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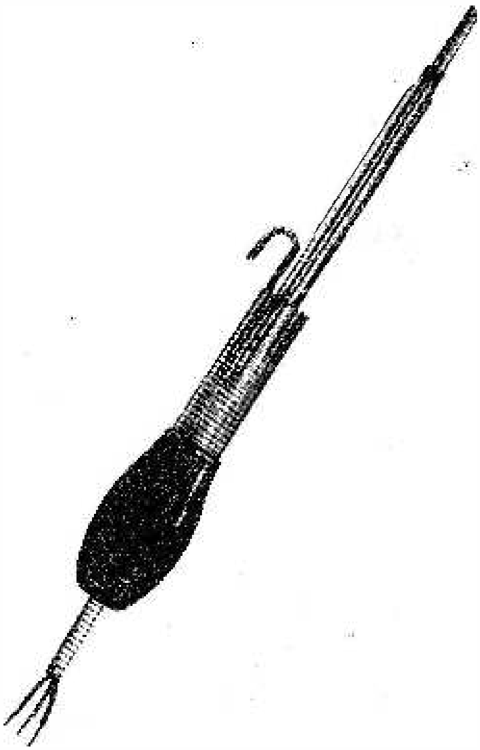

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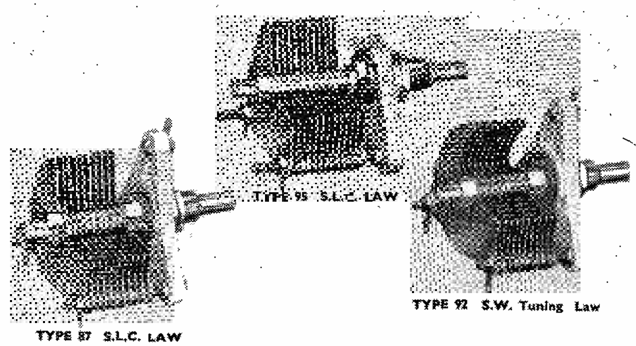

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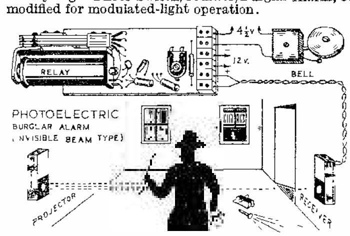

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Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.
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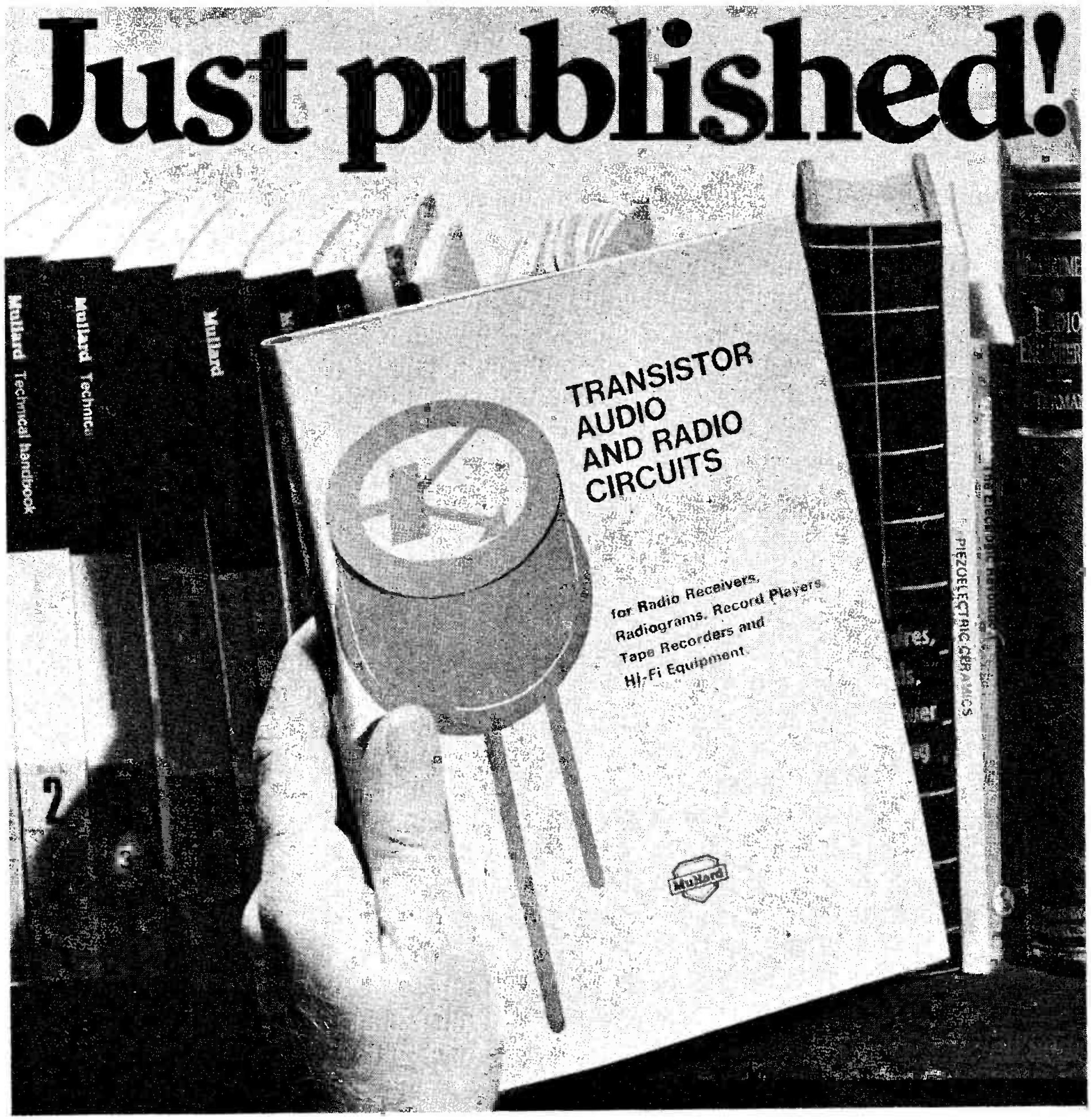

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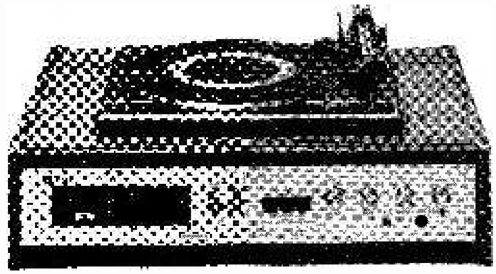

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The Orion is supplied fully built and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic carrying case—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others.

LASKY'S PRICE ONLY 39/6 Post 2/6 Extra rechargeable battery 3/6

***NOTE: The battery we supply with the Orion is a rechargeable type. Charger units are available enabling you to recharge the battery from AC Mains 220/240V supply.**

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3¼in.	Triple play, 600ft. Mylar	10 0
4in.	Triple play, 900ft. Mylar	17 6
5in.	Double play, 1200ft. Mylar	15 0
5in.	Long play, 900ft. Acetate	10 0
5in.	Standard play, 600ft. PVC	8 6
5in.	Triple play, 1800ft. Mylar	35 0
5¾in.	Double play, 1800ft. Mylar	22 6
5¾in.	Long play, 1200ft. Acetate	12 6
5¾in.	Standard play, 850ft. PVC	11 6
5¾in.	Long play, 1200ft. Mylar	15 0
5¾in.	Triple play, 2400ft. Mylar	45 0
7in.	Standard play, 1200ft. Acetate	12 6
7in.	Standard play, 1200ft. Mylar	12 6
7in.	Long play, 1800ft. Mylar	19 6
7in.	Double play, 2400ft. Mylar	25 0
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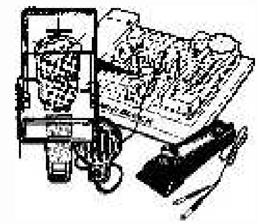
DENSHI BOARD KITS

EXPERIMENTAL AND EDUCATIONAL CIRCUIT SYSTEM



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

THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES:
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DENSHI BOARD KIT SR-1A *comprises:*
Base board; tuner block; 4 resistors; choke coil; transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces. **This kit permits the building of 16 basic circuits.**

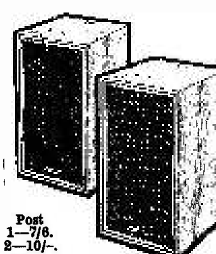
LASKY'S PRICE 87/6 Post 3/6

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

LASKY'S PRICE £6.2.6 Post 2/6

NEW! FOSTER "Criterion" MkII

2 SPEAKER TWO WAY BOOKSHELF SPEAKER SYSTEM



Another high quality sub-miniature bookshelf system from Foster. The "Criterion" Mk. II is a sealed infinite baffle type enclosure using 5¼in. bass/mid-range woofer with rolled cloth edge and a 2¼in. HF cone type tweeter. The compact cabinet is constructed of ½in. laminate with handsome oiled walnut veneer finish and black woven acoustic gauze front panel with satin chrome edge insert. SPEC: Frequency range 90–20,000Hz. Power handling 10 watts. Impedance 8 ohms. HF crossover. Screw tag connections at rear. Size 12¼ × 7¾ × 6¾in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

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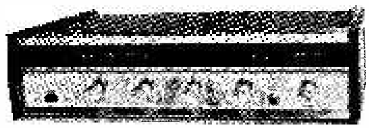
"NOVA" TRANSISTOR STEREO AMPLIFIER



A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 10 watts per channel. Frequency response 40-20,000 Hz ± 3dB. Inputs for radio, P.U. Ceramic, P.U. Magnetic Tape, Separate bass and treble controls, Volume and Balance controls Mono/Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14⅛×9½×3½in. A.C. 200/250V.

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

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E.M.I. 13×8in. HI-FI SPEAKERS

Fitted two 2½in. tweeters and crossover network. Impedance 3 and 15 ohms. Handling capacity 10 watts. Brand new.

99/6 P. & P. 7/6

Also available without tweeters

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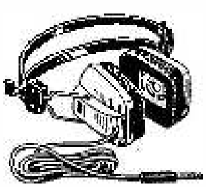
HI-FI STEREO HEADPHONES



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

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

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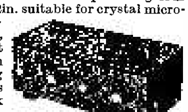
Specification as above. £18 18 0, Carr. 10/-.

SAVE NEARLY £5!

Premier Stereo System with "Nova" 10 watt Stereo Amplifier as above. 45 Gns. Carr. 35/-.

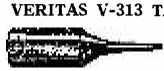
VERITAS V-149 MIXER



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

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

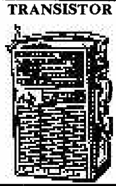
VERITAS V-313 TAPE HEAD DEFLUXER



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

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

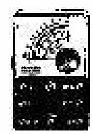
JULIETTE NA.5018 5 BAND 18 TRANSISTOR MAINS BATTERY RADIO



Covers AM 540–1600Kc/s. Marine 1.6–4.6Mc/s. FM 88–108Mc/s. VHF 108–134Mc/s. PB 148–174Mc/s. Ferrite bar aerial for AM MB. Telescopic aerial for FM/VHF PB. 4" P.M. Speaker and BFO switch. Operates on AC 250v. or D.C. by four 1.5v. batteries. Size: 9⅜" x 5¾" x 3⅜".

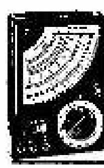
PREMIER PRICE 39 GNS. P. & P. 10/-.

MULTI TESTERS



"TEST 7". A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0–15–150–1000 volts. Resistance 0–100,000 ohms. Current 0–150 mA D.C. Size only: 3⅝" x 2¼" x 1⅛" Complete with battery test leads and instructions.

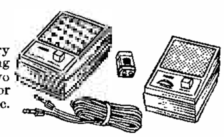
59/6 P. & P. 2/6.



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

£4.19.6 P. & P. 3/6.

TWO STATION TRANSISTOR INTERCOMS.

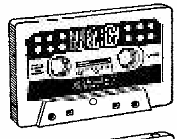


Complete with battery and 50ft. connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc.

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

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

"PREMIER" TAPE CASSETTES



C60 (60 min.) **7/6**
THREE FOR 21/-
C90 (90 min.) **12/6**
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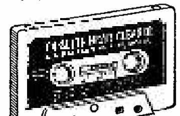
C120 (120 min.) **17/6**
THREE FOR 51/-
P. & P. 1/-.

CASSETTE HEAD CLEANER



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

11/6 P. & P. 1/-.

"VERITONE" RECORDING TAPE

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

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

LP3	3"	250'	P.V.C.	5/6	LP6	5¾"	1200'	P.V C.	12/6
TT3	3"	450'	POLYESTER	7/6	DT6	5¾"	1800'	POLYESTER	22/6
DT3	3¼"	600'	POLYESTER	11/6	TT6	5¾"	2400'	POLYESTER	37/6
SP5	5"	600'	P.V.C.	8/6	SP7	7"	1200'	P.V C	12/6
LP5	5"	900'	P.V.C.	10/–	DT7	7"	2400'	POLYESTER	25/–
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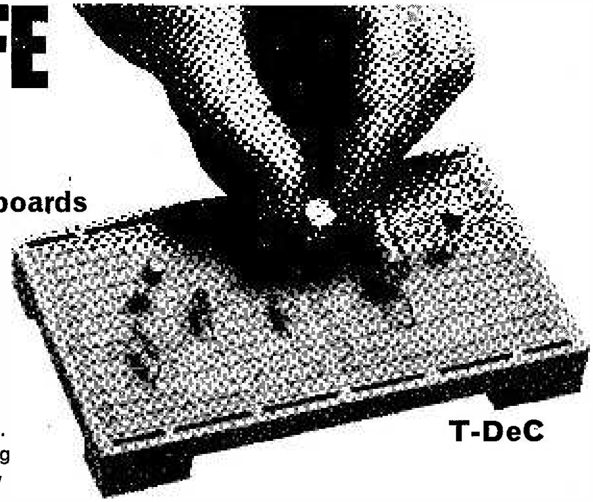

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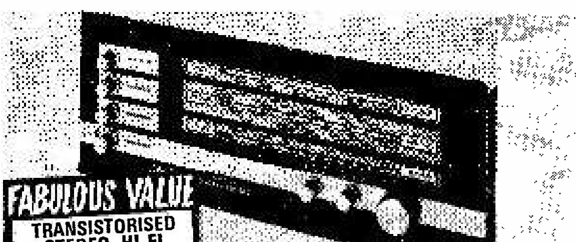

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FULLY TRANSISTORISED STEREOPHONIC RADIOGRAM CHASSIS

Complete with 2-10″ x 6″ speakers and the latest BSR Mono/Stereo Record Changer – a complete radiogram at half normal price ONLY

10 Watts Total output
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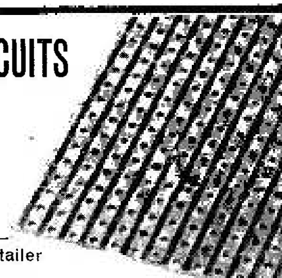

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TYPE AAU-4. Provides Stereo Record/Replay connections between 2 Stereo or Mono Tape Recorders, to 1 Stereo Amplifier. One Recorder can be permanently installed in the cabinet with amplifier, connected via the rear sockets. The other can be used externally, and be connected to the front socket as required.

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51/2B

Complete stereo system – £29-10

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"×4" speaker and 2¼" tweeter. Teak finish 12"×6¾"×5¾". **4 guineas** each. 7/6d. p. & p.
Type 2 as type 1. Size 17½" × 10¾" × 6¼". Incorporating 10½" × 6½" bass unit and 2¼" tweeter. 3 ohms impedance **5½ guineas** plus 7/6 p. & p. 7/6d. p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

The items illustrated can be purchased together for £29-10.

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. Cross-talk better than 30dB at 1 Kc/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.

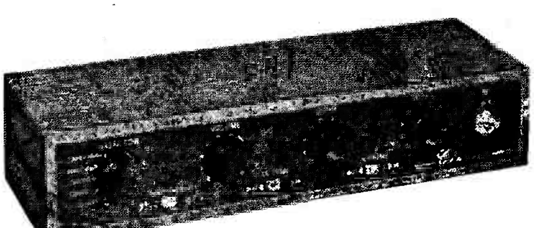
Duetto **Integrated Transistor Stereo Amplifier** **£9-10** **plus 7/6d. p. & p.**

The above 5 items can be purchased together for £29.10 + £1.10.0 p. & p.

The Classic **£9** plus 7/6 p. & p.

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

Specification: Sensitivities for 10 watt output at 1KHz into 3 ohms. *Tape head:* 3mV (at 3¾ i.p.s.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80 mV. *Tuner:* 100mV. *Aux.:* 100mV. *Tape/Rec. output:* Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ±13dB at 60Hz. Treble ±14dB at 15KHz. *Total distortion:* (for 10 watt output) <1·5%. *Signal noise:* <—60dB. A.C. mains 200–250v. Built and tested. Size 12½in. long, 4½in. deep, 2¾in. high. Teak finished case.



The Viscount **£14.5** plus 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. A.C. Mains Input: 200–240V. 50–60Hz. Size, 12¼" x 6" x 2¾" in teak finished case. Built and tested.
VISCOUNT MARK II for use with magnetic pick-ups specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1kc. Input impedance 47k. **£15.15** plus 7/6 p. & p.

also see opposite page

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comprising SP 25 Garrard Mk II with diamond cartridge, Viscount Mk I amplifier, two type 2 speakers, plinth and cover

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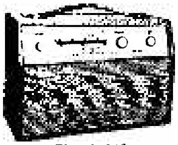

Circuit 2/6
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The ELEGANT SEVEN
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7 transistor fully tunable M.W.–L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.
MAINS POWER PACK KIT: 9/6 extra.

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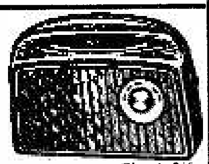
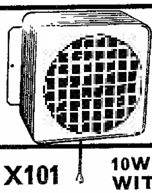


Circuit 2/6
FREE WITH PARTS.



EXTRACTOR FAN

A.C. mains 230/250v. complete with pull switch. Size: 6 × 6 × 4in.

Price **27/6** plus 7/6 P. & P.

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. DC. at 800mA (6-24V. may be used).

Price **69/6** plus 2/6 P. & P.

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:
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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 hardwear (screws, washers, etc.).

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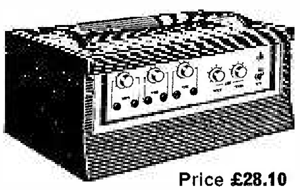
A.C. Mains 200-250V



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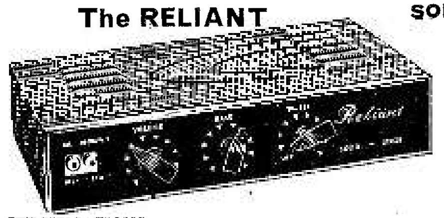
An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money. TECHNICAL SPECIFICATIONS 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The 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 300mV 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 60Hz. Bass Cut —13dB at 60 Hz. Treble Boost +11dB at 15 KHz. Treble Cut —12dB at 15 KHz. With bass and treble controls central —3dB points are 30 Hz and 20 KHz. POWER OUTPUT: For speech and music 50 watts rms. 100 watts peak. For sustained music 45 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. Total distortion at 20 watts 0.15% at 1KHz. Output to match into 8 or 15 ohms speaker system. NEGATIVE FEEDBACK 20dB at 1KHz. SIGNAL TO NOISE RATIO 60dB. MAINS VOLTAGES adjustable from 200–250V. A.C. 50–60 Hz. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

B.S.R. TD-2 TAPE DECK

Takes 5¾in. spools, fitted with B.S.R. ½ Track Heads. Size 13¼in. long by 8¾in. wide.

Price **£8.19.6** plus 7/6 P. & P.

The RELIANT
SOLID STATE GENERAL PURPOSE AMPLIFIER



SPECIFICATIONS
Output—10 watts
Output Impedance—3 to 4 ohms
Inputs—1. -xtal mic 10mV
2. -gram/radio 250mV
Tone Controls—Treble control range ±12dB at 10 KHz.
Bass control range ±13dB at 100Hz
Frequency Response—(with tone controls central) Minus 3dB points at 20Hz and 40KHz. Signal to Noise Ratio—better than —60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input—220/250V. A.C. Size of chassis—10½" × 4¾" × 2½". For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control from gram. and mike. Built and tested. 8" × 5" speaker to suit price 14/6 plus 1/6 p. & p. Crystal mike to suit 12/6 plus 1/6 p. & p.

RELIANT Mk. I
As above less teak case
£5.15 plus 7/6 P. & P.

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In teak finished case.
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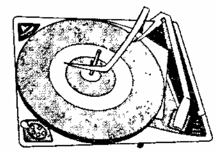
The "Princess", 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7" to 10" or 12". Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself 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 ins. 7/6 extra.



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Inputs—6 position rotary switch (3 position mono, 3 position stereo). Tuner 150mW into 680k. Magnetic pick-up fully equalised and suitable for magnetic cartridges with minimising output of 4mV/cm/sec. Load 47k. Ceramic pickup 150mV into 680k. Sensitivities taken for 200mV output. Controls—separate volume controls for each channel. Twin ganged bass, 12dB lift and 15dB cut at 60c/s. Twin ganged treble, 10dB lift and 15dB cut at 10kc/s. Voltage required 23–30V DC at 5mA. Size 12½ × 3¼ × 2¾in. In teak finished case, complete with front panel and knobs, Built and tested.

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

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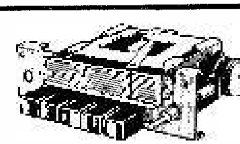
Push Button Tuning Heart

This PRESTOLOCK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6¼" × 4" × 2". As illustrated but without knobs.



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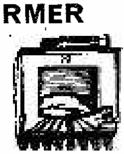

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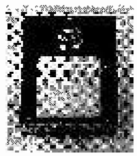

POWER CONTROLLER. Power at your finger tips. Not merely half wave control but full wave. A single variable control gives zero to full power. Uses latest 15amp 3kW triac and special triggering device. Ideal for all types of lighting, fires, motors, drills, etc. Complete with box, power socket, cables, etc. In kit form with easy to follow instructions **£6.9.6.** Ready built **£9.4.6** plus 5/6 P.P. & Ins.

VOX SWITCH. This sound operated switch is ideal for mobile TX work, tape recorder switching, etc. You speak, it switches. High and medium imp. inputs. AF take off point. Drives your 12 volt relay. In kit form with full instructions, **42/6.** Ready built, tested and guaranteed, **62/6** plus 2/6 P.P.

METRONOME UNIT. Variable beat. Listen while you play and keep in time. Easily built, pocket size with personal mini earphone. In kit form **27/6** post paid. Ready built in an attractive black and white polythene case **37/6** post paid.

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Free lists with every order. For lists only send* 1/6 *(deductable from first order).

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No. 19 Sets and Ancillary Equipment available.

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COLLINS TCS RECEIVER 7 valve Int. Octal Covers 1·5–12 Mc/s Tuneable RF.AF.BFO. Power required 240v D.C. 80 MA 12v 1·25A. **£8.10.0.** Carr 15/-.

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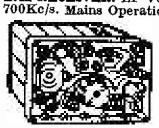

R.209 MK II COMMUNICATION RECEIVERS. 11 valve. Covers 1–20Mc/s. 4 bands. AM/FM. CW. BFO. 12v DC. Internal Power Supply. Tested. **£13.10.0,** Carr. 15/-.

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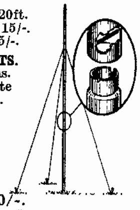

TELE 'F' FIELD TELEPHONES. Communication up to 10 miles. Tested with batteries. **£5.15.0 pair,** Carr. **20/-.**

LIVINGSTONE LAB TRANSISTOR AMPLIFIER. 50 watts R.M.S. Size 14½ × 9 × 4in. With mains p.s.u. Size 16 × 9¼ × 6½in. **22 Gns.,** Carr. 20/-.

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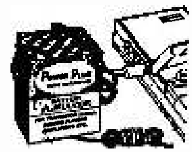

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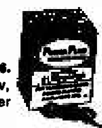

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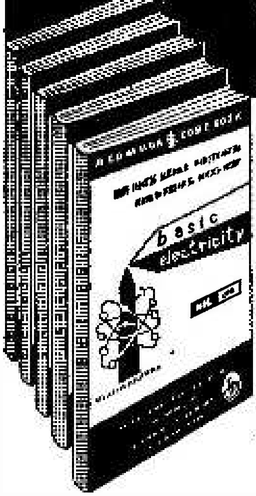

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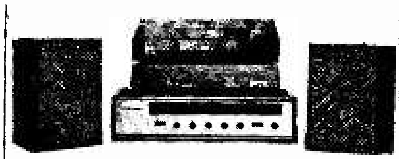

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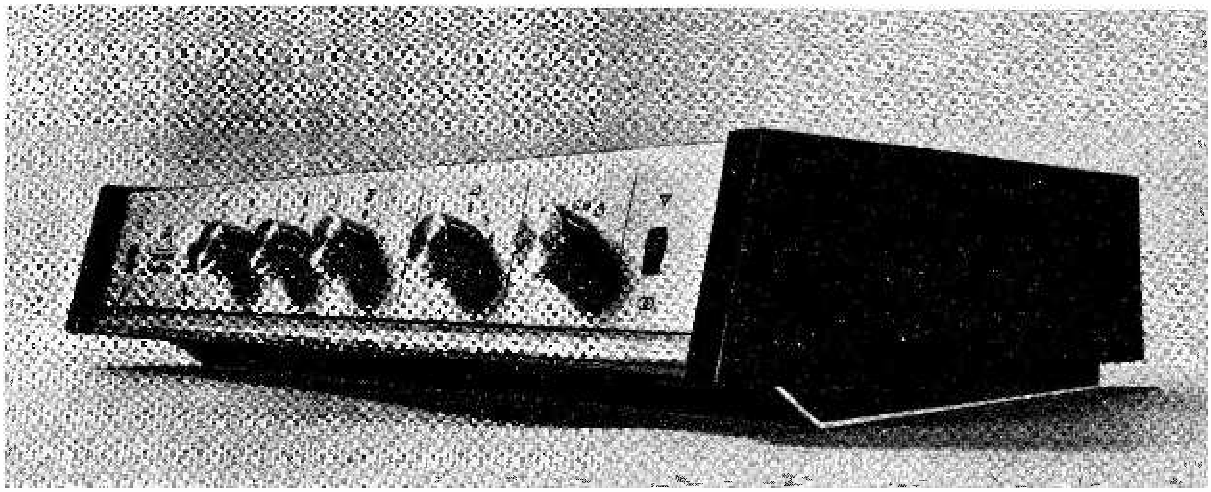

developed out of the highly successful PW. 12+12 and now in complete kit form to save you still more.

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Peak Sound guarantee that their equipment meets all specifications as published by them and that these are written in the same terms as used in equipment reviews appearing in this and other leading British hi-fi journals. Audio output powers are quoted at continuous sine wave power in terms of Root Mean Square values (R.M.S.) into stated loads at stated frequencies.

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Overload factor: 29dB on all input channels.
Signal/noise ratio: —65dB on all inputs. Vol. control at max.
Controls: Volume, Treble, Bass, Low-pass Filter. Mono/Stereo: On/off; Balance.

Complete kit of parts including cabinet assembly, knobs, transistors, well-prepared instructions and wire to length, colour coded and stripped at ends as well as built-in mains power supply. *(Post free in U.K.)* **£32.12.6**

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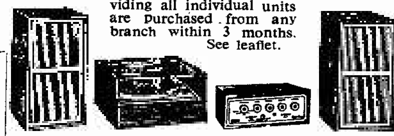

EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afrormosia veneer. Transparent plastic cover.

30 WATT OUTPUT
★ Garrard SP25 Mk II Turntable on Plinth
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★ Super 30 amplifier in veneered housing
★ Pair Stanway II Speaker Units
Four fully wired units ready to "plug-in". Special total price **76 Gns.** Carr. 30/-.

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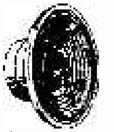
AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS



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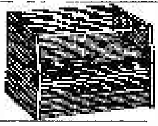

MOTOR BOARDS cut for Garrard Turntables and many other units. Price **12/9**

R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER

200-250v. AC mains operated. Frequency Response 30–20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3–15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9¼x2¾x5¼in. Attractive brushed silver finish facia plate 10½ x 3¼in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. Carr. 7/6 **7 Gns.**
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Money saving units. Mounted on Plinth. Supplied with transparent plastic cover Ready to plug into Amplifier or Tape recorder.
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Other types available with Magnetic cartridges and with alternative design plinths.

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for Record Playing units, cut for Garrard 1025, 2025, 3000, AT60, SP25 etc.

59/9
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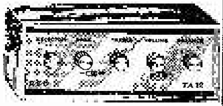
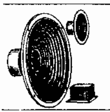
FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL



Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3–15 ohms ★ For 200–250v. A.C. mains ★ Frequency Response 30–20,000 c.p.s. —2dB ★ Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise —70dB ★ Sensitivities (1) 300mV (2) 50mV (3) 100mV (4) 2mV. Output rating I.H.F.M. ★ Handsome brushed silver finish Facia and Knobs. Complete kit of parts with full wiring diagrams & instructions. Factory built with 12 mth gntee 17 Gns or Deposit £5.2.6 and 9 mthly pymts 34/- (Total £20.8.6). Or in Teak or Afrormosia veneer housing 20½ Gns. Dep. £5.10.6 and 9 monthly payments £2.1.7 (Total £24.4.9). **13½ Gns.** Carr. 7/9

AUDIOTRINE HI-FI SPEAKER SYSTEMS



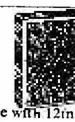
Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. Or Senior 15 Watt inc. HF126 15,000 line Speaker £6.15.0. Carr. 6/6 **£5.15.0** Carr. 5/9

LINEAR L10 HIGH FIDELITY 10W AMPLIFIER

with separate Pre-amp. Magnet P.U. matching. To clear **10 Gns**

HI-FI SPEAKER ENCLOSURES

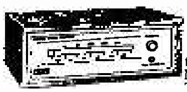
Teak or Afrormosia veneer finish. Modern design. Acoustically lined.



All sizes approximate Prices Inc. carr.
JE8 Size 16 x 11 x 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi 'speaker. **£4.14.6**
SE8 For optimum performance with any 8in. Hi-Fi 'speaker. Size 22 x 15 x 9in. Ported. **£5.15.0**
SE10 For outstanding results with 10in. Hi-Fi 'spkr Size 24x15x10in. P'td. **£5.19.6**
SE12 For exclnt prfmnce with 12in Hi-Fi speaker and Tweeter. Size 25 x 16 x 10½in. **£6.19.9**

R.S.C. TFMI SOLID STATE VHF/FM RADIO TUNER

Total cost of parts with detailed wiring diagrams & instructions.Inc. Carr. **14 Gns.** Or factory built 18 gns. Or in Teak finished cabinet as illustrated. 21 gns. Terms: Deposit £6.1.0 and 9 monthly payments 2 gns. Total £24.19.0

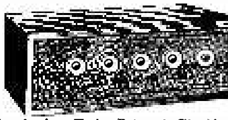


★ High-sensitivity. ★ 200-250v. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Output ample for any amplifier (approx. 500 m.v.). ★ Simple alignment instructions. ★ Output available for feeding tuning meter. ★ Output for feeding Stereo Multiplexer. ★ Tuner head using silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input. Visually matching our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. The pre-wired tuning head facilitates speed and simplicity of construction. Printed circuitry. Only high grade transistors and components used. A quality product at considerably less than the cost of comparable units. Stereo version, all parts 20 gns. inc. carr. Assembled 23½ gns. inc. carr.

R.S.C. SUPER 30 MK II HIGH FIDELITY STEREO AMPLIFIER

High Grade Components Specifications comparable with units costing considerably more.

TRANSISTORS 9 high quality types in each channel.
OUTPUT 10 Watts R.M.S. continuous into 15Ω (per channel). 15 Watts R.M.S. continuous into 3Ω.
INPUT SENSITIVITIES Mag. P.U. 4 mV. Ceramic P.U. 35 mV, Tape Amp. 400 mV. Aux. 100 mV. Mic. 5 mV. Tape Head 2.5 mV.
FREQUENCY RESPONSE ±2 dB. 10–20,000 c.p.s.
TREBLE CONTROL +17 dB to —14 dB at 10 Kc/s.
BASS CONTROL +17 dB to —15 dB at 50 c/s.
HUM LEVEL —80 dB.



Employing Twin Printed Circuits. 200/250v. A.C. mains operation.
HARMONIC DISTORTION 0.1% at 10 watts 1,000 c.p.s.
CROSS TALK 52 dB at 1,000 c.p.s.
CONTROLS 5 Position Input Selector, Bass, Treble, Vol., Bal., Stereo/Mono Switch, Tape Monitor Switch, Mains Switch.
INPUT SOCKETS (1) P.U. (2) Tape Amp. (3) Radio, (4) Mic. or Tape Head. (Operation of Input Selector assures appropriate equalisation).

CHASSIS Strong Steel construction. Approx. 12 x 3 x 8in.
FACIA PLATE Attractive design in rigid Perspex. Spun silver finish matching control knobs as available.
COMPLETE KIT OF PARTS Carr. 15/- **22 Gns.**
Point to point wiring diagrams and detailed instructions.
Eminently suitable for use with any make of Pick-up or Mic. (Ceramic or Magnetic, Moving Coil, Ribbon or Crystal) currently available. Superb sound output quality can be obtained by use with first-rate ancillary equipment. Unit factory built. **29 Gns.**
or Deposit £7.5.0 and 9 monthly payments 58/9 (Total £33.13.9) or in Teak or Afrormosia veneer housing 32 Gns. Carr. 15/-. Terms: Deposit £7.3.6 and 9 monthly payments of 66/6 (Total £37.2.0). Send S.A.E. for leaflet.

R.S.C. SUPER 15 HIGH FIDELITY SOLID STATE AMPLIFIER

Approx. as Super 30 but single channel. Complete kit with full constructional details and point to point wiring diagrams. Carr. 12/6 **12½ Gns.** or factory built 15½ Gns. Carr. 12/6. Terms: Deposit 4 Gns. and 9 monthly payments 31/1 (Total £18.3.9) or in Teak or Afrormosia veneered housing. 19 Gns.

BRADFORD 10 North Parade. (Half-day Wed.) Tel. 25349
BLACKPOOL (Agent) O. & C. Electronics, 227 Church Street
BIRMINGHAM 30/31 Gt. Western Arcade 021-236-1279 (Half-day Wed.)
DERBY 26 Osmaston Rd., The Spot (Half-day Wed.) Tel. 41361
DARLINGTON 18 Priestgate (Half-day Wed.) Tel. 68043
EDINBURGH 133 Leith St. (Half-day Wed.) Tel. Waverley 5766
GLASGOW 326 Argyle St. (Half-day Tues.) Tel. CITy 4158
HULL 91 Paragon Street (Half-day Thursday) Tel. 20505

R·S·C HI-FI CENTRES LTD.

MAIL ORDERS TO: 102 Henconner Lane, Bramley, Leeds 13. No C.O.D. under £1. Terms C.W.O. or C.O.D. Postage 4/6 extra under £2. 5/9 extra under £5. Trade supplied. S.A.E. with enquiries. Branches open all day Sats.
MAIL ORDERS MUST NOT BE SENT TO SHOPS

32 High Street (Half-day Thurs.) Tel. 56420 **LEICESTER**
5-7 County (Mecca) Arcade, Briggate (Half-day Wed.) Tel. 28252 **LEEDS**
73 Dale St. (Half-day Wed.) Tel. CENtral 3573 **LIVERPOOL**
238 Edgware Road, W2 (Half-day Thurs.) Tel. PAD 1629 **LONDON**
60A Oldham Street (Half-day Wed.) Tel. CENtral 2778 **MANCHESTER**
106 Newport Rd. (Half-day Wed.) Tel. 47096 **MIDDLESBROUGH**
41 Blackett Street (Opp. Fenwicks Store) (Half-day Wed.) Tel. 21469 **NEWCASTLE UPON TYNE**
13 Exchange Street (Castle Market Bldgs.) (Half-day Thursday) Tel. 20716 **SHEFFIELD**

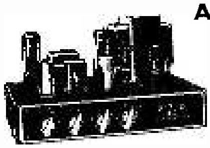
THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM

★ Moderate size, only 25 × 14 × 10in. Complete Kit **20 Gns.**
★ Response 30-20,000 c.p.s. Impedance 15 ohms
★ Performance comparable with units costing considerably more. Carr. 12/6

Consists of (1) 12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 x 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. Terms: Dep. £5.10.6 and 9 monthly payments 39/- (Total £23.1.0).

DEMONSTRATIONS AT ALL BRANCHES

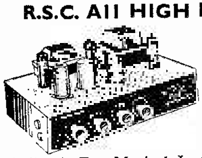
R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



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 36mV. Suitable for high impedance microphones. Crystal or Ceramic P.U's. Designed for Clubs, Schools, Theatres, Dance Halls or Outdoor Functions, etc. For use with Electronic Organ, Guitar, String Bass, etc. Gram, Radio or Tape. Reserve L.T. and H.T. for Radio Tuner. Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250v. 50c/s A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts with point-to-point wiring diagrams and instructions. **15 Gns.** Carr. 12/6

Twin-handled perforated cover 27/6. Supplied factory built with EL34 output valves. 12 months' guarantee for 18 gns. TERMS: Deposit £6.3.0 and 9 monthly payments of 34/- (Total £21.9.0). Send S.A.E. for leaflet.

R.S.C. A11 HIGH FIDELITY 12-14 WATT AMPLIFIER



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

RSC A11T TRANSISTORISED VERSION of above complete kit 9 Gns. (Assembled 13 Gns.)

R.S.C. BASS-REGENT 50 WATT AMPLIFIER

An exceptionally powerful high quality all - purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak O-P rating.
★ Two extra heavy duty 12in. Loudspeakers.
★ Four Jack inputs and two Volume Controls for simultaneous use of up to four pick-ups or "mikes". Bass and Treble controls.

55 Gns. Carr. 30/- or dep. £13.4.9 and 9 monthly payments of £5.11.9. (Total 60½ gns.). Send S.A.E. for leaflet.

G100 100 watt peak output with Pr. speaker columns and a Bass Unit (Six 12" and Two 15" Speakers). 99½ gns.

R.S.C. BATTERY/MAINS CONVERSION UNITS

Type BM1 An all-dry battery eliminator. Size 5½x4½x2in.approx. Completely replaces batteries supplying 1·5v. and 90v. where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram 52/6 or assembled 3 Gns.

SELENIUM RECTIFIERS | F.W. (Bridged)
All 6/12v. D.C. output. Max. A.C. input 18v. 1a. 4/3. 2a. 6/11. 3a. 9/9. 4a. 12/9. 6a. 15/9.

