COMMUNICATION RECEIVER

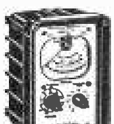
11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, B.F.O., aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked £15.0.0. Carr. 20/-



TYPE 13A DOUBLE BEAM OSCILLOSCOPES



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



MARCONI T/44/TF956

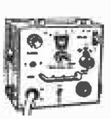
AF Absorption Wattmeter

1 µ/watt to 6 watts. £20. Carr. 10/-.

SOLARTRON CD-1016 OSCILLOSCOPE

Double beam. D.C. To 5 Mc/s. Excellent condition. £55 each. Carr. 20/-.

CLASS D WAVEMETERS



A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6 volts D.C. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6. Or brand new with accessories. £7.19.6. Carr. 7/6.

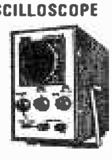
CLASS D WAVEMETERS No. 2

Crystal controlled. 1·2–19 Mc/s. Mains or 12V. D.C. operation. Complete with calibration charts. Excellent condition. £12.10.0. Carr. 30/-.

SOLARTRON CD.711S.2 OSCILLOSCOPES

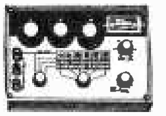
Double beam. D.C. to 9Mc/s. Perfect order. £65. Carr. 50/-.

TO-2 PORTABLE OSCILLOSCOPE



A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS–1 mHz. Input imp 2 meg Ω 25 pF. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240V. a.c. Supplied brand new with handbook. £22.10.0. Carr. 10/-.

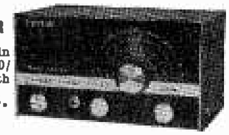
TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 meg Ω 6 Ranges ±1%. L.1 µ H – 111 HENRYS 6 Ranges −2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

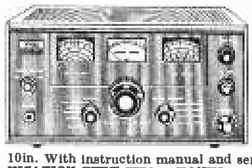
Covering 550 Kc/s–30 Mc/s. Incorporates BFO. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. A.C. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**



LAFAYETTE SOLID STATE HA600 RECEIVER

5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 Kc/s–400 Kc/s and 550 Kc/s–30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V. A.C./12V. D.C. neg. earth operation ● RF gain control. Size 15in. × 9½in. × 8½in. Weight 18 lbs. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver covering 550 Kc/s to 30 Mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit, 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455 Kc/s ● Audio output 1·5 W. ● Variable RF and AF gain controls. 115/250V. A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. £42.10.0, carriage paid. **TRIO COMMUNICATION TYPE HEADPHONES.** Normally £5.19.6. OUR PRICE £3.15.0 if purchased with above receiver.

TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER

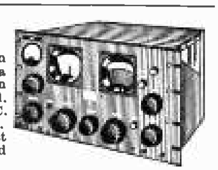
TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212. IN STOCK!

Covers all the amateur bands in 7 separate ranges between 3·5 and 29·7 Mc/s, 7 valves, 2 transistors and 5 diodes plus 8 crystals: output 8 and 500 ohm and 5,000 ohm phone jack. Crystal controlled oscillator. Variable BFO. VFO. AVC. ANL. S meter, SSB-CW. Stand-by switch. Special double gear dial drive with direct reading down to 1 kHz. Remote control socket for connection to a transmitter. Audio output 1 watt. 115/250v. A.C. mains. Superb modern styling. Size 7 × 13 × 10in. with instruction manual and service data. £69.10.0. Carr. Paid.

SPECIAL BONUS OFFER! TRIO SP5D Matching Speaker Mate and TRIO HS4 Communication Headphones. Normal Value £10.7.0, FREE OF CHARGE with every JR.500SE purchased.

HAMMARLUND SP600JX COMMUNICATION RECEIVER

High quality professional dual conversion communication receivers available for the first time in this country at a reasonable price. Frequency range 540 Kc/s–54 Mc/s. in 6 bands variable tuning or 6 channel crystal controlled. 2·5 watt output into 600 ohms. Input 110/230V. A.C. 20 valve circuit incorporating: Xtal filter B.F.O. A.N.L. Xtal calibrator, S meter etc. Size 19 × 12 × 22in. (List £520). Offered in excellent condition, fully tested and checked. £100 each.

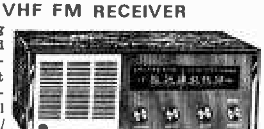


RCA COMMUNICATIONS RECEIVERS AR88D

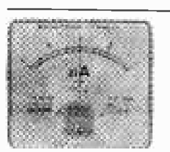
Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s–32 Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £37.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

A completely new transistorised receiver covering 152–174 Mc/s. Fully tunable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. £37.10.0. Carr. 10/-.



CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. $1^{21}/_{32}$in. square fronts.

50µA 37/6	500-0-500µA 25/-	50mA 25/-	150V. D.C...25/-
50-0-50µA 35/-	1mA 25/-	100mA 25/-	300V. D.C...25/-
100µA 35/-	1-0-1mA 25/-	150mA 25/-	500V. D.C...25/-
100-0-100µA 32/6	2mA 25/-	200mA 25/-	750V. D.C...25/-
200µA 32/6	5mA 25/-	300mA 25/-	15V. A.C....25/-
500µA 37/6	10mA 25/-	500mA 25/-	50V. A.C....25/-
	750mA 25/-	3V. D.C.....25/-	150V. A.C...25/-
	1 amp 25/-	10V. D.C....25/-	300V. A.C...25/-
	2 amp 25/-	20V. D.C....25/-	500V. A.C. 25/-
	5 amp 25/-	100V. D.C...25/-	S meter 1mA 29/6
	20mA 25/-		VU meter ..39/6

FULL RANGE OF OTHER SIZES IN STOCK. SEND S.A.E. FOR LEAFLET

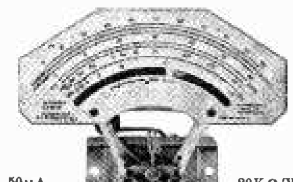
Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230V. 50–60 cycles.
Output full variable from 0·260 volts. Bulk quantities available.
1 amp.—£5.10.0; 2·5 amp.—£6.15.0; 5 amp.—£9.15.0;
8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21.0.0;
20 amp.—£37.0.0.

RACAL RA-17

First ministry release of these world famous communication receivers. Frequency range 500 kc/s–30 Mc/s. Available in excellent condition, fully tested and guaranteed. £150. Carr. 40/-.

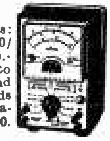
AVOMETER MOVEMENTS



50µA 20KΩ/V

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New & Boxed. 69/6. P. & P. 3/6.

TE-40 HIGH SENSITIVITY A.C. VOLTMETER



10 meg. input 10 ranges: ·01/·003/·1/·3/1/3/10/30/100/300V. R.N.S. 4cps.-1-2 Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17.10.0. Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0–20 Kc/s. on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. £12.10.0. Carr. 10/-.

TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.C. volts 1·5—1,500v. A.C. volts 1·5—1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation. Complete with probe and instructions. £17.10.0. P. & P. 6/-. Additional probes available: R.F. 35/-, H.V. 42/6.

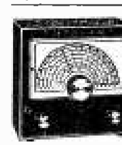
COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES. D.C. coupled. Band width 1Kc/s. Perfect order. £25. Carr. 30/-.

AM/FM SIGNAL GENERATORS

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

GEARED MAINS MOTORS

Paralux type SD19 230/250V. A.C. Reversible. 30 r.p.m. 40 lb./ins. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.



TE-16A Transistorised Signal Generator. 5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. £7.19.6. P. & P. 4/-.

FIELD TELEPHONES TYPE L

Generator ringing, metal cases. Operates from two 1·5V batteries (not supplied). Excellent condition. £4.10.0 per pair. Carr. 10/-.

AUTO TRANSFORMERS

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

150 W. £1.12.6. P. & P. 3/6.
300 W. £2. 7.6. P. & P. 4/6.
500 W. £3.10.0. P. & P. 6/6.
1,000 W. £5.10.0. P. & P. 7/6.
1,500 W. £7.19.6. P. & P. 8/6.
7,500 W. £15.10.0. P. & P. 20/-.

G. W. SMITH & CO (RADIO) LTD.

Also see oppos. page

BENTLEY ACOUSTIC CORPORATION LTD.

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THE VALVE SPECIALISTS *Telephone 01-722-9090*

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1LN5	8/-
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3V4	5/6
5R4GY	8/9
5U4G	4/9
5V4G	7/6
5Y3GT	5/6
5Z3	8/-
5Z4G	6/9
6/30L2	12/6
6A8G	5/6
6AC7	3/-
6AG5	3/6
6AK5	4/6
6AK6	6/-
6AL5	2/3
6AM6	3/3
6AQ5	4/9
6AR6	20/-
6AT6	4/-
6AU6	5/-
6AV6	5/6
6B8G	2/6
6BA6	4/6
6BE6	4/3
6BH6	7/6
6BJ6	6/9
6BQ5	4/6
6BQ7A	7/-
6BR7	8/6
6BR8	8/-
6BS7	16/6
6BW6	12/9
6BW7	11/-
6C4	2/9
6C6	3/9
6C9	11/-
6CD6G	19/6
6CH6	6/-
6CL6	8/6
6D3	7/6
6D6	3/-
6F1	8/9
6F6	12/6
6F6G	4/-
6F12	3/3
6F13	3/6
6F15	9/6
6F18	7/6
6F23	13/3
6F24	11/9
6F28	10/6
6G6G	2/6
6H6GT	1/9
6J5G	3/9
6J6	3/-
6J7G	4/9
6J7GT	6/6
6K6GT	5/-
6K7G	2/-
6K7GT	4/6
6K8G	3/-
6K8GT	7/-
6L1	19/6
6L6GT	7/9
6L7GT	12/6
6L18	5/-
6L19	19/-
6LD20	8/6
6N7GT	6/6
6P1	12/-
6P25	12/-
6P26	12/-
6P28	25/-
6Q7G	6/-
6Q7	8/6
6R7G	7/-
6R7	11/-
6SA7GT	7/-
6SC7GT	6/6
6SG7	6/-
6SH7	3/-
6SJ7	6/6
6SK7GT	4/6
6SN7GT	4/6
6SQ7GT	6/-
6U4GT	12/-
6U7G	7/-
6V6G	3/6
6V6GT	6/-
6X4	3/6
6X5GT	5/-
6Y7G	12/6
7B6	10/9
7B7	7/-
7C6	6/-
7F8	12/6
7H7	5/6
7R7	12/-
7V7	5/-
7Y4	6/6
9BW6	7/-
9D7	9/-
10C1	12/6
10C2	10/-
10D1	8/-
10D2	14/7
10F1	15/-
10F9	9/-
10F18	7/6
10LD11	10/-
10P13	18/-
10P14	12/6
12A6	3/6
12AC6	7/-
12AD6	6/-
12AE6	7/6
12AT6	4/6
12AT7	3/9
12AU6	4/9
12AU7	4/6
12AV6	5/6
12AX7	4/6
12AY7	9/9
12BA6	6/-
12BE6	5/9
12BH7	6/-
12E1	17/-
12J7GT	6/6
12K5	10/-
12K7GT	5/9
12K8GT	7/6
12Q7GT	4/6
12SA7GT	6/9
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	4/6
12SK7	4/9
12SQ7GT	7/6
12Y4	2/-
14H7	9/6
14S7	15/-
18	12/6
19	10/6
19AQ5	4/9
19H1	40/-
20D1	13/-
20D4	20/5
20F2	14/-
20L1	13/-
20P1	17/6
20P3	18/-
20P4	18/6
20P5	18/-
25A6G	7/6
25L6GT	5/6
25Y5	6/-
25Y5G	8/6
25Z4G	6/-
25Z5	7/-
25Z6G	8/6
30C1	6/6
30C15	13/6
30C17	12/6
30C18	8/9
30F5	13/6
30FL1	15/-
30FL12	16/-
30FL14	12/6
30L1	6/-
30L15	13/9
30L17	13/-
30P4	12/-
30P4MR	17/6
30P12	13/-
30P19	12/-
30PL1	15/-
30PL13	15/-
30PL14	15/-
30PL15	15/-
35A3	9/-
35A5	15/-
35D5	12/6
35L6GT	8/-
35W4	4/6
35Z3	10/-
35Z4GT	4/9
35Z5GT	6/-
50B5	6/3
50C5	6/3
50CD6G	41/-
50L6GT	9/-
72	6/6
85A2	8/6
90AG	67/6
90AV	67/6
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DF33	7/9
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DH77	4/-
DH81	10/9
DK32	7/-
DK40	10/-
DK91	5/6
DK92	7/9
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EC70	4/9
EC86	10/3
EC92	6/6
ECC31	15/6
ECC32	4/6
ECC33	29/1
ECC34	29/6
ECC40	9/6
ECC81	3/9
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/-
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ECC804	12/6
ECC807	27/-
ECF80	6/6
ECF82	6/6
ECF86	9/-
ECF804	42/-
ECH21	12/6
ECH35	5/9
ECH42	10/-
ECH81	5/9
ECH83	8/-
ECH84	7/-
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PCF80	6/6
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UBL21	9/-
UC92	5/6
UCC84	8/-
UCC85	6/6
UCF80	8/3
UCH21	9/-
UCH42	9/9
UCH81	6/6
UCL82	7/-
UCL83	10/-
UF41	9/6
UF42	9/-
UF80	6/9
UF85	6/9
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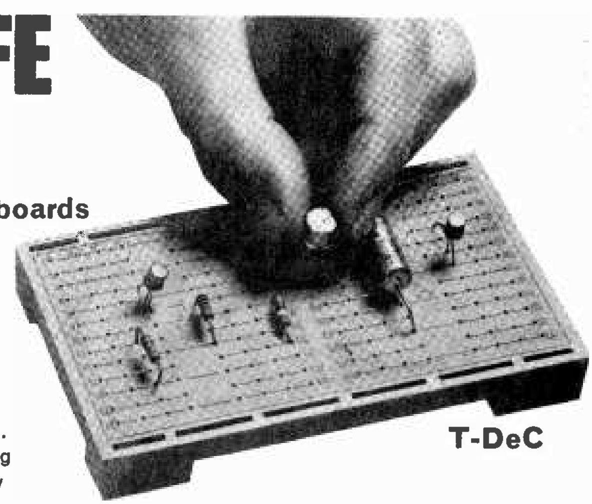
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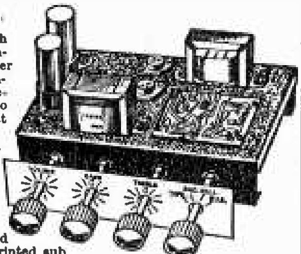
NEW! HSL.700 MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated pre-amplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for AC mains 200-240v. Controls: Bass, Treble, Volume/on/off. Function selector for PU1, PU2, Tape, Radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9½ × 5 × 4½ in.

Performance figures:
Sensitivity: PU1-50m/v. 56K input impedance.
PU2-110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6.2 watts RMS into 3 ohms, 5.8 watts RMS into 15 ohm. Overall frequency response 30 c/s-18 Kc/s: Continuously variable tone controls; Bass, + 8 db to − 12 db at 100 c/s. Treble, + 10 db to −10 db at 10 Kc/s. The HSL.700 has been designed for true high fidelity reproduction from Radio Tuner, Gramophone deck and Tape Recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, full circuit diagram and operating instructions.

Our Special Price **£7.19.6** P. & P. 7/6.

LOUDSPEAKER BARGAINS
5in. 3 ohm 16/-. P. & P. 3/-. 7 × 4in. 3 ohm 21/-. P. & P. 4/-. 10 × 6in 3 ohm. 27/6. P. & P. 6/-. E.M.I. 8 × 5 in. 3 ohm with high flux magnet 21/-. P. & P. 4/-. E.M.I. 13½ × 8in. 3 ohm with high flux ceramic magnet 42/- (15 ohm 45/-). P. & P. 6/-. E.M.I. 13 × 8in. 3 or 15 ohm with two inbuilt tweeters and crossover network 4 gns. P. & P. 6/-.

BRAND NEW. 12in. 15w. H/D Speakers, 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £5.10.0. P. & P. 7/6. Guitar models: 25w. £6.0.0, 35w. £8.0.0.

E.M.I. 3½in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms 15/- each; 15 ohms 18/6 each. P. & P. 2/6.

12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm 37/6. P. & P. 6/-.

35 OHM SPEAKERS
3½in. 14/-. P. & P. 2/6; 7 × 4in. 21/-. P. & P. 4/-.

SPECIAL OFFER
Hi-Fi Celestion Speaker Unit. Size 6 x 4in. Powerful 11,000 line magnet with specially treated cone surround. 10-12 ohm impedance. Few only at 20/-. P. & P. 3/6.

QUALITY PORTABLE TAPE RECORDER CASE. Brand new. Beautifully made. Only 49/6. P. & P. 8/6.

DUAL PURPOSE BULK TAPE ERASER AND TAPE HEAD DEMAGNETISER 35/-. P. & P. 3/-.

CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity. 18/6. P. & P. 1/6.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE 21/-. P. & P. 1/6.

S.T.C. TYPE 25 MINIATURE RELAYS—48 volt. 4 s/p, c/o contacts. 1 amp rating. Coil resistance 5,800 ohms. Size approx. ¾ × 1½ × 1½n. high. 8/6 each. P. & P. 1/6.

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 6:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2 × 1 × 1½in. Only 8/6. P. & P. 2/6.

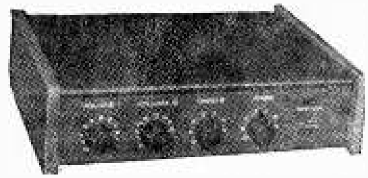
BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240v. Secondary combinations. 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price 32/6. P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240v. Sec. 9-0-9 at 500 mA. 11/-. P. & P. 2/6. Pri. 200/240v. Sec. 12-0-12 at 1 amp. 14/6. P. & P. 2/6. Pri. 200/240v. Sec. 10-0-10 at 2 amp. 27/6. P. & P. 3/6.

BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. AC Sec. 240v. at 50mA and 6·3v. at 1·5 amp. Stack size 2¾ × ¾ × 2¼in. 10/6. P. & P. 3/6. (Special quotations for quantities.)

HIGH GRADE COPPER LAMINATE BOARDS
8 × 6 × 1/16 in. FIVE for 10/-. P. & P. 2/-.

TRANSISTOR STEREO 8 + 8 MK II



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

PRICES: AMPLIFIER KIT £10.10.0; POWER PACK KIT £3.0.0; CABINET £3.0.0. All Post Free.

Also available STEREO 10+10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT £12. POWER PACK KIT £3.10.0.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

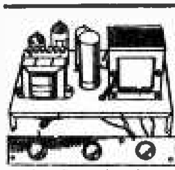
Official stockists of all
PEAK SOUND HI-FI EQUIPMENT
including the
P.W. DOUBLE 12 STEREO AMPLIFIER as featured in Practical Wireless April, May and June issues. Component pack as specified. Total cost £23.5.6 Plus P. & P. 11/-. (Excluding metalwork, knobs, plugs and sockets and fuses.)

SPECIAL PURCHASE!
E.M.I. 4-SPEED PLAYER
Heavy 8½in. metal turntable. Low flutter performance 200/250 v. shaded motor (90 v. tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY 63/-. P. & P. 6/6.

QUALITY RECORD PLAYER AMPLIFIER MKII
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. wide × 3in deep × 6in. high. Ready built and tested. PRICE 75/-. P & P. 6/-.

ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.

DELUXE QUALITY PORTABLE R/P CABINET MKII
Uncut motor board size 14½ × 12in. clearance 2in. below. 5½in. above. Will take above amplifier and any B.S.R. or GARRARD autochanger or Single Player Unit (except AT60 and SP25). Size 18 × 15 × 8in. PRICE 79/6. P & P. 9/6.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½" w. × 4" d. × 4½" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £4.15.0. P. & P. 6/-.

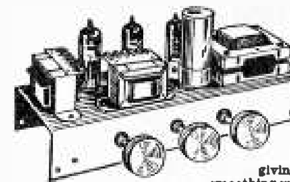
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. 79/6. P. & P. 6/-.

BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) 15/-; V15/10p 10/-; OC71 5/-; OC76 6/-; AF117 3/6; 2G339 (NPN) 3/-.
Set of Mullard 6 transistors OC44, 2—OC45, AC128D matched pair AC128 25/-; ORP12 Cadmium Sulphide Cells 10/6. All post free.

VYNAIR AND REXINE SPEAKER AND CABINET FABRICS. Approx. 54in. wide. Usually 35/- yard. Our PRICE 13/6 per yard length. P. & P. 2/6 (min. one yd.). S.A.E. for samples.

BRAND NEW! PARMEKO MAINS TRANSFORMERS Primary 110v-250v. Secondary 330-0-330v. 100 mA and 6·3v. at 2 amps, 6·3v at 2 amps and 6·3 v. at 1 amp. Conservatively rated. Fully impregnated Electrostatic screen. Suitable for vertical or drop through mounting. Overall size 4½ x 3¾ x 3½in. Weight 8 lb. Limited number only at 37/6. P. & P. 8/-.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up: —2 × ECL86 Triode Pentodes. 1 × EZ80 as full wave rectifier. Two Dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A Dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v. for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs. Chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. **PRICE** 8 gns. P. & P. 8/-.

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing. B.S.R. UA25 with latest mono compatible cart. £6.19.6
All plus Carriage and Packing 6/6

LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for latest Prices!

PLINTH UNITS cut out for Garrard Models, 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE 5 gns. complete. P & P. 8/6.

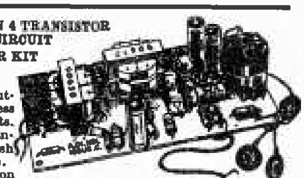
LATEST RONETTE T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo/78. Only 32/6. P. & P. 2/-.

LATEST RONETTE T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only 30/-. P. & P. 2/-.

SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus 50/-. P. & P. 2/-.

FEW ONLY! ACOS High-G for EP and LP. Only 10/-. P. & P. 2/-.

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 × 3in.
- Generous size Driver and Output Transformers.
- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GET114 or 81 Mullard AC128D and matched pair of AC128 o/p).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately.

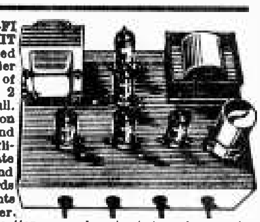
SPECIAL PRICE 45/-. P. & P. 3/-.
Also ready built and tested, 52/6. P. & P. 3/-.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer, EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedence 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE **49/6** P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT



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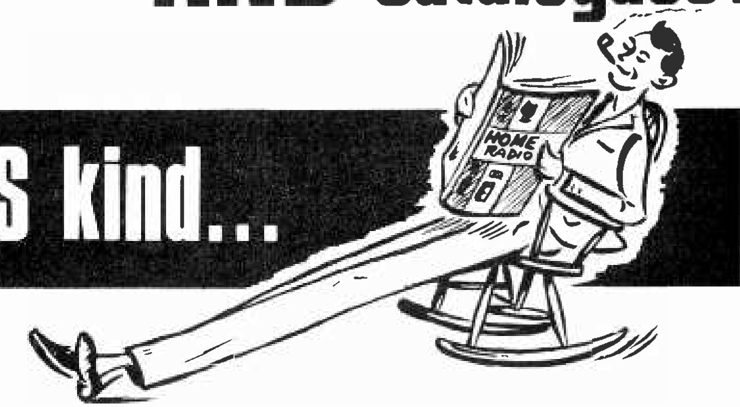

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PRACTICAL WIRELESS

VOL 45 No 6

Issue 752

OCTOBER 1969

TOPIC OF THE MONTH

Them—and us

IMAGINE, if you can, a radio, TV and audio exhibition at which the general public (some 700,000 of them) are encouraged to enter into the spirit of the event by seeing rehearsals of favourite TV and radio shows, meet show business personalities, and even try out their own talent (or lack of it) in front of the cameras. Add to this studios for hi-fi dems., displays of telecommunications equipment and special features for the amateur radio enthusiast.

Then consider colour TV promotion which includes a 7,500 sq. ft. screen showing colour shots of the exhibition scene, and colour programmes of shows and amateur talent displayed throughout the exhibition in special viewing lounges. For good measure, let us also imagine supporting social activities such as fashion shows, promenade concerts, cable car trips, a miniature railway, and an amateur dancing contest. Not forgetting the static displays mounted by 120 manufacturers.

No, this is not an LSD-inspired fantasy. It is this year's German Radio Exhibition at Stuttgart. And while the Germans justifiably grow prosperous on expanding sales, our own dull and unimaginative industry slithers further into the doldrums, admittedly hindered by restrictive Government measures, and reduced to an uncoordinated splatter of exhibitions in hotel suites which are held together only by the vague concept of "traditional show time" yet from which, perversely, the paying customers, the general public, are strictly barred.

With colour on three channels imminent and extended v.h.f. radio in the offing, to name just two selling tags, the industry is missing an opportunity it seems foolish to ignore. From the outside it appears that they don't want the business.

There is, however, one crumb of comfort to readers of P.W. We still have the RSGB exhibition. It does not have the glamour of a Stuttgart or the glitter of our erstwhile public radio shows, but it stands unrivalled as an exhibition and social get-together combined, where everyone you meet is interested in amateur radio. Make a note in your diary—October 1-4 inc.—and support the one event still left. P.W. will be there; we hope you will be, too.

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

NOVEMBER ISSUE WILL BE PUBLISHED ON OCTOBER 3rd

NEWS AND COMMENT...

BROADCASTING IN THE 'SEVENTIES—BBC RESHAPING PLAN

The BBC plan for reshaping radio in a way planned to best meet the requirements of the 1970s has now been submitted to the Postmaster-General for approval. It features improved m.w. coverage, a further step towards v.h.f. expansion and a scheme for setting up a 40-station local broadcasting network.

A high priority in the plan is to improve m.w. coverage of Radio 1 and Radio 4 and this is to be achieved by making better use of m.w. channels released by discontinuing Radio 3 on m.w. and by eliminating the English Regional "opt-outs" from Radio 4 which will be no longer needed with the proposed new network arrangements.

Radio 1: This is planned as a popular music programme with news summaries on the half-hour, transmitted on m.w. only. Despite reallocation of frequencies there will continue to be night-time interference from Continental stations, but the new plan will make Radio 1 available to 4½ million more people.

Radio 2: Light music programme with news summaries on the hour, transmitted on l.w. and v.h.f. The l.w. coverage is 98% during the day and 83% at night, a situation it will be difficult to improve upon. A BBC spokesman told **PW** that a good deal of stereo is planned for the v.h.f. channel.

These two networks will be kept separate during the daytime and possibly late in the evening but will combine during the main evening periods.

Radio 3: This is to be shifted completely to v.h.f., but the BBC assures us that a m.w. facility will be available until such times as the m.w. outlets can be phased out. Programmes will consist of mainly classical music with some drama and speech in the evenings.

Radio 4: Mainly speech, with emphasis on news and current affairs, and with plays, discussions and light entertainment, to be transmitted on m.w. and v.h.f. Night-time reception on the m.w. band will be improved for some 11 million people; the daytime coverage being substantially total.

It is proposed that the v.h.f. transmitters should also be used part of the time for the Open University (28½ hours per week) and the schools and further education programmes (5 hours per week); the m.w. transmission of these latter would then be discontinued.

This complete overhaul of the m.w. services is estimated to cost some £400,000, phased over two years, including the construction of a new 150kW station at Stagshaw.

Audiences: Some interesting figures have been supplied by the BBC on listening habits. For Radio 1 and 2 the main audience is during daytime, between 0700 and 1500, peaking to 14 million. After 1500 the audience tails off to an average of 1 million in the evenings. Radio 4 peaks to 7 million at 0800 and 1400 and again at 3 million at 1800. Radio 3 has an average audience of only 100,000, but this is quite evenly spaced throughout the hours of broadcasting.

Local Radio: One of the main proposals in the plan is to expand the present experimental group of 8 v.h.f. local broadcasting stations to a system of 40 stations reaching nearly 90% of the population of England. This would be basically a v.h.f. service but during the transitional period some m.w. support may be provided. The first phase would be to launch 20 stations, covering 70% of the population, within a year of approval.

Additional v.h.f. channels would be required to accommodate the complete chain of stations. These would be in the band of 95-97·6MHz in which the BBC now only have 7 frequencies, the remainder being used for non-broadcasting services. These are being cleared gradually and will be completely free within five years. The type of local stations envisaged by the plan will have an e.r.p. of 5kW and will cost around £80,000 each.

Although these local stations would broadcast local news, information and commentary programmes, it is anticipated that many would want to carry the Radio 1 broadcasts as a main evening sustaining programme. Provision has been made to arrange this facility.

Fourth V.H.F. Service: The band 97·6-100MHz is now used exclusively by non-broadcasting services. It is planned to make these eventually available for a fourth national BBC v.h.f. network at a capital cost of £4 million.

Drive Against Car Radio Licence Dodgers

A huge drive against car radio licence evaders is likely in the near future. A recent estimate gives the number of car radios at over 3 million, yet only a third of that number of licences have been issued.

At present a licence is required only if the radio is a fixture in the car, that is permanently installed and powered by the car battery; ordinary portable radios, even if they use a proper car antenna, have been exempt. It is probable that this anomaly will disappear and licences will be necessary whenever a radio is used in a vehicle. The cost of a car radio licence is available for 25s. from major post offices.

