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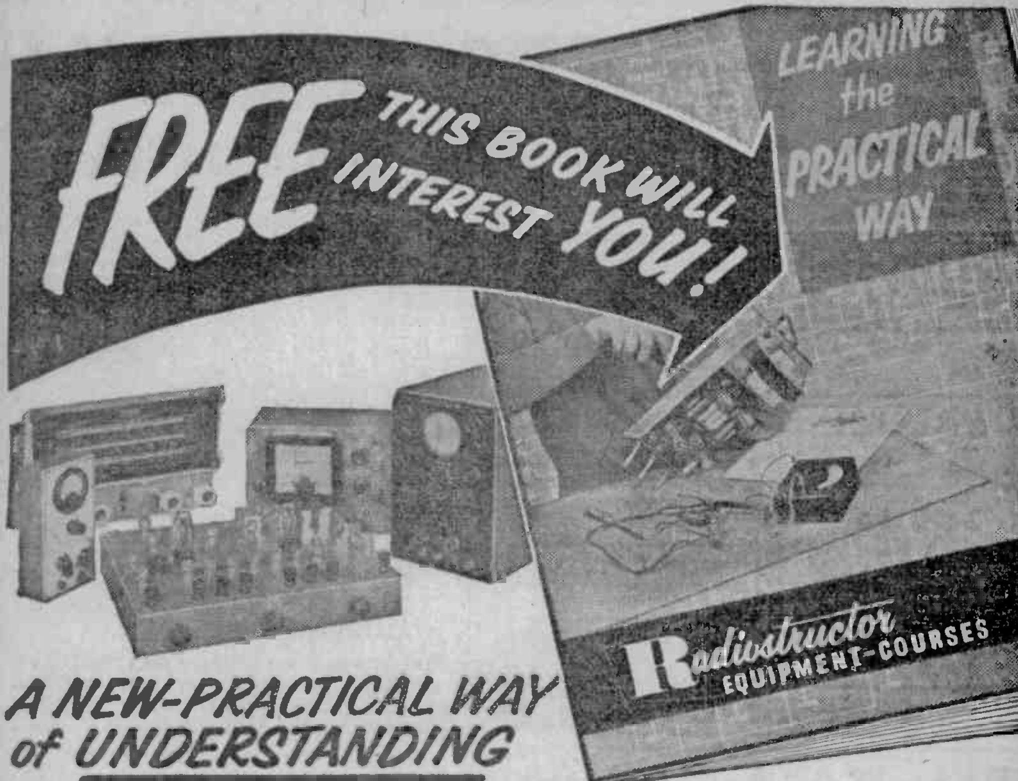

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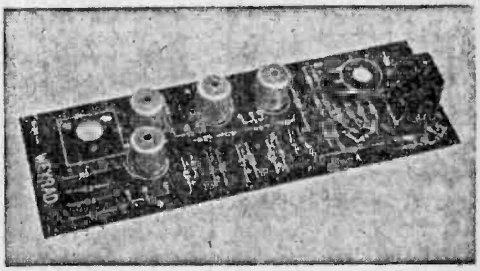

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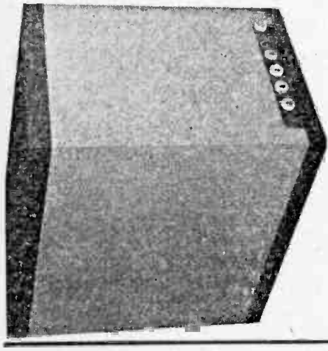
THE R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER



A MULTI-PURPOSE HIGH FIDELITY, HIGH OUTPUT UNIT FOR VOCAL AND INSTRUMENTALIST GROUPS

Eminently suitable for bass guitar and all other musical instruments

- ★ Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter speech coils. Designed for efficiently handling full output of amplifier at frequencies down to 25 c.p.s.
- ★ Dual Cone in second speaker reproduces frequencies up to 17,000 c.p.s.
- ★ Heavily made cabinet of convenient size 24 x 21 x 14in. has an exceptionally attractive covering in two contrasting tones of Vynair.
- ★ For 200-250 v. to 50 c.p.s. A.C. mains operation.
- ★ Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones.
- ★ Separate bass and treble controls providing more than adequate "Boost" or "Cut".
- ★ LEVEL frequency response throughout the audible range.
- ★ SUPERIOR TO UNITS AT TWICE THE COST.

39½ Gns. Send S.A.E. for leaflet. OR DEPOSIT of £4.3.0 and 12 monthly payments of £3.9.11. Carr. 17/6.

R.S.C. JUNIOR GUITAR AMPLIFIER 5-watt high quality output. Separate bass and treble "cut" and "boost" controls. Sensitivity 15 m.v. Two high impedance inputs. 10in. loudspeaker. Handsome. strongly made cabinet (size 14 x 14 x 7in. approx.) finished in attractive and durable polychrome. 200-250 A.C. mains operation. **£8.19.6** Or DEPOSIT £1 and 9 monthly payments of £1. Carr. 7/6.

LINEAR TREMOLO/PREAMP. UNIT Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. L.T. This applies to practically all amplifiers of our manufacture, and to those of several other manufacturers. The unit plugs into power supply point and any input socket of amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect), Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY **4 Gns.**

R.S.C. SENIOR Guitar Amplifier 14 watt high-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-up can be used at the same time. Two loudspeakers are incorporated. a 12in. high flux 14 watt bass unit, and a 6 x 4in. elliptical for treble. Cabinet is well made and finished as Junior Model. Size approx. 18 x 18 x 8in. Only **16 Gns.** Carr. 10/- Send S.A.E. for leaflet. Or DEPOSIT 37/- and nine monthly payments of 37/-.

ANNOUNCING THE R.S.C. B20 BASS GUITAR AMPLIFIER

A highly efficient unit incorporating a massive 15in. high flux loudspeaker specially constructed to withstand heaviest load conditions. Rating 25 watts. Individual bass and treble controls give ample "boost" and "cut". Two high impedance jack socket inputs are separately controlled. All controls are conveniently positioned in a recess on top of the cabinet. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair. Size approx. 24 x 21 x 13in. Operation from 200-250 v. 50 c.p.s. A.C. mains.
Send S.A.E. for leaflet.

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LEICESTER BRANCH NOW OPEN

TRANSISTOR SALE. Mullard OC71 3/9. OC45 4/11, OC44 4/11, OC72 4/9, OC81 4/11, OC171 8/9, Ediswan XA101 3/9, XB102 3/9, XA112 3/9, XB113 3/9, XB104 3/9, XC101A 3/9. Postage 6d. for up to 3 Transistors.

D.C. SUPPLY KIT. 12 v. 1 a. consisting of a partially drilled metal case, mains trans., F.W. Bridge Rectifier, 2 fuseholders and fuses. Change Direction switch, variable Speed regulator and circuit. For 200-250 v. A.C. mains. Suitable for Electric Trains. Limited number available at 29/11.

SELENIUM RECTIFIERS

F.W. BRIDGE		24 v. 2 amp.	.. 14/9
6/12 v. 1 a.	.. 3/11	24 v. 20 amp.	.. 89/9
6/12 v. 2 a.	.. 6/11	H.T. TYPES H.W.	
6/12 v. 3 a.	.. 9/9	150 v. 40 mA	.. 3/9
6/12 v. 4 a.	.. 12/3	250 v. 50 mA	.. 3/11
6/12 v. 6 a.	.. 15/3	250 v. 60 mA	.. 4/11
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CONTACT COOLED. 250 v. 75 mA. F.W. (Bridge). 10/11. 250 v. 50 mA. F.W. (Bridge). 8/11. H.W. 250 v. 60 mA. 5/11.

LINEAR TAPE PRE-AMPLIFIER Type LP/1, Switched Negative feedback equalisation Positions for Record 1⅞in. 3¾in., 7½in. and Playback. EM84 Recording Level Indicator. Designed primarily as the link between a Collaro Tape Transcriptor and a high fidelity amplifier, but suitable for almost any Tape Deck. Only 9 gns. S.A.E. for leaflet.