R.S.C. MAINS TRANSFORMERS

FULLY GUARANTEED. Interleaved and Impregnated. Primaries 200-250v. 50c/s. Screened

MIDGET CLAMPED TYPE $2\frac{5}{8} \times 2\frac{5}{8} \times 2\frac{1}{4}$in.
250v., 60mA, 6·3v. 2a.............. **17/11**
250-0-250v., 60mA 6·3v. 2a.......... **18/11**

FULLY SHROUDED UPRIGHT MNTG.
250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a. **24/9**
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
300-0-300v. 130mA, 6·3v. 4a., c.t., 6·3v. 1a. For Mullard 510 Amplifier **47/11**
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a. **47/9**
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a. **89/9**
425-0-425v. 200mA, 6·3v. 4a., 6·3v. 3a., 5v. 3a **93/9**
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a. **99/9**

TOP SHROUDED DROP-THRO' TYPE
250-0-250v. 70mA, 6·3v. 2a., 0-5-6·3v. 2a. **23/9**
250-0-250v. 100mA. 6·3v. 3·5a......... **27/9**
250-0-250v. 100mA, 6·3v. 2a., 6·3v. 1a. **28/9**
350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a. **29/11**
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
300-0-300v. 130mA, 6·3v. 4a., 0-5-6·3v. 1a. Suitable for Mullard 510 Amplifier.. **46/9**
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. **39/9**
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a. **46/11**

FILAMENT or TRANSISTOR POWER PACK Types
6·3v. 1·5a. **8/9**; 6·3v. 2a. **9/9**; 6·3v. 3a. **13/9**; 6·3v. 6a. **22/9**; 12v. 1a. **9/11**; 12v. 3a. or 24v. 1·5a. **23/9**; 0-9-18v. 1¼a. **19/11**; 0-12-25-42v. 2a. **31/9**.

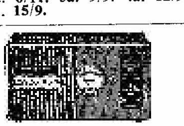
CHARGER TRANSFORMERS 0-9-15v. 1¼a. **18/9**; 2½a. **19/11**; 3a. **21/11**; 5a. **25/11**; 6a. **29/9**; 8a. **36/9**.

AUTO (Step UP/step DOWN) TRANSFMRS
0-110/120v. 200-230-250v., 50-80 watts **19/9**
150 watts, **33/6**; 250 watts **49/9**; 500 watts **105/-**

OUTPUT TRANSFORMERS
Standard Pentode 5,000Ω or 7,000Ω to 3Ω **8/9**
Push-Pull 8 watts EL84 to 3Ω or 15Ω.. **14/9**
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15Ω.......................... **24/9**
Push-Pull EL84 to 3 or 15Ω 10-12 watts **23/9**
Push-Pull Ultra Linear for Mullard 510, etc **39/9**
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω...... **35/9**
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15Ω **59/9**

SMOOTHING CHOKES
150mA, 7-10H, 250Ω **12/9**; 100mA, 10H, 200Ω **10/9**; 80mA, 10H, 350Ω **8/9**; 60mA, 10H, 400Ω **4/11**.

6/12V CAR BATTERY CHARGERS



Complete kit of parts with Ammeter and Circuit. Both models with variable charge rate selector.

4 amp 49/9 **6 amp 69/9**

All types 200-250v. A.C. Mains. Built 10/- extra.

14 WATT HI-FI AMPLIFIERS

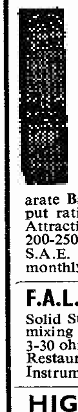
High sensitivity. Two separate inputs. Two vol. controls for mixing purposes. Separate Bass and Treble Controls. Valves ECC83, ECL86, ECL86, EZ80. Output for 15 ohm Loudspeaker. 200-250v. 50 c.p.s. A.C. mains operation. Size approx. 8x8x6in. Factory built and fully guaranteed. Limited number to clear at **£7-19-11** Carr. 10/-

FANE POP 30c LOUDSPEAKERS

R·S·C HI-FI CENTRES LTD.

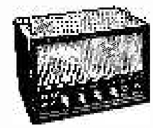
12in. 8-15Ω 25 watts R.M.S. continuous. Dual cone. Carr. free **£5-19-9**

R.S.C. COLUMN SPEAKERS



Covered in two-tone Rexine/Vynair, ideal for vocalists and Public Address, 15 ohm matching.
C57 15 watts inc. five 7 × 4in. speakers £7.19.11.
TYPE C48S 25/30 WATTS. Fitted four 8in. high flux 8 watt speakers. Overall size approx. 42 × 10 × 5in. Or deposit 67/- and 9 monthly payments 34/9 (Total £18.19.9). Carr. 10/-. **16 Gns.**
TYPE C412S, 50 WATTS. Fitted four 12in. 11,000 line 15 watt speakers. Overall size 56 × 14 × 9in. approx. Carr. 15/-. **26 Gns.** Or Deposit £5.17.6 and 9 monthly payments of 54/6 (Total £30.7.0).

30 WATT HI-FI AMPLIFIER

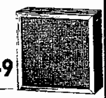


for Guitar, Vocal or Instrumental Group.
A 2 or 4 input, 2 vol. control Hi-Fi unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/gold perspex facia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Deposit 5 gns. and 9 monthly payments of 39/8 (Total 22 gns.) **19 Gns.** Carr. 12/6

F.A.L. 'Phase Fifty' PUBLIC ADDRESS AMPLIFIER

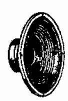
Solid State Circuitry. 50 Watts Peak Output. 3 separately controlled inputs for mixing purposes. Separate Bass and Treble Controls. Output for loudspeakers 3-30 ohms. Suitable for Dynamic, Ribbon or Crystal Mikes. For Clubs, Theatres Restaurants, Hotels, Schools, etc. For Vocal or Instrumental Groups. Send S.A.E. for leaflet. only **29** GNS. Carr. free

HIGH QUALITY LOUDSPEAKERS



In Teak or Afrormosia veneered Cabinets
L13 13" × 8" 10 Watt 10,000 lines 3 or 15 ohms. Carr. 7/6 **£4-19-9**
L12 12" 20 Watt 10,000 lines 15 ohms. Carr. 8/9 **£8-19-9**

FANE ULTRA HIGH POWER LOUDSPEAKERS



All power ratings are R.M.S. continuous. 2 years' guarantee. High Flux 14,000 line ceramic magnets. Heavy cast chassis.

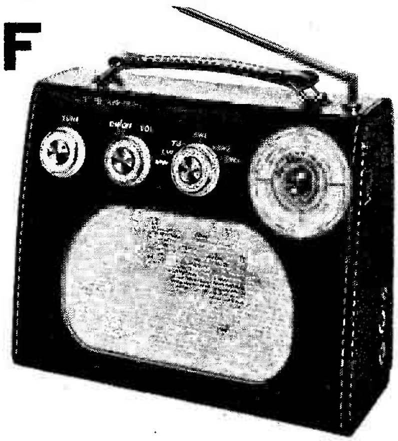
'POP' 100	'POP' 60	'POP' 50
18" 100 Watt	15" 60 Watt	12" 50 Watt
21 GNS. Carr. free	**12** GNS. Carr. free	**10** GNS. Carr. free

POWER PACK KIT Consisting of Mains transformer, Metal Rectifier, Electrolytics, smoothing choke, chassis and circuit. 200/250v. A.C. mains. Output 250v. 60mA 6·3v. 2a. Supplied with case in lieu of chassis 32/11. Or assembled 44/-. **28/11**

MINI-8 HI-FI Loudspeaker Units Special Offer
Teak or Afrormosia veneeredc abinet, size approx. 10¾ × 6½ × 7½in. Peak power handling 8 watts 3-5 ohms. Inc. Carr. **69/11**

TRANSISTOR RADIOS TO BUILD YOURSELF

Backed by after sales service



NEW! roamer eight mkI

WITH VARIABLE TONE CONTROL

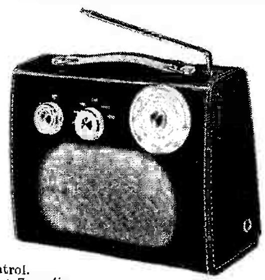
7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for Medium and Long Waves. Five section 22in. chrome plated Telescopic aerial for Short Waves can be angled and rotated for maximum performance. Push pull output using 600 mW transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. Eight transistors plus 3 diodes. Famous make 7in. x 4in. Speaker. Air spaced ganged tuning condenser. On/Off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4in. approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build.

Total Building Costs **£6.19.6**

Parts Price List and Easy Build Plans 5/- (FREE with parts).

P & P 7/6.

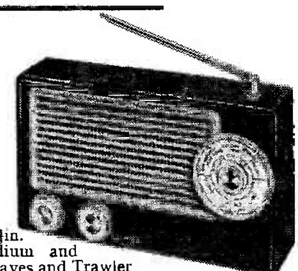
roamer seven mkIV



SEVEN FULLY TUNABLE WAVEBANDS—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. Five Section 22in. chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. Seven transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in. P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts). Personal Earpiece with switched socket for private listening, 5/- extra.

Total building costs **£5.19.6** P.& P. 7/6

NEW! trans eight

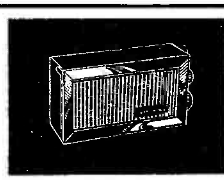


SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

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

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

pocket five

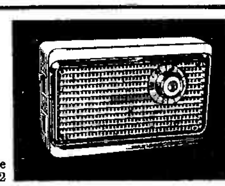


MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5½ x 1½ x 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

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

transona five

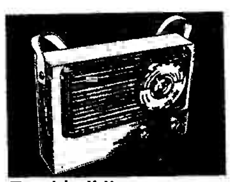


MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6¾ x 4½ x 1½in. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

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

roamer six



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C	1/4W	10%	4.7Ω–10MΩ	E12	2.5	1.75	1.5
C	1/2W	5%	4.7Ω–10MΩ	E24	3	2.25	2
MO	1/2W	2%	10Ω–1MΩ	E24	9	8	7
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Codes : C = carbon film, high stability, low noise.
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2N3703	3/3	BC167	2/6
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2N3706	3/3	BC177	6/3
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2N3904	7/6	BFX29	10/9
2N3906	7/6	BFX85	8/3
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IF YOU HAVE
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Our aim in life at Home Radio Components Ltd. is to make *your* life happier and less complicated! To this end we have recently introduced a Credit Account Service, one advantage of which is that you can order components by telephone *any time, any day.* If you phone out of shop hours a recording machine will take your message for us to deal with as soon as we open shop next day.

There are *other* advantages to the new Service—if you want to order by post we provide Order Forms and *Prepaid* Envelopes. You settle your account just once per month. We stipulate *no* minimum order value. Of course for ordering your components you first need our Catalogue, and after you have been in the Service 12 months we regularly send you an up-to-date catalogue—FREE!

For full details of our Credit Account service just drop us a line or phone 01-648 8422.

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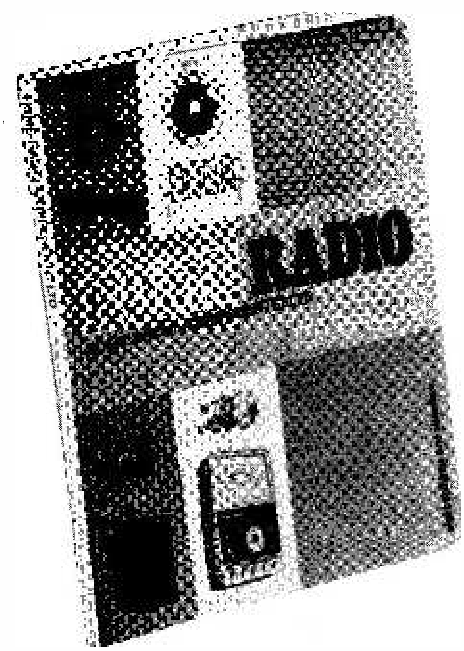

Whether or not you want to use the Credit Account Service described above, you certainly need the Home Radio Components Catalogue if you construct or repair radio and electronic gadgets. The catalogue has 350 pages, lists 8000 components and has over 1500 illustrations. It contains 6 vouchers, each worth 1/- when used as indicated. Post the coupon with 12/- (8/6 plus 3/6 postage and packing) and we will send a catalogue by return of post. By the way, we supply *free* a 30-page Price Supplement and a Bookmark giving electronic abbreviations.

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PRACTICAL WIRELESS

VOL 45 NO 10

Issue 756

FEBRUARY 1970

TOPIC OF THE MONTH

The point is...

FOR as long as we can remember, Practical Wireless has offered a readers' postal query service. In a measure, of course, we are obliged, at least morally, to do all we can within reason to help out readers with problems relating to articles and projects which have been published in these pages. Nothing in this world is perfect, however; sometimes readers think we fall short of their ideal and sometimes we feel that readers expect too much. It might be helpful to consider what is involved, especially to newer readers.

First of all, cost. Even if a reader submits a query strictly to the rules, enclosing a prepaid envelope plus a query coupon, it can cost several shillings to process a reply, taking into account all the time and expenses involved. In fact, to answer a query costs us more than we get from the sale of a magazine! This is why we cannot guarantee a reply if the rules are broken.

Secondly, the time factor. Many queries can be dealt with immediately. Others involve a good deal of research, which may mean telephone calls and letters to manufacturers, etc. Also, in order to provide the best possible service, many queries are dealt with by a panel of outside specialists.

Thirdly, feasibility. We cannot be held responsible for poor workmanship!

Fourthly, terms of reference. Don't write asking for formulae or valve and transistor characteristics that can be obtained from standard data books; don't ask us to modify a P.W. design to suit a personal requirement. Of course, we cannot undertake to run a free professional advisory and design service.

Fifthly, procedure. All queries should conform to the rules: i.e., query coupon, SAE, etc. We regret that technical queries cannot be answered over the telephone.

Sixthly, period of validity. We cannot guarantee to answer queries relating to projects published more than two years ago.

We are constantly trying to improve the turn around in readers' queries, but the sheer volume often endangers the aims to provide a quick and effective advice service. We are fully conscious of the help often needed and we will continue to do everything possible to sort out the difficulties. All we ask in return is that readers try to appreciate just how much is involved in running a free query service.

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

March issue will be published on February 6th

NEWS... NEWS... NEWS...

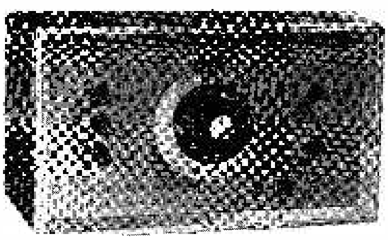
First London rally

We hear from Mr. A. P. Teale, G3SGT, the Hon. Sec. of the Ealing and District Amateur Radio Society, G3UUP, that the Society will be holding a Mobile Rally at the Hanwell Community Association on May 10th, 1970.

It is thought that this will be the first time a rally has been held in London and it is hoped that it will prove to be a large and successful one with attendance figures in excess of 500.

The Automobile Association will do the signposting (15 signposts in all) and have their own exhibition caravan at the sight. In the main hall there will be many other trade stalls. The Rally address will be: Hanwell Community Association, Westcott Crescent, Hanwell, London, W.7. Further details may be obtained by sending a s.a.e. to Bill Teale, G3SGT, 16 Whitestile Road, Brentford, Middlesex.

Low pass filters



Lionmount & Co. Ltd., are now manufacturing Low Pass Active Filters which can be varied continuously throughout the passband.

Two types are available, one of which covers the range 1kHz to 10kHz in one band—the other being a switched-band version covering the frequency range of 1Hz-10kHz in four switched bands. The designs are based on 9th order Butterworth or Chebychev configuration and can realise 80 dB/decade attenuation at cut off.

The filters will accept an input voltage of $\pm$10V. peak and may be loaded with a minimum of 2000 ohms. *Lionmount & Co. Ltd., Belleview Road, New Southgate, London, N.11.*

Interlocking boxes

Liden Products (Whitewood) Ltd introduce their storage boxes which interlock with each other. By sliding these in and out numerous permutations can be made. The all-round grooving allows for several boxes to be joined up. The boxes are provided with holes at the back for wall fixing; a slot in the front for inserting identification labels and removable plastic divider in each box. They are available in grey or white.

The measurements are: 2¼ x 4⅞in. and the width for the large box is 4in. Small boxes cost 2s. 6d. and large boxes 4s. 6d.

The Gunn effect

An article on Gunn effect devices and their applications, originally published in Mullard Technical Communications, is now available as a pamphlet.

It contains an explanation of the Gunn effect, describes the construction of the device and gives advice on the design of oscillator cavities for Gunn devices. Factors affecting stability are discussed and information is given on noise, frequency locking and pulsed operation.

Requests for the pamphlet should be made on company-headed notepaper to *I.E.D./Valves Sales, Mullard Limited, Mullard House, Torrington Place, London, W.C.1.*

Pathfinder radio group

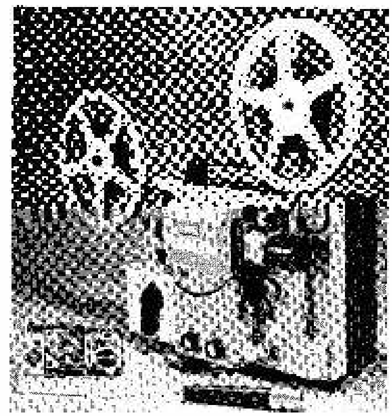
We have been informed by the organiser of the Pathfinder Radio Group, Mr. Lex-Arnold, that the Group is temporarily inactive due to reorganisation. Membership applications will be dealt with as and when the Group is re-formed.

The sound of Eumig

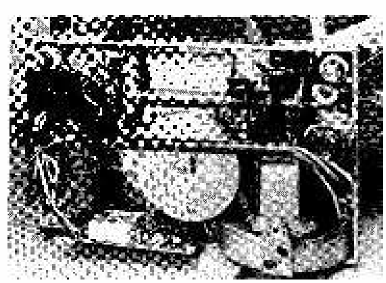
Eumig have announced the Mark S 712D projector which takes Super-8, single and standard-8 sound films, has an f1.6 15/27mm zoom lens, and costs only £110 15s 5d.

There is a combined record and playback amplifier with an integrated circuit (the first time that i.c.'s have been used in an amateur sound movie projector). Amplifier line-up is: type TAA 310 i.c., two 2N5172 transistors, two BC148B transistors, a complementary pair AC187K/188K, two DAX13 diodes, one MV1 varistor, a B832001P/130E thermistor and a type BY164 silicon bridge rectifier.

The frequency range on edge-striped film is 80-8,000Hz at 18 frames per second and 75-10,000Hz at 24 f.p.s. Signal to noise ratio is 40dB.



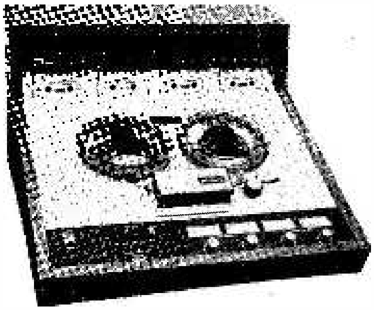
The Eumig S 712D. Below, viewed from the back, the amplifier is seen mounted under the central flywheel.



...TALKING OF PROJECTORS, DON'T FORGET THE P.W. FILMSHOW.

NEWS... NEWS... NEWS...

How your cassettes are recorded



Fraser-Peacock Ltd., announce that they have been appointed sole distributors for the Infonics range of high-speed tape duplicating equipment.

As well as reel-to-reel equipment, a new reel-to-Philips cassette duplicator is now available. The machine shown will make four 1-hour programmes (C 60 cassette) in four minutes.

In addition to their reel-to-reel service, the company are now able to offer a high-speed cassette copying service. *Fraser-Peacock Associates Ltd., 94 High Street, Wimbledon Village, London, S.W.19.*

FET F.M. tuner

Tripletone announce their Solid State FET F.M. Tuner which uses a dual gate f.e.t., minimising drift and giving improved signal/noise performance. The outputs are fed via emitter followers.

The tuner can be supplied in mono form to which the decoder board can be plugged in at a later date. Price of the Stereo Mk. 2 F.M. Tuner is £37 19s. 10d. including PT complete with decoder. The mono version costs £31 9s. and the decoder unit separately is £8. Both models are available without teak case at £35 1s. 3d. and £28 13s. 9d. respectively. *The Tripletone Manufacturing Co. Ltd., 241a The Broadway, Wimbledon, S.W.19.*

Mullard pocket data book

We hear from Mullard that stocks of their 1969 Pocket Data Book are now exhausted. It is regretted therefore that no further orders can be accepted. Preparations for the 1970 edition are, however, in hand and a further announcement will be made in due course.

V.H.F./F.M. reception on band II

With the announcement by the Minister of Posts and Telecommunications (G.P.O.) of the next twelve Local Broadcasting Stations, it is appropriate to draw attention to the need for suitable aerials and properly adjusted v.h.f. receivers.

The BBC recently completed an analysis of complaints of unsatisfactory v.h.f. reception received during 1968/69 and this shows that more than 50% of complaints were due to the use of inadequate aerials or to faulty or maladjusted receivers.

Class 'B' stereo

Welbrook Engineering and Electronics Ltd. have released two new stereo amplifiers both incorporating an entirely new design of output circuit.

For further details on the amplifiers, model W.30 priced at £52 and model W.20 priced at £42, contact *Welbrook Engineering and Electronics Ltd., Brooks Street, Stockport, Cheshire, SK1 3HT.*

Readers are cordially invited to the

Practical Wireless and Practical Television Filmshow

(in collaboration with Mullard Ltd.)

at

Caxton Hall, Caxton Street, London, S.W.1

(Great Hall Site)

on

Friday 6th March, 1970

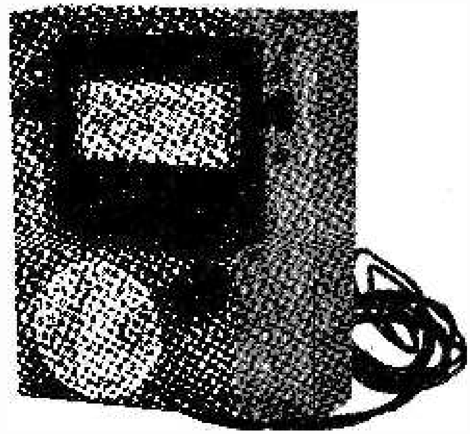
7-15 p.m. for 7-30 p.m.

W. N. Stevens, Editor Practical Wireless and Practical Television will be in the chair

The film this year is entitled "Something big in Microcircuits" and the principal speaker will be Mr. Ian Nicholson of Mullard Ltd.

THE MICROTEST

a multi-range test meter



C. MARSHALL

IT is generally true that the more accurate a multimeter is, the larger it will be and the greater will be its cost. For many home constructors both space and money are severely limited, and they are usually forced into either buying or making a small, cheap multimeter. The accuracy of such a meter is limited partly by the short-scale length which limits the reading accuracy, and partly because of the limited number of ranges which are provided. This latter failing means that many readings must be taken near the zero end of the scale where the accuracy is greatly reduced.

This article begins by discussing some of the factors which limit the accuracy of a multimeter, then describes a multimeter which reduces the effects of these limitations by providing many more ranges than usual but without using any non-standard switches. The Microtest is both small and inexpensive, but maintains a high standard of accuracy comparable to instruments costing much more.

MULTIMETER ACCURACY

The most common measurement made by a multimeter is that of voltage, although the same sources of error also affect the measurement of current. The voltmeter is basically a high sensitivity current meter in series with a high resistance, and there are five sources of error associated with such an arrangement.

1. The voltmeter may draw current from the voltage source it is required to measure, and this may affect the voltage being measured. This situation can best be improved by reducing the full scale current required by the meter. It is normally difficult to obtain meters more sensitive than 50μA f.s.d. and this is the sensitivity that is used in the Microtest.

2. The meter scale on anything but the most expensive meters is normally a mass-produced linear scale, but unfortunately the actual meter deflection may not be exactly linear, thus causing an error in reading. This error is usually greatest at about centre scale, but its magnitude is seldom quoted in advertisements for meters of the type intended for this instrument. Its effect is normally lumped together with the next source of error to give an overall accuracy figure for the meter.

3. The meter required for the Microtest has a nominal sensitivity of 50μA f.s.d., but unless the meter is individually calibrated (and thus expensive), its actual sensitivity will differ from the nominal value. The magnitude of this error is normally given so as to cover both the f.s.d. error and the non-linearity error, and is typically about 2% of the reading, although it is often quoted as the same percentage of the full-scale reading.

4. The most important source of error in a multimeter is the error involved in reading what the meter deflection actually is, and this is the real limitation on the smallness of a multimeter. A typical 2½ inch square meter has a scale length of about 3 inches, and with a fine knife-edge pointer it should be possible to read the meter to within $\pm$0·5μA, or 1% f.s.d. The scale markings are normally so coarse that any improvement on this would be difficult. It may be thought that an error of 1% should hardly be called "most important", and this would be true if the error were to remain at a constant 1% over the whole scale, but unfortunately this is not the case: the error is a fixed 0·5μA at all points on the scale.

Most multimeters provide ranges which increase in multiples of ten, such as 10V, 100V, 1000V etc. If it were required to use such a meter to read a voltage of 101V, then this would have to be measured on the 1000V scale, and the meter deflection would be only about 10% full scale. When making this reading our fixed error of 0·5μA causes an error of no less than 10%, which is far from being unimportant. If however the ranges were grouped closer together so that it was never necessary to make a reading at less than 25% full scale, then this error is kept to the much more satisfactory level of 4%.

The ideal system would be to have the ranges increasing in multiples of $\sqrt{10}$ each time, giving full scale deflections of 1V, 3·16V, 10V, 31·6V, etc, and a maximum error of about 3%, but unfortunately meters with suitable scales are not generally available in the price range required. However a reasonable compromise can be made by having ranges of 1V, 2·5V, 10V, 25V, etc, where the maximum error is 4%. A scale divided into 100 equal divisions will give easy reading on all ranges. To provide coverage from 1V to 1000V f.s.d. using these scales would normally require seven positions of the range switch, and for a similar coverage of current ranges from 100μA to 2·5A would require a further ten positions. Although it is not impossible to obtain eighteen way switches, they are very expensive, and a much simpler solution is possible. If ranges are provided on the switch in the usual scale-of-ten series, and a separate two way switch is used to change the meter sensitivity to give the intermediate 25V ranges, then only nine range positions are needed to give the required coverage, leaving three other positions of a standard twelve way switch for resistance ranges. This is the method used in the Microtest to provide increased accuracy for a given meter size, with fewer components and reduced cost. The actual circuits used are described later.

5. The final source of error comes from the multiplier resistors themselves, and these are the components over which the constructor has the most control. These can be obtained to almost any required accuracy, and 1% resistors are the ones recommended for this circuit. A higher accuracy would greatly increase the cost without a great increase in meter accuracy, because of the other sources of error. If a somewhat lower performance is satisfactory then 2% resistors could be used instead. In order that the accuracy of the meter should not change with age, it is important that high stability resistors should be used throughout.

We have therefore three sources of error affecting the accuracy of our multimeter: a sensitivity error of 2%, a multiplier error of 1%, and a reading error of 0·5µA, which is at worst a 4% error. The maximum error should therefore not be greater than 7% at the worst case and 4% at the best. Fortunately, because these sources of error may be of differing signs the actual error is likely to be very much less than this, and it can be shown that a better estimate of the maximum error is given by taking the square root of the sum of the squares of the individual errors. This gives an error of 4·6% at the worst case and 2·5% at full scale, which is quite adequate for most construction and repair work.

As a comparison, if the accuracy of reading had been improved by doubling the scale length of the meter (and at least doubling its cost), and ranges were provided in the usual scale of ten, then the worst case accuracy would have been 5·5%. A ready built meter costing about £10 would not be expected to be better than about 3% accurate.

When a.c. voltages are being measured with a multimeter, the resistance of the bridge rectifier is in series with the multiplier, and this can cause additional errors on the low voltage ranges. On the Microtest, 1V and 2·5V a.c. ranges are provided with the intention that these be used only for indicating the presence of a small signal, not for making accurate measurements at these levels. The rectifier can cause gross non-linearity of the scales, and the maximum error on these ranges can easily be as high as 20%. Similar remarks would also apply to any other multimeter providing such ranges without the use of an amplifier. It is most important that this limitation is realised when using the Microtest.

THE CIRCUIT

The full circuit is shown in Fig. 1, and this will be studied in its separate functions.

Most of the circuitry is fairly standard, except for the two way switch associated with the meter which is used to change the sensitivity of the meter. With the switch in the x1 position the series and shunt resistors have no effect. If the meter is of 1000 ohms internal impedance (a typical value) the meter will

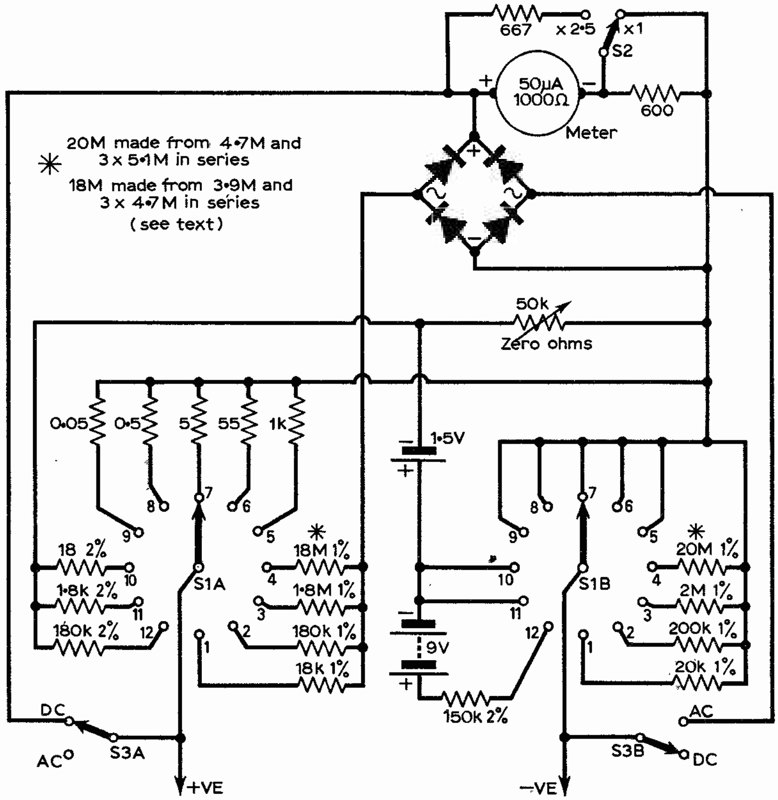


Fig. 1: The complete circuit of the Microtest.

read full scale when 50µA passes through it (voltage ranges) or when 50mV is applied across it (current ranges). When the switch is moved to the ×2·5 position, a shunt is placed across the meter which reduces the sensitivity to 125µA f.s.d. The series resistor reduces the voltage sensitivity of the shunted meter to 125mV f.s.d. These two adjustments have the effect of multiplying the voltage or current required for full scale deflection on any range by 2·5. This function may be used on any voltage or current range provided by the meter, but not on the resistance ranges.

One small disadvantage of this feature should be pointed out here. When the Microtest is being used to measure a voltage on the ×2·5 range, then the current drawn from the voltage source for full scale deflection will be 125µA, giving a sensitivity of only 8kΩ/V, compared to 20kΩ/V on the x1 range. If the source being measured is of a high internal impedance, then different readings would be obtained according to which range was being used for the measurement because of the different loadings imposed on the source. For most measurements this effect causes negligable error, but it is important to be aware that it can occur in certain cases.

The range switch S1 is a two-pole twelve-way switch and for most convenience in use it should be the type without a stop, to allow continuous rotation. A ceramic switch with silver plated contacts would be the best from the point of view of reliability, but a paxolin wafer switch costing only a few shillings can give many years good service before the contacts wear. Once again a compromise is necessary between cost and performance, and it is worth spending some time deciding just what sort of performance you require from your Microtest, then spending accordingly.

S1b switches in the d.c. multiplier resistors and the appropriate batteries for the resistance ranges. S1a switches the shunts for the current ranges, and the multipliers for the a.c. voltage ranges and the ohms ranges. All the multipliers are standard values at 1% tolerance and little difficulty should be experienced in obtaining them. The a.c. voltage multipliers are chosen so that the meter reads r.m.s. voltage for a sine wave input: for other input waveforms the meter will read 1·11 times the average voltage.

The 1000V multipliers on the a.c. and d.c. ranges will have to withstand up to 2500V when the ×2·5 function is used. While this does not exceed the power rating of the resistors, it does exceed their voltage rating of about 750V. To get round this problem each of these multiplier resistors is made up from four separate resistors so as to divide the voltage load between them. Under no circumstances should fewer resistors be used, and even so, care must be taken when wiring up the Microtest to provide a good clearance between the high-voltage multipliers and the other components.

The bridge rectifier used in the original Microtest was a surplus unit advertised simply as a 50μA meter rectifier. Almost any meter rectifier will work in the circuit, but in order to keep the scale linear a metal oxide rectifier of the type intended for use at 50μA should be used. The leakage resistance of the bridge should be as high as possible or the meter sensitivity will be reduced. The addition of the bridge rectifier introduces an error of up to 2% on all a.c. voltage measurements.

The current ranges provided are of perfectly standard form, each range being obtained by a separate shunt. The resistance quoted for the shunts on the circuit are approximate values only, and are given for 1000 ohm meter. In practice the shunts have to be individually adjusted to give the required ranges, and this process is described in more detail below. A 50μA range was not provided on the original Microtest, 100μA being the most sensitive range. The reason for this was simply the lack of available positions on the range switch. If a 50μA range were considered essential, it could easily be provided, but only at the expense of, say, the 1A range.

Three resistance ranges are provided, these having 18Ω, 1·8kΩ and 180kΩ as the centre scale readings. These three ranges are adequate to cover the full range of prefered values of resistance, and to give reasonable indications down to 0·1Ω. Using standard 2% resistors for the resistance ranges will give an accuracy of between 5% and 10% over the useable portion of the scales, which is about as good as any other multimeter. For increased accuracy of measurement other techniques such as a bridge have to be employed. The accuracy of the resistance range is not greatly dependent upon the battery voltage, but these should be renewed as soon as their voltage begins to fall to prevent the possibility of their leaking into the case and damaging other components.

A few words about the choice of meter would not be amiss here, as this is the heart of the instrument. Within reason it is usually worth getting the most expensive meter you can afford, as its accuracy will increase with price. There would be little point in getting a meter bigger than about 4 inches square or the instrument would hardly warrant the Microtest; about 3 inches square would seem to be a reasonable compromise between cost and performance. The scale

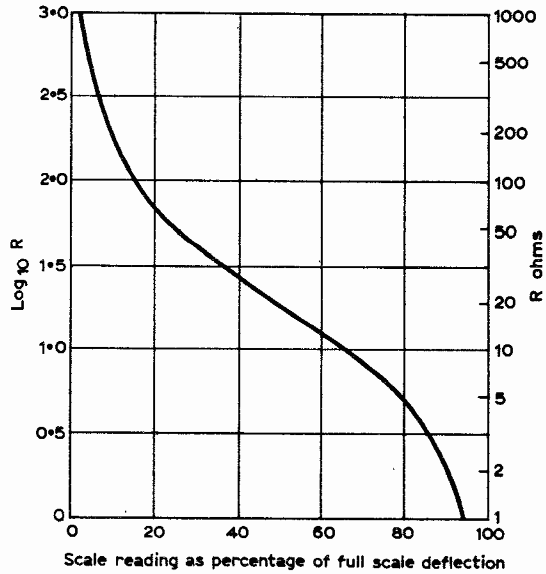


Fig. 2: Resistance measurements can be calculated from a graph stuck on the bottom of the case.

is best divided into 100 equal divisions, marked 0-10. A fine knife edge pointer will greatly increase the accuracy of reading the meter. The resistance scale may be either drawn directly onto the meter's scale plate if great care is taken, or a calibration graph may be attached to the back of the Microtest. A graph suitable for either purpose is given in Fig. 2.

CONSTRUCTION AND TESTING

The component layout of the Microtest is in no way critical, except that high current leads should be kept as short as possible to avoid unwanted voltage drops. Because the actual size and layout of the instrument will depend to a large extent on the meter chosen for the Microtest, no details are given of the cabinet construction or component layout. The prototype used a three inch square meter, and the whole instrument was built into a Formica box $4\frac{1}{2}'' \times 5\frac{1}{2}'' \times 1\frac{1}{2}''$ deep. Either the front or back of the instrument should be easily removeable to enable the batteries to be changed when necessary.

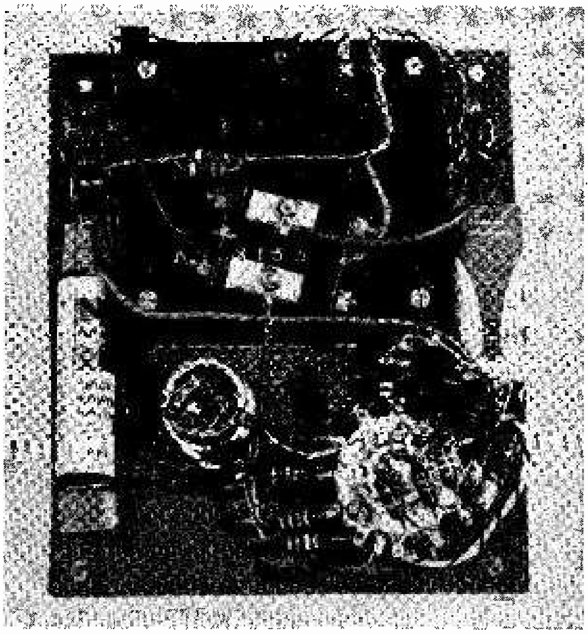
All the multipliers and shunts are mounted directly onto the range switch to minimise their lead length. The shunt and series resistors used to change the meter sensitivity are mounted directly onto the multiplier switch, and the bridge rectifier is mounted on the a.c./d.c. switch. The batteries can be held in place by small sponge pads on the lid of the case. Contact is made to the 9V battery by a snap connector, and to the 1·5V battery by two small brass contacts fixed to the case. The "ohms-zero" control should preferably be a wire-wound control for reliability.

The Microtest should first be built omitting the current shunts and the ×2·5 multipliers. No provision is made in the circuit for accurately setting the voltage ranges, but if a high accuracy meter is available it is worth getting an estimate of the accuracy of the Microtest by comparing the readings of the two instruments when they are reading the same voltage. The accuracy should be within the limits stated in the first section. If such a comparison is not possible then it must be assumed that the error is zero when using the instrument.

The ×2·5 multiplier must now be added. Using any convenient voltage source such as a twelve volt battery in series with a 50kΩ variable resistor, set the Microtest and the variable resistor until the meter reads full scale on the 10V range. The multiplier switch should be set to ×1. Now without altering any other components, select a resistor or a number of resistors so that when soldered directly across the meter terminals the reading drops from 10V to 4V.

While the meter is still set up reading 10V full scale the 100μA shunt can be prepared by the same technique. This time a resistor is required that will reduce the meter deflection to half scale (5V), and again this should be done as accurately as possible. When selected it should be wired directly onto the range switch in the correct position for the 100μA range. The series resistor of the ×2·5 multiplier can now be selected.

Connect a 9V battery, 100kΩ variable resistor and the Microtest set to read 100μA all in series, and adjust the variable resistor until the meter reads full scale. Now try a number of resistors in the multiplier position until one is found which gives a meter reading of 100μA in the ×1 position and 40μA in the ×2·5 position. This resistor may then be left in



An interior view of the prototype.

position, completing the setting up of the range multiplier. This will have a negligible effect on the accuracy of the voltage ranges.

There are two methods of adjusting the three remaining current shunts. The simplest and most accurate method is to use a calibrated meter in series with the Microtest, then adjusting the appropriate shunt until the two instruments read exactly the same. All adjustments should be carried out at the current required to give full scale deflection of the Microtest. Great care must be taken to ensure that the full current is never passed through the meter except when the shunt is firmly soldered into place, or the meter will be severely, if not fatally, damaged. The 1A shunt should be made from wire no thinner than 22swg, or it will be burnt out when the 2·5A passes through it. The other shunts are not particularly critical as the currents involved are small. A few feet of thin copper wire should be sufficient for the 100mA shunt and two 10 ohm resistors in parallel form the basis of the 10mA shunt.