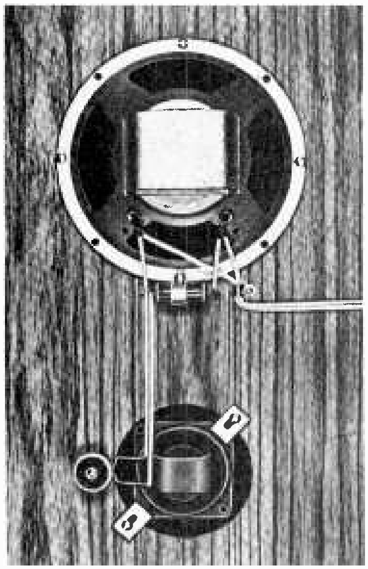
£1,000,000,000

This is not the first prize for spotting all the mistakes in News and Comment but the output of the British electronics industry during 1968. The actual output rose 19% over the previous year to reach a figure of £1,047 million.

Of this, exports and re-exports totalled £222 million while imports were worth £196 million. Consumer electronics are of course only a small part of the total industry and accounted for just under £150 million. The armed forces were the single largest customer spending £142 million. Computers and related equipment totalled £110 million of which £39 million was exported.

NEWS AND COMMENT...

Danish Speaker Kits



P. F. and A. R. Helme have been appointed sole UK distributors for *Peerless Fabrikkerne A/S* of Denmark. The company is the largest speaker manufacturer in Scandinavia and amongst their range are a wide variety of speakers, cross-over networks and speaker kit systems.

Illustrated above is the *Peerless 2-8* which consists of a 6½in. woofer and 2½in. tweeter. Frequency response is claimed as 50-18,000Hz with a handling capacity of 8 watts. Price, less cabinet and baffle board is £6 7s. 10d. The impedance of the entire range is 8Ω.

P. F. and A. R. Helme, Summerbridge, Harrogate, Yorks.

IC FM TUNER KIT

The first f.m. tuner available in kit form using i.c.s. with pulse counting techniques is being marketed by *General Avionic Associates Ltd.*

The circuit was developed by Marconi-Elliott Microelectronics in conjunction with the distributors. The pulse counting technique eliminates the need for complex discriminator and i.f. transformers and removes the problems associated with the alignment and stability of this type of receiver.

The tuner has built-in automatic frequency control (a.f.c.) and with the inherent stability of the i.c.s. a reliable and easily set up circuit is offered to the home constructor. The circuit in effect contains 44 transistors including those in the integrated circuits and although a fairly high number of discrete components are used, the entire tuner is built on a board measuring approx. 4 x 5¼in. The price of the complete kit is £9 19s. 6d. plus 5s. postage from *General Avionic Associates Ltd., 9 Wimpole Street, London, W.1.*

HI-FI AND RADIO AMATEURS COURSES

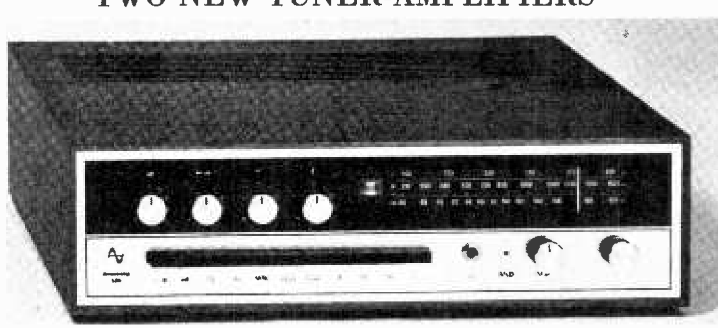
The *Brentford Centre for Adult Education* is running two courses starting in late September which will be of interest to readers. The first deals with Hi-Fi and Tape Recording which includes both theory and construction; the series will include a section on film sound recording. The Radio Amateurs Course prepares students for the City and Guilds examination which qualifies successful candidates to become licensed "Hams".

Enrolment is in mid-September; further details from the *Adult Education Office, Hounslow Manor School, Holloway Street, Hounslow.*

Sony Radio TFM 8030L

New to the *Sony* range of portable radios is the TFM 8030L—a three band portable designed especially for the British market. At a recommended retail price of £29 15s. 0d., the radio covers m.w., l.w. and v.h.f. bands—in the case of the latter a.f.c. is incorporated. It will operate from three power sources, internal battery, car battery or from a.c. mains using an optional adaptor. The case is finished in a black padded leatherette.

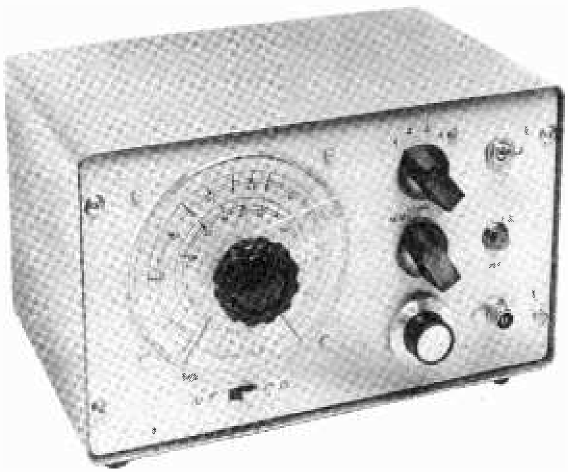
TWO NEW TUNER-AMPLIFIERS



Two new stereo tuner-amplifiers (it seems wrong to call them radios) will be available from late August from *Armstrong Audio Ltd.* The 525 FM is a v.h.f. only model, while the 526 AM-FM (illustrated) includes coverage of the medium and long waves.

Both models have an excellent specification: power output of 25 watts per channel; inputs for magnetic and ceramic pickups and tape playback; tape recording and headphone outputs; bass and treble controls; bass and treble filters; a loudness control and tape monitor. There is a suppression control for f.m. inter-station noise and automatic mono-stereo switching on f.m.

The recommended prices are £87 16s. 9d. for the 525 FM and £98 15s. 6d. for the 526 AM-FM.



audio signal generator

C. JOHN COURTNEY

MANY circuits for sine-wave audio signal generators have appeared in the popular technical journals but few with both sine- and square-wave output have ever been presented particularly in simplified form and suitable for home construction from readily available components. This design (Fig. 1) is based on a transistorised Wien bridge oscillator published some time ago by Mullard Limited. The original circuit employed p-n-p transistors and delivered a sine-wave only output of approximately 1V r.m.s. The writer has retained the original Wien bridge circuitry which has been suitably modified for operation with silicon n-p-n transistors (except Tr2) and to which has been added a squaring circuit, switching for sine- or square-wave output and an attenuator network.

CIRCUIT DETAILS

The oscillator employs a Wien bridge network with fixed capacitive elements, frequency variation over the range 15 to 100,000Hz being obtained by varying the resistive elements (VR1 and VR2). The n-p-n/p-n-p pair of transistors Tr1 and Tr2 between them form a high gain amplifier coupled to a n-p-n emitter follower. Feedback is provided by the unbypassed emitter resistors of Tr1 and Tr2 and also via the thermistor (TH) between the output and the emitter circuit of Tr1. The thermistor also ensures constant amplitude output regardless of small variations in supply voltage and temperature.

For sine-wave output the signals are taken from the emitter of Tr3 via S3 and S4 to VR3 which is the variable section of the output attenuation network formed by Tr7 (emitter follower) and the switched ladder attenuator R17, R18, R19, R20 and R21. This switched attenuator allows r.m.s. output levels of 1 volt, 100mV and 10mV, each range being continuously variable from zero to maximum. The variable attenuator VR3 is a linear control so that with a dial calibrated 0-10 the output signal levels can be determined with reasonable accuracy.

For square-wave signals, an overdriven amplifier (Tr4 and Tr5) has been employed ending with an emitter follower (Tr6). Note that the large value coupling capacitors (C12 and C13) are essential for

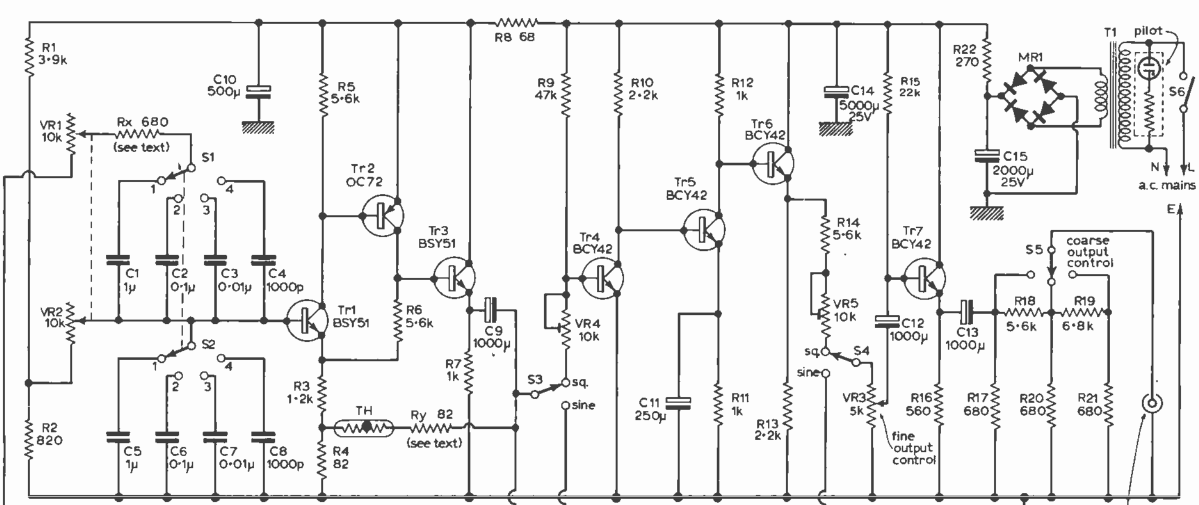


Fig. 1: Complete circuit of the sine and square wave audio signal generator.

a perfectly uniform square-wave right down to 15Hz. The square-wave signal from Tr6 is switched via S4 to the output network. The adjustment of the pre-set resistors VR4 and VR5 will be dealt with later.

The generator could be operated from batteries (12V) since the total current is only 30mA. An incorporated power supply does however ensure a constant voltage and is more economical if the generator is to be run for long periods. No stabilisation is necessary as the thermistor (TH) takes care of small fluctuations in supply voltage. However, more than adequate smoothing is essential to reduce a.c. ripple to an amount which can be considered as negligible, hence the use of the large reservoir and smoothing capacitors C15 and C14 respectively.

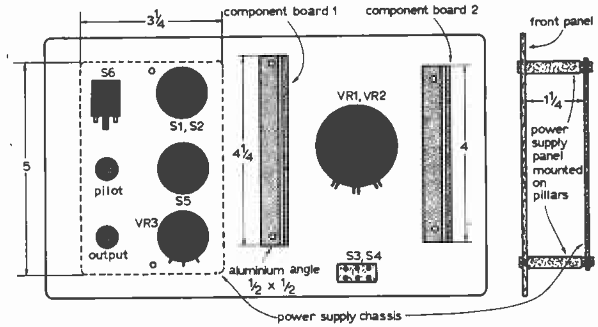


Fig. 3: Layout of panel components, viewed from rear. The power supply panel is shown on right.

CONSTRUCTION

The prototype shown in the photographs was constructed to fit comfortably into an Electroniques Dinki-case type DD6106. A case of similar dimensions 10 × 6 × 6 in. could of course be constructed from aluminium or mild steel. Details for drilling the front panel are given in Fig. 2 and for the mounting of components on the panel in Fig. 3. The two transistor and components boards are also attached to the front panel as in Fig. 4 by means of aluminium angle ½ × ½in. Plain Veroboard with a 0·15in. matrix is used for the component boards. Component board 2 contains the transistors and components for the squaring circuit (TRs, 4, 5 and 6) and the output stage Tr7. The output attenuator network resistors, R17, R18, R19, R20 and R21 are wired directly to the switch S5. Component board 1 contains the Wien bridge oscillator Tr1, Tr2 and Tr3 and appropriate components including the thermistor TH. Board 2 measures 4 × 3¾in. and board 1, 4¼ × 3¾in.

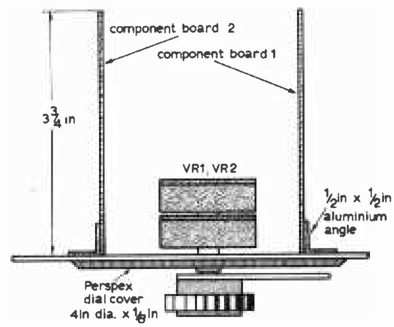


Fig. 4: The two transistor and component boards are attached to the front panel as shown on left. Details of the Perspex dial cover are also shown.

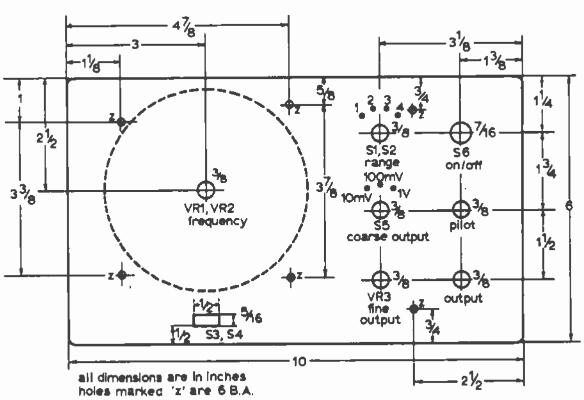
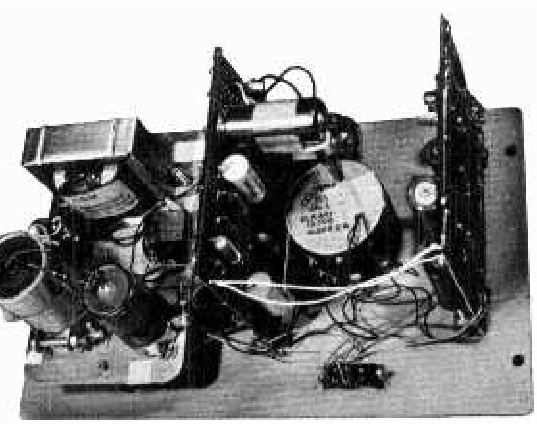
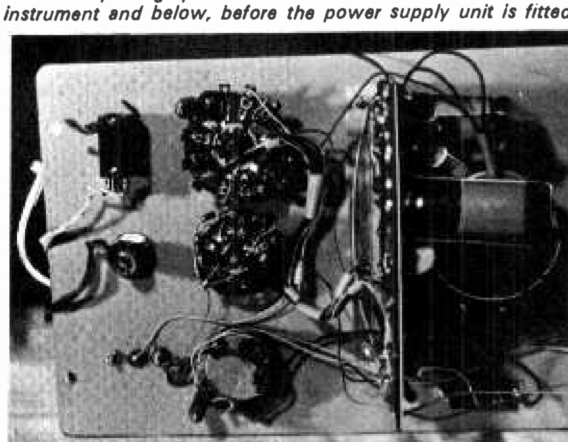


Fig. 2: Front panel dimensions and drilling details.



The above photograph shows the internal view of the assembled instrument and below, before the power supply unit is fitted.



The power supply chassis is simply a small sheet of 16 s.w.g. aluminium mounted on pillars or threaded rod so as to clear the panel components beneath it (see Fig. 3). Some idea of the layout for components on the two boards and for the power supply can be obtained from the photographs. VR1 and VR2 however call for comment regarding the wiring. To obtain the requisite increase in frequency with clockwise rotation VR1 and VR2 must be wired as shown in Fig. 5. Note that RX which is nominally 680 ohms is wired directly to VR1.

In order to give the finished instrument a nice appearance a circular Perspex cover was made for the frequency dial. This is optional of course and could be cut from celluloid or clear cinemoid. For the original, as shown in the photographs, $\frac{1}{8}$in. thick Perspex was used; the $4\frac{1}{4}$in. disc being first cut with a fretsaw. The disc was then mounted on an electric drill and the edge smoothed and bevelled with a Surform tool. The hair-line pointer was also fashioned from $\frac{1}{8}$in. Perspex and fitted to a $1\frac{1}{2}$in. diameter control knob.

ADJUSTMENT AND TEST

First ensure that the Wien bridge section is operating correctly and producing a pure sine-wave. This can only be done correctly with an oscilloscope for although a small error in wiring or a faulty component might not stop the oscillator from working, one or the other could be the cause

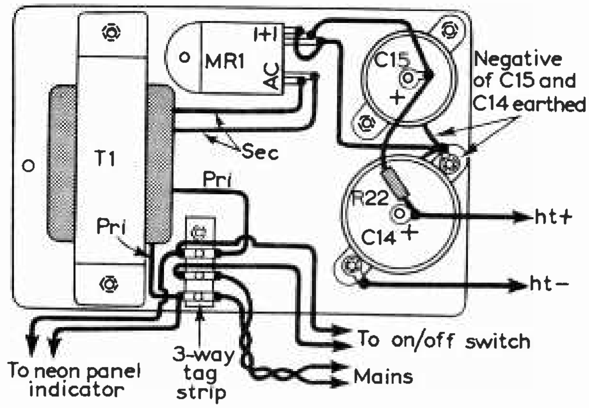


Fig. 6: Layout and wiring of the power supply.

of a poor waveform. The maximum output signal should be 1V r.m.s. plus or minus a few milivolts but can only be accurately checked with a valve voltmeter. To obtain an accurate 1V r.m.s. sine-wave output signal level some adjustment to the value of the nominally 82 ohm resistor Ry in series with the thermistor TH may be necessary. However, this should not be increased to greater than 120 ohms otherwise the waveform will become distorted.

The square-wave mark/space ratio is controlled by VR4 and again an oscilloscope is necessary to check the waveform. VR4 should be adjusted to obtain a 1 to 1 mark/space ratio. The output from the squaring circuit is pre-attenuated by VR5, which should be adjusted to obtain 1 volt

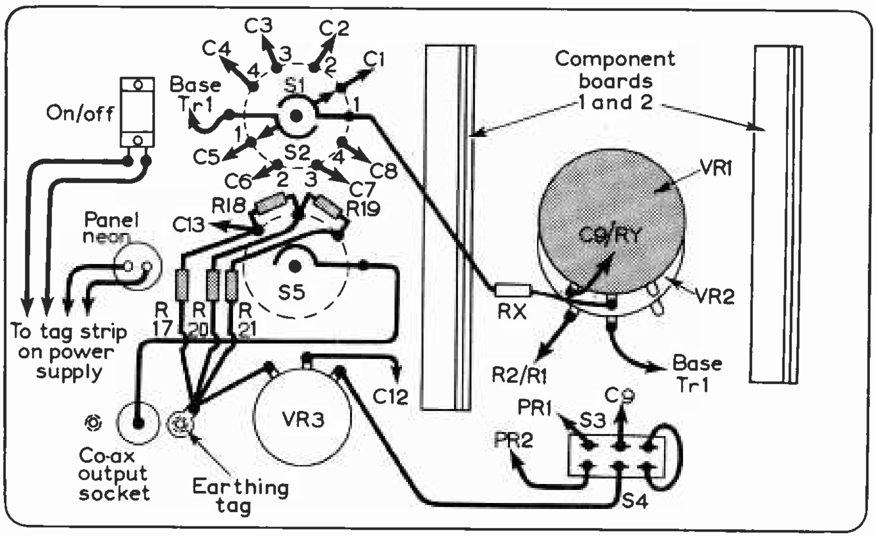


Fig. 5: Showing front panel wiring and layout.

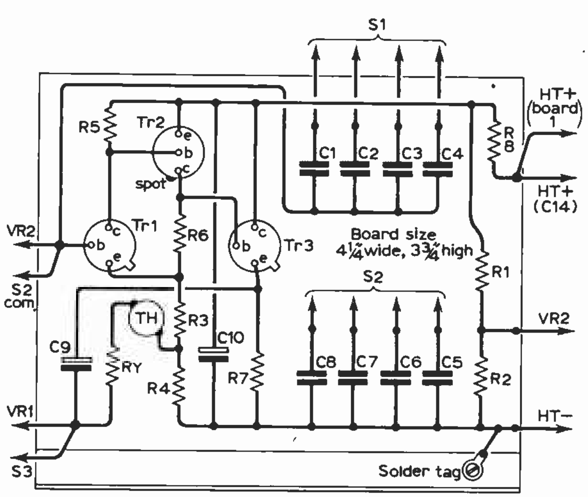


Fig. 7: Layout and wiring of component board 2 (oscillator). All transistor connections are viewed from the underside.

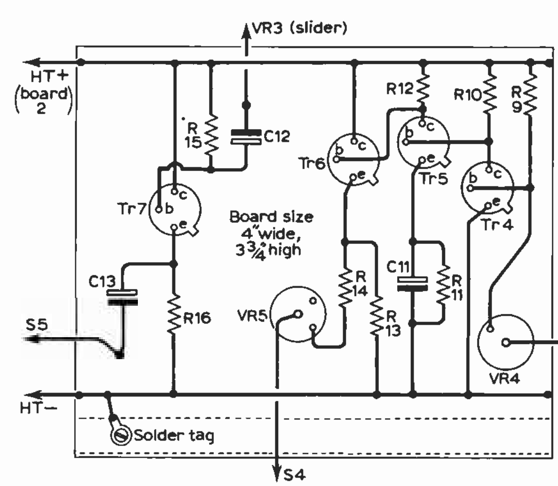


Fig. 8: Component board 1 layout and wiring (squaring circuit and emitter follower output stage).

r.m.s. at the generator output socket with the switched attenuator S5 in the 1V position and VR3 fully clockwise

The preceding tests are best made at a frequency of 1,000Hz as the settings of the controls should then hold good for the full frequency range of the generator. It is possible however, that the output attenuator network may require some adjustment, i.e., a small variation of R18 and R19 may be necessary to obtain an exact 100mV and 10mV respectively with VR3 fully clockwise. Otherwise the output voltages should be within ±5% of the rated output using the resistor values quoted.

★ components list

Resistors:

R1	3·9kΩ	R13	2·2kΩ
R2	820Ω	R14	5·6kΩ
R3	1·2kΩ	R15	22kΩ
R4	82Ω	R16	560Ω
R5	5·6kΩ	R17	680Ω
R6	5·6kΩ	R18	5·6kΩ
R7	1kΩ	R19	6·8kΩ
R8	68Ω	R20	680Ω
R9	47kΩ	R21	680Ω
R10	2·2kΩ	R22	270Ω
R11	1kΩ	RX	680Ω (see text)
R12	1kΩ		

all 10% ¼ watt.

Potentiometers:

VR1/VR2 10kΩ+10kΩ Colvern CLR5018/15F type G
VR3 5kΩ linear, wire wound
VR4, VR5 10kΩ miniature pre-set

Capacitors:

C1 1μF paper
C2 0·1μF paper
C3 0·01μF paper
C4 0·001μF paper
C5 1μF paper
C6 0·1μF paper
C7 0·01μF paper
C8 0·001μF paper
C9 1000μF 12V wkg. electrolytic
C10 500μF 12v wkg. electrolytic
C11 250μF 12V wkg. electrolytic
C12 1000μF 12V wkg. electrolytic
C13 1000μF 12V wkg. electrolytic
C14 5000μF 25V wkg. electrolytic
C15 2000μF 25V wkg. electrolytic
All paper capacitors, miniature, low working voltage.

Semi-conductors:

Tr1, Tr3 BSY51
Tr2 OC72
Tr4, Tr5, Tr6, Tr7 BCY42

Switches:

S1/S2 two-pole four-way rotary
S3/S4 two-pole two-way slide
S5 single-pole three-way

Miscellaneous:

Case (see text) 10 x 6 x 6in.; Thermistor TH, STC type R53; H.T. transformer T1, Henry's Radio type PS12; H.T. rectifier MR, Henry's Radio type 1H3 contact cooled; 0·15in. matrix plain Veroboard.

Frequency range Sine- or square-wave:	Range 1	15 to 150Hz.
	Range 2	150 to 1,500Hz.
	Range 3	1,500 to 15,000Hz.
	Range 4	15,000 to 100,000Hz.
Output level:	Max. 1 volt r.m.s. with attenuation to 100mV and 10mV. Each range continuously variable.	
Sine-wave:	Distortion less than 0·75%.	
Square-wave:	Uniform 15 to 100,000 Hz. Rise time better than 1 microsecond. Mark space ratio 1 to 1.	
Output level:	±0·5dB 15 to 100,000Hz. Sine- or square-wave.	
Output impedance:	Nominal 600 ohms.	

Note: Output load must not be less than 600 ohms on the 1 volt range.

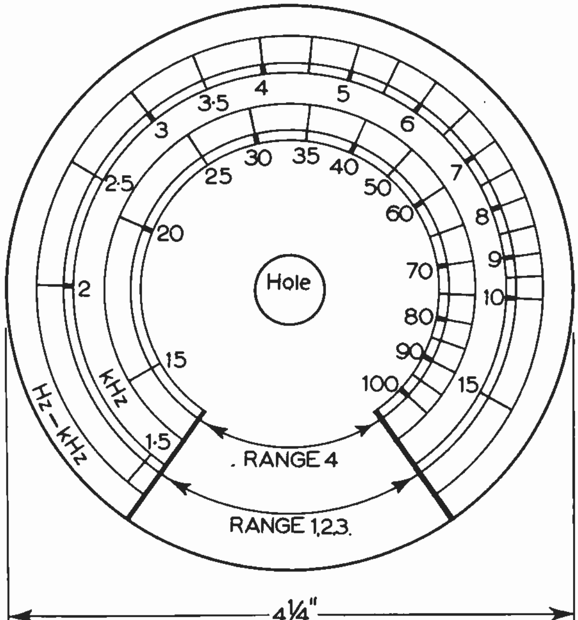


Fig. 9: The calibrated dial. This may be scaled-up to 4¼in. diameter to give actual size.

CALIBRATION

The calibration of testing instruments always presents a problem unless one has another by which to check. For really accurate calibration it will be necessary to employ another generator and an oscilloscope and use the Lissajous pattern method to determine the requisite spot frequencies. This is how the prototype of the generator described here was calibrated and from which the dial given in Fig. 9 was obtained. Note that a small adjustment to frequency can be made by variation of RX (nominally 680 ohms).

continued on page 395

PRINTED CIRCUIT Design

A. G. BLEWETT

HOME-built transistor designs are invariably built on some form of printed circuit, the tendency these days being to use the readily available SRBP perforated board, or that with copper strip bonded to it.

Although this makes for rapid assembly, the result is by no means professional looking, works out comparatively expensive, and is not as compact as it might be by other means. The copper strip type of board costs about 5d. per sq. in., whereas ordinary copper laminate board can be obtained at around ½d. per sq. in.; 10 times cheaper!

Besides these considerations, a great deal of satisfaction can be gained by designing and preparing a tailor-made printed circuit, the finished job can then be said to be completely "home brewed."

PLANNING AND LAYOUT

In circuits where the capacitance of the copper is not significant, i.e., below v.h.f., such as a.f. low r.f. and switching circuits, almost any layout can be adopted, but the writer has found the best method being to follow the circuit diagram as far as is practical, with regard to the relative positions of components.

Knowing the size of the components, and the required distance between lead-out wires etc., a rough layout and connection diagram can be drawn, full size. All points to be connected together are supplied with this connection in the form of copper "blocks". Figure 2 shows the final design of a Wien bridge oscillator, which is one of the P.C. boards used in the construction of an a.f. sine/square generator, and shows the use of these copper "blocks". The circuit from which the design was evolved is given in Fig. 1. Note that those components not labelled on the theoretical diagram are external to the P.C. board. The drawing in Fig. 2 is shown full size.

The optimum position and size of these copper "blocks" is determined by trial and error, the writer having found that 3 drawings were necessary; (1) the rough layout as per the circuit diagram, (2) the layout drawn as neatly as possible taking into consideration component size and best use of space on the P.C. board, and (3) the final design, which is drawn on tracing paper, having ironed out any anomalies that may have arisen in designs 1 and 2. Difficulty may be experienced where far-reaching feedback paths or cross-connections are required, such as in bistable circuits in the latter case. Here, the best solution lies in using "link" wires, an example of which occurs between the collector of Tr3 and the emitter of Tr2 in Fig. 1.

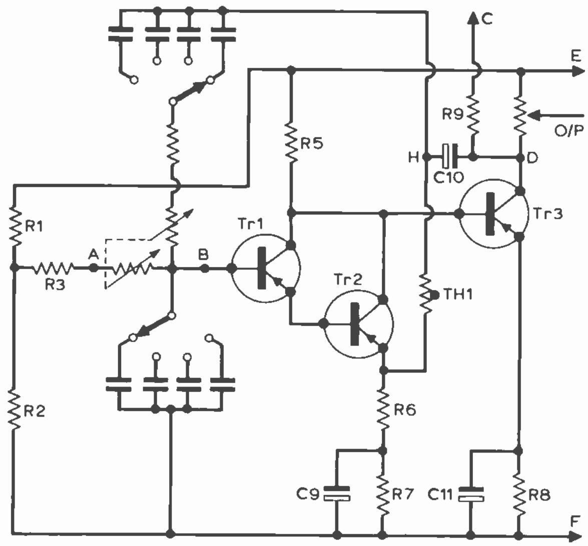


Fig. 1: Circuit of a wien bridge audio oscillator. The points marked A, C, D etc. are explained in the text.

A link wire is used to connect the thermistor and Tr2 emitter together (Fig. 2). Had this not been done, a thin copper strip would have had to be designed to wend its way through the other copper blocks. The link wires go on the side of the board away from the copper.

TRACING AND ETCHING

The laminate board is cut to the required size with a fine saw and the edges cleaned up with a file. The copper should now be scrupulously cleaned using domestic wire wool. Cleanliness at this stage is most important, as any oxide impedes the etching process.

The final design on the tracing paper is then lined up on the board, and with carbon paper interposed between paper and board, the design is traced to the copper. During this process the paper can be folded and stuck at the back with Sellotape, to hold it steady on the board. There is no need to mark the position of the holes at this stage. Transparent tape (Sellotape) is then stuck in strips over the copper, so as to cover it completely. The board can now be handled with no danger of the design being rubbed off.

