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OCTOBER
1969

310

AUDIO SIGNAL GENERATOR



also inside: **PRINTED CIRCUIT DESIGN**

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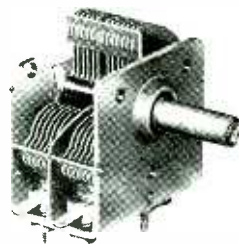
PW174

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The Jackson 'O' range contains six basic types of different air-dielectric tuning capacitors with a wide variation of capacities available in each type. In addition, there are optional extras such as concentric-spindle slow-motion drives, built-in trimmers and plastic covers. The maximum capacitance per section ranges from 12, 18 or 24 pF for FM types to 420 pF for AM types.

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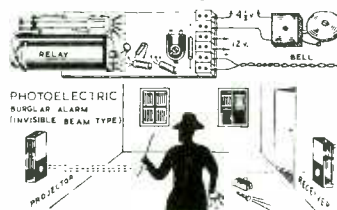
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Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.

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Send a S.A.E. for full details, a brief description and Photographs of all Kits and all 52 Radio, Electronic and Photoelectric Projects Assembled.

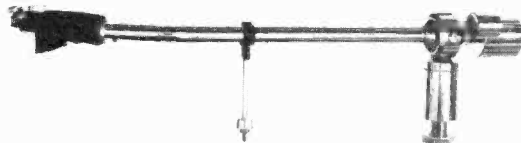
Lasky's

AMAZING VALUE AD-309K PICK-UP ARM

FITTED WITH
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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 1/4 in. 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 1/4 in. 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/-

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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.



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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. 0-0.125-1.25-5-0.25-125-500V 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 125mV. 0-50uA at 250mV. ● 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 (U7 type) batteries. Black bakelite cabinet, size 5 1/2 x 6 1/2 x 2 1/2 in. Strong, resilient plastic handle. Complete with test leads.

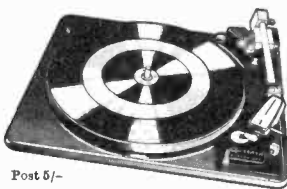
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ALSO AVAILABLE READY BUILT AND TESTED £18.10.0. Post 5/-.

Garrard

SP25 MkII

**LASKY'S
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cartridge .. £21.10.0
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Postage on all above 5/-

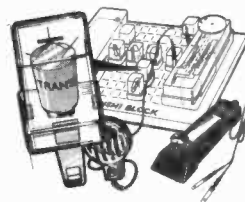
tion. The highest quality components and 1% tolerance resistors are used throughout. Both offer professional standards of accuracy. Supplied complete in every detail with full constructional, circuit and operating instructions.

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 +83dB. ● Output: 0.05uF blocking capacitor. Uses two 1.5V (U7 type) batteries. Black bakelite cabinet—Size: 5 1/2 x 3 1/2 x 1 1/2 in. Complete with test leads.

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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.

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Base board; tuner block; 4 resistors; choke coil; transformer; 28A 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.

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LASKY'S PRICE £4.19.6 Post 3/6

DENSHI BOARD KIT SR-2A as SR-1A but with the following additional parts; 28B 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.

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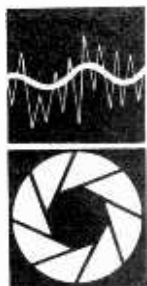
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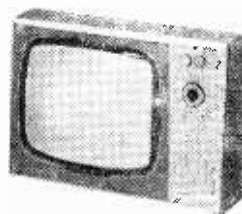
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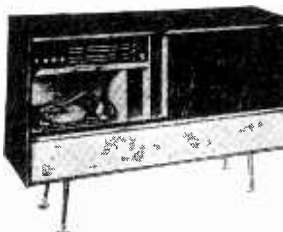
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Speakers 6/6: 2"—75Ω. 2½"—35Ω. P. & P. 2/6. Acos Mics. 35/- Standard: Stick Mic. 2 gns. P. & P. 3/6. Asstd. Condensers: 10/- for 50. P. & P. 7/6. Asstd. Resistors: 10/- for 50. P. & P. 4/6. Asstd. Controls: 10/- for 25. P. & P. 7/6. Transistors: Mullard matched output klt 9/- OC81D—2 OC81's. P. & P. FREE.

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Lasky's

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FROM RUSSIA



Made to the highest Russian space-age standard—this remarkable micro-size set measures only 1 11/16 x 1 3/10 x 5 5/16in. yet it contains 6 transistors and other components combined in a photo etched circuit, only ½ x ½in.; tuning capacitor, ferrite rod (or core) aerial, battery, wave band selection, switch etc. Output to a high impedance, crystal earpiece, giving ample volume (automatically adjusted) and clear tone. Brief tech. spec. Waveband coverage—Medium wave 525 to 1605kc/s. Long wave 150kc/s to 408kc/s. Sensitivity: 35mV max. Selectivity—10dB (at 30kc/s de-tuning). Power consumption 4mA max. Power source: 1 x 1.4V Mercury battery (Mallory type RM625 or equivalent).

The Orion is supplied fully built and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic presentation/carrying case (matching the Orion). Never miss your favourite music, sport, news—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others. Lasky's price 39/6 Post 2/- Extra battery (rechargeable type) available.

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A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 10 watts per channel. Frequency response 40-20,000 Hz $\pm$ 3dB. Inputs for radio, P.U. Ceramic, P.T. 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 14 1/2" x 8 1/2" x 3 1/2". A.C. 200/250V.



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VERITAS V149 MIXER

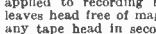
Battery operated 4-channel audio mixer providing four separate inputs. Size 6 x 3 x 2 in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1.5v. Max. output 2.5v. Gain 6 dB. Standard jack plug socket inputs, phonoplug output. Attractive teak wood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



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

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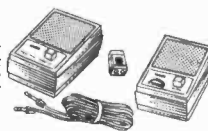
MODEL D14. A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0-15-150-1000 volts. Resistance 0-100,000 ohms. Current 0-150 mA D.C. Size only: 3 1/2" x 2 1/2" x 1 1/2". Complete with battery, test leads and instructions. 49/6 P. & P. 2/6.



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P. & P. 1/-.



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Removes unwanted deposits from delicate tape heads. Fits all cassette recorders. 11/6 P. & P. 1/-

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SP5 5" 600'	P.V.C.	8/8	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" 5/-, 7" 1/9. TAPE CASES 5" 7" 2/6.

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The Duetto

Integrated Transistor Stereo Amplifier

9 Gns.
+ 7/6 p & p

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 2 1/2" tweeter. Teak finish. 12" x 6 1/2" x 5 1/2", 4 gns each, p & p 7/6. Type 2 as Type 1. Size 17 1/2" x 10 1/2" x 6 1/2". Incorporating Elac 10 1/2" x 6 1/2", 10,000 lines & 2 1/2" tweeter. 3 ohms impedance.

5 1/2 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

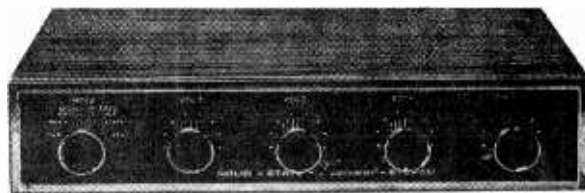


The Classic

8 1/2 Gns. + 7/6 p & p

Controls: Selector switch Tape speed equalisation switch (3 1/2 and 7 1/2 l.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 3 1/2 l.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 12 1/2 in. long, 4 1/2 in. deep, 2 1/2 in. high. Teak finished case.



The Viscount

13 1/2 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:** 12 1/2" x 6" x 2 1/2" 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 12 in. x 6 1/2 in. x 5 1/2 in. 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 modulated and pre-alignment techniques makes this simple to build. Size: 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.

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.



Price 69/6

plus 2/6 p. & p.

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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 hardware (screws, washers etc.). PRICE £4.19.6. (post and packing 5/- extra).

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



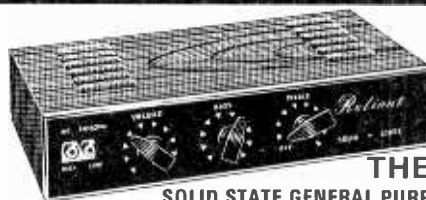
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An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.

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 40 watts rms. 90 watts peak. For sine 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

Inputs—1. xtm mic 10mV

2. gram/radio 250mV

Output Impedance—3 to 4 ohms

Tone Controls—Treble control range ± 12 dB at 10KHz

Bass control range ± 13 dB at 100Hz

Frequency Response—(with tone controls central) Minus 3dB points are 20Hz and 40KHz. Signal to Noise Ratio—better than -60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input—220-260V. A.C. Size of chassis—10 1/2" x 4 1/2" x 2 1/2". A.C. Mains, 200-250V. For use with St4, or L.P. records, musical instruments, all makes of pick-ups and makes. Separate bass and treble lift control. Two inputs with control for gram. and mike. Built and tested, 8" x 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. 5 1/2 gns. plus 7/6 p. & p.

As above less teak case.

Reliant Mark II. 6 1/2 gns. plus 7/6 p. & p.

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2 TRANSISTOR U.H.F. TUNER

Brand new. Complete with circuit diagram.

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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 13 1/4 x 8 1/4 x 4 1/4 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.

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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.



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Size 3 1/4 x 2 1/4 x 1 1/4 in. Meter size 2 1/4 x 1 1/4 in. 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 0-100K. Complete with test leads, 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.

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takes 5 1/2 in. spools, fitted with B.S.R.

1/2 Track Heads. Size 13 1/2 in. long by 8 1/2 in.

wide. £6 19s. 6d. plus 7/6 p.p.



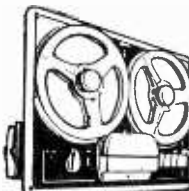
MOTEK

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

Incorporating 3 motors.

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

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5 SHAW LANE, HALIFAX

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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 4½ in. £10.4.0, p.p. & ins. 6/-.

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For single outputs, 6v, 9v, 12v, 18v, 30/6. For two separate outputs, 4½v + 4½v, 6v + 6v, 9v + 9v, 42/6. P. & P. 2/6 per unit. (Please state outputs reqd.)



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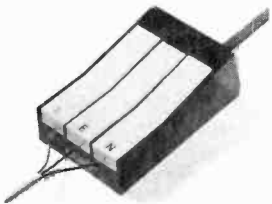
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J1004	5"	Double Play Poly	1200ft.	15/- P. & P. 1/8.
J1005	5 1/2"	Long Play PVC	1200ft.	12/6 P. & P. 2/-.
J1006	5 1/2"	Double Play Poly	1800ft.	22/6 P. & P. 2/-.
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MT154	75W	Size 2 1/2 x 2 1/2 x 2 1/2 in.	Wgt 1 1/2 lb 14oz	Price 21/9	P & P 4/6
MT174	150W	Size 3 1/2 x 2 1/2 x 3 1/2 in.	Wgt 4 1/2 lb	Price 33/-	P & P 6/-
MT65	200W	Size 3 1/2 x 4 1/2 x 4 in.	Wgt 4 1/2 lb	Price 38/6	P & P 6/-
MT66	300W	Size 4 x 4 x 3 1/2 in.	Wgt 6 1/2 lb 7oz	Price 59/4	P & P 9/-
MT110	400W	Size 4 1/2 x 4 1/2 x 4 in.	Wgt 11 1/2 lb	Price 85/-	P & P 10/-
MT67	500W	Size 5 1/2 x 4 1/2 x 4 in.	Wgt 12 1/2 lb 8oz	Price 89/-	P & P 10/6
MT68	750W	Size 6 1/2 x 5 1/2 x 4 1/2 in.	Wgt 13 1/2 lb 4oz	Price 95/7	P & P 10/6
MT64	1000W	Size 6 1/2 x 5 1/2 x 4 1/2 in.	Wgt 16 1/2 lb	Price 142/2	Carr. ex.
MT63	1500W	Size 6 1/2 x 5 1/2 x 4 1/2 in.	Wgt 25 1/2 lb 9oz	Price 170/6	Carr. ex.
MT94	1750W	Size 5 1/2 x 6 1/2 x 6 1/2 in.	Wgt 31 1/2 lb	Price 185/-	Carr. ex.
MT95	2000W	Size 7 x 6 1/2 x 8 1/2 in.	Wgt 40 1/2 lb	Price 211/2	Carr. ex.
MT73	3000W	Size 6 1/2 x 7 1/2 x 8 1/2 in.	Wgt 45 1/2 lb 8oz	Price 300/-	Carr. ex.

LOW VOLTAGE 12 VOLT RANGE

Primary 200-250v. Secondary 12v				
MT111	0.5 Amp	Size 3 x 2 1/2 x 1 1/2 in.	Wgt 1 1/2 lb	Price 15/8 P & P 2/6
MT71	2 Amp	Size 2 1/2 x 2 1/2 x 2 1/2 in.	Wgt 1 1/2 lb	Price 19/- P & P 3/6
MT69	4 Amp	Size 3 1/2 x 2 1/2 x 2 1/2 in.	Wgt 2 1/2 lb 4oz	Price 28/- P & P 6/-
MT70	6 Amp	Size 4 x 3 x 3 1/2 in.	Wgt 3 1/2 lb 12oz	Price 39/- P & P 6/-
MT72	10 Amp	Size 3 1/2 x 4 1/2 x 4 in.	Wgt 6 1/2 lb 3oz	Price 51/- P & P 9/-
MT105	20 Amp	Size 4 1/2 x 4 1/2 x 4 in.	Wgt 11 1/2 lb 13oz	Price 95/- P & P 9/-
MT187	30 Amp	Size 6 1/2 x 4 1/2 x 4 in.	Wgt 16 1/2 lb 12oz	Price 180/- P & P 13/6

LOW VOLTAGE 24 VOLT RANGE

Primary 200/250v. Secondary 24v				
MT68	1 Amp	Size 2 1/2 x 2 1/2 x 2 1/2 in.	Wgt 1 1/2 lb 7oz	Price 23/9 P & P 4/6
MT114	3 Amp	Size 2 1/2 x 3 x 3 in.	Wgt 3 1/2 lb 8oz	Price 38/- P & P 6/-
MT72	5 Amp	Size 4 x 3 1/2 x 3 1/2 in.	Wgt 5 1/2 lb 12oz	Price 58/10 P & P 6/-
MT17	8 Amp	Size 4 1/2 x 3 1/2 x 4 in.	Wgt 7 1/2 lb 8oz	Price 72/7 P & P 9/-
MT115	10 Amp	Size 4 1/2 x 4 1/2 x 4 in.	Wgt 11 1/2 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 3 1/2 x 2 1/2 x 1 1/2 in.	Wgt 1 1/2 lb 4oz	Price 17/4 P & P 3/9
MT79	1 Amp	Size 2 1/2 x 2 1/2 x 2 1/2 in.	Wgt 2 1/2 lb	Price 23/- P & P 6/-
MT20	3 Amp	Size 4 x 3 1/2 x 3 1/2 in.	Wgt 4 1/2 lb 6oz	Price 48/2 P & P 6/-
MT61	6 Amp	Size 4 1/2 x 3 1/2 x 4 in.	Wgt 6 1/2 lb 8oz	Price 60/9 P & P 9/-
MT62	8 Amp	Size 5 1/2 x 3 1/2 x 4 in.	Wgt 9 1/2 lb 6oz	Price 81/6 P & P 9/-
MT89	10 Amp	Size 6 1/2 x 4 1/2 x 4 in.	Wgt 12 1/2 lb 2oz	Price 103/6 P & P 11/-

LOW VOLTAGE 50 VOLT RANGE

Primary 200-250v. SECONDARY TAPPED 12-25-30-40-50v				
MT102	0.5 Amp	Size 2 1/2 x 2 1/2 x 2 1/2 in.	Wgt 1 1/2 lb 11oz	Price 21/8 P & P 6/-
MT104	2 Amp	Size 4 x 3 1/2 x 3 1/2 in.	Wgt 6 1/2 lb	Price 45/8 P & P 6/-
MT106	4 Amp	Size 4 1/2 x 4 1/2 x 4 in.	Wgt 9 1/2 lb 4oz	Price 77/- P & P 9/-
MT118	8 Amp	Size 5 1/2 x 5 1/2 x 4 1/2 in.	Wgt 18 1/2 lb 9oz	Price 132/- P & P 13/6
MT119	10 Amp	Size 6 1/2 x 4 1/2 x 6 1/2 in.	Wgt 19 1/2 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 3 1/2 x 2 1/2 x 2 1/2 in.	Wgt 2 1/2 lb 4oz	Price 24/- P & P 6/-
MT127	2 Amp	Size 4 x 3 1/2 x 3 1/2 in.	Wgt 5 1/2 lb 6oz	Price 52/10 P & P 6/-
MT123	4 Amp	Size 4 1/2 x 3 1/2 x 4 1/2 in.	Wgt 10 1/2 lb 6oz	Price 99/- P & P 11/-
MT122	10 Amp	Size 6 1/2 x 5 x 6 1/2 in.	Wgt 23 1/2 lb	Price 152/- Carr. ex.