HUGE PURCHASE OF BRAND NEW 24 v. 20 Amp. F.W. (Bridge) SELENIUM RECTIFIERS. each **49/9**

HEAVY DUTY LOUDSPEAKERS IN SUBSTANTIAL REXINE COVERED CABINETS. Type BG1. Suitable for Bass Guitar. Speaker Unit 15in., High Flux, 15 ohms, 25 watts. Cabinet size approx. 24 x 21 x 13in. Only 19½ gns. Or Deposit 42/- and 12 monthly payments of 34/9. Type BG2. Suitable for Bass Guitar. Super Sensitive, 15in. 15 ohms high flux speaker. Cabinet size approx. 30 x 21 x 14in. Attractive covering of two contrasting tones of Rexine and Vynair. Rating 50 watts. Only 29 gns. Or Deposit £3.7.6 and 12 monthly payments of 50/-.
Type BG3/2. Suitable Bass and Lead Guitar. Two 12in. high flux 15 ohm 25 watt speakers. one with aluminium speech coil and dual code to provide smooth frequency response from 25 to 17,000 c.p.s. Cabinet size approx. 30 x 21 x 14in. Covered in two contrasting tones of grey Vynair and Rexine. Rating 50 watts. Only 29 gns. Or Deposit £3.7.6 and 12 monthly payments of 50/-.

LARGE REXINE COVERED SPEAKER CABINETS. Heavy blockboard construction. Very attractive two tone covering of Rexine and Vynair. Size 30 x 21 x 16in. cut for 15in. or 18in. speaker or for two 12in. 11 gns. or Deposit 25/9 and nine monthly payments 25/9. Size 30 x 30 x 16in. cut for 15in. or 18in. speaker 13 gns. or Deposit 30/4 and nine monthly payments 30/4. Suitable speakers available.

FANE ACOUSTICS 15in. HEAVY DUTY LOUDSPEAKER. High flux. 15 ohm 25 watt. Total flux 186,000 lines. Cast chassis. Suitable for Bass Guitar. Only 13 gns. or Deposit 31/6 and nine monthly payments 31/6.

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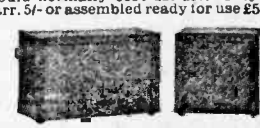
COMPLETE POWER PACK KIT, 19/11 Consisting of Mains Trans., Metal Rectifier. Double electrolytic, smoothing choke chassis and circuit. For 200-250 v. A.C. mains. Outputs 250 v., 60 mA, 6.3 v. 2 a.

R.S.C. POWER PACK, 39/9. Louvred metal case only 8 x 5½ x 2½ins. Stove enamelled. For 200-250 v. A.C. mains Output at 4 pin plug and socket 250 v. 60 mA. fully smoothed and 6.3 v. 2 a. Suitable for power requirements of almost any Pre-amp or Radio Tuner.

R.S.C. BABY ALARM or INTER-COMM. KIT. Complete set of parts with diagrams. etc. Housed in two polished walnut finished cabinets of pleasing design. High sensitivity. For 200-250 v. A.C. mains. Fully isolated. Controllable at both units. An Intercomm. of this class would normally cost £20-£30. Only 79/6, carr. 5/- or assembled ready for use £5.15.0.



EX. GOVT. SELENIUM RECTIFIERS 12v 15 AMP (BRIDGE) F.W. ONLY 19/9

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SENSATIONAL STEREO OFFER

(4 Gns.) A complete set of parts to construct a good quality Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and wiring diagrams supplied. Stereo Pick-up Head 19/9 extra with above only.

R.S.C. 30-WATT ULTRA LINEAR

HIGH FIDELITY AMPLIFIER A10

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 db down. Frequency response ±3 db. 30-30,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS**, etc. For use with Electronic **ORGAN, GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for a **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for 19/9. The amplifier can be supplied, factory built with EL34 output valves and 12 months' guarantee, for **14 gns.**

11 Gns. Carr. 10/-

Send S.A.E. for leaflet.

TERMS: DEPOSIT 33/9 and 9 monthly payments of 33/9.

Suitable microphones and speakers available at competitive prices.

WE STOCK ARMSTRONG, DULCI LINEAR and JASON EQUIPMENT GOODMANS W.B. AND FANE SPEAKERS

GARRARD AND GOLDRING T/TABLES

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner (specially suitable for use with our Amplifiers). Delayed A.V./C. Controls are Tuning, W/Ch. and Vol. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size approx. 9 x 6 x 7in. high. Simple alignment procedure. Point-to-point wiring diagrams, instructions and priced parts list with illustrations, **2/6.** Total building cost **£4.15.0.** S.A.E. for leaflet.

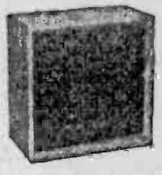
P.M. SPEAKERS. 10in. W.B. "Stentorian" 3 or 15 ohms type HF 1012 10 watts, hi-fidelity type. Recommended for use with our A11 Amplifier. £4.7.6. 12in. R.A. 3 ohms 10 watts (12,000 lines). **59/6.**

TWEETERS. Plessey 3Ω 19/9, 15Ω **25/9.**

Jason FMT1 V.H.F./F.M. Radio Tuner design. Total costs of parts including valves. Tuning dial, Escutcheon, etc., **£6.19.9.** Other Jason equipment in stock.

LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for any record playing unit, and most microphones. Negative feed-back 12 db. Separate Bass and Treble Controls. For mains 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Mullard valves EZ80, ECC83, EL84. Size only 7-5-5½in. high. Guaranteed 12 months. Only **£5.19.6.** Send S.A.E. for leaflet. Terms: Deposit 22/6 and 5 monthly payments of 22/6.

12in. 10 WATT HIGH QUALITY LOUDSPEAKER



In walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/-. Terms: Deposit 11/3 and 9 monthly payments of 11/3.

12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x 10in. Finish as above. Terms: Deposit **17/9** and 9 monthly payments of 17/9. Only **£7.19.6.** Carr. 8/6.

For larger types see page 201.

R.A. 12in. DUAL CONE 3 ohm 8 watt Speakers. Ideal for Stereo. Only **39/9 ea.**

R.S.C. 4-5 WATT A5 HIGH-GAIN AMPLIFIER

A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads, in addition to all other types of pick-ups and practically all "mikes". Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 db. down 15 db. of Negative feedback is used. H.T. of 300 v. 25 mA and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape-Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes full punched chassis (with baseplate) with Blue Hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4.15.0, or assembled ready for use 25/- extra. Plus 3/6 carr., or deposit 22/6 and 5 monthly payments of 22/6 for assembled unit.

NOW OPEN AT LEICESTER

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

THE SKYFOUR T.R.F. RECEIVER A design of a 3 valve long and medium wave 200-250 v. A.C. Mains receiver with selenium rectifier. High gain H.F. stage and low distortion detector. Valve line-up 6K7, SP61, 6V6G. Selectivity and quality excellent. Simple to construct. Point-to-Point wiring diagrams, instructions and parts list **1/9,** maximum building costs **£4.19.6.** inc. attractive walnut veneered wood cabinet 12 x 6½ x 5½in.