Using a steel rule and a sharp modelling knife, the areas to be retained after etching (the blocks) are now cut out, and can be removed with a pair of tweezers. Care should be taken to apply only such pressure to the knife that is required to cut the Sellotape, and not mark the copper underneath excessively.

The copper side of the board is now painted, car touch-up enamel is ideal for this as it dries rapidly. The remaining adhesive tape will have acted as a mask, and when the paint is dry it is removed, again using tweezers. to leave the accurate design in paint on the copper surface.

The etching solution used comprises 30% ferric chloride, 1% dilute hydrochloric acid, and 69% water, per unit volume. These chemicals are readily available from the larger chemists, and may be ordered from the others. The acid can be omitted if desired, but is included to speed up the chemical etching process. A depth of about half an inch of this solution is poured into a shallow plastic or glass container, and the prepared board put in. Avoid physical contact with the etchant—rubber gloves should be worn to protect the hands.

Left alone a circuit board such as given in the example will take about 45 minutes to etch completely, but if the solution is agitated frequently, etching can be complete in around 25 minutes. Inspection will determine when it is complete, ensure there are no "spots" or "hairlines" of copper left exposed, and that the edges of the painted areas are clean cut in appearance.

The board is now washed in water to remove all traces of etchant, and the paint cleaned off. This can be done using a solvent for the paint (acetone in the case of cellulose enamels), or by carefully rubbing with domestic wire wool. The writer prefers the latter method as it makes far less mess, and leaves an ideal soldering surface.

The tracing paper design is now positioned over the etched circuit, and the position of the holes marked using a scriber. The writer has found a 3/64in. drill ideal to take component lead out wires, but any size may be used as required, the only precaution being necessary is that the holes should be drilled from the copper side, to avoid lifting the copper foil.

Not including the original outlay of chemicals the board shown cost the writer approximately 2d., not including labour, but we don't do it for the money anyway do we! ■

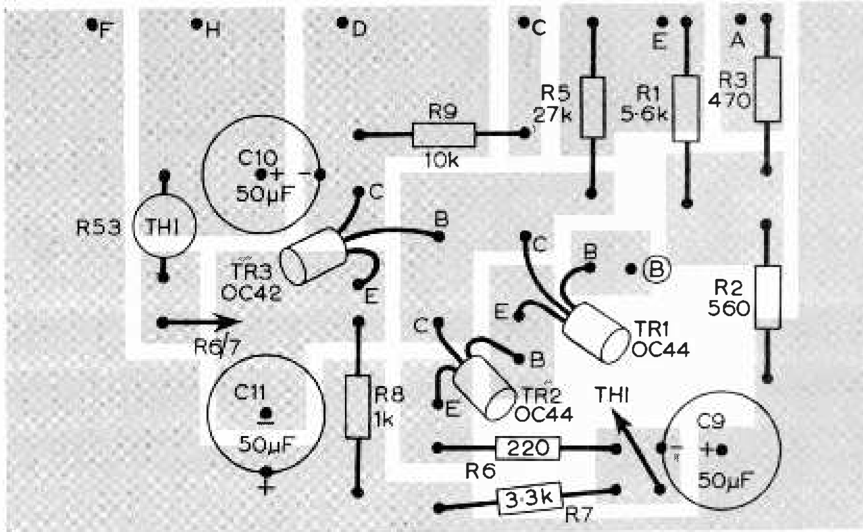
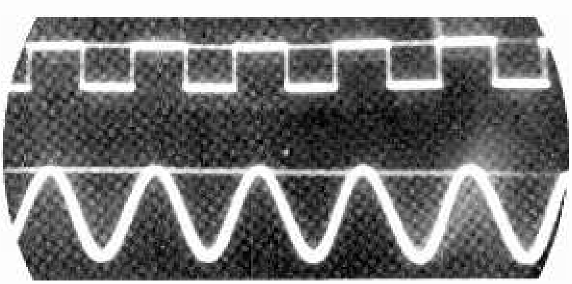


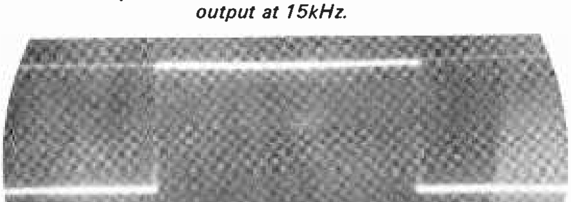
Fig. 2: Printed circuit design for the circuit given in Fig. 1.

AUDIO SIGNAL GENERATOR

—continued from page 393



The photograph above shows oscilloscope traces of square and sine wave outputs at 1kHz, that below shows square wave output at 15kHz.



The oscillograms show actual photographs of the generator waveforms displayed on a Cossor 1049 Mk. III Oscilloscope.

One final point concerns the h.t. voltage. This must be as near 12 volts as possible at the junction of R22 and C14, with the generator operating on sine-wave output. If not, then adjust the value of R22 by a small amount as necessary. The recommended mains transformer (T1) only should be used. ■

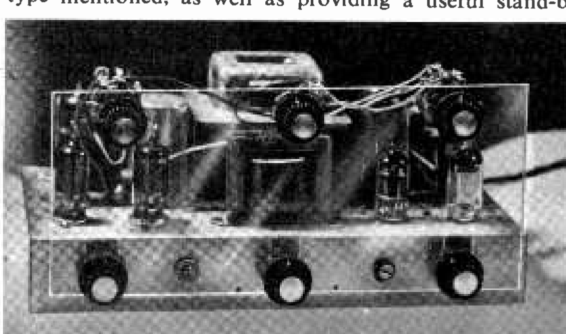
MONO-STEREO AMPLIFIER

JAMES HOSSACK

THE newcomer to stereo, unless he has previously been an enthusiast in the field of mono hi-fi and consequently knows precisely what his requirements are likely to be, is usually a little bewildered by the wide choice of equipment available. Most record players sold today, even those in the medium or lower price range, are fitted with a stereo pick-up cartridge with provision for adding an external amplifier, so that advantage may be taken of the stereo characteristics of modern recordings. It would be necessary to construct or purchase a small transistor amplifier and speaker, which, suitably positioned and wired to the player, will be capable of providing a surprisingly inexpensive introduction to the exciting dimension of "stereo sound". Unfortunately, perhaps because of its simplicity, this solution is not always the best one. In the first place, there are now two sets of batteries to be replaced (assuming the built-in amplifier were also transistorised), and, secondly, the volume and tone controls for each channel are independent, and have to be manipulated simultaneously when alterations of the settings are required, with the result that correct balance between the two channels is difficult to maintain. It is then that thoughts begin to turn to the possibility of procuring a single amplifier for both channels.

There is a further consideration. V.H.F. radio broadcasts are now transmitted in stereo over a large part of the country, and can be made available by the addition, to the average radio or tuner, of a simple decoder arrangement, *provided* a 2-channel amplifier is available to handle the resulting dual signals. Finally, and perhaps of more direct interest to the experimenter, is the possibility of feeding a stereo signal simultaneously to the amplifier from microphones, tape head, or even musical instrument pick-up coils. For this latter purpose, a fairly high-gain amplifier is necessary, and since matching transformers may have to be used before the input, special precautions will have to be taken as regards pick-up of extraneous hum and other noise by careful screening of the input to this section of the equipment.

The amplifier which is described here will be found eminently suitable for experimental applications of the type mentioned, as well as providing a useful stand-by amplifier for a hi-fi stereo system. It was designed, originally, for use with a *mono* v.h.f. tuner, with the additional consideration that it could also be used as the "second channel" for a cheap record player of the type described above. Valves were chosen in preference to transistors, because the record player in question used a valve line-up.



View of the assembled amplifier.

Although v.h.f. stereo broadcasts had not reached the writer's area, and a mono amplifier was therefore considered at the time to be sufficient, it was decided to make provision for the future, and sufficient room was left on the chassis for the construction of a duplicate amplifier. In addition, the original intention having been to provide mixing facilities for microphone or tape input for announcements, etc, as required, a low-noise, high gain audio pentode, together with the appropriate mixing controls, was included in the amplifier circuit. Partly to preserve the symmetry of the layout, and partly with an eye to possible future applications, these mixing facilities were duplicated when the second channel was constructed. The result is a very useful and versatile amplifier with a performance in the medium to high-fidelity range and an output of about four watts per channel, which can, moreover, be built up in sections and added to as time and the available budget permit.

A chassis must be chosen of sufficient size to accommodate, eventually, both channels, together with a power supply of ample reserve capacity. The amplifier can then be constructed in one of four ways; as a simple record player/tuner amplifier for one channel only; as a dual microphone and p.u./tuner mono amplifier with mixing facilities; and finally as a stereo amplifier using one or both of the preceding arrangements. Further modifications to suit the individual experimenter's needs are also possible.

Circuit

The circuit of the complete stereo amplifier, including both microphone preamplifier sections, is shown in Fig. 1. It will be observed that, though dual-purpose valves are used, none of these is common to both channels, which can thus be constructed and operated quite independently of each other. For descriptive purposes, it is convenient to divide each channel into a main amplifier and two preamplifiers. The main amplifier comprises one-half of an ECC83 feeding into an ECL82 triode-pentode, which provides an output power of about four watts, with an overall distortion figure of under 2% when the normal negative-feedback circuit in the output stage is fully operative. The remaining half of the ECC83 forms a preamplifier for use with a record pick-up or high-output tuner. In order to bring the total harmonic distortion figure down to less than 1·5%, two further negative feedback circuits were incorporated, one over each ECC83 half-triode. Despite the resulting reduction in gain, full power output can still be obtained with 50-60mV of input signal.

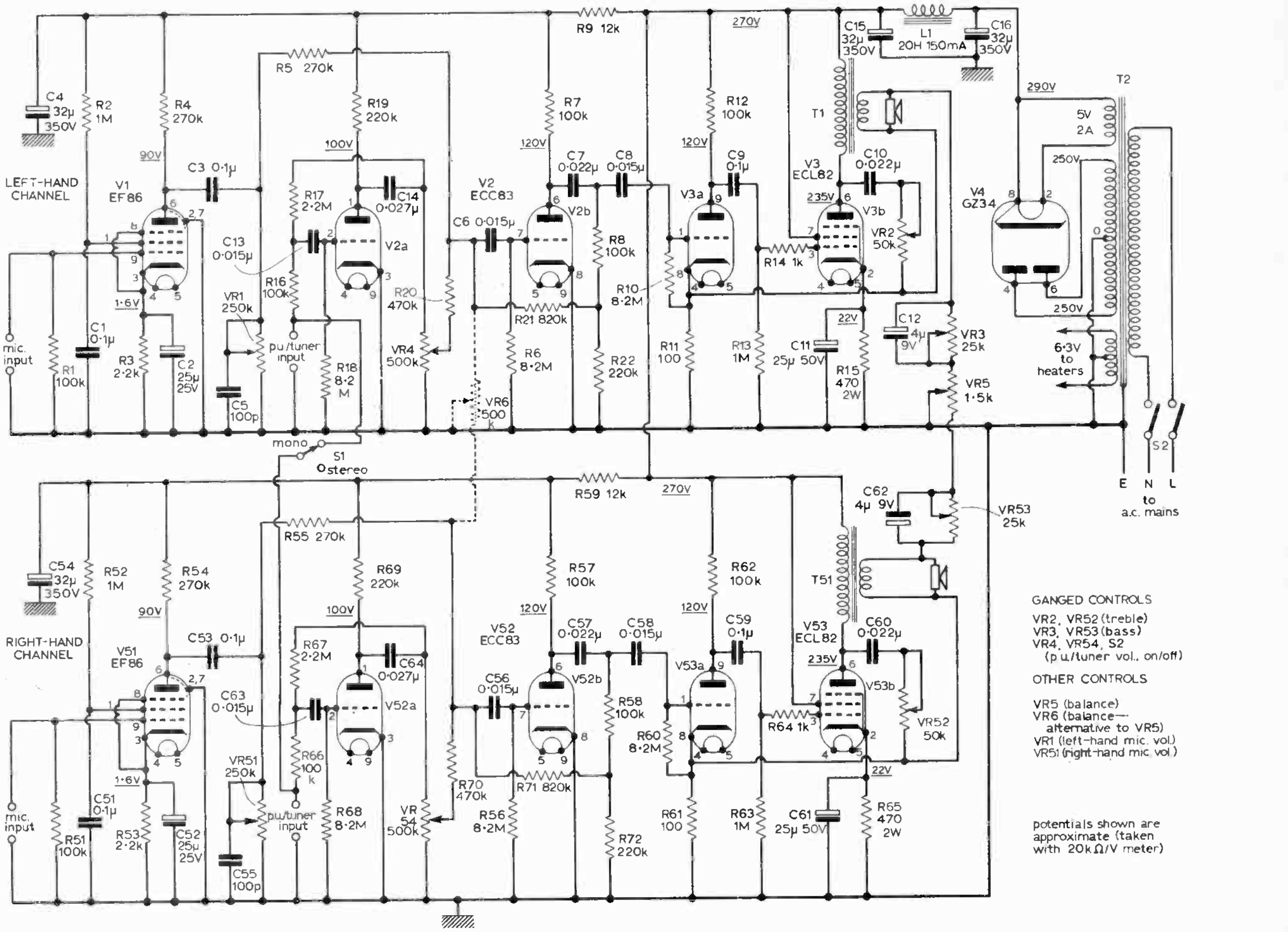


Fig. 1: Complete circuit of the mono-stereo amplifier.

For inputs down to four or five millivolts, the second preamplifier section, involving an EF86 will provide full power output, without matching problems, from the average crystal microphone, low power tuner, or tape head, although certain types of magnetic pick-up or microphone may require a matching transformer for best results. Independent volume controls permit full mixing facilities to be simultaneously achieved on both channels if desired.

Before considering the circuit in detail, mention should be made of the system of component identification used in Fig. 1. All components associated with the left-hand channel are numbered in the usual way; corresponding components in the right-hand channel are prefixed by the same reference number, but increased by 50. Thus, the bias resistors for the left and right channel output pentodes (V3B and V53B) are numbered R15 and R65 respectively.

Preamplifiers

The following description refers to the left channel, the right one being identical. V1 an EF86 is operated at full gain, with the usual cathode bias and without negative feedback. Consequently, it is rather susceptible to overloading, and care should be taken to limit the maximum input to about 50mV. Capacitor C5, which shunts VR1, the preamplifier volume control, compensates for any harshness due to a non-linear response; if exclusive use of a low-level high-quality input is envisaged (for example, from a variable-reluctance pick-up of 10-15mV.) C5 may be reduced in value, or removed completely.

For the high-input preamplifier, one-half of V2 (ECC83) is used, with negative feedback via C14 and R17. The volume controls for each channel (VR4 and VR54) are ganged, in contrast to the low-level controls VR1 and VR51) which are separate. The reason for this is as follows: In the "mono" mode, where each channel is functioning as a straightforward amplifier, one would normally take advantage of mixing facilities to "fade-in" for example a microphone announcement or other material of the sort. If both volume controls were ganged, hum would then be likely to appear in the other channel, when operating on stereo, as the microphone volume control was advanced, since the unused input lead would be "floating" above earth potential. It is, of course, a simple matter to introduce additional switching either to isolate this unused input, or to parallel the microphone etc. signal through both channels, as is done with the high-level input; and if it is envisaged that facilities of this sort will be frequently required, ganged controls and switching of the type mentioned can easily be incorporated, provided screened cable is used throughout. In the prototype, this was not felt to be necessary, and the mono-stereo switch S1 is therefore a simple one-pole type controlling the high-level input.

Main Amplifier

C6 is the coupling capacitor which feeds both pre-amplifier outputs to the second ECC83 half-triode, this functioning as the first stage of the main amplifier. Like the first half of the ECC83 this triode also has a proportion of its output fed back, via R8, in order to obtain a more linear characteristic. C8 is used to couple this stage to the triode section of the ECL82. The values of both capacitors C6 and C8 have been purposely kept smaller than is usual with a circuit of this type in order that some attenuation of bass will be obtained. Since bass boost is incorporated at a later stage, the overall effect is to provide a "normal" bass response at about mid-position of the boost control; but, if boost only is desired, with no attenuation, this can easily be achieved by increasing the value of these capacitors slightly. Do not go however, above about 0·05μF.

There are no unusual features in the triode-pentode circuit. R14 is necessary to prevent parasitic oscillation, and should not be omitted. If the amplifier is being constructed for stereo operation from the outset, the impedance and power-handling capacity of the loudspeakers, together with a pair of matched transformers, will probably already have been chosen. Even if the second channel is to be added at a later stage, it is a good plan to obtain a suitable pair of transformers, similar though not necessarily indentical, since matching of components in the two output stages will ensure more satisfactory operation of the bass and balance controls, which, as explained in the next section, are incorporated in the negative feedback line to this stage.

Controls

The arrangement of the gain controls (two single and one ganged) has already been dealt with. Potentiometer VR2, in conjunction with C10, is a conventional treble cut arrangement, and provides equalisation for records and v.h.f. radio. Treble boost was felt to be unnecessary. The arrangement of bass and balance controls, although a little unusual, has been found completely satisfactory in practice, although it does call for one or two special precautions. Examination of Fig. 1 shows that one side of the output transformer secondary is taken directly to the ECL82 triode cathode, which is earthed via R11. The feedback voltage is thus developed directly across this resistor. However, no actual feedback can result unless the other secondary lead is also at, or near, earth; any impedance present at this point being regarded by the transformer as if it were directly in series with the feedback line. The mode of operation of VR3 and VR5 will now be clear. The latter controls the degree of feedback distribution operating on each channel; the former renders this feedback frequency-selective, so that, for each channel, the setting of VR3, in conjunction with the reactance of C12, determines the extent of feedback reduction, and hence the boost, at the lower frequencies. It will be seen, therefore, that in order to obtain an equal degree of lift on both channels in the bass region of the response curve, the balance control must be in approximately the correct position at the outset, otherwise, feedback may be insufficient on one channel to permit satisfactory boost to be obtained.

The second precaution is to ensure that no external earth connection is made directly to the speaker or the output transformer secondary. This is important if the amplifier is being used, for example, in a small hall.

★ components list

Resistors:

R1	R51	100kΩ	R12	R62	100kΩ
R2	R52	1MΩ	R13	R63	1MΩ
R3	R53	2·2kΩ	R14	R64	1kΩ
R4	R54	270kΩ	R15	R65	470Ω 2 watt
R5	R55	270kΩ	R16	R66	100kΩ
R6	R56	8·2MΩ	R17	R67	2·2MΩ
R7	R57	100kΩ	R18	R68	8·2MΩ
R8	R58	100kΩ	R19	R69	220kΩ
R9	R59	12kΩ	R20	R70	470kΩ
R10	R60	8·2MΩ	R21	R71	820kΩ
R11	R61	100Ω	R22	R72	220kΩ

(All resistors are ½ watt carbon, 10% tolerance unless otherwise stated)

Capacitors:

C1	C51	0·1μF
C2	C52	25μF 25V elec.
C3	C53	0·1μF
C4	C54	32μF 350V elec.
C5	C55	100pF
C6	C56	0·015μF
C7	C57	0·022μF
C8	C58	0·015μF
C9	C59	0·1μF
C10	C60	0·022μF
C11	C61	25μF 50V elec.
C12	C62	4μF 9V elec.
C13	C63	0·015μF
C14	C64	0·027μF
C15		32μF 350V elec.
C16		32μF 350V elec.

(All capacitors paper, 350V wkg. except where stated)

Potentiometers:

VR1 VR51, 250kΩ log.
VR2 VR52, 50kΩ log. ganged
VR3 VR53, 25kΩ log ganged
VR4 VR54, 500kΩ log ganged, with switch (S2)
VR5, 1·5kΩ linear
VR6 (if used), 500kΩ linear (see text)

Transformers:

T1	T51	Output transformers, pri. matched to ECL82, sec. to 3 or 15Ω speaker
T2		Mains transformer 250-0-250V 150–200mA; 5V 2A; 6·3V 5A

Valves:

V1	V51	EF86
V2	V52	ECC83
V3	V53	ECL82
V4		GZ34 or alternative

Miscellaneous:

S1 Single-pole rotary or toggle switch; L1 Smoothing choke, 20H 150mA; several 3, 4, and 5-way etc tag strips; Screened cable; Co-axial sockets (coloured stereo type); L/S output sockets; 6 B9A valve-holders; 1 octal-base holder; 1 clip for upright-mounting double can electrolytic; 6 pointer knobs.

Here, facilities are sometimes provided for a low-voltage extension speaker connection which dispenses with the

continued on page 411

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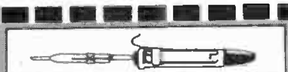

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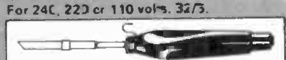

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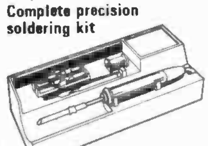

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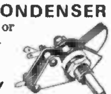

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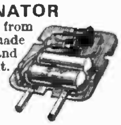

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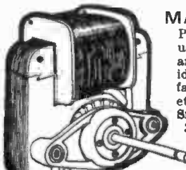

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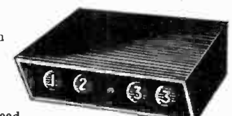

An imposing instrument ideal for modern reception centre or for Managing Director's office—definitely a showpiece to create interest and efficiency—mains frequency controlled so always keeps right time without adjustment—in black semi-matt perspex case—made up, tested and guaranteed—offered for only the cost of components £29.10.0, post and insurance 10/-.

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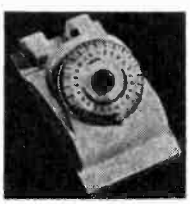

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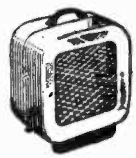

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SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times in GMT • Frequencies in kHz

THE BROADCAST BANDS

Malcolm Connah

I HAVE, at short notice, taken the position of temporary editor of this column. I would like to receive many reports and letters from readers of the column so I can estimate exactly what **you** require from these articles. This particular column is inclined more towards the DX side of the hobby than previous articles and I would be interested to hear if this is what the readership requires.

The **Limerick City Short Wave Radio Club** now issues certificates for the verification of 15, 30 and 50 countries on the Broadcast Bands. The awards can be obtained by sending a list of the QSL's that you hold and a 1s. postal order to: *Limerick City SWRC, 7 Colbert Park, Janesboro, Limerick City, Ireland.*

Propagation forecast for the month of September is as follows: Europe 7 and 9MHz; North America 17 and 21MHz; South America 17 and 21MHz; Africa 11 and 15MHz; Asia 11 and 15MHz, and Oceania 11MHz. These figures apply to reception in Europe during the period 1700-2100, figures for the remainder of the 24 hours are easily estimated if you remember that darkness anywhere on the path lowers the frequency whilst daylight increases the frequency.

AFRICA

Biafra: *Radio Biafra* is often heard at this QTH on 6144 between 2300 and 2315.

Liberia: *ELWA*, Monrovia, Liberia has changed frequency to 15095 and can be heard in Arabic from 2130 until 2200 when they close down. Identification in English is given at close down.

Morocco: *Radio Rabat* has three new frequencies of 6045, 6170 and 6190.

Ruanda: The new 250kW relay of *Deutsche Welle* is testing from 0000 to 0300 on 17865.

ASIA

Kuwait: The most recent programme schedule available for the *Kuwait Broadcasting Service* is as follows: 0400-0600 English for India on 15150; 0900-1100 Arabic for Europe on 15430; 1300-1905 Arabic for N. Africa on 21685; 1600-1900 English for Europe on 15405.

Nepal: *Radio Nepal* is making test transmissions between 0220-0700 and 1300-1600 on 11970.

Syria: *Radio Damascus* has replaced 15165 by 15270 for the Foreign Service transmissions from 1730-2100.

UAR: *Radio Cairo* is requesting reports on its test transmissions on 9630.

EUROPE

Andorra: *Radio Andorra* is reported to be using English from 2300 until 0400 on 5995. I would like to hear from anyone who can confirm this.

Portugal: *Radio Portugal* has a new transmission to Africa at 1715 on 15345 in parallel with 21700.

NORTH AMERICA

Hawaii: The *Billy Graham Evangelistic Association* is planning to build a 500kW Short Wave station on the island of **Maui.**

Grenada: The *Windward Islands Broadcasting Service (WIBS)* is now using the frequency of 21690 up to close down at 2245.

OCEANIA

Australia: The *ABC* has changed frequency from 15180 to 15160 for the 2000 to 0830 transmission.

SOUTH AMERICA

Guatemala: Dennis M. Evans, an ex-member of the ISWL, is now a volunteer technician at *La Voz de Nahuala*. The station operates on 3360 between 2300 and 0300 except Tuesday, Thursday and Sunday when it opens at 2000. The transmitter used by the station is a Philips 1kW. Several reports have been received from American listeners and Dennis hopes to receive the first report from a European listener in the near future.

Netherlands Antilles: The *Radio Nederland* transmitter at **Bonaire** does not use the frequency of 9715 despite several reports to the contrary.

In conclusion here is a list of special Latin American holidays (my thanks go to the Cimbrer DX Club for this item). These holidays often lead to extended schedules and good DX. September 14 Nicaragua; Sept. 15 El Salvador, Guatemala, Honduras, Costa Rica and Nicaragua; Sept. 16 Mexico; Sept. 18 Chile; Sept. 24 Dominican Republic; Sept. 29 Paraguay. October 3 Honduras; Oct. 9 Ecuador; Oct. 12 Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Argentina and Chile; Oct. 20 Guatemala; Oct. 21 Honduras. November 1 Guatemala and Peru.

73s, good listening and hoping to hear from you soon.

THE AMATEUR BANDS

David Gibson, G3JDG

MUCH the same conditions as last month prevail and, alas, no real improvement in 10 metres. The short skip on 20 has been rather more noticeable. There's always something weird about hearing odd G stations at S9 on this band. One scribe informed that the sunspots were rather reluctant to decline and that the count was still high. However, at my QTH, 10 metres has been very quiet indeed. The JDG solid state tx, running a cool 30 milliwatts (v.f.o. and buffer only) has produced results on the home receiver but not on anyone else's apparently.

Almost all the logs sent in were for 20 and 15, although one or two did reckon to have heard a mumble or two on 10. Nobody even mentioned topband (shame on you all) and 40 metres was only referred to in a highly offensive fashion. Data available under plain cover!

TWENTY/FIFTEEN

Quads and beams proved useless compared to a 380ft. long wire according to **Robert Dinning** (Scotland) who made the practical comparisons. Verticals on 15 and 20 fared better though. The earth system is a car radiator buried 6ft. down below the spring line of a nearby river. (What happened to the driver?) The back-up equipment is an HA350, RQ10, PR3OX and a pair of stereo headphones. On 20 metres s.s.b. the log reads—CP5DB, HB9FC/P/VP9, HBØAG, HP9FC/MM, JX1OM, KP4AMI, LZ1XA, MP4TCN, OX3MT, OY9LV, PJ2CJ, PJ6ZF, TI2TH, VK6FD, VP2KF, YA1DAN, ZA1KAA, ZP5CE, 3A1TL, 5A1TL, 5H3MA, 5Z4DW, 6Y5AK, 8R1G, 9A1K.

Fifteen s.s.b. produced—AP2MR, CEØAE, CN8HL, CR7IC, CT2AU, CX7BF, ELØC/MM, ET3USA, FL8DJ, HBØAFM, HR1KAS, HS1AF, JA2AHV, JA4WI, JA7GIV, JH1QLW, KZ5MC, MP4BGX, PZ1BX, UJ8AJ, VK2FU, VK9KY, VK9XI, VP8KL, VS6AA, WB6AGZ/MM (U.S. hospital ship off 3W8 coast), XE1CE, YA1AR, YA1DAN, 1JM, YBØACC, YN1FR, 7P8AB.

John Moore (Leics), found topband and 80 useless, while a peep at 40 produced PY-type signals promptly blotted out by BC or EU's. John favours 15 which, he says, is open to 9M2/9V1 from around 1500 hrs onwards. In the evenings the CR6/JA contingent are a constant feature. John's best on 15 were—CN8HL, CR6CA, EL2I, ET3USA, F6ABP/FC, JA3LVT, JA3MIY, JH1FZM, KG4AA, KV4AD, MP4BHL, VE3ACD, VS6AA, VS9MB (Gan), W6FEX, YA1JK, 4X4GT, 4Z4HF, 6W8DY, 7Z3AB, 9H1R, 9M2BD, 9V1OE, 9X5AA. All these s.s.b. except the MP4 on a.m. Gear is a CR100/2 plus 60ft. end fed.

Ian Poole (Yorks), sent a picture of a very neat shack. Equipment spotted by your scribe included a KW/Geloso converter fed into a 19 set which, in turn, is fed by a 60ft. long wire. (So, it was a big picture!) The 15-metre log reads—AP2MR, CEØAE, HS3 ML, KR6VX, MP4TAF, VP2AW, VS6AL, XW8CS, YA1AR, YA1SG, ZS3HX, 7P8AB, 9M2BD, 9N1MM, 9V1CN.

If you've been taking "A" level exams and you reside at Spalding in Lincolnshire, you stand a very good chance of being **K. Tatnall.** If you are he, then you'll know all about your modified "Clubman" receiver and 65ft. aerial not to mention you hearing—EA6AR, EA8FG, EP2BQ, EL2Y, HI8LA, HK1BQR, HP1XS/MM, JA1PNA, JA1WEK, JA3ERG, JA3MNP, JA4DGG, JA8DO, KP4DEY, KR6DI, MP4TAF, PY1TX, SVØWJJ, TF2WLJ, VP5AA, VP8KD, VS5PH, VS9MB, YV4RZ, ZF1GC, ZP5CN, 4X4RQ/AM, 5N2ABG, 5Z4LS, 7Q7RM, 9G1DY, 9M2BO. Oh yes, you heard that on 15 s.s.b. remember?