The alternative method of calibration is to use one range of the Microtest to set the current being used to calibrate the next range up. This method is not to be recommended if the first method is possible, because errors gradually creep in during the calibration, and the 1A range can easily be as much as 10% in error. A regulated supply of at least 30V in series with an appropriate value of variable resistor is used as the current source.

Initially the meter is set to read 250μA f.s.d. and the current adjusted to exactly this value. This setting should be continually checked during the next stage. Wire in an appropriate value resistor as a 1mA shunt, then turn to this range. With the multiplier switch set to ×1, adjust the 1mA shunt until the meter reads exactly 250μA. The 1mA range is now calibrated, and this range may now be used to set the reference current to 2·5mA, which is used in turn to calibrate the 10mA range. This process is repeated until all the shunts are correctly adjusted. It is then worth repeating the whole process to check the final accuracy. When using the meter it is important that all the ranges should agree with one another at the points where they overlap. When these shunts are finally set to your satisfaction, the Microtest is ready for use.

★ components list

Resistors

1% high stability types
18kΩ, 20kΩ, 180kΩ, 200kΩ, 1·8MΩ, 2MΩ, 3·9MΩ, 4x4·7MΩ, 3x5·1MΩ.

2% high stability types
18Ω, 1·8kΩ, 150kΩ, 180kΩ.

High stability types selected for use as shunts
5Ω, 55Ω, 600Ω, 680Ω, 1kΩ.

Zero-ohms potentiometer, 50kΩ wirewound.

Switches

2 pole 12 way rotary.
2 pole 2 way slide type.
1 pole 2 way slide type.

Miscellaneous

Batteries: 1·5V U16, 9V PP3; Rectifier: 50μA bridge meter type; Meter movement: 3in. square moving coil.

No meter will remain accurate for long if it is regularly overloaded: the needle will get bent and the coil will be damaged. To avoid such accidents with any multimeter always begin making a measurement with the meter set to the highest range, then working down. When making current measurements, do not change ranges while the meter has a high current flowing through it, as it is possible for the shunt to be disconnected for an instant as the switch is moved, and in that instant the meter may be damaged. Provided the Microtest is treated, like all other sensitive instruments, with care and respect, it will provide many years of useful service, repaying its cost many times over. ■

I.C. OF THE MONTH

L.A.J. IRELAND

Number 4 The Mullard TAD100, a.m. tuner and preamp.

IN January of 1968 Mullard introduced their TAD100 linear i.c. which was principally designed for use in medium and long wave portable receivers although the frequency response of the circuit was such that it could also be used as a 10·7MHz i.f. amplifier and audio preamp. in f.m. receivers. In addition to many of the passive components required in an ordinary radio set the circuit also incorporates all the active elements as far as the audio driver stage. Different output stages can therefore be chosen to suit individual requirements. This month's article describes how the TAD100 may be used in a medium wave receiver giving an audio output of about 500mW.

The complete receiver circuit is shown in Fig. 1. The first three transistors are used in the front end of the receiver with the first stage of the long-tailed pair transistors acting as an r.f. amplifier and the second stage as mixer. A separate transistor is used as the local oscillator with the oscillator signal injected at the base of Tr2 and the i.f. produced extracted at its collector. The block filter type LP1175 is the only selectivity element used to extract the 470kHz signal but it provides sufficient attenuation and bandwidth as three conventional i.f.t.'s.

Due to the emitter follower action of Tr4 and Tr5 the input impedance of the i.f. amplifier is very high and the three stages are arranged in a d.c. feedback circuit to the base of Tr3. Tr7 acts as the detector with the audio signal appearing across its emitter resistor and it also supplies the a.g.c. voltage for controlling the bias of Tr1.

Due to its stability and flexibility the differential amplifier or long-tailed pair arrangement forms the basic circuitry in most linear i.c.'s and where previously it would have been economic madness to use extra discrete transistors the i.c. comes into its own. Even in the audio stages of the TAD100 this is evidenced with the use of four transistors in the preamp and driver stages. The audio signal from the volume control is applied to the base of Tr9 which is diode connected to the Darlington pair Tr10 and Tr11. Overall negative feedback of up to 20dB can very neatly be applied to the base of Tr8 thereby providing good stability under a wide range of operating conditions. The only two other active elements used in the set are the complementary output pair of transistors Tr12 and Tr13 and these are directly coupled to the i.c. driver stage and deliver 500mW. into a 15 ohm speaker.

Continued on page 765

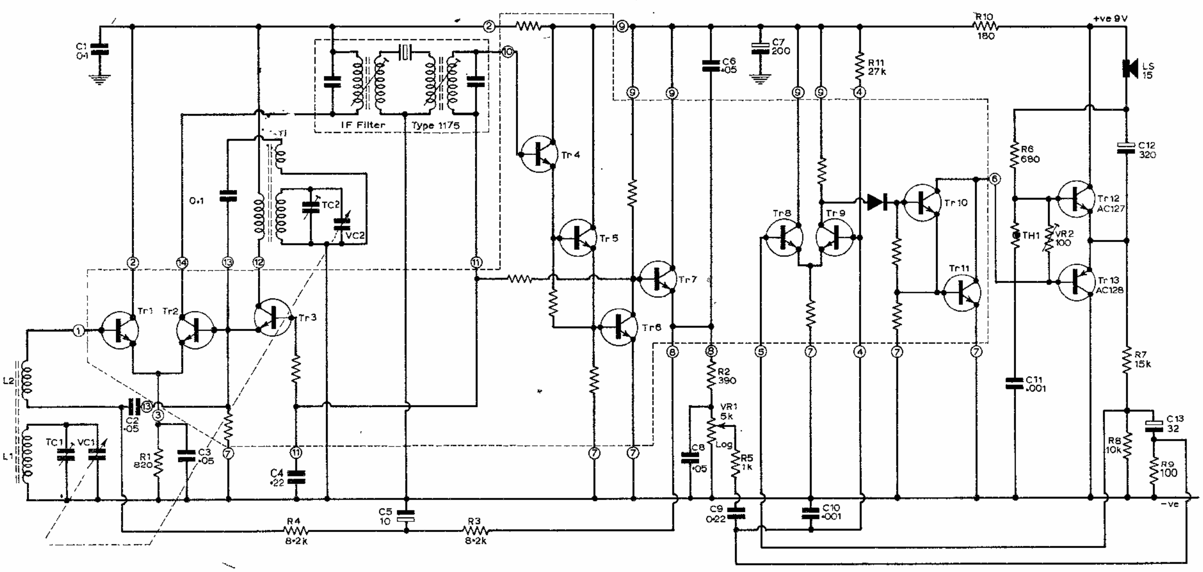


Fig. 1: A practical circuit for a m.w. radio using the TAD100 and an i.f. filter type 1175. The thermistor and C11 junction should be shown connected to the base of Tr13.

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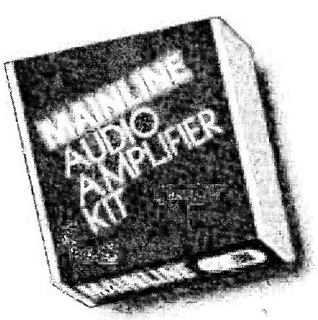

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REPAIRING TRANSISTOR RADIOS

PART 1

V. CAPEL

THE cheap transistor radio can often pose something of a headache for the professional engineer. All repairs take time, and sometimes an elusive fault can take more time than a straightforward fault on a television receiver. The situation is aggravated by a lack of service information and spares where, as is more often than not, the radio is imported. A repair bill can result which is a large proportion of the original cost of the set, and the owner naturally thinks he is being had.

Because of this, many dealers understandably refuse to accept these cheaper radios for reepair. Amateur repairers not having to make their time pay may agree to have a go, often later to wish they had not!

In general, it is prudent to set a time limit of say a quarter of an hour and if the fault cannot be located in this time, the set should be returned to the owner as being beyond economic repair. This calls for quick, short-cut methods of diagnosis and repair, some of which may be frowned upon if used with conventional equipment, but which in many cases would be the only alternative to refusing the repair. We should add that these remarks do not apply to the better class transistor radio which is backed by spares service and technical information. These should, of course, be serviced in the normal way.

A common fault is for the receiver to be completely dead. While in theory a number of things could be responsible, in practice a few faults crop up with almost monotonous regularity, so these can be checked first.

Batteries that have been left in cause corrosion of the contacts which of course remains when the owner fits new batteries. Often the trouble is nothing more than poor battery contact due to this cause. The remedy is obvious.

Another very common source of trouble is the on/off switch. Generally an integral part of an edge-type volume control, they are impossible to repair economically and the only course is to fit a complete new control. Fortunately, the value of the volume control seems to be standardised at 5kΩ, and a number of component firms make controls that will fit. The main consideration is physical size, if too large it will jam in the case aperture, and if too small, will not reach far enough through. The disposition of the contacts may not line up with the original on the printed panel but this can usually be overcome by bending some of the contacts and soldering a section of copper wire to those that may not reach. A few controls have the switch mounted externally in which case a repair can often be made by adjusting the switch contacts.

A quick test can be made on both battery contacts and switch by taking a voltage reading at some convenient point on the print, from an earth point, say one of the coil screening cans to one of the tags on the output or driver transformer. This should show almost full battery voltage, if it is much less, there is a high resistance in series, possibly corroded battery contacts or faulty switch.

Correct voltage measured here means we must look further. Scratching the volume control terminals with the meter probe and the meter switched to the ohms range should produce crackling in the loudspeaker, and if so, suggests that the fault is in preceding stages. No crackling means trouble in driver or output circuit. Open-circuit loudspeaker speech coils are not at all uncommon, especially the higher impedances, so this is worth checking next; failing this, check earphone socket shorting contacts.

MECHANICAL DAMAGE

Often the radio has been subject to a fall and a frequent result is that the output or driver transformer is partly wrenched from its position in the print. A casual glance may not indicate this but sometimes one or more of the fine wires coming from the windings are broken away from their terminal posts. Whenever there is trouble in this end of the set, it is always worthwhile to make a visual examination of the transformers, especially the lead-out wires.

If the set is lively from the volume control onwards, flicking the waveband switch may produce clicks, which would suggest that the i.f. stages are working and that the mixer and r.f. stages should be investigated first. It is still possible for the i.f. stages to be at fault, but the odds are on the previous ones.

If the trouble appears in the first stage it is wise to check the connections to the ferrite aerial coils. The rod is not always rigidly mounted, and any mechanical shock could easily strain the fine wires from the coils to the print. In many cases these wires are left long enough by the makers to facilitate adjustment by sliding along the rod, but this slack may already be taken up by a previous alignment. Broken aerial wires are very common and can give rise to several faults. Complete lack of signals is one, where the broken lead is common to both wavebands or as is sometimes the case, where there are more than one broken. Often it leaves one waveband dead and sometimes produces a rather puzzling symptom of breakthrough from one band into the other. Thus the light programme on 1500 metres is superimposed on the BBC London or Welsh Home service.

A close look at the components mounted on the printed panel would not come amiss. Look for vertically mounted parts that are leaning over at an angle, suggesting they may have been forced and either damaged or pulled from their printed connection. Components mounted near the battery compartment are particularly prone to this sort of trouble by suffering from the attempts of a ham-handed owner to replace the batteries! A probe at any likely looking suspect with an insulated tool will confirm the suspicion.

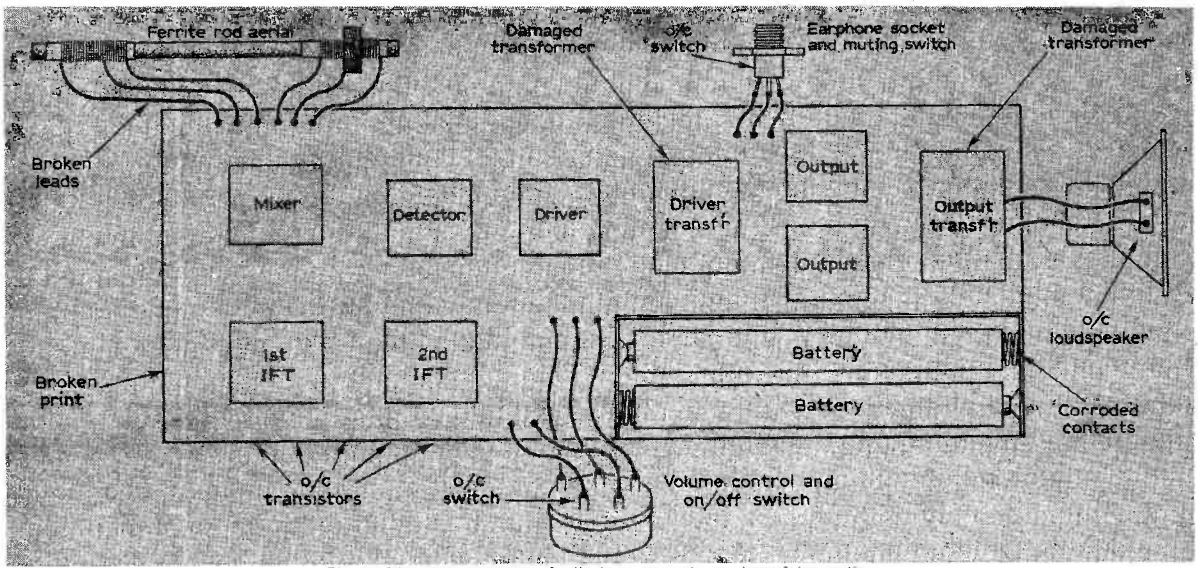

Fig. 1: The most common faults in a normal a.m. transistor radio.

The rough tests we have described followed by a visual check of the suspected part of the circuit will take just a matter of a few minutes. Many faults will come to light by this means. Remember that a large proportion of troubles with portable transistor radios are mechanical in origin.

Next, after these checks, the most likely possibilities to investigate are printed circuit faults or defective transistors. This is where the meter must be used again and voltage measurements taken. We will have already roughly isolated the section of the receiver in which the trouble lies, so now collector, base and emitter voltages of transistors within that section can be measured. If service information is not to hand, exact readings cannot be compared with correct figures, however in most cases defects can be quickly spotted.

Collector voltages are generally not less than about three-quarters of the battery voltage except in audio stages where the collector is directly coupled to the base of the following stage. Where two batteries or a tapped battery is used, the full voltage is often only applied to the output stage and perhaps the driver, the rest of the circuit being supplied from one battery or section.

Base and emitter voltages vary considerably according to the circuit from a few tenths of a volt to over one volt. The main thing is to compare the base voltage with the emitter. Assuming germanium p-n-p transistors, the base must be slightly more negative than the emitter, so a difference of one or two tenths of a volt should be measured. A higher base voltage could be due to an internal leak or an open-circuit bottom bleeder resistor to the base. A low base voltage could indicate an open-circuit top resistor. No emitter voltage is the result of an open-circuit transistor, unless of course the emitter has no series resistor. A high emitter and base voltage with a low collector voltage betrays excessive current due to internal leakage.

Some confusion can result when taking voltage readings as to which point to measure from, as some sets have positive earths and others negative. It is usually the most straightforward practice to ignore the earth and to clip the positive lead of the meter to the battery positive terminal taking all readings from there.

If a transistor appears to be at fault, it is not always necessary to remove it in order to try a replacement. This takes time, and more time is wasted re-fitting it if it is not the trouble, to say nothing of possible damage by soldering (it is usually impossible to use a heat sink). In most cases, just connect a substitute in parallel with the suspect, on the print side of the board and without cutting the wires. If the set works, then the old one can be removed and the replacement fitted properly, if not, little time is wasted. The old one seems to have little effect on the working except where it is drawing excess current. In such case, just disconnect the collector wire.

Many imported sets use transistors with type numbers that mean little to the average engineer. An equivalent list is very handy if available. If not,

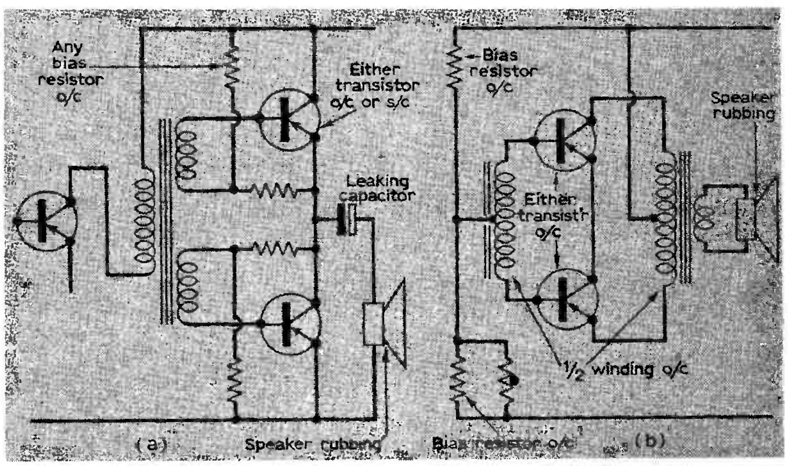

Fig. 2: Faults associated with the two commonest output stages.

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AF126	4/-
AF127	4/-
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BCY30	5/6
BCY31	8/6
BCY32	10/-
BCY33	5/-
BCY34	6/-
BCY38	7/-
BCY39	8/6
BCY40	10/-
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NKT273	4/-
NKT274	5/-
NKT275	5/-
NKT277	5/-
NKT278	5/-
NKT279A	4/-
NKT301	6/-
NKT304	7/-
NKT352	8/-
NKT403	15/-
NKT404	9/6
NKT449	8/6
NKT451	10/-
NKT452	7/6
NKT453	6/-
NKT612	5/-
NKT675	5/-
NKT677	5/-
NKT678	6/-
NKT713	6/-
NKT773	6/-
NKT777	8/-
NKT12329	7/6
NKT12429	9/6
NKT13329	4/6
NKT20329	11/-
NKT35219	10/-
MPF102	8/6
MPF103	7/-
MPF104	7/6
MPF105	8/-
OA5	3/-
OA7	4/-

OA9	3/-
OA10	4/-
OA47	2/-
OA70	2/-
OA71	2/-
OA73	2/-
OA74	2/-
OA79	2/-
OA81	2/-
OA85	2/6
OA86	4/-
OA90	2/-
OA91	1/6
OA95	1/6
OA200	1/9
OA202	2/-
OA210	6/-
OA211	9/6
OAZ200	11/-
OAZ201	10/-
OAZ202	8/6
OAZ203	8/6
OAZ204	8/6
OAZ205	8/6
OAZ206	8/6
OAZ207	9/6
OAZ208	6/6
OAZ209	6/6
OAZ210	6/6
OAZ211	6/6
OAZ212	6/6
OAZ213	9/6
OAZ222	9/6
OAZ223	9/6
OAZ229	9/6
OAZ231	9/6
OAZ238	9/6
OAZ241	4/6
OAZ223	7/6
OAZ224	7/6
OAZ225	7/6
OAZ228	7/6
OAZ234	7/6
OAZ242	4/6
OAZ244	4/6
OAZ245	4/6
OAZ246	4/6
OAZ247	4/6
OAZ272	4/6
OAZ290	7/6
OAZ291	7/6
OAZ292	7/6
OC16	10/-
OC19	7/6
OC20	19/6
OC22	9/6
OC23	12/6
OC24	12/6
OC25	7/6
OC26	5/-
OC28	12/6
OC29	12/6
OC35	10/-
OC36	12/6
OC41	5/-
OC42	6/-
OC43	8/-
OC44	4/-
OC44M	4/-
OC45	3/6
OC45M	3/6
OC46	5/6
OC57	12/-
OC58	12/-
OC59	13/-
OC70	3/-
OC71	3/-
OC72	5/-
OC73	6/-
OC74	6/-
OC75	5/-
OC76	5/-
OC77	8/-
OC78	5/-
OC78D	2/6
OC79	4/6
OC81	5/-
OC81D	4/-
OC81M	5/-
OC81DM	3/-
OC81Z	7/6
OC82	5/-
OC82D	3/-
OC83	5/-
OC84	5/-
OC122	10/-
OC123	10/-
OC139	5/-
OC140	7/6
OC141	15/-
OC169	5/-
OC170	5/-
OC171	6/-
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OC202	12/6
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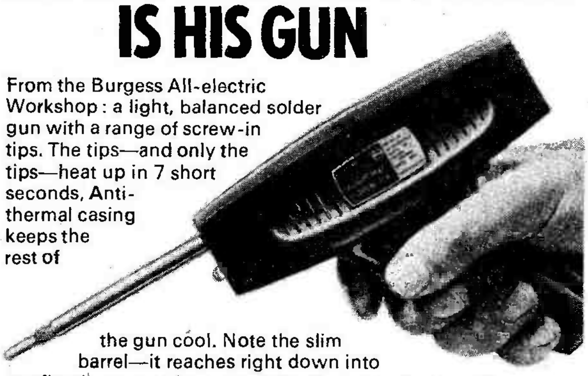

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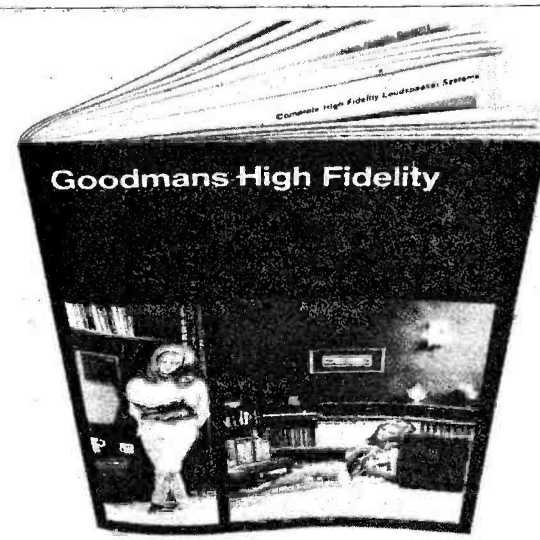

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or if the type is not listed, then fit anything which is in the same class (mixer, r.f., a.f. or output). Unlike valves, transistors have a high degree of compatibility and in the field of the cheap portable radio, any minor differences in performance are unimportant, it might even be better than the original! Certainly it is uneconomic to spend time trying to chase exact equivalents even if there are such. The output stage is the only one where some thought may have to be exercised in choosing a replacement, and alteration of the base forward bias may be required. After replacing such, check for distortion and that the quiescent current is reasonable for the type of set.

This brings us to perhaps the most troublesome and frustrating fault to locate, print faults. These may be dry joints between print and components or hair-line cracks in the print itself.

Bending and flexing the panel will often make the fault come and go although not necessarily indicate where it is. Gentle prodding around will sometimes bring it to light, but not always. Another way of tackling the trouble is to take a voltage reading around the suspected area, then flex the panel to see if there is any change in value. This can be repeated at various points, and any change discovered followed up through connecting print and components.

DISTORTION

Another very common complaint is distortion. In by far the majority of cases, the trouble is in the output circuit, so diagnosis should not take so long as with some other faults. First of all though, check the battery voltage. Even if it is claimed to be a new battery, it could have been left switched on when not in use, not an uncommon occurrence.

The usual source of trouble is failure of one half of the push-pull output pair. If the series configuration is used, take voltage readings to find if the collector of the bottom transistor and the emitter of the top one are about half of the battery voltage. If this mid-point is in fact either higher or lower by any marked extent from the half value, most likely one of the transistors is either open-circuit or partially so, or has a high leakage, depending on whether the voltage is high or low and which transistor is defective. The quickest and cheapest course is to replace both transistors. Before doing so though, just check the base-bias resistors, and take another measurement with the speaker disconnected. The capacitor feeding the speaker may be leaky and cause an abnormal voltage reading, disconnecting the speaker will remove the leakage return path and restore correct voltage if this is the cause of the trouble.

If the output stage is of the normal transformer push-pull type, voltage readings will not be a great help. Defective transistors will not have a great effect on voltage because of the low series impedances. Voltages should be measured of course, to make sure that bias is present and the output transformer windings are continuous. If these are in order, the quickest way of checking the transistors is to short the base to emitter of each in turn with a screwdriver blade. When both transistors are working correctly, the result will be distortion and a drop in volume. Shorting a defective one will have little or no effect, while shorting its companion will stop the set working completely or nearly so.

Thus the faulty transistor can be quickly located and replaced. Discretion can be used as to whether it is deemed necessary to replace the other as well. If only one is replaced, then the replacement should be of the same type.

A frequent cause of distortion is the loudspeaker. Trouble is due to the speech coil rubbing the pole pieces of the magnet. This is not always easy to identify as it can sound very much like distortion originating in the output stage. It is usually worse at low volume settings, because the rubbing tends to be masked at higher volumes. Often it can be felt by gently pushing the cone in and out with the finger tips, but this is not always decisive. Hooking up another speaker is the best test. Impedance is not too critical, a 3-ohm can be used in place of an 8-ohm for testing, but a series resistor should be used in a 30-ohm circuit. A 15-ohm speaker is very useful for bench testing if one can be acquired, as it can be used with almost any circuit.

Distortion can be traced to other causes than the output circuit. The driver stage can be responsible and even the pre-detector stages. These however are rarer and will have to be tackled by voltage measurements and other conventional servicing techniques.

TO BE CONTINUED

I.C. OF THE MONTH

—continued from page 758

★ components list

Resistors

R1	820 Ω	R7	15k Ω
R2	390 Ω	R8	10k Ω
R3	8·2k Ω	R9	100 Ω
R4	8·2k Ω	R10	180 Ω
R5	1k Ω	R11	27k Ω
R6	680 Ω		

All resistors, ½watt, 10% types
VR1 5k Ω pot. with switch
VR2 100 Ω preset pot.

Capacitors

C1	0·1μF	C8	0·05μF
C2	0·05μF	C9	0·22μF
C3	0·05μF	C10	0·001μF
C4	0·22μF	C11	0·001μF
C5	10μF 6V	C12	320μF 12V
C6	0·05μF	C13	32μF 12V
C7	200μF 12V		

VC1, VC2 208pF + 176pF ganged tuning capacitor.
TC1, TC2 trimmer capacitors associated with above

Semiconductors

TAD100 Integrated circuit
Tr12 AC127
Tr13 AC128

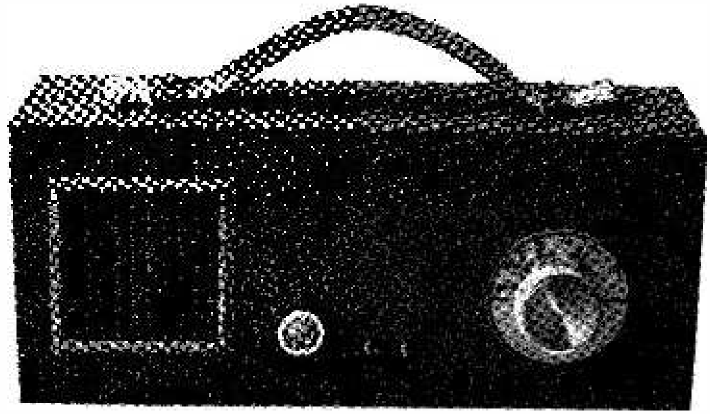
Miscellaneous

L1, L2, medium aerial on ferrite rod suitable for 208pF tuning with secondary; T1, oscillator coil Weyrad type P50/1AC; I.F. filter type LP 1175; THI, VA1077; Loudspeaker 15 Ω type.

The sensitivity of the receiver is very good giving a performance comparable to an equivalent eight transistor quality receiver using conventional discrete components. In addition the TAD100 integrates the major portion of the set providing a far more reliable and rugged receiver. ■

the CHELMER SIX

R. L. GRAPER



THE author's first attempts at transistor set construction were not very successful, mainly through being too ambitious with miniaturisation. The sets made were mixtures of reflex circuits, employing home wound ferrite aerials with feed-back windings, but they could not be relied upon for stability, and reproduction quality was far removed from that easily obtainable with a modern superhet which may be built for little extra cost.

The author decided to adhere strictly to the superhet circuitry recommended by Weyrad and Mullard, which has stood the tests of time and reliability. There are a few slight deviations from some components used due to lack of availability of the original items, but the performance of the substitutes is well up to standard. The chassis design, and layout of the components was, however, arranged by the author to give a really robust set, yet one which could be removed from its cabinet in a few seconds.

In fact the "Chelmer Six" is one hole fixing in its cabinet, the only control needing attachment being the tuning knob. To achieve this simplicity the speaker is mounted on the chassis, and the volume control and switch are mounted on two brass studding pedestals. No fixing screws are necessary, as four turnbuttons inside the cabinet press the chassis panel firmly against the front panel of its cabinet.

The circuit

The full circuit is shown in Fig. 1. The signal received in the ferrite aerial is tuned by VC1, the aerial section of the ganged capacitor. The signal is then fed into the mixer/oscillator Tr1 via the small coupling coil on the aerial. The signal, now at i.f., passes on to two stages of i.f. amplification. The amplified signal is then fed by the third i.f. transformer to the detector diode, D1, where the audio signal is extracted.

This signal is tapped off by the 5kΩ potentiometer VR1, the volume control. The signal passes on to Tr4, the driver stage, and on to the phase-splitting driver transformer T2. The push-pull amplifier consists of Tr5 and Tr6. The much amplified signal is then fed to the loudspeaker via the output transformer T2. There is, of course, an a.g.c. system, R5 and C3, which controls the bias of Tr2.

One detail that must be explained is a series resistance of 100Ω, R21. This allows a faint signal to be received immediately the set is switched on, thus acting as a safety precaution to prevent one unwittingly leaving the set on when not in use.

Construction

The main component board drilling plan is shown

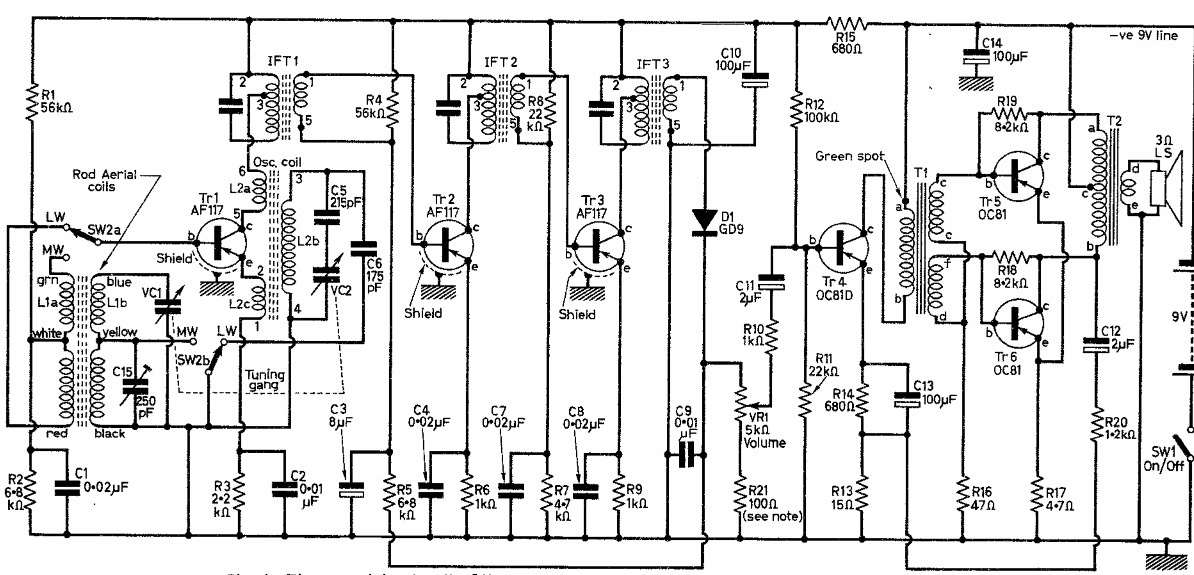


Fig. 1: The complete circuit of the six transistor two waveband Chelmer Six.

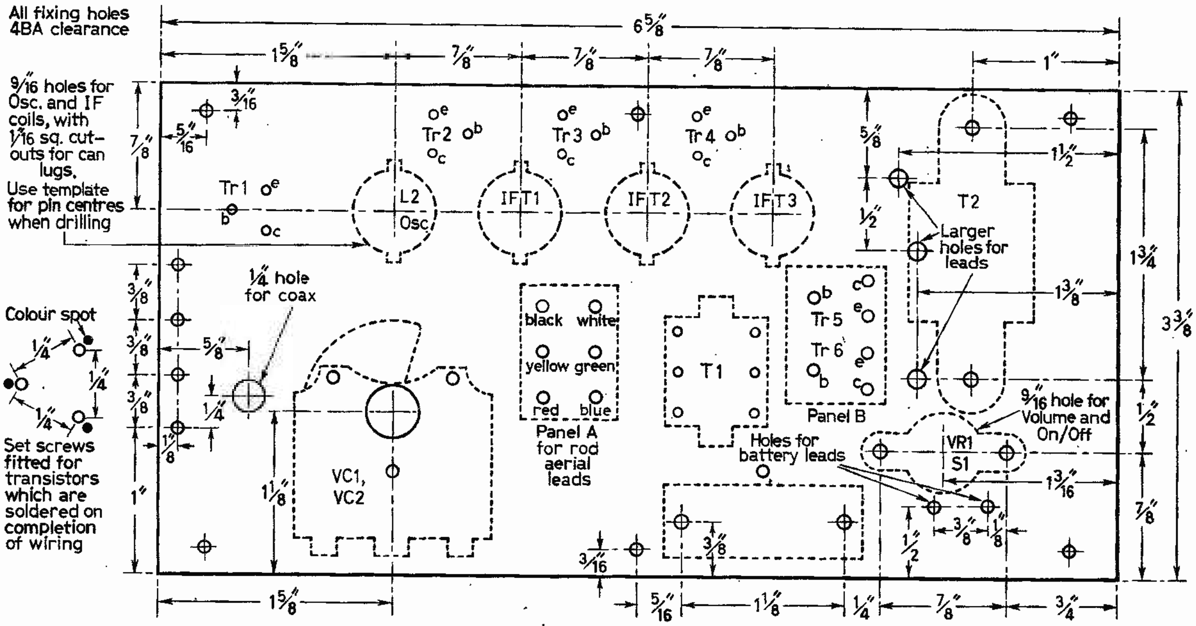


Fig. 2: The main component board drilling plan.

in Fig. 2 and the plan for the front panel in Fig. 3. The two panels, when all the components are mounted, are bolted together with studding and nuts. Studding is also used for mounting the slide switch and volume control to the component board, and also to retain a perspex panel holding the 250pF padding capacitor. Diagrams of all the sub-panels, control mountings and chassis feet are in Fig. 4. The tag panels A and B have to be made up as shown to fit the available panel space. The rear feet are simply to allow the board to stand upright when out of the case.

The chassis

The chassis is constructed from two panels of 1/16in. paxolin. These are connected together by four lengths of 4BA or 6BA brass studding. The main (rear) panel carries all of the components, except the loudspeaker, while the larger second panel has mounted on it the loudspeaker. This system allows the speaker to be positioned close to the front of the cabinet and provides a convenient battery space.

All the component centres and positions for the various holes are shown in Figs. 2 and 3. When drilling for the tuning capacitor shaft and the six holes for the screwed brass rods, bind the two panels firmly together with plastic tape and drill holes in both simultaneously. Make sure, of course, that the panels are correctly aligned with the shorter panel on the left. It is not necessary, however, to drill the two or three fixing holes for the tuning capacitor through both panels as the extension spindle or shaft only passes through the front panel. Note the clearance hole for the knob of the potentiometer; these components usually have only flat edge controls which are not long enough, so the author stuck on a tapered type knob with Evo-Stik. The loudspeaker holes will have to be determined by the speaker itself which can, of course, be positioned on the panel to mark the fixing hole centres.

Referring to Fig. 2 again, it is as well to make a paper template for marking out the centres for the oscillator coil and i.f. transformer pins, and advisable to keep the pins of the latter the same way round as shown. The oscillator coil should be spot marked on the panel in red between pins 1 and 6 so that intermediate pin numbers can be identified. On the P50/1 transformer there will be found an identifying red spot on the top of the screening can, and between pins 1 and 6. A template should also be made for the tags of the driver and output transformers.

Special care should be taken when drilling the centres for the Jackson '00' gang capacitor. Take great care that the mounting screws are not too long, or the fixed plates of the capacitor may be fouled.

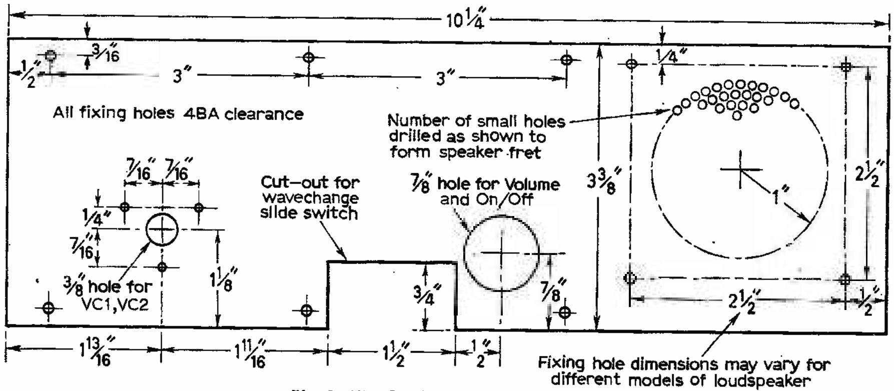


Fig. 3: The front panel drilling plan.

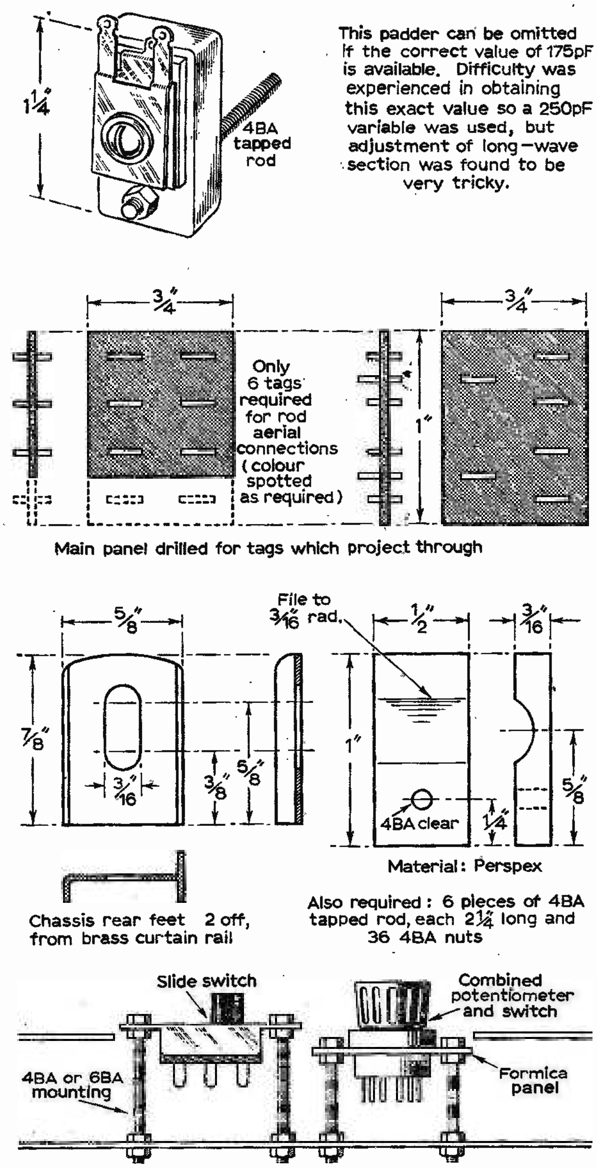


Fig. 4: Details of the sub panels, control mountings, chassis feet and l.w. trimmer capacitor support. Tag panel A is shown on the left, panel B on the right.