MAINS H.T. RANGE

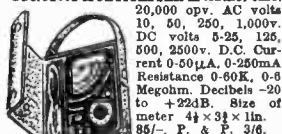
Size				
MT1AT	250-0-250v	80MA	6-3v 3-5A 5/6-3v 1A	3 1/2 x 3 x 3in. 33/- 6/-
MT6AT	250-0-250v	100MA	6-3v 3-5A 5/6-3v 1A	4 x 3 1/2 x 3 1/2 in. 38/3 6/-
MT110	250-0-250v	120MA	6-3v 3-5A 5/6-3v 1A	4 x 4 x 3 1/2 in. 44/9 6/-
MT11AT	300-0-300v	100MA	6-3v 3-5A 5/6-3v 1A	4 x 3 1/2 x 3 1/2 in. 37/9 6/-
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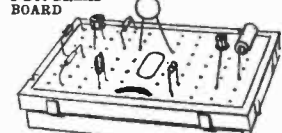
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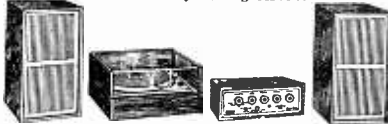
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 ★ Super 30 Amplifier in veneered housing
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 Special total price. Four fully wired units ready to "plug-in". Carr. 30/-
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 ★ Garrard SP25 Mk II Turntable on Plinth
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 Cabinets latest style Satin Teak or Afrormosia veneer. Acoustically lined or filled woollen damping. Ported where appropriate, credit terms available

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EXTREMELY ATTRACTIVE PLINTHS
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13 WATT OUTPUT

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 ★ TA12 Amplifier in veneered housing
 ★ Pair of Dorchester Loudspeaker Units. Special total price. Carr. 25/-

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 MARK II DUAL CHANNEL VERSION OF THE SUPER 15 Employing Twin Printed Circuits. High quality Gangs. P.M.T. Matched Components. CROSS TALK: -32dB at 1,000 c.p.s. CONTROL: 5 position Input Selector, Bass Control, Treble Control, Volume Control, Balance Control, Stereo/Mono Switch, Tape Monitor Switch, Mains Switch, INPUT SOCKETS (Matched Pairs). (1) P.U. (2) Tape Amp. (3) Radio/Aux. (4) Mic. or R.F. Head. Operation of the Input Selector Switch assures appropriate equalisation. Rigid 18 s.w.g. Chassis. Size approx. 12in. wide, 3in. high and 8in. deep. Neon Panel Indicator. Attractive Facia Plate and Spun Silver Matching Knobs. Above facilities, etc., except for Ganging and Balance Control, apply also to Super 15. THESE UNITS ARE ESPECIALLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MICROPHONE (Crystal, Ceramic, Magnetic, Moving Coil, Ribbon). CURRENTLY AVAILABLE SUPER SOUND OUTPUT QUALITY CAN BE OBTAINED BY USING WITH FIRST RATE ANCILLARY EQUIPMENT. All required parts, point to point wiring diagrams and detailed instructions. Carr. 15/- Unit factory built 28 Gns. or Deposit £7.5.0 and 9 monthly payments 56/8. (Total £32.13.3). Or in veneered housing 31 Gns. Carr. 15/- or Deposit £7.3.6 and 9 monthly payments 64/- (Total £35.19.6). Send S.A.E. for leaflet.

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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 38 mV. Suitable for high Impedance microphone or 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

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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), E281. High quality sectionally wound output transformer. Bass and TREBLE CONTROLS. Frequency response +3dB 30-20,000 c/s. Hum level - 80dB. SENSITIVITY 40 millivolts. For Crystal or Ceramic P.U.s. High Impedance

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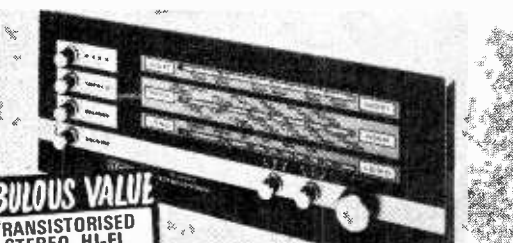
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21 GNS. Carr. free	12 GNS. Carr. free	10 GNS. Carr. free

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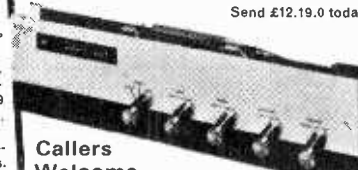
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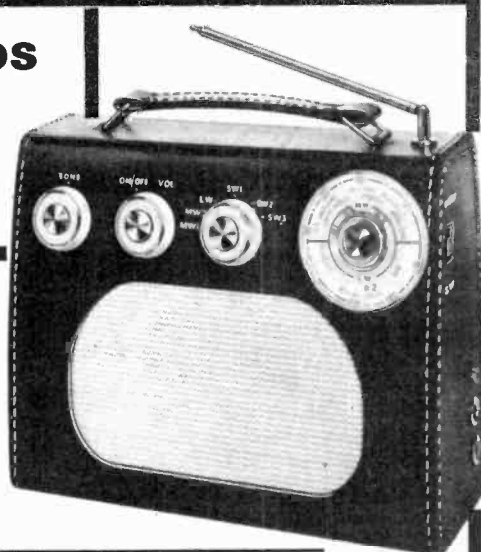
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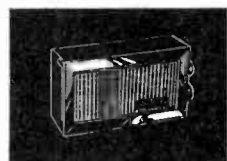
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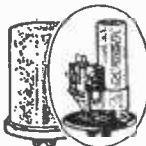
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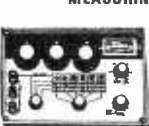
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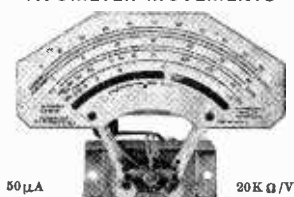
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MODEL TE-10A. 20KΩ/Volt 5/25/50/250/500/2,500v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2-5mA/250mA D.C. 0/6K/6 meg. ohm. -20 to +22dB. 10-0, 100mFd. 0-100-0-1mFd. 60/6. P. & P. 2/6.

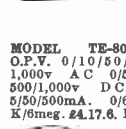


MODEL TE-90 50,000 Ω/Volt mirror scale overload protection 0.3/12/60/300/600/1200 v. D.C. 0.6/30/120/300/1200v. DC. 0.6/60/60/600mA. DC. 16K/160K/1.6/16meg Ω. -20 to +63dB. \$7.10.0. P. & P. 3/-.



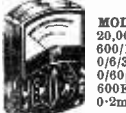
LAFAYETTE 67 Range Super 50KΩ/volt multimeter. D.C. volts 12 mV -1000V. A.C. volts 1-5V -1000V. D.C. current 25μA-10 amp. Ohms 0-10 meg Ω -20 to +81 dB. Overload protection. \$12.10.0. Carr. 3/6.

MODEL TE-70. 30,000 Ω/Volt. 0.3/15/60/300/600/1200v. DC. 0.6/30/120/300/600/1200v. AC. 0.3/30/120/300/600/1200v. A.C. 0.16K/160 K/1.6M/16 Meg. Ω. \$5.10.0. P. & P. 3/-.



MODEL TE-80. 20,000 Ω/Volt. 0.1/10/50/100/500/1,000v. AC. 0.6/25/50/250/500/1,000v. D.C. 0-60μA. 5/50/500mA. 0.6K/60K/600 K/6meg. \$4.17.6. P. & P. 3/-.

MODEL PT-34. 1,000 Ω/Volt. 0.1/10/50/250/500/1,000v. AC. and DC. 0.1/100/500mA DC. 0/100K Ω. 39/6. P. & P. 1/6.



MODEL TE-12 20,000 Ω/Volt. 0.1/10/50/100/500/1,000/5,000/2,500v. D.C. 0.6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6Meg. 60 Meg. Ω. 50F. 0-2mFd. \$5.19.6. P. & P. 3/6.

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185 3/9	6CL6 8/8	6UTG 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
1U4 5/9	6D3 7/8	6V6G 8/8	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
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3B7 6/9	6G12 8/8	6Y7G 10/8	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
3D6 2/9	6F13 3/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
3Q4 6/8	6F15 9/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
3Q5GT 6/8	6F18 7/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
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3V4 5/8	6F24 11/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
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6A8G 5/8	6K6GT 5/-	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
6AC7 8/-	6K7G 2/-	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
6AG5 3/8	6K7GT 4/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
6AK5 4/8	6K8G 3/-	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
6AK6 6/-	6K9GT 7/-	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
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6AM6 3/8	6L6GT 7/9	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
6AQ5 4/8	6L7GT 12/8	6Y7 7/-	12C7 6/9	30PL15 15/-	AC/TH1 10/-	E83F 24/-	EC98 5/8	EL45 4/8	KT74 12/8	PEN45DD 12/8	SP42 12/8	U33 29/8
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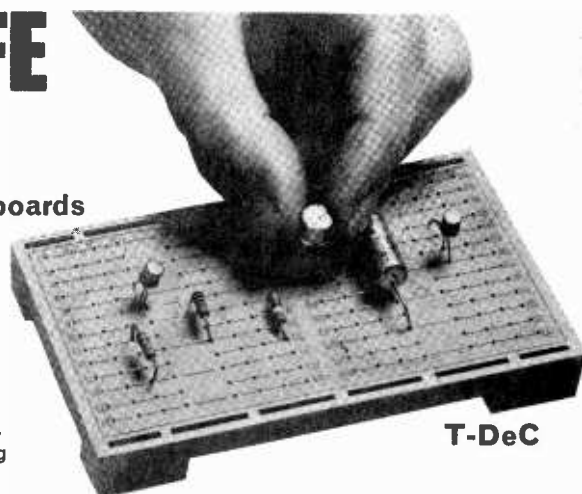
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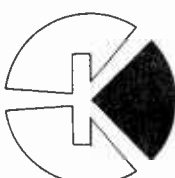
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DULCI FMT.7FM Tuner	£22 1 0	£19 0 0
DULCI FMT.7S FM Stereo Tuner	£29 8 0	£23 0 0
GOODMANS Stereomax AM/FM Stereo Tuner	£82 10 5	£69 19 6
LEAK Troughline Tuner with multiplex	£51 10 6	£39 19 6
QUAD Stereo FM Tuner	£51 0 0	£43 19 6
ROGERS Cadet Mark III Tuner	£20 12 6	£17 13 0
ROGERS Ravensbourne Tuner with Decoder	£60 15 3	£52 2 0
TRUVOX FM 200/IC Tuner	£52 0 0	£42 0 0

TUNER-AMPLIFIERS

ARENA 2400 with Decoder	£90 6 0	£69 19 6
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TELETON F.2000 AM/FM Stereo Tuner/Amplifier 2 x 5 watts RMS with silicon transistors	£43 0 0	£35 19 6
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TELETON 7AT1 Stereo Tuner/Amplifier AM/FM 50 watts RMS Stereo Decoder with F.E.T.	£133 0 0	£95 0 0
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KEF Concord	£43 10 0	£36 0 0
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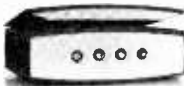
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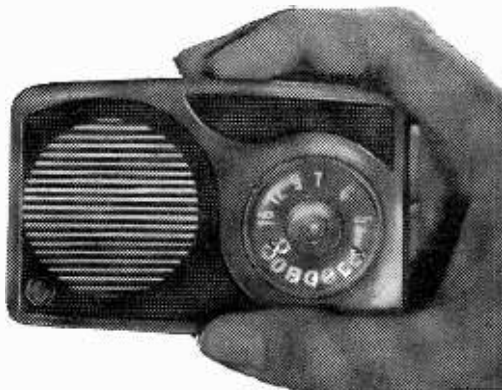
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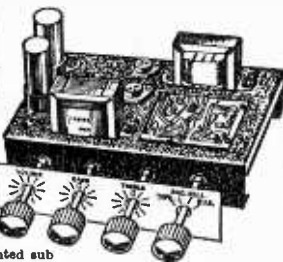
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Performance figures:
Sensitivity: PU1-50mV/v. 66K input impedance.
PU2-110mV/v, 1 meg input impedance.
Tape-110mV/v, 1 meg input impedance.
Radio-110mV/v, 1 meg input impedance.
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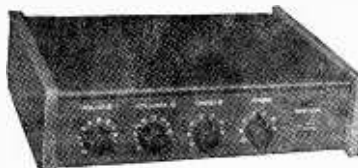
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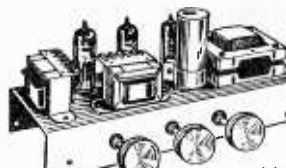
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PRACTICAL WIRELESS

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.*

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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.

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,

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.

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

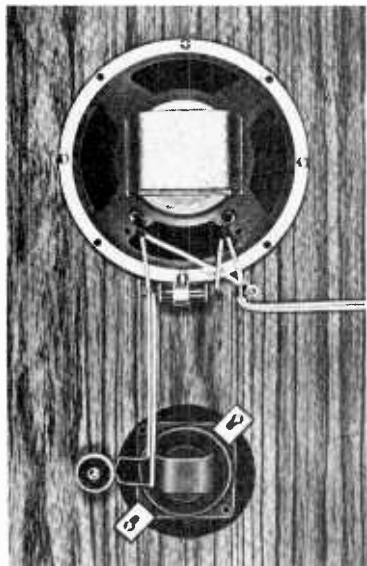
This is not the first prize for spotting all the mistakes in News and Comment but the output of the British electronics industry during 1968. The actual output

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, crossover 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 5½in. 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".

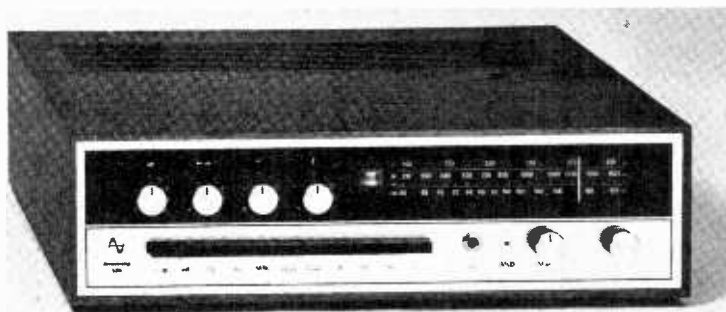
Enrolment is in mid-September; further details from the *Adult Education Office, Hounslow Manor School, Holloway Street, Hounslow.*

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.

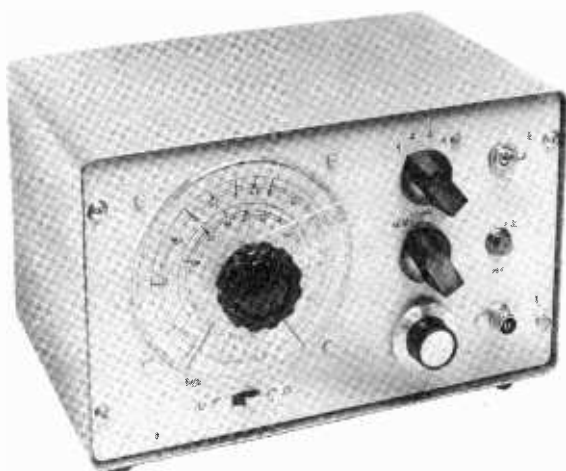
TWO NEW TUNER-AMPLIFIERS



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

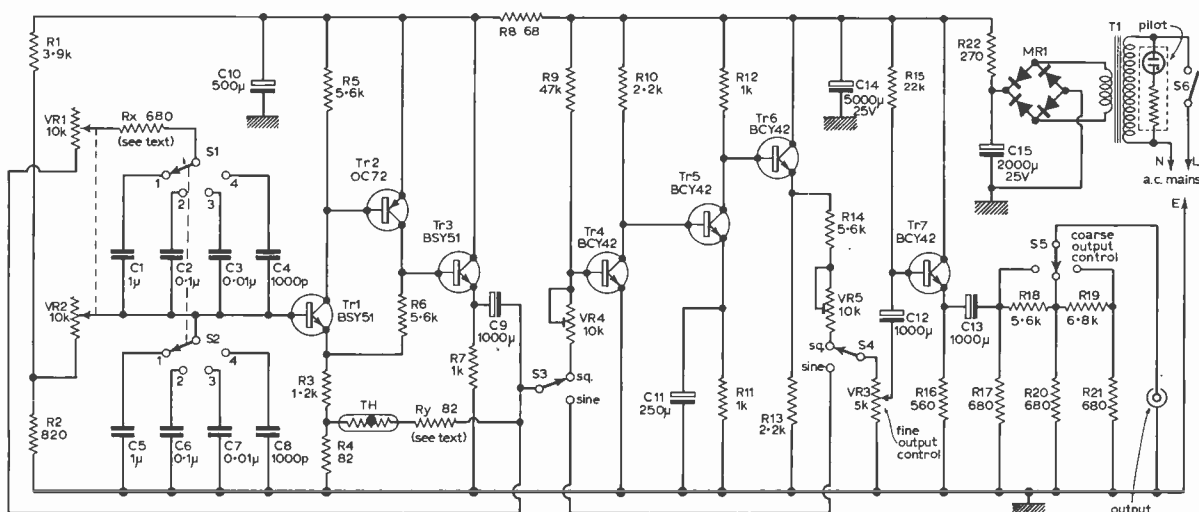


Fig. 1: Complete circuit of the sine and square wave audio signal generator.

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.

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 $\frac{1}{2} \times \frac{1}{2}$ in. Plain Veroboard with a 0.15 in. 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 × 3½ in. and board 1, 4½ × 3½ in.

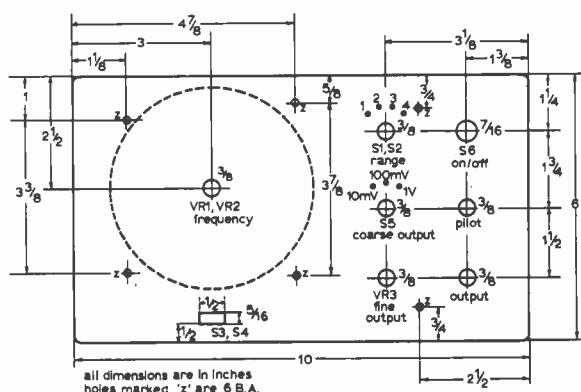


Fig. 2: Front panel dimensions and drilling details.