Just think, at the exact spot on the whole world map, just exactly where **Michael Pipes** is living, there's a Trio 9R—59DE as well. By the most amazing coincidence, this is also the exact location of a 66ft. end fed too. And by the very strangest of happenings, while all these other things were together, who should come along but—AP2MR, CE3AIA, DU1LP, FH8CD, HC2MM, HBØGJ, ITØ ARI, PY7PT, TA3AB, VU2DK, VQ9EP, VS9MB, 4S7PB, 4U1ITU, 5L2BJ, 5N2ABG, 6W8DY, 9M2BD, 9Q5GE, 9V1PA, 9Y4VT. All s.s.b. on 15.

ELSEWHERE

Not many logs for the other bands this month. **Stephen Cole** wrote while on holiday in Devon where the temperature was 80 degrees plus—and that was in the frig! Back home in Monmouthshire Stephen runs a Trio JR60 and a 25ft. vertical. He sent a fab log for 15 which I'm not putting in (write out 500 times—JDG's a baddie) but the list for 80 reads—F9RY/FC, PY7ASQ, WB2NCS/VP9, W1AW, VS9MB, YV4QG, 9H1BQ, 9Q5EP which just goes to show what's about.

Let's see now, Carisbrooke, Isle of Wight, JXK converter into a tuneable i.f. at 28-30MHz into the receiver, a GC-1U. No name at the bottom but the log for two metres looks good. Stations 80-110 miles away—F1RJ/P, F5NS, (both these in Normandy), G2JF (Ashford, Kent), G3KDG (Devon), G3OZF (Essex), G3UCC (Somerset), GC8AZZ/P (Jersey, C.I.). Further afield in the 140-160 mile range—F1APK (Brittany), F1TC (Brittany), G3OQB (Shropshire), G8BBB (Cambridgeshire), and G3GZJ at Redruth in Cornwall at 180 miles heard on c.w. The antenna is only a 6ft. length of wire in the bedroom. Just think what an 8 over 8 would pull in.

EVENTS

Happenings for September include—6-7th, v.h.f. n.f.d.; 14th, 3·5MHz field day; 21st, national finals of the d.f. hunt at Rugby; 21st, 144MHz contest. One mobile rally this month at Magdalene Laver, near Harlow in Essex. See any of you at this one? Owners of R1155 receivers will be pleased to hear of the 1296MHz contest on October 5th.

DON'T FORGET

1-4 October, the annual get-together of Radio Amateurs of the RSGB International Radio Engineering and Communications Exhibition, Royal Horticultural Hall, Greycoat Street, Westminster, London, S.W.1 (10 am to 9 pm).

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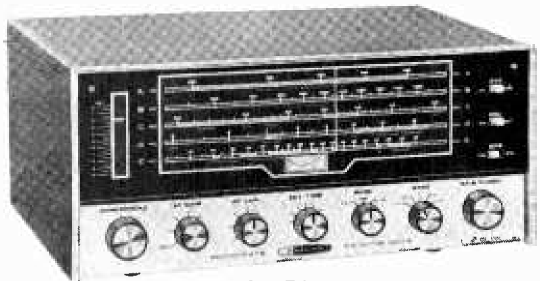

GR-54

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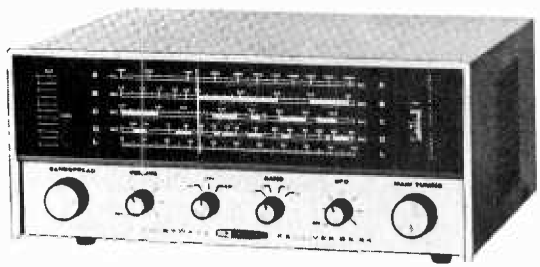

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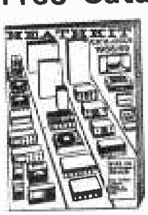

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pulse circuits in operation

I. J. KAMPEL

In pulse circuitry there are various other forms of elements designed to speed up pulses in order to obtain a fast trigger pulse from a slow input trigger pulse. It is also a frequent requirement that a circuit trigger at a pre-determined level, and switch off at a predetermined level. The Schmitt Trigger will perform both of these functions.

The most basic Schmitt Trigger is shown in Fig. 5.1. In its normal state no input is provided, Tr1 is therefore in the OFF state, and since $V_{c1} = V_{cc}$, Tr2 is switched into hard saturation. If a positive voltage is gradually increased at the input terminals, a point will be reached where Tr1 will switch on. The circuit current in the OFF state of Tr1 is given by:

$$I_{c2}\text{sat} \simeq \frac{V_{cc}}{R_2 + R_3}$$

since only about 0·1V are dropped by V_{ce2}sat. From this the triggering voltage to switch Tr1 into the ON sate may be determined by:

$$V_{\text{trig (on)}} \simeq V_{be1} + \frac{R_3 \,.\, V_{cc}}{R_2 + R_3}$$

When Tr1 switches on, V_{c1} drops to V_{ce1}sat + V_{r3} There is not sufficient voltage to support V_{be2} and thus Tr2 is cut off, causing a positive-going output at B, with a corresponding negative-going output at A. Since both transistors share the same emitter resistor, during the actual switching operation, as the input pulse causes Tr1 collector to go negative, I_{e2} starts to reduce at the same moment that I_{e1} starts to increase. The reduction of emitter current in Tr2 encourages the current to be transferred to the emitter which is now opening up, that of Tr1. A regenerative effect thus occurs, the switching off of Tr2 speeding up the switch on of Tr1. Fast outputs thus occur.

Tr1 will stay in the conducting state for as long as a positive voltage is applied at the input. If this voltage is reduced, Tr1 will switch off as soon as its V_{be} is not supported. The switching off of Tr1 speeds up the switch on of Tr2 and again fast edges are realised. In practice there is a slight backlash in such a circuit, i.e. it takes a slightly different potential to switch Tr1 on than to switch it off. The loop gain should be greater than one for positive switching.

The Schmitt Trigger can be used in conjunction with a ramp generator to form a delay line. If a slowly rising positive-going ramp is applied to the input of the Schmitt Trigger, the circuit will only trigger when the ramp voltage will support V_{be1}. It will thus be seen that there is a delay: the initial trigger pulse triggers the ramp to start, and the output is delayed until the Schmitt circuit triggers.

Figure 5.2 is a modified Schmitt Trigger in which a potential divider is used to set the base potential of Tr2. By making the potential of the divider adjustable by means of Vr1, the point at which the circuit triggers on a rising input may be adjusted.

Figure 5.3 also uses a potential divider, but a zener diode is employed to give a positively predetermined trigger. In this circuit, the states will change when:

$$V_{ce1} \simeq V_z + V_{be2}$$

A speed-up capacitor C1 is used to give Tr2 an initial overdrive of base current to drive it into hard saturation initially, relaxing after the initial transient with the only base current through the zener diode.

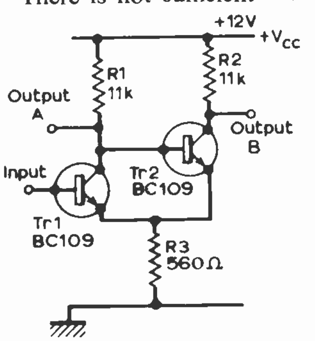


Fig. 5.1: A basic Schmitt trigger.

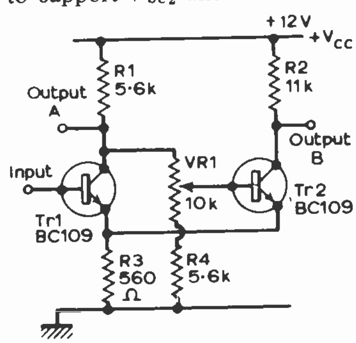


Fig. 5.2: A Schmitt trigger with variable setting.

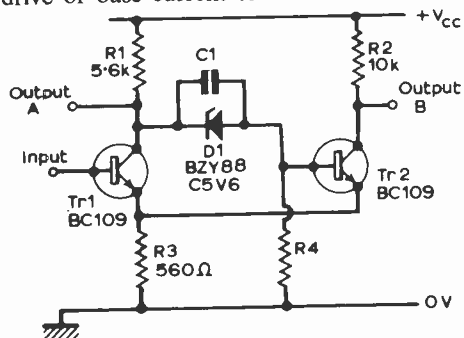


Fig. 5.3: Use of a Zener diode to set the triggering point.

Schmitt Trigger circuits can have very fast rise and fall times, and by modifying the design with lower loads or clamping diodes so that the transistors do not drive into saturation, switching times better than 10nS are possible.

It should be pointed out that the formulae given on the Schmitt Trigger have been chiefly to indicate in the explanation how the circuits work. It is very difficult to exactly predict switch-on and switch-off voltages, and these should ultimately be determined experimentally. It is quite usual for circuits such as that of Fig. 5.1 to have a backlash greater than 1·5V. The greatly simplified expressions given earlier in the text should give voltages within the backlash voltage range.

part five the trigger and ramp generator

COMPLEMENTARY SWITCH

Figure 5.4 shows a fast switch using complementary transistors, i.e. similar n-p-n and p-n-p types, although they need not be closely matched. An advantage with this circuit is that it only draws leakage current until

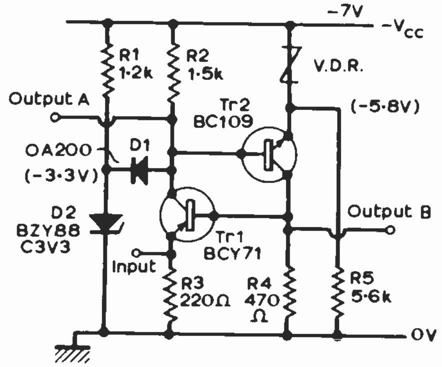


Fig. 5.4: A trigger similar to the Schmitt circuit but which draws virtually no current when off.

an input voltage is applied, if the zener current is ignored. In fact, with modern silicon planar zener diodes (such as the BZY88 C3V3 for D2) it is possible to only drive the zener diodes with a few hundred microamps, and the same applies to the v.d.r.

This circuit operates as follows. Since there is a closed loop round the emitter-base of Tr1 when no input is applied, Tr1 cannot switch on. V_{c1} is therefore at $-V_{cc}$ volts, and since the v.d.r. ensures that the emitter of Tr2 is about 1·2V away from the negative line, the emitter-base of Tr2 is under reverse bias. If a positive voltage is applied at the input terminal, it carries Tr1 emitter positive, below the earth rail, and it then enables Tr1 to switch on. As it switches on, the collector voltages go positive, bringing into conduction Tr2. As Tr2 goes on it increases the voltage at the base of Tr1 which further increases the current through Tr1. There is thus a loop encouraging the two transistors to switch sharply on. Output A goes positive and output B goes negative.

Now the zener diode clamps the cathode of D1 at −3·3V, thus preventing the collector of Tr1 falling below about −2·6V, and stopping it from being driven into saturation. This will result in minimal stored base charge, and will assist a fast turn-off time. When the positive input is removed, regenerative action similar to that in the switch-on encourages a fast switch-off, further enhanced since Tr2 tends to have its emitter-base reverse-biased.

The complementary circuit thus acts in a similar manner to the Schmitt Trigger. If the fastest switching characteristics are not required and the zener diode and the clamping diode are removed, allowing Tr1 to drive into saturation, an excellent switching circuit still exists with the virtue of practically no drain current when not in operation. For many purposes the circuit will operate rapidly enough if the emitter of Tr2 is simply taken to the −ve rail through a resistor, R5 then of course not being in circuit. The emitter-base of Tr2 will not then drive into reverse bias, but with Tr1 switched off, Tr2 will still be switched off, if not quite so positively.

A GATED RAMP GENERATOR

There are a number of uses for rising or falling voltage ramps, one of which, as a delay, has already been mentioned. Ramp generators are of course, the basic elements of scanning systems.

Figure 5.5 shows a simple gated ramp generator. We shall assume initially that capacitor C3 is fully charged to $V_{cc} - V_{ce}$sat volts. Tr2 is initially non-conducting, as is Tr1. If a positive pulse is applied via C1, Tr1 switches on, driving the base of Tr2 negative. Resistor R1, being smaller than the input impedance of Tr1, gives a more specific time constant at the input.

As Tr1 collector goes negative it brings into conduction Tr2, C2 acting as a speed-up capacitor. Tr2 is driven hard on and effectively shunts C3 with its low saturation impedance. C3 discharges through the transistor provided that the input pulse is long enough to ensure this. When the trigger pulse is removed, Tr1 and Tr2 switch off and the shunt across C3 is removed. Since the voltage at the base of Tr3 is constant, held so by the potential divider of R5 and R6, and since V_{be3} may be regarded as constant, the voltage across R4 is constant, and a constant current is therefore driven into Tr3 emitter. Virtually all of this current passes out of the collector and flows into C3. C3 is thus charged with a constant current, and produces a fairly good linear ramp. The ramp will continue until Tr3 goes into saturation, *or* until the cycle is started again by the application of a positive trigger pulse.

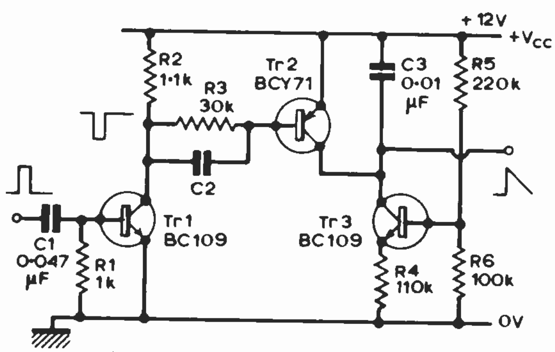


Fig. 5.5: A sawtooth or ramp generator.

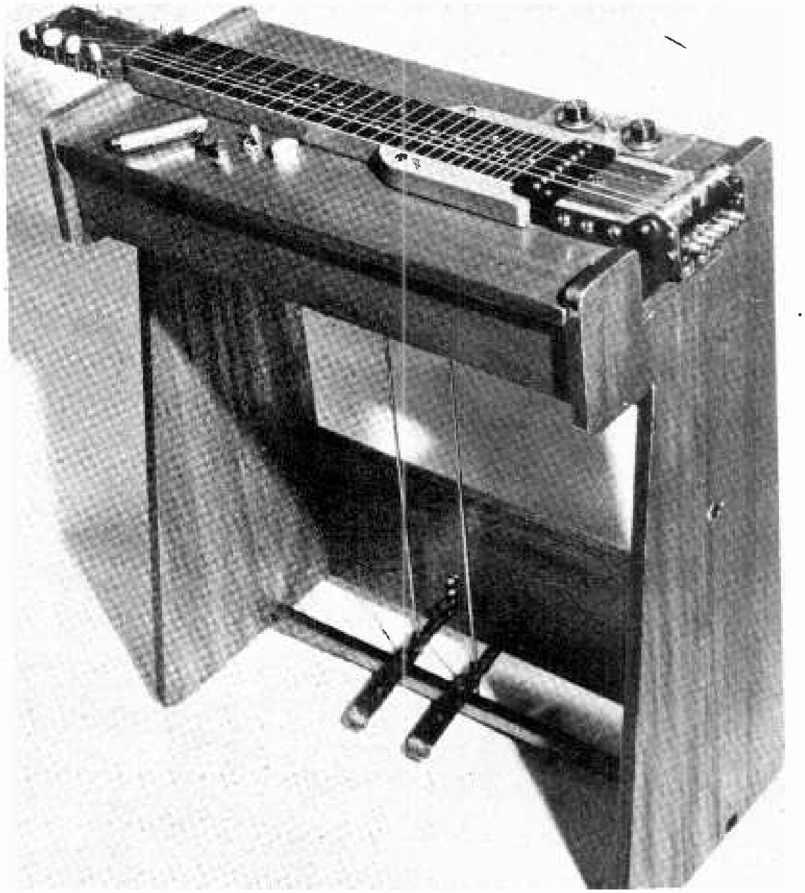
If a ramp generator is required to give a continuous sawtooth output, a multivibrator might be used to supply trigger pulses, or a feedback mechanism from the ramp output itself can be used so that when the ramp reaches a certain voltage, it switches on a monostable circuit which gates on Tr2. When the monostable releases Tr2, after the C3 discharge period, the ramp will start again.

CONCLUSION

In this series saturation switching, astable, monostable, bistable circuits, Schmitt triggers, complementary triggers and ramp generators have been discussed in detail. It is hoped that the original aim of clearly describing pulse circuits in operation has been achieved, and that this treatment may have assisted the beginner in particular to appreciate some of the finer points of transistors in pulse circuits. ■

SOME HIGHLIGHTS OF NEXT MONTH'S P.W.

PEDAL STEEL GUITAR



The popularity of "Country and Western" style music has brought about a new kind of electrical musical instrument. It stems from the Hawaiian steel guitar and has become generally known as the "pedal steel guitar".
The cost of commercially-made pedal steel guitars ranges from around £350, but the instrument to be described in the November and following issues should not involve a total outlay of more than about £30. Within the console body a preamplifier is incorporated, and the output may be taken to a suitable external power amplifier.

IC OF THE MONTH

Integrated circuits in ever increasing numbers are now being offered by advertisers to the home constructor. A number of designs have appeared already in Practical Wireless in which an IC is incorporated. Starting with the next issue we are introducing an "IC of the Month" series, each article of which will describe the practical application of a different device. Part I will feature the construction of an IC short wave converter.

AUDIO SUPPLEMENT

With the increasing interest in audio and hi-fi equipment, a special Audio Fair supplement will be published in next month's issue of Practical Wireless. It will include details of manufacturers' products and a preview of things to come at the 1969 Audio Fair.

PRACTICAL WIRELESS

All in the November issue on sale Friday, October 3

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practically wireless commentary by HENRY

No. 61

Power Complex

AT the risk of riding my hobby-horse too hard, I must revert again to the sore subject of audio output power. Not all the pundits agree on power nomenclature, it seems, though all deprecate the copywriters who make a six-watt struggler appear (in the brochure) too dangerous to couple to anything less than a pair of hundred-watt speakers.

"The greater the power, the more dangerous the abuse," quotes Editor John Crabbe in *Hi-Fi News*. Edmund Burke's argument is inside-out when applying politics to audio. The less the actual power the more it is made to sound good. Just now there is another trick way of defining power output. From America (of course) comes IHF$\pm$1dB. If a manufacturer of an amplifier can specify "so many watts, IHF$\pm$1dB" he is giving himself a scope for variations wide enough to admit a London 'bus. $\pm$1dB with a 100W amplifier is like saying "anything between 79 and 126 watts". And those "watts", remember, are music power, not your true-blue British r.m.s.

What have I said? R.M.S.? That's taboo now, according to Mr. Myall, of Wow and Flutter fame. He would like to know, what are "Watts r.m.s.". Me too!

The product of root-mean-square voltage and current is average power, or equivalent constant power. If we wish to express a varying power in the form of an equivalent constant power, it must be equal to the *average* value, not root-mean-square, which is 0·707 of peak. If the phrase "continuous sine-wave power" is to be taken literally, then half the peak value (implying a sinusoidal drive voltage) is neither r.m.s. nor average.

We couldn't hear the dratted noise

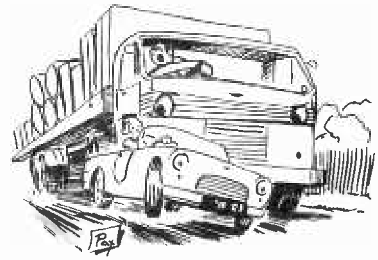
Continuous, in the terms of the audio boys, really means over a period of many cycles. It implies that the driving force, i.e. the sinewave voltage, is continuous, *not* that the power is flat and even over a long straight graph of output. The power must vary cyclically, or we couldn't hear the dratted noise it makes.

So we are asked to interpret r.m.s. power as "power arising from the r.m.s. voltage of a continuously applied sinewave signal".

We can accept that the power waveform is $\sin^2$, and half the peak value becomes the average.

None of this helps us if the manufacturer, or his indefatigable Boswell, the copywriter, uses EIA terms. The Engineering Industries Association of America has a standard which permits the manufacturer to quote power output at mid-frequency at a distortion content of 5%. And if IHF$\pm$1dB admits a London 'bus, this so-called standard would leave room for a couple of hansom cabs also.

Frank Jones gives the best analogy I have seen to explain the difference between the various power specifications. Imagine, he says, you are in a car and wish to overtake a lorry. Your engine must produce power to accelerate and let you pass. With continuous power, you could just accelerate in time to avoid bashing your brains out on an oncoming bonnet. By comparison, no other type of power would be so effective.



You could just accelerate in time...

Music power has excellent initial acceleration, but there is no sustaining strength, and the engine "dies away" as you are abreast of the juggernaut. EIA power would simply mean that as you put your foot down, the engine would make a horrible noise, but get you nowhere, and IHF$\pm$1dB would not allow you to pull out and pass; neither would any form of peak power.

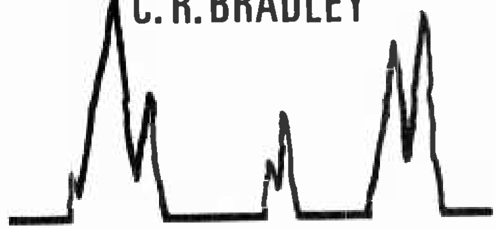
He does defend one practice that has a slight whiff of embellishment. Doubling up the power because you are in stereo is legitimate because ". . . a stereo amplifier should be capable of handling power on both channels together, or on either channel by itself. Peaks can occur on one channel only." Too true, especially with some of the gimmicky records dealers have been unloading since r.p.m. was abolished.

So how do we specify power, when there are so many ways we can be fooled? Mr. Crabbe suggests we ask for continuous power for a set period of time, say two seconds. He does not mention distortion, nor specify the test frequency.

All this, and my hobby-horse hasn't even worked up a sweat. What about the vexed question of power handling (speakers) or the myth of transistor sound which usually means that the speakers now have to handle a wider response and cleaner transients . . . what about . . . well, your turn, Joe. How do you figure in the power game?

ADDING SQUELCH

C. R. BRADLEY



VIRTUALLY all radio receivers and tuners incorporate a.g.c. (automatic gain control), also known less accurately as a.v.c. (automatic volume control). This works by utilising an otherwise wasted by-product of detection, the d.c. level produced by the carrier signal. This voltage depends on the strength of the carrier and is not affected by any sound modulation of the carrier. It is generally prevented from reaching the radio's audio stages by a capacitor after the detector. The principle of a.g.c. is to return this voltage to one or more r.f. stages in the receiver where it will progressively reduce gain by biasing one or more stages away from the normal Class A working point towards cut-off. Thus the carrier level reaching the detector is kept fairly constant over a wide range of received signal strengths.

The effect is that the radio is more satisfactory to use, a.g.c. can counteract atmospheric fading of radio signals, and the effect of moving a portable radio. One can tune across the wavebands without being "blasted" by strong signals and missing weak ones. Stages which are a.g.c. controlled and subsequent stages are not overloaded by strong signals. Of course a.g.c. cannot produce any improvement in the radio's maximum gain or signal-to-noise ratio and in fact must be carefully designed to avoid impairing these qualities.

A.G.C. circuits often work over a very wide range and tend to be taken for granted. It is interesting to disconnect the a.g.c. line from the detector and connect it to the radio's earth temporarily. The effect on reception of, say, Radio Luxembourg (while fading) is instructive, but be prepared for sound "blasting" if trying this on a radio with a powerful audio output.

SQUELCH

There is one defect in all a.g.c. circuits which can be remedied by a squelch circuit. The a.g.c. circuit cannot "know" whether a weak signal or no signal is being received. Therefore the r.f. stages work "flat out" (full gain) when there is no signal, and the radio reproduces interference and circuit noise at unpleasant volume, this is especially noticeable when a car radio gives a burst of crackle when driving under a bridge which shields the signal, and when a loud hiss (circuit noise) is heard between stations on a v.h.f. receiver. A squelch circuit removes this annoyance by muting the audio output until a carrier of predetermined strength is received. The squelch circuit to be described is a relay with transistor amplifier which is connected to the radio a.g.c. line. When there is no a.g.c. feedback, indicating that no signal is being detected, the relay closes and its contacts are arranged to mute the receiver audio.

Valve and transistor a.g.c. circuits must be considered separately as the voltage levels are slightly different. Figure 1 shows the essential a.g.c. components of a typical a.m. transistor radio using p-n-p transistors. The r.f. transistor is normally biased in Class A by R1 which supplies emitter-base current via i.f.t.1 secondary. A strong signal detected by D1 produces a swing in the positive direction in the r.f. transistor's bias, i.e., the emitter-base current is reduced and the transistor moves towards cut-off. Thus the voltage across the 8μF smoothing capacitor which is sensed by the squelch unit varies as follows:

No signal: −1·5 volts approx.
Strong signal: 0 volts approx.

If the a.g.c. circuit is similar but n-p-n transistors are used, the voltages are positive.

Figure 2 shows a squelch circuit suitable for both p-n-p and n-p-n transistor radios. A simple current amplifier driving a relay would not be sufficient due to the relay hysteresis or voltage lag between energised and non-energised conditions. To reduce hysteresis the relay coil RL is driven by a Schmitt trigger, Tr2/Tr3.

The a.g.c. supply is tapped off by VR1. If the a.g.c. voltage is sufficiently high (no signal), Tr1 draws current through R1 and away from Tr2. Tr2 and Tr3 share load resistor R3 and therefore the circuit resembles a long-tailed pair in that as Tr2 turns off, Tr3 is biased on by the initial reduction in voltage drop across R3. But Tr2 and Tr3 are also coupled in the same sense by R4. At a certain threshold value of input to Tr1, the loop gain of the trigger exceeds unity and Tr3 is suddenly turned full on by Tr2. When the input to Tr1 drops below the

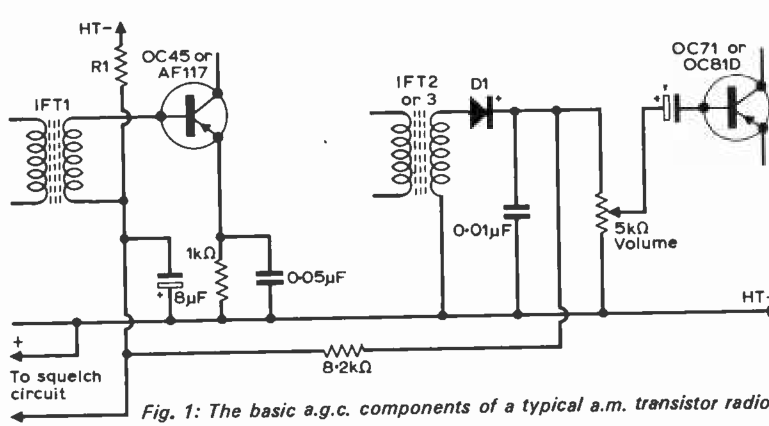


Fig. 1: The basic a.g.c. components of a typical a.m. transistor radio.

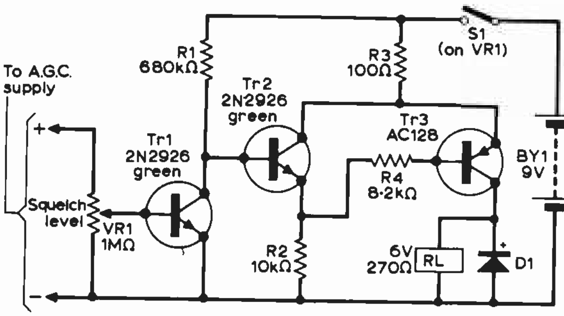


Fig. 2: Squelch circuit suitable for transistor radios.

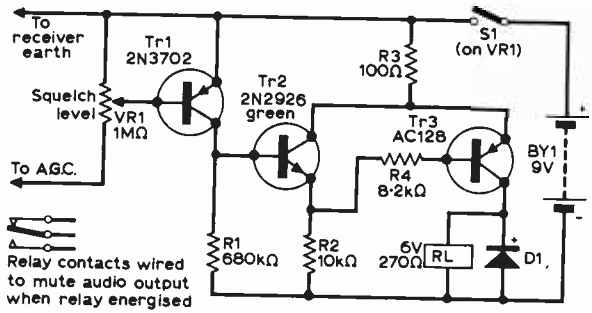


Fig. 4: The modified squelch circuit for valve radios.

threshold value, Tr2 suddenly turns on and turns Tr3 off. With the circuit shown, the threshold input current to Tr1 was about 1/25th of a microamp and the hysteresis was too small to measure. Since Tr3 turn off very rapidly, diode D1 is included to protect it from reverse transients induced in the relay coil.

The relay contacts are arranged to mute the audio when the relay is energised. This can be done in a variety of ways e.g., by breaking the h.t. supply to an audio stage or bypassing audio at some point to earth through a capacitor somewhat larger than the nearest audio coupling capacitor. For audio stages not working at peak level it is safe to interrupt the audio at the loudspeaker in the following manner.

Where there is an audio output transformer; wire the relay contacts to short the speaker terminals together when the relay is energised. Where there is no output transformer; wire the relay contacts to open-circuit the loudspeaker connection when the relay is energised. These rules must be observed to avoid damage to the audio output stage.