MULTI-METERS. CABY M1. Sensitivity 2,000 ohms per volt. A.C. and D.C. 54/-. **A.10.** Basic Meter sensitivity 155 micro-amps A.C. and D.C. ranges **£4.17.6. B.20.** Sensitivity up to 10,000 ohms per volt A.C. and D.C. **£6.10.0.** 30,000 ohms per volt **£8.19.6.**

R.S.C. JUNIOR HI-FI REPRODUCER. The very latest Goodmans Axiette 8 High Fidelity loudspeaker (retailing at approx. 5 gns.) fitted in a specially designed Bass Reflex cabinet size 12in. x 18in. x 10 in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency range 40-15,000 c.p.s. Power handling 6 watts nominal. Ideal for Stereo. Limited number. **8 Gns.** Carr. 4/6

R.S.C. BASS REFLEX CABINETS. JUNIOR MODEL. Specially designed or W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Handsome appearance. Ensure superb reproduction for only **£3.19.6.**

STANDARD MODEL. As above but for 12in. speakers. Size 20 x 15 x 13in. For vertical or horizontal use. **£5.19.6.** Suitable legs with brass ferrules, **19/6** per set of 4.

R.S.C. CORNER CONSOLE CABINETS

Polished walnut veneer finish. Pleasing design. **JUNIOR MODEL.** Size 20 x 11 x 8in. for 8 x 5in. or 10 x 6in. speakers. **£2.9.9. STANDARD MODEL.** Size 27 x 18 x 12in. for 8 or 10in. speakers. **£4.11.9. SENIOR MODEL.** Size 30 x 20 x 15in. for 12in. Speaker. Suitable Speaker systems below. Only **7 gns.**

AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker; cross-over unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating **£4.19.9.** Carr. 5/-. Or Senior 15 watt, **7 gns.** Carr. 7/6.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 and 90 v.** This includes low consumption types. Complete kit with diagrams, **39/9,** or ready to use, **46/6.**

Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA and 2 v. 0.4 a. to 1 amp. fully smoothed. Thereby **completely replacing both H.T. batteries and L.T. 2 v. accumulators when connected to A.C. mains supply** 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulators. Complete kit of parts with diagrams and instructions, **49/9,** or ready for use, **59/6.**

AUDIOTRINE EQUIPMENT CABINETS

Size 36 x 15 x 18in. Beautiful walnut veneered finish. Elegant contemporary design. Robust construction. Uncut removable baseboard Depth above baseboard 5½". Only **12½ gns.** Carr. 15/-

Terms: Dep. **29/9,** and 9 mthly. pymts. **29/9**

AUDIOTRON HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6

REALISM AT INCREDIBLY LOW COST, CAN BE ASSEMBLED IN AN HOUR

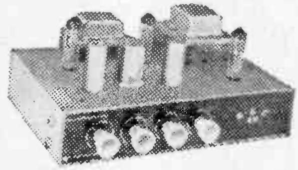
Incorporating the latest Collaro Studio Tape Transcriptor. The audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, size 14¼ x 15 x 8¼in. high and circuit. Total cost if purchased individually approximately £40. Performance equal to units in the £60-£80 class. S.A.E. for leaflets. **TERMS. Deposit £2.13.9** and 12 monthly payments of **44/-**. Cash price if settled in 3 months.

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

SPECIAL NOTE. The Tape Decks we supply are latest models. Where customers already have a Deck or wish to use one of those being offered cheaply we can supply Kit less Deck at **13 gns.** carr. 10/-. Or deposit 2 gns. and 12 monthly payments 23/9. Also if required we can supply in lieu of portable cabinet and 7 x 4in. speaker, the Equipment Cabinet illustrated at foot of opp. page and a high flux 8¼ x 5¼in. speaker for 8½ gns. extra.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES

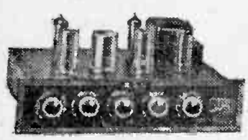


Two input sockets with associated controls allow mixing of "mike" and gram., as in A.10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS**. For **MUSICAL INSTRUMENTS** such as **STRING, BASS, LEAD OR RHYTHM GUITARS**, etc. **OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-
(Or factory built 51/- extra.)
If required louvred metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9** and 9 monthly payments of **24/9**. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speaker, Microphones, etc., with cash and credit terms.

B.S.R. MONARDECK TAPEDECKS. Speed 3¾in. per sec. With high quality recording heads. £6.19.6. Carr. 5/-. Cabinets to take Deck and amplifier 39/6.

R.S.C. TRANSISTORISED GRAM. AMPLIFIER. Output 1 watt, for 3ohm speaker. Transistors Mullard OC71, OC81D, OC81, OC81. Fitted Vol. Control with switch. Assembled and tested. Suitable for any normal crystal pick-up. Only **59/9.**

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER



A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts, suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation of "lift" and "cut". Provision is made for use as straight (monaural) 10-watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-.
Kit can be supplied assembled ready to use for 59/6 extra.

HI-FI CRYSTAL PICK-UP HEADS. (Cartridges.) Acos Standard replacement for Garrard, B.S.R. and Collaro. **16/9.** Acos Stereo-Monaural **29/9.** Ronette Stereo-Monaural **59/6.** B.S.R. Stereo **39/9.**
BRADMATIC RECORDING HEADS. High Impedance Record/Playback 22/-. Low Impedance Erase. **12/6.**
PICK-UP ARMS. Complete and with latest Acos/hi-fi Turnover Cartridge **29/11.**
CRYSTAL MICROPHONES. Hand type NP110 **14/9,** R.T.C. **19/9.** Acos Mic 40 **25/9.** Acos Mic 45 **29/9.** Stick type Acos 39-1 **39/9,** BM3 with neck band and heavy table stand **59/9.** Lapel type **35/9.**
COLLARO JUNIOR 4-speed Single Player Unit and Crystal Pick-up with hi-fi Turnover head. Only **£3.19.6.**
B.S.R. UA14 4-sp'd AUTO-CHANGERS with hi-fi turnover head. **£6.19.6.** Carr. 4/6.
GARRARD AUTO-SLIM 4-SPEED AUTO-CHANGER with high fidelity pick-up. Latest model For 200-250 v. A.C. mains. **£7.19.6.** Carr. 4/6.
GARRARD AT6 AUTO-SLIM DE-LUXE 4-SPEED AUTO-CHANGERS. Turnover GC8 head. for 200-250 v. A.C. mains. **11 gns.**
GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER. For use with any single or auto-change unit. Output for 2-3 ohm speaker. For 200-250 v. A.C. mains. Size 11¼ x 2¼ x 2¼in. Controls: Vol. and Tone with switch. Only **59/6.**

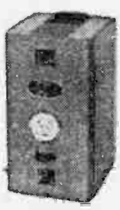
R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months.

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps. variable output. Consisting of Mains Transformer 0-200-230-250 v.; F.W. (Bridge) Selenium Rectifier; Ammeter, Variable Charge Rate Selector Panels, Plugs, Fuses, Fuseholder and circuit. **59/9.** Carr. 4/6.

CHARGER KIT. 12v. 14 AMP or 24v. 7 amp. Consisting of mains trans. 200-230-250 v. F.W. (Bridge) selenium Rectifier, F Ammeter, Fuses, Variable Resistor and Circuit. Only **6 gns.** Carr. 15/-. Please state if 12v. or 24v. kit required.

SOLDERING IRONS. 230-250 v. 30 watts. First quality. For Radio work, **18/9.** Spare elements and bits available.



Assembled 4-5 amps. 6/12 v.
Fitted Ammeter and variable charge rate selector. Also selector plug for 6 v. or 12 v. charging. Louvred steel case with stoved blue hammer finished. Fused and ready for use with mains and output leads. **69/9** Carr. 5/-. Terms: Deposit 13/3 and 5 monthly payments 13/3. 6/12 v. 3a., all facilities as above. Only 59/9, carr. 3/9.

ASSEMBLED 6/12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case finished attractive hammer blue. Fused, ready for use with mains and output leads **49/9** Carr. 3/9
6/12 v. 1 amp. **27/9** Less meter.

ASSEMBLED 12V. 10 Amp with variable charge rate adjustment, ammeter and strong louvred, stove enamelled case. Ready for use. Only **7 gns.** Carr. 10/- or in Kit Form 5 gns.

BATTERY CHARGER KITS Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses. Fuse-holders. Grommets, panels, Heavy Duty Clips, circuit. Carr. 3/6 extra.