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

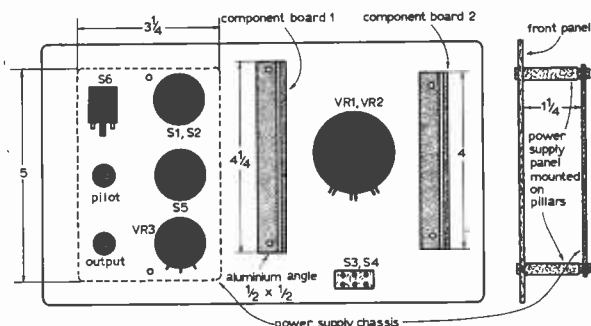


Fig. 3: Layout of panel components, viewed from rear. The power supply panel is shown on right.

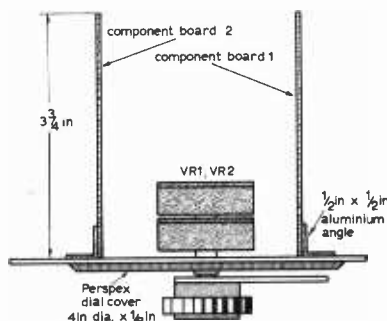
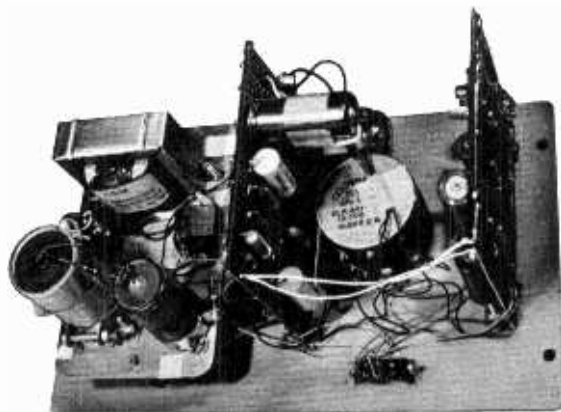
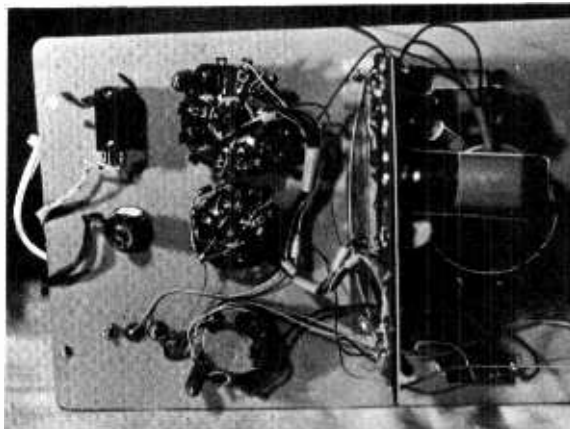


Fig. 4: The two transistor and component boards are attached to the front panel as shown on left. Details of the Perspex dial cover are also shown.



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



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 $\frac{1}{2}$ 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 $\frac{1}{2}$ 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

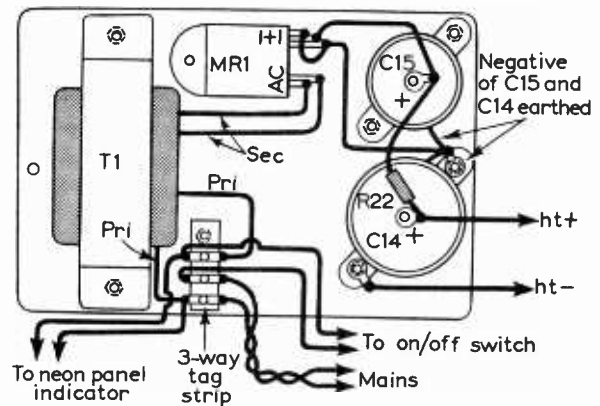


Fig. 6: Layout and wiring of the power supply.

of a poor waveform. The maximum output signal should be 1V r.m.s. plus or minus a few millivolts 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

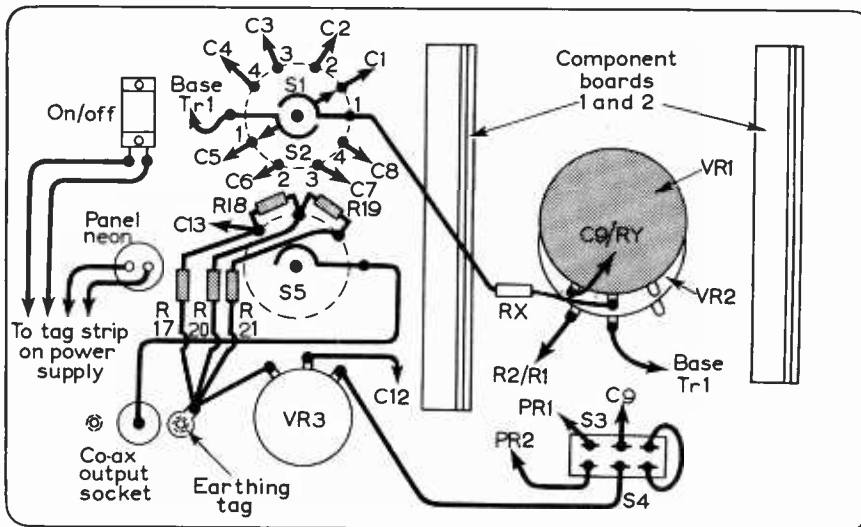


Fig. 5: Showing front panel wiring and layout.

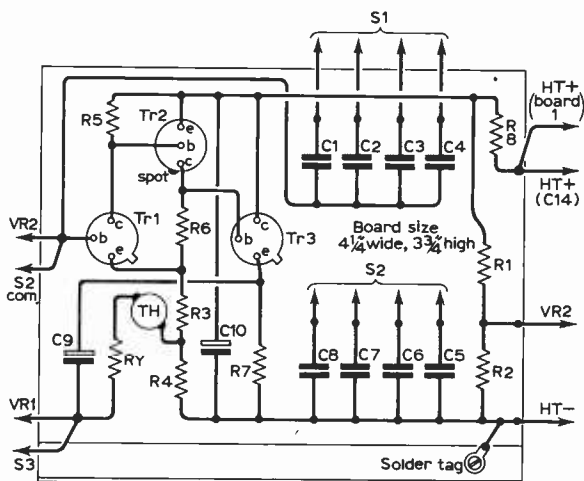


Fig. 7: Layout and wiring of component board 2 (oscillator). All transistor connections are viewed from the underside.

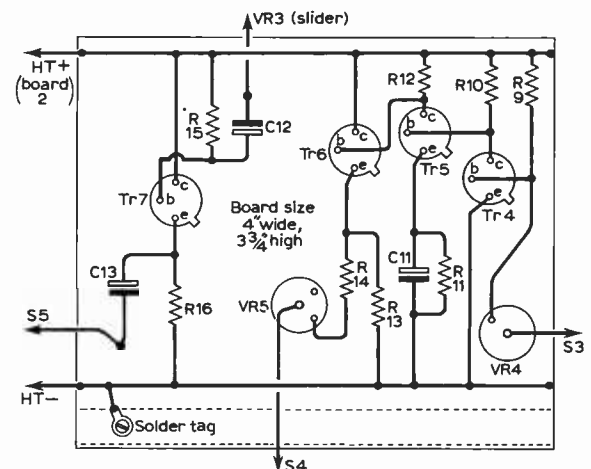


Fig. 8: Component board 1 layout and wiring (squaring circuit and emitter follower output stage).

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 $\pm 5\%$ of the rated output using the resistor values quoted.

★ components list

Resistors:

R1	3.9k Ω	R13	2.2k Ω
R2	820 Ω	R14	5.6k Ω
R3	1.2k Ω	R15	22k Ω
R4	82 Ω	R16	560 Ω
R5	5.6k Ω	R17	680 Ω
R6	5.6k Ω	R18	5.6k Ω
R7	1k Ω	R19	6.8k Ω
R8	68 Ω	R20	680 Ω
R9	47k Ω	R21	680 Ω
R10	2.2k Ω	R22	270 Ω
R11	1k Ω	RX	680 Ω (see text)
R12	1k Ω		

all 10% $\frac{1}{4}$ watt.

Potentiometers:

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

Capacitors:

C1	1 μ F paper
C2	0.1 μ F paper
C3	0.01 μ F paper
C4	0.001 μ F paper
C5	1 μ F paper
C6	0.1 μ F paper
C7	0.01 μ F paper
C8	0.001 μ F paper
C9	1000 μ F 12V wkg. electrolytic
C10	500 μ F 12V wkg. electrolytic
C11	250 μ F 12V wkg. electrolytic
C12	1000 μ F 12V wkg. electrolytic
C13	1000 μ F 12V wkg. electrolytic
C14	5000 μ F 25V wkg. electrolytic
C15	2000 μ F 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	Range 1	15 to 150Hz.
Sine- or square-wave:	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: ± 0.5 dB 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.

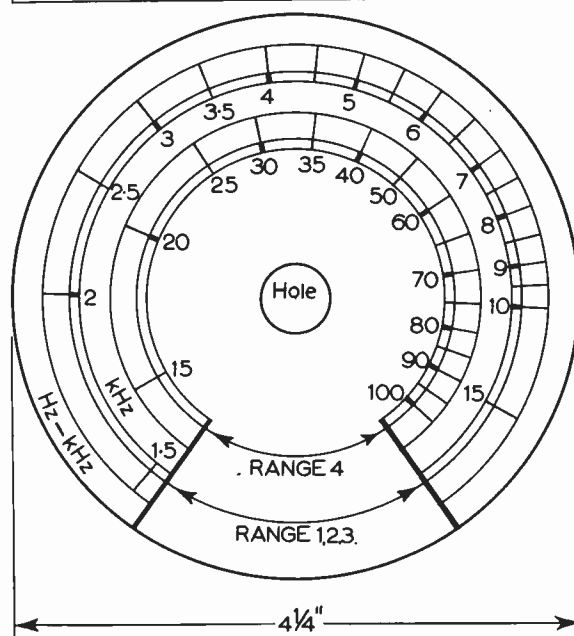


Fig. 9: The calibrated dial. This may be scaled-up to 4 1/2 in. diameter to give actual size.

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.

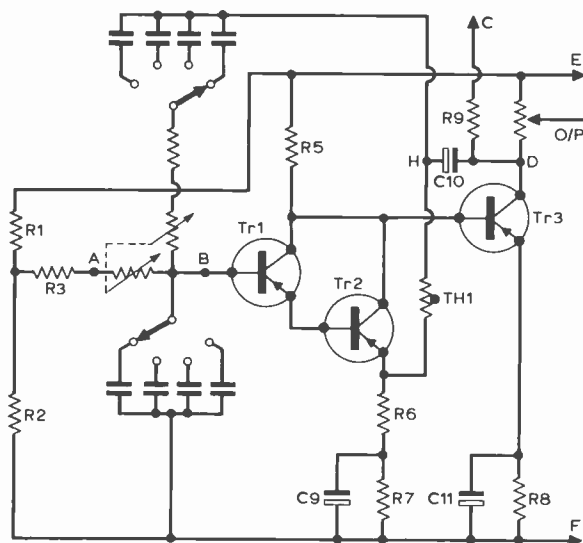


Fig. 1: Circuit of a wien bridge audio oscillator. The points marked A, C, D etc. are explained in the text.

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 Sello-tape, 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

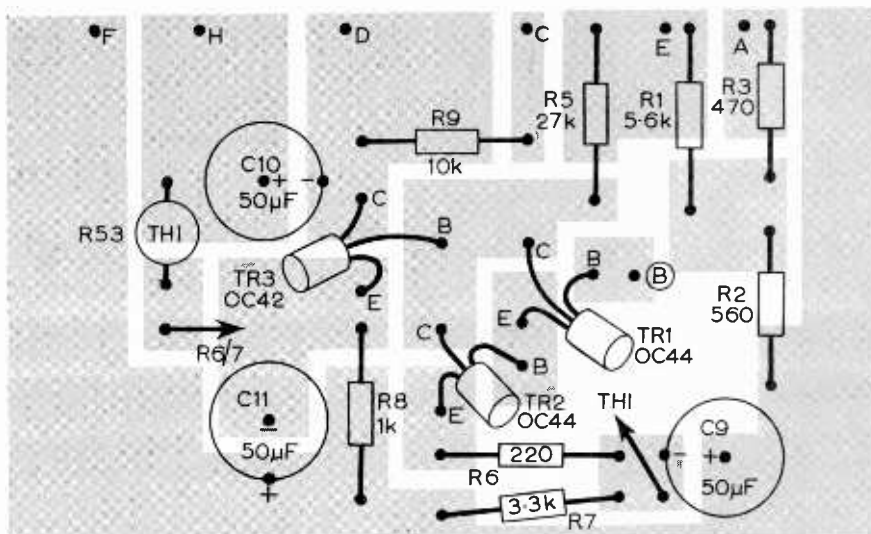


Fig. 2: Printed circuit design for the circuit given in Fig. 1.

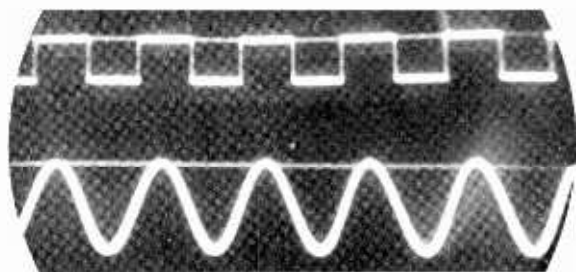
traces of etchant, and the paint cleaned off. This can be done using a solvent for the paint (acetone in the case of cellulose enamels), or by carefully rubbing with domestic wire wool. The writer prefers the latter method as it makes far less mess, and leaves an ideal soldering surface.

The tracing paper design is now positioned over the etched circuit, and the position of the holes marked using a scribe. 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!

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.

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MONO-STEREO

JAMES HOSSACK AMPLIFIER

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

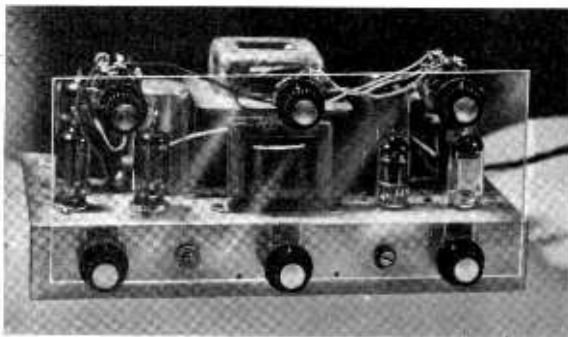
amplifier for a hi-fi stereo system. It was designed, originally, for use with a *mono* v.h.f. tuner, with the additional consideration that it could also be used as the "second channel" for a cheap record player of the type described above. Valves were chosen in preference to transistors, because the record player in question used a valve line-up.

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.



View of the assembled amplifier.

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 0.05 μ F.

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 identical, 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	100k Ω	R12	R62	100k Ω
R2	R52	1M Ω	R13	R63	1M Ω
R3	R53	2.2k Ω	R14	R64	1k Ω
R4	R54	270k Ω	R15	R65	470 Ω 2 watt
R5	R55	270k Ω	R16	R66	100k Ω
R6	R56	8.2M Ω	R17	R67	2.2M Ω
R7	R57	100k Ω	R18	R68	8.2M Ω
R8	R58	100k Ω	R19	R69	220k Ω
R9	R59	12k Ω	R20	R70	470k Ω
R10	R60	8.2M Ω	R21	R71	820k Ω
R11	R61	100 Ω	R22	R72	220k Ω

(All resistors are $\frac{1}{2}$ watt carbon, 10% tolerance unless otherwise stated)

Capacitors:

C1	C51	0.1 μ F
C2	C52	25 μ F 25V elec.
C3	C53	0.1 μ F
C4	C54	32 μ F 350V elec.
C5	C55	100pF
C6	C56	0.015 μ F
C7	C57	0.022 μ F
C8	C58	0.015 μ F
C9	C59	0.1 μ F
C10	C60	0.022 μ F
C11	C61	25 μ F 50V elec.
C12	C62	4 μ F 9V elec.
C13	C63	0.015 μ F
C14	C64	0.027 μ F
C15		32 μ F 350V elec.
C16		32 μ F 350V elec.

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

Potentiometers:

VR1	VR51	250k Ω log.
VR2	VR52	50k Ω log. ganged
VR3	VR53	25k Ω log ganged
VR4	VR54	500k Ω log ganged, with switch (S2)
VR5		1.5k Ω linear
VR6	(if used)	500k Ω linear (see text)

Transformers:

T1	T51	Output transformers, pri. matched to ECL82, sec. to 3 or 15 Ω 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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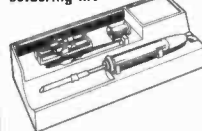


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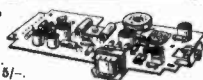
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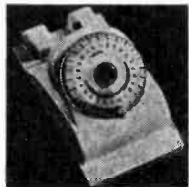
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SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

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.