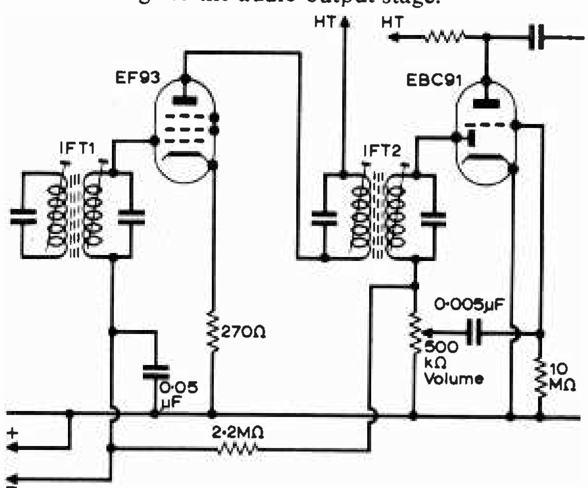


Fig. 3: The basic a.g.c. components of a typical valve radio.

The essential components of a valve receiver a.g.c. circuit are shown in Fig. 3. The EBC91 valve contains a detector diode which provides both a.g.c. and audio. There are many variations on this arrangement; sometimes separate diodes provide a.g.c and audio. When a strong signal is received, the detected audio and a negative voltage appear at the top end of the volume control. The 0·005μF capacitor couples the audio to the grid for further amplification. The negative voltage passes through the 2·2MΩ resistor and the secondary of i.f.t.1 to the grid of r.f. valve EF93. As this is a variable-μ pentode, application of increased negative bias progressively reduces the gain of the stage. Thus the voltage across the 0·05μF decoupling capacitor varies as follows:

No signal: −3 volts approx.
Strong signal: −6 volts approx.

Actual voltages may be considerably different, depending on the circuit. The important point is that the a.g.c. voltage *increases* when a strong signal is received as opposed to the opposite action in a transistor radio. For valve circuits, the squelch circuit must be rearranged slightly as shown in Fig. 4. Tr1 is now a high gain p-n-p transistor which supplies current to Tr2 when a *high* a.g.c. voltage is sensed across VR1. The delay coil is therefore energised when there is no radio signal as before.

★ components list

Resistors:
R1 680kΩ — R3 100Ω
R2 10kΩ — R4 8·2kΩ
All 10%, ¼ watt miniature

Semiconductors:
Tr1 2N2926 green (Fig. 1)
2N3702 (Fig. 2)
Tr2 2N2926 green
Tr3 AC128
D1 Any germanium diode e.g. OA70

Miscellaneous:
VR1 1MΩ carbon pot. with switch; RL 6V 270Ω miniature Siemens relay, one set of contacts used. 9V battery; Aluminium chassis; tagstrip; battery clips; knob for VR1, etc.

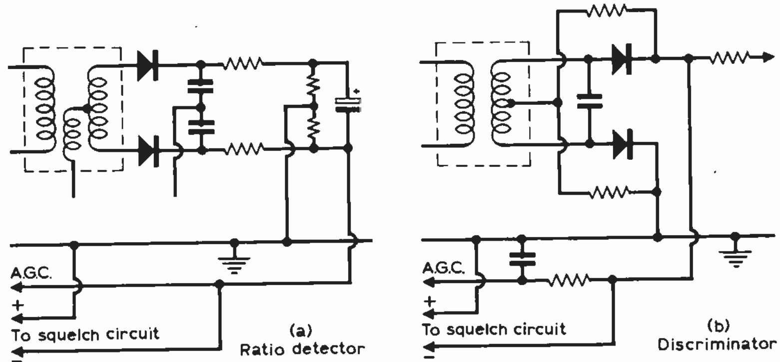
CONSTRUCTION

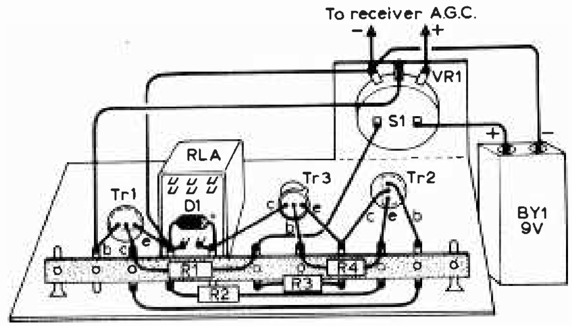
The layout of the squelch circuit is not critical and it can be built small enough to fit inside almost any radio. The author's prototype was laid out on a tagstrip bolted to a piece of aluminium without any attempt at miniaturisation as shown in Fig. 5. This layout is for the circuit in Fig. 2 and the necessary re-arrangement for the circuit in Fig. 4 can be deduced easily. A piece of the aluminium chassis is bent up to carry the squelch level control VR1. The tagstrip must be clean and dry around the base connection of Tr1 as the circuit will trigger on the slightest leakage current here. Just touching the base and collector leads of Tr1 with a fingertip causes the relay to energise.

None of the components are critical and there is no harm in trying substitutions. Tr1 and Tr2 were chosen for high gain and low leakage and similar cheap silicon types should work. Tr3 is a general-purpose

Fig. 5 (below): The component layout of the circuit shown in Fig. 2; this will have to be slightly modified for the circuit in Fig. 4.

Fig. 6: A.G.C. circuits of valve receivers using (a) a ratio detector and (b) a discriminator.





germanium type and an OC81 would be a possible substitute. A miniature Siemens 6 volt relay was used as it is available cheaply. A 24 volt 400Ω relay was also made sufficiently sensitive to work in the circuit by stripping it of three of its four contact sets and carefully weakening the one remaining spring. Any relay coil that will pull in on about 12mA will work in the circuit if the d.c. resistance is below 1 kΩ.

If the relay does not energise, try reducing R2 to 8·2kΩ and/or increasing R1 to 820kΩ or 1MΩ. If the relay remains constantly energised with no input to Tr1 base, try increasing R2 or reducing R1 to 500kΩ. These adjustments should only be necessary with lower gain transistors and/or a less sensitive relay and result in a less sensitive circuit.

CONNECTION TO RADIO

The possible ways in which the relay contacts can be arranged to mute the receiver audio when the relay is energised have been mentioned and a suitable arrangement can easily be made. With valve receivers it is best to leave low level audio circuits alone to avoid introducing hum and muting is best achieved by interrupting the h.t. supply to the output valve. In this case a 0·1μF capacitor should be wired across the relay contacts to minimise sparking.

On a.m. receivers, the a.g.c. decoupling capacitor to which the squelch circuit is connected is easily located by reference to Figs. 1 and 3. It is usually just "one resistor away" from the live end of the volume control.

On f.m. receivers, the way in which the a.g.c voltage is derived depends on the type of detector used. Figure 6 shows the a.g.c. circuits of typical valve receivers with ratio and discriminator detectors. The a.g.c. controlled stage(s) work in the same way as in the a.m. circuits Figs. 1 and 3 and the a.g.c. voltage varies as before for p-n-p transistor, n-p-n transistor and valve stages.

For normal squelch use, VR1 is set so that the relay just energises when no signal is received by the radio. Any reasonable signal will then cause the relay to de-energise but it is often useful to set VR1 so that only strong signals can break through the squelch. In this way, the crowded medium wave band can be "weeded out" so that it is reduced to a few strong local stations separated by silence.

Although the squelch circuit is very sensitive, it is necessary to switch it off in order to receive very weak signals that do not produce any noticeable a.g.c. voltage.

The circuit draws about 15mA when the relay is energised. In normal use the relay will not be energised for long periods and several week's life can be expected from a PP3 battery; the author's circuit continued to work with a battery voltage as low as 4 volts. It is important to switch off the circuit when the radio is off or the battery will soon be drained, especially with the valve radio circuit where the relay would remain energised. ■

MONO-STEREO AMPLIFIER

——*continued from page 398*

usual twin wiring, and relies on a single wire, with earth return. The amplifier, as shown, will not operate satisfactorily under these conditions.

Power Supply

This is quite conventional. The only points to note are that the mains transformer and smoothing choke are sufficiently large to handle the current required. The rectifier specified (GZ34) is the octal-based near-equivalent of the popular EZ81, which can equally well be pressed into service if desired. A B9A holder is required in place of the octal base. If this valve, or an EZ80 is used in preference to the GZ34, a *separate* 6·3V heater winding will not be necessary on the mains transformer, as the heater-cathode insulation of these valves is sufficient to permit using them with the heater winding which supplies the remaining valves. The EZ80 is on the low side to handle the power necessary for stereo operation but will be sufficient, initially, for a mono version of the amplifier, and has the same base connections as the EZ81, with which it can be later interchanged. Smoothing capacitors C15 and C16 should be of the rated capacity, or slightly larger. Decoupling capacitors C4 and C54 are essential for stability, and should not be omitted, although, if space is at a premium, they may be reduced to 16μF at the rated working voltage.

to be continued

MEDIUM WAVE DX • RECEIVER •

D. GIBSON G3JDG

DESIGNS for various types of receiver have commonly appeared in the popular construction journals. However, these have fallen into two categories, those for the short wave amateur bands from 1·8 to 30MHz, and those more specialist types intended for the higher frequencies such as 144MHz.

To date, the medium wave enthusiast appears to have been sadly neglected, and the purpose of this article is to offer ideas on which a specialist receiver, intended specifically for the 0·5 to 1·5MHz segment of the r.f. spectrum, may be founded.

The circuitry provided offers a medium wave solid state receiver, but there is room for improvement both in performance and construction. It is intended, therefore, that this article should stimulate ideas for further experiment and improvement rather than offer circuitry which should be copied parrot-fashion.

DESIGN CONFLICTIONS

Any design is, of necessity, a compromise. In dealing with a medium wave receiver the same conflictions arise as for any receiver. Perhaps the two most important are sensitivity and cross-modulation characteristics with second channel interference running a close third. Other problems, such as noise, selectivity and spurious responses must be considered.

An inherent weakness in superhet design is image interference. The receiver shown minimises this by the choice of a high i.f. frequency—1·6MHz instead of the more usual 465kHz. Selectivity is good because there are two tuned circuits prior to the mixer. The i.f. bandwidth at the 6dB points is approximately 2kHz, this narrow bandwith assists in selectivity and a reduction in noise.

An a.m. signal, which is the normal type on medium waves, has two sidebands each containing identical information. Thus if we receive only one, it is possible to achieve intelligibility, a technique used in this design.

The narrow i.f. bandwidth is achieved by the use of a half-lattice crystal filter containing two crystals. The result is a filter having response characteristics with very steep sides.

In order to minimise cross-modulation problems the gain of the receiver is purposely kept low ahead of the mixer, the main gain coming after the crystal filter.

In designing the receiver it was envisaged that the average constructor would not have access to expensive test equipment and many would not possess a wobbulator or oscilloscope, two items needed to align an i.f. section accurately. Thus, in the present circuit, a commercial i.f. strip is used which is prealigned and on setting up in the completed receiver

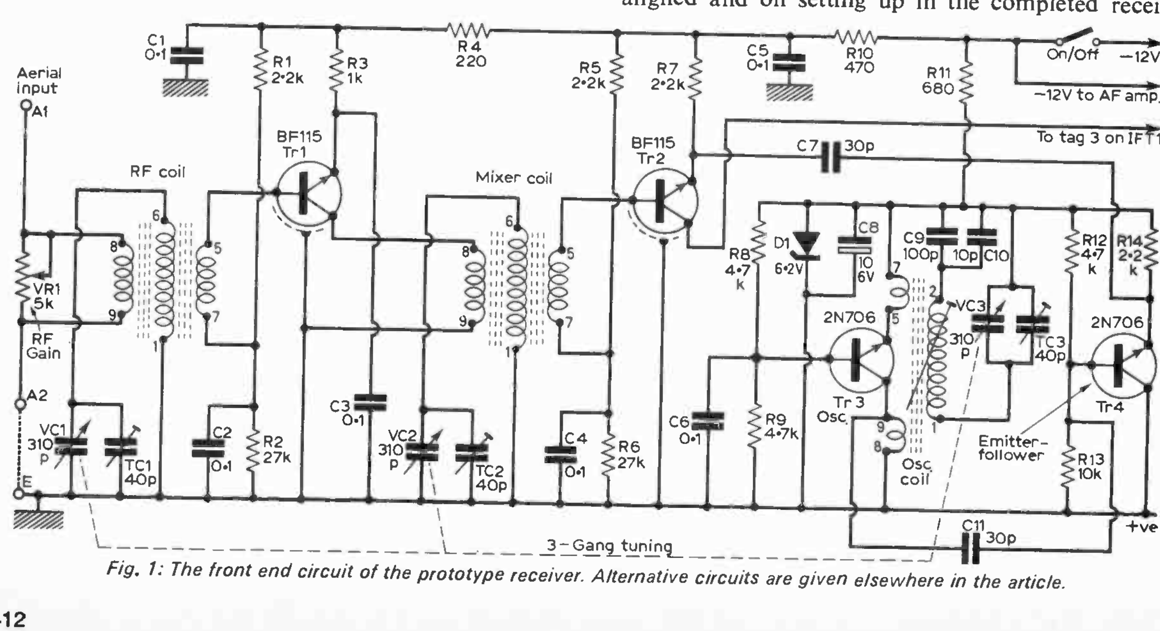


Fig. 1: The front end circuit of the prototype receiver. Alternative circuits are given elsewhere in the article.

★ components list

Resistors:

R1	2·2kΩ	R13	10kΩ	R25	1kΩ
R2	27kΩ	R14	2·2kΩ	R26	56Ω
R3	1kΩ	R15	1kΩ	R27	1Ω
R4	220Ω	R16	10kΩ	R28	1Ω
R5	2·2kΩ	R17	1kΩ	R29	18kΩ
R6	27kΩ	R18	68kΩ	VR1	5kΩ lin.
R7	2·2kΩ	R19	10kΩ	VR2	50kΩ log.
R8	4·7kΩ	R20	33kΩ	VR3	5kΩ log.
R9	4·7kΩ	R21	2·2kΩ	VR4	5kΩ lin.
R10	470Ω	R22	470Ω	VR5	10kΩ lin.
R11	680Ω	R23	560Ω		
R12	4·7kΩ	R24	4·7kΩ		

All resistors 10% ¼W miniature, all potentiometers miniature carbon

Capacitors:

C1 0·1μF
C2 0·1μF
C3 0·1μF
C4 0·1μF
C5 0·1μF
C6 0·1μF
C7 30pF
C8 10μF 6V electrolytic
C9 100pF
C10 10pF
C11 30pF
C12 10μF 6V electrolytic
C13 10μF 6V electrolytic
C14 100μF 6V electrolytic
C15 100μF 15V electrolytic
C16 100μF 15V electrolytic
C17 100μF 15V electrolytic
C18 200μF 15V electrolytic
C19 1,000μF 12V electrolytic
C20 1,000μF 12V electrolytic
VC1/VC2/VC3 310pF swing variable 3-gang capacitor
TC1/TC2/TC3 40pF trimmers (air spaced if possible)
Cx see text
Cz see text
All capacitors 125V wkg., miniature foil or polyester unless otherwise stated.

Semiconductors:

Tr1 BF115 } (or OC170 or 2N3819,
Tr2 BF115 } see alternative circuits)
Tr3 2N706; Tr4 2N706; Tr5 OC81; Tr6 OC81D; Tr7 OC81; Tr8 AC127
D1 6·2V 5% zener diode, 250 mW.

Inductors:

R.F. coil Denco blue transistor coil 2T
Mixer coil Denco yellow transistor coil 2T
Oscillator coil Denco white transistor coil 2T
} using BF115s or OC170s in front end

R.F. coil. Denco blue miniature dual purpose valve coil 2T
Mixer coil Denco yellow miniature dual purpose valve coil 2T
} using 2N3819s in front end

I.F.T.1 S1/T11/1·6 Denco

Miscellaneous:

I.F. strip IFA/1.6/SSB Mk. II, Electroniques; S-meter, 0–1mA, Eagle; 10Ω–35Ω loudspeaker; two open-circuit jack sockets; tuning dial assembly, Electroniques SM2; case and chassis, Philpotts Metal Works, Chapman Street, Loughborough; panel labels, Sherrard's Training Centre Digswell, near Welwyn, Herts.; plain Veroboard, 0·1 in. matrix and matching pins, r.f. board 2 x 3¾ in., a.f. board 1¾ x 3¾ in.; three terminals; five knobs; two toggle on-off miniature switches; one single pole changeover switch; two PP1 batteries; battery clips.

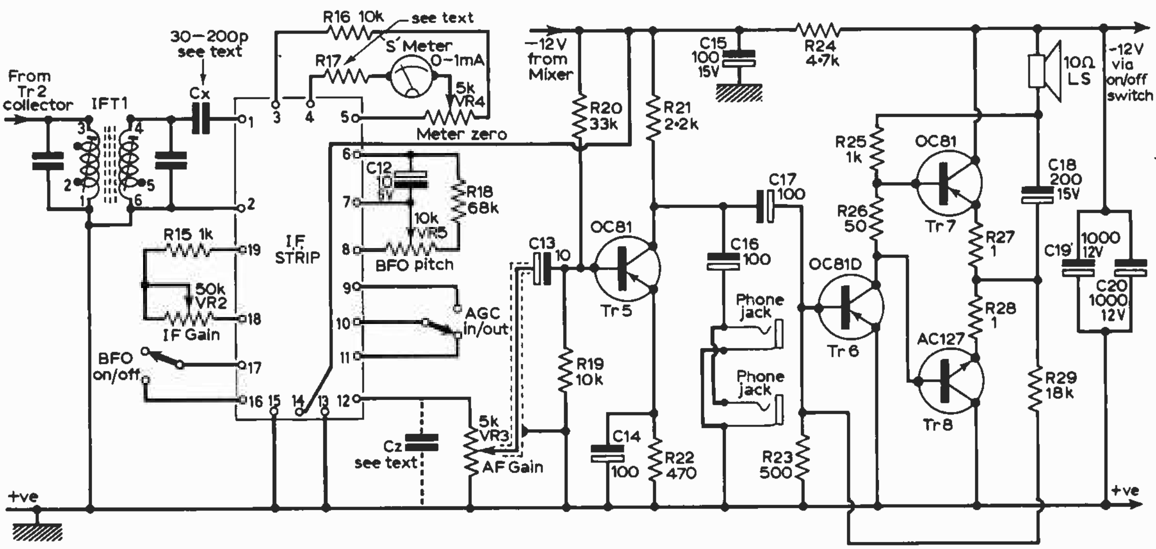


Fig. 2: The i.f., detector and audio stages. R17 is 1K in the prototype but its value will depend upon the d.c. resistance of the meter chosen.

requires only one core to be adjusted for maximum response.

FRONT END

The front end of the receiver uses four transistors, all n-p-n types. It is a little unusual in that the circuitry is turned upside down to comply with the positive earth, a requirement of the i.f. strip.

A warning here. The transistors in the r.f. and mixer stages are Mullard types BF115. These transistors have four leads. There are some transistors marked BF115 currently on the market, usually offered cheaply, which have only three leads. These three-lead types are not suitable, having been tried and found to lead to instability. For those readers who intend to use this design as a basis for further experiment, it is strongly urged that only brand new manufacturer's semiconductors be used.

Another important consideration is the choice of device for the oscillator. The type specified is a 2N706 and not a 2N706A. The latter type was found to emit rather more spurious squeaks than could be tolerated. Four 2N 706As were tried and all gave similar results whereas the problems vanished when the 2N706 was used.

The r.f. stage uses a Denco blue coil inductively coupled to the aerial via a parallel-wired potentiometer. This method of r.f. gain control was adopted in favour of the more common configuration of varying resistive values and varying voltages fed to the transistor because it offers an improvement in cross-modulation performance.

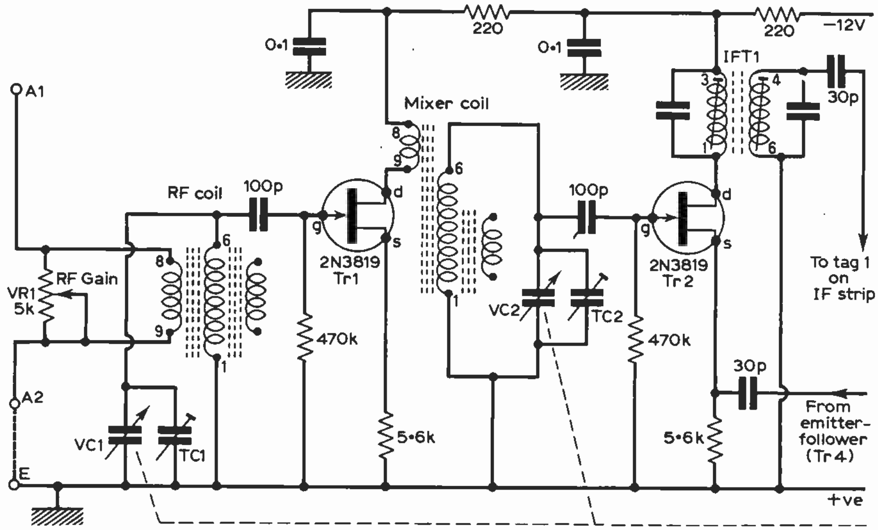


Fig. 3: An alternative front end using f.e.t.s. Although this circuit lacks gain, the use of 2N3829's should be an improvement.

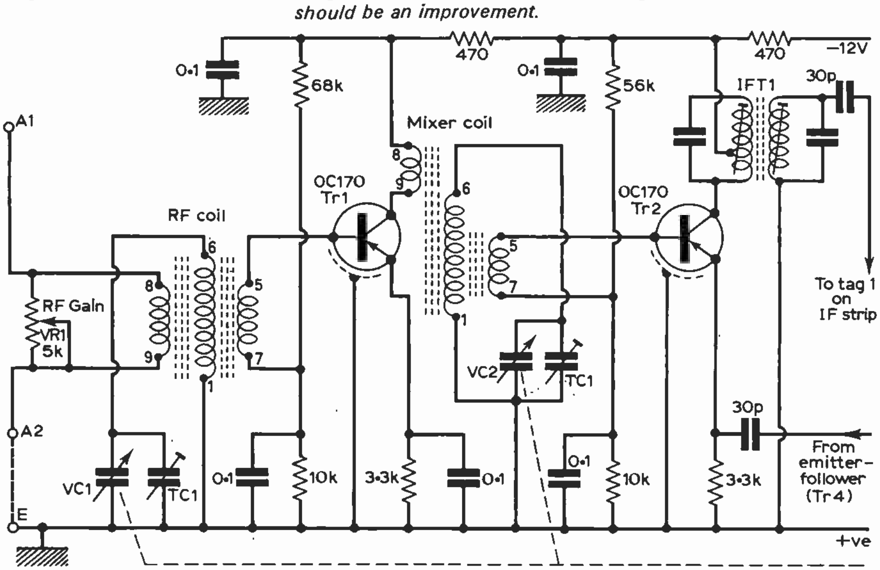


Fig. 4: Circuit for the front end using p-n-p transistors. Although providing better gain it suffers from cross modulation.

ALTERNATIVE FRONT ENDS

In order to investigate the claims that field effect transistors (f.e.t.s) gave improved cross-modulation performance, a front end was constructed using 2N3819 f.e.t.s in the r.f. and mixer stages. The oscillator and emitter follower sections were left as shown.

Although these devices certainly gave improved performance in one direction, they lacked gain and were therefore abandoned in favour of bipolar devices. There are f.e.t.s available which are superior to the 2N3819 and doubtless these would prove satisfactory, perhaps the 2N3829 which is a "hotted" up version of the 2N3819.

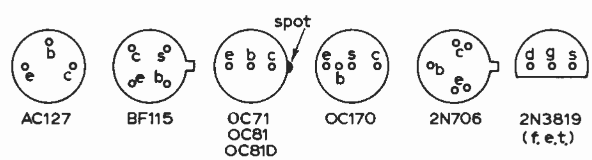


Fig. 5: The transistor connections for the types mentioned.

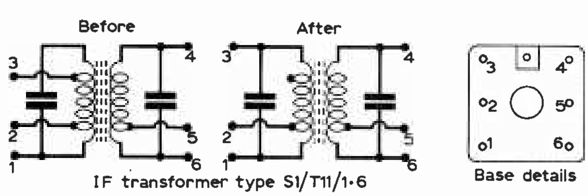


Fig. 6: The modification of i.f.t. 1.

For constructors who are unhappy about the use of n-p-n devices in upside down circuitry, a p-n-p front end was tried using the trusty Mullard OC170. This circuitry gave greater gain than that shown in the final circuit but by the same token proved more susceptible to the terrors of cross modulation. It must be admitted, however, that sensitivity with the circuit configuration gave most impressive results when using ten feet of twin lighting flex as an aerial.

For the experimentally minded, the other two front ends tried are shown in Figs. 3 and 4. Again, these were wired up on a strip of Veroboard in superb "rats nest" style and would doubtless benefit from a little thought for further improvement.

One last point regarding the f.e.t. A friend working at a university offered to check the actual gain of an f.e.t. and with an untuned load found this to be only 3dB, a result verified by his learned tutor.

LOCAL OSCILLATOR

The oscillator uses a standard Denco coil but note that this is the white one intended for an i.f. of 1·6MHz. It is coupled to an emitter follower, also a 2N706, which gives good isolation between the oscillator proper and the mixer stage. This isolation is further enhanced by the use of very low value coupling capacitors, nominally 30pF.

The use of a separate oscillator is common in communications receivers to avoid any slight variations in the load offered by the mixer from detuning the oscillator slightly or "pulling" it off frequency. The emitter follower is an admitted luxury but the circuit works very well and no pulling can be detected in the prototype.

Both oscillator and emitter follower are fed from a stabilised supply obtained with the aid of a 6·2V 250mW zener diode decoupled by a 680Ω resistor and a 10μF 6V electrolytic. This is not the most stable of supplies but the use of further transistors in either series or shunt stabilising circuitry was not considered necessary, and to date this decision has proved correct.

A transistor mixer requires very little in the way of oscillator injection voltage and thus the low voltage to the oscillator stage plus the very low coupling capacitors are entirely adequate. No advantage was evident when either or both were increased. The coupling capacitors were increased in value up to 1,000pF with no apparent increase in performance and strangely enough, no apparent pulling of the oscillator.

The i.f. strip has two crystals with the resultant response centred on 1·62MHz and not 1·6MHz which is the frequency for which the oscillator coil is intended. No deleterious results have come to light so far, the oscillator core allowing a wide adjustment of frequency. For the purist, intent on squeezing the very last ounce of performance out of the circuit, then theoretically the padder capacitor should be made variable so that the slight variation in frequency can be adjusted with due regard for the correct LC ratio. In this case, it would be in order to use an 82pF silver mica capacitor in parallel with a 30pF trimmer, preferably a beehive type so that these very slight adjustments can be catered for.

THE I.F. STRIP

Coupling to the i.f. strip is via an i.f. transformer mounted separately on the underside of the chassis. The secondary winding is capacitively coupled to the i.f. transformer on the strip. The value here is nominally 30pF. Increasing the capacitance will result in a greater transference of signal but will load the i.f. transformer on the strip more heavily. The result is that although "better" results are obtained from the loudspeaker, the shape of the response curve is distorted and it thus becomes again a matter of compromise as to how much shape distortion can be tolerated.

In an effort to check this to the limit, the collector of the mixer transistor was taken directly to the input of the i.f. transformer on the strip itself, thus bypassing completely the separate i.f.t. The resultant distortion of the i.f. shape factor was quite marked but selectivity was still reasonable.

A very important point is the adjustment of the strip's input i.f.t. This has two cores which can be adjusted by a special plastic tool. Under no circumstances should the top core of this transformer be touched. Only the lower core, accessible from the bottom of the can, should be adjusted. This is very important since the other, the top core, is carefully pre-aligned by the manufacturers for the correct response from the crystal filter.

The strip is colour coded by little blobs of paint. These correspond to the numbers shown in the diagram. To avoid any error here, a table has been included showing which colour corresponds to which number. This information is also included in the *Hobbies Manual* which the manufacturer also markets.

The resistor shown in series with the meter, i.e., between the meter and point 4 on the strip was found superfluous with the particular meter used. Originally a 5kΩ skeleton preset was wired in directly behind the meter for adjustment. A separate front panel control permits the meter to be set to zero.

In the manufacturer's circuitry for the strip there is an error in the wiring of the a.g.c. on/off switch. This should be wired as shown in the circuit diagram and not as in the *Manual.*

The original circuitry also showed a 0·1μF capacitor wired directly across the a.f. gain potentiometer. The omission of this component will result in an increase in signal but will also be accompanied by an increase in noise. Varying the value of the capacitor will produce *pro-rata* results.

A.F. SECTION

The a.f. amplifier section was derived from an early Mullard design which was modified and ruthlessly pruned of components until the bare minimum workable circuitry remained. Considerable experiment was called for to get the circuit to function satisfactorily in both performance and current consumption. With the values as shown, the circuit draws approximately 8mA in its no-signal condition. Current on peaks is far greater than this.

Two jack sockets are wired in immediately following the preamplifier stage. This was to allow headphone reception for one or two listeners or to take a lead out to a tape recorder. The speaker remains in circuit when these jacks are in use and it might be an idea to utilise jack sockets with spare contacts which could be arranged to break the supply to the other three transistors in the interests of battery economy.

In its present form the receiver covers from 0·5MHz to 1·5MHz over a 180° dial. It has three separate

—continued on page 434

BASIC SEMICONDUCTOR TECHNOLOGY

PART FIVE

by M.F. DOCKER, M.Sc.

PREVIOUS articles in this series have shown how semiconducting materials can be made to rectify alternating current, respond to light signals by producing a varying current when the illumination is altered, and so on. These devices have all been two electrode ones, or diodes. Their electrical behaviour has been shown to be connected with the internal, atomic energy levels of the materials used, and with the distribution of impurity concentrations within the devices.