6v. or 12v. 1 amp.	22/9
As above, with Ammeter	28/9
6 v. 2 amps	19/9
6v. or 12v. 2 amps	25/9
6 v. or 12 v. 2 amps, inclusive of Ammeter	35/9
6 v. or 12 v. 4 amps	45/9
6 v. or 12 v. 4 amps. with Ammeter and variable charge rate selector	52/9

CHARGER AMMETERS 0-1.5 a., 0-3 a., 0-4 a., 0-7 a., 0-60 a., **8/9.**

R.S.C. MAINS TRANSFORMERS (FULLY GUARANTEED)

Interleaved and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened

TOP SHROUDED DROP THROUGH

250-0-250v. 70mA. 6.3v. 2a, 0-5-6.3v. 2a	17/9
350-0-350v. 80mA. 6.3v. 2a, 5v. 2a	18/9
250-0-250v. 100mA. 6.3v. 2a, 6.3v. 1a	21/9
250-0-250v. 100mA. 6.3v. 3.5a, C.T.	19/9
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	25/9
300-0-300v. 130mA. 6.3v. 4a, 6.3v. 1a, for Mullard 510 Amplifier	29/9
300-0-300v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	26/9
350-0-350v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	26/9
350-0-350v. 150mA. 6.3v. 4a, 0-5-6.3v. 3a	29/9
425-0-425v. 200mA. 6.3v. 4a, 5v. 3a	49/9

FULLY SHROUDED UPRIGHT

250-0-250v. 60mA. 6.3v. 2a, 0-5-6.3v. 2a. Midget type 2½-3-3in.	17/11
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	27/9
300-0-300v. 100mA. 6.3v. 4 a, 5v 3a	27/11
300-0-300v. 130mA. 6.3v. 4a, C.T. 6.3v. 1a, for Mullard Amplifier	33/9
350-0-350v. 100mA. 6.3v. 4a, 5v. 3a	27/11
350-0-350v. 150mA. 6.3v. 4a, 5v. 3a	35/9

FULLY SHROUDED (continued)—

425-0-425v. 200mA. 6.3v. 4a, C.T. 5v. 3a	55/-
425-0-425v. 200mA. 6.3v. 4a, C.T., 6.3v. 4a, C.T., 5v. 3a.	59/9
450-0-450v. 250mA. 6.3v. 4a, C.T. 5v. 3a	69/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	4/6
Small Pentode, 5,000 Ω to 3 Ω	4/6
Small Pentode 7/8,000 Ω to 3 Ω	4/6
Standard Pentode 5,000 Ω to 3 Ω	5/9
Standard Pentode 7,000 Ω to 3 Ω	5/9
10,000 Ω to 3 Ω	5/9
Push-Pull 8 watts, EL84, or 6V6 to 3 Ω or matched to 15 Ω	9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 or 15 Ω	19/9

Following types for 3 and 15 Ω speakers:

Push-Pull 10-12 watts 6V6 or EL84	18/9
Push-Pull 15-18 watts, 6L6, KT66	22/9
Push-Pull Mullard 510 Ultra Linear	29/9
Push-Pull 20 watts, sectionally wound, 6L6, KT66, EL34, etc.	49/9

MIDGET MAINS Primaries 200-250 v. 50 c/s.

250 v. 60 mA, 6.3 v. 2a.	11/9
250-0-250 v. 60 mA, 6.3 v. 2a	12/11

Both above size 2⅝ x 2⅝ x 2⅝ins.

FILAMENT TRANSFORMERS All with 200-250 v. 50 c/s. primaries 6.3 v. 1.5a. 5/9; 6.3 v. 2a. 7/6; 0-4-6.3 v. 2a, 7/9; 12 v. 1 a. 7/11; 6.3 v. 3 a. 8/11; 6.3 v. 6 a. 17/6; 12 v. 1.5 a. twice, 17/6.

SMOOTHING CHOKES

150 mA, 7-10 H H 250 ohms	11/9
100 mA, 10 H 200 ohms	8/9
80 mA, 10 H 350 ohms	5/9
60 mA, 10 H 400 ohms	4/11

CHARGER TRANSFORMERS All with 200-230-250 v. 50 c/s Primaries; 0-9-15 v. 1½ a. **12/9;** 0-9-15 v. 2a. **14/9;** 0-9-15v. 3 a., **16/9;** 0-9-15 v. 5 a., **19/9;** 0-9-15 v. 6 a. **23/9;** 0-9-15 v. 8a. **28/9.**

AUTO (Step up/Step down) TRANS. 0-110/120-230/250 v. 50-80 watts. **13/9;** 250 watts. 39/9; 150 watts. 27/9.

MICROPHONE TRANSFORMERS 120 : 1 high grade, clamped. **6/9;** 120 : 1 Plotted. Mu-metal screened. **9/9.**

SURBITON PARK RADIO LTD.

FOR POST HASTE—POST FREE SERVICE

MARTIN RECORDAKITS

HALF TRACK

B.S.R. TD2 Monardeck, latest model 5¾in. spool ... £9.9.0
Deposit £1.0.0 and 9 monthly ... £1.1.0

Tape Amplifier for B.S.R. deck, printed circuit ready wired, with ECC83, ECL82, EM85 and EZ81. Complete with all plugs, sockets, panes, knobs, etc. The whole amplifier mounts on to the deck, making a self-contained unit ... £8.8.0
Deposit £1.0.0 and 8 monthly ... £1.1.0

Case with 7in. x 4in. speaker, in two tone grey ... £4.4.0

Complete Kit as above ... £22.0.0
Deposit £2.4.0 and 12 monthly ... £1.16.6

The above recorder can be supplied assembled, tested and complete with tape and microphone for ... £25.0.0
Deposit £2.10.0 and 12 monthly ... £2.1.6

Collaro Studio Deck. Very latest model 3 speeds 7in. spools ... £12.10.0
Deposit £1.5.0 and 12 monthly ... £1.0.8

Tape Amplifier for studio deck, with ready wired printed circuit control and input panels, mains and output transformers. Complete with valves, knobs, plans, screws, etc. EF86, ECC83, EM84, EZ81, OA81 and 2 EL84. 3 watts output. Magic eye, radio and mic. inputs, EX L/S socket, tone and monitor controls. Can be used as an amplifier ... £11.11.0
Deposit £1.4.0 and 12 monthly ... 19/-

Case for above including 9in. x 5in. speaker ... £5.5.0

Total Kit as above ... £29.0.0
Deposit £2.18.0 and 12 monthly ... £2.8.2

We can offer the above recorder, complete with tape and microphone, in a De Luxe two tone grey cabinet, assembled for ... £35.0.0
Deposit £3.10.0 and 12 monthly ... £2.18.2

This Machine is listed at 39 gns. by makers and is a very good buy.
Building Instructions available at 2/6 each kit (refunded if kit bought.)

QUARTER TRACK

B.S.R. TD2 ... £11.11.0
Deposit £1.4.0 and 12 monthly ... 19/-

Tape Amplifier as above, but quarter track ... £9.9.0
Deposit £1.0.0 and 9 monthly ... £1.1.0

Case, two tone grey, with speaker ... £4.4.0

Complete Kit as above ... £25.0.0
Deposit £2.10.0 and 12 monthly ... £2.1.6

Collaro Studio Deck, 4 track ... £17.17.0
Deposit £1.17.6 and 12 monthly ... £1.9.5

Tape Amplifier, as above, but 4 track ... £12.12.0
Deposit £1.7.0 and 12 monthly ... £1.0.8

Case with 9in. x 5in. speaker ... £5.5.0

Complete Kit 4 track Collaro ... £35.0.0
Deposit £3.10.0 and 12 monthly ... £2.18.2

Tape Pre-amplifier for Collaro deck, with power supplies, ECC83, ECL82, EZ80 and EM85, Radio and Mic. sockets, gives an equalised output of 400 m/Volts.