Times
in GMT

Frequencies
in kHz

THE BROADCAST BANDS

Malcolm Connah

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 Cimbler 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, JX10M, 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, U78AJ, VK2FU, VK9KY, VK9XI, VP8KL, VS6AA, WB6AGZ/MM (U.S. hospital ship off 3W8 coast), XE1CE, YA1AR, YA1DAN, IJM, 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, ITØARI, 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, JXX 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

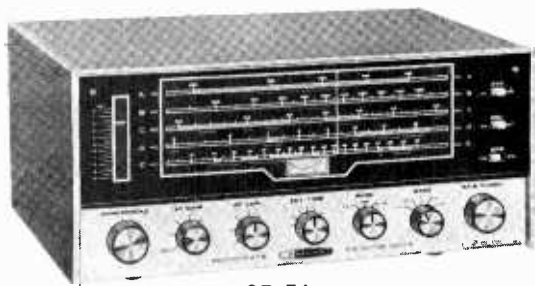
Happenings for September include—6-7th, v.h.f. n.f.d.; 14th, 3-5MHz field day; 21st, national finals of the d.f. hunt at Rugby; 21st, 144MHz contest. One mobile rally this month at Magdalene Laver, near Harlow in Essex. See any of you at this one? Owners of R1155 receivers will be pleased to hear of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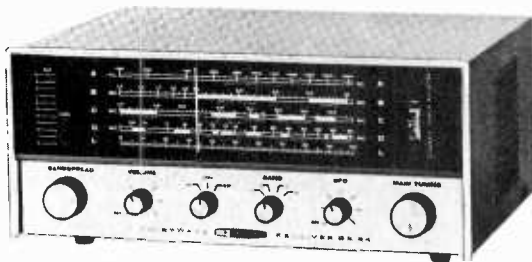
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pulse circuits in operation

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:

$$I_{e2\text{sat}} \approx \frac{V_{cc}}{R_2 + R_3}$$

since only about 0.1V are dropped by $V_{ce2\text{sat}}$. From this the triggering voltage to switch Tr1 into the ON state may be determined by:

$$V_{\text{trig (on)}} \approx V_{be1} + \frac{R_3 \cdot V_{cc}}{R_2 + R_3}$$

When Tr1 switches on, V_{c1} drops to $V_{ce1\text{sat}} + V_{r3}$. There is not sufficient voltage to support V_{be2} and

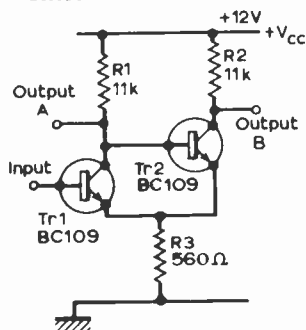


Fig. 5.1: A basic Schmitt trigger.

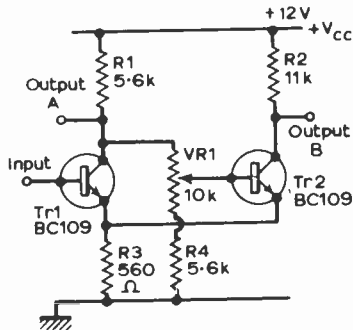


Fig. 5.2: A Schmitt trigger with variable setting.

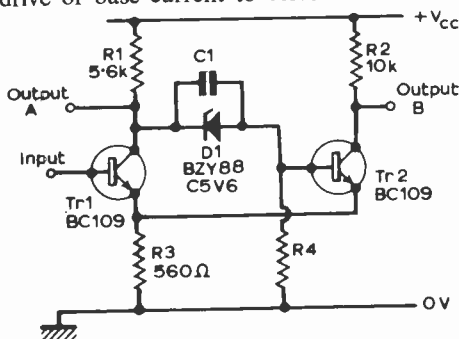


Fig. 5.3: Use of a Zener diode to set the triggering point.

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:

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

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.

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

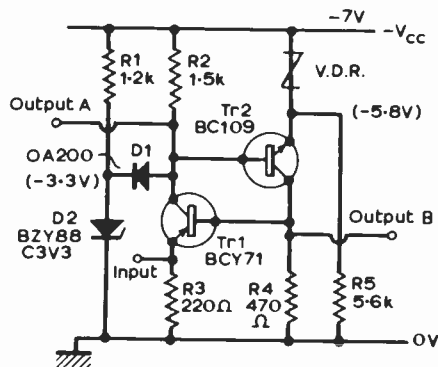


Fig. 5.4: A trigger similar to the Schmitt circuit but which draws virtually no current when off.

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_{e1} 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 $V_{cc} - V_{cesat}$ 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.

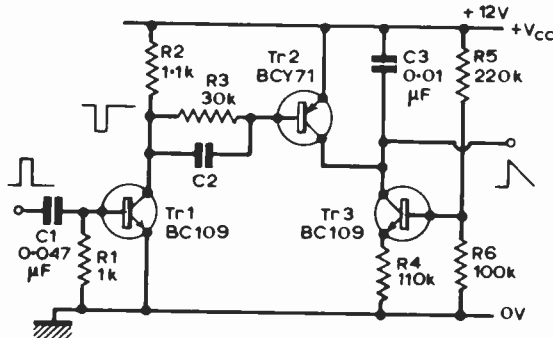


Fig. 5.5: A sawtooth or ramp generator.

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

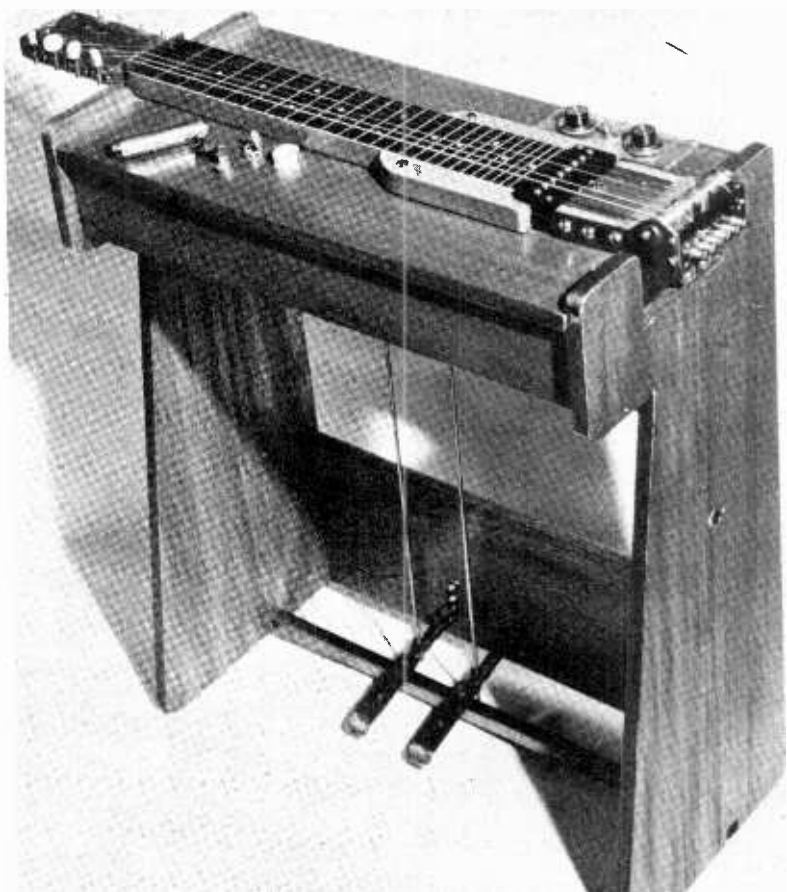
In this series saturation switching, astable, monostable, bistable circuits, Schmitt triggers, complementary triggers and ramp generators have been discussed in detail. It is hoped that the original aim of clearly describing pulse circuits in operation has been achieved, and that this treatment may have 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.

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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 $\text{IHF} \pm 1\text{dB}$. If a manufacturer of an amplifier can specify "so many watts, $\text{IHF} \pm 1\text{dB}$ " he is giving himself a scope for variations wide enough to admit a London 'bus. $\pm 1\text{dB}$ 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 con-

stant 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.

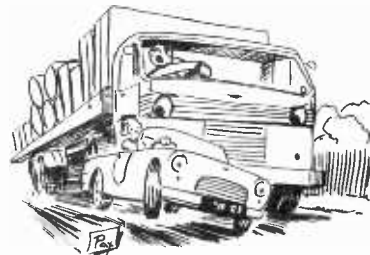
Continuous, in the terms of the audio boys, really means over a period of many cycles. It implies that the driving force, i.e. the sinewave voltage, is continuous, *not* that the power is flat and even over a long straight graph of output. The power must vary cyclically, or we couldn't hear the dratted 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 $\text{IHF} \pm 1\text{dB}$ 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 $\text{IHF} \pm 1\text{dB}$ 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.

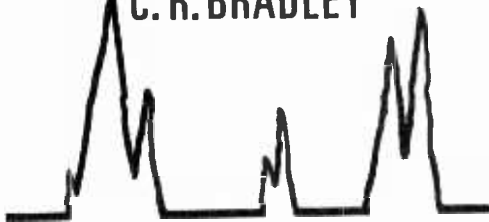
All this, and my hobby-horse hasn't even worked up a sweat. What about the vexed question of power handling (speakers) or the myth of transistor sound which usually means that the speakers now have to handle a wider response and cleaner transients... what about... well, your turn, Joe. How do you figure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



We couldn't hear the dratted noise

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 $8\mu\text{F}$ 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

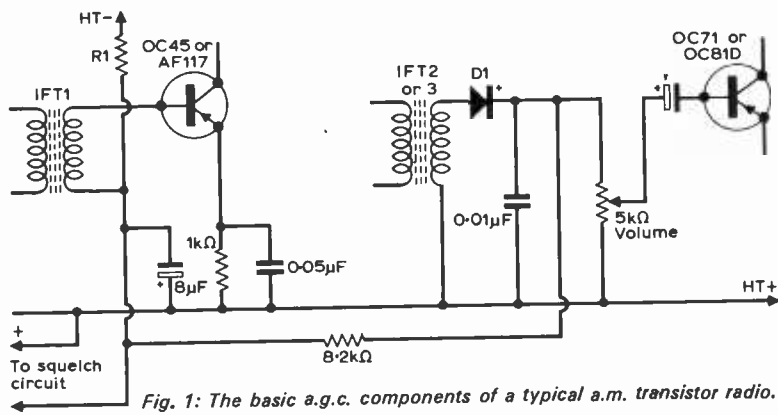


Fig. 1: The basic a.g.c. components of a typical a.m. transistor radio.

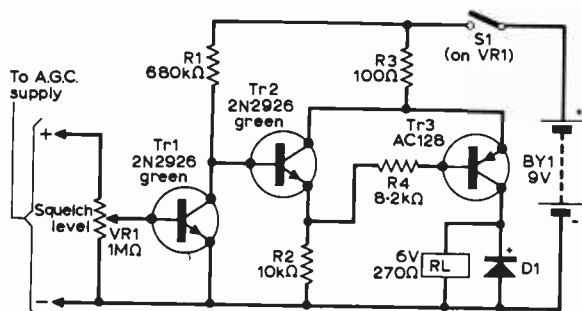


Fig. 2: Squegl circuit suitable for transistor radios.

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.

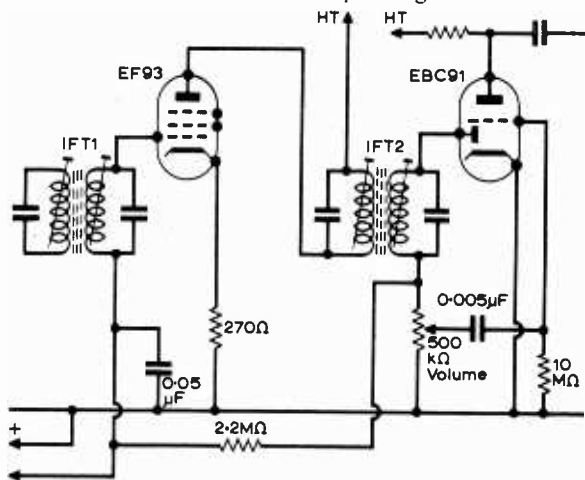


Fig. 3: The basic a.g.c. components of a typical valve radio.

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, applica-

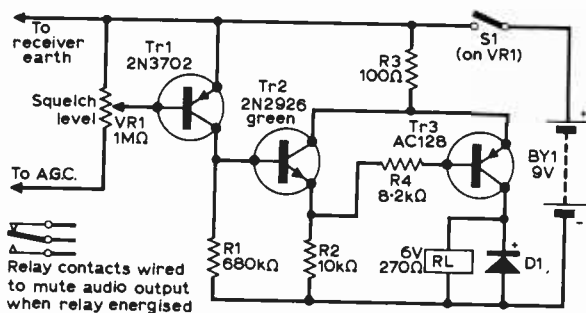


Fig. 4: The modified squegl circuit for valve radios.

★ components list

Resistors:

R1 680kΩ R3 100Ω
R2 10kΩ R4 8.2kΩ
All 10%, 1/4 watt miniature

Semiconductors:

Tr1 2N2926 green (Fig. 1) Tr3 AC128
2N3702 (Fig. 2) D1 Any germanium
Tr2 2N2926 green 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.

tion 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 squegl 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.

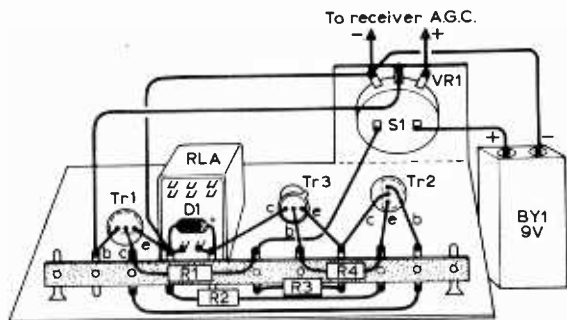
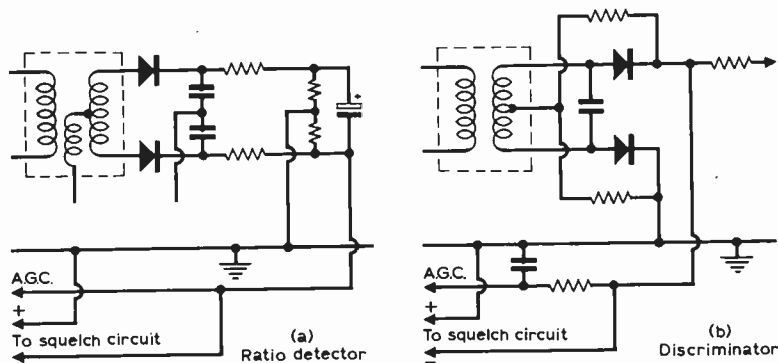
CONSTRUCTION

The layout of the squegl 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 400 Ω 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 k Ω .

If the relay does not energise, try reducing R2 to 8.2k Ω and/or increasing R1 to 820k Ω or 1M Ω . If the relay remains constantly energised with no input to Tr1 base, try increasing R2 or reducing R1 to 500k Ω . 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 0.1 μ F 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 16 μ F at the rated working voltage.

to be continued

MEDIUM WAVE **DK** • 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 confictions 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 bandwidth 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 wobulator 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 pre-aligned and on setting up in the completed receiver

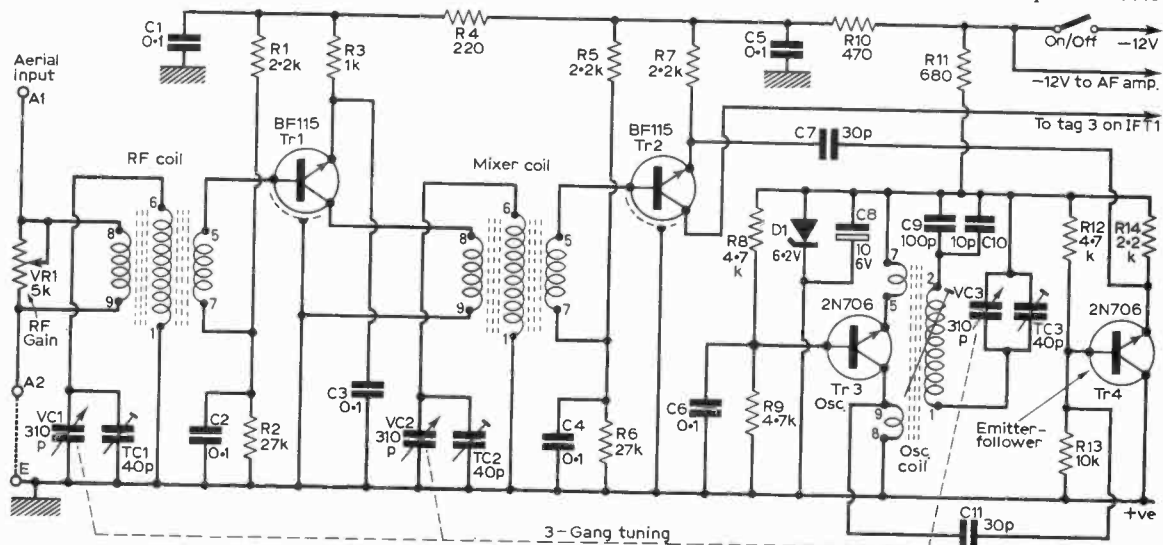


Fig. 1: The front end circuit of the prototype receiver. Alternative circuits are given elsewhere in the article.

★ 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 1in.
R7 2.2kΩ	R19 10kΩ	VR2 50kΩ log.
R8 4.7kΩ	R20 33kΩ	VR3 5kΩ log.
R9 4.7kΩ	R21 2.2kΩ	VR4 5kΩ 1in.
R10 470Ω	R22 470Ω	VR5 10kΩ 1in.
R11 680Ω	R23 560Ω	
R12 4.7kΩ	R24 4.7kΩ	

All resistors 10% $\frac{1}{4}$ W miniature, all potentiometers miniature carbon

Capacitors:

C1 0.1 μ F
C2 0.1 μ F
C3 0.1 μ F
C4 0.1 μ F
C5 0.1 μ F
C6 0.1 μ F
C7 30pF
C8 10 μ F 6V electrolytic
C9 100pF
C10 10pF
C11 30pF
C12 10 μ F 6V electrolytic
C13 10 μ F 6V electrolytic
C14 100 μ F 6V electrolytic
C15 100 μ F 15V electrolytic
C16 100 μ F 15V electrolytic
C17 100 μ F 15V electrolytic
C18 200 μ F 15V electrolytic
C19 1,000 μ F 12V electrolytic
C20 1,000 μ F 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

R.F. coil. Denco blue miniature dual purpose valve

coil 2T
Mixer coil Denco yellow

miniature dual purpose
valve coil 2T

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; 10 Ω -35 Ω 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 3 $\frac{3}{4}$ in., a.f. board 1 $\frac{3}{4}$ x 3 $\frac{3}{4}$ in.; three terminals; five knobs; two toggle on-off miniature switches; one single pole changeover switch; two PP1 batteries; battery clips.