Discovering the transistor

Shockley, Bardeen and Brattain together with other research workers sought for many years to find a solid state device which would produce amplification of power; in other words a solid state version of the thermionic triode valve. They were aiming to make a device which had been theoretically predicted by Lilienfeld. In 1948 they disclosed the invention of an amplifier, different from the one that they were trying to make, but none the less an amplifier. They called it a transistor, a contraction of the term TRANSfer resISTOR. It was not until several years later, in the 1960s, that the device they were seeking, the field effect transistor, was found. This had to await the advent of higher purity materials than were at that time available.

The device which they did make was a variant of the point contact diode. They placed two metal cat's whiskers close together on the same chip of germanium. One of the diodes thus formed was forward biased and the other reverse biased. The amazing fact that came to light was that the current between the two metal contacts depended strongly on the current flowing into the forward biased junction. A large current could be made to flow across a high impedance reverse biased junction, amounting to a high power outout, simply by altering the current flowing in a low impedance forward biased junction, a low power input. The solid state amplifier was here to stay!

Basic transistor operation

In order to explain the transistor action it is convenient to discuss the p-n-p junction transistor. This is a descendant of the point contact transistor and the methods used in their manufacture will be described later. At present it suffices to say that it consists of an n-type base region, corresponding to the semiconducting chip in the point contact device, and two p-type regions called the emitter and collector corresponding to the forward and reverse biased junctions respectively. The cross section of a typical device of this form is shown in Fig. 1. The two p-type regions have to be placed very close together in order to get a good transistor action.

The voltages (batteries) shown in this figure correspond to those used in the basic common emitter transistor circuit. The emitter to base junction is forward biased by making the emitter positive with respect to the base, and the collector to base junction is reverse biased by making the collector negative with respect to the base.

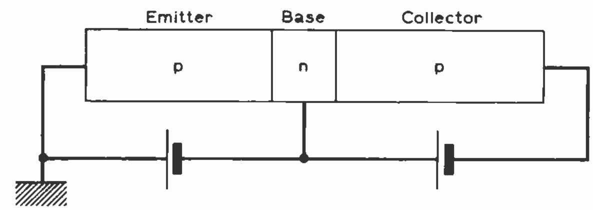


Fig. 1: Basic physical representation of a junction p-n-p transistor. The connections here correspond to the common emitter mode (emitter earthed).

At the forward biased emitter-base junction there is a flow of holes from the p-type region to the n-type region and a flow of electrons in the opposite direction. However the impurity concentration of the emitter is arranged to be much greater than that of the base so that the number of electrons flowing from the base to the emitter can be ignored in the simple treatment of the transistor. In more rigorous treatments of the device the "injection efficiency" of the emitter is involved: this is defined as the ratio of the current flowing across the emitter base junction due to the hole flow to that due to the electron flow together with that due to the holes, or more simply it is the ratio of hole current to total current.

Now consider what happens to the holes which are injected into the base region. If the base region were infinite in length all the individual holes would eventually recombine with the majority carriers, electrons, which are present in large numbers in the base region. However the holes can travel on average a certain distance through the base region before recombining. The time they exist in the base region is called their lifetime and is again an average concept. In the transistor the base region is made as narrow as possible so that a large fraction of the injected holes are able to diffuse to the collector junction.

At the collector junction they come under the influence of the electric field across the depletion layer, and because of their positive charge they are attracted to the collector which is negative with respect to the base.

Once the holes reach the collector they constitute the emitter to collector current. The holes which recombine with electrons in the base region result in the number of electrons in the base region decreasing. However the concentration has to remain constant in order to maintain equilibrium so electrons flow into the base from the external power supply, contributing to the base input current.

If by open circuiting the base no electrons are allowed to flow into the base region from the external circuit, only a very small emitter to collector current will flow. However if a small base current is permitted to flow an emitter to collector current many times this will be able to flow. In this way current amplification has been achieved. The ratio of the number of holes crossing the base junction to the number suffering recombination is called the beta of the device and given the symbol β.

Power gain

It is now possible to see how a power gain can be achieved. Considering the circuit of Fig. 2, called the common base mode of transistor operation, it is seen that the emitter current is almost the same as the collector current as just explained. The input current is the emitter current and the output current is that

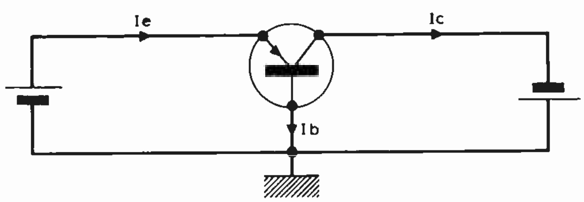


Fig. 2: Circuit showing the common base transistor arrangement (base earthed this time).

flowing from the collector. However these are nearly the same in size, the ratio of collector to emitter current being called the alpha of the device and given the symbol α. So how has a power gain been achieved?

Remember that the collector junction is reverse biased so the base to collector voltage Vbc is large, perhaps 10V in a small transistor or 100V in a larger device. However the base to emitter voltage Vbe is very much smaller, typically 0·3V for a germanium device and 0·5V for a silicon device. Consequently there is a power gain between the emitter input and the collector output of several hundred times.

A simplified relationship between the α and the β of the transistor can easily be found. From the explanation so far given it is clear that the emitter current is equal to the sum of the collector and base currents. Consequently from the definitions of α and β the following equations can be written:

$\alpha = I_c/I_e = I_c/(I_c+I_b) = I_c/(I_c+I_c/\beta) = \beta/(\beta+1)$.

Alternatively the equation can be written in the form

$$\beta = \alpha/(1-\alpha).$$

The equation for α shows that it is always less than 1 as β is always positive. A typical transistor could have a current gain, β, of 100. Consequently the value of α for this device would be 0·99. Obviously a large change in β gives rise to only a small change in α.

The manufacture of transistors

Various processes are used in the manufacture of transistors in order to produce devices of different capabilities in respect of frequency response, speed of switching, power dissipation, maximum collector voltage and so on. However many of the procedures are common to those used in the manufacture of diodes.

The starting point in the production of a transistor is once again a highly purified slice of silicon or germanium or perhaps some other semiconductor as mentioned previously such as gallium arsenide which is being increasingly used in the manufacture of devices. Into this material the appropriate impurities are introduced in order to obtain the junctions upon which the action of the transistor depends.

The grown junction transistor

The grown type of transistor is produced by the same process used to prepare the grown diode. Either the impurity content of the melt from which the crystal is being grown is altered to obtain p- and n-type regions, or else the rate at which the crystal is pulled is altered giving the rate growth process. In either case very close control over the process has to be exercised in order to obtain a transistor which conforms to the required specifications.

A grown junction transistor might be made in the following way. Initially the collector is grown using a comparatively high purity n-type melt and a suitable seed crystal. After a short length of this material has been grown p-type impurity is added to the melt in order to over-compensate for the n-type impurity giving a net p-type behaviour to the region. A very short region of this material is proced to give a thin base. Finally the emitter is grown by adding an excess of donor impurity in order to give a region of low resistivity and a high injection efficiency. Typical resistivities of the collector, base and emitter regions might be 10, 1 and 0·02 Ω/cm. respectively. The resistivities of the regions of course vary inversely with their impurity concentration, low resistivity corresponding to a high impurity concentration. This process can be repeated several times in the growth of one crystal so that many transistors can be produced together.

The next step towards a finished transistor is to cut the crystal into slices. This means that the junctions have to be located, and this is done by etching the crystal, when the junctions are easily seen under a high power microscope. The transistor slices are then cut and divided up into small dice, perhaps one millimetre square, to give the individual transistors which are then mounted on to metal headers. Finally the leads are attached by soldering or by alloying and the complete transistor is encapsulated in its case and hermetically sealed to prevent contamination by airborne impurities.

The alloy junction transistor

One of the most popular types of transistor is the alloy junction device. This is made in the case of a germanium p-n-p device by attaching two indium "dots" to an n-type germanium dice. This is then raised to an accurately controlled temperature of around 600° C for a short time. The indium dots melt and dissolve some germanium from the dice until they are

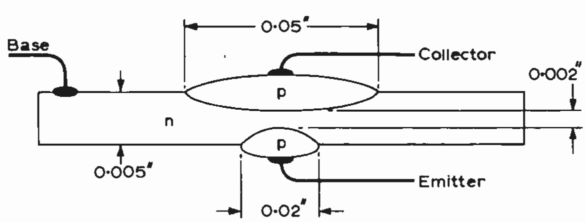


Fig. 3: The structure of a typical p-n-p alloy junction transistor.

saturated. After a short time the heating is removed and the wafer allowed to cool. The indium solidifies again but the germanium near the edge of the molten indium

—continued on page 423

TAKE 20

JULIAN ANDERSON

No. 6 ONE TRANSISTOR RADIO

A series of simple transistor projects, each using less than twenty components and costing less than twenty shillings to build.

EVER since I first started playing about with transistors about eight years ago I wanted to build a one-transistor radio, operating a loudspeaker without an external aerial. This was not possible in those early days as there were no transistors on the market with sufficient gain. A few months ago I had a crack at this again using the very high gain silicon transistors now costing about a couple of bob each, the result is published here.

I don't want to mislead anyone, the volume is low but it is sufficient for a child's or bedside radio.

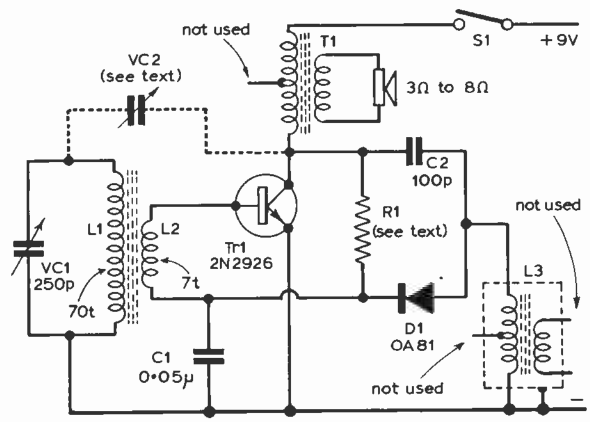


Fig. 1: The circuit of the one transistor radio.

THE CIRCUIT

With the prices of nearly all components falling—and transistors falling most rapidly, many readers will think that it would be cheaper and easier to use two transistors and do away with some of the other parts. They are perfectly correct, but until there are laws forbidding slavery in transistors there is a lot of satisfaction in getting the last ounce of work out of them.

The signal is picked up on the aerial winding L1 on the ferrite rod and tuned by VC1. L2 transforms the signal and feeds it to the base of the transistor, C1 acting as a d.c. blocking capacitor. The amplified r.f. signal appears at the collector and finding its path blocked by the inductance of T1, passes through C2. Now C2 and L3 are chosen so that they form a tuned circuit, which is slightly damped by the other parts of the circuit, and it encourages the r.f. through it. The diode D1 detects this signal and after being smoothed by C1 passes to the base of Tr1. The amplified a.f. signal appears at the collector and T1 acts as the load, transforms it and feeds it to the speaker. C2 is too low in value to pass much a.f. but any that does is taken straight to the earthy side of the circuit by L3. R1 provides the bias for the transistor and will vary with the one chosen; it is best found by experiment but will probably lie between 47kΩ and 1MΩ.

COMPONENT NOTES

Almost any m.w. ferrite rod aerial may be used but the larger the better. If you want to wind your own, the aerial winding should consist of about 70 turns and the secondary, wound either beside or on top, of about 7 turns. Any transistor output transformer will suffice for T1, most of these are centre tapped but this should be ignored. L3 is the primary of an i.f. transformer; take off the can protecting this and cut off the small capacitor if one is fitted; in this case the centre tap and secondary are ignored. The larger the loudspeaker the better and although sufficient volume is obtained with a 2in. speaker, the larger ones are far better. A volume control, if needed, is best fitted across the secondary of the output transformer—a 10Ω pot should do. If this were fitted into any other part of the circuit it would affect the working conditions.

★ components list

R1—see text	T1 Transistor output transformer
C1 0·04μF	L3 i.f. transformer
C2 100pF	Ferrite rod with m.w. winding
VC1 250pF variable	9V battery, loudspeaker, Paxolin board
VC2—see text	
Tr1 2N2926 or similar	
D1 OA70, OA79, OA81 etc	

CONSTRUCTION

Care must be taken in the layout. Owing to the very high gain it is easy for the circuit to break into oscillation and L3 must be kept well away from L1 and L2 and the collector of Tr1 must be away from the aerial coil. This explains VC2; regeneration can be applied by feeding a tiny part of the signal back to the aerial coil, but the value of such a capacitor will be in the order of 0·5pF and its value is critical. It is best to keep the two apart as much as possible and then with a wire fixed to Tr1 collector to lay this near the winding. If the radio fails to oscillate reverse the connections of L2. If Veroboard is used even the capacitance between the strips may send it into uncontrolled oscillation.

The current consumption is between 4mA and 15mA and a battery should last a fair while under these conditions.

After switching on, adjust the core in L3 for best results over the section of the band you will normally be using. ■

P.W. GUIDE TO COMPONENTS

PART 10

M. K. TITMAN, B.Sc. (Eng)

Part 9 last month dealt with temperature-sensitive transducers. This month a number of transducers sensitive to other physical effects are described.

Proximity Detectors

Proximity detectors are used to sense mechanical changes in objects, including the measurement of length, position and movement. Among the most prominent components used for these applications are microswitches, reed relays, capacitive and inductive probes.

Microswitches

The simplest form of proximity detector is the mechanically operated microswitch and these devices are widely used for control and safety applications. Basically they are mechanical switches operated by a small movement of a plunger and a typical microswitch is illustrated in Fig. 8. Single or double contact

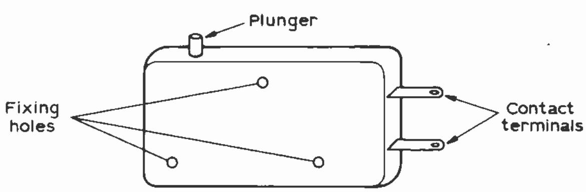


Fig. 8: Typical microswitch.

versions are available including normally open, normally closed or changeover. The contact is usually made by a wiping action rather than a contact closure as in relays and thus microswitches tend to be self cleaning and consequently more reliable. The actual movement is a sprung snap action which generally requires a small button plunger movement of less than 0·1in.

Most microswitches are available with various add-on lever movements for depressing the button and some are also available for rotary activation. These are illustrated in Fig. 9 and can usually be modified by the designer to fit a particular requirement.

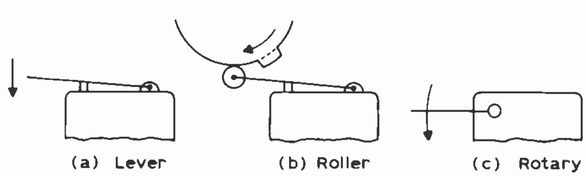


Fig. 9: Microswitch movements.

As the force requirement to operate the button is usually from 2oz. to 10oz. for small microswitches, the mechanical advantage of a lever allows extremely sensitive, low force operation. Indeed low torque devices requiring torques of less than 1oz. are available.

Contacts are usually of silver or gold and in common with relays maximum current and voltage ratings are given. However it must be remembered that the actual power which can be reliably switched is considerably less than the product of these two maximum ratings. Maximum contact ratings vary from 0.2A, 250V d.c. and 2A, 250V a.c. to 1A, 250V d.c. and 10A, 250V a.c. Power levels for these contacts would generally be 20W and 100W respectively for reliable operation. Contact and mechanical life are generally 10^5 to 10^6 operations.

Since microswitches are mechanical in operation they are inherently unreliable components as they have a definite lifetime. However they are widely available at prices from 5s. to 20s. for domestic types, to 10s. to £10 for robust and special purpose industrial units. Disadvantages include the low speed of operation—usually less than 500 operations per minute—and the switch bounce associated with contact closure. Operating time including snap action and switch bounce is usually 5-15msecs.

Microswitches are used in electronic equipment for safety applications such as the disconnection of dangerous h.t. voltages when panels and casings are removed and also as the switching element of push buttons. They are particularly suitable for button arrays where their size contributes to high button density on front panels. In domestic and industrial applications they are used to sense the closure of doors and guards and as limit switches for machinery.

Reed Relays

Reed relays in conjunction with permanent magnets are being used increasingly in applications where high reliability and noncontact conditions are required. Since the construction, rating and design limitations of reed relays have been discussed in Part 7 in this series we will consider only the transducer aspects of their operation.

The reed operation when activated by a permanent magnet is shown in Fig. 10. It should be noted that the axis of the magnet should be in the same plane as the reed axis for correct operation. As the magnet approaches the reed the contact is closed (Fig. 10(a)) and the minimum distance for reliable operation for a given magnet and reed is termed the just operate distance. When the magnet moves away

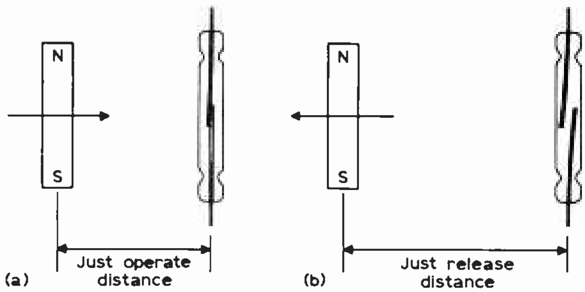


Fig. 10: Reed relay operation.

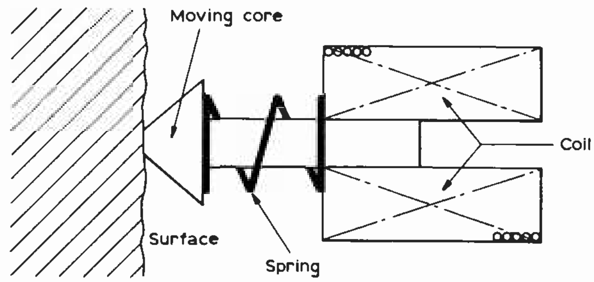


Fig. 12: Inductive proximity transducer.

from the reed the contact opens (Fig. 10(b)) and this distance is known as the just release distance and is greater than the just operate distance. Typical spacings are 0·2-0·4in. and 0·3-0·6in., just operate and release distances respectively, for small 0·2in. diameter, 1in. long magnets and average reeds to 1-2in. for larger 0·5in. diameter 2in. long magnets.

Permanent magnet and reed combinations are used as proximity detectors for applications where high speed switching or noncontact operation is required or for high reliability. Reed switching times are an order better than microswitches at 1-5msecs and operating rates are higher with maximum greater than 100 operations per second. Lifetime is also increased to 10^7-10^8 operations, however the contact ratings are considerably reduced at 3-10W.

Capacitance Probes

Whilst capacitance probes are not generally available as components they are useful as proximity detectors particularly for metal detection. They consist of a plate connected to an oscillator circuit whose capacitance, with respect to the earthed object being detected, increases as the probe approaches. This alters the oscillator frequency and by feeding into a tuned circuit and detection stage a voltage variation is achieved which can operate a meter or switch a relay. The operation is illustrated in the block diagram of Fig. 11.

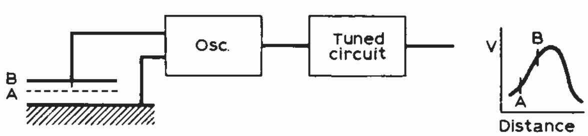


Fig. 11: Capacitance probe system.

The advantage of this form of proximity detector is that a proportional signal results and can be used for measurement and in addition the probe is very robust and easily constructed. Disadvantages are that the probe requires additional circuitry for control purposes and can be affected by atmospheric conditions such as humidity.

Inductive Probes

Inductive probes are used for precise linear measurement and a typical probe is shown in Fig. 12. The inductance of the coil is varied by the movement of the plunger which moves the coil core. The inductance variation is used to vary the frequency of an oscillator and the frequency variation is monitored by a frequency to d.c. converter. Hence a proportional signal can be achieved and used for position or thickness measurement. The spring loading of the plunger allows a continuous surface or thickness variation measurement to be made.

Such transducers are generally used for fine linear measurement in the region of 0·001in. to 0·02in. Consequently they are precision made and extremely expensive. They are not robust and consequently are not generally used for control applications.

Pressure Transducers

By far the most interesting pressure transducers to the electronic engineer are those used for sensing and producing acoustical air pressure variations. However since loudspeakers and microphones have been discussed in a previous part in this series no further discussion is necessary. The remaining pressure transducers are not generally used in electronic equipment as components and have specialist applications only. Consequently they will be discussed only briefly.

Mechanical Pressure Transducers

Standard pressure gauges are used as electrical transducers when fitted with electrical contacts, mechanically operated. Two basic configurations are used as illustrated in Fig. 13. The Bourdon pressure gauge consists of an elliptical cross-section tube which tends to uncoil as the pressure increases and this results in the pointer moving: at a specific point the contacts close. Both normally-open and normally-closed versions are available as well as changeover types.

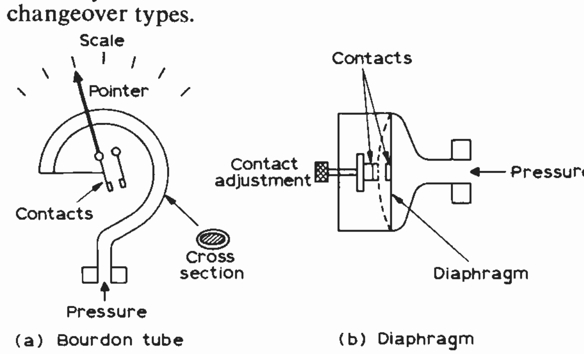


Fig. 13: Mechanical pressure gauge and transducer.

The diaphragm pressure gauge is the basis for most pressure transducers and in Fig. 13(b) the electrical output is obtained from contacts which close when a pressure increase forces the diaphragm outward. Adjustment of the pressure at which the contacts close is achieved by screw adjustment of the contact. Since the diaphragm displacement is proportional to pressure any form of linear displacement transducer may be used. The basic methods used however are: the alteration in air gap of a transformer which gives a variation in transformer output; the resistance method in which carbon piles are used and connected in bridge form with resistors to give a balanced output; and the piezoelectric method which uses changes in the characteristic of a crystal and hence an oscillator frequency to give the required output variation.

Many miniature pressure transducers utilise a semiconductor strain gauge element connected as a bridge to give a proportional electrical output signal. Such a device is illustrated in Fig. 14. The pressure

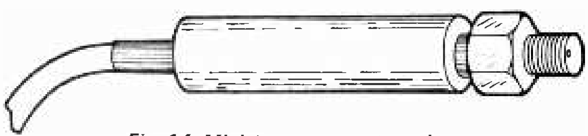


Fig. 14: Miniature pressure transducer.

range for all these devices is dependent largely upon the mechanical properties of the diaphragm and varies from 0-10 p.s.i. to 0-1000 p.s.i. Prices vary considerably and are generally in the range £5-£50.

Load Cells

Load cells are basically diaphragm pressure gauges using piezoelectric, semiconductor strain gauge or potentiometric electrical outputs for the direct measurement of force or weight. Such devices are generally available in miniature form at prices from £5 to £25.

Light Operated Transducers

Since light operated transducers can be used in a wide range of measurement and control applications a very large number of devices is available. The applications include density measurement and control, colour matching and mixing, exposure meters, counting and pulse speed measurement and control, proximity detection, infra-red sensing and security applications. Three basic types of photoelectric cell are used and these are known as photovoltaic devices, photoemissive cells and photoconductive elements.

Photovoltaic Devices

These are essentially e.m.f. generators and are the only devices which do not require an externally applied voltage. The voltage generated across the cell terminals is proportional to the light intensity and although small can be used to drive a current meter since it is generated at low source impedance.

Selenium Cells

The selenium cell is one of the most widely used light sensing mechanisms especially since its spectral response is very like that of the human eye. The response peaks in the region of yellow-green and falls off in infra-red and ultra-violet.

The construction of a selenium photovoltaic cell is illustrated in Fig. 15. The selenium is spread whilst

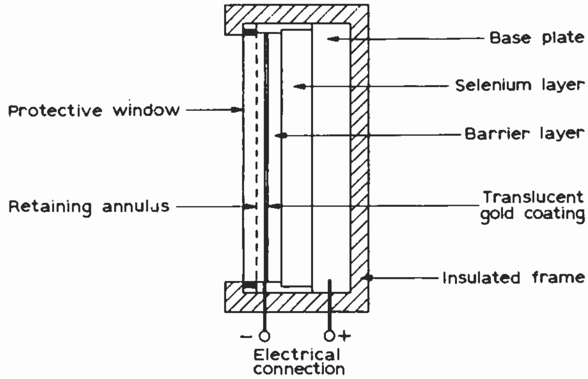


Fig. 15: Selenium photocell construction.

molten across an aluminium base plate and then annealed. The annealing produces a barrier layer on the surface on to which is deposited an extremely thin layer of gold to form a translucent surface electrode. The surface is then protected by a transparent glass or plastic window. Since the voltage is produced by light impinging on the selenium surface the cell is essentially a surface operated device and for high power output levels a large surface area is required. This can be an advantage in some applications since it can average light intensity over a large surface.

The mechanism by which the e.m.f. is generated depends upon the semiconductor characteristics of the device. The barrier layer formed on the surface of the selenium produces a barrier potential between the translucent conductor and the selenium and this is broken down by photon bombardment: the greater the light intensity the greater the breakdown and consequently the higher the e.m.f. produced. Since the impedance is low only low e.m.f. levels are generated but the current is sufficiently large to drive sensitive current galvanometers. Alternatively the e.m.f. can be amplified to give reading and control signals. However the response characteristics can vary with external influences and with time and in consequence they are generally only used for non-critical measurements and control functions. Another disadvantage is that the cells suffer from fatigue when subjected to light for long periods.

Selenium cells are widely available at prices ranging from 10s. to £5 depending on construction and size. They are also available in multifocus panel form and as simple panels. The are fairly large and commonly 1in. square or larger in panel size since they are primarily intended to give direct readings of light intensity to galvanometers.

Photovoltaic cells are also manufactured using alternative semiconductor materials in order to operate in other spectral regions. Notable amongst these materials are cuprous oxide and iron selenide. Another important device is the gallium arsenide photovoltaic detector which has an extremely high amplification factor and is considerably more sensitive than photomultipliers. These devices do not suffer from lack of sensitivity at high light levels and can operate at temperatures in excess of 100°C. They are however very expensive.

Photoemissive Devices

Photoemissive devices are valve-like structures in which the flow of electrons is regulated by the light intensity on the cathode. The cathode is surfaced with a light sensitive material such as caesium, which when bombarded with photons releases electrons which are attracted to the anode which is maintained at a high positive potential. Figure 16 illustrates this construction and the circuit shows the load resistor. The assembly is encapsulated in a glass envelope and is either evacuated or filled with an inert gas such as argon.

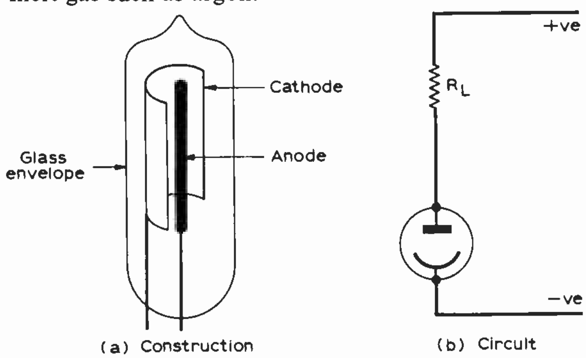


Fig. 16: The photoemissive valve.

The vacuum photocell is used for precision luminosity measurements since the current flow is independent of anode voltage provided this is maintained at a sufficiently high level to catch all the electrons emitted from the cathode. The current is also linear with light intensity which makes it particularly suitable for critical measurement and indication. A further important advantage is that the vacuum cell can operate at frequencies up to 10MHz.

The gas filled photoemissive cell operates in the same manner as the vacuum cell but providing the anode is at a sufficiently high potential electron collisions with the ionised gas particles releases further electrons. Consequently a current magnification is achieved and a magnification of 10 is possible. However these cells suffer from lack of linearity and are limited to operating frequencies below 10kHz.

The spectral response depends upon the cathode material and response peaks from the infra-red region (caesium on silver oxide) to the ultra-violet (caesium antimony) can be obtained. Disadvantages of this type of device are generally due to their large size and relative fragility. They are widely available at prices ranging from £1 to £15.

Photoconductive Elements

These are basically light dependent resistors of which cadmium sulphide and cadmium selenium cells are widely used. Most of the photovoltaic devices can also be used in conductive modes of operation such as selenium and silicon. A typical miniature cadmium sulphide cell is illustrated in Fig. 17 and the deposited CdS track can clearly be seen.

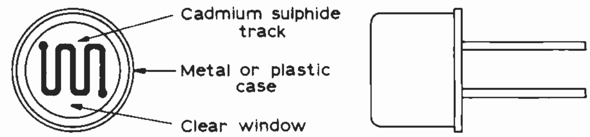


Fig. 17: The cadmium sulphide cell.

When no light reaches the conductive element the resistance is high and this is known as the dark resistance and the minimum value for a particular device is quoted. Typical values are from 100kΩ to 10MΩ. The resistance decreases rapidly with light intensity falling to values of from 50Ω to 2kΩ. Since they are capable of high power dissipation—from 200mW to 1W—they can be used at current levels which are sufficient to drive meter movements or relays. Consequently they can be used in conjunction with low voltage batteries in direct control systems, for example the automatic exposure control of cameras. They are also small and very robust which makes them particularly suitable for portable apparatus.

The spectral response is generally biased towards the red and infra-red regions but covers the visible spectrum. The peak is in the orange-red region. However since the response continues into the infra-red region precautions must be taken when this is not required. The operating temperature range is wide and −40°C to +70°C is normal. Cadmium sulphide cells are readily available at prices ranging from 5s. to 40s. and are available with either end view operation, as illustrated, or with side view. The variation in price is determined largely by method of construction and quantity requirements.