Half Track ... £8.8.0
Deposit £1.0.0 and 8 monthly ... £1.1.0

Quarter Track ... £9.9.0
Deposit £1.0.0 and 9 monthly ... £1.1.0

Bradmatic R/PB and Erase on Collaro bracket ¼ track ... £1.19.6

Bradmatic R/PB, Ideal 3rd head Collaro deck ¼ track ... £1.12.6
Pressure pad (Studio deck only) ... 4/0

Brenell Mk.5 deck, ¼ track, 4 speeds ... £29.8.0
Deposit £3.1.6 and 12 monthly ... £2.8.7

Brenell Mk. 5 Amplifier, with power ... £24.0.0
Deposit £2.8.0 and 12 monthly ... £1.19.10

JASON F.M. TUNERS

FMT1, complete with valves ... £6.17.6
Deposit £1.1.0 and 6 monthly ... £1.2.9

FMT2, complete with valves, Less Power ... £7.17.6
Deposit £1.0.0 and 7 monthly ... £1.2.6

FMT2, complete with valves, Self powered ... £9.15.0
Deposit £1.0.0 and 9 monthly ... £1.1.8

FMT3, complete with valves, Less power ... £9.12.6
Deposit £1.0.6 and 9 monthly ... £1.1.4

FMT3, complete with valves, Self powered ... £12.0.0
Deposit £1.4.0 and 12 monthly ... 19/10

Power pack kit ready drilled chassis for FMT1, etc. ... £2.12.6
The instruction books are included in all kits but are otherwise 2/6.

JTV/2, switched F.M. and TV. Sound self powered. All valves ... £14.15.0
Deposit £1.9.6 and 12 monthly ... £1.4.5

Mercury 2 as JTV/2 but less power, with all valves ... £10.15.0
Deposit £1.1.6 and 12 monthly ... 17/10

The instruction book is again included but is otherwise 3/6.
All the above units are available ready built and aligned. Price on request.

RADIO TUNERS

Armstrong T4 C. V.H.F. Tuner self powered ... £17.19.0
Deposit £1.19.6 and 12 monthly ... £1.9.5

Armstrong ST3 Mk2. AM/FM self powered ... £25.12.0
Deposit £2.13.0 and 12 monthly ... £2.2.4

Armstrong AF208 AM/FM Radio chassis, Bass and Treble controls. P.U. inputs etc. ... £21.4.0
Deposit £2.6.0 and 12 monthly ... £1.14.10

Armstrong Jubilee Mk2. AM/FM Push Pull Output stage. Bass and Treble ... £28.5.0
Deposit £2.16.6 and 12 monthly ... £2.6.11

Armstrong Stereo 55, AM/FM Radio chassis, with stereo gram. Bass and Treble etc. ... £29.18.0
Deposit £3.2.6 and 12 monthly ... £2.9.5

Armstrong Stereo 12 Mk2. AM/FM Radio chassis. Stereo gram. Push pull output ... £40.5.0
Deposit £4.0.6 and 12 monthly ... £3.6.11

Brass escutcheon available for AF208 and Jub. Mk2 ... 7/6

Pye HFT109. FM tuner self powered ... £23.12.6
Deposit £2.9.6 and 12 monthly ... £1.19.0

Pye HFT113, AM/FM Tuner self powered ... £28.7.0
Deposit £2.18.6 and 12 monthly ... £2.6.11

Quad F.M. Tuner un-powered ... £24.18.9
Deposit £2.13.3 and 12 monthly ... £2.1.1

AMPLIFIERS (MONO)

Linear L45 Three valve amplifier ... £5.19.6

Linear Diatonic Five valve, push pull ... £12.12.0
Deposit £1.7.0 and 12 monthly ... £1.0.8

Linear Concord 30 watt with case ... £18.0.0
Deposit £1.16.0 and 12 monthly ... £1.9.10

Tripletone Hi Fi Major, with Pre-amp ... £15.18.9
Depost £1.15.3 and 12 monthly ... £1.6.1

Pye Mozart, including Pre-amp. 10 watt ... £25.4.0
Deposit £2.10.6 and 12 monthly ... £2.1.11

Leak TL 12. Main amp. only 10 watt ... £18.18.0
Deposit £2.0.6 and 12 monthly ... £1.11.1

Leak Varislope 111 Pre-amplifier ... £15.15.0
Deposit £1.11.6 and 12 monthly ... £1.6.1

Quad Main amp. only 15 watt ... £22.10.0
Deposit £2.5.0 and 12 monthly ... £1.17.4

AMPLIFIERS (STEREO)

Dulci AC202. Integrated ... £12.12.0
Deposit £1.7.0 and 12 monthly ... £1.0.8

Dulci GA505. Integrated ... £18.18.0
Deposit £2.0.6 and 12 monthly ... £1.11.1

Rogers Cadet Mk2, with Pre-amplifier ... £26.15.0
Deposit £2.13.6 and 12 monthly ... £2.4.5

Leak Stereo 20 Main amplifier ... £30.9.0
Deposit £3.4.6 and 12 monthly ... £2.10.3

Leak Varislope 111 Stereo Pre-amplifier ... £25.0.0
Deposit £2.10.0 and 12 monthly ... £2.1.6

Quad 22 Stereo Control unit. Pre-amplifier ... £25.0.0
Deposit £2.10.0 and 12 monthly ... £2.1.6

GRAMOPHONE UNITS

Garrard SRP10 with G.C8 mono cartridge ... £9.0.11

B.S.R. UA14 TC8 cartridge ... £6.19.6
Deposit £1.0.0 and 6 monthly ... £1.3.3

Garrard Autoslim Mono cartridge ... £7.17.0
Deposit £1.0.0 and 7 monthly ... £1.2.6

Garrard Autoslim De Luxe Mono cartridge ... £11.9.0
Deposit £1.6.6 and 9 monthly ... £1.4.9

Philips AG1016 with Stereo cartridge ... £12.12.0
Deposit £1.7.0 and 12 monthly ... £1.0.8

Decca Deram Arm only ... £5.5.0

Decca Deram Transcription cartridge ... £4.14.6

Decca Deram Auto cartridge ... £3.13.6

Goldring GL58, with arm, less cartridge ... £15.19.8
Deposit £1.12.0 and 12 monthly ... £1.6.6

Goldring '88' Transcription, no pick up ... £17.14.0
Deposit £1.19.0 and 12 monthly ... £1.9.0

Goldring GL55X as GL58 but less P.U. arm ... £13.1.7
Deposit £1.7.7 and 12 monthly ... £1.1.8

Garrard 4HF with Mono cartridge ... £17.0.0
Deposit £1.14.0 and 12 monthly ... £1.8.2

Garrard Lab: Type 'A' Auto-changer. Mono ... £19.14.9
Deposit £1.19.6 and 12 monthly ... £1.12.9

Garrard 301 ... £20.12.2
Deposit £2.3.2 and 12 monthly ... £1.14.0

Garrard 301 Strobe ... £22.0.0
Deposit £2.4.0 and 12 monthly ... £1.16.6

LOUDSPEAKERS

Goodmans Axiette 8 ... £5.5.7

Goodmans Axiom 10 ... £6.5.11

Goodmans Axiom 201 ... £10.7.0
Deposit £1.1.0 and 8 monthly ... £1.5.9

Goodmans 5H/20/XL Tweeter with cross over ... £7.0.0

Wharfedale RS12/DD 12in. full range ... £11.10.0
Deposit £1.7.6 and 9 monthly ... £1.4.9

Whiteley Electrical W.B. H.F. 1012 10in. ... £4.7.6

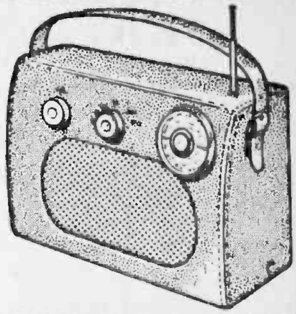
48 SURBITON ROAD, KINGSTON UPON THAMES, SURREY

Established over 30 years
Telephone KIN 5549

We pay all postage and insurance. All orders despatched same day. Money refund guarantee.
Hours: 9 a.m.–6 p.m. (1 p.m. Wednesday). We do not close for lunch. Open all day Saturday.