The author drilled lots of small holes at random all over the panel, which may be found useful if the constructor finds that an odd wire needs to be passed through the panel. This drilling should, of course, be done before actually mounting the components on to the panel.

Wiring

With the circuit diagram Fig. 1 and the wiring plan Fig. 6 to refer to, the constructor should find no difficulty as there is plenty of space available. The author prefers the method of laying resistors and capacitors flat on or near to the panel, rather than the more conventional method of mounting these components vertically. Make sure that all the electrolytic capacitors are correctly connected for polarity. It is best to solder the transistors on last, the triangular arrays of screws on tag panel B being provided to allow all other components to be put into position and wiring completed first. Colour spot marking beside these pins is useful to avoid mistakes when the transistors are soldered on finally. The spot marks should be put on both sides of the panel.

Care is needed when soldering to the i.f. transformer and oscillator coil pins, which should be gripped with a pair of thin nosed pliers to form a heat-sink.

The potentiometer with its incorporated switch is a little tricky to wire up and colour coding beside the small tags might be an idea to avoid mistakes. Note also the colour coded and numbered tags on panel A (Fig. 4) which tie up on the circuit with the leads taken from the ferrite rod aerial.

A little extra spacing is needed, incidentally, at each side of the tuning capacitor to avoid the grub screws of the extension spindle, these project slightly, and free rotation of the control is essential.

Fig. 6 gives an idea of the length of the various wires required. Wires not connected are shown crossing, and only where a black dot is shown are the wires soldered together.

The Weyrad transformer LFDT3 has a split secondary, and there is a correct way of wiring it so the author advises the reader to study the Weyrad literature before connecting it. The colour code spot denotes the start of the primary.

Alignment

A signal generator is, of course, the ideal instrument to use for alignment, but an alternative procedure is feasible, and will be described.

1. Switch the set to m.w.
2. Set the aerial and oscillator trimmers to mid-point.
3. Use tuning scale to set tuning capacitor to correct position for the local station.
4. Adjust the oscillator coil core to bring this station in at the correct point on the tuning scale.
5. Tune to a weak signal anywhere in the band, preferably one not subject to fading, and adjust the i.f. transformer cores for maximum output. This will ensure that the i.f's. are peaked for maximum gain.
6. Tune to the high frequency end of the band and adjust the oscillator trimmer to bring the station in line with the scale calibration.
7. Tune to other end of band and adjust the medium wave coil on the ferrite rod for maximum gain.
8. Repeat steps 5 and 6 until adjustment of one end has no effect on the other.
9. Switch the set to l.w.
10. Tune in Radio 2 on 1500m. and adjust l.w. aerial winding for maximum volume.
11. Trim C15 to obtain maximum volume of Radio 2.

Use the correct trimming tool; a thin brass strip mounted in an insulating handle. The brass strip should pass right through the full length of the slot in the iron cores of the transformers and oscillator coil. Do not use an ordinary screwdriver for these adjustments or the lugs will break up and jam in the thread.

The scale used is that issued by Weyrad for use in conjunction with their rod aerial RA2W. Unless the set is incorporated in its cabinet, on to which the scale is glued, the alignment adjustments will have to be delayed until the cabinet is completed.

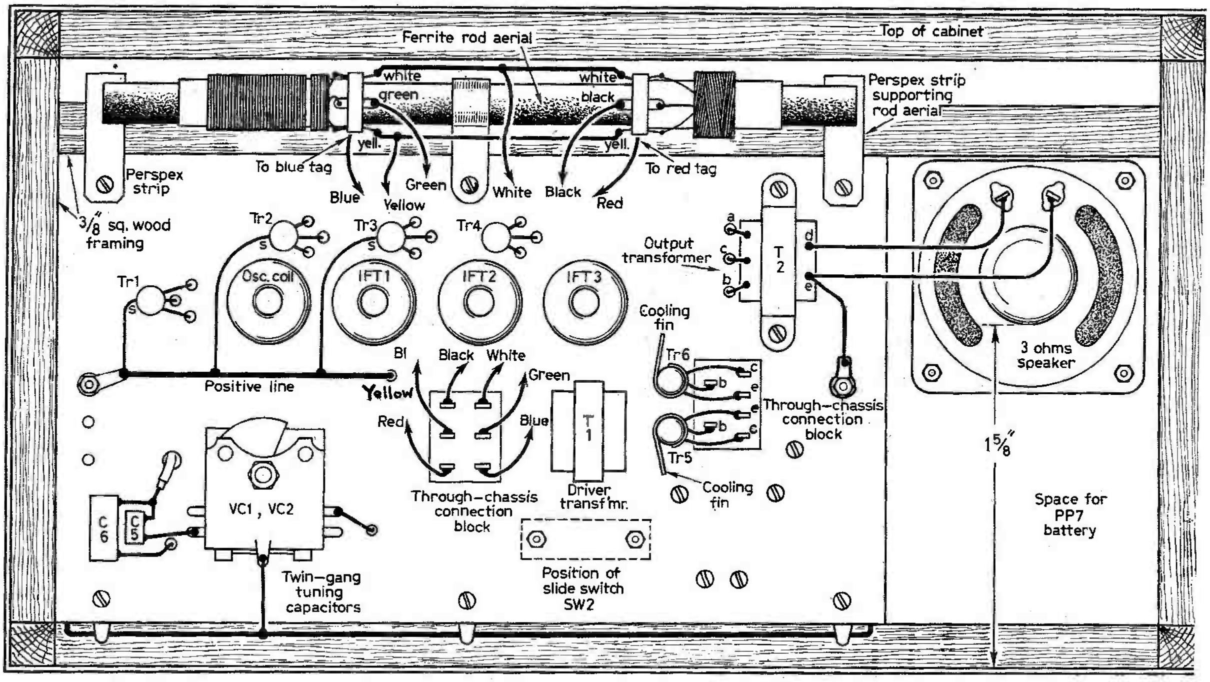
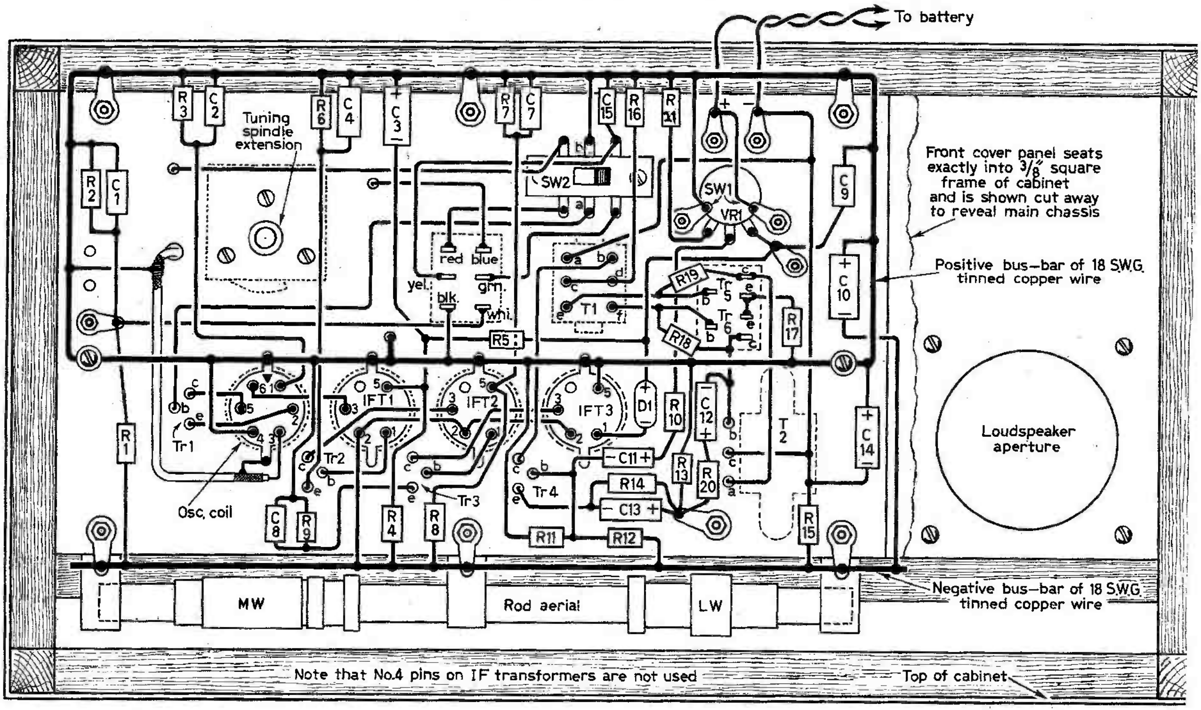


Fig. 5: (above) The component layout viewed from the rear of the case, the drilling plan is shown in Fig. 2.

Fig. 6: (below) The main wiring diagram.



The cabinet

The author has always favoured plastic laminate material, such as Formica, for radio cabinets. The material is light and very strong, so that when built on a light section wood frame it cannot warp. Further it can be obtained in many attractive colours.

When the panels are cut out they should be fastened together with adhesive tape and trimmed up to make exact pairs. Unbind and bevel all the edges at 45°, which makes a neat cabinet with flush edges. On the front panel a frame of $\frac{3}{8}$in square stripwood is next glued, spaced from the edges to a distance equal to the thickness of the material. The frame thus formed need not be

★ components list

Resistors

R1	56k Ω	R12	100k Ω
R2	6·8k Ω	R13	15 Ω
R3	2·2k Ω	R14	680 Ω
R4	56k Ω	R15	680 Ω
R5	6·8k Ω	R16	47 Ω
R6	1k Ω	R17	4·7 Ω
R7	4·7k Ω	R18	8·2k Ω
R8	22k Ω	R19	8·2k Ω
R9	1k Ω	R20	1·2k Ω
R10	1k Ω	R21	100 Ω
R11	22k Ω		

All resistors ¼ watt, 10% tolerance
VR1 5 k Ω log. potentiometer with switch

Capacitors

C1	0·02μF	C9	0·01μF
C2	0·01μF	C10	100μF, 12V
C3	8μF, 12V	C11	2μF, 12V
C4	0·02μF	C12	2μF, 12V
C5	215pF, 2% ceramic	C13	100μF, 12V
C6	175pF, 2% ceramic	C14	100μF, 12V
C7	0·02μF	C15	250pF trimmer
C8	0·02μF		

VC1, VC2 208+176pF tuning capacitor. Jackson type "00".

Inductors

L1 Ferrite rod aerial, 6in. x 7/16in., Weyrad RA2W
L2 Weyrad P50/1AC oscillator coil (red spot)
IFT1, IFT2 Weyrad i.f. transformers type P50/2CC (white spot)
IFT3 Weyrad i.f. transformer type P50/3CC (blue spot)
T1 Driver transformer. Weyrad LFDT3 or Radiospares T/T1
T2 Output transformer. Radiospares T/T2

Semiconductors

Tr1	AF117	Tr5	OC81 } matched pair
Tr2	AF117	Tr6	OC81 } matched pair
Tr3	AF117	D1	GD9, OA81, OA91, etc.
Tr4	OC81D		

Miscellaneous

Loudspeaker 2½in. diameter 3 Ω or 8 Ω, SW2, 2 pole 2 way slide switch; paxolin sheet; 4BA brass studding; battery clips; Formica for case etc.—see text for case materials.

mitred to 45°, but the lengths should be exact and tried out before glueing. The top panel should also be fitted with a ⅜in. wood frame but only on rear edge. The end panels and bottom may be left out until after assembly before glueing on the remaining strengthening stripwood pieces.

Before actual assembly of the panels into box form it is best to cut out the large hole for the loudspeaker in the top right hand side of the front panel.

Assembly is quite simple. Treat the outside faces of the ⅜in. wood framing with Evostik and after a short drying time bring the panels together to form the box shape. Then cut the lengths of ⅜in. stripwood for the sides, and lengths of ¼in. square wood for the battery holder and glue them in individually. Four screw holes only are necessary for the back panel cover which can be countersunk. The best method of getting the correct position for drilling out the clearance holes for capacitor spindles and that for the potentiometer knob is to spot at each centre with Indian ink. The chassis can then be carefully inserted until the spindle and knob touch, leaving a black dot on the panel. The large hole for the potentiometer knob can then be marked with compasses, cut out by means of a fretsaw and piercing saw blade.

The front panel of the chassis should fit neatly inside the frame of the front panel of the cabinet. A piece of speaker fabric can be glued inside, over the speaker aperture to improve the appearance and exclude dust.

The carrying strap was cut from 1in. plastic material, and the cross strips from Formica.

The set described has been in use continuously for several months, and yet no maintenance has so far been necessary. ■

REPAIRING LOUDSPEAKER CONES

H.C. BENNET-CLARK, B Sc., Ph. D.

I WAS recently asked for advice about an old 12in. loudspeaker that had suffered from the attentions of house-proud mice. The mice had succeeded in removing most of the cone but the voice coil, leads and inner cone support were intact. (Fig. 1.)

I suggested that the unit should be returned to the makers for re-coning, but the owner was horrified to learn that this would cost at least £2 and probably £4. He bought a new low-cost 12in. unit for 32s. and presented me with the relics of a first-class loudspeaker.

This presented such a challenge that I decided to try to make an entirely new cone, incorporating some ideas I have had on this subject.

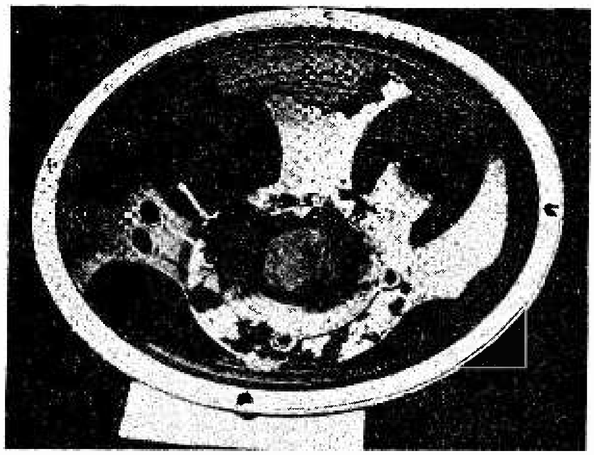


Fig. 1: The 12in. Goodman's loudspeaker attacked by mice. The cone has been destroyed, but the coil assembly is intact.

A BIT OF THEORY

The problem is that the cone should be as light and rigid as possible and also be very free to move. Some of the best loudspeakers use expanded plastic foam diaphragms, constrained by a soft plastic roll surround. This arrangement produces a loudspeaker that is very free of distortion and coloration over a band from maybe 40Hz to 2kHz, but a tweeter is also needed.

Alternatively, a soft corrugated paper cone can produce sound over the whole audio band, but this is achieved because the cone does not vibrate as a whole at the highest frequencies; only the centre moves and h.f. radiation may be improved by fitting a small inner cone to the voice coil. This type of speaker generally gives a rather poorer performance than is realised with separate l.f. and h.f. units.

In production, the cones for both types of speaker are stamped or cast in a mould. Obviously, it is unrealistic to try to make a mould for a single loudspeaker and the amateur must try to build cones in a different manner, not losing sight of the need for lightness, strength, and a flexible surround.

There must be thousands of old loudspeaker units lying around unused because the cones are damaged. Any of these is a suitable subject for restoration and the methods suggested should make a unit with a very good performance.

MAKING THE OUTER CONE

The first thing with any unit is to remove most of the old cone; this may sound drastic, but it makes things far easier. Remove the paper or felt gasket from the chassis and remove the old cone surround from the chassis. Trim the cone to leave a rim about ¼in. wide around the coil former and leave a support for the voice coil leads. (Fig. 2.) You must be very careful of the voice coil leads; if you wreck them it is very difficult to save the speaker.

The outer cone is made from a sheet of thin good quality paper. I used tracing paper, but good lightweight drawing paper is also suitable. This must be marked out in such a way as to make a suitable shaped cone. In the case of a 12in. Goodman's which has a fairly steep cone of about 105°, this can be made from a circle of 6in. radius, with a sector of 90° removed. (Fig. 3.) There are various tips that will assist you in making a suitable paper cone. Do not use the sheet of high quality paper for this experiment—use brown paper.

Draw a circle of 6in. radius and inside that draw concentric circles of radius 5¾in., 5½in., 5in., and in the middle of ¾in., 1in., 1¼in., 1½in. radius (as in Fig. 3). Draw in a radius and cut along this, cut around the outside circle and around the innermost circle. This will give you a variable sized cone former, which can be pinned or glued temporarily and offered up to the voice coil.

The aim is to make a template for the final cone. By adjusting the amount of overlap the cone can be made more or less acute and you should aim to make it fit with a gap of about ¾in. all round the

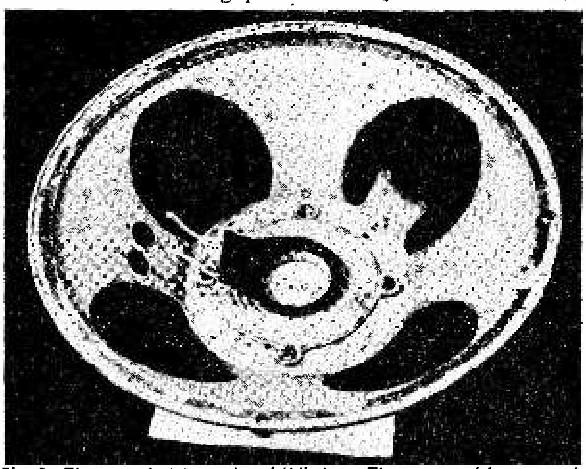


Fig. 2: The cone is trimmed and tidied up. The surround is removed entirely.

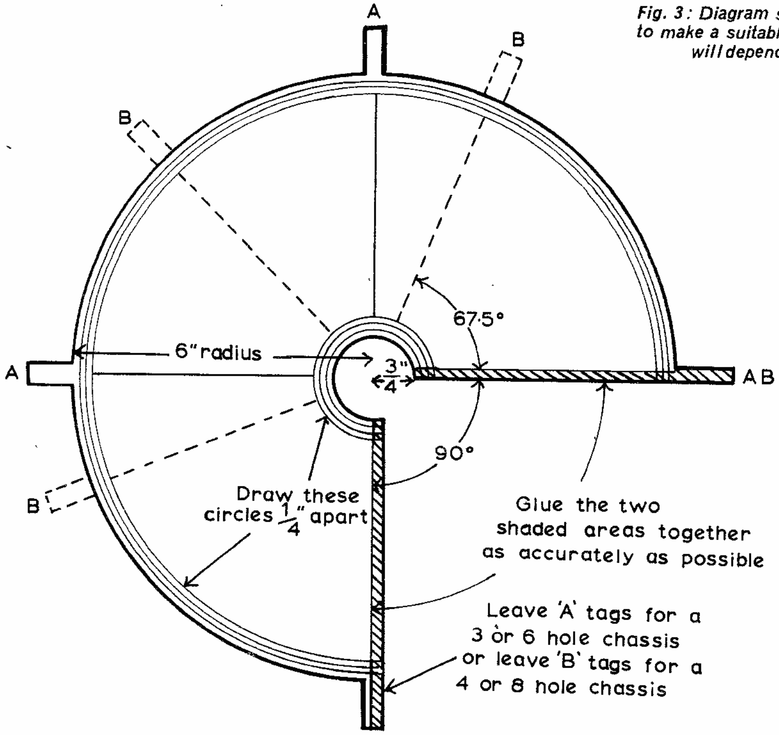


Fig. 3: Diagram showing how a sheet of paper should be marked out to make a suitable cone for a 12in. speaker. The detailed dimensions will depend on the speaker, but this will serve as a guide.

inside of the chassis level with the rim. The outer diameter can be trimmed to size by cutting all round one of the lines that you draw. The inner diameter should be made a snug fit around the outside of the voice coil former, again by trimming all round inside the template, using the lines as a guide. Then mark the template to indicate the degree of overlap required to get the correct angle.

The template for a 12in. Goodman's unit is shown in Fig. 3. Very conveniently, the cone is made by cutting out a 90° sector. The outer radius is about 6in. and the inner radius about ¾in. After marking out the circles with compasses, mark out a series of radii as is shown in the diagram: these and the tags "A" and "B" are used later to align the cone in the chassis. I have drawn the cone template so as to suit either a 6-hole chassis or a 4 or 8-hole chassis. If the chassis has 3 or 6 holes, draw in the radii and tags shown as full lines in the diagram. For a 4 or 8-hole chassis, 3 equidistant lines should be drawn, as shown dotted and the tags "B" should be made. Cut out the paper and glue it up using the overlap and the various circles as guides: if you do this, it should be truly conical.

Obviously, if the loudspeaker had a flatter cone, requiring a sector of only 60° to be removed, the "A" radii should be spaced 100° apart or the "B" radii 75° apart.

Now you must attach the paper cone to the existing voice coil. This job must be done perfectly as it is the basis for the final cone. I used balsa wood cement spread pretty thickly on the old cone and then offered up the new paper cone, fitting it, rather like a motor tyre so that the lines drawn around the new cone were concentric with the voice coil. While setting, the cone was held in place by Sellotape between the chassis and the tags on the edge of the cone.

When the glue has set, it is an advantage to fit an extra layer to the inside or apex of the cone: this inner cone can be about 1in. wide and serves to strengthen the attachment of the new cone to the voice coil.

SUSPENDING THE CONE

The edge suspension should be firm enough to support the coil in the magnet but flexible enough to allow free movement of the cone. Suitable materials for the suspension are chamois leather (expensive), cloth or polyurethane foam. A sheet of foam, 15in. square and $\frac{3}{16}$in. thick costs 7d at Woolworths, but be careful to get the thinnest material!

This foam is marked out into a ring of the same outside diameter as the chassis and an inside diameter about ½in. smaller than the new cone.

The new cone is temporarily suspended by attaching the tags on its edge to the chassis. In doing so, ensure that the cone is circular and centred (I found that it was a help to put a disc into the cone to shape it: try a 7in. gramophone record), the chassis holes can be used as guides.

The foam surround is cut into 4, 6 or 8 equal sectors and two opposite sectors are glued to the chassis using Copydex adhesive. The inner edges of these sectors are then glued to the cone. After the glue has set, test that the cone moves freely. Continue thus until a complete surround has been built and replace the gasket strips (Fig. 4).

STRENGTHENING THE CONE

The thin paper cone will be far too flexible for hi-fi purposes. It can be made very much more rigid by reinforcement with expanded polystyrene

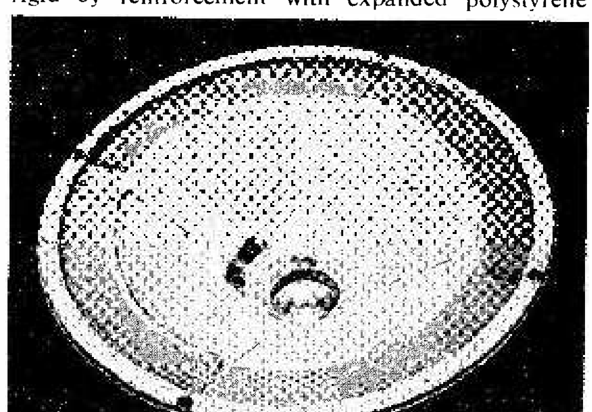


Fig. 4: The thin paper cone is suspended at its edge by polyurethane foam. The centre is reinforced and guide lines help in centring the cone.

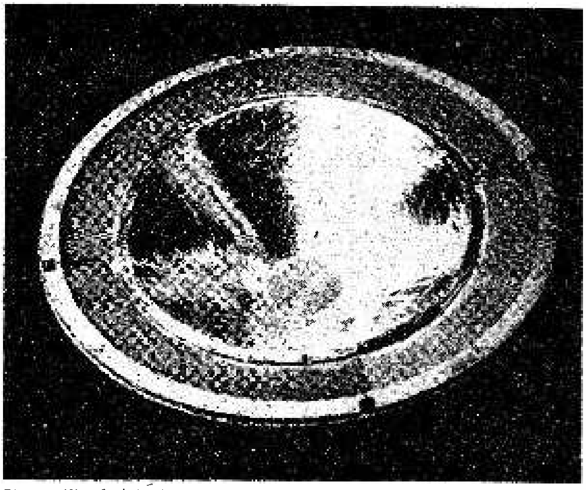


Fig. 5: The finished bass unit. The cone has four layers of polystyrene foam and is finished with aluminium foil.

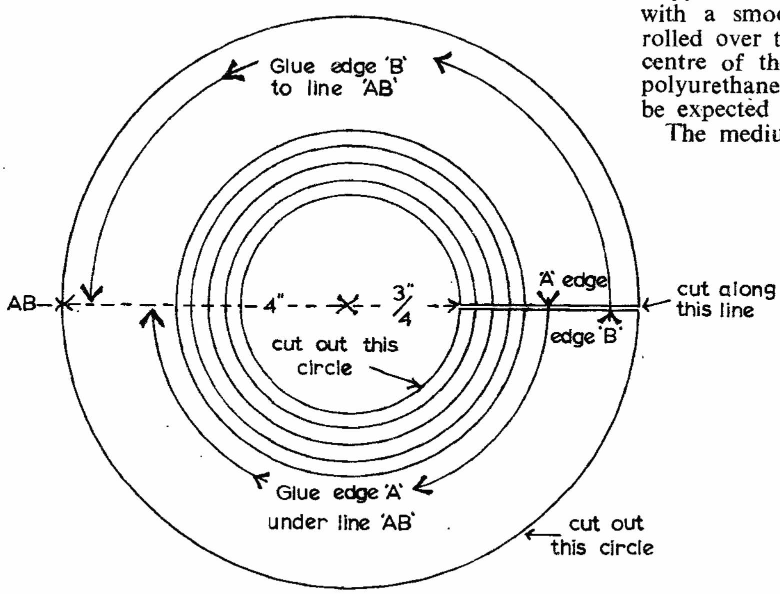


Fig. 6: Diagram showing how a sheet of card should be cut and glued to form a small h.f. radiator for the centre of the large cone.

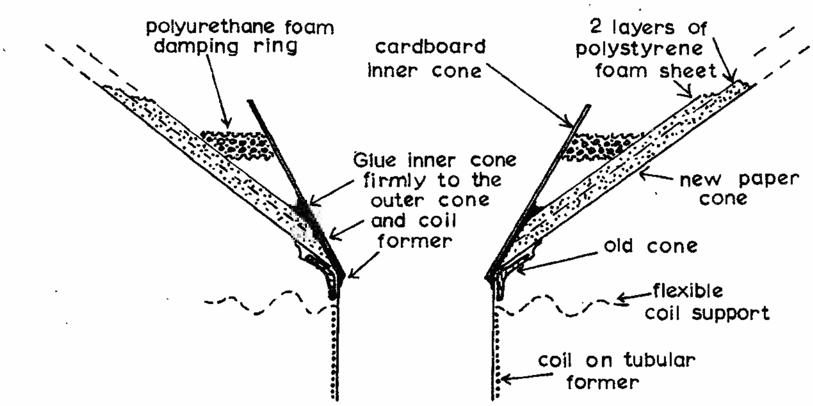


Fig. 7: Diagram showing the fitting of the h.f. radiator cone to the large cone and the siting of a damping ring of polyurethane foam.

foam. The foam can be bought as a roll of household insulation costing about 6s 11d for 33ft. x 3ft. x 2mm. This very light material is cut to the same shape as the cone template (Fig. 3) and divided into three or four sectors. The sectors are then glued around the inside of the thin paper cone. This glueing must be as strong as possible and I suggest you use either Copydex or Britfix balsa cement (many glues dissolve polystyrene—carry out a test).

At this point you must decide whether you want a hi-fi bass unit or a medium quality full range unit. For hi-fi you need a rigid cone, but this will not respond well above 2kHz. For medium quality, the cone may be less rigid but should be fitted with an auxiliary high frequency cone at the centre.

The rigid l.f. cone is made by adding three further layers to the cone. The gaps between the sectors of succeeding layers should be staggered for strength. These layers are glued on with Copydex. The cone is finished off with a layer of aluminium cooking foil, again cut to the template and glued with Copydex. This foil is rolled down on to the cone with a smooth object to ensure adhesion and is rolled over the inside and outside of the cone. The centre of the cone is finished with a dust cap of polyurethane foam (Fig. 5). This speaker should not be expected to perform well above 2kHz.

The medium quality full range version uses only two layers of polystyrene foam and no aluminium skin. It is fitted with a laminated inner cone of 60° angle. This accessory cone is made from a circle of radius 4in. marked out as in Fig. 6. Use thin card, similar to postcard, and mark out a series of guide-rings ⅛in. apart; these will help in fitting the cone to the voice coil. Cut along a single radius and fold the two cut edges, one inside and one outside the cone to form the double cone. Glue it carefully all over with Copydex.

As the purpose of this small cone is to radiate directly from the coil, it must be fastened firmly to the voice coil tube. First, trim up the polystyrene foam around the apex of the large cone, until the small cone is a snug fit on the large cone and edge of the coil former (see Fig. 7). Then trim the apex of the small cone, using the guide-rings to ensure concentricity, until the cone apex is only slightly smaller than the large cone. Then glue the small cone on to the large cone and coil former with balsa cement.

Practical experience shows that thin cones of this type have undesirable resonances. These can be damped to a great extent by fitting a ring of polyurethane foam between the h.f. cone and the main cone. This should be made of ⅜in. thick foam (Woolworths, again cut in a ring of outside radius 2½in. and inside radius 1¼in. and fitted over the inner cone as in

★ components list

Materials required	Approximate cost	
1 sheet tracing or drawing paper 15in. x 20in.	6d.	
1 roll polystyrene foam wall covering 33ft. x 2ft. x 2mm.	6s.11d.*	(You only need about 3ft. of this, so you can scrounge it!)
1 tube balsa wood cement (Britfix)	1s. 3d.	
1 tube Copydex	2s. 6d.	
1 sq. ft. of domestic foil (L.F. unit only)	2s. 9d.*	(Give the rest to your wife!)
8in. square of card 0.015in. thick (Full range unit only)		
1 sheet polyurethane foam 15in. x 15in. x $\frac{3}{16}$in.	7d.	Woolworths.
1 sheet polyurethane foam 6in. x 6in. x $\frac{3}{8}$in. (Full range unit only)	7d.	Woolworths.
	14s. 9d. or 12s. 7d.	

* You can restore about ten loudspeakers from these packages!

Tools

Pencil, ruler, protractor, pair of compasses and scissors.

Fig. 7; this is not glued in place. An appropriate circle of foam should be cut and glued inside the inner cone to protect the pole of the magnet from dust.

The main problems are that the new cone may be eccentric or may not be firmly glued to the voice coil. This is very easily tested by feeding the speaker with between 3 and 10 watts of 50Hz signal; for a 3Ω speaker, 4 to 6 volts; or for a 15Ω speaker 8 to 12 volts from a transformer will provide this power. The cone should vibrate through about $\frac{3}{8}$in., but should not set up a scraping noise in the process. If the speaker can stand this usage, it should stand domestic music!

For various purposes, it is useful to find the bass resonant frequency; unfortunately, you will need an a.f. generator and an amplifier for this. Connect an a.c. voltmeter across the loudspeaker and feed from the amplifier via a 15Ω to 30Ω resistor. Resonance causes the loudspeaker impedance to rise and thus the voltage across the voice coil rises and the point at which this voltage is maximum is the resonant frequency. Alternatively, the resonance can be seen as a greatly increased amplitude of cone movement. When designing a new enclosure, the resonance is used to assist in tuning the enclosure and so the value should be noted carefully.

If the finished cone causes rubbing on the poles of the magnet, it is a comparatively simple task to re-align it; the site of friction can be observed and the whole cone pulled to and fro to free the coil. After the correct pull has been found, the foam surround can be freed from the cone and re-glued appropriately.

The instructions given here hold for a typical 12in loudspeaker with a pole piece of about $1\frac{3}{4}$in. diameter. For other units, appropriate adjustments to the dimensions will have to be made.

If you do not have a tweeter or crossover unit, the wide range medium fidelity unit can be used without further modification.

For the best results, the l.f. unit is preferred. My speaker responds very smoothly from 50Hz to 1·5kHz, and is flat over this range to ± about 5dB. The bass resonance is 32Hz. ■

THE MW COLUMN

DURING the winter months there is quite a lot of DX on the medium waves from about 1500 hrs. GMT onwards. Stations reported recently include Taiwan 750 KHz; Bagdad 760; *Radio Irana* Teheran 895 (closes down at 1930 hrs.); Anwhei China on 940; Kermanshah Iran 985; *AIR* Calcutta on 1130; *VOA* Okinawa 1178 (behind Horby Sweden); Kabul Afghanistan 1280; China 1290; Teheran 1325; Kuwait 1345; Ahwaz Iran 1390. The *VOA* station in Malalos in the Philippines on 920 was transferred recently to the Philippines government and is now called the Voice of the Philippines, it has programmes in English and signs off at 1600 hrs. Later in the evening a number of interesting African stations can be heard. Tenerife in the Canaries is usually a prominent signal on 620 KHz. Monrovia in Liberia on 629 is more difficult but has been logged. EAJ103 *Radio Sahara* in El Aioun is on 656; Dakar in Senegal on 764 is generally strong after Sottens closes down; EAK92 Las Palmas Canaries is on 827 mixed with EAJ1 Barcelona: EFJ57 in Tenerife is now on 894 after moving recently from 872; EAJ202 *Radio Villa Cisneros* in Spanish Sahara is on 998; *Radio Atlantico* Las Palmas on 1097 is behind EFE14 Madrid; Conakry Guinea on 1403 is invariably a strong signal with African music after 2300 hrs.; Funchal Madeira 1529 is sometimes audible before close down at 2300 hrs.

A number of European MW stations broadcast special programmes in English for DXers. *Sweden Calling DXers* is on 1178 KHz at 2300 hrs. GMT on Tuesdays, *Radio Portugal* has a DX programme on Mondays on 755 and 1161 at 2300 hrs. and on 1412 at 2315 hrs. Recently, *Deutschlandfunk* on 1268 has started *DX Circle* at 1800 hrs. on alternate Wednesdays. This programme is introduced by Alan Thompson of the World DX Club. *Radio Andorra* 701 KHz now has a nightly programme of pop music and announcements in English starting at midnight GMT. Reports are requested and should go to PO Box 1, Andorra.

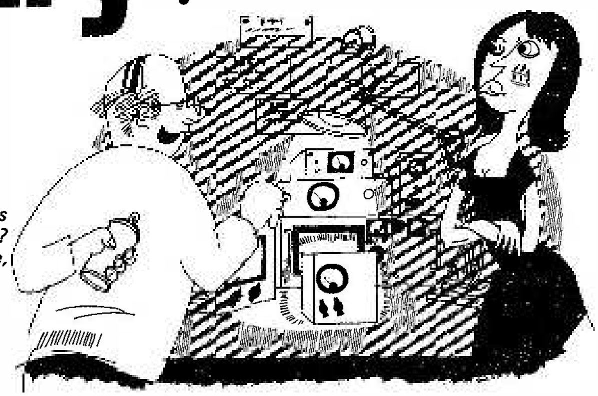
The writer is often asked by newcomers how they can find North America on the MWs. At this time of the year, the easiest station to locate is CBA Moncton New Brunswick, an outlet of the *Canadian Broadcasting Corporation on 1070 KHz. Paris II* on the same frequency closes down at 2300 hrs. GMT nightly and when the path is open CBA should be audible after the Paris carrier is switched off. If it is not heard by 2330 hrs. then conditions are below average and a further attempt should be made a few days later, conditions do vary. Other stations that have been logged recently between 2300 hrs. and midnight GMT are VOCM on 590 in St. John's, Newfoundland; WOR New York City on 710; WABC also in NYC on 770; WHDH Boston on 850; CJON St. John's Newfoundland on 930; WINS in NYC on 1010; WBAL Baltimore on 1090 and WNEW 1130 in NYC. When conditions are good numerous NA stations can be heard up to 0300 hrs. when interference starts to become troublesome.

CHARLES MOLLOY

home and dry! *

F. G. SADLER, G3UZ

THERE is one item that seems to have escaped discovery, and I have never seen in print, and that is "How to buy and get into the shack, unbeknown to the wife, new gear". I have been around this country and abroad visiting other "Hams" at various times and during this period, have picked up quite a few hints and tips on this subject, and for what they are worth I will try to pass them on.



"I reckon this paint is wonderful, don't you? Just feel the surface, it's bone dry!"

First tip is to get the XYL to pay a visit to her mother and as soon as she is out of the way, go out and buy a new bit of gear. As soon as you arrive home place it on the bench with other equipment, if after a time she happens to spot it, do not worry, you can get away with it in nine cases out of ten, by saying: "Haven't you seen that before dear, it has been laying on the bench for years." I know this can work very well, as, just after the war, I got rid of XYL as described above, and straightaway went down to radio dealer and bought a R1155 receiver. I had to carry it about two miles to my home, but I was so pleased about it all, it seemed to me as light as a feather!

Tip No. 2, again you are thinking about a piece of new gear, first thing to do is to get your best friend, who by the way is also a "Ham", to pay you a visit then after he has been there for about half an hour and just as the XYL is bringing a cup of tea into shack, let him drop the remark that he has a bit of useless gear at home that he intends to throw out, you up and say (while wife listens) as a great favour to him you will take it off his hands for spare parts.

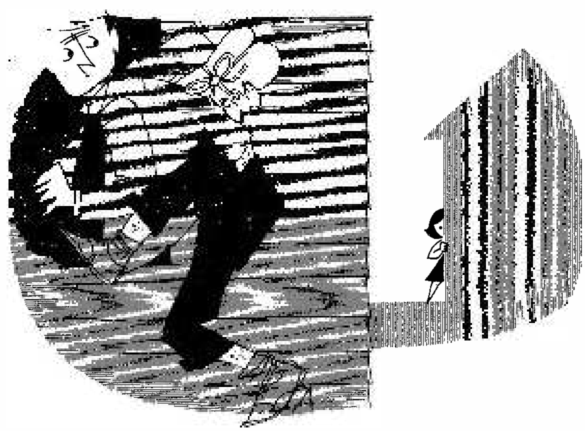
As soon as XYL is out, bring in gear, place on bench, when she arrives home again, take her in shack, show her gear with the remark, "What a good chap that Fred is to be sure, look dear he has even brought it around". One look at it, and she will reply "Another bit of rubbish, I expect". Alas it is a sad state of affairs that wives think this way but you've got your new piece of gear!

No. 3 tip and best of all, to my way of thinking, was passed to me by a friend who resides in Eire, and this is how it goes.

When you come home from work, and you are having your meal, get your copy of PRACTICAL WIRELESS out and start to read it. Suddenly you read out to the XYL, an advert., contained therein relating to "So and So quick drying paint". "I must get a tin of that" you say and you do so.

Now you have got your new gear, which you have hidden under cover of bench, so straight to the shack you go, open up the tin of paint, and paint an old cabinet. When this has been done (door and windows have been kept shut whilst doing the job so the smell of the paint cannot get out), put new gear on bench, stick old repainted cabinet under bench, then rush out of shack, to living room where XYL is reading paper and say : "Come and have a look at the job I have just painted." When she gets into the shack the smell of paint is really awful, however, do not let her go back to her newspaper yet. Just say: "I reckon this paint is wonderful, don't you? Just feel that shiny surface dear, it is bone dry." Though she may feel the top of gear, she will not take much notice of it being new as she will want to get away from smell of paint, so once again you have run out as a winner!