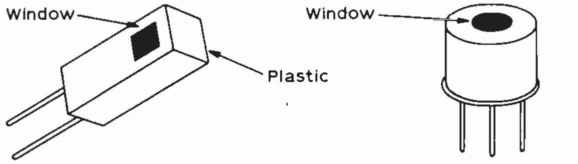
Photodiodes and Phototransistors

The photodiode is essentially a photovoltaic device since it operates by current flow due to incident light breaking down the barrier potential of the diode junction. However since the current flow is dependent upon light it can be operated in the photoconductive mode. Both germanium and silicon photodiodes are available but silicon devices have now largely superseded germanium devices due to the wider operating temperature range and increased power dissipation. In addition modern fabrication techniques have resulted in a higher frequency response of up to 150kHz compared with germanium devices having cut-off frequencies of 3-10kHz. The dark current is in the region of 50nA-10μA for silicon devices and 15-300μA for germanium.

The spectral response peaks in the red to infra-red region but covers the visible spectrum up to ultra-violet. Since the sensitivity is high in the infra-red region they can be used as infra-red detectors in such applications as fire and smoke detection.

The phototransistor is essentially a photodiode which amplifies the current generated at the base-emitter junction by incident light. Consequently the operation and spectral response are similar whilst the power output is considerably increased. The frequency response however tends to be limited and is usually less than 100kHz.

Figure 18 shows typical encapsulations for plastic encapsulated silicon diodes and transistors. Generally the lens is also of plastic, moulded to give the

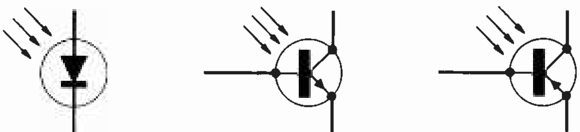


(a) Photodiode (b) Phototransistor

Fig. 18: Photodiode and phototransistor encapsulations.

correct focal characteristics. Glass encapsulations are used for applications where humidity is critical. The circuit symbols are shown in Fig. 19 for both p-n-p and n-p-n phototransistors.

Both photodiodes and phototransistors are readily available at prices ranging from 10s. to 60s. Multiple arrays for such purposes as computer character recognition and readouts are also available and the price depends largely upon the complexity. Photodiode and phototransistor arrays are now used for a large number of applications such as paper tape and card readers, interfaces and even in an extremely complicated matrix form as a television camera tube replacement.



(a) Photodiode (b) NPN phototransistor (c) PNP phototransistor

Fig. 19: Photodiode and phototransistor circuit symbols.

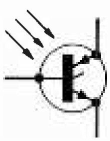


Fig. 20 (left): Circuit symbol for the light-activated s.c.r. (l.a.s.c.r.).

Light Activated S.C.R.

The gate diode of an s.c.r. can be operated by incident light by the same mechanism as the phototransistor and consequently these devices are a logical extension of phototransistor applications. Since the s.c.r. or thyristor behaves essentially as a switch these devices cannot be used for light intensity measurement but are extremely useful in power control circuits. Light activated s.c.r.s (l.a.s.c.r.) can directly switch power levels up to 2kW and are therefore the most powerful light operated component. They are used in industrial applications for motor and heat controls as well as high power lamp controls. The circuit symbol is shown in Fig. 20.

Since the applications of l.a.s.c.r.s are limited they tend to be relatively expensive control elements. Prices range from £2 to £20 and only a few of the major semiconductor suppliers manufacture them. However as their application becomes more widely known it is expected that prices will fall.

The Future

Transducers are perhaps one of the least known groups of electronic components in the electronic industry. Since they largely measure and monitor physical phenomena in fields unfamiliar to the electronic engineer this is to some extent understandable. Conversely as they are essentially electronic, engineers of other disciplines are likewise uninterested. However it is in this group of components that some of the most spectacular advances may be made, since they can be linked directly with electronic complexes such as computers. This should give increased stimulus to their development, particularly since the breakthrough of thyristors into the domestic equipment field will increasingly require direct transducer control.

Among the advances likely in the very near future are integrated circuit photodiode arrays to replace television camera tubes, especially for computer interface uses such as character recognition and drawn information. Similarly pressure sensing and temperature controlling elements will be incorporated in linear integrated circuits to give direct electronic outputs. All these advances will be stimulated by increased interest by electronic and other engineers and it is for this reason that an understanding of transducer mechanisms is essential in electronics today.

TO BE CONTINUED

BASIC SEMICONDUCTOR TECHNOLOGY

—continued from page 417

recrystallises into the main lattice. As the recrystallised germanium contains indium as an impurity it is of the p-type near to both of the indium dots. Consequently at the boundaries between each of the p-type zones and the n-type zones there are p-n junctions and the device is now a p-n-p alloy junction transistor. Fig. 3 shows the structure of such a p-n-p alloy transistor.

The two dots used for the emitter and collector regions are either punched from a very thin sheet of indium or else formed in small drops from molten indium. The collector is made several times larger than the emitter to improve the efficiency of collection of the holes injected into the base from the emitter. In this way only a small percentage of holes are lost by diffusion to the surface of the base region where they recombine with electrons on the surface.

In the alloy junction transistor difficulty is experienced in precisely controlling the width of the base region during manufacture. The slightest variation in the heating process can produce a base which is too wide or too narrow. If it is too wide the frequency characteristics of the device are poor because injected holes take a long time to cross to the collector junction, and also the alpha of the device will be reduced because the number of recombined holes increases with the transit time across the base. If the base is too thin the maximum voltage which can be applied to the base-collector junction will be reduced since if too large a voltage is applied the collector junction depletion layer will reach right through to the emitter and short out the transistor. This means that it is difficult to achieve a very close tolerance during manufacture and in many cases devices are prepared in families and selected into individual types after they have been completed. Finally, the device has leads attached and is then encapsulated in a suitable container depending on the power dissipation expected in the device.

Despite their limitations this type of transistor is used extensively in low frequency amplifiers, power control circuits and so on, although they are slowly being replaced by the newer epitaxial devices.

TO BE CONTINUED

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

Ex-Meter

Why do radio enthusiasts place the S meter so high in the list of receiver requirements? On tuning the bands, one so often hears remarks like, "... coming in S7 here, Jack ... using AR88 plus 40m dipole." Very well, Jack knows his signal is getting out, but he knows nothing about his *field strength* at that location. No doubt he and his contact both relate it with S readings, so they continue with the ragchew quite happily.

Looking closer at this business, we find that on a receiver, when a particular level of signal is present at the aerial terminal, a particular reading is given on the S meter; but this is *only* true if the r.f., i.f., and aerial atten. circuits are in the same condition as when the S meter was calibrated, i.e. all gains unchanged and all r.f. and i.f. circuits in tune. Even with such a receiver, we find that different aerials will give different S readings for the same field strength. To give useful signal strength information to a contact, all front end controls must be set to maximum gain, and average S meter reading taken over a short period, and the result sent back with full details of the aerial type, length, height, direction along with details of its special peculiarities due to surrounding objects. From what I hear on the bands, nothing approaching this is given, which is understandable. Personally I dislike touching the controls after reaching a good balance between r.f., i.f., and a.f. gains. I am not against operators having a rough guess at the signal strength, but am merely pointing out that there is no need for a S meter. If one wants to start using instruments then use a proper field strength meter and give the figures in volts/metre—not in meaningless S units.

Someone may say "Well I use the S meter to find a peak while tuning in weak signals". Speaking for myself, I have rarely come across any DX which did not require slight offset tuning to avoid adjacent channel interference or to increase intelligibility.

Take my advice, disconnect that worthless gadget, add a switch and a shunt, and use it to measure something worthwhile—like the h.t. current in each section!—**R. Mitchell** *(Glasgow)*.

Take 20

I have built the electronic organ by Julian Anderson (August issue) and while I am extremely pleased with the results, I feel that the claim that it can be built for twenty shillings is highly misleading as my components cost 39s., the 2N2646 alone cost 16s!

I realise one can buy components at one shop cheaper than at another, but the differences are small. Would it not be better for the author to either confine himself to the limit or to change the title of the series?—**S. King** *(York)*.

The author replies

The business of costing projects is very difficult and this is why prices are rarely given. The object of Take 20 is to provide each month a simple constructional project which will fall within the pocket of most readers. I am sorry that Mr. King had to pay 39s. for his components but I can assure him that this project was costed out from components available from advertisers in PRACTICAL WIRELESS. *In the August issue OC81 transistors were advertised for prices between 2s. and 5s. (excluding untested cheaper ones). Many shops charge 6d. for resistors yet the same ones are available for under 2d. from other advertisers.*

The reasons for these price differences are not usually due to one retailer making a thumping great profit but because a lot of the components sold are surplus in one form or another.

Because of this readers are well advised to obtain as many lists and catalogues as possible, especially if component cost is a major consideration in whether to build a project or not.

Can I take this opportunity to thank all the readers who have written to me on Take 20 giving various suggestions—these are genuinely welcome especially the ones asking for particular projects.—Julian Anderson.

Availability of Integrated Circuits

We continually hear that new integrated circuits are being introduced and that soon most constructional projects will be based on them.

Your excellent magazine has given a number of circuits utilising i.c.s. yet the component stockists in my area do not have them and I am told that manufacturers are reluctant to make these generally available.

I wonder why this is so? I am sure that in the past amateurs like the readers of P.W. have contributed to the growth of the electronics industry, why should we now be deprived of the latest devices for experimenting?—**J. Pope** *(London E.12)*.

Jack's alright

I agree in the main with your comments in the June leader, although I would prefer to see your magazine carry on using cycles. However, one point which did strike me was your comment on DIN plugs. As one who has spent many hours making special leads and soldering phono plugs I see a need for standardisation. However, I wonder why not the GPO Jack, which has been used by the BBC and others for years. The two versions, two way and three way, provide most normally needed connections, in addition to which they are very strong, easy to fit and enable switched sockets to be used. Equivalent DIN plugs and sockets are also usually at least 2s. more than their counterpart jack sockets.—**R. J. Paulton** *(Birmingham, 26)*.

Old Name?

I wonder how many readers have thought about the name Practical Wireless? "Wireless" as a word has almost fallen from our vocabulary and "Radio" has taken its place, yet our most progressive magazine sticks to its title. I am not complaining, in fact I think it is rather a pleasant link with the early days—but it is a bit odd isn't it?—**K. Matthews** *(Cambridge)*.

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

Can't stand the din!

Whilst agreeing with most of your June editorial concerning changing standards your appraisal of the DIN plug does nothing but arouse my utmost wrath.

Admittedly the "dreaded DIN plug" does have the advantage of multiple connections compared with, for example, that other horror, the cheap 'n' nasty phono plug. However just thinking about all those close packed pins waiting for the stray strand of wire or blob of solder to short them out makes me shudder, not to mention those two pieces of metal casing which will inevitably collapse between the fingers or that tenacious plastic cover which never budges an inch (sorry 25·4 mm!!) in an emergency. Even one of my friends—a most staunch supporter of the beast, was somewhat daunted when, after carefully rewiring all the DIN sockets on his tape recorder to the international convention, he found that the machine would not match anyone else's leads.

Anyone with any great respect for his equipment should stick to that good old stalwart, the *standard* jack plug. Reliable, almost indestructible and easy to connect, with switched sockets, screening and 3-way (stereo) systems all easily available this is quite simply unbeatable. And if this is a little on the expensive side another frequently neglected plug (and, incidentally, the only other species known to survive a year of university parties, dances and amateur dramatics!) is the metal TV co-ax plug, which I and several friends have *independently* concluded to be the next best thing, both on grounds of performance, availability and cheapness.

So all I have left to say to you, DIN plug is go home and never darken these shores again!—**J. Dowson** *(Trinity College, Cambridge).*

★ ★ ★

It is with regret that I see you are lending your support to the abominable DIN plug system. The spread of these connectors is one more example of the current trend towards choosing the worst conceivable alternative and making it a "standard"; a trend which has already given us meaningless mains flex coding and an inconvenient unit of length (millimetres, used for dimensions of cabinets), and will doubtless introduce peak music power before long.

Quite apart from the poor construction, reliability and endurance of the DIN plugs available at present—a thing which could be remedied—the system possesses inherent faults. The plugs must be angularly aligned, which in their usual inaccessible position is difficult. The simultaneous use of different pins results in a loss of versatility. Some twelve different plugs exist, which makes separate leads necessary for each function even when functions are not required together; and within the common five-pin 180° plug, variations are still necessary to accommodate the morass of reversed connections, pin bridges and series resistors. Did somebody say *standard?*—**R. A. Lyons** *(Reading, Berkshire).*

[We agree that the DIN plug system is not perfect but at least it is a standard—something that UK audio manufacturers have not bothered to devise as yet.—Editor.]

No Mars bar here

Now you DX experts, having on your splendid equipment received hosts of stations, look about 11 pm towards the east! There is a splendid prize for you, the acme of man's most earnest endeavours, to contact any intelligent beings, outside his own planet. It is the red planet Mars!

I believe that Lowell's ideas are nearer the truth even today, than are all those of his opponents! I am convinced there are a few Martians left, safely ensconced within some great castle-like refuges, inside covered craters.

Go down the garden path to your quiet den. Put on your phones. At once the sweet silence is subdued by babel. Yet may there not still be some small unexplored "windows"? Through one of these a clattering, staccato, intensive message may be received? The well informed operator will know it can be from nowhere on earth. He will be the lucky guy to receive the first "message from Mars!"

During the quite early days of wireless, during Martian oppositions, there were quite earnest and some even desperate attempts to contact Mars. "Popular Wireless" even made a 24-valve set as early as 1924. The results were rather inconclusive. Some people actually claimed to have received signals; even the great Marconi did! Nothing however could be proved absolutely. Equipment today is so much more powerful, that success may be at last attained!

With my little one to four valve sets I myself have tried. My finest results have generally ended with a sweet little voice announcing, "this is Sydney, etc, etc." That however was a well worth while achievement. — **A. Trowbridge** *(Middlesex).*

The secret of success

I'm in rather a desperate situation at the moment and I wonder if any of your readers could help?

Having used valves in all my constructional projects up till now I have been blessed with about 99% success, but being more and more tempted by gleaming transistors (and incidentally the almost complete absence of valve designs in P.W.) I decided to have a go with semiconductors. So far I have attempted about a dozen designs of one sort and another and the only one that worked was a crystal set!

My latest project has been a complementary push-pull amplifier—could I get anything out of it?—not a !!!! I adjusted biasing resistors, substituted transistors, checked the wiring till I was blue in the face and I still couldn't even get a mA of quiescent current. Meanwhile my friends design these contraptions, which always work perfectly, and then even sell their designs but still not a sausage out of my own designs.

Please, what is the secret?—**Richard Ross** *(Warwickshire).*

60 r.p.m. Geared Motor. This is a powerful unit, driven by a mains motor of similar type to, but rather larger than the average Tape Deck or Record Player motor. The gear boxes may be detached. It is, in fact, a unit measuring approximately 3¾ x 2¼ x 1½in. thick. The final drive shaft is ¼in. wide, 1in. long. **35/-**

A Micro Meter bargain. Limited quantity only, centre zero 50–0–50 micro amps. This is a Weston Meter enclosed in clear perspex case for flush mounting. Dial size approximately 2¼in. wide. The scale is not engraved but has a red part in the centre and a green part to the left of centre. Scale could be cleaned off and re-written to suit your particular requirements. Regular price probably over £5 each, our price **29/6** each.

Battery Record Player. Made by Collaro. This is made up on a unit plate with speed selector and pick-up. The turntable is a heavy one and measures approximately 9½ins. Pick-up is fitted with the famous "Studio" cartridge. Price **69/6**, postage and insurance 6/6.

E.H.T. Condenser. 28Kv. 0·0011 mfd. Suitable for transmitting test conditions 6A at 300k/c. Bakelite case. **18/6** each.

85 Watt Tubular Element. Very well made unit. The element is wound on a porcelain former then encased in a brass tube terminated with beaded leads 12in. long. Normal mains voltage. Price **5/-** each or **54/-** per doz.

Press to Make Switch. Double pole, 5 amp contacts or can be used as single pole, 10 amp, contacts 250 volt working. Single hole fixing. **2/6** each, **24/-** dozen.

Door Switch. Contacts open when plunger is depressed. Prevents lights being left on. 15 amp contacts, 230 volt working. Made by Arrow. **3/6** each, **36/-** per dozen.

Rotary Appliance Switch. 16 amp, 230 volt on moulded ceramic base. Operated by pointer knob (not supplied). **2/-** each, **18/-** per dozen.

1/40th h.p. Motor. Made by the French (Cassor) Company. This is an excellent totally enclosed motor, powerful enough to operate small lathe, drilling machine, washing machine, etc. It's speed is 1,450 r.p.m. Made for normal 50 cycle, 230/250 volts mains, totally enclosed, size 2¼ x 3¼in. dia. with 1in. of ¼in. spindle. Price **19/6** plus 4/6 postage and insurance.

Burglar Alarm Kit. Protect your home and family by frightening away the intruder. With our circuit a mains operated bell rings loudly directly the door or window is opened. Kit comprises 12 reed switches, 12 magnets, relay, mains transformer and bell with circuit. Price **49/6**.

NICAD RECHARGEABLE BATTERIES

3·6V 500mA size 1¾ x 1⅜in. dia. type ref DKZ500. Really powerful, will deliver 1 amp for ½ hour. Regular price 32/6. Our price **17/6** each. New and guaranteed. Other voltages available, single cell 1·2V **6/6**. 10 cell 12V **65/-**.

ELECTRIC CLOCK WITH 25 AMP SWITCH

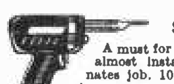
Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6**, less than the value of the clock alone—post and insurance 2/9.

INDICATOR LAMP

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

BECKASTAT

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



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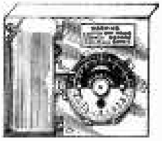

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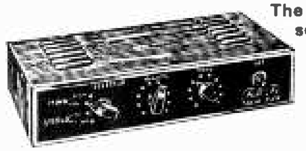

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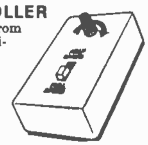

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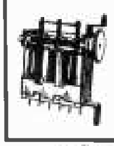

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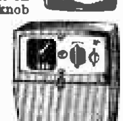

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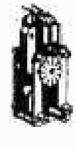

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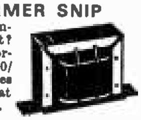

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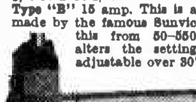

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a beginner's TRANSISTOR CAPACITANCE BRIDGE

PART 1

A NUMBER of useful LCR bridges suitable for the home constructor have been described in the past, some with fairly complex circuitry, and therefore suitable as accurate laboratory standards. The author, however, felt the need for a quite simple instrument which would constitute a useful addition to the average home workshop. The present bridge was built up on Cir-kit board, with used components which were immediately to hand in the spares box. All parts can, of course, be purchased new if necessary.

Of the three constants, inductance, capacitance, and resistance, commonly encountered in electronic circuits the one most likely to require test facilities which are not immediately available is capacitance. Generally, coils and resistors can be satisfactorily tested, at least for continuity and resistance, with a good ohmmeter. Even larger value electrolytic capacitors of 16μF and above can be roughly examined in this way, by comparing the size of the "flick" registered on the ohmmeter due to the charging current with that shown by a sound capacitor. D.c. leakage is, in this case, detected by the presence of a steady current, or a fixed value of high resistance, which is generally greater in one direction than the other. It is when dealing with small values of capacitor, in the range, say, from 10pF up to a few microfarads, that difficulties may be encountered with the usual meter tests, and it is therefore in this range that the present instrument fulfils its most useful purpose.

While the bridge principle will probably be familiar to experienced constructors, a brief summary of the basic principles involved may not be out of place for those encountering this type of circuit for the first time. Referring to Fig. 1, a typical

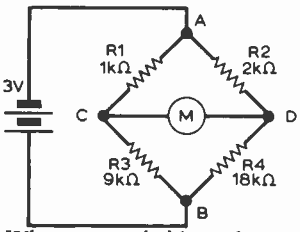

Fig. 1: A basic Wheatstone bridge.

Wheatstone bridge, the application of a voltage of, for example, 3V, between points A and B results in no voltage appearing across C and D with the values of resistance shown, so that no reading is shown on the meter, M. This is because the bridge is in what is known as the "balanced state". In actual fact, the voltages at C and D are each 0.3V with respect to A, and are therefore zero with respect to each other. The circuit would now become unbalanced if, for example, resistance R2 were replaced by either a higher or lower value. In these cases, the voltage at D would differ from that at C, and this unbalance would be registered by a reading on the meter.

A little consideration will show that, in Fig. 1, the condition of balance is obtained when $\frac{R1}{R2}=\frac{R3}{R4}$ so that $R1=\frac{R2 \times R3}{R4}$ when the bridge is in balance. This basic circuit can, therefore, be used to determine the value of an unknown resistance when the other three are known.

If we now replace R3 and R4 by capacitors, and the source by an alternating voltage, the circuit becomes that of Fig. 2, where, in the unbalanced state, an a.c. signal appears between C and D, resulting in an audible note in the headphones, H.

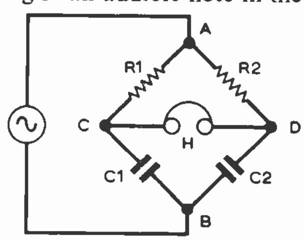

Fig. 2: A Wheatstone bridge adapted for reactance balancing, using an a.c. source and headphones for detecting balance.

Now, let us consider how to use this arrangement to determine the value of an unknown capacitor. If R1=R2, by making the unknown capacitor C1 in the figure and substituting different values in turn for C2, we would eventually achieve a balanced state (as indicated by silence on the phones) when C1=C2, as only then would the above ratios be equal. Note that the resistance of a capacitor to d.c. is inversely proportional to its capacitance. Obviously, this would be a rather clumsy procedure, and a much better scheme is to fix C2 at some convenient value, not greatly differing from the expected value of C1, and make one of the resistors variable. This will enable an equally satisfactory condition of balance to be obtained. Then, by measuring the value of the resistance at this balance point, and either having a calibrated scale, or calculating from the above equation, the value of C1 can be determined. In practice, since we wish to be able to carry out measurements over quite a wide range of capacities, C2 becomes a switched bank of capacitors increasing in steps of 10 from 10pF to 100μF. In this way, capacitors from 1pF to 100μF can be tested, and measurements carried out on cable and even valve inter-electrode capacitances. Some typical applications are discussed at the end of the article.

To return to the circuit of Fig. 2, this could be made the basis of a very simple bridge, merely by employing a 50 Hz mains input (obtained, for example, from the secondary of a mains transformer), retaining the headphones for detection purposes. However, the slightly more elaborate arrangement employed in the present bridge, as shown schematically in Fig. 3, was considered well worth while. The three main sections are an audio oscillator, the bridge itself, and an audio amplifier feeding into an indicating meter. The choice of this arrangement has three advantages. First, the tester is completely portable, being operated from two 9V batteries; second, the operating frequency can be chosen to enable the most suitable resistance-reactance combination to be employed on all ranges; and third, by amplifying the signal following the bridge, the use of a meter becomes possible, enabling higher accuracy to be obtained than would be the case with a simple audio detector. A further advantage concerns the testing of a capacitor for leakage.

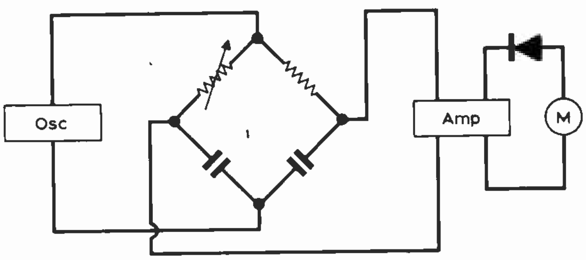

Fig. 3: A practical arrangement for a capacitance measuring bridge, with an amplifier and meter to give a more positive reading than Fig. 2.

This test is especially important in the case of the sub-miniature type of coupling capacitor (usually 4 or 8μF) used in transistor audio circuits, as a partially leaky component here can easily introduce sufficient bias voltage variation to ruin a transistor. The presence of leakage in a capacitor of this type is immediately indicated with the present instrument.

Oscillator and Amplifier

Figure 4 shows the oscillator circuit. Only one transistor is used, and the transformer can be any audio type which is conveniently to hand. Separate batteries are used for the oscillator and amplifier, so as to avoid unwanted feedback, or the effect of the signal being picked up directly from the oscillator instead of through the bridge. Since the instrument is a null-point detector, it can be realised that a small amount of pickup of this type would have a serious effect on accuracy. Using a separate battery also means that the oscillator portion can be checked immediately after construction, which, in any case, is advisable, for some adjustment to the values of R1 and C1 may have to be made if oscillation is difficult to obtain. If this is the case, try also reversing the connections to the windings of the audio transformer, or reversing the windings themselves. R1 and C1 will also vary the frequency, so these should be altered, if necessary, to provide a note of about 800

Hz indicated by headphones across R2. The current should be approximately 1mA. Headphones could be used directly to the bridge after this oscillator circuit, but some amplification enables a meter to be used, as already explained.

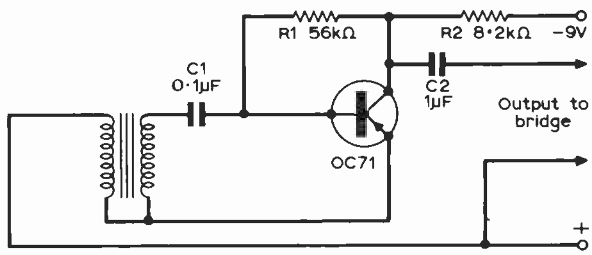

Fig. 4: A simple 800Hz audio oscillator suitable for driving a bridge.

A straightforward push-pull amplifier circuit was decided upon, as the transformers and transistors were available from an old amplifier which had just been dismantled. The circuit is shown in Fig. 5, and presents no novel features. It should be tested with a speaker first, by injecting a signal from any a.c. source. The no-signal current should be about 8mA. A diode in series with the secondary of the output transformer is used to rectify the d.c. signal and provide a d.c. voltage to operate the microammeter. In the original bridge, an army surplus moving-coil

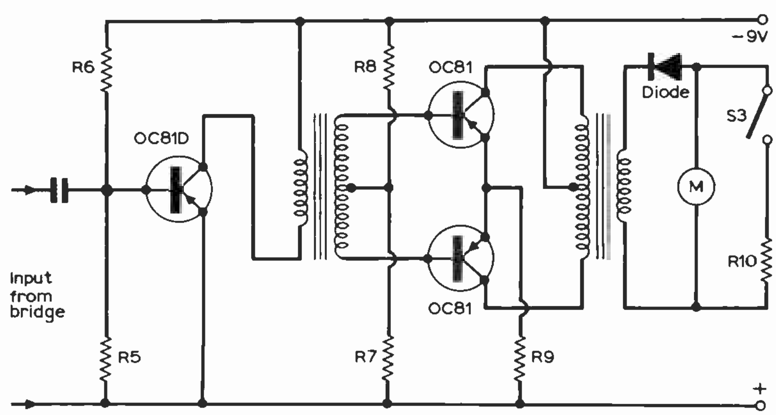

Fig. 5: A push-pull amplifier, detector and meter.

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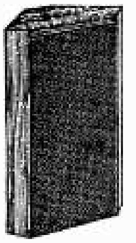

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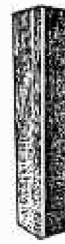

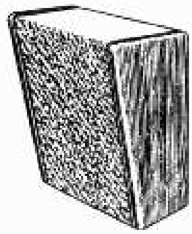

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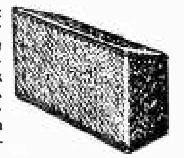

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AF115	7/–	OC35	11/6	OC75	6/–	OC81DM	6/–	OC170	7/–
AF116	7/–	OC44	4/6	OC76	6/–			OC171	8/–
AF117	7/–	OC45	4/–	OC77	8/–	OC82	6/–	OC200	7/6

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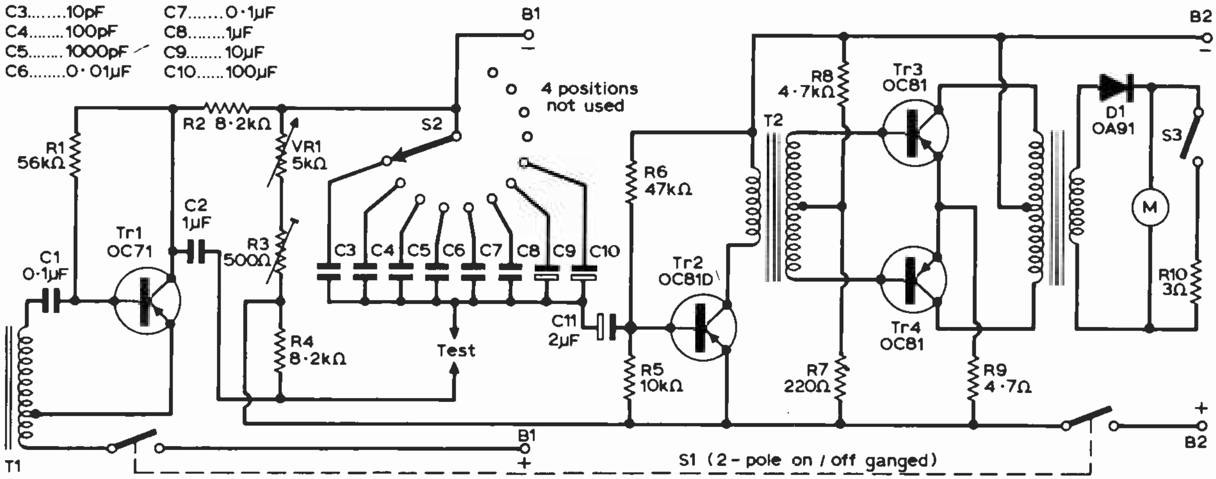


Fig. 6: The complete capacitance bridge capable of measuring from 1pF to 100μF. The accuracy of the bridge can be improved by decreasing the coverage of each range, revised component values being given in Table 1.

meter of 0·5mA (500mA) f.s.d. was used; constructional details are therefore given using this meter, but, if a commercial meter is preferred, the front panel cut-out can be modified accordingly (see Fig. 8).