"ROAMER-7 MK. II" (5 Wavebands)

PERFORMANCE WILL AMAZE YOU!



★ (7 Transistor plus 2 Diode design)

★ Med/Long Waves, Trawler Band and 2 S.W. to approx. 17 metres.

★ Rich-toned heavy duty 5in. Speaker.

★ Fine for car radio use.

★ Telescopic aerial for S. Waves & T.B.

★ FERRITE ROD AERIAL FOR M/L.

★ Full After Sales Service.

★ Air spaced ganged Tuning Condenser.

★ No alignment problems.

Total cost of parts **£7.9.6** P.P. 5/6.

Less case and dial £5.19.6. P. & P. 3/-

★ Push-Pull output for room filling volume.

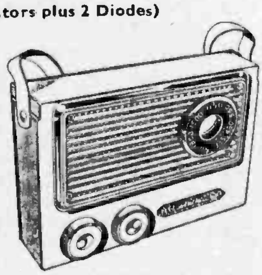
★ Simulated hide case saddle stitched, with golden trim and with shoulder & hand straps.

★ Case size 9 x 7 x 4in. approx.

★ Parts price list and data 3/-.

THE SUPER SEVEN

★★ (7 Transistors plus 2 Diodes)



★ 2 R.F. STAGES.

★ Coverage of Medium, Long Waves, Trawler Band.

★ Telescopic aerial for Trawler Band.

★ Use as domestic radio, car radio or fit with strap for carry-about.

★ No aerial required.

★ 3-inch speaker but will drive a larger speaker.

★ Push-Pull Output.

SIZE: 7½ x 5½ x 1½in.

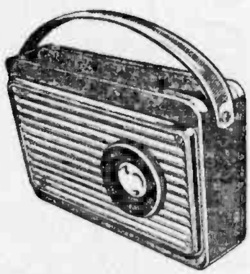
May be built for **£6.5.0** plus 3/6 post, etc.

PARTS PRICE LIST AND EASY BUILD PLANS 2/-

NEW TRANSONA-6

★ (6 Transistors, plus 2 Diodes, 8-Stage)

★ MW/LW



Powerful magnet 3in. high grade speaker. Push-pull transformers. This is a top performing receiver. Many stations listed in one evening including Luxembourg loud and clear. A pleasure to listen to. **FERRITE ROD AERIAL.** All parts sold separately, grille in red. Uses 9 volt battery.

Total building cost **£3.19.6** P.P. 3/-. Size 6½ x 4½ x 1½in.

"Luxembourg as loud as local. Your easy build diagram helped a lot . . . my first attempt."—H. S., Penzance, Cornwall (poor reception area).

PARTS PRICE LIST AND EASY BUILD PLANS 1/6

All components used in our receivers may be purchased separately if desired.

AFTER SALES SERVICE

Radio Exchange Co.

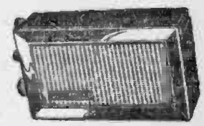
27 HARPUR STREET, BEDFORD

Phone: 2367

10 a.m.—1 p.m. Sat. Opp. Co-op.

"POCKET-5"

MW/LW and TRAWLER BAND (7 Stages)
(5 Transistors, plus 2 Diodes)



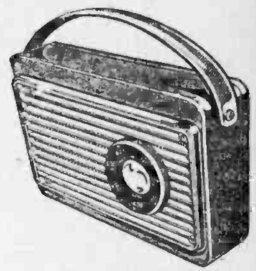
Designed round supersensitive **FERRITE ROD AERIAL** and fine tone moving coil speaker. Attractive case in black with speaker grille in red. On test, Home, Light, Radio Luxembourg and many Continental stations were received.

Total cost of all parts required **£2.19.6** P.P. 3/-.

EASY BUILD PLANS AND PARTS PRICE LIST 1/6

PUSH-PULL FIVE

(5 Transistors, plus 2 Diodes, 7 Stage)



★ 2¾in. Super-tone Loudspeaker.

★ Ferrite rod aerial.

★ Tuning condenser.

★ Volume control.

★ Case with speaker grille in red.

★ Fully tunable over med/long waves.

★ Simple assembly diagrams.

★ Push-pull output.

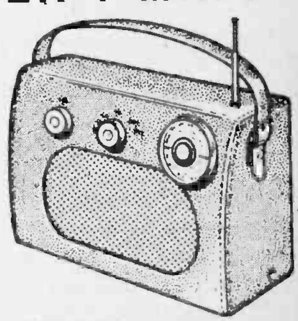
Can be built for **59/6** P.P. 3/-.

★ PARTS PRICE LIST, etc., 2/-.

"Home, Light, AFN, Lux., all at good volume."—G. P., Durham.

"ROAMER-7 MK. I"

5 Wavebands
(M/L, T.B. and 2 S.W.)

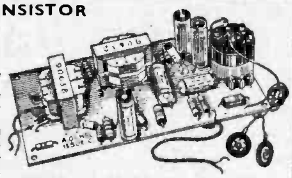


Uses 6 top grade transistors plus 2 diodes. 5in. Speaker. Ferrite rod aerial for sensitivity. Telescopic aerial for short waves. Handsome case with gilt fittings size 9 x 7 x 4in. approx. Listen to stations half a world away.

Total cost of parts **£6.19.6** Post & Packing 5/6.

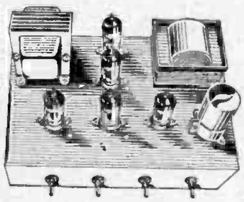
Plans, parts price list 3/-.

HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-** P. & P. 2/6.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded ultra output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts).

All parts sold separately. **ONLY £6.19.6** P. & P. 6/6.

AMPLIFIER ON PRINTED CIRCUIT BOARD
Two valve. UY85, UL84 O.P. trans., use with 80 volt tap off motor. 39/6. P.P. 2/6 on above. Dropper res. for filaments if required. 2/6.

B.S.R. AUTO UNITS
160 v. Suitable for use with above. (Slightly soiled.) £4.4.0.

UNREPEATABLE OFFER!
BRAND NEW 8" x 5" 3 OHM SPEAKERS
By well known maker
10/6 each.
P. & P. 1/6 per speaker
A pair of these are ideal for Stereo

LARGE CABINET Suitable for above two items. Complete with 3 ohm speaker. £3.9.6. Carr. 5/-.

Superior CABINET Similar to above to take 8 x 5in. speaker, with motor board, will accommodate BSR UA14 or UA16. £3.9.6. Carr. 5/6. Speaker 15/- extra. P. & P. 1/6 extra.

BRAND NEW 3 OHM LOUDSPEAKERS
2½in. 12/6; 5in. 12/6; 6½in. 15/-; 8in. 21/-; 10in. 25/-; 12in. 27/6.

Goodmans 5in. tweeter ..	10/6
E.M.I. 2½in. tweeter ..	10/6
E.M.I. 10in. x 6in. ceramic magnet	25/-
E.M.I. 13½in.x8½in. high flux	32/6
Rola Celestion approx. 9in. x 6in. middle register speaker	10/6

Also 15 ohm 12in., 30/-
P. & P. 1/6 per speaker.

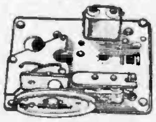
RECORDING TAPE
P.V.C. base, full frequency L.P. tape. 7in., 1800ft. (normally 50/-) 27/6; 5¾in., 1,200 ft. (normally 35/-), 18/9. 5in., 900ft. (normally 28/-), 15/-. P. & P. 1/- per spool. Ideal for 2 or 4 track recorder.