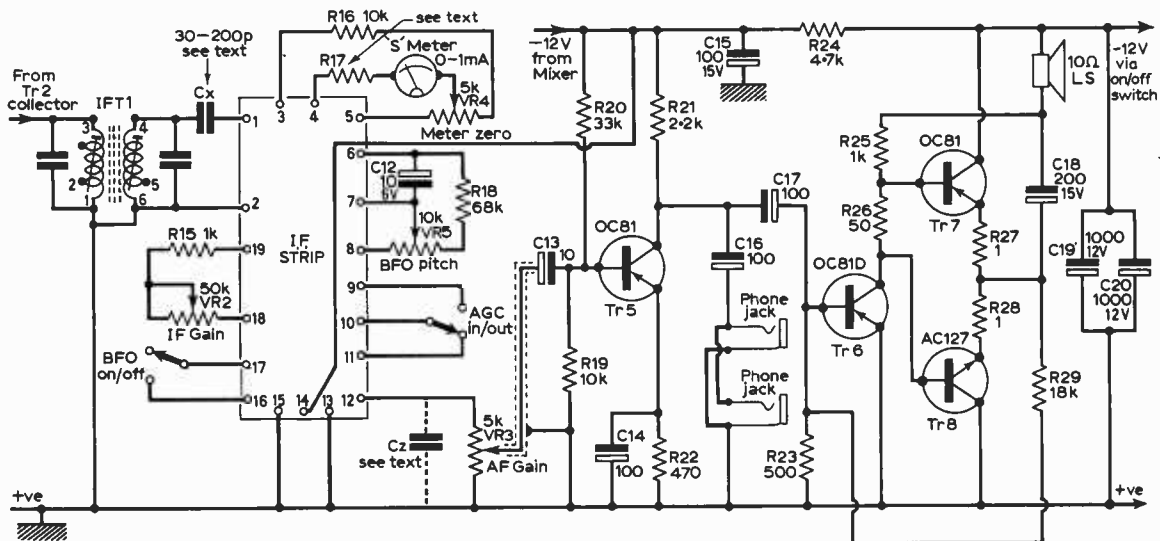


Fig. 2: The i.f., detector and audio stages. R17 is 1K in the prototype but its value will depend upon the d.c. resistance of the meter chosen.

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.

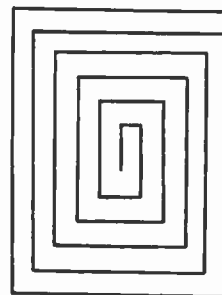
Two jack sockets are wired in immediately following the preamplifier stage. This was to allow headphone reception for one or two listeners or to take a lead out to a tape recorder. The speaker remains in circuit when these jacks are in use and it might be an idea to utilise jack sockets with spare contacts 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 output, 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.

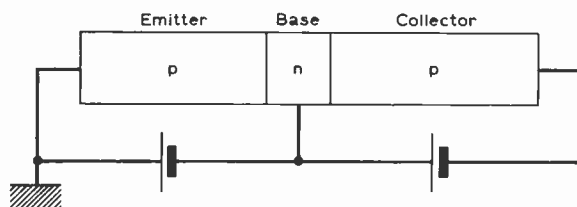


Fig. 1: Basic physical representation of a junction p-n-p transistor. The connections here correspond to the common emitter mode (emitter earthed).

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

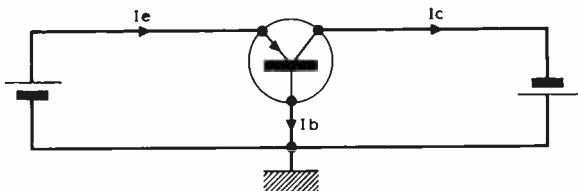


Fig. 2: Circuit showing the common base transistor arrangement (base earthed this time).

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 V_{bc} is large, perhaps 10V in a small transistor or 100V in a larger device. However the base to emitter voltage V_{be} 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 produced 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

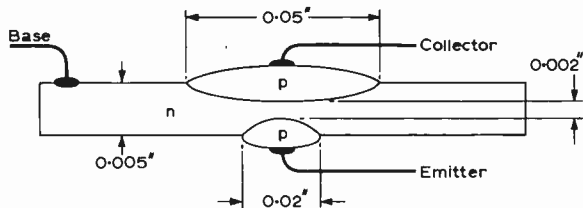


Fig. 3: The structure of a typical p-n-p alloy junction transistor.

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

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

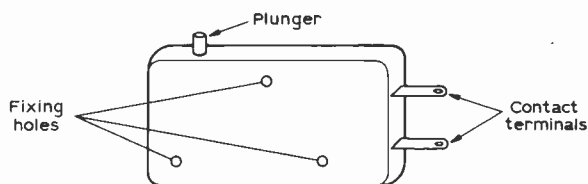


Fig. 8: Typical microswitch.

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 0.1 in.

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 require-

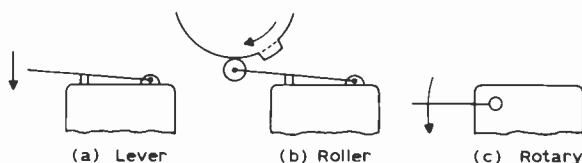


Fig. 9: Microswitch movements.

ment. 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

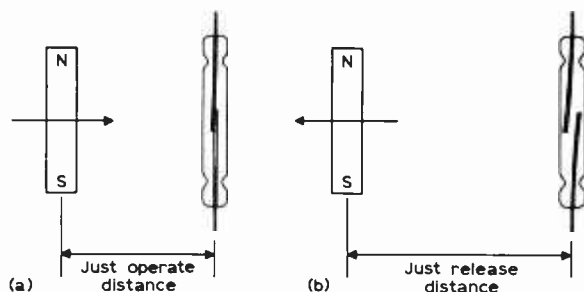


Fig. 10: Reed relay operation.

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.

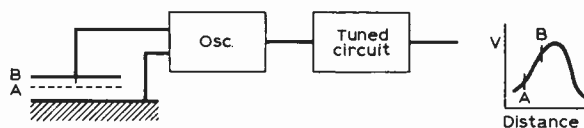


Fig. 11: Capacitance probe system.

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

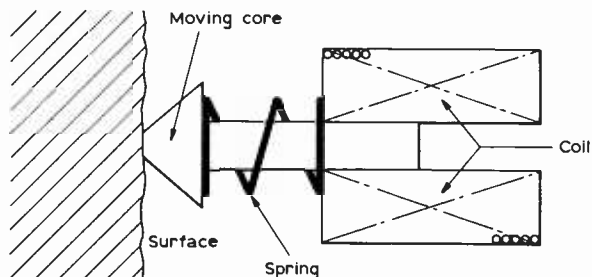


Fig. 12: Inductive proximity transducer.

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.

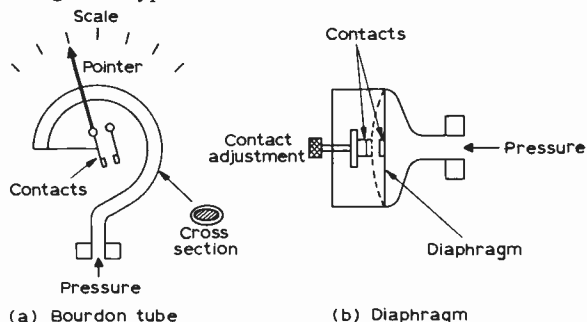


Fig. 13: Mechanical pressure gauge and transducer.

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 spec-

tral 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

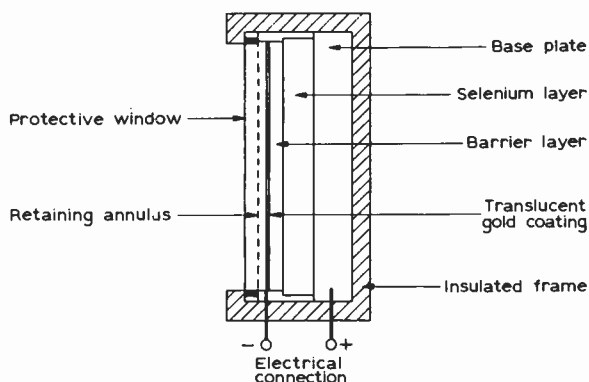


Fig. 15: Selenium photocell construction.

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. They 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.

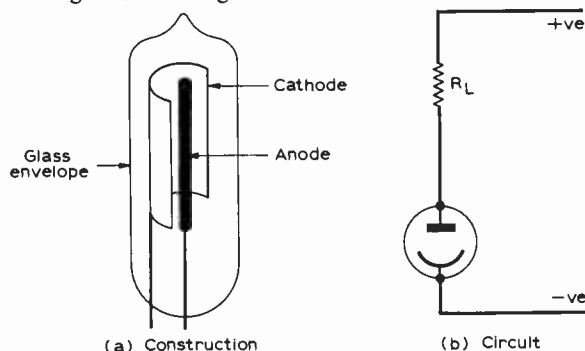


Fig. 16: The photoemissive valve.

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.

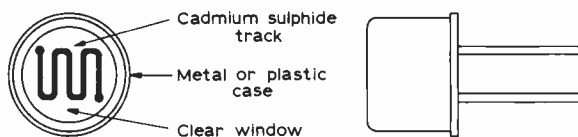


Fig. 17: The cadmium sulphide cell.

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

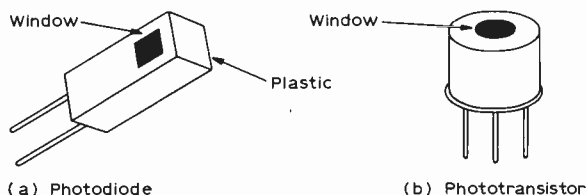


Fig. 18: Photodiode and phototransistor encapsulations.

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

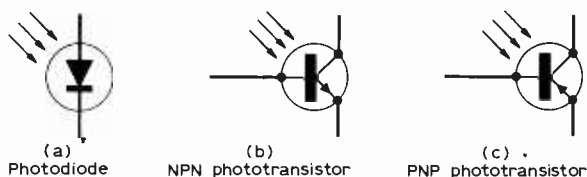


Fig. 19: Photodiode and phototransistor circuit symbols.



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

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.

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).

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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 budes 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 3 1/2 x 2 1/2 x 1 1/2 in. thick. The final drive shaft is 1/2 in. wide, 1 in. 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 2 1/2 in. 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 29/8 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 9 1/2 in. Pick-up is fitted with the famous "Studio" cartridge. Price 69/8, postage and insurance 6/6.

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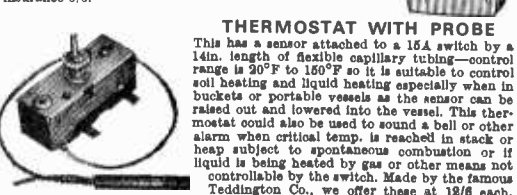
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OC45	2/6
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8C109	3/6
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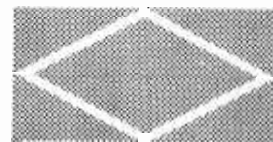
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a beginner's TRANSISTOR CAPACITANCE BRIDGE

PART 1

KEITH JOHNSON



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 16 μ F 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

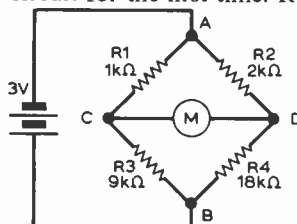


Fig. 1: A basic Wheatstone bridge.

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.

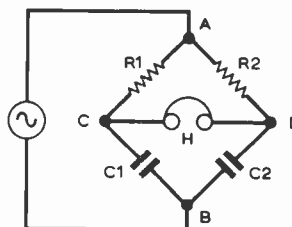


Fig. 2: A Wheatstone bridge adapted for reactance balancing, using an a.c. source and headphones for detecting balance.

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 100 μ F. In this way, capacitors from 1pF to 100 μ F 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.

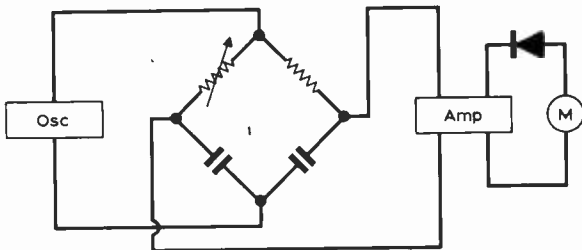


Fig. 3: A practical arrangement for a capacitance measuring bridge, with an amplifier and meter to give a more positive reading than Fig. 2.

This test is especially important in the case of the sub-miniature type of coupling capacitor (usually 4 or $8\mu\text{F}$) 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 bridge 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 R_1 and C_1 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. R_1 and C_1 will also vary the frequency, so these should be altered, if necessary, to provide a note of about 800



Hz indicated by headphones across R_2 . 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.

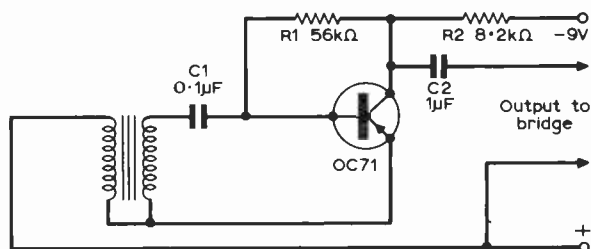


Fig. 4: A simple 800Hz audio oscillator suitable for driving a bridge.

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

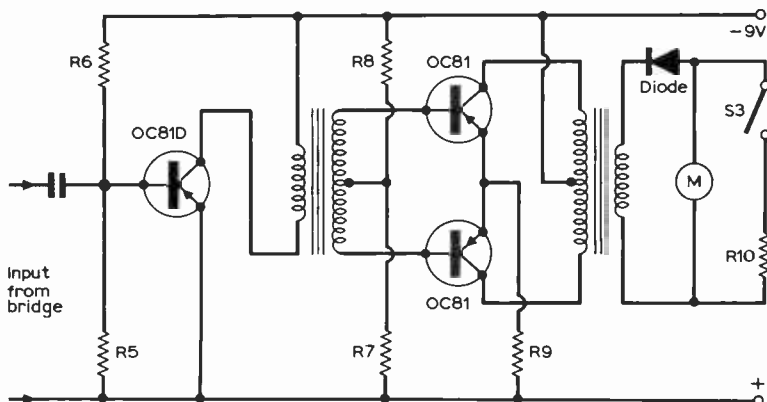
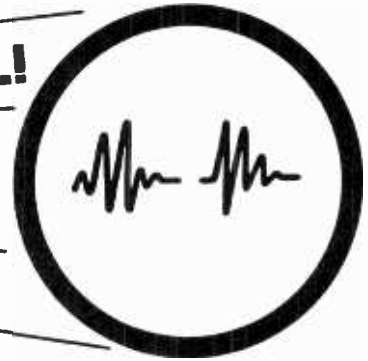


Fig. 5: A push-pull amplifier, detector and meter.

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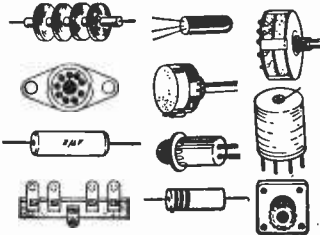
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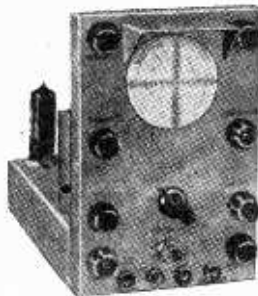
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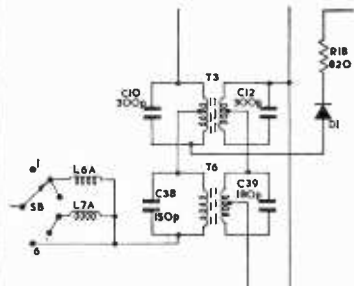


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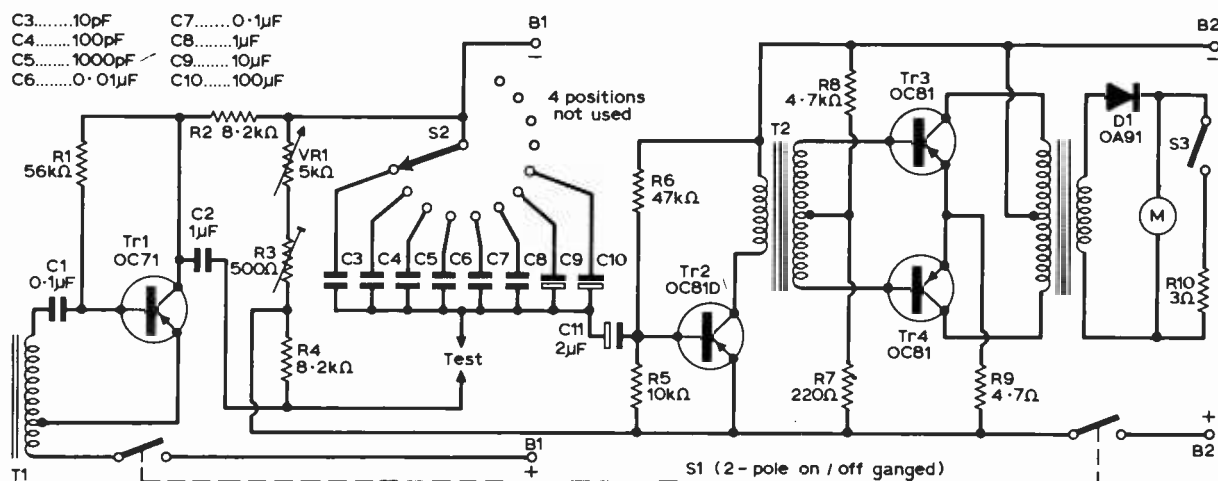
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meter of 0.5mA (500mA) f.s.d. was used; constructional details are therefore given using this meter, but, if a commercial meter is preferred, the front panel cut-out can be modified accordingly (see Fig. 8).

loads 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.