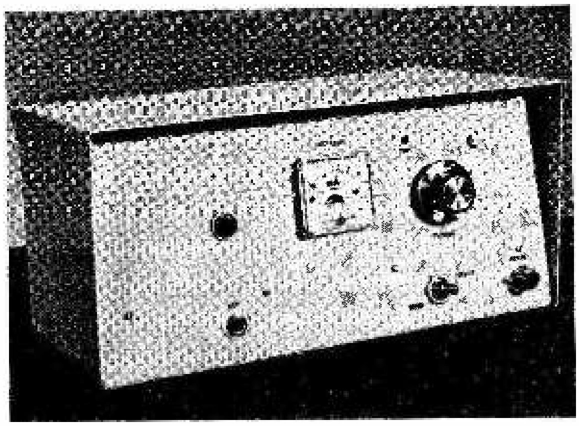
If later on, she does happen to see it and asks about it, and where it came from you can always turn around to her and say "Why you little silly billy, that's that bit of old gear I painted up, don't you remember?" Well, Mr. Editor, I have done my best to help other "Hams" in their painful ordeals, and I sincerely trust they have happier times buying their gear.



When smuggling a new piece of gear into the shack, make sure the XYL is not lurking round the corner!

The TWO-FIFTY TRANSMITTER 2·50

A S CARPENTER G3TYJ



NOW that the 2-metre (144-146MHz) amateur band is usable by GPO-licensed G8 (Class B) call-signs additional to Class A licensees, a reasonably potent v.h.f. transmitter design may be of interest to readers. All parts used in the transmitter are readily obtainable and the total building cost, when every item has to be purchased, is in the region of £10.

When operated in the author's preferred mode, viz. A1 (c.w.) emission the transmitter will run at up to 40W input from a 300V d.c. supply rail voltage and at 25W input from 250V d.c.; running the transmitter from a h.t. rail voltage lower than 250V is not recommended, except perhaps for preliminary setting-up operations.

Current requirements are 200mA (minimum) plus 3 amps from a 6·3V a.c. source for the heaters and panel warning lamp. A complete power supply unit (PSU) should be provided as an outboard item.

The transmitter keying socket is associated with the penultimate r.f. stage but the final valve is fully protected during "key-up" conditions by fitment of a clamp valve. Provision is also made for type A3 emission (phone) working via an external modulator;

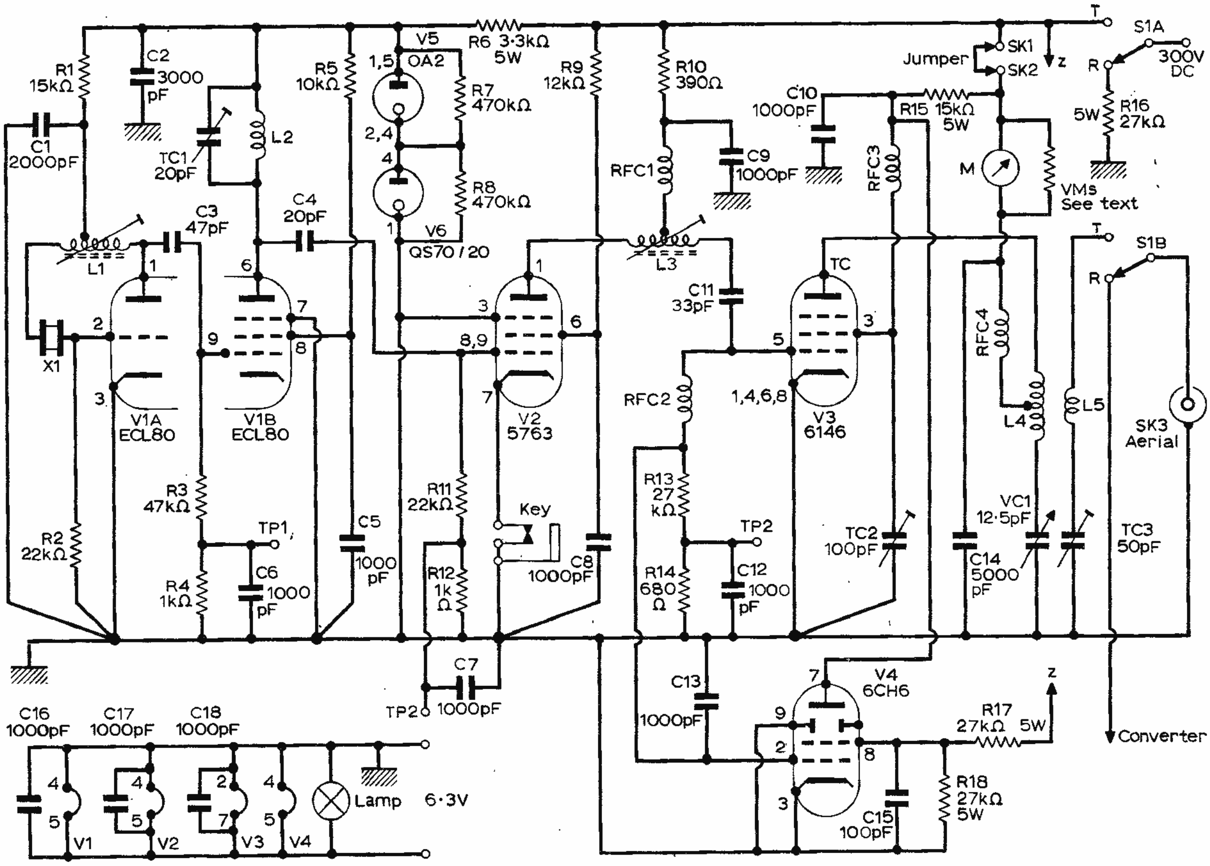


Fig. 1: The complete circuit of the transmitter.

anode and screen modulation requires audio power of some 15W and must be provided by a separate unit. Clamp valve modulation, although not so effective as preferred anode and screen systems, can possibly be used; this does confer simplicity and a suggestion regarding it will be made later.

CIRCUITRY

The complete circuit of the "Two-Fifty" transmitter is given in Fig. 1 where the required final output in the 2-metre band is secured via multiplied oscillations generated initially at a nominal frequency of 8MHz and obtained via a crystal. The crystal oscillator coil L1 in conjunction with the triode section of V1a is tuned to the third crystal harmonic in the 24MHz region; this is injected into the pentode grid circuit of V1b. Output multiplied to 72MHz is available at the pentode anode and is developed across coil L2. The 5763 valve, V2 then doubles the 72MHz input applied to it and signals in the 144MHz band are developed at the pi-tuned anode-grid coil Le. The PA valve, a 6146, then raises the signals to a suitable level for transmission.

Output is taken from a small link coil, L5, wound centrally within series-tuned coil L4. In the PA stage choke RFC3 and trimmer CT2 are neutralising items whilst the pair of sockets SK1-2 fitted in d.c. supply circuit permit modulation to be applied to both anode and screen from an external unit.

The PA anode meter *M* is useful as a current monitor but for more precise tuning-up an absorption type wavemeter is preferred; meter *M* in the prototype is a 5mA f.s.d. item shunted to read 0-150mA. The shunt value required is 0·2 ohms approximately for the particular movement used and this is made up by winding some fine enamelled copper wire on to a $\frac{1}{8}$in. former and checking the panel meter to f.s.d. against an external test meter appropriately driven to 150mA.

PA PROTECTION

The drive voltage present at the "earthy" end of choke RFC2 when the transmitter is operating is in connection with the control grid of clamp valve V4, but biasing it to cut-off; V4 is thus normally inoperative. If the voltage developed across R13-14 by drive disappears at any time however, the clamp valve conducts heavily and a large voltage drop occurs across R15 as extra current is drawn; the 6146 valve screen voltage then falls low and the valve is protected. The clamp valve thus immediately offers itself as a keying safety device which can operate in sympathy with the Morse characters keyed. The valve specified for the clamp operation is a 6CH6 but any small output pentode capable of accommodating a current capacity of 40mA or so is suitable.

Keying the transmitter causes h.t. voltage fluctuations thus it is essential to stabilise the supply to V1; series-connected stabiliser valves V5 and V6 enable this to be done satisfactorily. A single OA2 stabiliser valve can be tried but this does reduce the available h.t. potential to V1 to 150V. A type QS70/25 can be used in place of the QS70/20 specified, provided base differences are noted at the wiring-up stage. Series resistor R6 should be so chosen that current taken by the stabiliser valves does not exceed 20mA under any circumstances.

★ components list

Resistors:

R1	15kΩ	R12	1kΩ
R2	22kΩ	R13	27kΩ
R3	47kΩ	R14	680Ω
R4	1kΩ	R15	15kΩ, 5W
R5	10kΩ	R16	27kΩ, 5W
R6	3·3kΩ, 5W	VM_S	See text
R7	470kΩ	R17 }	27kΩ, 5W
R8	470kΩ	R18 }	
R9	12kΩ	All $\frac{1}{2}$W, 20% except where stated	
R10	390Ω		
R11	22kΩ		

Valves:

V1	ECL80	V4	6CH6 (or see text)
V2	5763	V5	OA2
V3	6146 Brimar	V6	QS70/20

Capacitors:

C1	2,000pF ceramic	C13	1,000pF ceramic
C2	3,000pF ceramic	C14	5,000pF
C3	47pF ceramic	C15	1,000pF ceramic
C4	20pF ceramic	C16	1,000pF ceramic
C5	1,000pF ceramic	C17	1,000pF ceramic
C6	1,000pF ceramic (feed through type)	C18	1,000pF ceramic
		VC1	12·5pF variable
		CT1	20pF air-spaced trimmer
C7	1,000pF ceramic		
C8	1,000pF ceramic	CT2	100pF trimmer
C9	1,000pF ceramic	CT3	50pF air-spaced trimmer type C801 or similar
C10	1,000pF ceramic		
C11	33pF ceramic		
C12	1,000pF ceramic (feed through type)		

Miscellaneous:

Key socket, self-closing type; Modulation input sockets (2); Coaxial-type aerial socket; DPDT switch; Valveholders (see text), B9A (3), B7G (2), I.O. (1); panel and chassis material; Meter, miniature panel type 0-5mA (see text) or 0-150mA.

SWITCHING

The function switching of the "Two-Fifty" transmitter is simply, if crudely, done by means of S1A-B, one section being used for h.t. purposes and the other for aerial change-over. A more refined method of switching r.f. may be desirable but since the system seems to work to date it is retained. Resistor R16 is fitted as a current "bleeder" during "receive" periods. On/Off switching proper is associated with the external PSU.

LAYOUT AND CONSTRUCTION

Layout of v.h.f. equipment requires care and it is thought that the layout adopted can hardly be improved upon since it affords short, direct wiring. Wiring-up should follow normal v.h.f. practice with a single chassis connecting point being used for each stage; thick connecting wire of solid core—

say 18s.w.g.—is required. Ceramic valveholders must be used for V1, V2 and V3; a metal ring should be associated with the V3 valveholder and tags No. 1, 4, 6 and 8 should be soldered directly to it with short lengths of 18s.w.g. copper wire.

COIL WINDING

All coils are wound by hand and full details are given below:

Coil No.	Frequency MHz	Turns	Wire s.w.g.	Coil former and spacing etc.
L1	24	25	30 enam.	⅜in. dust-cored former, turns close wound, tapped 5 turns from X1 end.
L2	72	4	16 t.c.	½in. air-cored, turns spaced wire thickness.
L3	144	3¾	16 t.c.	⅜in. dust-cored former, turns spaced wire thickness, centre tapped.
L4	144	4	16 t.c.	⅝in. air-cored, turns spaced wire thickness ×2. Tapped centrally.
L5	—	1	22 t.c.	⅝in. air-cored. P.V.C. insulated and inserted centrally in L4.

Note: t.c.=tinned copper wire. enam.=enamelled copper wire.

RF chokes RFC1 and RFC2 can be v.h.f. types or some 100 turns of fine enamelled copper wire may be wound on to a 1MΩ resistor. For choke RFC3 40 turns of 36d.s.c. copper wire are close-wound on to a ½in. diameter air-cored former whilst choke RFC4 consists of 50 turns of 30s.w.g. enamelled copper wire close-wound on to a 1½in. length of ball-pen barrel approximately ¼in. diameter.

TESTING

Initially the oscillator should be checked with a low h.t. voltage applied and with V2 and the *insulated* jumper to sockets SK1-2 removed. A test meter set to read 0-10mA connected from TP1 to chassis (chassis + ve meter prod) should indicate when the core of L1 is adjusted; the core is first adjusted for maximum meter indication then rotated to slightly disengage the windings and until the meter reading falls by a small amount. Failure to make this adjustment may result in the oscillator going

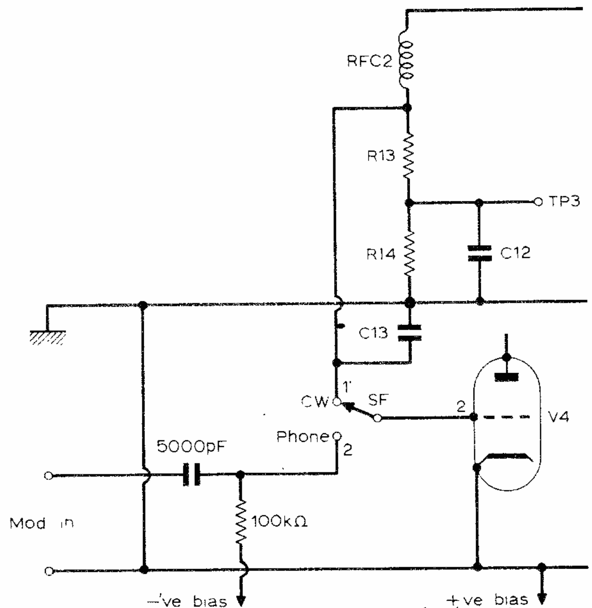


Fig. 3: Suggested modification to permit clamp type modulation.

"dead" when switched on next time. An absorption type wavemeter should now show the circuit to be operative at the crystal frequency × 3, viz. in the 24MHz region. With V2 plugged in, the meter is moved to TP2 and CT1 adjusted for maximum indication after which L2 is checked with a wavemeter for output in the 72MHz region. At TP3 the core of L3 is set for maximum meter indication and a wavemeter check at 144MHz made. If VC1 is now rotated the test meter at TP3 should show little or no change as L4 is tuned through resonance but in practice a sharp downward kick may be observed; when this occurs CT2 needs to be reset and should be adjusted to provide but the smallest change in reading when the test is repeated.

With the function switch S1 set to *receive* an insulated jumper can be applied to sockets SK1-2, a low-wattage lamp applied to the aerial socket and power applied. The lamp should glow when S1 is moved to "Transmit" and when VC1 is adjusted for lowest panel meter reading—say 100mA.

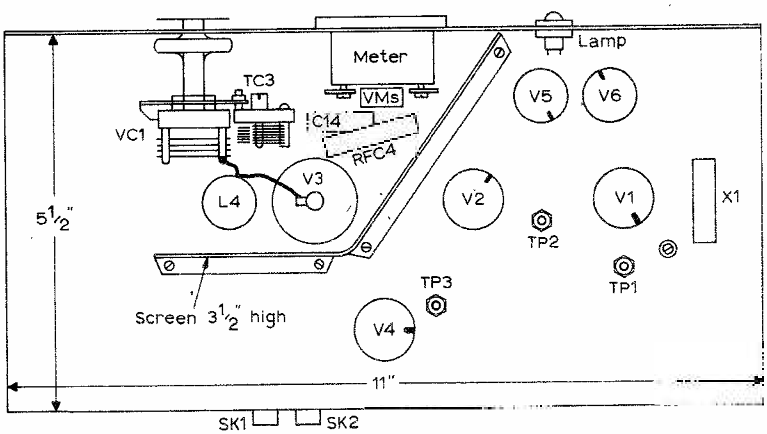


Fig. 2: The above-chassis layout.

When the key jack-plug is inserted—or the keying contacts opened—the panel meter reading should fall very low and the lamp should go out. If this does not occur either the clamp valve is not functioning or the 6146 valve has "taken off"; this can be checked by momentarily touching the tapping point of L1 with a screwdriver blade whereupon the lamp should dim and then recover from the disturbance.

The current passing through the stabiliser valves should also be checked; if they remain unlit resistor R6 is too high in value.

—continued on page 781

A PANORAMIC RECEIVER for 160 to 80 METRES

BY D. BOLLEN **PART 2**

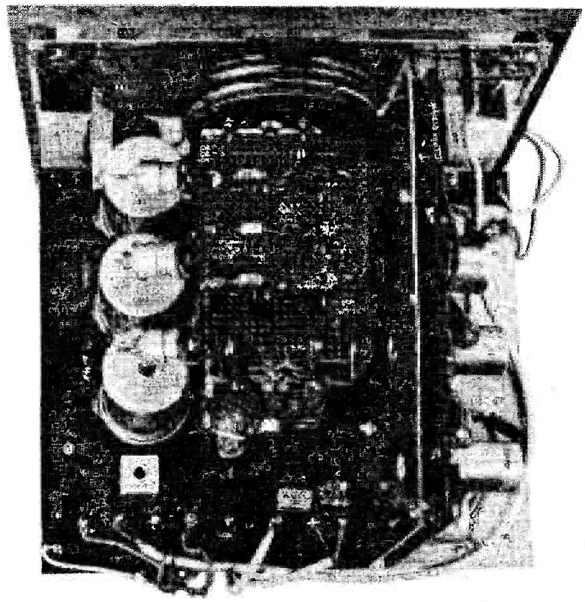
Last month the theory and circuit of the Panadaptor were given. This month's article deals with the construction.

PANORAMIC RECEIVER CONSTRUCTION

USING Fig. 6 as a guide, drill a 5⅞in. × 7in. s.r.b.p. panel to take the tuning capacitor mounting screws, B9A coil holders, i.f. transformer tags, VR4, C12, the bias battery, and all turret tags. Also, holes to take the aluminium bracket screws and the two wires going to the diode tuner panel. Insert and rivet all turret tags before mounting the above components on the s.r.b.p. panel. Complete coil holder and i.f. transformer wiring using Fig. 6b as a guide, but ignore for the time being all connections to the converter controls and diode tuner panel.

The next stage is to make up the diode tuner panel on either 0·1in. matrix Veroboard, with 21 × 30 holes and copper strips running parallel to the longest side, or else plain drilled s.r.b.p. or the same matrix with copper wire or Cir-Kit strips on the underside. Insert and wire up diode tuner components as shown in Fig. 7, and take care to observe the correct diode polarities.

Four short 18s.w.g. copper wire legs will serve to mount the diode tuner panel on top of the



Top view of the Panadaptor—compare this with Fig. 6.

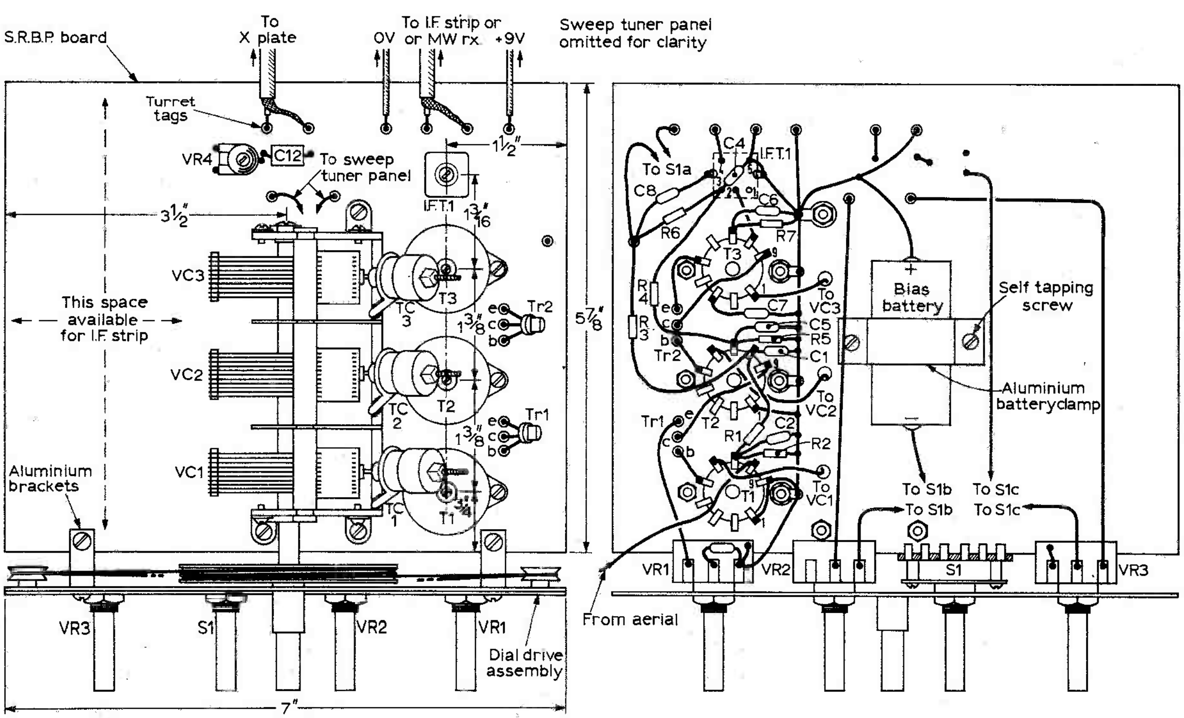


Fig. 6: The layout and wiring diagram.

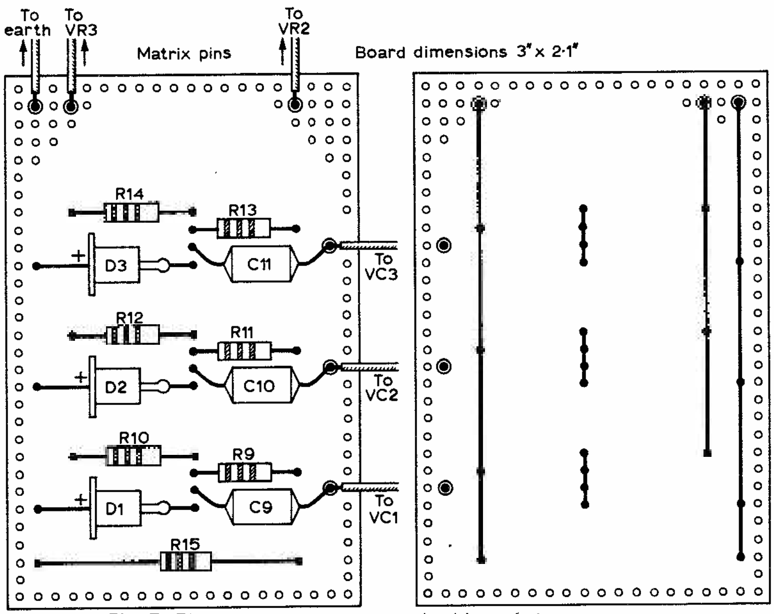
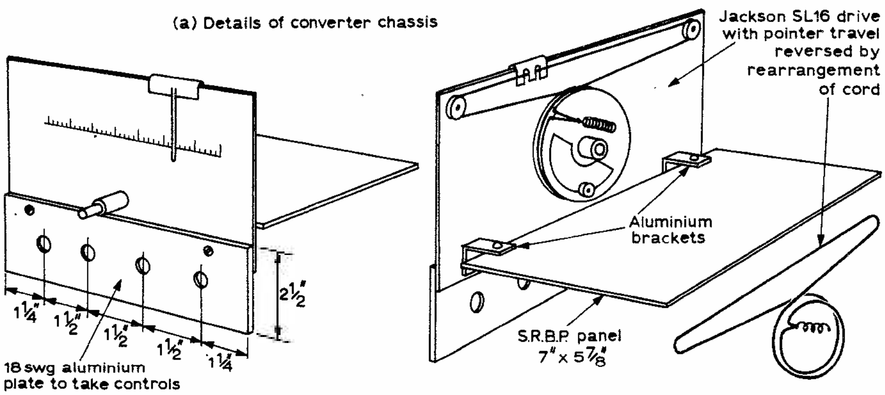


Fig. 7: The component layout and wiring of the sweep tuner panel.



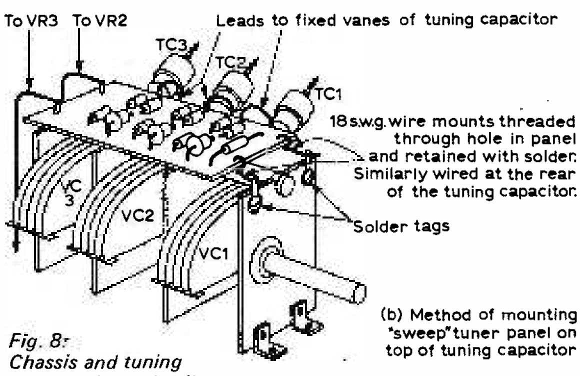


Fig. 8: Chassis and tuning constructional details.

The plate is bolted to the tuning scale drive assembly with two 4BA screws and nuts, which also serve to secure the aluminium brackets on the main s.r.b.p. converter panel. If it is desired to have a tuning scale with the lowest frequency on the left-hand side, it will be necessary to lengthen the drive cord and then re-wind it as shown in Fig. 8a. Whichever way the drive cord is wound, a clockwise rotation of the tuning knob gives a natural deflection of signals on the oscilloscope display to the right, and the bandspread control VR2 works similarly.

After mounting the converter controls VR1, VR2, VR3, and S1, offer up the tuning capacitor spindle and s.r.b.p. converter panel to the scale drive assembly, then complete final wiring.

converter tuning capacitor, for details see Fig. 8b. Solder tags (4BA) to accept the ends of the wire legs are screwed to the tuning capacitor frame by means of the tapped holes provided. After offering up the tuner panel, solder the legs to the solder tags.

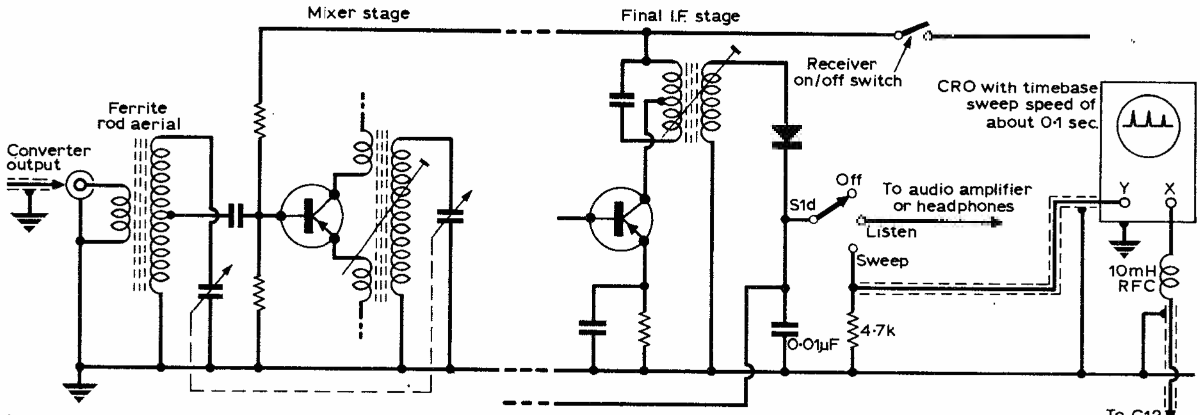
Make up and drill an 18s.w.g. aluminium plate to take the converter controls, according to Fig. 8a.

COUPLING ARRANGEMENTS

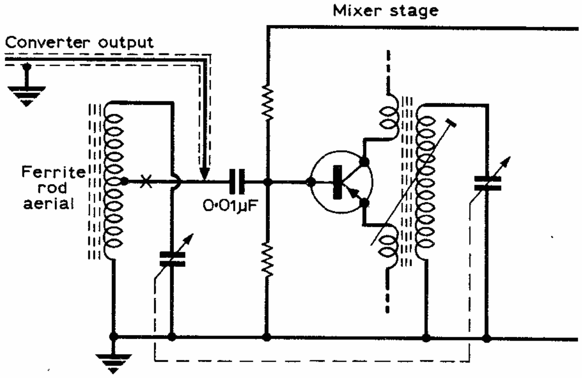
If a transistor medium wave portable receiver is to hand, this can be employed as a mixer-i.f. strip without any modification, by feeding the output from the converter straight to the aerial socket of the receiver, and by taking an output straight from the receiver detector diode to the oscilloscope Y amplifier. The resistor R8 shown in Fig. 4 can be inserted if instability is experienced. A slightly better arrangement is shown in Fig 9a, where switching is included after the diode detector to prevent the loud, rasping note of the sweep input being relayed to the headphones or loudspeaker. Note also the use of a 10mH r.f. choke in series with lead from the oscilloscope X terminal, to reduce harmonic interference from the timebase flyback, which can be especially troublesome on Top Band.

A problem likely to be encountered when the converter output is coupled to a medium wave receiver via the ferrite aerial winding is that, with the ferrite aerial still in circuit, it may be difficult to avoid spurious medium wave signals, especially after dark. Figure 9b gives an alternative method of coupling which removes the ferrite aerial from circuit. Where the ferrite aerial has a separate base winding, the circuit of Fig. 9c can be employed.

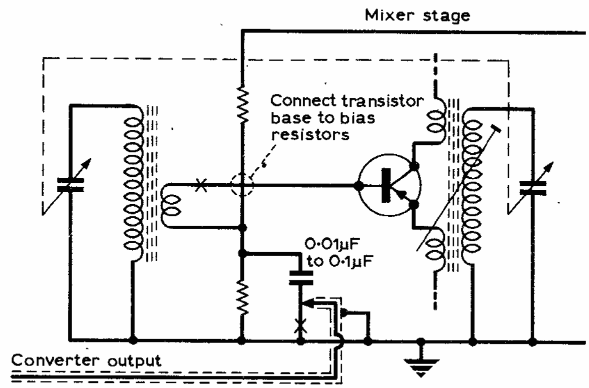
If a transistor receiver is not available for use with the converter, a 1·6MHz i.f. strip will have to be constructed, or purchased as a module. To achieve a performance comparable to that obtained with a mixer stage and 465kHz i.f. strip, the 1·6MHz i.f. strip should have three stages of amplification. A way of connecting the first i.f. stage to the converter output is shown in Fig. 9d.



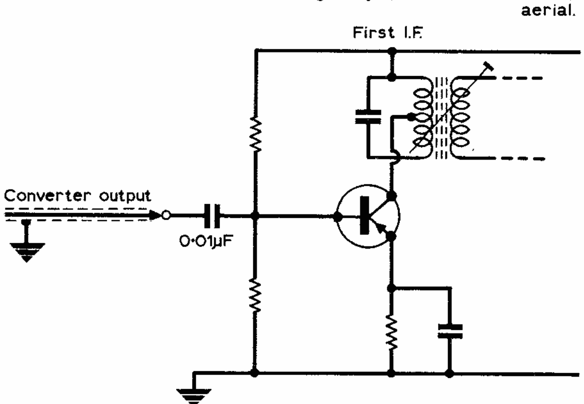
(a) Converter coupled to a medium wave receiver. Also showing output connection to an oscilloscope.



(b) Alternative method of coupling to by-pass the ferrite rod aerial.



(c) Method of by-passing a ferrite rod aerial which has a separate base winding.



(d) Converter coupled to a 1·6MHz I.F. strip.

Fig. 9: Coupling arrangements for the Panadaptor—see text for explanations.

When the medium wave receiver or 1·6MHz i.f. strip employs p-n-p transistors its supply rail will, of course, be at negative potential, which will conflict with the power requirements of the n-p-n transistor converter. However, in the interests of stability as well as simplicity, it is preferable anyway to employ two batteries, one for the converter and one for the receiver or i.f. strip.

Next month's final part will describe the alignment procedure and show the traces given on an oscilloscope by the prototype.

THE TWO-FIFTY TRANSMITTER

continued from page 778

Although in no way comparable to anode-and-screen modulation a clamp valve system can be tried when the simple additional switchery around SF in Fig. 3 is suggested. Negative bias—3 or 4 volts—sufficient to bring the panel meter pointer to about half-scale is needed. Modulation from a simple 2- or 3-stage speech amplifier using say 12AX7s and with a crystal microphone should swing the screen potential of the 6146 valve in sympathy with the input signals. Adequate space exists on the transmitter chassis for the inclusion of such a simple modulator. It must be appreciated however that no practical tests with this form of modulation have been made.

So far no mention has been made of the actual crystal frequency except to say that it should be in the 8MHz region; it should of course be selected in relation to the particular area in which the transmitter is to be used. The 144-144·10MHz region is a nationwide c.w. segment but for phone working the 2-metre Band Plan zonings should be observed; it is also necessary to keep clear of various Services guard channels.

Final loading into the station aerial can follow preferably using as an aid an absorption type wavemeter; the setting assigned to trimmer CT3 can then be found which affords optimum performance. ■

practically wireless

commentary by HENRY

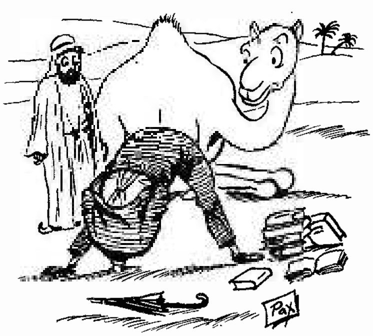
No. 65

Obvious Innit?

Half the fun of reading the glossier technical magazines comes from their correspondence columns. Professor Pundit begs for space to point out that the formula for interactive floating feedback given by J. Sproggs in his otherwise interesting article contained the sort of popular error usually attributed to inattentive schoolboys. The parsating factor, given as $10^{-5}Zt_{sup}$, had been proved 0·0072% too large in detailed experiment by the Capanfish Laboratories in 1937, and verified by independent field research.

Well, of course, Sproggs is not the man to take that lying down and he parries smartly to the effect that the learned Professor should have taken more trouble to read right through the offending article, where, in para 4 of Page 391 he would have seen that parsation was indeed compensated by factor K. Mr. S. goes on to say that he is surprised that Prof. P. should have seen fit to use the now discredited Binnacle Assessment. It was to be hoped, for the sake of the professor's pupils, that the bulk of his teaching was not based on such fallacious argument.

Thoroughly incensed, the Prof. fights back, quoting armsful of sources, and Sproggs caps him with reference to recent spin-off researches from the NASA programme. He implies that the Prof. has his head buried too deeply in the historical sand.



His head buried in the sand.

It goes on for a few months, with others joining in to add their weight or villify; with the inevitable red herring letter (which Henry always suspects the Editor to have written himself), until a terse *'This correspondence is now closed'* allows us to concentrate on another argument that has sprung up.

Half the trouble with these 'frank exchanges' is lack of communication. Words are a treacherous form of communication, especially when used to discuss a subject as beset by different standards as electronics. Or, worse, high fidelity audio, where one man's power is another man's fixation.

Just at present there rages an argument about the relative merits of Class A and Class B operation of push-pull transistorised output stages. The protaganists have been polite, so far. Gordon J. King has recently been experimenting with amplifier assessment, and concludes that crossover distortion is such a subjective matter that by the time you have got down to the low levels where you doubt the validity of your instruments, the noise level of the amplifier masks instrumental interpretation anyway. Agreed! There does not seem much point in donning earphones to listen to your hair grow.

Listening to your hair grow.

Taking a practical example of a 20-watt amplifier (r.m.s., we presume?) with the good noise figure (overall noise relative to full power output) of 78dB . . . *You will already have noted that we needed to qualify two of our parameters—that's how it goes with hi-fi lads* . . . he works out the maximum distortion measurable by the usual methods, and finds that this gives a ratio to the noise level of 2900:18 (44dB, or 0·65%).

From which we conclude that it is virtually impossible to measure low-level distortion at power around the 10mW mark (for the aforementioned amplifier) as the distortion falls into noise.

Let's come down a bit to where the air is not refined. Down to information retrieval, in fact. That formidable term simply means being able to flip over the pages until you find the data you want. My back numbers of PW are well-thumbed and dog-eared by this process because I had no way of finding the information I wanted except a vague jog of the memory and a patient flip. Now you would think that someone as erudite as Marshall McLuhan would see the value of browsing.

But, No Sir, in Dewline Newsletter he talks about communications and says: *'To go on building nineteenth century spaces for the storing and dissemination of classified information is perfectly natural. It is also fatal.'* He goes on to advocate microfilmed books, available to all at the touch of a button, extracts appearing on your TV screen.

If the Dewline extract had appeared in one of our technical glossies. McLuhan would soon have been challenged. What seems obvious to the dogmatist can be torn to pieces by the terriers of technical readership. He has overlooked the basic point about books—that all the information is under one's hand; that browsing can turn up related facts as we subconsciously do our ferreting.

CLUB SPOT

BROMSGROVE & DISTRICT AMATEUR RADIO CLUB G3VGG

THE club was formed in January 1965 when John Harvey, a keen SWL, decided to put a CQ in the local newspaper calling any radio enthusiasts to a meeting at the Bromsgrove Co-op Hall. Twelve chaps turned up for the first meeting.

Among them was the Late Jack Casey, G8JC. Jack was a great help in helping to form the rules of the club and getting the finances organised. The present chairman Jack Gwynne, G2CLN has held that office right from the first meeting and has played a major part in the development of the club. G2CLN has been a source of inspiration to the members in getting club projects organised and also in helping with RAE lectures.

Other founder members include the present treasurer, John Harvey and J. Dufrane (Hon. Sec.). Since then the club has made great strides, a prominent landmark was the acquisition of a club shack. January 1st 1967 saw every able-bodied member armed with paints, brushes, tools, etc. and in a short time work benches and an "operating table" were fixed up. Now the shack boasts a top band Tx and various Rx sets for members' use. In addition, the club, using its call sign G3VGG takes part in various contests.

NFD is a very popular event and at the present rate of progress we should win the event in 1975! VHF and f.m. in particular is becoming very popular and a club project organised by G2CLN is for a 2m f.e.t. converter. The club has operated portable on 2m on the Clee Mills.

A very popular event is the annual mobile picnic: this is a true picnic and the aim is to cater for the wives and kids as well as the amateurs. This year's picnic on August 31st was held in the grounds of Hartlebury Castle, near Kidderminster, talk-in stations operating on 2m and top band.

A group of members at the finish of the 1967 N.F.D. event

Other outdoor activities include several exhibition stations put on at local fetes and flower shows.

The club's newsletter is edited by Ray Young and his XYL.

Licensed members include Howard, G3NOY; Robin, G3WNT; Hugh, G3VHL; Ian, G3WUG; Ken, G810 and several perspiring RAE candidates.

For SWL members the club runs a logging contest —each month a specified band with points for number of calls logged. A trophy has been presented by G2CLN to be awarded to the winner at the end of the year.

Club meetings are held every second Friday of the month at the Co-op Hall in Bromsgrove, talks and demonstrations with film shows, etc. Visitors are welcomed.

Details from Jack Dufrane, Hon. Sec., 44 Hazelton Road Marlbrook Bromsgrove, Worcestershire.

CQ!CQ!CQ!CQ!

ISSUES WANTED

...September 1967 issue of Practical Television.—R. H. Taylor, 7 Antrobus Close, Sutton, Surrey.

...the issues of P.W. containing part 2 onwards of the Spectreuphon article by I. J. Kampel (March 1964 on).—E. J. Thornton, Townley Hall, Burnley, Lancashire.

...February 1963 issue of P.W. which contains details of the General Purpose Communication Receiver by R. F. Graham.—W. Butterworth, 50 Kinder Avenue, Hazelhurst, Ashton-under-Lyne, Lancs.