TAPE DECKS
COLLARO STUDIO DECK
£10.10.0. plus 5/6 carr. and ins.
B.S.R. MONARDECK
(Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, £6.15.0 plus 5/6 carr. and ins. (Tapes extra on both).

SPECIAL PURCHASE! TURRET TUNERS
by famous maker

Brand new and unused. Complete with PCC84 and PCF80 valves, 34-38 Mc/s I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied.
ONLY 25/- each. P.P. 2/6.

F.M. TUNER HEAD



A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) and drum and spindle, 18/6, plus 1/9 P. & P. Valve 8/6 extra. Drum and spindle 3/6 extra.

GÖRLER F.M. TUNER HEADS
10.7 Mc/s I.F.
15/-, plus 1/9 P. & P.
(ECC85 valve, 8/6 extra.)

E.M.I. 4-speed Player and P.U.
FURTHER HUGE PURCHASE enables us to offer these at **67/6** P. & P. 4/6.

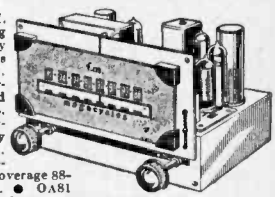
Heavy 8½in. metal turntable. Low flutter performance 200/250V shaded motor with tap at 45 V for amplifier valve filament if required. Turnover LP/78 head.

RECORD PLAYER AMPLIFIER
2 valve (EZ80, ECL82), A.C. mains, 3 watts output, ready built, tested and complete with valves and output transformer. Size 7in. w. x 2½in. d. x 5½in. h. 55/-, P. & P. 3/-. Suitable speakers: 6in. 15/- or 10 x 6in. 25/-. P. & P. 1/6 on each.

4-SPEED PLAYER UNIT BARGAINS
SINGLE PLAYERS
TU/12, £3.10.0. Carr. 3/6.
AUTO CHANGERS
B.S.R. UA14, £6.2.6.
Latest B.S.R. UA16, £7.2.6.
Latest Garrard "Auto-Slim" £6.17.0. Carr. 5/- on each.

SPEAKER & CABINET FABRICS
Oatmeal fabric for speaker or cabinet or Red rexine for cabinet 54in. wide, 13/6 per yard length. P. & P. 1/6.

HARVERSON'S F.M. TUNER Mk.I



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage 88-100 Mc/s. ● OA81 balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5½in. ● All parts sold separately. Set of parts if purchased at one time £5.19.6, plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. Mark II Version as above but complete with magic eye, front panel and brackets, £6.12.6. P. & P. 8/6.

Mark III Version as Mark I but with output stage (ECL82) and tone control. £7.7.0. P. & P. 8/6.

Handsome Metal Cabinets. Choice of Grey, Black or Green. To fit Mark I, 25/-, P. & P. 2/6. To fit Mark II, 17/6, P. & P. 2/6.

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 waveband transistor superhet. ● Printed circuit panel (size 8½ x 2¾in.) ● 3 pre-aligned I.F. transformers. ● High-gain Ferrite rod aerial. ● All First-grade transistors. ● Car aerial winding. ● Push-pull output. ● All parts supplied with simple instructions.

All parts sold separately
Set of parts if purchased at one time.

ONLY £4.5.0 P. & P. 2/6

35 OHM SPEAKERS
Suitable for use with above.
2in. Goodmans. Ideal replacement for most pocket portables 8/6; 2½in. 10/6; 3½in. 12/6; 5in. 17/6; 7 x 4in. 21/-.
P. & P. 1/6 per speaker.

Portable CABINET
Size approx. 9½ x 6½ x 3½in. Suitable for above using 3½in. speaker. 25/-. P. & P. 2/-.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET
3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and aerial coupling), 28/6 complete, post 1/-. 6 transistor printed circuit, board to match, 8/6, post 9d. Circuit diagram 1/6 extra.

QUALITY RECORD PLAYER AMPLIFIER
A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs ECC83, EL84, EZ80 valves. Bass, treble and volume controls. On/off controls.

PRICE 69/6 P. & P. 3/6

DITTO. Mounted on board with output transformer and 6½in. speaker.
Complete at 89/6, P. & P. 4/6.

TRANSISTORS
GET15 (Matched Pair) 15/-

OC71	5/-	PXA101 ..	6/6
OC72	6/-	XA103 ..	6/6
OC76	6/-	V15/10p ..	12/6

Set of Mullard 6 transistors, OC44, 2—OC45, OC81D, matched pair OC81. 25/-. All Post Free.

SPECIAL BARGAIN OFFERS!
MAINS TRANSFORMERS. Tapped Primary. ½ wave or Bridge Rectifier. Secondary 250 v. at 75 mA 6.3 volts at 2 amps. 10/6 each. P. & P. 3/-.

TWO GANG .0005 TUNING CONDENSER. Geared precision reduction drive. Size 2⁷⁄₁₆ x 2 x 1¾in. Brand new and unused. 3/6 each. P. & P. 1/-.

MAINS TRANSFORMER. Impregnated and fully shrouded. Size 4½ x 3½ x 2¾in. Weight 6 lbs. Tapped primary 205, 225, 245v. Electrostatic screen. Output 360-0-360 v. at 120 m/a D.C. plus 1050 v. half wave at 3 m/a D.C. 6.3 v. at 3.5 amps centre tapped 5 v. at 2½ amps and 6.3 v. at .6 amps PRICE ONLY 21/- each. P. & P. 5/-.

CARBON MIKE INSERTS. Brand new, 2½in. dia., 3/6. P. & P. 9d.

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MIDGET 2/GANG CONDENSERS. Capacity 195 and 100 pF. Polystyrene case with built-in trimmers. Size ¾ x ¾ x ½in. Not used but removed from P/C Boards. Two for 9/-, plus 1/- P. & P.

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TELEFUNKEN HI-FI STEREO AMPLIFIER. 110/250 v. A.C. input. 5 watt undistorted output (10 watts nominal). Size 12 x 9 x 2in. Weight 9 lb. Complete with spec. and instructions. Now only £5.9.6. Carr. 5/-.

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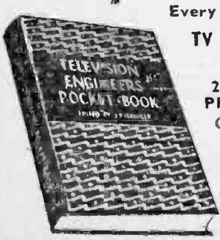

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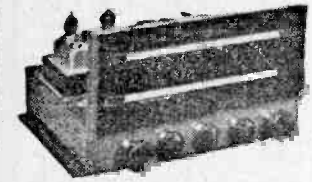

STEREO 12 Mk. 2 £40/5/-
8 watts push-pull output from each channel 16 watts total; VHF, with automatic frequency control medium and long bands; A hi-fi system on one compact chassis.

STEREO 55 £29/18/-
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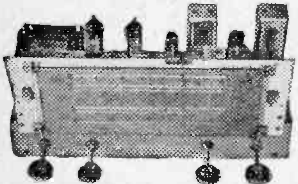

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LATEST MULLARD
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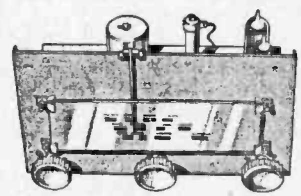

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Size 9 x 6 x 5½in. high. Tested by us ready for use. 200/250 v. A.C./D.C. Mains. As illustrated with illuminated dial. Fully tunable with Medium and Long Wave. 12-month Guarantee. Only £4.19.6. post 5/-.

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Postage 2/- each transformer.

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4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER
Size 3 x 1½ x ½.
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Price **47/6** 9 v. Batt. 2/3, 2½in. Speaker 15/-

C.R.T. BOOSTER TRANSFORMERS
for heater cathode short circuit, or tubes with failing emission. Full instructions supplied, mains input. **Type A optional 25% and 50% boost 2v. or 4v. or 6.3v. or 10.8v. or 12.6v. State voltage required. PRICE 10/6.**

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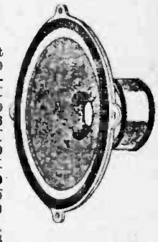
13½ x 8in., Double Cone E.M.I., 35/-.