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.

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 $\times 100$ 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 $\times 1$ 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,

★ components list

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

C1	0.1 μ F	C7	0.1 μ F
C2	1 μ F	C8	1 μ F
C3	10 pF	C9	10 μ F
C4	100 pF	C10	100 μ F
C5	1,000 pF	C11	2 μ F
C6	0.01 μ F		

TR1	OC71	TR4	OC81
TR2	OC81D	D1	OA91
TR3	OC81		

T1 Interval transformer
T2 Driver transformer
T3 Output transformer

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.

vary C5 by substitution until the scale does register 2 at this point. Similarly, C6 on the $\times 10$ 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 1 μ F, 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 reduc-

Table I

Components	Value for full range coverage	Value for half coverage
C3-C10	10pF, 100pF etc.	10pF, 50pF, 100pF etc.
four additional capacitors	—	0.1 μ F, 0.5 μ F, 1 μ F, 5 μ F
VR1	5000 Ω pot.	2000 Ω pot.
R4	8.2k Ω	4.7k Ω

ing the capacitance coverage on each range by half. Suggested alterations to component values are given in Table 1.

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

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.

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.

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

PRACTICAL TELEVISION in the OCTOBER issue

TRANSISTOR AND DIODE ANALYSER

Not just a tester—an analyser! This tester will not only carry out the normal diode and transistor tests, including a test of transition frequency to establish the frequency limitations of a device, it can also be used to determine all the information required for experimental purposes on a transistor that is unmarked and whose connections, type and purpose are unknown. You don't even have to know whether it is a pnp or npn, germanium or silicon device.

HEAT EFFECTS IN TV RECEIVERS

Heat is the cause of more trouble in a TV set than any other shortcoming. The faults attributable to excess heat are examined and the steps that can be taken to reduce heat described.

TOMORROW'S SETS

Next month we shall be looking at the effects on TV receiver design of the increased use of integrated circuits over the next few years. The problems of design, the setmakers, the retail trade and servicing will all be considered.

TRANSISTOR LINE OSCILLATORS

Basic waveform generating circuits described, including the flywheel sync techniques invariably used with modern line oscillator stages.

SERVICING TV RECEIVERS

The next chassis to be tackled is the STC VC11 chassis as used in the KB Featherlight portable and associated models.

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September 19th

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PORTABLE CABINET As illustrated. To fit standard 75/- player or autochanger. **RCS AMPLIFIER 3 WATT.** Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve giving a 3 watt output into a 3 ohm loudspeaker. Tone and volume controls mounted on panel. Supplied with knobs, loudspeaker and valves UCL82, UY85. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6**

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S.R.B.P. drilled 1/16 in. Board. 10 x 8in. 3/-.

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2 1/2	3	4	5	6	8	10	15	20	30	50	100	200	500	1000	2000	5000	10000
2/350V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
4/350V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
8/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
16/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
32/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
64/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
128/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
256/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
512/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	
1024/450V	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	

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1, 2, 3, 4, 5, 8, 15, 25, 30, 50, 100, 250mF 15V 10/-; 500, 1000mF 15V 3/6; 2000mF 25V 7/-.

CERAMIC. 500V 1pF to 0.01mF, 9d.

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SILVER MICA. Close tolerance 1%, 5-500pF 1/-; 560-2,200pF 1/-; 2.700-5,500pF 3/8; 6,800pF 1/-, mid 6/8 each.

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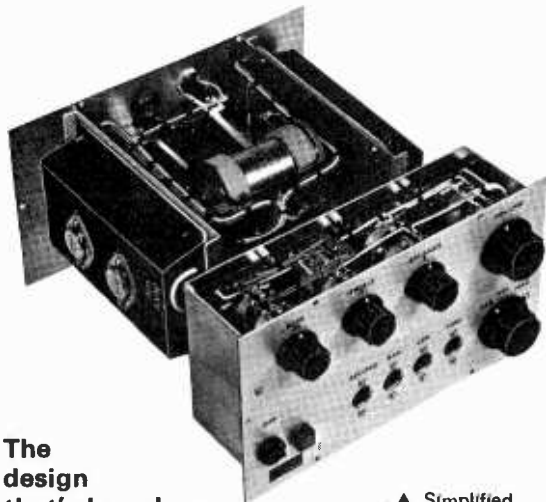
TRIMMERS. Compression ceramic 30, 50, 70pF 1/-; 100pF, 150pF, 250pF, 1/6; 600pF, 750pF, 1000pF, 2/6.

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Preferred values, 10 ohms to 10 meg. 1w, 1/4 w, 1/2 w, 2W, 5W, 10W, 15W, 20W, 25W, 30W, 35W, 40W, 45W, 50W, 55W, 60W, 65W, 70W, 75W, 80W, 85W, 90W, 95W, 100W, 110W, 120W, 130W, 140W, 150W, 160W, 170W, 180W, 190W, 200W, 220W, 240W, 260W, 280W, 300W, 330W, 360W, 390W, 430W, 470W, 510W, 560W, 620W, 680W, 750W, 820W, 910W, 1000W, 1100W, 1200W, 1300W, 1400W, 1500W, 1600W, 1700W, 1800W, 1900W, 2000W, 2200W, 2400W, 2600W, 2800W, 3000W, 3300W, 3600W, 3900W, 4300W, 4700W, 5100W, 5600W, 6200W, 6800W, 7500W, 8200W, 9100W, 10000W, 11000W, 12000W, 13000W, 14000W, 15000W, 16000W, 17000W, 18000W, 19000W, 20000W, 22000W, 24000W, 26000W, 28000W, 30000W, 33000W, 36000W, 39000W, 43000W, 47000W, 51000W, 56000W, 62000W, 68000W, 75000W, 82000W, 91000W, 100000W, 110000W, 120000W, 130000W, 140000W, 150000W, 160000W, 170000W, 180000W, 190000W, 200000W, 220000W, 240000W, 260000W, 280000W, 300000W, 330000W, 360000W, 390000W, 430000W, 470000W, 510000W, 560000W, 620000W, 680000W, 750000W, 820000W, 910000W, 1000000W, 1100000W, 1200000W, 1300000W, 1400000W, 1500000W, 1600000W, 1700000W, 1800000W, 1900000W, 2000000W, 2200000W, 2400000W, 2600000W, 2800000W, 3000000W, 3300000W, 3600000W, 3900000W, 4300000W, 4700000W, 5100000W, 5600000W, 6200000W, 6800000W, 7500000W, 8200000W, 9100000W, 10000000W, 11000000W, 12000000W, 13000000W, 14000000W, 15000000W, 16000000W, 17000000W, 18000000W, 19000000W, 20000000W, 22000000W, 24000000W, 26000000W, 28000000W, 30000000W, 33000000W, 36000000W, 39000000W, 43000000W, 47000000W, 51000000W, 56000000W, 62000000W, 68000000W, 75000000W, 82000000W, 91000000W, 100000000W, 110000000W, 120000000W, 130000000W, 140000000W, 150000000W, 160000000W, 170000000W, 180000000W, 190000000W, 200000000W, 220000000W, 240000000W, 260000000W, 280000000W, 300000000W, 330000000W, 360000000W, 390000000W, 430000000W, 470000000W, 510000000W, 560000000W, 620000000W, 680000000W, 750000000W, 820000000W, 910000000W, 1000000000W, 1100000000W, 1200000000W, 1300000000W, 1400000000W, 1500000000W, 1600000000W, 1700000000W, 1800000000W, 1900000000W, 2000000000W, 2200000000W, 2400000000W, 2600000000W, 2800000000W, 3000000000W, 3300000000W, 3600000000W, 3900000000W, 4300000000W, 4700000000W, 5100000000W, 5600000000W, 6200000000W, 6800000000W, 7500000000W, 8200000000W, 9100000000W, 10000000000W, 11000000000W, 12000000000W, 13000000000W, 14000000000W, 15000000000W, 16000000000W, 17000000000W, 18000000000W, 19000000000W, 20000000000W, 22000000000W, 24000000000W, 26000000000W, 28000000000W, 30000000000W, 33000000000W, 36000000000W, 39000000000W, 43000000000W, 47000000000W, 51000000000W, 56000000000W, 62000000000W, 68000000000W, 75000000000W, 82000000000W, 91000000000W, 100000000000W, 110000000000W, 120000000000W, 130000000000W, 140000000000W, 150000000000W, 160000000000W, 170000000000W, 180000000000W, 190000000000W, 200000000000W, 220000000000W, 240000000000W, 260000000000W, 280000000000W, 300000000000W, 330000000000W, 360000000000W, 390000000000W, 430000000000W, 470000000000W, 510000000000W, 560000000000W, 620000000000W, 680000000000W, 750000000000W, 820000000000W, 910000000000W, 1000000000000W, 1100000000000W, 1200000000000W, 1300000000000W, 1400000000000W, 1500000000000W, 1600000000000W, 1700000000000W, 1800000000000W, 1900000000000W, 2000000000000W, 2200000000000W, 2400000000000W, 2600000000000W, 2800000000000W, 3000000000000W, 3300000000000W, 3600000000000W, 3900000000000W, 4300000000000W, 4700000000000W, 5100000000000W, 5600000000000W, 6200000000000W, 6800000000000W, 7500000000000W, 8200000000000W, 9100000000000W, 10000000000000W, 11000000000000W, 12000000000000W, 13000000000000W, 14000000000000W, 15000000000000W, 16000000000000W, 17000000000000W, 18000000000000W, 19000000000000W, 20000000000000W, 22000000000000W, 24000000000000W, 26000000000000W, 28000000000000W, 30000000000000W, 33000000000000W, 36000000000000W, 39000000000000W, 43000000000000W, 47000000000000W, 51000000000000W, 56000000000000W, 62000000000000W, 68000000000000W, 75000000000000W, 82000000000000W, 91000000000000W, 100000000000000W, 110000000000000W, 120000000000000W, 130000000000000W, 140000000000000W, 150000000000000W, 160000000000000W, 170000000000000W, 180000000000000W, 190000000000000W, 200000000000000W, 220000000000000W, 240000000000000W, 260000000000000W, 280000000000000W, 300000000000000W, 330000000000000W, 360000000000000W, 390000000000000W, 430000000000000W, 470000000000000W, 510000000000000W, 560000000000000W, 620000000000000W, 680000000000000W, 750000000000000W, 820000000000000W, 910000000000000W, 1000000000000000W, 1100000000000000W, 1200000000000000W, 1300000000000000W, 1400000000000000W, 1500000000000000W, 1600000000000000W, 1700000000000000W, 1800000000000000W, 1900000000000000W, 2000000000000000W, 2200000000000000W, 2400000000000000W, 2600000000000000W, 2800000000000000W, 3000000000000000W, 3300000000000000W, 3600000000000000W, 3900000000000000W, 4300000000000000W, 4700000000000000W, 5100000000000000W, 5600000000000000W, 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330000000000000000W, 360000000000000000W, 390000000000000000W, 430000000000000000W, 470000000000000000W, 510000000000000000W, 560000000000000000W, 620000000000000000W, 680000000000000000W, 750000000000000000W, 820000000000000000W, 910000000000000000W, 1000000000000000000W, 1100000000000000000W, 1200000000000000000W, 1300000000000000000W, 1400000000000000000W, 1500000000000000000W, 1600000000000000000W, 1700000000000000000W, 1800000000000000000W, 1900000000000000000W, 2000000000000000000W, 2200000000000000000W, 2400000000000000000W, 2600000000000000000W, 2800000000000000000W, 3000000000000000000W, 3300000000000000000W, 3600000000000000000W, 3900000000000000000W, 4300000000000000000W, 4700000000000000000W, 5100000000000000000W, 5600000000000000000W, 6200000000000000000W, 6800000000000000000W, 7500000000000000000W, 8200000000000000000W, 9100000000000000000W, 10000000000000000000W, 11000000000000000000W, 12000000000000000000W, 13000000000000000000W, 14000000000000000000W, 15000000000000000000W, 16000000000000000000W, 17000000000000000000W, 18000000000000000000W, 19000000000000000000W, 20000000000000000000W, 22000000000000000000W, 24000000000000000000W, 26000000000000000000W, 28000000000000000000W, 30000000000000000000W, 33000000000000000000W, 36000000000000000000W, 39000000000000000000W, 43000000000

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The design that's based on PEAK SOUND "Cir-Kit"

- ▲ Simplified Unit Construction
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This 12+12 watt integrated stereo hi-fi amplifier and pre-amp is proving one of the most successful P.W. designs ever. With good ancillary equipment, you will find it one of the best you have ever heard, and it is a delight to build and handle. Basically, the design of the "P.W. Double 12" as described in P.W. April, May and June demonstrates the value of using "Cir-Kit". However, Peak Sound have contributed more besides to the success of this project. This includes the power amplifiers, the power pack and the ingenious cabinet which almost assembles itself. Go right ahead and build this exciting new design now with authentic, exact-to-specification Peak Sound kits as recommended by the designers.

This is your PW Double 12 Shopping List

These are the Peak Sound units with which you can build this excellent design. Transistors included.

- 2 Spools of "Cir-Kit" at 2/- each 4 0
- 2 Pre-amp and tone control kits 4 13 0
- 4 Pre-amp matrix boards 7 0
- 2 PA.12-15 Power Amplifier Kits 7 19 0
- 2 Heat Sink assemblies 12 0

- 2 P.A. matrix boards 8 0
- 1 PS.45K 45 volt power supply kit 4 10 0
- 1 Pack-flat afrormosia teak finished Cabinet kit 2 12 6
- 5 Controls as specified 2 0 0

TOTAL COST £23 5 6

- Hardware Kit of knobs, plugs, sockets, switches, fuses, screws, wire, etc. £2 10 0
- Metalwork cut, shaped and punched. £2 12 6

P.W. Double 12 abridged specification

Controls—Bass and treble cut and lift based on Baxandall circuitry/Volume/Balance/Rotary selector.
Input Sensitivity—Magnetic P.U. (per channel) 2.5mV into 68k Ω . Ceramic P.U.—25mV into 27k Ω , equalised for flat response. Radio/Aux. 60mV. HIGH OVERLOAD FACTOR ON ALL INPUTS.
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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.

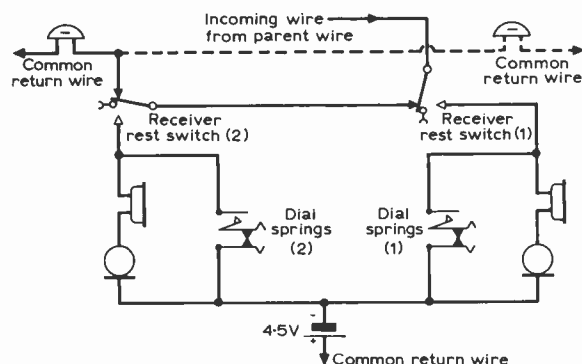


Fig 10: Two extensions having access to two-wire line to parent

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.

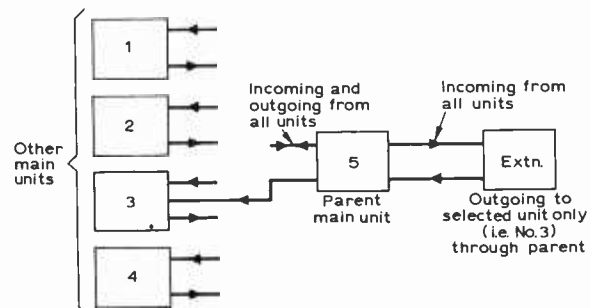


Fig. 11: Block diagram showing connection of auto-extension.

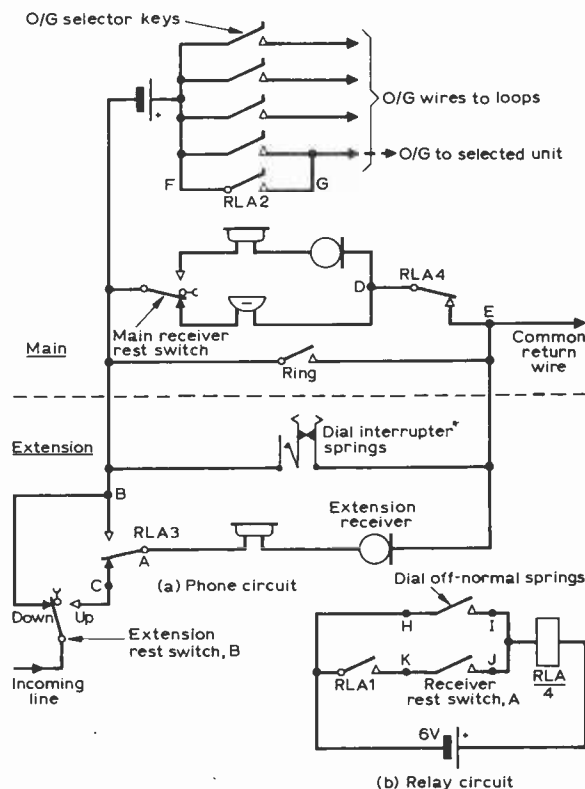


Fig. 12: Circuit diagram of auto-extension.