The complete theoretical circuit is shown in Fig. 6. Note that a 3Ω resistor (R10) and switch (S3) are inserted so that the full-scale deflection can be reduced on the higher capacitance ranges, and the null-point dip more readily detected. This dip switch was purposely chosen to be a "push-push" type. Initially, the 3Ω shunt resistance is switched in to act as a shunt across the meter. This is the "safe" position, as the meter is protected from overloads imposed by the relatively large current on the higher ranges, the switch then being operated as the condition of balance is approached, to enable the dip to be detected more accurately. Since the on-off positions are not indicated, there is a natural tendency to return it to the "safe" position after use.

★ components list

Resistors:

R1	56kΩ	R7	220Ω
R2	8·2kΩ	R8	4·7kΩ
R3	500Ω preset	R9	4·7Ω
R4	8·2kΩ	R10	3Ω
R5	10kΩ	VR1	5kΩ log. pot.
R6	47kΩ		

Capacitors:

C1	0·1μF	C7	0·1μF
C2	1μF	C8	1μF
C3	10pF	C9	10μF
C4	100pF	C10	100μF
C5	1,000pF	C11	2μF
C6	0·01μF		

Semiconductors:

TR1	OC71	TR4	OC81
TR2	OC81D	D1	OA91
TR3	OC81		

Transformers:

T1 Intervalve transformer
T2 Driver transformer
T3 Output transformer

Miscellaneous:

B1, B2 PP3 or equiv.; M, Meter, 0–0·5mA; S1, two-pole on/off switch; S2, one-pole twelve-way wafer switch; S3, one-pole on/off switch.

Details of the Bridge Circuit itself

The bridge consists of variable resistor, VR1, which in association with the test capacitor, fixed resistors R3 and R4, and the switched bank C3-C10, constitute the balancing bridge circuit by means of which the null-point (dip) is obtained. A pointer knob and scale, graduated in capacitance from 1 to 10 are affixed to VR1. It was found originally that the readings of capacitance tended to be cramped to one end of the scale, and the pre-set resistor, R3, was therefore added in series with VR1. Although this does not completely prevent cramping, it does tend to distribute the readings more evenly over the entire scale. Once the optimum position for this pre-set has been determined, it can be waxed in position.

Since there is only one basic scale for all eight ranges, the fixed capacitors, C3-C10, must be chosen with care, so as to ensure reasonably correct agreement with the scale on all ranges. The use of close tolerance capacitors is one possible way of tackling this problem. However, the author considered this to be an unnecessary refinement in a bridge which is not, in fact, designed as an accurate standard, and finally the following compromise was adopted.

Consider three capacitors of the usual tolerance (5%) with a 10 times ratio in their values, e.g. 200, 2,000 and 20,000pF. On the ×100 range, with the first of these connected in the test position, the bridge should of course, register a null indication at a point corresponding to 2 on the capacitance scale. Let us assume that we start with a blank scale and a reasonably accurate capacitor bank, then this point can be pencilled in as 2, which, unless we were particularly unlucky in the choice of this first capacitor, ought to represent a reasonably correct marking. Now switch to the ×1 range, and substitute the 2,000pF capacitor which should result in a minimum reading at the same point on the scale. If it does not, vary C5 by substitution until the scale does register 2 at this point. Similarly, C6 on the ×10 range, using the third capacitor for testing, can be adjusted to give the correct reading. This procedure is repeated for all ranges. The author was fortunate in having a fairly large stock of capacitors. For the constructor lacking this facility, the use of close tolerance capacitors in the fixed bank might prove a better, and possibly cheaper, solution.

On some of the ranges, it may not be possible to obtain a reading in both the 1 and 10 positions on the scale, but, with the large coverage of the instrument, this is unavoidable. If the reader wishes to make a more accurate bridge, and is willing to accept reduced test facilities, say, equivalent to the first six ranges from 10pF to 1μF, this can be achieved by using the full number of positions in the range switch (which, in the original design, is a 12-pole type, with four poles unused. See Fig. 6), and reducing the capacitance coverage on each range by half. Suggested alterations to component values are given in Table 1.

Table I

Components	*Value for full range coverage*	*Value for half coverage*
C3–C10	10pF, 100pF etc.	10pF, 50pF, 100pF etc.
four additional capacitors	—	0·1μF, 0·5μF, 1μF, 5μF
VR1	5000Ω pot.	2000Ω pot.
R4	8·2kΩ	4·7kΩ

TO BE CONTINUED

M.W. DX RECEIVER—continued

gain controls for r.f., i.f. and a.f. The a.g.c. may be switched in or out and a b.f.o. is also available at the flick of a switch. The "s" meter may be zeroed and is useful for signal strength comparisons. The aerial circuitry is wired for a single wire feed, but by a simple modification can offer a balanced input. This will be useful for devices such as balanced loop aerials and the like.

TABLE I

Connection and colour codes for the IFA/1·6/SSB Mk II i.f. strip.

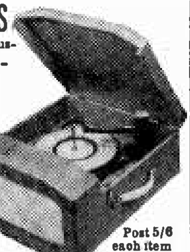
Connection Number	Function	Colour code
1	Input	Brown
2	Input (Earth)	Plain
3	"S" Meter	Plain
4	"S" Meter	Red
5	"S" Meter	Black
6	B.F.O. control	Plain
7	B.F.O. control	Orange
8	B.F.O. control	Yellow
9	A.G.C. on/off	Green
10	A.G.C. on/off	Blue
11	A.G.C. on/off	Violet
12	A.F. output	Grey
13	A.F. output (earth)	Plain
14	Negative line—12V	Black
15	Positive line (earth)	Plain
16	B.F.O. on/off	White
17	B.F.O. on/off	Black
18	I.F. gain	Black
19	I.F. gain	Pink

NOTE: All numbers without colour, i.e., plain, are connected to earth. All numbers coloured black are connected to the negative line.

Next month we will consider the construction of the receiver followed by the alignment procedure. A signal generator will be needed since the set must be aligned carefully because of the very narrow bandwidth of the i.f. strip.

TO BE CONTINUED

DE LUXE PLAYERS



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Garrard SP25 MkII	£13.19.6	MA70 Transcrip'n	£13.19.6
		Garrard 3000 with Sonotone 9TA Diamond	£12.19.6.

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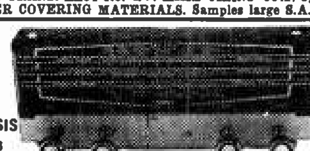

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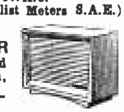

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J.E.BARRETT

A VERSATILE INTERCOM SYSTEM

PART 3

Two units on two-wire extension

It was found useful at a later stage to add a second extension to the two-wire extension so that incoming calls could be received by either extension and similarly outgoing calls could be made to the parent by either.

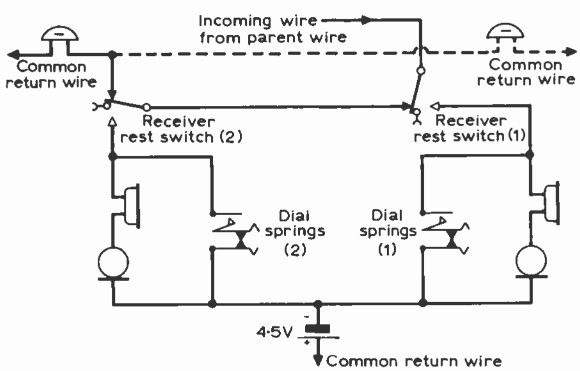

Fig 10: Two extensions having access to two-wire line to parent

Note that calls cannot be made from one extension to the other, since lifting the receiver of either extension cuts out the other. The circuitry is simple and involves the use of two GPO type dial phones. Only the dial springs and receiver rest switch are needed so the remainder of the equipment may be removed, the battery may be housed in either unit. If the units are in close proximity, only one bell will be required but an extra one may be added as shown if required.

Auto-extension

It was found convenient for an extension to call another unit without access to the parent unit. The block diagram in Fig. 11 clarifies this point.

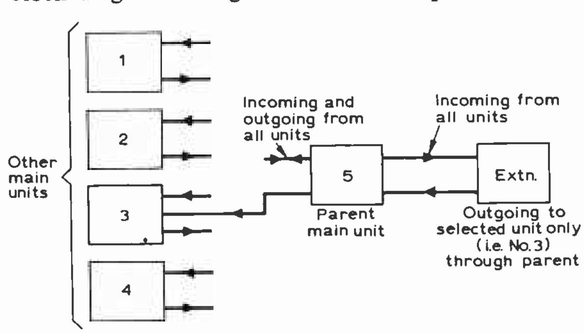

Fig. 11: Block diagram showing connection of auto-extension.

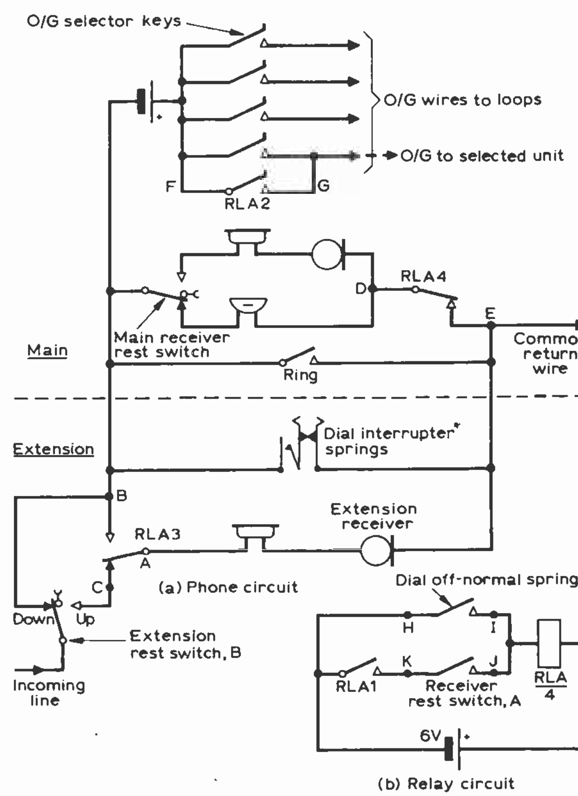

Fig. 12: Circuit diagram of auto-extension.

The extension is wired to the parent in such a way that dialling out from the extension causes the call to route to the prewired main unit. The facility is useful, for example, when the main unit is on a desk with the extension by the bed. The extension is a GPO dial phone, the circuit is shown in Fig. 12.

The relay, RLA, is operated from a 6V dry battery which, with moderate use, should last six months or more.

Lifting the receiver has no effect on the circuit at the moment. As soon as the dial is moved off normal, the contacts complete the circuit for RLA to the battery. RLA1 operates and latches the relay through the receiver rest switch A. RLA2 switches the outgoing line selector to the main unit being called (prewired) RLA4 operates to cut out the main unit

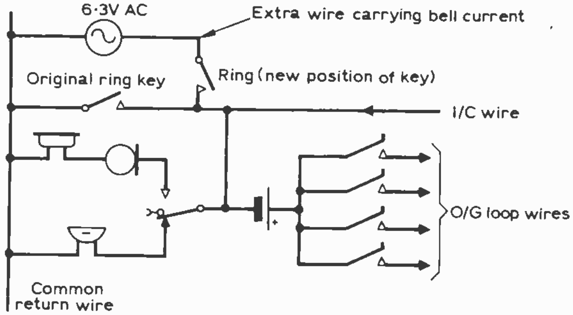

Fig. 13: Modification of circuit for a.c. ringing.

and a path is set up for the receiver through RLA3. When the dial is released, after dialling 0, ten pulses are sent along the outgoing loop wire to operate the buzzer at the distant end. Conversation may proceed on lifting the receiver of the called unit. At the termination of the call the relay, RLA, is de-operated by the receiver rest switch A when the receiver is replaced and all the contacts restore to normal.

If a large intercom is to be constructed for an office or small works, the reader may be interested in using a transformer to supply ringing current instead of relying on the 4·5V battery on which there is quite a considerable current drain during ringing. The part of the circuit to be modified is shown in Fig. 13. One side of the transformer (6·3V sec) is permanently connected to the common return wire and an extra wire carrying the ringing current is run with the loop wire. ■

PRACTICAL WIRELESS QUERY SERVICE

The PW Query Service is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot easily be solved by reference to standard text books. In order to prevent unnecessary disappointment, prospective users of the service should note that:

(a) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

(b) We cannot undertake to supply detailed information for converting war surplus equipment, or to supply circuitry.

(c) It is usually impossible to supply information on imported domestic equipment owing to the lack of details available.

(d) We regret we are unable to answer technical queries over the telephone.

(e) It helps us if queries are clear and concise.

***(f)* We cannot guarantee to answer any query not accompanied by the current query coupon and a stamped addressed envelope.**

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This coupon is available until 10th October, 1969 and must accompany all queries in accordance with the rules of our Query Service.

PRACTICAL WIRELESS, OCTOBER 1969

YOUR ? QUESTIONS ANSWERED

Altering Charging Rate

I have a battery charger that charges at 2 amps (12 volts). I also have a radio set (ex-army) that requires 12 volts plus 14V for the wobbulator network.

The battery I have six 2 volt batteries wired up together in series to give 12 volts. On the side of these batteries it has printed "...charge at 1 amp".

Is it possible to alter the charge from my battery charger from 2 amps to 1 amp?—H. Waite (Staffs).

In order to reduce the charging current of your battery charger, it will be necessary to add a resistor in series with one of the leads between the charger and the battery. The resistor will have a value of a few ohms only, but will need to be rated at a suitable wattage. The procedure is to connect an ammeter in the circuit and gradually reduce the value of the resistor until the charging current is 1 amp.

A.M., F.M. and S.S.B.

When one uses an a.m. transmitter, the books state that one transmits the r.f. carrier and also the sidebands. With an f.m. transmitter the frequency varies with the a.f. but I do not understand this with a.m.

If you could explain these things to me, I would be extremely enlightened about many radio topics, i.e., s.s.b.—H. Mason (Bolton).

It is really beyond the scope of a letter, and our query service, to examine a.m./f.m. transmission in detail, however, we hope the following will help regarding s.s.b.

Suppose the transmitter is operating on a frequency of 1,000kHz. Suppose also that the signal is modulated with an audio signal of 1kHz, say, a sine wave. It can be shown that there are now three frequencies involved apart from the 1kHz tone. These frequencies are: the 1,000kHz carrier, and two sidebands at 999kHz and 1,001kHz. The point to remember is that the carrier frequency of 1,000kHz is unaltered and this is the reason why, in single sideband (s.s.b.), it can be left out, although it must be reinserted at the receiver so that the information contained in the sidebands can be extracted. Again, since reception of either sideband will give exactly the same information, then one of the sidebands can be eliminated also which is what happens in s.s.b., both carrier and one sideband are removed.

CORRIGENDA

TAKE 20 No. 5 Transistor Tester Plus. Julian Anderson.

The author has drawn our attention to an error in the text of this article. R1 and R2 are referred to in the text as 330Ω; this should have read 330kΩ as in the circuit.

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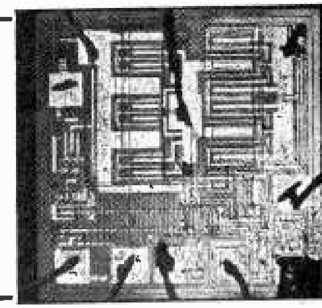
SINCLAIR
IC-10

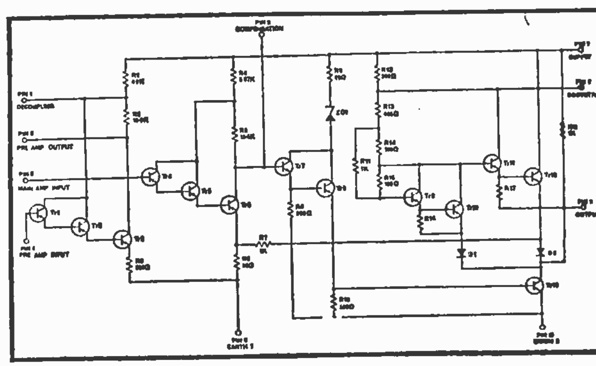
10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

Specifications

Power Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz$\pm$1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 x 0.4 x 0.2 inches.
Sensitivity	5 mV.
Input impedance	Adjustable externally up to 2.5 M ohms for above sensitivity.

ABOVE SHOWS ACTUAL SIZE OF IC-10.
TO RIGHT, VIEW OF AMPLIFIER MAGNIFIED 625 TIMES.





Circuit Description

The circuit diagram of the IC-10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.

Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

Applications

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud-hailers, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers.
The transistors in the IC-10 have cut off frequencies greater than 500 MHz so the pre-amp section can be used as an R.F. or I.F. amplifier making it possible to build complete radio receivers without any additional transistors.

SINCLAIR IC-10

The complete IC-10 with the manual and 5 year guarantee costs just

59/6

Post free

SINCLAIR RADIONICS LIMITED,
22 NEWMARKET ROAD, CAMBRIDGE
Telephone 0223 52996

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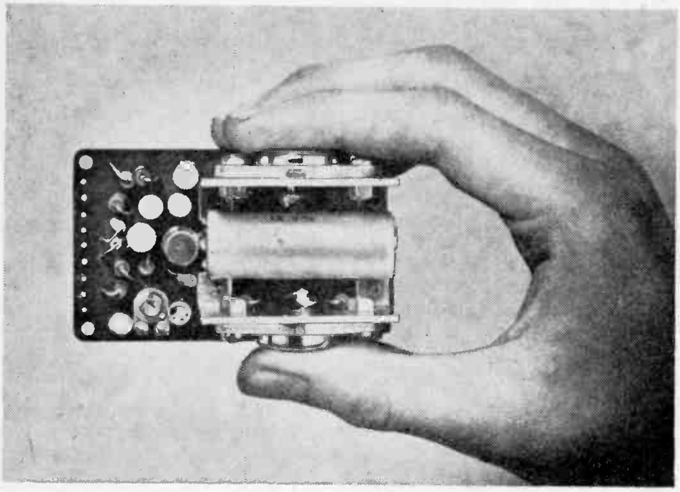
SINCLAIR Z.12 12 WATT INTEGRATED HI-FI AMPLIFIER & PRE AMP



12 watts R.M.S. continuous sine wave output

This is the recommended amplifier for those requiring greater power than that provided by the IC.10. This eight transistor amplifier is the most successful of its kind ever designed. It has an excellent power to size ratio and is easily adapted to a wide variety of applications. The Z.12 performs satisfactorily from a wide range of voltages and it can easily be run from car batteries. This true 12 watt amplifier comes to you ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo, when the Sinclair Stereo 25 will be found the ideal control unit for use with it.

Size—3in × 1¾in × 1¼in Class B Ultralinear Output: Frequency response from 15 to 15,000Hz ±1dB: Output suitable for loudspeakers from 3 to 15 ohms impedance Two 3 ohm speakers may be used in parallel: Input 2mV into 2K ohms: Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak) Power requirements 6—20V d.c. from battery or PZ.4 Mains Supply Unit. Ready built, tested and guaranteed.

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SINCLAIR STEREO 25

De Luxe Pre-amp and Control Unit to use with Z.12 Stereo assemblies. Switched input for PU (equalized to R.I.A.A. curve from 50 to 20,000Hz ±1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/Input are solid aluminium. Size—6½ x 2½ x 2½in. plus knobs. Built, tested and guaranteed.

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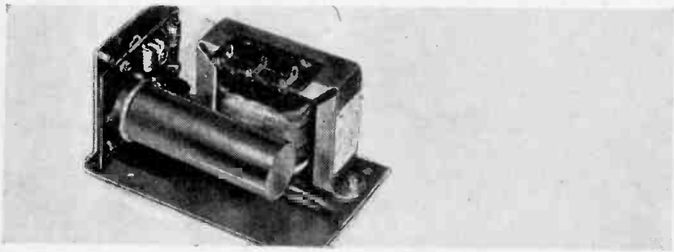

SINCLAIR PZ4

STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V d.c. at 1·5A. Designed specially for use with two Z.12 or IC.10 Amplifiers together with Stereo 25. Built, tested and guaranteed.

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- High quality magnetic earpiece
- Choice of many stations
- Plays anywhere

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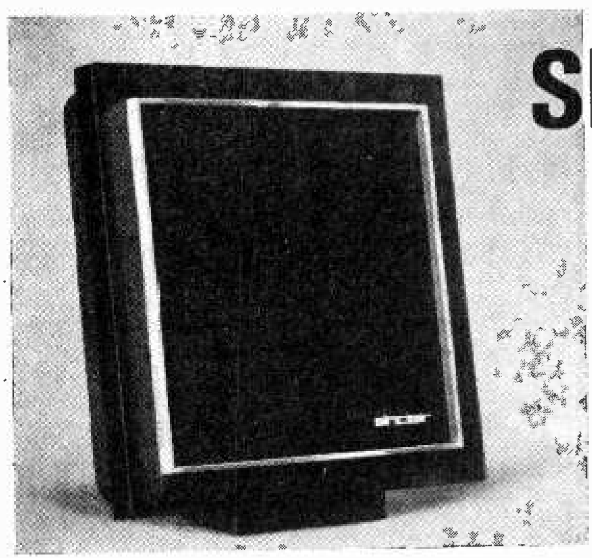

SINCLAIR Q.14

the most challenging loudspeaker design in years

It is more than a matter of saving money when you choose the Q.14. This is the loudspeaker that delights experts and critics alike for its fine forward quality, its clarity and exceptional adaptability. Designed on original lines and from unusual materials, the Q.14 will easily carry up to 14 watts and has very smooth response from 60 to 16,000Hz. Size—$9\frac{3}{4}$in square × $4\frac{3}{4}$in deep, with matt black finish and solid aluminium bar embellishment. Input impedance—8 ohms.

The Q.14 costs about a quarter of what you might expect to pay for a good stereo speaker system. A pair used with two Z.12s and the Stereo 25 will give you superb high fidelity to stand comparison with far costlier equipment.

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64	50	32	20	12·5	8	5	1/2	10/4	22/6	77/9
125	100	64	40	25	16	10	1/–	8/9	18/9	63/6
250	200	125	80	50	32	20	1/1	9/6	20/9	70/9
400	320	200	125	80	50	32	1/2	10/4	22/6	77/9
800	640	400	250	160	100	64	1/6	13/4	29/6	102/9
1250	1000	640	400	250	160	100	2/–	18/10	37/9	134/4
2000	1600	1000	640	400	250	160	2/6	22/3	44/3	165/6
3200	2500	1600	1000	640	400	250	3/–	26/9	59/–	204/3
				800	500	320	5/3	46/6	101/–	343/9
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½W	5%	3d.	2/–	4/–	12/10

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Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radial leads.
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0·05	8d.	6/–	12/6	41/8
0·1	10d.	7/1	15/6	51/–
0·2	1/2	10/–	20/10	68/6
0·5	2/–	17/6	37/6	125/–

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470, 560, 680, 820, 1,000, 1,500	6d.	4/–	8/8	26/8
2,200, 3,300, 4,700, 5,600 ..	7d.	5/–	10/10	33/4
6,800, 8,200, 10,000, 15,000	8d.	6/–	13/–	40/–
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Miniature, fully enclosed, rear tags, carbon brush wiper. Long life, low noise. Body dia., ⅝in. Spindle, 1in. × ¼in. ¼W at 70°C. ±20% below ½M, ±30% over ½M. Lin. 100 ohms to 10 Megohms. Log. 5 Kohms to 5 Megohms.

Prices—per ohmic value	each	10 off	25 off	100 off
	2/–	18/4	41/8	150/–

GANGED STEREO POTENTIOMETERS (Carbon)
½W at 70°C. Long Spindle.
Logarithmic and Linear: 5k + 5k to 1M + 1M.

Prices—per ohmic value	each	10 off	25 off	100 off
	8/–	70/–	162/6	575/–

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High quality pre-sets suitable for printed circuit boards of 0·1in. P.C.M. 100 ohms to 5 Megohms (Linear only). Miniature: 0·3W at 70°C. ±20% below ½M, ±30% above ½M. Horizontal (0·7in. + 0·4in. P.C.M.) or Vertical (0·4in. × 0·2in. P.C.M.). Subminiature: 0·1W at 70°C. ±20% below 2·5M, ±30% above.

Prices—per ohmic value	each	10 off	25 off	100 off
Miniature (0·3W)	1/–	8/9	18/9	66/8
Subminiature (0·1W) ..	10d.	7/1	14/7	46/8

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

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¼in. Type P3. Tip-Ring-Sleeve Stereo version of Type P1.
¼in. Type P4. Tip-Ring-Sleeve Stereo version of Type P2.
3·5mm. Type P5. Standard. Screened. Aluminium cover.
3·5mm. Type P6. Standard. Unscreened. Unbreakable moulded cover.

Prices	each	10 off	25 off	100 off
P1	3/–	26/8	62/6	233/4
SE/P1	3/6	30/10	66/8	280/–
P2	2/6	23/4	54/2	200/–
P3	6/6	60/–	137/6	500/–
P4	6/2	59/6	127/6	455/–
P5	2/2	19/2	43/9	158/4
P6	1/8	15/–	33/4	116/8

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¼in. Type S5. Standard. Moulded body. Chrome insert.
3·5mm. Type S6. Standard. Moulded body. Chrome insert.
Available with make or break contacts on Tip. Ring and Sleeve.

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S6	1/6	13/4	33/4	100/–

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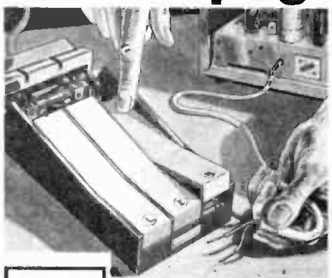

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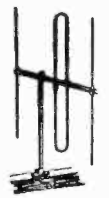

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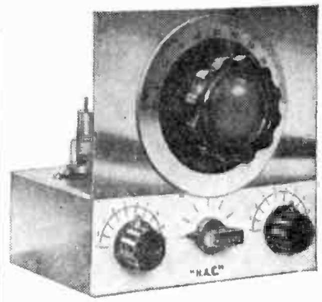

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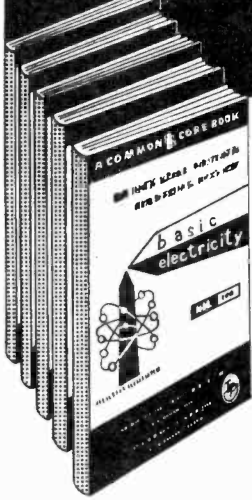

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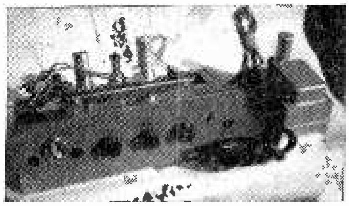

Chassis 12½ x 5½ x 4½in. high. Front panel alum and black—12½ x 4½in. 200–250 A.C. Mains Trans. Off/On-Tone; Vol./Mic.; Vol./Gram.; Mic. Input; Gram. Input; Monitor; Valves 6BR7, ECC83, EM84, EL84 and Rect. 2 Track £10.10.0; 4 Track £12 (12/6 p. & p.). Ready for bolting direct to Magnavox deck.

STEREO AMPLIFIER type HV—2 x 3 Watts

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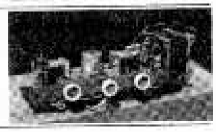

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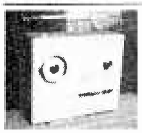

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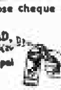

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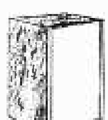

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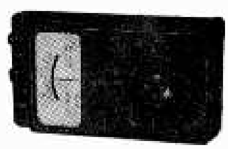

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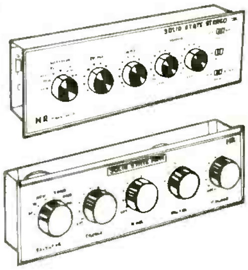

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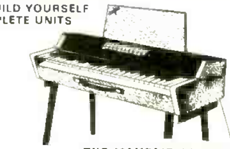

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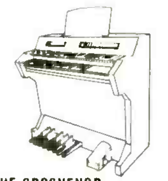

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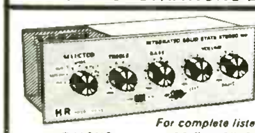

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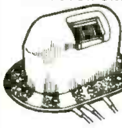

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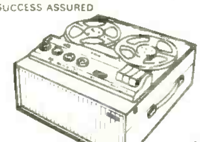

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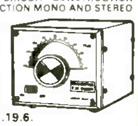

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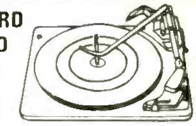

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SL55	11	19	6
SL65	14	14	0
SL75	29	0	0
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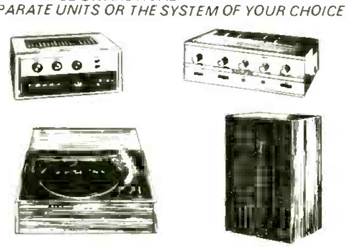

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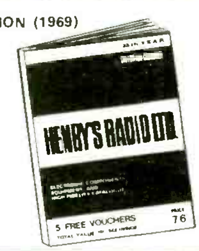

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