...February 1966 issue of P.W.—James Beveridge, 18 Braeside, Haugh of Urr, Castle Douglas, Kirkudbrightshire.

...issues of P.W. from May 1966 to February 1967; from November 1967 to January 1968 and the March and April 1968 issues. Dates inclusive.—M. Donald, 116 Moncks Spur Road, Redcliffs, Christchurch 8, New Zealand.

...June 1964 issue of P.W. please state price.—45 Victoria Street, Burton-on-Trent. Staffs.

...loan of these issues of P.W.: April and May 1966 and September to December 1967. Also would like Tape correspondent interested in SWL and of 16 years of age.—Kevin Piper, 118 Hawthorn Road, Bognor Regis, Sussex.

...sell or lend March and April 1967 issues of Practical Television.—R. A. Jackson, 228 Woodside View, Honington, Bury St. Edmonds, Suffolk.

...February 1968 issue of Practical Television.—Michael Camilleri, 18 St. Anthony Street, Valletta, Malta.

...February 1966 issue of Practical Television containing the article Scope from an old TV Chassis.—J. P. Thurgood, Moorfield, North Cowton, Northallerton, Yorks

...the Practical Wireless magazine dated May 1963 containing the Double Con version Communications Receiver.—Keith Portman, 23 Fell Wilson Street, Warsop Mansfield, Notts.

...August and September 1961 issues of P.W.—John Watson, 20 Watson Road, Sheffield, 10.

...November and December 1964 issues of P.W. describing the 10-5 Receiver.—P. Hudson, 338 Bennett Street, Long Eaton, Nottingham, NG10 4JD.

...January 1967 issue of P.W. containing details of the "Explorer".—S. Kendall, "Handsel", Peel Crescent, Ashton, Chester.

...Practical Wireless March and April 1966 containing mods to the 19 set.—A. M. Laird, The Tower, Patra Road, Kirkmichael, Ayrshire.

...copies of P.W. from October 1953 to July 1954 containing the P.W. Electronic Organ.—A. D. Varley, "Belfairs", 252 Liverpool Road, Penwortham, Lancs. PR1 OLY.

...P.W. June 1967 and P.E. July 1966, June 1967 and July 1967.—C. M. Davis, 1 Willesden Road, Hughesdale 3166, Victoria, Australia.

TAKE 20

JULIAN ANDERSON

No. 10
ONE WATT AMPLIFIER

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

IT was not many years ago that virtually all transistor amplifiers consisted of a driver transistor feeding its output into a phase-splitting transformer which powered a couple of output transistors which in turn fed their output to an output transformer. Things have changed, however; firstly with the introduction of cheap pairs of complementary transistors and secondly the rapid rise in the price of transformers against the general trend of price reductions in the electronic component field.

It is now possible to build a really simple transformerless amplifier giving an output of between 750mW and 1W feeding into a 3Ω speaker which costs well under £1. The quality is *not* high fidelity but it does compare favourably with the better quality transistor radios. The supply voltage shown, 9V, is about the lowest that this type of amplifier will operate from. However, a greater output can easily be achieved merely by increasing the supply to a maximum of 20V—no circuit modifications are necessary.

The Circuit

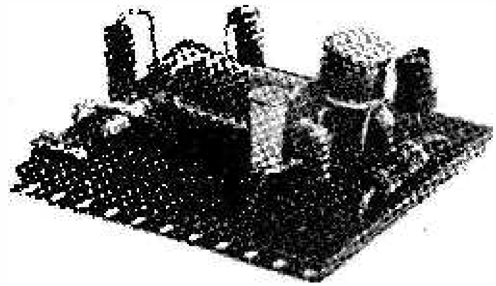
Tr1 acts as a high gain amplifier feeding a complementary pair; one of the output transistors amplifies the positive going signal which appears at the collector of Tr1, while the other takes care of the negative going signal.

The circuit is a very common type but most recommend the use of 15Ω or even higher impedance speakers. 3Ω speakers are, however, far more common and are generally cheaper and the component values have been chosen to ensure that this impedance speaker can operate with the circuit. If higher impedance speakers are already available they may, of course, be used, but this will be at the expense of volume.

Considerable heat is dissipated from the output transistors—especially when using a supply in excess of 9V—and adequate heat sinks are imperative. The larger types of battery should be used as the current drawn at full output can be as much as 150mA—far too much for the PP3, etc.

The Complementary Pair

Several complementary pairs of transistors were tried and all worked perfectly including an unmarked pair retailing at 3s. 6d. including postage and packing from Bi-Pre-Pak Ltd. These transistors are germanium types and are matched, but the gain of one pair is not necessarily the same as another; three pairs were built into circuits, one low gain, one high gain and the other chosen at random—all worked well.



The prototype is constructed on a small piece of Veroboard but almost any method of construction should be satisfactory.

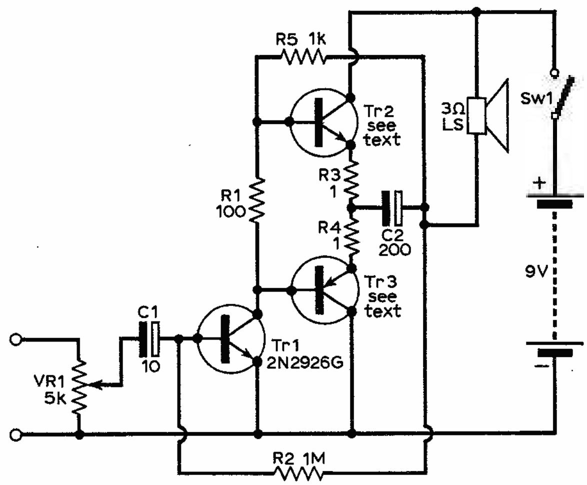


Fig. 1 : The circuit diagram of the Take 20 amplifier.

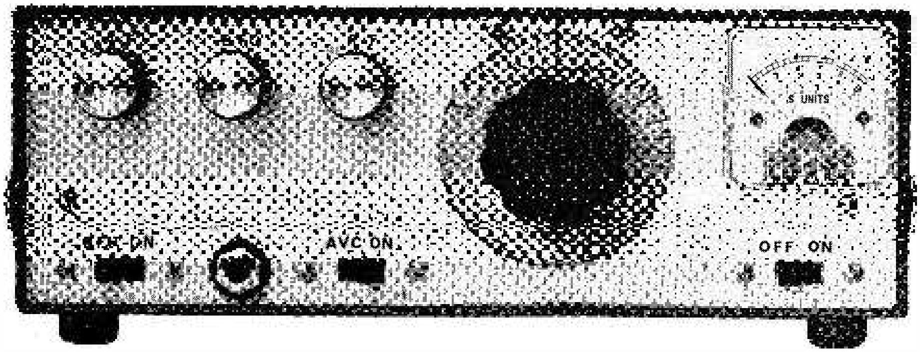
★ components list

R1	100Ω	10%, ¼Watt	3d.
R2	1MΩ	,,	6d.
R3, R4	1Ω	,,	3d.
R5	1kΩ	,,	3d.
C1	10μF 25V		1s. 2d.
C2	200μF 25V		1s. 3d.
VR1	5kΩ log.		3s. 0d.
Tr1	2N2926G		2s. 6d.
Tr2, Tr3	pair†		2s. 6d.
3Ω	Loudspeaker*		3s. 0d.
			14s. 8d.

† Bi-Pre-Pak Ltd.
* Ex TV set speaker, Padgetts Radio Store, see advertisements for addresses.
Prices are only a guide.

Construction and layout are absolutely straightforward and so no layout diagram is shown. The prototypes, one of which is shown in the photograph, were built on Veroboard, but there is no reason why pin board or even tag board should not be used. ■

'S' METER for the CLUBMAN RECEIVER



J. THORNTON LAWRENCE GW3JGA

READERS' letters which have been received in connection with the series of "Clubman" receiver articles, (PRACTICAL WIRELESS, January to July 1968), indicate that an "S" meter would be a desirable addition to the receiver. A simple circuit has therefore been developed and tested in the prototype, and will be described here. It is suitable for use in the Mk II version onwards, and could possibly be used in other transistor receivers having similar i.f. circuits.

The main requirements of an "S" meter circuit are that it should give a sensible indication of signal strength and, for transistorised equipment, it should have a low current consumption.

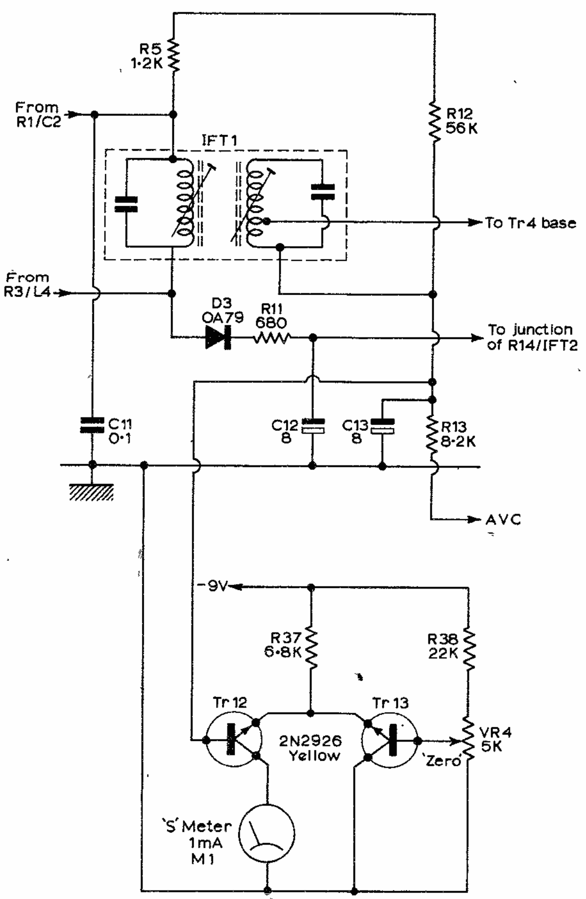


Fig. 44: 'S' meter circuitry as fitted to the Clubman Mk. II receiver.

Circuit Description

The "S" meter circuit (Fig. 44) operates from the a.g.c. line of the receiver. It consists of two silicon transistors Tr12 and Tr13 connected as a "long-tailed pair". The base of Tr12 is connected to the receiver a.g.c. line on the i.f. panel at D5-9, the junction of R12, R13, C13 etc. (see P.W. March 1968, Page 831, Fig. 23) and the base of Tr13 is connected to the slider of the "zero" control VR4. A current is fed to both emitters via R37 and the "S" meter itself is in the collector circuit of Tr12.

With no input signal, the base of Tr12 is at approximately −0·9 volts, with respect to chassis. VR4 is adjusted so that Tr13 is conducting all the current supplied by R37 and no current is passing through Tr12 to the meter. In the presence of any signal, a positive voltage is developed at the detector diode causing the base of Tr12 to become less negative. This results in Tr12 conducting and allowing the current supplied by R37 to flow through the collector of Tr12 to the meter. The increase of meter current with increase of input signal is approximately logarithmic, which will give a linear scale for the meter when this is calibrated in decibels. The particular meter used is a MR38P "S" meter which is scaled in "S" units and in dB above S9.

It is usual to make each "S" unit equal to a 4dB increase in signal. Unfortunately the "S" units and dB markings on the scale are not linear and do not agree exactly with the changes of input signal. However, the error is sufficiently small over the major portion of the scale to be neglected for most practical purposes. The meter indication has been found to agree well with "S" reports based on personal estimation of the received signal.

The graph in Fig. 45 shows the relationship between input signal and "S" meter reading for the Clubman II and Clubman III with its r.f. stage.

The position and mounting of the meter depends on personal requirements. It is obviously easier to

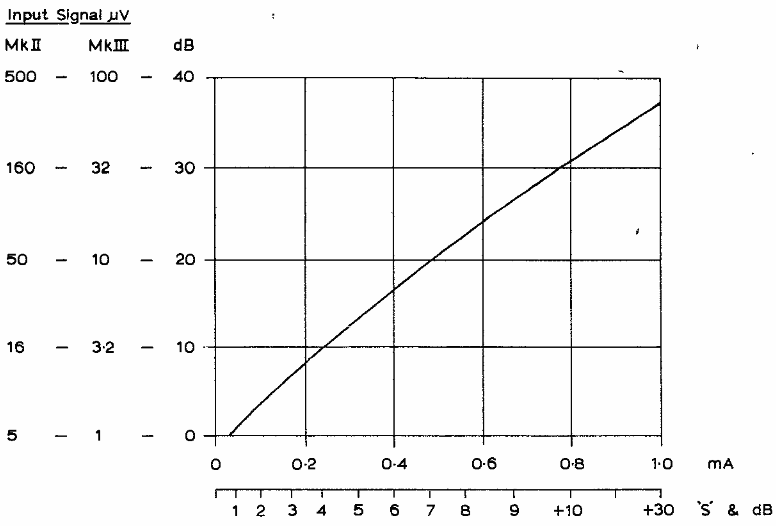


Fig. 45: Graph showing input signal/'S' meter readings for Mk. II and Mk. III Clubman.

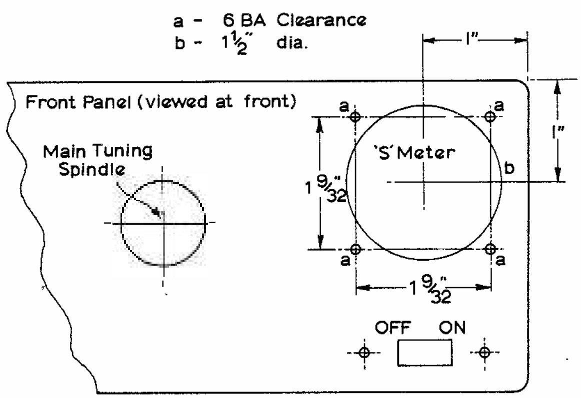


Fig. 46: Front panel drilling for the 'S' meter.

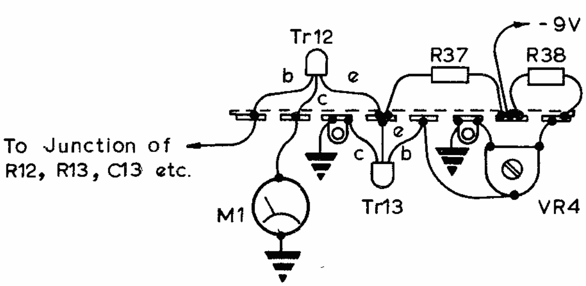


Fig. 47: Component layout and wiring for the 'S' meter circuitry.

mount the meter externally if the receiver is already built. The meter could be housed, for example, in a small metal or plastic box. Alternatively, it is possible to fit the meter at the right-hand side of the front panel of the Clubman II, as shown in Fig. 46. With the meter in this position, the clearance between the meter case and the oscillator coil L4, 5 and 6 is very small and it is necessary to remove the coil screening can. If the receiver is about to be constructed, the oscillator coil holder could be positioned ¾in. further back to give the necessary clearance. In the Clubman III etc., the r.f. tuning control is in the position required by the meter. The more experienced constructor will find it still possible to fit the meter to the front panel but it is necessary to dispose of the separate r.f. tuning control. This may be done by replacing the two-gang tuning capacitor VC1, VC2 and the single r.f. tuning capacitor VC4 with a three-gang unit, e.g. Wingrove & Rogers, C73-23. The capacitance law of this unit is different to the Jackson one used originally and a new dial will be required. The use of a three-gang tuning capacitor in the Clubman V, with the d/f loop aerial, is not recommended due to difficulties in getting the loop aerial to track the main tuning circuits. The "S" meter circuit may be built on a small tagstrip under the chassis as shown in Fig. 47, or on Veroboard and mounted in some convenient position.

★ components list

Resistors:

R37	6·8kΩ, ½ watt, 10% carbon	
R38	22kΩ, ½ watt, 10% carbon.	
VR4	5kΩ, skeleton preset, or similar.	

Semiconductors:

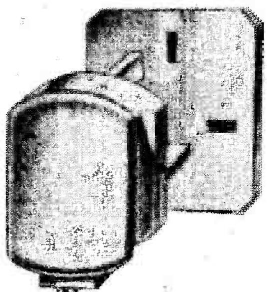
Tr12	2N2926
Tr13	2N2926

Meter:

M1	MR38P "S" Meter (1mA)

'S' Meter Adjustment

With no signal input to the receiver, the "S" meter zero control VR4 should be adjusted so that the pointer indicates just off the zero end of the scale, about 50 microamps (0·05 milliamps). This ensures that the meter indicates even the weakest of signals and does not have a "dead" zone at zero. ■



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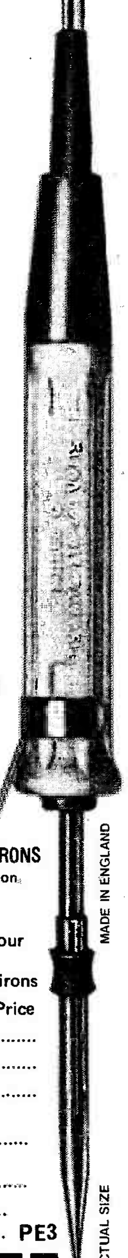

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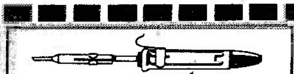

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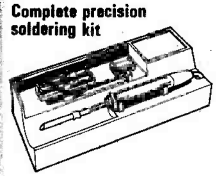

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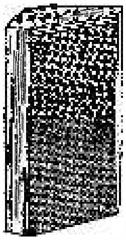

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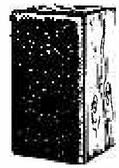
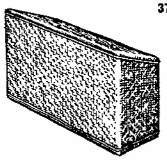
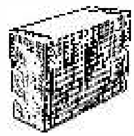


ELF. An extension speaker of quality 9 x 5½ x 3½in. deep veneered in natural teak with smart gold and brown Vynair front trimmed in white. Fitted with 3 ohm speaker unit mounted on ½ in. baffle. Exceptional value **37/6d.** P. & P. 3/9d. each.



SCOTT. This elegant tapered cabinet 10½ x 16 x 5½in. deep is attractively finished in black cloth with striped grey Vynair front. Suitable for table or for wall mounting. Fitted with 13½ x 8 in. speaker unit and volume control. 3 or 15 ohms impedence—please state impedence required. **£4.5.0.** P. & P. 7/6d each. Fitted with E.M.I. 13 x 8 in. speaker unit and twin tweekers. 15 ohms impedence, capacity 10 watts. **30/-** extra.



IMP. Wedge shaped extension speaker 7½ x 6½ x 4 in. (max.). Covered in walnut wood grain cloth with foam Vynair front. Keyhole slot at back. Fitted with 3 ohm speaker unit. Only **25/6d.** P. & P. 3/9d. each.

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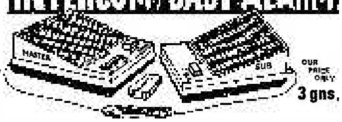

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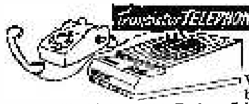

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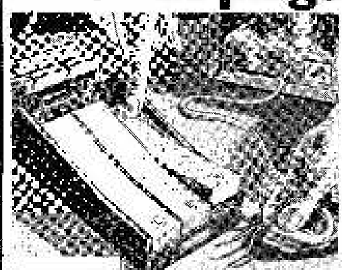

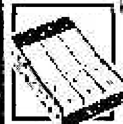

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ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

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THE BROADCAST BANDS

Malcolm Connah

BY the time that you read this a tragic event may have occurred in the world of Shortwave radio. I am referring to the cessation of foreign language broadcasts from the *Voice of Denmark*. Originally scheduled for the 1st. April 1970, the date of closure was brought forward to the 1st. January 1970.

The decision was taken by the Danish Radio Committee and two reasons were given: (1) very few people listen to the *Voice of Denmark* (although 3,000 letters were received in the last half year); (2) The Danish Radio and Television Service has to cut its budget (although the Shortwave department costs only 345,000 D. Kr. annually, which is a fraction of the cost of one of the expensive TV productions).

If you have any loggings of *Radio Denmark* which you have not used for reception reports I suggest that you use them now and include a plea to keep the station open. Rodney Baggaley wrote to me from Daventry suggesting that protests should also be sent to the Director-General of Danmarks Radio at the following address:—Mr. Hans Sølvhøj, The Director-General, Danmarks Radio, Radio House, Copenhagen, Denmark.

In the past several stations have made similar decisions only to have them reversed by the large number of protests from shortwave enthusiasts from all over the world. Please act as soon as possible and we may yet be able to save this excellent station from extinction.

Worldwide QSL Card Poll

The results of this poll, which was conducted by the Cellardyke Short Wave Radio Group to find the shortwave station which has issued the best QSL card since January 1967, arrived just too late for inclusion in the last issue. Votes were received for nearly fifty stations and the top five with the number of votes in parentheses were:—

1) Radio Portugal (62)
2) Radio Australia (48)
3)=Radio RSA (47)
3)=Radio Nederland (47)
5) Radio Canada (46)

Congratulations to *Radio Portugal* who emerged as clear winners.

The poll was also used to determine what details were thought to contribute to an ideal QSL card. The results indicated that date, time and frequency were regarded as essentials. The next most popular detail was transmitter power followed by transmitter location, reporter's name, genuine signature on the QSL, etc.

Africa

Nigeria: The *Voice of Nigeria* in Lagos has dropped 11770 for the English broadcast to Europe and has now been noted on 7275, 15365 and 21455 from 0600 to 0730.

Seychelles: F.E.B.A. test transmissions are scheduled for 0030-0330 on 15165; 1300-1630 on 17755 and 1700-2000 on 21635 using a power of 3 kW. Reports should be sent to F.E.B.C., Box 234, Victoria, Seychelles or to F.E.B.A., Sky Waves, St. Paul's Road, Woking, Surrey. Taped reports should preferably be sent to the British address.

Asia

Cyprus: As reported last month the Cyprus Broadcasting Corporation continues to transmit with a power of 30 kW on 15260 and 17875. From the 1st. November they introduced the new frequency of 11910. The station issues a very good multi-coloured QSL card.

Syria: *Radio Damascus* has returned to the frequency of 15165 for its broadcasts in German at 1830, French at 1900 and English at 2030.

Europe

Greece: *Radio Athens* has news in French, German and English at 0715-0730, 1115-1130, 1315-1330 and 1830-1845 on 9605 and 11720; 1730-1745 and 1945-2000 on 15345 and 17745; 2200-2215 and 2300-2315 on 11720 and 15345.

South America

Brazil: *Radio Piratininga*, Sao Paulo, has a religious programme in English, Monday-Friday, at 2100-2115 called "Lesson for Life." The frequencies are announced as 6025 and 11745.

Ecuador: The *Voice of the Andes*, HCJB, is testing on 21460 to Europe from 1800 to 2145.

El Salvador: El Salvador has announced that it is going to have an international service. The broadcast will be from 0300 on 9555 and the languages used will be Spanish, French and English.

Mexico: A new station is *Radio Mexico*, XERMX, Apt. 20100, Mexico City 20. The station has been heard testing from 2350 to 0300 on 11720 with announcements in English, French, German and Spanish.

THE AMATEUR BANDS

David Gibson, G3JDG

GOOD news this month for the ten metre fans. The band has been providing some very good openings and quite a large number of eager hearing utensils have been frantically logging most continents. Signal levels have varied and it must be admitted that some of the signs from further afield have been down in the 5 and 4 range.

One item of interest for those who like tuning in to something a bit different. Why not tune down between 28 and 27MHz and eavesdrop on the American citizens band? Some of these stations have to be heard to be believed. Seriously though, the citizens band does give an excellent indication of just how much the band is open, particularly towards W land.

As might be expected, the fifteen metre band opened up with ten and some very good openings here too. Down another notch on twenty things have been quite good but surprisingly enough it is ten metres which has provided the majority of DX signals. Twenty has been open at times but mostly to S. America with good sigs from PY and surrounding districts. Africa, too, has done quite well on twenty from the s.w.l. in Britain's point of view.

Forty and eighty have had their moments but mostly Europeans (EUs) logged at this QTH. One or two W stations made it through the QRM on forty and in the W segment of eighty.

Topband hasn't fared too well. Lots and lots of QRM/QRN and the best for the month was only GW and GM. No W stations were logged on c.w. Anyone hear any W-type tweets down the l.f. end?

Logland

On to the field where lovely logs grow. This one was cared for by **John Moore** (Leicester) and is an all-band edition. Envious readers should (like me) gnash CQ on their teeth while reading—160: GM3ONS/A, GM3UYF, GM3WDF GW3RBM.

80: CT1GD, JW1CI (Bear Is.), KV4FZ, OY1X, UA9KAX, VE1IE, VP2VP, W1EBC.

40: EA6BN, PJØDX, WA2ZAA.

20: CT2AK, DU1BEN, ET3ZU, FG7TI/P/FS7, FG7XT, HK3RQ, HK4AXZ, HZ1AB, JA8EL, JW1CI, KP4AST, KR6NR, KV4FZ, KZ5DA, LU8DF, OD5BZ, PJØDX, PY1NBF, TA2SC, TG9UZ, TF2WLN, VE1SH, VE2DHF/YV1, VE5US, VP2VI (Tortola), VP7DL, VP8KD, VS6DR, YV1EJ, ZS5XA, 4X4UF, 5A1TL, 5H3LV, 8P6AZ, 9H1BL, 9Y4AA.

15: CR7IZ, DU1FH, F6ABP/FC, JA3LVT, JA8QN, KH6SP, KL7MF, OD5FA, PJØDX, PZ1CU, TG9F, UA9FU, VE2AFC, VE3BMB, VE5XC, VE7TL, VP2VP, VK6US, W7RM, ZS6AR, 4M1A (Venezuela ?), 4X4KT, 9Q5GV, 9Y4AA.

10: CN8DW, CN8HD, CR6LV, CT2AS, CX7BF, EP2BQ, ET3USA, HC1RF, HK4DF, K6NA, KV4AD, KZ5AT, LU2QT, MP4BBA, OA1BT, OA4PF, OD5BZ, PJ1AA, PJØDX, PY1NBF, PZ1DB, UAØBP, VE1ATC, VE2AYW, VE3BIZ, VO2AP, VP2VI, VS6AL, VS6DR, VUØDK, W6ESI, XW8CR, ZS5DC, 4Z4HF, 5Z4ALS, 9H1BP.

All this bunch on s.s.b. picked up with the aid of a 60ft. end fed and a CR100/2.

A. Woodland (Somerset), confesses to usually listening to non-amateur type stations (some people have no shame) but admits to weakening while ill. His receiver is a Hammarlund SP600JX (suddenly I'm green) and the aerial a V-beam 40ft. up plus a 72ft. vertical "condensed" into 41ft. (Good Gawd!) Stations logged on ten metres include—CE3OE, CR6CA, EP2BQ, GC4LI, HK4DF, JA1AEA, JA2CLI, JA4FRB, JA6YCU, JA7BCR, JA8PMK, KA9MF, KH6SP, KR6VX, KV4FZ, KZ5CD, K6CM, K6KGU, K7AB, LU7FAG, LU8DKA, LX1BW, MP4BL, OA1OX, OA4PF, OD5EP, PJØDX, VE6AUT, VE6ADX, VE7AGZ, VE8YM, VK6US, VP2GBL, VP9BU, VP9EP, W6ABN, W6EJJ, WA6EPQ, W7AC, W7GUX, XE1WS, XW8CS, YN1HS, YV6GL, ZE1CY, ZE1JU, 6Y5DW, 8P6CX, 9Y4AA. All these on s.s.b.

A. Crooks (Leicester), recently had his RA1 serviced and peaked up. It showed its appreciation by teaming up with a PR30 and 45ft. end fed to hook these on 15 s.s.b.—CX1JM, JW1CI, KØVBX, K5QHS, JA2KKZ, TF3EA, UD6BD, VE6XF, VE7HN, VP8KO, (S. Orkneys), W6ZQI, W7GVA, WF2LIB, ZS5JY, 9I5EJ (Zambia).

B. Hughes (Worcester), JR5OOSE, dipole, had a quick squint at 20 and came up with—CR7DS, CR6IK, CR4BC, JX8IL, LAØAD, SVØWN, TG9EP, TR8MC, VUØGE, VK9KY, (Cocos Keeling), VK2BKM/VK2 (Lord Howe Is.), VP2GLE, VR1L, ZS2MI, 6W8BD, 9V1PA, 9X5AA.

All these on s.s.b. except ZS2MI on Marion Island who was a.m., just shows what you can receive without a b.f.o.

A. Lister (London), CR7OA, home brew pre-selector and 150ft. end feed informs that ZL's are loitering on 3.8MHz from 0600-0700. Fifteen with this set up raised—AP2AGC, CT1GD, EA6BN, IS1LIO, KP4KBS, KV4FZ, LG5LG, LX1JES, PY1MT, TF2WKO, VE3ZO, VO2DAL, VQ8CR, dozens of W's, ZS6QK, 4X4LN, 5A3JR, 9Q5FM, 9Q5AE. On eighty, Adrian's best were five ZL's and he managed VK2WX on ten metres.

R. Hall (Belfast) modified AR88D, 50ft. end fed; listens at weekends. The last session on twenty s.s.b. produced—AP5HQ, CR6IK, CT1WB, FP8AP, HK3RQ, HR1KAS, JA9AG, KC4CL, KZ5NG, OZ7TF, PJ1AA, TF2WKI, VE3CBG, VK6RU, VP7DL, 3Z3AMZ, 4X4OS, 6Y5SR, 8R1UC, 9H1M, 9K2CF, 9N1MM, 9Y4UV to mention just a few.

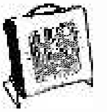
NEWS of contests—

According to my diary, contest lovers will be out of luck for the cold days in January. I can find only two with February not faring very much better.

January 10-11th., AFS contest; 31-Feb. 1st., French c.w. contest.

Logs for the Amateur Bands, with stations in alphabetical order, must arrive before the 18th. of each month. Logs only to: 5 Edward Close, St. Albans, Herts.

FAN HEATER



Three position switching to suit changes in the weather. Switch up for full heater (2½ kW), switch down for half heat (1¼kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cutout. Complete kit £3.15.0. Post and ins. 7/6 or similar 2¼kw made up heater £4 5s. Post & ins. 7/6.

FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20w. 19/6. Kit B—30-40w. 19/6. Kit C—80 w. 23/6. Kit E—65 w. 19/6. Kit MF1 is for 6in., 9in. and 12in. miniature tubes, 19/6. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

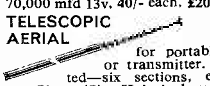
BLANKET SWITCH

Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case. 5/6 each. 3 heat model 7/6.

HIGH CAPACITY ELECTROLYTICS

Brand new, not ex equipment.
100 mfd 25v, 1/3 each, 12/- doz.
200 mfd 25v, 1/6 each, 15/- doz.
500 mfd 12v, 2/- each, £1.1.0 doz.
1,000 mfd 12v, 3/- each, £1.10.0 doz.
5,000 mfd 12v, 4/9 each, £2.8.0 doz.
10,000 mfd 6v, 5/9 each, £3.0.0 doz.
10,000 mfd 15v, 8/6 each, £4.10.0 doz.
15,000 mfd 10v, 10/6 each, £5.0.0 doz.
60,000 mfd 8v, 22/- each, £10.0.0 doz.
70,000 mfd 13v, 40/- each, £20.0.0. doz

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA. screw. 7/6.

TOGGLE SWITCH

3 amp 250v with fixing ring 1/6 each 15/- doz.

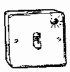
80 OHM BALANCED ARMATURE EAR PIECE

Usable as microphone or loudspeaker, 4/6 each.

MINIATURE EAR PIECE

As used with imported pocket radios 1/6 ea. 15/- doz.

ISOLATION SWITCH

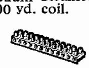


20 Amp D.P. 250 volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on, 4/6. 48/- per dozen.

FLEX BARGAINS

Screened 3 Core Flex. Each core 14/0076 Copper PVC insulated and coloured, the 3 cores laid together and metal braided overall. Price £3.15. per 100 yds. coil.
15 Amp 3 Core Non-kink Flex. 70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3 Kw. fires. Regular price 3/6 per yd. 50 yd. coil £4.10.0, or cut to your length 2/6 per yard.
10 Amp 3 Core Non-kink Flex. As above but cores are 28/0076 Copper. Normal price 2/6 per yd. 100 yd. coil £7.10.0, or cut to your length 1/9 yd.
6 Amp 2 Core Flex. As above, but 2C ores each 23/0076 as used for Vacuum Cleaners, Electric Blankets, etc. 39/6 100 yd. coil.

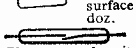
15/20 AMP CONNECTORS



Polythene insulated 12 way strip 2/6 each 24/- doz.

13 AMP FUSED SWITCH

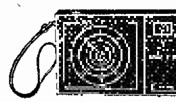
Made by GEC. For connecting water heater etc., into 13 amp ring main. Flush type 3/6 each 30/- doz. Metal boxes for surface mounting 1/6 each 15/- doz.



REED SWITCHES

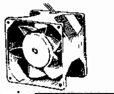
Glass encased. switches operated by external magnet—gold welted contacts. We can now offer 3 types.
Miniature. 1in. long × approximately ⅛in. diameter. Will make and break up to ½ amp up to 300 volts. Price 2/6 each. 24/- dozen.
Standard 2in. long × 3/16in. diameter. This will break currents of up to 1 amp, voltages up to 250 volts. Price 2/- each. 18/- per dozen.
Flat. Flat type, 2in. long, just over 1/16in. thick, approximately ⅛in. wide. The Standard Type flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1 amp, 200 volts. Price 6/- each, £3 per dozen.
Small ceramic magnets to operate these reed switches 1/3 each, 12/- dozen.

'GLADIATOR' 2 WAVE BAND TRANSISTOR RADIO



7 transistor, 2 wave band (medium and long) pocket radio with carrying handle and earplug. These radios use a ferrite slab aerial and a conventional superhet circuit with built in moving coil speaker. Completely built up, ready to play. Offered at less than importers price due to bankrupt purchase. A remarkable bargain. 39/6 plus 3/6 post and insurance

MINIATURE EXTRACTOR FAN



Beautifully made by famous German Company. PAPST System, 230/240 A.C. Mains operated, size 3½in. × 3½in. × 2in. Made for instrument cooling but ideal to incorporate in a cooker hood, etc. 65/-.

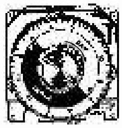
DISTRIBUTION PANELS

Just what you need for work bench or fab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs. Supplied complete with 6 feet of heavy cable and 13 amp plug. Similar panels advertised at £5. Our price kit of parts 39/6 Plus 3/6 Post and insurance. Made Up 45/- Plus 4/6 Post and insurance.

Horstmann "Time and Set" Switch

(A 15 amp Switch). Just the thing if you want to come home to a warm house withut it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price 29/6, p. & ins. 4/6.

24 HOUR TIME SWITCH

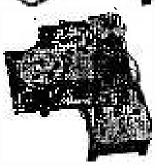


Mains operated. Adjustable Contacts give 2 on/offs per 24 hours. Contacts rated 15 amps, repeating mechanism so ideal for shop window control, or to switch hall lights (anti-burglar precaution) while you are on holiday. Made by the famous Smiths Company. This month only 39/6 with Perspex cover, plus 3/6 postage and insurance, a real snip which should not be missed.

PROTECT VALUABLE DEVICES

FROM THERMAL RUNAWAY OR OVER-HEATING: Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected. Simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90deg. to 190deg. F. or with the dial removed range setting is between 80 to 800deg. F. Price 10/-.

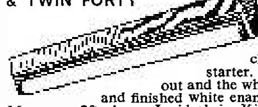
BATTERY OPERATED TAPE DECK



With Capstan control. This unit is extremely well made and measures approx. 6 × 5 × 2in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 volts. Supplied complete with 2 spools ready to install. Record, Replayhead is the sensitive M4 type intended for use with transistor, amplifier. Price 79/6. Post and insurance 4/6.

ATLAS SLIMLINE FLUORESCENTS

THE TWENTYLITE & TWIN FORTY

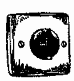


A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. Measures 2ft. long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, 39/6 with tube. Assembled ready to install. Postage and insurance 6/6 extra.

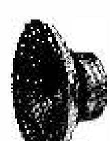
1 WATT AMPLIFIER & PREAMP

5 transistors—highly efficient, made for use with tapehead G4 but equally suitable for microphone or pick up—limited quantity 39/6. Full circuit diag. also shows tape controls 5/-.

VARYLITE



Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob £3.19.6.



FULL F1 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.
Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis Diam. 12in.—12⅜in. over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4, holes —⅛in. diam. on pitch circle 11⅛in. diam.—Overall height 5⅛in. A £6 speaker offered for only £3.9.6 plus 7/6 p. & p. Don't miss this offer. **15in. 30 watt £7.19.6. 18in. 100 watt £24.10.0.**

DOUBLE ENDED MAINS MOTOR

On feet with holes for screw-down fixing. To drive models, oven, blower heater, etc. 10/- each, plus 3/6 post and insurance, 6 or more post free.

MINIATURE WAFER SWITCHES

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

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 10/- post free.

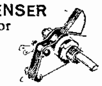
AC FAN

Small but very powerful mains motor with 5½in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. 17/6. post 4/6. Mounts from back or front with 4BA screws.

750 MICRO AMP MOVING COIL METER

2½in. ex W.D. but brand new and unused 19/6.

0.0005mFd TUNING CONDENSER



Proved design, ideal for straight or reflex circuits 2/6 each. 24/- doz.

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275W. internally mirrored bulb with b.c. end for plugging into lamp holder 19/6 each plus 4/6 postage and insurance.

COPPER CLAD ELEMENT

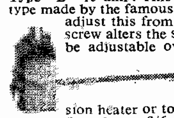
1250 watts—4ft. long but bent to U shape. ideal for overhead heater—just mount reflector above, 12/6 each, plus 4/6 post. £6 doz. post paid.
Battery Record Player. Made by Collaro. This is made up on a unit plate with speed selector and pick-up. The turntable is a heavy one and measures approximately 9¼ins. Pick-up is fitted with the famous "Studio" cartridge. Price 69/6, postage and insurance 6/6.
E.H.T. Condenser. 28Kv. 0.0011 mfd. Suitable for transmitting test conditions 6A at 300k/c. Bakelite case. 18/6 each.
85 Watt Tubular Element. Very well made unit. The element is wound on a porcelain former then encased in a brass tube terminated with beaded leads 12in. long. Normal mains voltage. Price 5/- each or 54/- per doz.
Press to Make Switch. Double pole. 5 amp contacts or can be used as single pole, 10 amp, contacts 250 volt working. Single hole fixing. 2/6 each, 24/- dozen.
Door Switch. Contacts open when plunger is depressed. Prevents lights being left on. 15 amp contacts, 230 volt working. Made by Arrow. 3/6 each, 36/- per dozen.
Rotary Appliance Switch. 16 amp, 230 volt on moulded ceramic base. Operated by pointer knob (not supplied). 2/- each, 18/- per dozen.
1/40th h.p. Motor. Made by the French (Cassor) Company. This is an excellent totally enclosed motor, powerful enough to operate small lathe, drilling machine, washing machine, etc. It's speed is 1,450 r.p.m. Made for normal 50 cycle, 230/250 volts mains, totally enclosed, size 2½ x 3¼in. dia. with 1in. of ⅛in. spindle. Price 19/6 plus 4/6 postage and insurance.