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

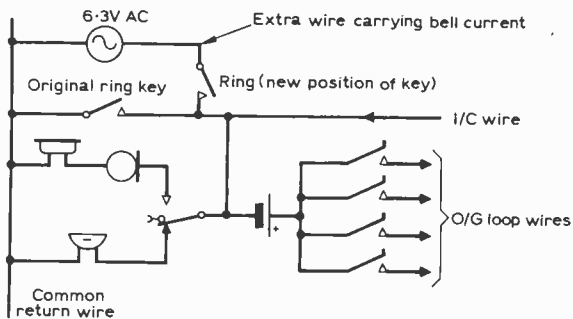


Fig. 13: Modification of circuit for a.c. ringing.

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.

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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 wobblulator 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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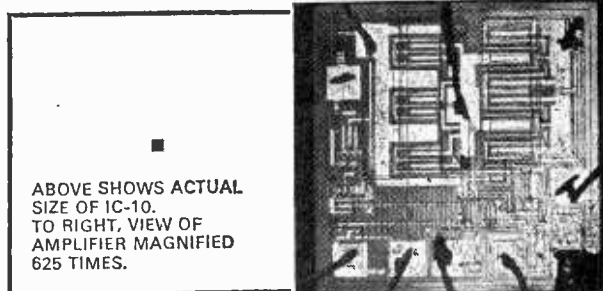
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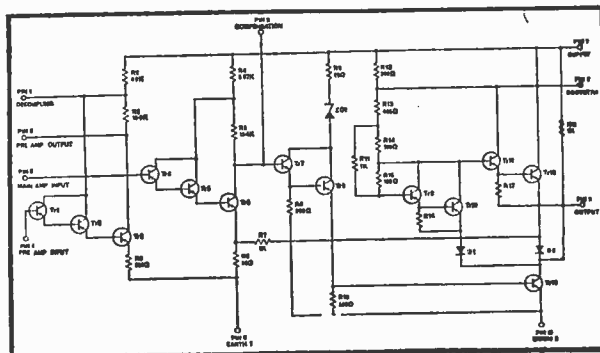
■ Specifications

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.
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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.



■ 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.

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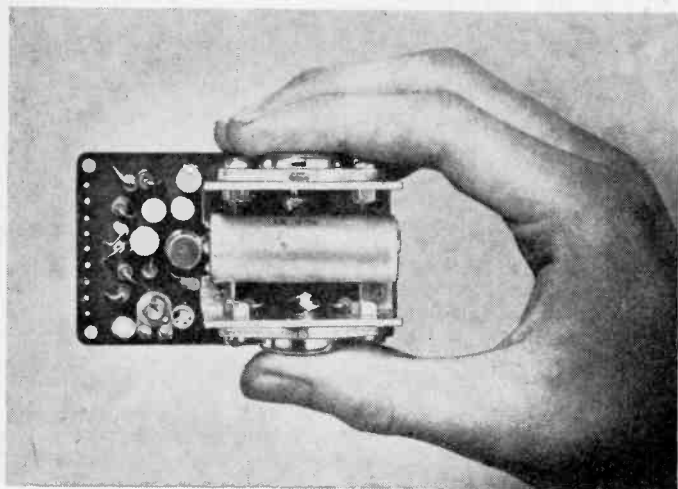
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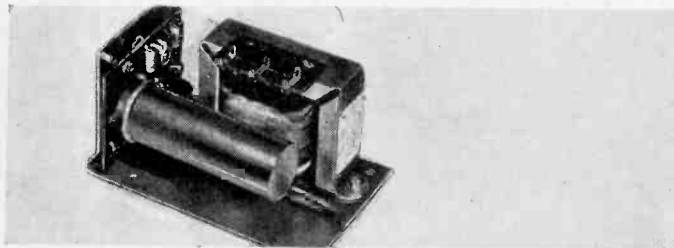
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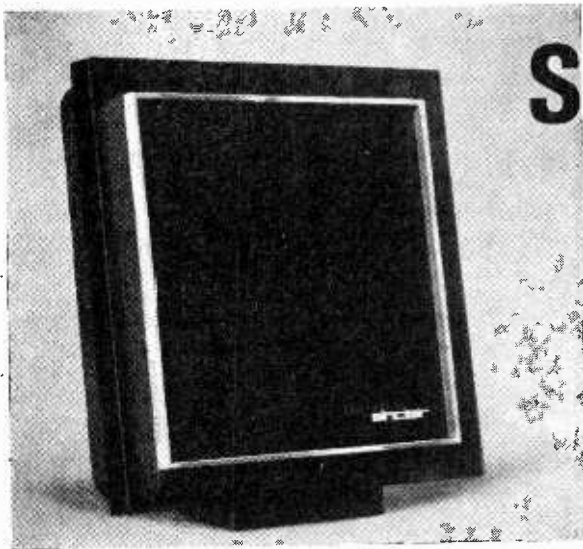
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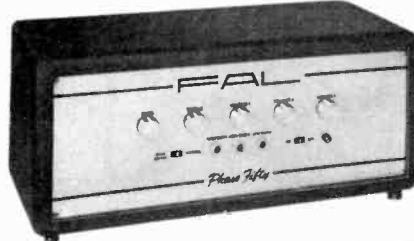
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Miniature, fully enclosed, rear tags, carbon brush wiper. Long life, low noise. Body dia., 1/8 in. Spindle, 1 in. × 1/8 in. 1/4W at 70°C. ±20% below 1/4M, ±30% over 1/4M. Lin. 100 ohms to 10 Megohms. Log. 5 Kohms to 5 Megohms.

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1/4W at 70°C. Long Spindle.

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Prices—per ohmic value each 10 off 25 off 100 off

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3.5mm. Type P6. Standard. Unscreened. Unbreakable moulded cover.

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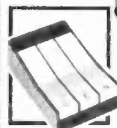
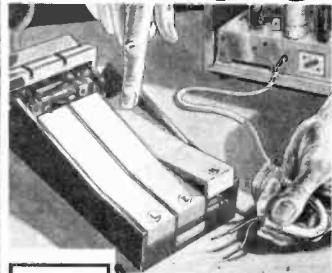
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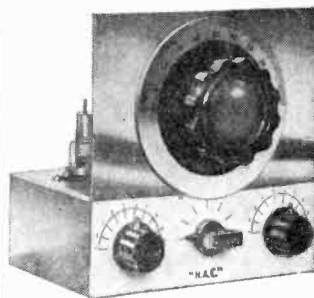
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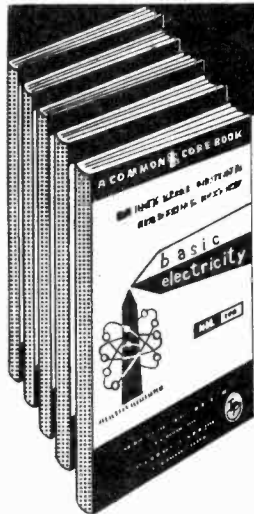
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OA47	1/9	OC81D	2/-
OA81	1/6	OC82D	2/3
OA85	1/6	OC140	5/-
OA91	1/9	OC169	3/6
OC23	6/6	OC170	2/3
OC25	5/-	OC171	2/2
OC26	5/-	OC202	4/6
OC28	6/6	TK22C	1/6

Crystal Diodes—6 for 2/6 (7d.).

Additional Transistors—AF147 and AF150, 24v. Larger envelope, 4 leads, collective current 10mA, gain 70—4/- each. AF149—gain 225—4/6 each.

Also 8µF 50V 1/2, 25µF 25V 1/3 and 50µF 50V 1/8. Other electrolytics in current list. Postage, Packing and Insurance all above 7d. up to 3/-; 1/- from 4-11/-; 12/- and over paid.

2.0 µF VAR. CONDENSER: Mod., air-spaced, .0005 ea. sec. 5/- (1/-).

SUB-MIN. TRANSFORMERS Output (3 for OC72 etc.) 2/8. Driver 2/9 (either 7d.).

MULTIMETER: 20,000 Ω/V D.C., 10,000 Ω/V A.C. 0-5/25/50/250/500/1K volts D.C.

0-10/50/100/500/1K volts A.C. 0-50 µA/2-5mA/250mA D.C. 0-6K Ω/6 meg Ω

0-10 µA/0-100mV/1mV. —20 to +22dB. Complete with test leads and instructions.

Over-load protected 1989 model with every refinement. \$4.7.6 (8/- p. & p.). JUNIOR MODEL

at 47/6 (2/6) 100 Ω/V described in free list.

SOLDERING IRON. Slim Mod. British High speed, 8½ in., all parts replaceable, fully

guaranteed for professional, radio and general D.I.Y. use. 19/6 (1/-)

DIAMOND STYLII Replacements for BSR TC8LP, TC8/S and TC8LP/STEREO:

COLLARO "O": RONETTE BP40LP; GARRARD GC2LP and GC8LP; ACOS GP85/67;

all at 7/6 each (6d.). ACOS GP91 8T/LP; BSR 8T4 and 8T9; SONOTONE 9TA and

9TAHC, PHILIPS AC808 and 3060 (3063, 3066, 3301, 3302, 3304) state whether 4 in. or

4½ in. type, all at 18/6 (6d.).

SHAPIRE all the above 7/6 types only, also ACOS GP37 at 3/6 each (6d.). ACOS

GP91 at 6/9 (6d.). No other types at present, and no 78 rpm available in any type.

PICK-UP CARTRIDGES, all fitted 8T4 and Standard fittings. Mono GP87/2, 13/6. Mono

de Luxe GP112, 17/-. Stereo Compatible—Mono which also plays Stereo records

monaurally with min. wear, GP81/2, 19/6. Latest Stereo GP88, 22/-. Ceramic

8T4, top quality for expensive outfit, GP84, 38/6 (all 1/-).

PP3 ELIMINATOR (A.C.) 17/6. (1/6) TWO STATION TRANS. INTER-COM. Excellent

baby alarm. Instant, easy fitting with leads, plugs and battery. All you require 52/6 (3/-).

TRANSISTORISED AMPLIFIERS, 3 watt, 9V operation, 45/6 (1/6); 7½ watt, 6 trans.

24V operation, 67/6 (2/6).

Extra High Torque MINI-MOTOR, 4½ to 12V, 1½ x ½ in. 5/- (6d.). 9,000 r.p.m.

SUBSTITUTION BOXES, Capacitance 24/9 (1/6). Resistance 22/6 (1/6). Both full range and

complete. Full details in list.

TEST PROBES: Flexible, unbreakable 24" Red and Black leads, 1/6 "4" probe, 1½" plugs

4/9 (9d.).

RECORDING TAPE: Finest quality British Mylar. STANDARD: 5 in. 600ft. 7/8, 5½ in.

800ft. 8/9, 7 in. 1200ft. 11/8. LONG PLAY 5 in. 900ft. 10/-, 5½ in. 1200ft. 11/8, 7 in. 1800ft.

12/- (1/3 each). Still the finest quality and value obtainable.

MICROPHONES—CRYSTAL, MIC91, Desk, 16/8; MIC45, curved hand grip 17/8; Stick

"60" 20/8; Stick "39" 28/6 (1/6 each type). Cream plastic hand type 7/6, or with "strut"

stand, switch and 2 leads with 2-5 and 3-5 plugs 11/-, Lapel (or hand) with clip 6/6 (1/-).

Machined metal tapered stick type with neck cord and adaptor to fit standard floor stands,

25/- (1/6). DYNAMIC: Cream hand/table 14/- (1/-). MS10 50K Ω, 3½ x ½ in. with Base,

Adaptor and Neck Cord 37/6 (2/6). MS11, similar, but fixed on flexible 5/4 in. neck to switch-

fitted base 42/6 (2/6). DM128 Uni-directional, 50K/600 ohms imp, stand adaptor, very

high quality 6½ x 2 x 1½, \$5.9.6 (5/-).

CARDIOID DYNAMIC OMNI-DIRECTIONAL: Two highly successful mikes "SQUARE"

208, \$5.10.0. "BALL" type, 209, with built-in vol. control, switch 50K/600 ohms imp.,

\$5.17.6 (either type 5/-). Full details in list.

MICROPHONE INSERTS: Diameter 1.7 in. or 0.9 in. either size 5/6 (6d.).

SPEAKERS: 12 in. round, fitted Tweeter, 6W, 3 or 15 Ω (state which), 55/6 (5/6); 2 in. 3Q

6/6 (1/-); 6 x 4 heavy duty 3Q 14/6 (3/6) or for Stereo 34/6 pair, post etc. paid. Limited

quantity powerful 2 in. FM transistor replacement speaker, high ohms, excellent, 5/6

(1/-). HEADPHONES High Res. 2000 Ω ea. Earpiece 18/6 (1/6); Stereo Dyn 8-16 Ω,

89/- (3/-); EARPIECES with lead etc. Min. Plug Magnetic 1/6 (state whether 2-5 or

3-5mm.). Crystal 4/9 (either 7d.). (3-5mm. only).

AERIALS, Car Types: Telescopic, vandal proof, locks retracted, 2 keys and all fittings

28/6 (2/6). Motor driven, 12V, 5 section, complete 27.10.0 (5/-).

FOR ALL PORTABLES and F.M. SETS. Telescopic 5 section 54-22 in. with swivel, 5/6.

7-Section 54-32 in., no swivel, screw hole in base, 6/6. 10-section 64-47 in., no swivel,

screw hole in base, 12/6. DISAPPEARABLE 8 section, swivel fixing assembly, 64/35 in. 10/-.

New 8 section 54/25 in., screw hole in base no swivel 4/-, (1/- all sizes).

SWITCHES: Standard toggle, metal, 250V 2A. One hole fixing: SPST 2/3, SPDT 2/9.

DPST 3/-, DPDT 3/8. Slide types. Sub-min. DPDT 1/6 each. Small DPDT 3 way, centre

"off" 1/9. Reed magnetic on/off 1/9 (7d. each, all types). Rotary Switches etc. in list.

VIBRATORS: Famous makes only. 12 volt 4 pin non-synch 2/6, 12 volt 7 pin synch 10/-

6 volt 7 pin synch 10/- (1/- each, all types).

MAINS NEON TESTER: Fly leads 2/- (7d.). Pocket screwdriver type 2/6 (6d.). PLUGS: Std.

Jack, plastic body 2/8. Screened 3/-, Sockets 1/11 (all 7d.). VALVE HOLDERS: B70 or

B94, Moulded 6d. (7d. up to 4, 1/- over 4). CONNECTING WIRE: 5 coils assd. cols. each

5 yds. Solid Core 2/6 (7d.). Flexible 3/- (9d.). Super thin for transistor wiring etc. 3/- (7d.).

PICK-UP WIRE: Twin Super thin Flex, Screened, Shashed, 1/3 yd. (6d. up to 6 yds.,

over 6 yds. post free). TWIN MIKE CABLE: 1/8 yd. SINGLE MIKE CABLE: 7d. yd.

Both flexible, screened and sheathed. FREDER CABLE: Twin r.f. bal. "Bg. 8", 80 Ω,

or flat 300 Ω transparent polythene insulated, either 6d. per yd. (all cables up to three

yards 8d., each additional yard, 1d. extra).

R.F. INDICATOR, 5-Band, with meter antenna, monitoring crystal earpiece etc., 48/6

(1/6). Details in list.

RETRACTABLE FLEXIBLE LEADS. Space saving "Curly", many uses in car and home:

with phono plug each end, 6 ft. 4/8; 12 ft., 7/8. With phono plug one end, phono socket

at other, 6 ft., 5/-, 12 ft., 8/6 (9d. on any).

CAR RADIO: Splendid new All-British dash-mounting radio using Mullard transistors

and circuit. M. and L. wave. Separate speaker and baffle. Absolutely complete, for + or

— chassis. \$11.11.0 (6/8). A huge success since introduction.

CURRENT LIST: Send a free for a.s.e. details of cable, croc. clips and leads,

volume controls, Continental din plugs for Grundig, Telefunken equipment, etc., dials,

plugs and sockets, panel meters, record player and tape recording accessories. Battery

chargers, test equipment, test prods, tape recorder, special transistors, portable sets,

more switches and other components, tools, Veroboard etc. This advertisement cancels

all previous ones and lists supplied prior to August 31st.

FELSTEAD ELECTRONICS

(PW23)

LONGLEY LANE, GATLEY, CHEADLE, CHESHIRE, SK8 4EE

TERMS: Cash with order only. No C.O.D. or caller service. Post, packing and insurance charges are shown in brackets after all items. Regret orders under 5/- plus carriage cannot be accepted, and a minimum charge of 1/- is now made. Charges apply to G.B. and Eire only. Overseas air or surface mail extra at cost, plus 3/2 registration or insurance fee. S.A.E. please for all enquiries, otherwise regret cannot be replied to.

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500 CHESHAM HOUSE,
150 REGENT ST., LONDON, W.1.