THERMAL CUTOUT

A miniature device ⅜in. dia. on one screw fixing mount—can be used for motor overload protection—fire alarm—soldering iron switch off, etc., etc.—15 amp contacts open with flame—radiant or conducted heat. 1/6 each, 15/- doz. £5 100.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F, 9/6 plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.
Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjust this from 50–550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm. 8/6 plus 2/6 post and insurance.



Type "D". We call this the Ice-stat as it cuts in and out at around freezing point. 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yd 10/-) is wound round the pipes. 7/6. P. & P. 1/-.
Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 7/6, plus 1/- post.
Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price 18/- plus 2/- post and insurance.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

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BASIC SEMICONDUCTOR TECHNOLOGY

PART NINE

by M.F. DOCKER, M.Sc.

SINGLE semiconductor devices can be produced easily nowadays. They are rugged, stable and efficient. An early thought was why not put several devices on to one chip so that even more space saving could be achieved, not to mention the other advantages of this method. The advent of planar technology, where devices are produced by diffusion from one side of the chip only, brought this idea to economic feasibility in the form of integrated circuits.

The Planar Process

The techniques used to produce a planar epitaxial transistor and the diode counterpart are the same as those used to produce integrated circuits and it is convenient to discuss them together at this point. As was explained some time ago an epitaxial layer is one which has been produced on the surface of a silicon chip in such a way that its crystal structure is the same as that of the underlying layer or substrate. It is possible to produce an epitaxial layer of intrinsic p- or n-type material depending on the requirements.

An essential part of the process of producing devices by this method is that of masking the areas which are not to be affected by the various diffusion processes that are to take place. The method most commonly used is that of silicon dioxide masking. After a layer of epitaxial silicon has been grown on the surface of the crystal a layer of silicon dioxide (SiO_2) is produced over this either by an electrolytic oxidation (anodising) or by chemical deposition of silicon dioxide by oxidation of an organic silicon compound (tetraethyl orthosilicate). The uniform layer of silicon dioxide can then be etched with hydrofluoric acid to expose sites for later diffusion processing to take place. In order to locate the regions to be diffused, photolithographic techniques are used. A layer of photoresist is painted on to the slice, a suitable mask is used to protect the required pattern, and unexposed photoresist is removed to leave a mask which is resistant to hydrofluoric acid. Following this it is possible to etch the exposed regions to reveal the epitaxial layer into which dopent atoms can be diffused to produce the devices.

When producing a single silicon planar epitaxial diode it is only necessary to expose one region, although generally several hundred diodes are produced on a single wafer. If an n-type epitaxial layer has been grown then a diffusion of p-type impurity into the exposed region will produce a graded junction diode structure as seen in Fig. 1, where the various stages in the production of a single diode are shown in detail. In order to provide an ohmic contact to the n-type region it is necessary to go through the processes of photolithography and etching once more in order to allow a heavy diffusion of n^+-type dopent to provide a cathode contact. Finally, metallising is carried out to provide contact to the n^+- and p-type regions, and leads are attached to these regions after the slices have been cut to separate the individual diodes. The current and voltage ratings of the devices depend as always on the geometry of the arrangement and on the doping levels used. A compromise between the speed, capacity and maximum rating of the devices has to be made in order to suit the individual requirements.

Advantages of the epitaxial planar process described are numerous. The devices are produced by diffusion from one side of the chip only, simplifying manufacturing techniques; the epitaxial layer has reproducible properties which are uniform across the surface of the wafer, and it is possible to produce high resistivity material in this way. Of course, not only diodes are produced in this manner; resistors, capacitors, transistors and field effect transistors can all be produced by the planar process.

Isolation in I.C.s

Integrated circuits usually include several of the different devices on the same chip. The problem which now arises is that of isolation of one device from another to avoid unwanted circuit interconnections. Two processes are commonly used to achieve this. First, the use of two back-to-back diodes can be conveniently obtained in integrated circuit form. Both diodes are arranged to be reverse

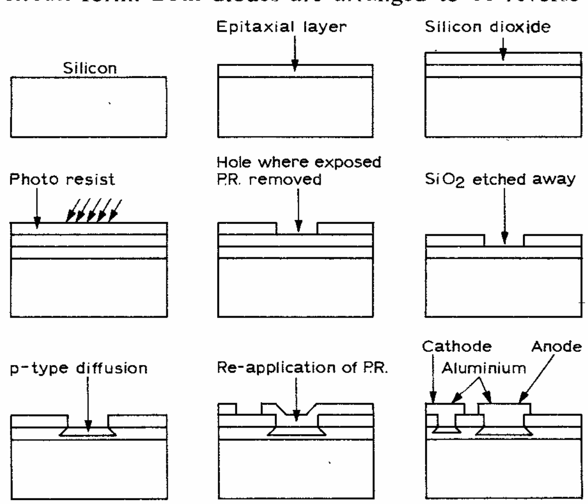

Fig. 1: Planar technology: the stages involved in the manufacture of an epitaxial planar diode.

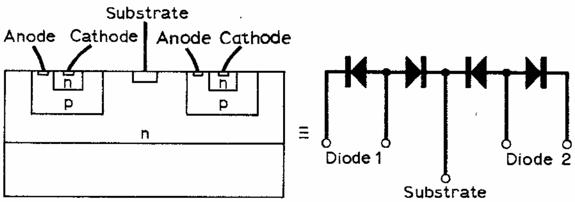

Fig. 2: Integrated circuit isolation achieved by means of back-to-back diodes.

biased all the time the circuit is in use. This reduces the coupling between the devices to that across a reverse biased diode, namely, several tens of megohms with a parallel capacitance of a few picofarads. Fig. 2 shows two diode structures in an integrated circuit together with this isolation arrangement. The diodes in this case are produced by double diffusion. In order to provide isolation with this arrangement the substrate has to be held more positive than any other point in the integrated circuit, and, of course, with a p-type substrate the substrate has to be made negative.

The second method is to produce isolated pockets of epitaxial material inside regions of polycrystalline material surrounded by thin layers of silicon dioxide. The method of achieving this is somewhat involved, but the important consideration is that the lifetime of the charge carriers in such polycrystalline material is very short. Hence the conductivity is very low so that good isolation is achieved. This method is not used so extensively in manufacturing because of the extra number of steps required in the process. Back-to-back diode isolation provides sufficient immunity to interference for the majority of applications.

Devices can be made in a similar way, not using an epitaxial layer but simply by carrying out diffusion into the surface of the substrate. These devices are called planar devices, sometimes abbreviated to just planar. They are also passivated with silicon dioxide in a similar way to that in which the planar epitaxial devices are treated, as described below.

Integrated Circuit Components

Capacitors are required in many circuits, but unfortunately they are difficult to fabricate in integrated circuit form. It is relatively easy to produce small value capacitors, as described in a previous article, using the capacitance of a reverse biased diode. In this way capacitors of up to 0·001 microfarad can be made. Larger values have to be obtained in other ways, either by use of external capacitors or by using electronic methods of multiplying the diode capacitance.

Another method of producing capacitors is by utilising the capacitance across the silicon dioxide layer. During the diffusion processes involved in making the integrated circuit a layer of high conductivity silicon is produced where the capacitor is required. Subsequently a layer of silicon dioxide is grown over this and finally a layer of metal is put on top to produce the second electrode. An advantage of this structure is that the capacitor produced is non-polar, that is it can be used with voltages applied in either direction.

The other passive element which can be fabricated using the diffusion process is the resistor. Since very thin sheets of high resistivity epitaxial material are available it is possible to produce resistors simply by placing two contacts on to a suitably shaped region of the epitaxial layer. There are two ways a given resistor can be made. First, a long wide resistor can be used; secondly, a short thin resistor may be used. The choice depends on several factors including the accuracy required and the power which the resistor will have to dissipate. The important factor determining the resistance is the aspect ratio of the resistor, that is, of course, the ratio of the length to the width of the resistor. It is possible to produce resistors with values up to 20,000 ohms, but it is very difficult to make the value of the resistor exactly equal to the circuit requirements. To overcome this difficulty the circuit of an integrated unit is designed so that its operation depends not so much on the absolute value of each resistor but on their relative values. Thus, in bias chains a potential divider is used rather than a single series resistor. This is because the relative values are determined by the mask shape whereas the absolute values depend strongly on the characteristics of the epitaxial layer. It is practical to produce resistor values accurate to within 10%, but ratios can be obtained with an accuracy better than 2%.

It is not practical to use or produce inductors using integration techniques. Consequently if it is essential to use these components they have to be provided externally to the circuit. However, using active filter techniques it is possible to dispense with the inductor in many circuit arrangements. In this way it is possible to produce filter circuits using only resistors and capacitors and yet attain very high Q values.

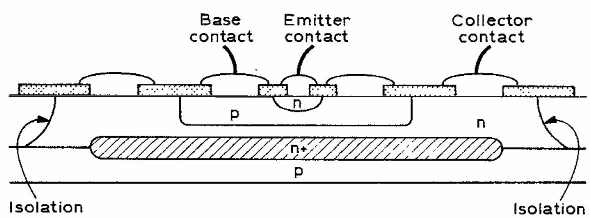

Fig. 3: Construction of an integrated circuit planar epitaxial transistor.

Bipolar transistors are produced in integrated circuits by multiple diffusion techniques. For instance, an n-p-n silicon epitaxial transistor, as shown in Fig. 3, could be produced in an integrated circuit by the following processes common to all diffusion device production. A layer of epitaxial n-type silicon is grown over a clean p-type silicon wafer. This epitaxial layer later becomes the collector of the transistor and because of this it has a high resistivity or low impurity concentration. After suitable oxide masking, photolithography and etching, a p-type diffusion is carried out to produce the base region and also in integrated circuits to produce the isolation region previously described. During the diffusion an oxide layer is regrown over the exposed region. Subsequently this is re-etched in the position of the emitter and an n-type diffusion is carried out to produce a low resistivity emitter with the resultant high injection efficiency. Finally a layer of silicon dioxide is grown over the device completely in order to passivate it against atmospheric contamination, and small areas are

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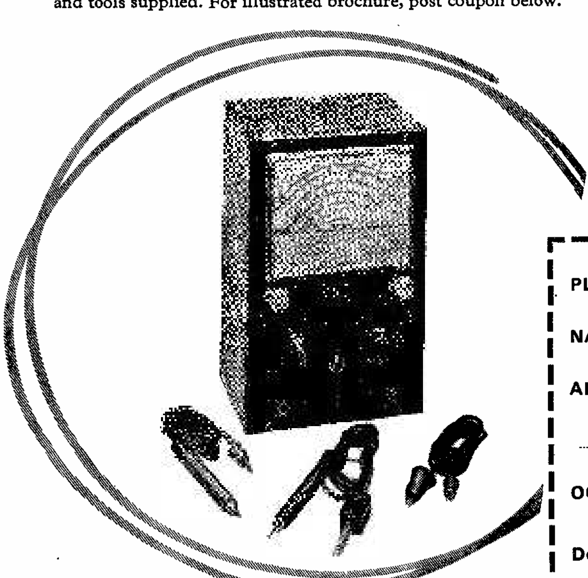

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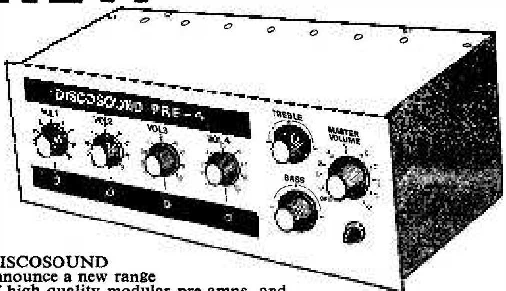

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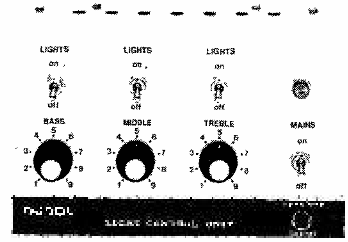

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etched away to allow metallising of the required external contacts.

One point not yet mentioned is the presence of the n^+ region in the collector layer. This is provided to give a uniform field across the collector to base junction, effectively lowering the collector output impedance.

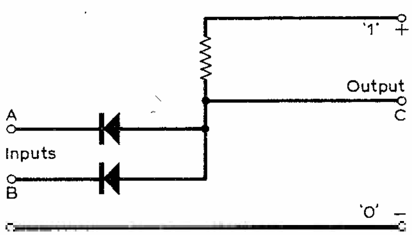
Logic and Linear I.C.s

It should now be apparent that most semiconductor devices can be produced in integrated circuit form and thus circuits of high complexity can be produced on a single chip of silicon. The procedures involved in producing optimisation of the manufacturing techniques for a given circuit are very involved, but in most cases it is possible to arrange that an integrated circuit will perform the desired function as well as its discrete component counterpart.

There are basically two types of integrated circuit available and these can conveniently be classified as "logic" and "linear" circuits. The difference between the two classes is that the logic circuits are used in applications where they are required to give yes/no types of output, whereas linear circuits are expected to give an output which has some continuous relationship with the input signal. In this context linear is used somewhat inappropriately as it in fact covers circuits with feedback which results in their output varying with the input signal but in a far from linear manner.

Types of Logic Circuit

The logic circuits are of very varied type. The first solid state logic circuits made were combinations of resistors and diodes and they performed numerous gating functions. Fig. 4 shows an "and" gate using these elements. If A and B are at the +5V level then C will also be at the +5V level, otherwise C will be at the zero level. Notice that if A and B are open circuit C assumes the high state.



A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 4: Simple diode-resistor logical AND gate with corresponding truth table.

Following on from this start there have evolved Resistor Transistor Logic (RTL), Diode Transistor Logic (DTL), Transistor Transistor Logic (TTL), Emitter Coupled Logic (ECL), Emitter Emitter Coupled Logic (E^2CL) and MOST logic circuits. Each of these types has its own advantages as seen in the following examples. RTL has a medium speed of operation which means that when a logical switch is made to the input the output follows this change within about 20 nanosec and the circuit also has a fairly low power consumption, each gate taking about 10mW. DTL is somewhat faster than RTL, especially when the nonsaturating type of logic is used so that all the transistors are in the active state rather than being either fully on or off. TTL

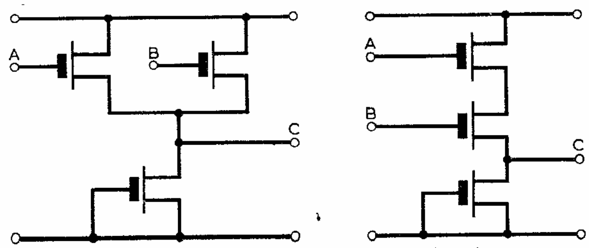


Fig. 5: MOST logic gates.

has a very long propagation delay. Emitter coupled logic has a very short propagation delay but has a large dissipation per gate. E^2CL is mainly used in the central processors of computers: it has an even shorter delay, typically one or two nanoseconds.

The final arrangement considered here is the MOST logic circuit which consists of arrays of MOS transistors. A MOST logical "and" and "or" gate are shown in Fig. 5. The advantage of this circuit type is that it is relatively cheap to make in highly complex arrangements as no isolation is required between the elements. They are slow but happily consume very little power.

Thus, there is a trade off between the speed of operation of the logical element and the power dissipation per gate. This is an important criterion for the circuit designer and the ideal system would use a combination of the different types to achieve maximum efficiency.

The final article in this series will describe the different linear circuits which are available and also the principles underlying thick and thin film circuit manufacture.

TO BE CONTINUED

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents

Air wave wasters

Recently I have heard a large amount of discussion on the BBC World Service on Commercial Radio in Great Britain. As you probably know, Australia has had commercial radio ever since broadcasting began. I think therefore that I am qualified to pass judgement on these nuisances and air-wave wasters.

I listen to many commercial radio stations in Australia and can state that what I have heard has been nothing but a programme format of continuous pop, high-powered advertisements rammed down the listener's throat and news that is often inaccurate. The number of advertisements is fantastic. For instance, in one quarter-hour on the local radio station up here (8DN-1240kHz) there was *one-half* of a gramophone record played (a latest pop of course) and all the rest of the time was taken up with advertisements.

I think therefore, that these air-wave wasters should be banned from cluttering up the air-waves and government radio should be developed to the point of having a service not unlike the BBC. **Terry Robinson** (*Darwin, Australia*).

A few memories

As a reader of your excellent magazine for more years than I care to recall, together with some of its early contemporaries which did not make the grade, your editorial article of issue 751 September 1969, encouraged me to write to you for the first time.

Needless to say I heartily applaud the sentiment of your article, we do with the advent of the i.c. have chance once again to rationalise, human nature being what it is, however, I wonder if the nettle will be grasped?.

Whilst pondering on this matter and the extent to which the art of radio construction has changed my mind went back to the halcyon days of the spaghetti resistance, Lewcos coils, Telsen, dutch R. valves, and all the last word gadgetry which was perpetrated upon the somewhat bewildered constructor even in those early days. I feel certain that some of your more senior readers must recall the "Magic" indoor aerials, the Loewe valves, and even then the attempts at integrated circuitry, I seem to recall that one could purchase a large black box which contained a transformer coupled amplifier, and which had three valve holders mounted upon its top, all one required was the ability to wire up an H. F. section and Voila! a wireless set.

In my opinion the period from the early twenties up to the late thirties was a fascinating one in the development of radio, and I write to ask if it would be possible for a series of articles with pictures and circuitry of constructional projects of the period could be printed, even small articles of the period would I feel raise a smile, and probably the wry comment that little is really new under the sun.

In closing I should like to do something that I have intended to do for so many years, that is to thank you for a very well produced magazine which has remained a real constructors magazine for so long. Long may you flourish. **R. C. Armet** (*Transvaal, Republic of South Africa*).

[*I would like to hear from readers who would like to see reprints of parts of* 1920-1930 *articles.*]—Editor

Ban the speaker!

Nowadays one reads of semiconductor devices being used to produce coherent light, etc. but nowhere can I find any reference to their being used to produce sound. This surprises me as I remember witnessing this phenomenom in 1964 whilst playing around with a set of transistors. (These transistors came boxed in a set and were, I believe, of Italian manufacture. They were encased in black-painted metal cans.)

I had built a crystal set at this time and was using the transistors to amplify the signal sufficiently to feed a loudspeaker. Being a newcomer to electronics at this time and entirely ignorant of circuitry I remember that in the three transistor amplifier lash-up I employed a separate battery for each transistor! Unorthodox as this procedure was, it worked well and to my great delight the strains of music obligingly came blasting out of the speaker! On removing the speaker, however, to make some adjustment or other, I noticed that I could still hear the music! The volume was not as high as with the speaker connected but was still at a comfortable level. My first thought was that the sounds were emanating from the speaker transformer core (a large, ex-TV item) but this was not the case. The sound source was the transistors themselves. I cannot now recall if one or all of the transistors were "sounding-off," but at least one of them was. I believe the actual sound came from the transistor cans which, as mentioned above, were metal and rang when "pinged" with a finger nail, but what caused them to vibrate I have never been able to ascertain.

I should be extremely grateful if any of your readers can collaborate this phenomenon or offer any explanation as to how it could have occurred.—**J. B. Jobe** (*Worcester*).

Marconi station

I thought that some history of the above station might be of interest to readers. It was opened in 1910 and was an outstanding landmark round these parts. It could be seen for many miles with its 400ft. aerials standing along the slopes of Cafn Dee mountain near Caernarvon.

With the advance of modern developments the old station went out of commission in 1939 and the aerials were pulled down.

During the First World War, the first wireless transmission ever sent to Australia from this country was transmitted from this station by Lloyd George to Hughes, another Welshman who was Prime Minister of Australia at the time.—**H. Roberts** (*Caernarvon, N. Wales*).

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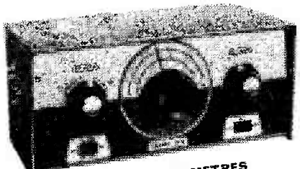

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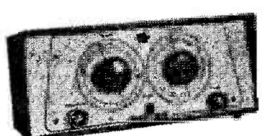

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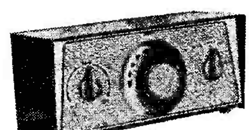

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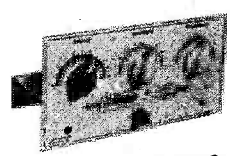

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P.W. GUIDE TO COMPONENTS

PART 14

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

Field Effect Transistors

There are two basic forms of construction used in the manufacture of field effect transistors (f.e.t.s). The resulting devices are known as junction f.e.t.s and insulated gate f.e.t.s. It will be convenient to examine each type separately.

Junction f.e.t.

The junction f.e.t. is a device utilising a single p-n junction with a structure very similar to the unijunction transistor which is a related device. The basic structure is illustrated in Fig. 12 and consists of a bar of n-type

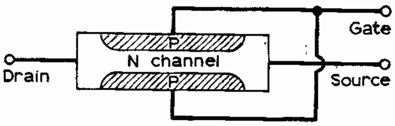

Fig. 12: Basic structure of a junction F.E.T.

semiconductor, usually silicon, with a p-type region on either side of the bar. The n-type portion between the p-type regions is called the channel and current flows through the channel from drain to source. Now if the diode formed between the p-type region, termed the gate, and the source is reverse biased by a negative potential on the gate, an electric field is set up in the channel which restricts the current flow through it. If the voltage is sufficiently negative all current flow is inhibited through the channel. The bias voltage for zero current is called the pinch off voltage (Vp).

The operation of an f.e.t. depends on an input through a reverse-biased diode and therefore the f.e.t. characteristically has a very high input impedance ($\sim$10MΩ). As with other semiconductor devices p-type and n-type materials can be reversed to give a p-channel f.e.t. with an n-type gate, and in this case the potential on the gate is reversed. The symbols for n-channel and p-channel f.e.t.s are shown in Fig. 13 together with the biasing voltages for normal operation. It should be remembered that the arrow direction indicates the diode forward current direction and hence potentials are such as to reverse bias the diode.

At this point most of us with valve experience will have noted the similarity between valves and f.e.t.s. In fact the n-channel f.e.t., which is by far the most commonly available f.e.t., is strikingly similar both in voltage polarities, as shown in Fig. 14, and characteristics, shown in Fig. 15. Unlike the valve however the maximum drain to source voltage is limited by breakdown characteristics, whilst f.e.t. transconductance $\left(\frac{Ids}{Vgs} \simeq gm\right)$ varies with bias voltage (Vgs) and is a maximum at Vgs=0. The transconductance is more linear than for conventional transistors.

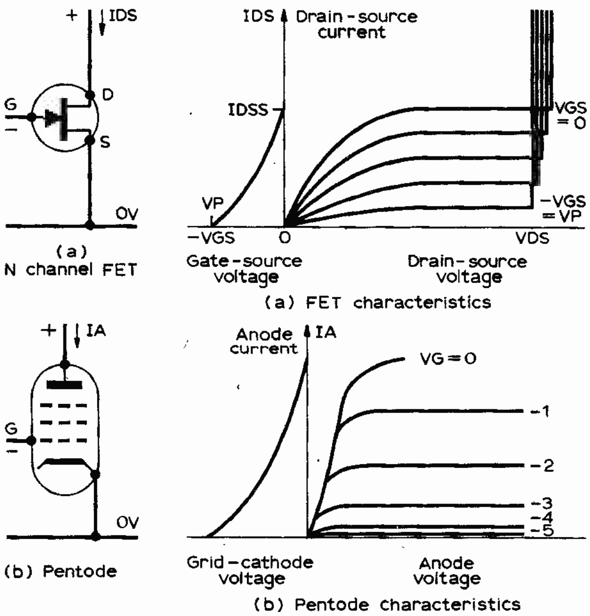

Fig. 14: (left) Comparison of F.E.T. and pentode symbols.
Fig. 15: (right) Comparison of F.E.T. and pentode characteristics.

Manufacturer's parameters for f.e.t.s usually include the items shown in Table 2, which also includes typical ranges of values for n-channel devices. Other parameters include maximum reverse transfer capacitance at 0·5-10pF and noise figures between 1-5dB. These are usually only important for critical applications.

Field effect transistors are used for many applications including microphone preamplifiers, d.c. differential amplifiers, r.f. amplifiers in v.h.f. radio circuits, switching circuits and instrument input amplifiers. At present they are used in circuits which particularly require the special features of low noise levels and high input impedance. The extremely low drift currents of 1pA (10^{-12}A) per °C and high input impedances make them particularly suitable for use in input and buffer circuits.

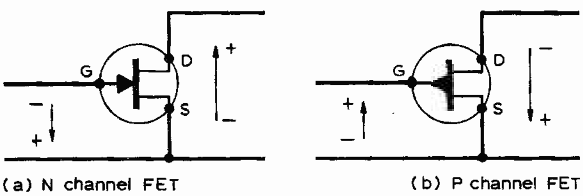

Fig. 13: B.S. preferred symbols and applied polarities for junction F.E.T.'s.

Table 2: Typical f.e.t. parameters

Parameter	*Symbol*	*Typical values*
Max. gate-source voltage	Vgso	20-50V
Max. drain-source voltage	Vds	20-100V
Drain-source current at Vgs=0	Idss	0·5-100mA
Max. pinch off voltage Vgs=Vp	V(p)gs Vgs(off)	2-10V
Max. gate current	Igss	0·1-10nA
Transconductance	gm	0·25-30mA/V

Typical input characteristics of an f.e.t. preamplifier are Zin>1MΩ, Cin>10pF, noise voltage <0·5mV and bandwidth >100MHz .

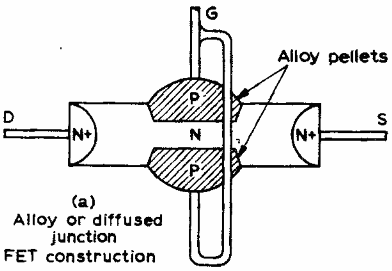

Fig. 16a: Alloy or diffused junction F.E.T. construction.

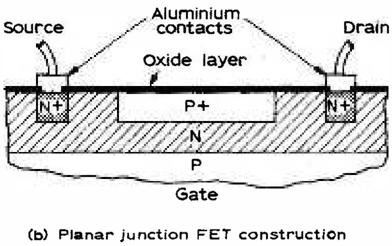

Fig. 16b: Planar junction F.E.T. construction.

Figure 16 illustrates the two basic forms of junction f.e.t. construction which are used at present. The alloy construction of Fig. 16(a) is still the most common where p-type pellets are alloyed to either side of an n-type slice. The geometrical outline is also used for diffused junction f.e.t.s. As with conventional transistors planar construction, using the more accurate photographic techniques, is used increasingly in close tolerance f.e.t. manufacture, and this form of construction is illustrated in Fig. 16(b).

A special form of construction used to obtain good high frequency characteristics is illustrated in Fig. 17 and this device is known as a tecnetron. Indium is deposited on the surface of an n-type slice etched to receive the plating. The result is a thin channel region of small area giving low capacitance and therefore good high frequency characteristics. The structure is however electrically and thermally less robust and is at present rather uncommon.

As with conventional transistors the encapsulation of

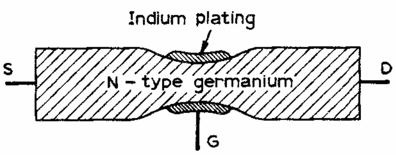

Fig. 17: Tecnetron construction.

f.e.t.s is mainly of the popular TO-18 or TO-5 types. A plastic encapsulation is shown in Fig. 18 but as the lead out connections are still unstandardised the precise terminal designations should be obtained from the manufacturer.

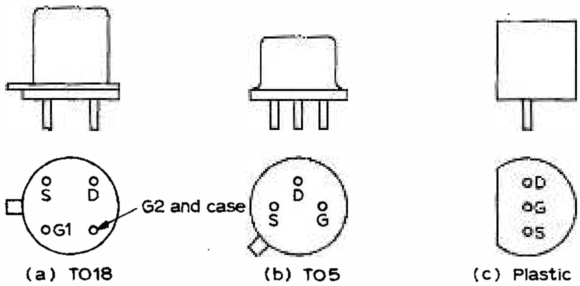

Fig. 18: F.E.T. encapsulations.

We have now examined the junction field effect transistor and should consider the second basic form of construction known as insulated gate f.e.t. It is interesting to note that it was experiments with crude constructions to obtain the insulated gate f.e.t., or unipolar transistor as it was then known, that led to the discovery by Shockley of the conventional or bipolar transistor. The insulated gate f.e.t. was therefore a forerunner of the modern transistor but it is only with the discovery of planar epitaxial techniques that the insulated gate or metal-oxide semiconductor (m.o.s.) transistor has been a practical proposition in terms of noise and gain.

Insulated Gate f.e.t. or Metal-Oxide Semiconductor Transistor (m.o.s.t.)

Metal-oxide semiconductor transistors (m.o.s.t.s) are constructed with p- or n-type semiconductor channels. In place of the reverse biased p-n junction which provides the controlling electric field, the field is formed through an extremely thin insulated junction. The insulation is provided by a silicon dioxide layer which acts as an efficient insulator. The basic form of construction is similar to that shown in Fig. 12 for a junction f.e.t. except that the junction is formed between a metal connection and the p- or n-type channel. The insulation is silicon dioxide thermally grown by passing steam over the basic chip. The basic symbol for a m.o.s.t. is shown in Fig. 19.

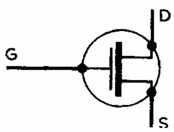

Fig. 19: Insulated gate (or M.O.S.T.) symbol.

The m.o.s.t. has properties which are peculiar to insulated gate structures. Two basic modes of action are possible. Firstly the depletion mode in which current normally flows through the channel but is reduced by channel width depletion until zero current flows at maximum gate voltage. The second mode of operation is known as the enhancement mode and in this mode the device is normally off but is turned on up to saturation point by increasing gate potentials. The enhancement mode is achieved by altering the end connections and type of channel material so that the path between the drain and source appears as back-to-back diodes and the gate potential increasingly reduces the blocking effect. It is clear from this that all junction f.e.t.s belong to the depletion mode of operation since the gate p-n junctions must be reverse biased.

—continued on page 806

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	Rec. Retail Price	Comet Price
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	Rec. Retail Price	Comet Price
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ARMSTRONG 523 FM ..	£52 9 0	£44 19 6
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ARENA 2500 complete with Decoder	£97 0 0	£79 0 0
ARENA T1500F AM/FM Stereo Tuner/Amplifier ..	£72 9 0	£59 19 6
ARENA T900 AM/FM Stereo Tuner Amplifier	£303 9 0	£258 0 0
ARMSTRONG 525 25 watts per channel FM	£87 16 9	£74 19 6
ARMSTRONG 526 25 watts per channel AM/FM ..	£98 15 6	£85 19 6
ARMSTRONG 127	£43 19 9	£37 19 6
(Teak Case for 127)	£3 17 0	£3 10 0
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DULCI AS3 Speaker ..	£8 8 0	£6 19 6
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GOODMANS Loudspeaker System Model 2005 (per pair)	£25 0 0	£21 0 0
KEF Celeste	£29 0 0	£23 19 6
KEF Concord	£43 10 0	£34 19 6
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QUAD Electrostatic ..	£66 0 0	£57 19 6
TRUVOX LS200	£22 7 3	£17 19 6
WHARFEDALE New Airedale	£69 10 0	£57 14 0
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Bases, plinths and covers stocked to suit all the above turntables.

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	Rec. Retail Price	Comet Price
AKAI X-360 4-track	£339 0 0	£284 0 0
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FERGUSON 3226 Four Track	£46 6 0	£29 19 6
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GRUNDIG TK149	£55 18 10	£47 19 6
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I.F. CRYSTAL FILTER

F. G. RAYER

RECEIVERS in the higher price range often have a crystal filter to give a very considerable increase in selectivity compared with transformers, thus reducing interference from adjacent transmissions. The simplest type of filter is that with a single crystal and variable phasing. The filter described here was fitted as an addition in the all-wave "Progressive Superhet" (March 1969 issue) but could equally well be included in other home-constructed, surplus, communcations-type receivers.

Figure 1 is the circuit, and uses the centre-tapped i.f. transformer listed, numbers being for the pins of this component. This i.f.t. is intended for 465kHz, but was found to be satisfactory anywhere in the 455-470kHz range.

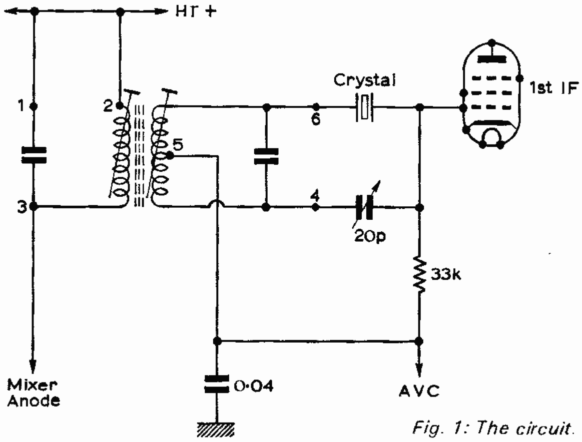

Fig. 1: The circuit.

The crystal was 464·75kHz, obtained from the supplier listed. There is no need to use this exact frequency, as all the i.f.t.s are later aligned on the crystal frequency.

When the 20pF variable capacitor is adjusted to balance the stray crystal circuit capacitance a symmetrical response curve similar to that at A in Fig. 2 is obtained. The crystal has a Q very much higher than that of an ordinary tuned circuit, so the response curve is very sharp, giving high selectivity. F is the crystal frequency. The ordinary tuned circuits of the other i.f.t.s help to reduce the response at the wider skirt frequencies, F1 and F2.

If the variable capacitor is adjusted slightly, changes in phase produce the notch shown at B: this is a frequency at which there is minimum response. The position of this rejection notch can be varied by adjusting the phasing capacitor, and can be moved to the other side of the resonant frequency F. The normal selectivity of the other i.f. tuned circuits helps compensate for the hump and extended skirt of B.

Maximum selectivity may be increased by reducing the value of the 33kΩ resistor, or reduced by increasing the resistor value. Selectivity with the circuit balanced (A, Fig. 2) is too great for normal reception, so for this purpose some means of cutting out the crystal or reducing its effect becomes necessary. The best method is to short out the crystal with a low-loss low-capacitance switch connected with short leads, but there are other ways such as adjusting the phasing capacitor well off optimum setting or bending one corner of a moving plate so that the capacitor shorts when closed. These methods avoid the switch but leave a secondary dip from the crystal when tuning.

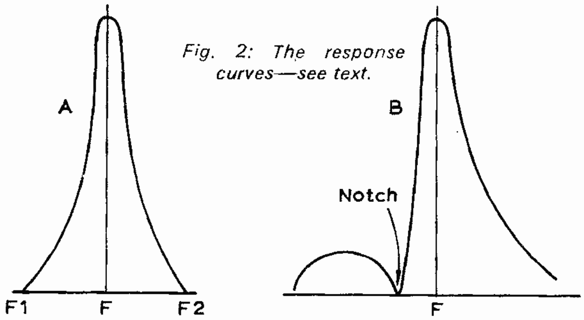

Fig. 2: The response curves—see text.

In the receiver mentioned, the first i.f.t. is removed and the centre-tapped type fitted in its place. The phasing capacitor is mounted on paxolin, fixed to the chassis with brackets. A ¼in. dia. insulated extension rod is attached to the capacitor spindle with a coupling, and passes through a bush placed in the "R.F./I.F. Gain" control position, this potentiometer being moved to the right of the panel above the chassis.

With other receivers, a well-screened layout is best, to avoid stray coupling round the crystal, thereby reducing its efficiency. The layout should also permit short wiring. Some commercial receivers have the phasing capacitor fitted to the panel, with only an insulated bush, but this can cause misalignment because of hand capacitance effects.

For best possible results alignment is quite critical, and is best done by tuning-in a quite strong, steady signal, such as that from a BBC transmitter.

With the crystal in circuit and the phasing capacitor about half closed, tune slowly through the signal, observing the S-meter or a meter temporarily placed in the h.t. circuit to one i.f. stage.

A very sharp peak should be seen, with a

★ components list

- Type IFT11/465/CT i.f. transformer (Denco, Clacton, Ltd., 357/9 Old Road, Clacton-on-Sea, Essex).
- Crystal, 464·75kHz or similar (Henry's Radio Ltd., 303 Edgware Road, London, W.2).
- 33kΩ ¼-watt resistor.
- 20pF or similar miniature air-spaced variable capacitor.
- Insulated extension spindle, coupling, bush etc. (Home Radio, 187 London Road, Mitcham, Surrey.)

broader but similarly strong response at a second but near frequency. The sharp peak is from the crystal, and broad peak from the i.f. tuned circuits.

Tune to the sharp peak, and adjust all the i.f.t. cores slightly for best results. As this is done, the second broad peak will disappear, and signal strength at the sharp peak will rise considerably.

Careful tuning will now probably show a response similar to that at B, Fig. 2. Adjust the phasing capacitor until this changes to that at A. Reduce signal input (a *very short* aerial can be used to do this) and carefully touch-up the i.f.t. cores.

With all i.f.t.s tuned exactly on the crystal, and the latter balanced, observation of the S-meter will give a response like that at A. If the receiver is tuned slightly above or below a carrier, adjustment of the phasing capacitor one way or the other should be found to place the carrier in the rejection notch, B, so that it almost completely disappears.

As the receiver i.f. has been modified, the oscillator cores and trimmers should be touched up, for best results on each band.

Maximum selectivity is primarily for c.w. only, the passband being too narrow for speech. However, when operating in a congested amateur or other band, selectivity can be degraded somewhat by adjusting to obtain the curve B, meanwhile placing the notch so as to reduce interference. This allows a great improvement in the reception of voice transmissions. ■

P.W. GUIDE TO COMPONENTS

continued from page 802

Insulated gate f.e.t.s are commonly of the depletion type and can be directly substituted with junction f.e.t.s of the same effective channel type. Gate currents are of course considerably lower and gate-source bleed resistors can be as high as 1,000MΩ and mainly depend only on external leakage requirements. The principal disadvantage of m.o.s. transistors is the high noise levels which are associated with the insulated gate and which preclude their use in small signal circuits.

Field effect transistors therefore are an extremely useful alternative to conventional bipolar transistors. They are encapsulated in similar cases to transistors, and where heavy current devices are required an interdigitated or multichannel device is used. At present plastic encapsulated, wide tolerance junction f.e.t.s (n-channel) are available from 5s. whilst closer tolerance f.e.t.s, both n- and p-channel, are usually available from £1 to £20. Insulated gate f.e.t.s are of the same order of price. Since the vast majority of f.e.t.s are junction n-channel devices it would be wise for the amateur to use these widely available and hence cheaper devices.

TO BE CONTINUED

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The problem of tackling a set of this complexity is overcome to such an extent that it can truly be classed in the beginners range. The set initially starts as a six transistor receiver and will provide excellent coverage in this form, but it builds up to a twelve transistor plus four diode set with the features mentioned above.

METAL DETECTOR

This article describes the principles of metal detection including the limitations of amateur types and goes on to describe a practical circuit which in addition to being useful for locating house wiring etc. can give endless hours of fun. In the described form the metal detector should cost under 50s. including headphones but a cheaper and simpler version making use of a standard radio set is also described.

BOOKSHELF SPEAKER

The "Decibella" speaker exclosure contains a woofer and a tweeter, frequencies above 3kHz being fed to the tweeter and below 3kHz to the woofer. A series L-C crossover network is employed.

Size of the enclosure is 13 x 8in. with a depth of 8¼in. and fed from a 10 Watt amplifier, two of these units will give really good stereo listening.

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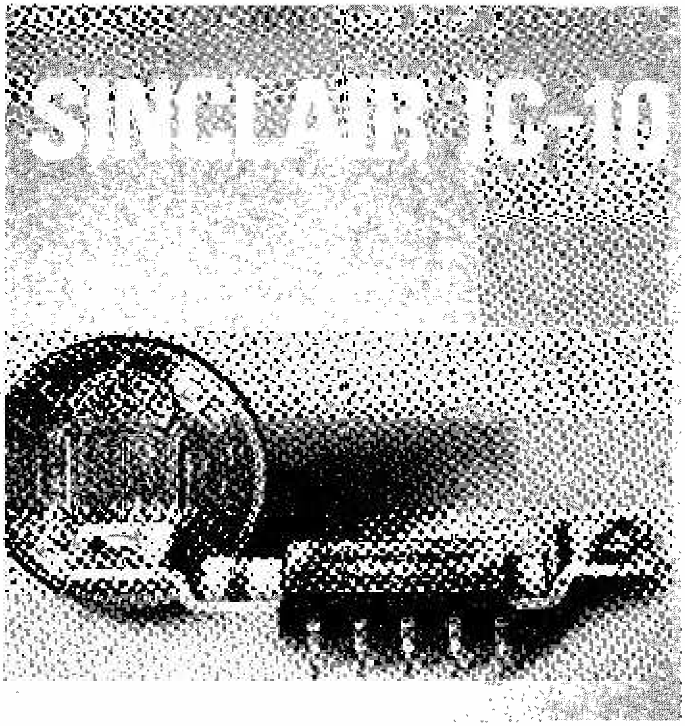
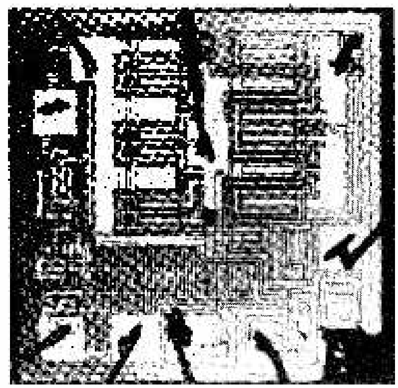


MONOLITHIC INTEGRATED CIRCUIT HIGH FIDELITY AMPLIFIER AND PRE-AMP



the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output of 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required for producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. It also enables us to give a 5 year guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

■ SPECIFICATIONS

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

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

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IC.10 *with IC.10 manual and 5 year guarantee* **59/6**

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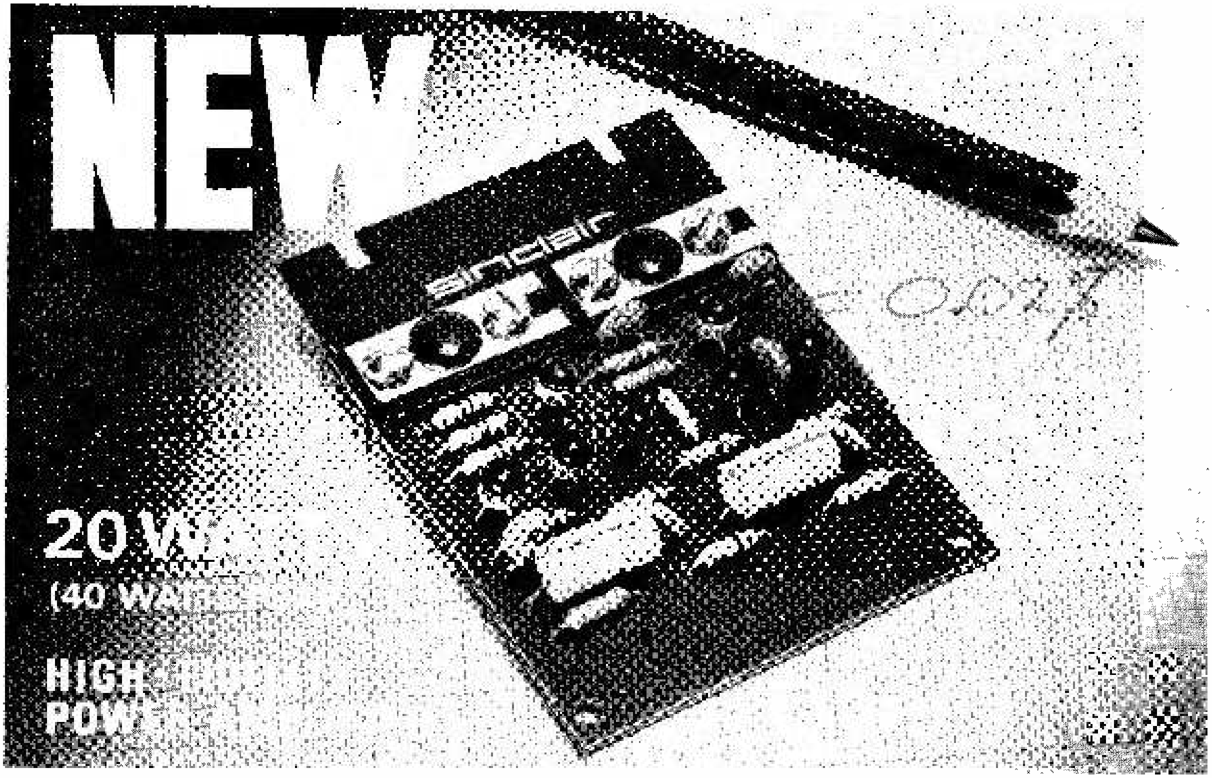


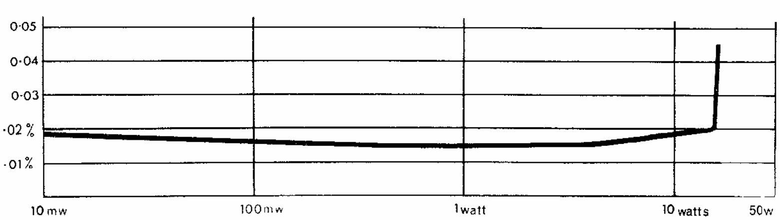
Z.30 THE WORLD'S LOWEST DISTORTION HIGH FIDELITY AMPLIFIER.

For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual boot-strapping. 9 silicon epitaxial planar transistors are used to provide enormous power (up to 20 watts RMS continuous sine wave, 40 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection.

At all output levels, distortion is only 0·02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. Yet this brilliant new Sinclair design costs not a penny more than its famous predecessor.

APPLICATIONS

Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; intercom; electronic music and instruments; P.A.; laboratory work, etc. Full details for these and many other applications are given in the manual supplied with the Z.30.



SPECIFICATIONS

Power output: 15 watts R.M.S. into 8 ohms using a 35 volt supply: 20 watts R.M.S. into 3 ohms using a 30 volt supply.

Output: Class AB.

Frequency response: 30 to 300,000Hz ± 1dB.

Distortion: 0·02% total harmonic distortion at full output into 8 ohms and at all lower output levels.

Signal-to-noise ratio: better than 70dB unweighted.

Input sensitivity: 250mV into 100 Kohms.

Damping factor: > 500.

Loudspeaker impedances: 3 to 15 ohms.

Power requirements: From 8 to 35V. d.c. (The Z.30 will operate ideally from batteries if required).

Size: 3½ x 2¼ x ½ inches.

Built, tested and guaranteed, with circuits and instructions manual **89/6**

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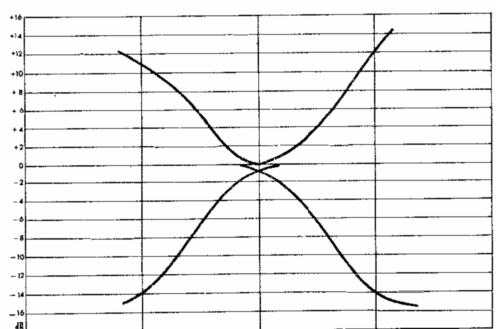

Curves to show bass and treble cut and boost

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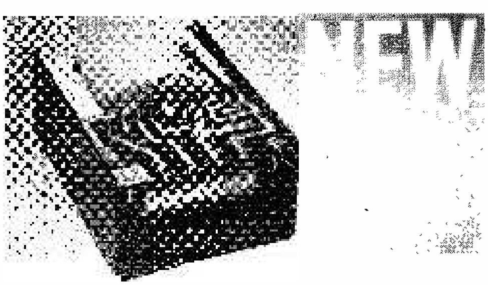

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This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV Magnetic Pickup —3mV; correct to R.I.A.A. curve ± 1dB; 20 to 25,000 Hz. Ceramic Pickup—up to 3mV: Auxiliary —up to 3mV.
- Output—250mv.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE +15 to —15dB at 10kHz. BASS +15 to —15dB at 100Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size $8\frac{1}{4}$ x $1\frac{1}{2}$ x 4 ins.

PZ.5 POWER SUPPLY UNIT

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design. For AC Mains, 200-240V/50Hz. **£4.19.6**

Q.16 Loudspeaker and Micromatic on next page.

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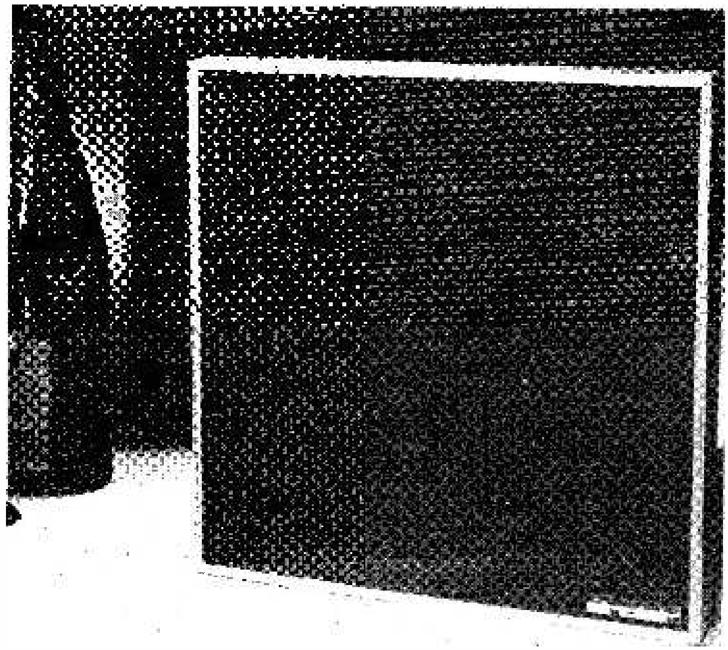
Q.16

new elegance in an outstanding loudspeaker



All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

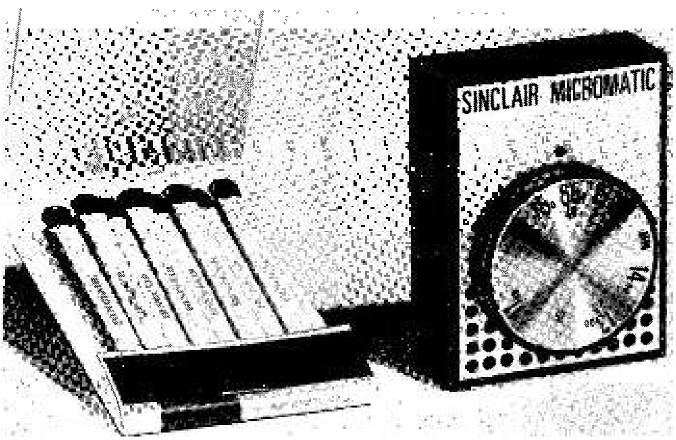
The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000Hz with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: $9\frac{3}{4}''$ square × $4\frac{3}{4}''$ deep from front to back.

£8.19.6

POST FREE

SINCLAIR MICROMATIC

The world's most successful miniature radio



SPECIFICATIONS—Size: $1\frac{13}{16}'' \times 1\frac{7}{16}'' \times \frac{1}{2}''$ (46×33×13mm). **Weight incl. batteries:** 1 oz. (28·35gm) approx. **Tuning:** Medium wave band with bandspread at higher frequency end. **Earpiece:** Magnetic type. **Case:** Black plastic with anodized aluminium front panel, spun aluminium dial.

Complete kit incl. earpiece, case, solder and instructions in fitted pack. **49/6**
Plus 11d. P.T. surcharge

Ready built, tested and guaranteed, with earpiece. **59/6**
Plus 1/1d. P.T. surcharge

Mallory Mercury Cell RM675 (2 req.) 2/9 each

Considerably smaller than an ordinary box of matches, this is a multi-stage A.M. receiver meticulously designed to provide remarkable standards of selectivity, power and quality. Powerful A.G.C. is incorporated to counteract fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy at all times. Vernier type tuning plus the directional properties of the self-contained special ferrite rod aerial makes station separation much easier than with many larger sets. The plug-in magnetic earpiece which matches exactly with the output provides wonderful standards of reproduction.

Everything including the batteries is contained within the attractively designed case. Whether you build your Micromatic or buy it ready built and tested, you will find it as easy to take with you as your wrist-watch, and dependable under the severest listening conditions.

USE THIS COUPON FOR MICROMATIC AND Q.16 ORDERS

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE
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For which I enclose cash/cheque/money order

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.... PW.170

SINCLAIR GENERAL GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

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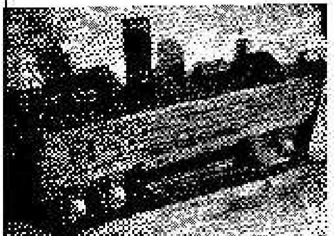
22 NEWMARKET RD., CAMBRIDGE
Tel: 0223 52731

6 PUSH-BUTTON STEREOGRAM CHASSIS

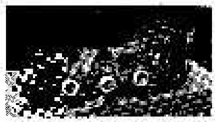


M.W.; S.W.1.; S.W.2; V.H.F.; Gram; Stereo Gram; Vol; Tone; Mains Trans; 200-250 Volts; 2 o.p. for 3 ohm. Also operates with two speakers on Radio. Chassis size: 15 × 7 × 6½in. high. Dial silver and black 15 × 3in. 190-550M; 18-51M; 60-187M; VHF 86-100 Mc/s. Valves: ECC85, ECH81, EF89, 2× ECL86, EM84 and Rect. Price £19.19.0, carr. paid. With Stereo Decoder fitted £8 extra.

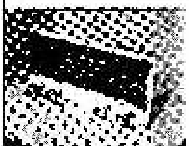
STEREO AMPLIFIER type HV— 2 x 3 Watts

Fully built. On off. sep. vol. and tone each channel 12 × 4½ × 6in. high. EZ80. 2 × ECL86; for 3 ohm speakers, double wound main trans: fixing flanges and base plate, suitable for crystal cart, tuner etc. £6.10.0 (8/- p. × p.)

STEREO AMPLIFIER type RC— 2 x 3 Watts



Fully built. 2 × UCL82, metal rect: ganged vol. and tone cont: on-off. balance. 11 × 3½ × 4in. high. Double wound mains trans. with supporting brackets. For 3-ohm speakers. £6 (8/- p. & p.).



MONO GRAM CHASSIS 3 WATT

3 Wave band long-med-short. Gram., 200-250v AC Ferrite aerial. Chassis 13 × 7 × 5in. Dial 13 × 4in. Double wound mains transformer 5 valves ECH81 EF89, EBC81, EL84, EZ80. Price £10.12.6. (7/6 p. & p.) Output trans. for 3-ohm speaker.

BAKERS' Selhurst Speakers. 12in., cast frame, 3, 8 or 15 ohm (state which). Group 25 (25 watt) for guitars, etc. £6.6.0: Stalwart 45-13,000 cps, 15W £6.6.0; de Luxe Mk2 dual cone 25-16,000cps. 15W £9 (all carr. paid) less 10% for 2 speakers.

GLADSTONE RADIO

66 ELMS ROAD, ALDERSHOT, Hants.

(2 mins. from Station and Buses). FULL GUARANTEE. Aldershot 22240
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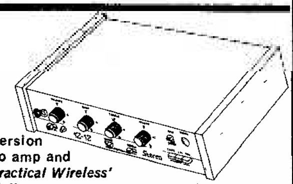
1/70

BRITISH NATIONAL RADIO SCHOOL

BETTER Bargains Service FROM TRS

BUILD THIS FINE VERSION OF THE PW.12-12 WITH A TRS KIT



T.R.S. have produced their own kit version of this outstanding combined stereo amp and pre-amp. It conforms precisely to *Practical Wireless'* excellent circuit but is styled for a flatter, more conventional cabinet which will be available shortly. Kit includes two-tone front panel and control knobs, components and transistors.

Inputs—Mag. P.U. (R.I.A.A.) 2·5mV into 68 Kohms; Ceramic P.U. and Radio; Response 20Hz to 30KHz ±1dB. Output—12 watts per channel. R.M.S. into 15 ohms.

Kit complete, less cabinet **£24.10.0** (Carr. 7/6)

Power Amplifier & Pre-amp Kits available separately. S.A.E. brings list.

AMPLIFIERS

Styled and kitted by T.R.S., using quality components, including valves or transistors as necessary and excellent instructions. Backed by T.R.S. service.

MULLARD 5-10. Basic kit (requires pre-amp). Input Sensitivity—40mV; Response 20Hz–15KHz ±1dB; Output 10 watts R.M.S. at 3 or 15 ohms. KIT **£10.10.0.** BUILT **£13.0.0** (Carr. either, 7/6).

MULLARD 2 VALVE PRE-AMP. Switching for 5 inputs; bass/treble/volume controls, etc. Sensitivity at input—4mV max. into 80K–1 Megohm; Response 20–25,000Hz ±1dB. KIT **£6.19.6.** BUILT **£9.10.0** (Carr. either 5/6).

MULLARD 10-10 STEREO AMPLIFIER. Input sensitivity—210mV per channel; Response 12Hz–35KHz ±3dB; 10 watts R.M.S. output per channel into 3 or 15 ohms. KIT **£18.10.0.** BUILT **£22.10.0** (Carr. either 12/6).

Basic Kit (no panel or controls) **£17.0.0.** Built **£21.0.0.** Pre-amp must be used here.

MULLARD 2+2 STEREO PRE-AMP with same characteristics per channel as mono pre-amp (+ balance). BUILT **£13.19.6** (Carr. 7/6).

T.R.S. 4×4 ECONOMY STEREO. Modular assembly. With cabinet power supply and Din plugs **£12.10.0** (Carr. 7/6).

SINCLAIR PRODUCTS AS ADVERTISED

TUNERS

T.R.S. 6 VALVE AM/FM. Self-powered, large scale; push-buttons. Magic eye. Med. Wave and F.M. Diode output per tape. COMPLETE KIT **£12.10.0** (Carr. 7/6).

T.R.S. FM TUNER. Transistors, inter-station suppression, A.F.C. etc. Modular assembly. Modules, chassis, drive etc. come to **£15.15.0** (Carr. 7/6)

Cabinet to match T.R.S.4+4	**£1.17.6** (Carr. 2/6)
Power supply	**£2.5.0** (Carr. 3/–)
Decoder for Stereo	**£10.10.0** (Carr. 2/6)

GRAMO UNITS & PLINTHS

GARRARD SP.25 MK. II. Manual: Arm and 10½in. die-cast t/table, cueing device, etc. less cartridge. Brand new in maker's carton **£12.7.6.**

GARRARD LM.2025. With Sonotone 9TA/HC Stereo Cartridge and lift control **£10.19.6** (Carr. 7/6)

Garrard WB.1 Plinth	**£3.7.6** (Carr. 5/–)
Garrard CLEARVIEW Cover SCP.1	**£3.5.0** (Carr. 4/6)
Garrard Scandinavian Type Plinth	**£5.5.0** (Carr. 5/–)

ALWAYS IN STOCK

Resistors in all values; wire-wound resistors; volume controls log or linear, 10K–2meg. Mono 3/6 (with switch 5/-). Stereo 8/6 (with switch, certain values 10/6). Log/antilog balance controls, capacitors and electrolytics; Vinair speaker covering 48in.—22/6 yd; Bondacoust 48in. x 1in. thick 7/- yd.; Veroboard; Cir-Kit; valves; transistors. S.A.E. with enquiries please.

TRS

RADIO COMPONENTS
70 BRIGSTOCK ROAD, THORNTON HEATH, SURREY

Open Sats. Close early Weds. ● *¼ min. Thornton Heath Stn. (Southern)* ● Phone: 01-684 2188

DE LUXE PLAYERS

PORTABLE CABINET As illustrated. To fit standard player or autochanger **75/-**

RCS AMPLIFIER 3 WATT
Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on panel. Supplied with knobs, loudspeaker and valves UCL8 2.UY85. Post 5/6 each item

Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6**

AUTOCHANGERS MONO			
Balfour Princess	£5.5.6		
BSR Superslim UA25	£6.19.6		
SINGLE PLAYERS MONO		BSR Mini Changer	£8.19.6
EMI Junior Mains	£2.19.6	AUTOCHANGERS STEREO	
Garrard SRP 22	£6.19.6	BSR Superslim	£7.19.6
SINGLE PLAYERS STEREO		Garrard 1025	£7.19.6
Garrard SP25 MkII	£12.19.6	Garrard 3000	£12.19.6

GARRARD TEAKWOOD BASE WB.1. Ready cut out for mounting 1025, 3000, SP25, AT60, etc. **77/6**
GARRARD PLASTIC COVER SPC.1 for WB1 BASE. Durable tinted attractive appearance. **65/-**

E.M.I. PICK-UP ARM, complete with mono cartridge 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-. ACOS LP only 10/6.

CRYSTAL MIKE INSERTS
1½" dia. 6/6; ACOS 1½" dia. 12/6 BM3 1" dia............9/6
QUALITY RIBBON MIKE with GOOSENECK..£11.11.0
CRYSTAL HAND MIKE. High Output..........12/6

A self-contained fully portable mini p.a. system. Many uses—ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player Amplifier, etc. Attractive rexine covered cabinet, size 12 × 9 × 4in., with powerful 7 × 4in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP9 battery. Brand new in makers' carton with full makers' guarantee. Only **90/-** Post Free
World famous make

WEYRAD P50—TRANSISTOR COILS

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

Telescopic Chrome Aerials 6in. extends to 23in. 5/-.
Ferrite Rods Only 8 × ⅜in. 4/-. 6 × ⅜in. 5/-.

VOLUME CONTROLS
Long spindles. Midget Size 5K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 5/-. STEREO L/S 10/6, D.P. 14/6 Edge 5K. S.P. Transistor, 5/-.

80 Ohm Coax 8d yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. 20/-; 60 yd. 30/-.
FRINGE LOW LOSS Ideal 625 lines. **1/6** yd

WIRE-WOUND 3-WATT POTS. TV Type. Knurled Knob Values 10Ω to 30k. Carbon 30K to 2meg. **4/6**

WIRE-WOUND 3-Watt Standard Size Pots. Long Spindle 10 OHMS to 100K **7/6**

VEROBOARD 0.15 MATRIX
2½ × 5in. 3/8. 2½ × 3¾in. 3/2. 3¾ × 3¾in. 3/8. 3¾ × 5in. 5/2.
EDGE CONNECTORS 16 way 5/-; 24 way 7/6
PINS 36 per packet 3/4. FACE CUTTERS 7/6.
S.R.B.P. Board 0.15 MATRIX 2½in. wide 6d. per 1in., 3¾in. wide 9d. per 1in.; 5in. wide 1/- per 1in. (up to 17in.).
S.R.B.P. undrilled $\frac{1}{16}$in. Board 10 × 8in. 3/-.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides, 7 × 4in., 5/6; 9 × 7in., 6/6; 11 × 3in., 6/6; 11 × 7in., 7/6; 13×9in., 9/6; 14×11in., 12/6; 15×14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12×12in., 6/6; 14×9in. 5/6; 12×8in., 4/6; 10×7in., 3/6; 8×6in., 2/6; 6×4in. 1/6.

Q MAX CHASSIS CUTTER

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

½in. 16/–	⅞in. 17/6	1⅛in. 19/6	1½in. 24/–	2$\frac{3}{32}$in. 44/3
⅝in. 16/–	1in. 19/6	1¼in. 20/6	1⅝in. 29/–	2½in. 57/3
¾in. 16/9	1$\frac{1}{16}$in. 19/6	1⅜in. 21/6	2in. 39/–	1in.sq. 36/6

1¼in. DIAMETER WAVE-CHANGE SWITCHES.
2p. 2-way, or 2p. 6-way, or 3p. 4-way 4/6 each.
1p. 12-way, or 4p. 2-way, or 4p. 3-way, 4/6 each.
1in. Diameter Wavechange "MAKITS" 1p. 12-way, 2p. 6-way, 3p. 4-way, 4p. 3-way, 6p. 2-way, 1 wafer 12/-, 2 wafer 18/-, 3 wafer 24/-, 4 wafer 30/-, 5 wafer 36/-. TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6.

ALL PURPOSE HEADPHONES
H.R. HEADPHONES 2000 ohms Super Sensitive........35/-
LOW RESISTANCE HEADPHONES 3-5 ohms........39/6
DE LUXE PADDED STEREO PHONES 8 ohms......79/6

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER **42/6** Post 2/6

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

BARGAIN STEREO/MONO SYSTEM

Attractive Slim PLAYER CABINET with B.S.R. Stereo Autochanger, 3 valve Stereo Amplifier, two 6½in. LOUDSPEAKERS. (Only 4 pairs of wires to join). Carr. 10/6. S.A.E. for details **£19.19.6**

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2/350V ..	2/3	100/25V ..	2/–	8/600V ..	9/6
4/350V ..	2/3	250/25V ..	2/6	16/600V ..	12/6
8/450V ..	2/3	500/25V ..	4/–	16+16/500V ..	7/6
16/450V ..	3/–	8+8/450V ..	3/6	50+50/350V ..	7/–
32/450V ..	3/9	8+16/450V ..	3/9	60+100/350V	11/6
25/25V ..	1/9	16+16/450V	4/3	32+32+32/350v	8/-
50/50V ..	2/–	32+32/350V	4/6	100+50+50/350v	9/6

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250mF 15V 2/-; 500, 100mF 12V 3/6-; 2000mF 25V 7/-.
CERAMIC. 500V 1pF to 0.01mF, 9d.
PAPER 350V-0.1 9d, 0.5 2/6; 1mF 3/-; 2mF 150V 3/- 500V-0.001 to 0.05 9d; 0.1 1/-; 0.25 1/6; 0.5 3/-.
1,000V-0.001, 0.0022, 0.0047, 0.01, 0.02 1/6; 0.047, 0.1, 2/6.
SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF 0.01 mfd 6/- each.
TWIN GANG. "0-0" 208pF+176pF, 10/6; 365pF, miniature 10/6; 500pF standard with trimmers, 12/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 19/6. Single "0" 365pF 7/6. Twin 10/6.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each.
TUNING. Solid dielectric 100pF, 300pF, 500pF, 7/- each.
TRIMMERS. Compression 30, 50, 70pF, 1/-; 100pF, 150pF, 1/3; 250pF, 1/6; 600pF 750pF, 1/9; 100pF 2/6.
RECTIFIERS CONTACT COOLED ½wave 60mA, 7/6; 85mA, 9/6.
SILICON BYZ13, 6/-; BY100, 10/-
Full wave Bridge 75mA 10/-; 150mA 19/6; TV rects. 10/-.
NEON PANEL INDICATORS 250v. AC/DC Red. Amber 4/6.
RESISTORS. Preferred values, 10 ohms to 10 meg
¼ w., ½ w., 1 w., 20% 3d; 1½ w. 8d. 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-. Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K, 2/- each; 3 watt, 0.5 ohms to 8.2 ohms, 2/-.
BRAND NEW TRANSISTORS 6/- each
OC71, OC72, OC81, OC44, OC45, AF117
MAT100, 7/9; MAT101, 8/6; MAT120, 7/9; MAT121, 8/6.
REPANCO TRANSISTOR TRANSFORMERS
TT45. Push Pull Drive, 9:1 CT, 6/-. TT46 Output, CT 8:1 6/-. TT49 Interstage, 4.5: 1, 6/-; TT52 Output 3 ohms, 20:1 6/-.TT23/4 PAIR 10 watt Amp. Transformers and circuit 35/-.

TRANSISTOR MAINS POWER PACKS, FULL WAVE 9 volt 500mA. Size 4¾×2½×2in. Metal case. Crackle finish. Output terminals. On/off switch **49/6**
Half Wave 9 volt 50mA. Size 2¾×1½in. Snap terminals 32/6.
9 volt 500mA. TRANSFORMER ONLY. 2½×1¾×1¾in. 10/6.

MAINS TRANSFORMERS

Post 5/- each

250-0-250 50 mA. 6.3v. 2 amps, centre tapped..........19/6
250-0-250 80mA. 6.3v. 3.5 a. 6.3v. 1a, or 5v. 2a........35/-
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300-0-300v. 120mA. 6.3v. 4a. C.T.; 6.3v. 2a..........45/-
MINIATURE 200v. 20mA., 6.3v. 1a 2½×2×1⅝in......12/6
MIDGET 220v. 45mA., 6.3v. 2a. 2¾×2½×2in. 17/6
HEATER TRANS. 6.3v. 1½a., 8/6; 6.3v. 4a. 12/6
Ditto tapped sec. 1.4v., 2, 3, 4, 5, 6.3v. 1½amp. 12/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30v. at 2a..........35/-
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60........35/-
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CHARGER TRANSFORMERS. Input 200/250v. for 6 or 12v, 1½amp., 22/-; 4 amp., 35/-.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v, outputs. 1½ amp 8/9; 2 amp. 11/3; 4 amp. 17/6.

COAXIAL PLUG 1/3. PANEL SOCKETS 1/3. LINE 2/-.
OUTLET BOXES. SURFACE OR FLUSH 4/6.
BALANCED TWIN FEEDERS 1/- yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-.
JACK PLUGS Std. Chrome 3/-; 3.5mm Chrome 2/6.
DIN SOCKETS Chassis 3-pin 1/6; 5-pin 2/-. DIN SOCKETS Lead 3-pin 3/6; 5-pin 5/-. DIN PLUGS 3-pin 3/6; 5-pin 5/-.
VALVE HOLDERS, 9d., CERAMIC 1/-; CANS 1/-.

T.S.L. LOUDSPEAKER CROSSOVER HLP2
2-way crossover for 8 or 15 ohm speakers and tweeters, 3 phono input/output sockets.
Made to sell at 42/- OUR PRICE Post 2/6 **22/6**

Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.
PHOTO-ELECTRIC RELAY SYSTEM. 240v. AC.
Exciter and relay unit with infra red filter.
For counting, door signals, alarms, etc. **£12** Post Free

MINI-MODULE LOUDSPEAKER KIT

10 WATT **65/-** CARRIAGE 5/-
Triple speaker system combining on ready cut baffle, ½in chipboard 15in×8½in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE 16×10×9in. Modern Scandinavian fluted front design for Mini-Module **94/6** Post 5/-

ALL MODELS "BAKER SPEAKERS" IN STOCK

BAKER MAJOR £8

30-14,500 c.p.s., Hi-Fi double cone woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s Rated 20 watts. Voice coils available 3 or 8 or 15 ohms. PRICE £8. or Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions **£10.19.6**

BAKER "GROUP SOUND" SPEAKERS — POST FREE

'GROUP 25'	'GROUP 35'	'GROUP 50'
12in. 25 watt **6 gns.**	12in. 35 watt **8½ gns.**	15in. 50 watt **18 gns.**

TEAK HI-FI SPEAKER CABINET. Fluted wood front.
For 10 or 12in round. Loudspeaker £8.10.0
For 13 × 8in. or 8in round Loudspeaker £4.14.6
For 10 × 6in. or 6½in. round Loudspeaker £3.16.6.
LOUDSPEAKER CABINET WADDING 18in wide, 2/6ft.

Goodmans Tweeter 3½in 3 ohm 35/-, EMI 2½in 8 ohm 17/6, Horn Tweeters 2-18kc/s, 10W 15ohm 29/6. Crossover 16/6.
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SPECIAL OFFER! 8 ohm, 2½in; 6×4in; 80 ohm 2½in., 2½in.
15/6 EACH 25 ohm, 6 × 4in& 35 ohm, 3in; 15 ohm TYPE 7 × 4in., 8 × 5in.
8in. LOUDSPEAKER UNITS 3 ohm 27/6; 15 ohm 30/-;
ELAC 8in. De Luxe Ceramic 3 ohm 45/-; 15 ohm 50/-.
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5in. WOOFER, 8 watts max. 20-10,000 cps. 8 or 15 ohm, 39/6.
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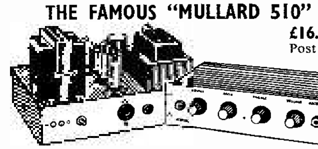

Main power, amplifier and 2 valve pre-amplifier. Silver grey facia panel. Volume, treble, bass controls. Function switch; Radio, Tape 1, Tape 2, Mic., Gram LP, Gram 78. Tape output socket. Valves: 2 × EL84, 3 × EF86, 1 × ECC83, 1 × EZ81. Ultra linear Parmeko output transformer, 20 db negative feedback. 10 watts rms. mono 3 and 15 ohm output. Brand new. Guaranteed.

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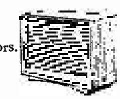

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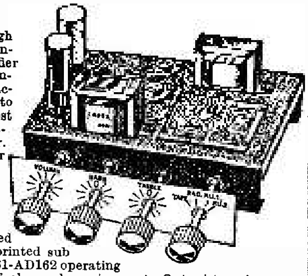
MONO TRANSISTOR AMPLIFIER HSL.700



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated pre-amplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for AC mains 200-240v. Controls: Bass, Treble, Volume/on/off. Function selector for PU1, PU2, Tape, Radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9¼ × 5 × 4¼ in.
Sensitivity: PU1-50m/v. 56K input impedance.
PU2-110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.
Output power measured at 1Kc—6.2 watts RMS into 3 ohms, 5.8 watts RMS into 15 ohm. Overall frequency response 30 c/s-18 Kc/s: Continuously variable tone controls; Bass, + 8 db to − 12 db at 100 c/s. Treble, + 10 db to −10 db at 10 Kc/s. The HSL.700 has been designed for true high fidelity reproduction from Radio Tuner, Gramophone deck and Tape Recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, full circuit diagram and operating instructions.

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

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

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Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W. mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ±3dB. 20–20,000 c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at ·6 amp.
PRICES: AMPLIFIER KIT **£10.10.0;** POWER PACK KIT **£3.0.0;** CABINET **£3.0.0.** All Post Free.
Also available STEREO 10+10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT **£12.** POWER PACK KIT £3.10.0.
Circuit diagram, construction details and parts list (free with kit) **1/6.** (S.A.E.).

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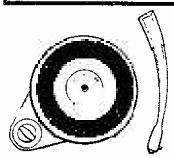

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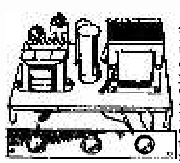

3-VALVE AUDIO AMPLIFIER HA34 MK II.
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½" w. × 4" d. × 4½" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm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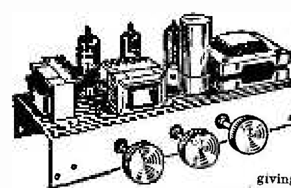

A.C. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up: —2 × ECL86 Triode Pentodes. 1 × EZ80 as full wave rectifier. Two Dual potentiometers are provided for bass and treble control, giving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

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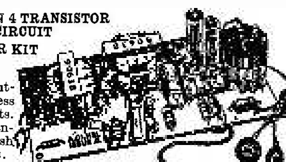
Type TA1



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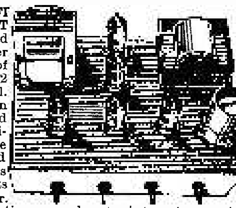

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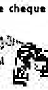

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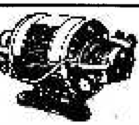

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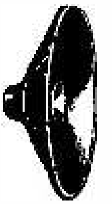

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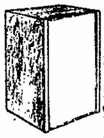

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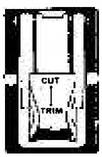
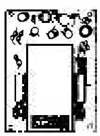


TAPE SPLICER/ EDITOR 19/6



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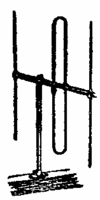

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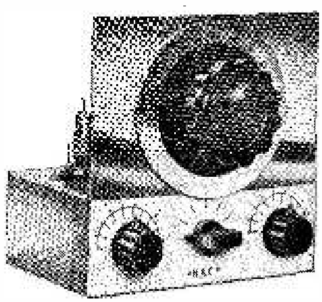

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PLEASE NOTE. To avoid any further increased Postal Charges to our Customers and enable us to keep our "By Return Postal service" which is second to none, we have re-organized and streamlined our Despatch Order Department and we now request you to send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

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PIV	750mA	3A	10A	30A
50	1/-	2/9	4/3	9/6
100	1/3	3/3	4/6	15/-
200	1/9	4/-	4/9	20/-
300	2/3	4/6	6/6	22/-
400	2/6	5/6	7/6	25/-
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	6/6	11/6	15/-	

TRIACS

VBOM	2A (TO-1)	6A (TO-66)	10A (TO-48)
100	14/-	15/-	22/6
200	17/6	20/-	28/-
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VBOM=Blocking voltage in either direction.

LUCAS 35A SIL.RECTS. Branded 400 PIV. Special Price, stud type, flying lead, **22/6** each.

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10 Amp. 3KV (3000 PIV) Stud Type with Flying Leads. **16/- each**

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PNP Sil. Plastic Trans. Similar to 2N3702, uncoded but fully tested, 1/6 each, 25-99, 1/3 each | 100 up, 1/- each.

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BP709C, Operational amplifier, 15/- each.
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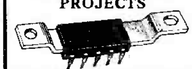

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T6	8	2G344A	OC44
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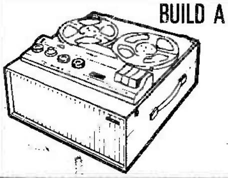

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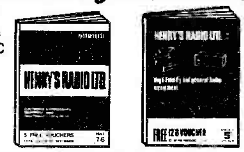

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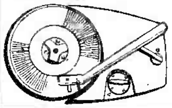

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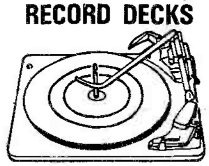

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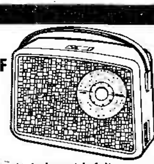

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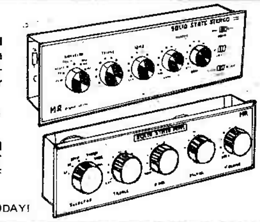

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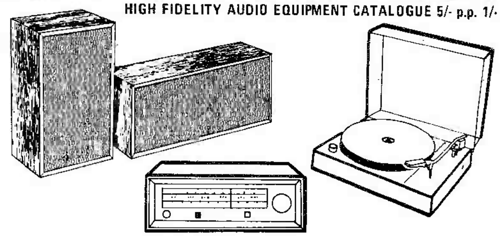

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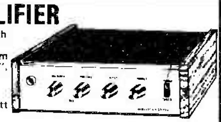

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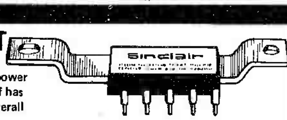
SINCLAIR EQUIPMENT



The SINCLAIR IC-10 is the worlds first monolithic intergrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself has an output power of 10 watts, yet with an overall size of 1 x 0.4 x 0.2 in.

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G.E. PA246*	52/6
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*Data sheets 3/6 set for these for others see catalogue.

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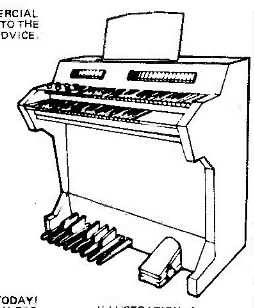

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