KING OF THE PAKS SUPER PAKS

Unequaled Value & Quality

BI-PAK NEW—UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	Price
U1	120 Glass Sub-min. General Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/RF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10/-
U4	40 Germanium Transistors like OC91, AC128	10/-
U5	60 200mA Sub-min. Sil. Diodes	10/-
U6	40 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	10/-
U8	50 Sil. Planar Diodes 250mA OA200/202	10/-
U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U12	12 Silicon Rectifiers EPOXY BY126/127	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 28104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1,000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
U20	12 1.5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/-
U21	30 AF Germanium alloy Transistors 2G300 Series & OC71	10/-
U22	10 1-amp Glass Min. Silicon Rectifiers High Volts	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/-
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U26	30 Fast Switching Silicon Diodes like 1N914 Micro-min.	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/-
U29	10 1-amp SCR's TO-5 can up to 600PIV CRS1/25-600	20/-
U30	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/-
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/-
U32	25 Zener diodes 400mW D07 case mixed Volts, 3-18	10/-
U33	15 Plastic case 1-amp Silicon Rectifiers 1N-4000 series	10/-
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2N302/4	10/-
U35	25 Sil. Planar trans. PNP TO-18 2N2906	10/-
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10/-
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2N322	10/-
U38	20 Fast Switching Sil. trans. NPN 400Mc/s 2N3011	10/-
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	10/-
U40	10 Dual trans. 6 lead TO-5 2N3060	10/-
U41	30 RF Germ. trans. TO-1 OC45 NKT72	10/-
U42	10 VHF Germ. PNP trans. TO-1 NKT667 AF117	10/-

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

FULLY TESTED

AC107	3/6
AC126-7-8	2/6
AF116-117	1/6
AF139	10/-
AL102	15/-
BC107-8-9	5/-
BFY60-81-82	7/6
BSY26-7	3/6
BSY28-9	4/6
BSY96-95A	4/6
OC22-25	5/-
OC26-35	5/-
OC28-29	7/6
OC44-45	1/9
OC71-81	5/6
OC72-75	2/6
OC81D-82D	2/6
OC82	2/6
OC140	5/-
OC170	2/6
OC171	2/6
OC201	7/6
ORP12-80	8/6
OCPT1	8/6
OA5-10	1/9
OA47	2/-
OA79	1/9
OA79	1/9
OA81-85	1/6
OA91	1/3
OA95	1/9
OA300	3/6
OA309	3/6
2N696-7	3/6
2N706	3/6
2N708	5/-
2N2160	15/-
2N2646	15/-
2N2712	5/6
2N2926	2/6
MAT100-101	3/6
MAT120-121	3/6
8T140	3/6
8T141	4/6
2N3819	10/-
2N3820	25/-

TESTED SCR's

PIV	1 AMP	7A	16A	30A
25	7/6	8/6	10/6	25/-
50	7/6	8/6	10/6	25/-
100	8/6	10/-	15/-	45/-
200	12/6	15/-	20/-	55/-
300	15/-	20/-	25/-	—
400	17/6	25/-	35/-	80/-
500	30/-	40/-	45/-	95/-
600	—	40/-	50/-	—

SIL. RECTS. TESTED

PIV	750mA	3A	10A	30A
50	1/-	2/9	4/8	9/6
100	1/3	3/8	4/8	15/-
200	1/8	4/-	4/9	20/-
300	2/3	4/8	9/6	25/-
400	2/6	5/6	7/6	28/-
500	3/-	6/-	8/6	30/-
600	3/3	6/9	9/-	37/-
800	3/6	7/6	11/-	40/-
1000	5/-	9/3	12/6	50/-
1200	6/8	11/6	15/-	—

PLEASE NOTE. To avoid any further Increased Postal Charges to our Customers and enable us to keep our "By Return Postal service" which is second to none, we have re-organized and streamlined our Despatch Order Department and we now request you to send all your orders together with your remittance, direct to our Warehouse and Despatch Department, postal address: **BI-PAK SEMI-CONDUCTORS**, Despatch Dept., P.O. BOX 6, WARE, HERTS. Postage and packing still 1/- per order. Minimum order 10/-.

BRAND NEW TEXAS GERM. TRANSISTORS

Code and Guaranteed	Pak No.	EQVT.
T1 8 2G3710	OC71	10/-
T2 8 2G374	OC75	10/-
T3 8 2G3744A	OC81D	10/-
T4 8 2G381A	OC81	10/-
T5 8 2G382T	OC82	10/-
T6 8 2G344A	OC44	10/-
T7 8 2G345A	OC45	10/-
T8 8 2G378	OC78	10/-
T9 8 2G399A	2N1302/10	10/-
T10 8 2G417	AF117	10/-

FULL RANGE OF ZENER DIODES
VOLTAGE RANGE 2-16V.
400mW 2/6 each
1.5W 8/6 each
10W 5/- each
All fully tested. State voltage required.

180 VCB NIXIE DRIVER TRANSISTOR 8lm. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND120. 1-24 3/6 each. TO-5 NPN 25 up to 8/- each.

UNIUNCTION

UT46 Eqty. 2N2646, 7/6
Eqvt. T1843 BEN3000 7/6
25-99 5/-, 100 up 4/- each

PRINTED CIRCUITS

EX-COMPUTER
Packed with semiconductors and components, 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards 10/-. Plus 2/- P. & P.

GRAND CLEARANCE SALE

everything must go

SUPER WHIP AERIALS. Brand new specially designed telescopic, chrome plated 25in. sectional aerials. Consists of 6 sections and screw base. An ideal aerial for TX/RX use. Price only 6/6 each, p.p. 1/6. Two aerials for 12/6 post free. Four aerials £1 post free.

PRECISION METERS. Brand new and boxed, size 3 1/2 in. sq. Type 1 0-500V FSD; Type 2 0-150 mA. Moving coil movement. Fully guaranteed. List £3.10.0. Sale price 30/- each. Two for 50/- post free.

RADIATION METERS. Pocket type. Brand new in makers cartons. Only 9/6 each, p.p. 1/6. Two for 17/6 post free.

TANNOY MIKES (Heavy Duty). Ideal for P.A. work. Complete with high quality moving coil headphones. Only 17/6, p.p. 5/-.

PRINTED CIRCUIT TOP BAND SUPERHET CHASSIS. Uses standard components. Complete with circuit. Only 15/- post free.

MINIATURE TRANSISTORISED B.F.O. UNIT. A compact B.F.O. unit that will enable your set to receive CW or SSB. Compact single hole fixing. The Unit will fit anywhere. Ideal for all Ex-Govt. and Commercial receivers. Complete with fitting instructions. Only 39/6, p.p. 2/6.

19 SET CONTROL BOXES. Brand new and boxed. 10/-, p.p. 5/-.

HEAVY DUTY POWER SUPPLY UNITS. Famous manufacture. Input 200/250V A.C. Output 250V D.C. at 175 mA. 6.3V/12V at 4A. Robust rack mounting cabinet. List £42. Sale price 69/6 carr. 10/-.

MATCHING MAINS P.S.U. For R1132 and 1392 receivers. Brand new and boxed only 59/6, carr. and insurance 10/-.

GOVERNMENT SURPLUS WIRELESS EQUIPMENT HANDBOOK. Gives circuit details and notes on most British and American wireless equipment. Only 35/-, p.p. 5/-.

R.F. AMPLIFIERS No. 2 Mk. III. Increase the output from your TX. Only 79/6, carr. 10/-.

DOUBLE 365 pF tuning capacitors with slow motion drive. Brand new. Normally 17/6 each. Our price 6/- each, p.p. 1/6. Two for 10/- post free. £1 for five post free.

RUBBER TELEPHONE HANDSETS. Moving coil type with press-to-talk switch and connecting cable. Brand new and boxed. 7/6 each, p.p. 2/6. 2 for 15/-, post free.

RHEOSTAT DIMMER UNITS. Will control up to 50V at 3A. Compact metal case. Ideal for lab. work. Only 15/-, p.p. 2/6. Two for 30/- post free.

IFT TRANSFORMER SETS. Comprising double tuned 1st and 2nd 3rd If single tuned. Only 12/6 per set of three post free.

TELEPHONE SPARES. 600 TYPE RELAYS. Only 3/6 each, p.p. 1/-.

Ten for £1 post free. **EYEBALL INDICATORS.** 6/- each. Four for £1 post free. **TELEPHONE DIALS** 4/6 each, p.p. 1/6. Four for £1 post free.

2 1/2 in. MOVING COIL SPEAKERS. 3 ohms. Brand new. Only 4/11, p.p. 1/1. Two for 10/- post free. **30 mfd 250V WIRE ENDED TUB ELECTROLYTIC CAPS.** £1 per doz. post free. 10 mfd 15V working tag ended electrolytics, 1/6 each. 10/- per doz., post free.

MEDIUM WAVE FERRITE SLAB AERIALS. Will fit most transistor radios. Only 3/6 each, p.p. 6d. Two for 6/- post free. Four for 10/- post free.

TELEPHONE EXCHANGES. PMBX Type Ex-GPO in good condition. Complete and ready to use. Cordless type only £13.10.0, carriage 50/-.

Cord type £12.10.0, carriage 30/-.

AIRCRAFT BAND CHASSIS. Printed circuit uses standard components. Full circuit details only 17/6 post free.

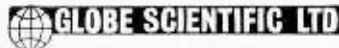
SMOOTHING UNITS. Cure your hum problems. Beautifully made pieces of equipment. 12V or 24V DC input gives a fully smoothed, fully regulated DC output. Worth £30 each. Robust metal cabinet with provision for stand-by battery. Brand new in makers cartons, price 55/- post free.

HANDY PLASTIC CASES. Size 2 1/2 x 1 1/2 x 3/4 ins. Ideal for building your transistorised equipment into. Only 1/- each, p.p. 4d. 12 for 10/- post free. 24 for 15/- post free. 50 for 30/- post free. 100 for 50/-, p.p. 5/-.

A very versatile little box.

ELECTRONIC CAR FAULT TRACING UNIT/BATTERY CHARGER. A wonderful piece of equipment enabling you to trace most faults on your car and a great aid to tuning your car. Meant to sell at six guineas each. Sale price £4.15.0, carriage and insurance 5/-.

Full 12 months guarantee. An ideal Christmas present.



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Fully guaranteed Individually packed VALVES

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Open 9-12.30, 1.30-5.30 p.m. Thursday 9-1 p.m.

MANY OTHERS IN STOCK include Cathode Ray Tubes and Special Valves. U.K. Orders up to 10/-, 1/-; 10/- to £1, 2/-; over £1, 2/- per £1; over £2 post free. C.O.D. 4/- extra

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ALL valves
guaranteed

TRANSISTORS, ZENER DIODES etc.

CY31	7/6	ECL80	8/6	KT66	21/-
DAF90	7/6	ECL82	6/6	KT88	29/-
DF96	7/6	ECL83	10/6	N78	15/-
DF92	9/-	ECL86	8/6	OA2	6/6
DK96	7/6	EF36	3/6	OB2	6/6
DL92	4/6	EF37A	3/6	PABCS8	7/6
DL94	6/6	EF39	6/6	PC86	10/6
DL96	8/6	EF40	9/6	PC97	9/6
DM70	6/6	EF41	10/6	PC900	7/6
DM71	7/6	EF42	13/6	PC84	6/6
DY86	6/6	EF80	4/6	PC89	9/6
DY87	6/6	EF83	9/6	PC189	10/6
DY802	9/6	EF85	6/6	PC82	17/-
EABL80	6/6	EF86	6/6	PC801	15/6
EAF42	9/6	EF89	5/6	PC82	6/6
EB91	2/6	EF91	3/6	PCP84	9/6
EB93	3/6	EF92	2/6	PCF86	9/6
EB94	9/6	EF95	5/6	PCF200	15/6
EB95	6/6	EF183	6/6	PCF201	15/6
EBF80	7/6	EF181	7/6	PCF801	3/6
EBF83	8/6	EF800	21/6	PCF802	9/6
EBF89	6/6	EF812	18/6	PCF805	14/6
EC081	6/6	EF1200	15/6	PCF806	14/6
EC082	5/6	EH90	7/6	PCF809	14/6
EC083	5/6	EL34	10/6	PCH200	12/6
EC084	5/6	EL41	10/6	PCL81	9/6
EC085	5/6	EL42	11/6	PCL82	7/6
EC086	5/6	EL44	10/6	PCL83	13/6
EC088	7/6	EL85	4/6	PCL84	8/6
EC089	9/6	EL86	5/6	PCL85	9/6
EC084	12/6	EL800	17/6	PCL86	8/6
ECF80	6/6	EL8035	17/6	PFL200	
ECF82	6/6	EM31	5/6		
ECF83	12/6	EM80	7/6	PL36	10/6
ECF80112	6/6	EM84	7/6	PL81	9/6
ECF80212	6/6	EM87	11/6	PL82	8/6
ECF80312	6/6	EY61	7/6	PL83	7/6
ECI84	7/6	EY86	8/6	PL84	6/6
ECI83	7/6	EY88	8/6	PL500	13/6
ECI42	10/6	EZ40	8/6	PX4	14/6
ECI81	5/6	EZ41	8/6	PX25	12/6
ECI83	10/6	EZ80	5/6	PY33	10/6
ECI800		EZ11	5/6	PY50	6/6
		EZ34	11/6	PY81	5/6

OA5	2/6	OC16	15/-	OC83	5/6	AC176	7/6	CR81/20	9/6	MPF102	
OA10	3/6	OC22	10/-	OC83B	4/6	AC178	4/6	CR81/30		MPF103	9/6
OA70	2/6	OC26	7/6	OC139	7/6	AD140	13/6		10/-	MPF104	
OA71	2/6	OC28	5/6	OC140	9/6	AF117	5/6	CR81/35			10/-
OA79	1/6	OC39	15/-	OC170	5/6	AF118	10/6	CR81/40	11/6		
OA81	1/6	OC35	10/6	OC171	6/6	AF124	7/6				
OA200	1/6	OC38	3/6	OC172	7/6	AF127	5/6	CR81/40	12/6		
OA202	2/6	OC44	4/6	OC200	7/6	AF139	10/6	CR83/05	6/6		
OA210	7/6	OC45	2/6	IN21	3/6	AF178	12/6	CR83/20			
OA211	8/6	OC71	2/6	IN21B	5/6	AFY19	22/6				
OA220011		OC72	4/6	IN25	12/6	AFY28	5/6	CR83/30	9/6 ca.		
OA220110		OC73	11/6	IN43	4/6	BFY19	5/6				
OA2202	6/6	OC75	6/6	IN70	4/6	BFY27	5/6	CR83/40	15/6		
OA2206	8/6	OC76	5/6	2N1306	6/6	BFY51	5/6				
OA2207	8/6	OC81	4/6	2N1307	6/6	BFY52	4/6				
OA2208	6/6	OC81D	3/6	28303	10/6	BY213	5/6				
OA2223	6/6	OC82	5/6	AC126	6/6	BY215	5/6				
OA2225	10/6	OC82	5/6	AC127	7/6	CR81/10	5/6				
		OC82DM	3/6	AC128	6/6						

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6K25G	16/6	12Q7GT	5/6	1822	17/6
6L6	14/6	12R7	4/6	2051	5/6
6L6GA	9/6	14S7	15/6	3505	13/6
6P25	13/6	19AQ5	5/6	3576	10/6
6SA7	7/6	19G3	60/6	5678	10/6
6SA7GT	6/6	19G6	20/6	5726	7/6
6SC7	7/6	19H4	70/6	5933	22/6
6SC7GT	5/6	20P4	20/6	6067	10/6
6SG7	6/6	25L6GT	7/6	6060	7/6
6SJ7	6/6	30C15	15/6	6064	7/6
6SJ7GT	6/6	30C17	18/6	6065	8/6
6SJ7Y	6/6	30C18	15/6	6080	27/6
6SK7	7/6	30F5	10/6	6146	28/6
6SL7GT	6/6	30FL1	15/6	9001	3/6
6SN7GT	6/6	30FL12	19/6	9002	4/6
6SQ7GT	7/6	30FL13	9/6	9003	8/6
6V6G	2/6	30FL14	15/6	9004	2/6
6V6GT	6/6	30L15	17/6	9006	2/6
6V6M	3/6	30L17	17/6	C.B. Tubes	
6X4	4/6	30P12	16/6	E4504/B	16/6
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6X5GT	5/6	30PL1	14/6	VC97	32/6
6-30L2	14/6	30PL13	18/6	VC9139A	30/6
6Z4	5/6	42	5/6	VC917B	30/6
7C5	14/6	50CD6G		VC91750	30/6
7C6	6/6	50EH5	7/6	VC917B	30/6
7D4	3/6	50E15	7/6	55/6	
7Y4	9/6	75	5/6	VC917C	30/6
9D6	2/6	78	5/6	5CP1	30/6
11E2	30/6	80	7/6	5FP7	26/6
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12AU7	4/6	807	9/6	6M6Z5	45/6
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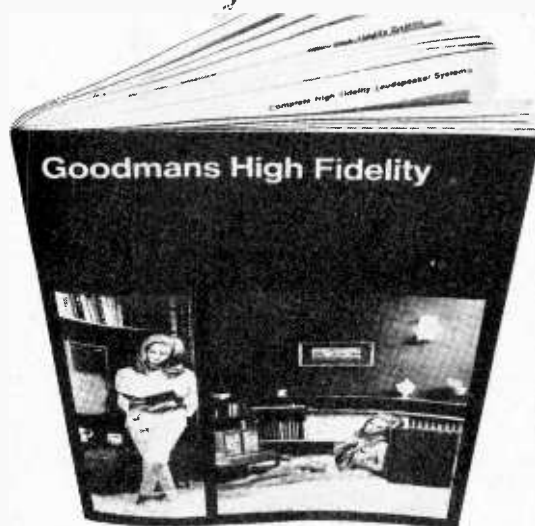


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PC97	9/6	PL82	8/6	U92	8/6	W729	12/6
PC900	9/6	PL83	8/6	U93	11/6	Z309	10/6
PC984	7/6	PL84	7/6	U403	10/6	Z319	55/6
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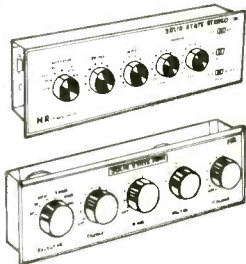
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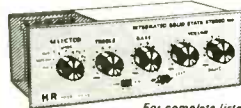
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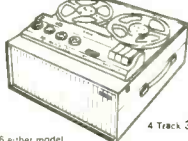
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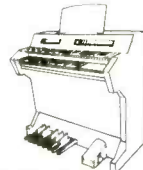
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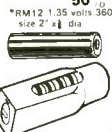
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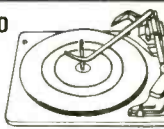
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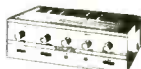
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