STENTORIAN HF.1012. 10in. 3 to 15ohms, 10 w. 87/6; 35 ohm, 7 x 4in., 21/-; 5in., 17/6; 3½in., 15/6.

BAKER SELHURST LOUDSPEAKERS



12in. Baker 15w. Stalwart 3 or 15 ohms, 45-13,000 c.p.s. 90/-
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12in. Standard H.D. 20w. 40-14,500 c.p.s. .. £8.0.0
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12in. Bass 25w. 20-18,000 c.p.s. .. £12.12.0
15in. Auditorium, 35 w., Bass, 20 c.p.s. to 12kc/s. £18
Details and Enclosures plans S.A.E.

TWIN GANG TUNING CONDENSERS. 365 pF, miniature 1in. x 1½in. x 1½in., 10/-; 500pF Standard with trimmers, 9/-; midget, 7/6; withstrimmers, 9/-; 500pF slow motion tuning, standard or midget, 9/-.
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SINGLE 25 pF, 50 pF, 75 pF, 100 pF, 160 pF, 5/6. Solid dielectric 100, 300, 500 pF, 3/6.
CONDENSERS. New stock. 0.001 mfd. 7 kV. T.C.C., 5/6; Ditto, 20 kV, 9/6; 0.1 mfd., 7 kV, 9/6. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5/500 v., 1/9; 0.1/350 v. 9d.; 0.1/2,000 v., 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 volts, 3/6.
CERAMIC CONDS. 500 v. 0.3 pF to 0.01 mfd., 9d.
SILVER MICA CONDENSERS, 10% 5 pF to 500 pF, 9d.; 600 pF to 3,000 pF, 1/-. Close tolerance (±1 pF) 2.2 pF to 47 pF, 1/-. Ditto 1% to 50 pF to 815 pF, 1/-; 1,000 pF to 5,000 pF, 1/9.

465 kc/s SIGNAL GENERATOR
Price 15/-. Uses B.F.O. Unit, ZA 30038 ready made with valve 1S5. **POCKET SIZE** 2½ x 4½ x 1in. One resistor to change, full instructions supplied. Battery 8/6 extra. 69 V1½V. Details S.A.E.

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8 p. 4-way 2 wafer long spindle 6/6
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CRYSTAL MIKE INSERTS, 6/6
Size 1in. dia. x ¼in.
ACOS MIC. 14. insert 1½in. dia. x ¼in. 8/6

ACOS 39-1 DE LUXE STICK MIKE 35/-
TSL QUALITY STICK MIKE.... 25/-

Valveholders. Pax. int. oct., 4d. EA50, 6d. B12A, CRT. 1/3. Engl. and Amer. 4, 5 and 7 pin. 1/-. MOULDED Mazda and int. oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic EF50, B7G, B9A, int. oct., 1/-. B7G, B9A cans, 1/- each.

ADASTRA 3-3 AMPLIFIER. Ready built A.C. only. 200-250 v. Valves ECL86 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved front panel with de-luxe finish. Heavy duty output transformer 3 ohm. Quality mains transformer. Stove enamelled chassis size 6in. x 5in. x 3in. **Bargain Price £4.19.6.** Circuit supplied.

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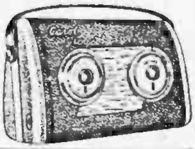
SPECIAL OFFER PRINTED CIRCUIT AM-FM CHASSIS AT ONLY £9

A small quantity of Printed Circuit chassis by famous manufacturer Valves UY85, UCH81, UF89, UABC80, UL84 and UCC85. O.p. trans. for 2–3 ohm speaker. Chassis 14 x 7 x 7in. Front controls concentric, left—Vol. and Tone; right—W/c and Tuning "Gold" centre knobs provided. 2-dial bulbs. Sockets, AE, E; Ext. sp; P.U. Mains isolating transformer free. Covers Long, Med., VHF (87-101 Mc/s). Unused, slightly tarnished, but not dirty; New Mullard Valves. Dial in gold and brown, size 13 x 3½in.

THIS SUPERB SET for £9



6-transistor radio covered in sponge clean Duracour fabric, in latest two tone shades, M.W. and L.W. ferrite rod, provision for car aerial, 2-colour scale. With PP9 battery giving 300 hours use. Weighs under 4 lbs. With carrying handle. 12 x 7½in. high x 4½in. at base tapering to 2in. at top. Brand new, fully guaranteed.

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Valves UY85, UF80 and UL84. Mains trans. 200-240 a.c. Covered baffle 13½ x 7½in. (6½in speaker); 3 front controls bass, treble, on-off/vol. 74/- (post 4/-) Rexine cabinet to fit, with carrying handle, and lid (detachable) 14in. 16/- extra.

5 WATT AMPLIFIER

Our price ONLY 56/- (post 4/-); NEW MANUFACTURE; valves EF91 and EL84 with metal rectifier: 6 x 4 x 1½in. high (5in. over EL84). Mains trans. and o.p. with vol. and tone controls; on/off; co-ax input.

COLLARO STUDIO TAPE TRANSCRIPTOR, 3 MOTORS, 3 SPEED. 1⅞, 3¾ and 7½ I.P.S. Push buttons, £10.7.6 (10/- carr.) inc. spool.

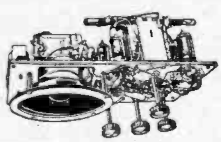
BATTERY ELIMINATOR

For 4 Low Consumption Valves (96 range) 90v. 15mA and 1.4v. 125mA, 45/- (2/6 post). 200-250v. A.C. Also for 250mA, 1.4v. and 90v. 15mA at same price. Two separate units to replace existing batteries.

BATTERY RADIO

Valves DK96, DF96, DAF96, DL96. Two Short Wavebands 16 to 49 M, and 25 to 75 M. Size 10½ x 4½ x 5in. £4.7.6, carr. paid. M.W. and S.W. £4.11.0, carr. paid.

MAINS OPERATED RADIO CHASSIS AND AMPLIFIER OF FAMOUS MANUFACTURE



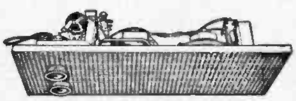
Chassis 10 x 5½ x 4in. front to back. Valves: UBC41, UCH41, UF89, UL84 with metal rectifier. 5in. speaker. Ferrite rod aerial. Tone, vol. and gram. position. Covers L. and M. waves. Limited quantity at only £6 (5/- carr.) complete with small dial. Unused and in working order.

TRANSISTOR SET BATTERY ELIMINATOR. Converts your 6 transistor receiver to mains operation. With flex lead and battery charging attachment. For Miniature Sets, size 1½ x 1 x ⅞in. Price 18/6. For Larger Sets, 3 x 1½ x ⅞in. Price 24/6.

TRANSISTOR COMPONENTS

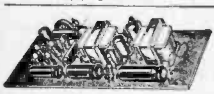
M.W. and L.W. ferrite rod aerial, with car coupling coil. For 208pF condenser, 6/-; Osc. coil: 1st, 2nd and 3rd I.F.'s, all 4/6 ea.; Driver trans., 6/-; min. 64mF 10v.; 10mF 16v., 100mF 9v.; all 1/3 ea.; Tuning cond. 208mF +176pF 8/6; post 9d. on all orders.

GRAMOPHONE AMPLIFIER



With 5in. SPEAKER Baffle 12½ x 6in. ECL82 and Rectifier, Tone and Volume On/Off switch. Two Knobs. Ready to play. Useful for Stereo. ONLY 57/-, post 4/-.

4 TRANSISTOR MINIATURE PUSH-PULL AUDIO AMPLIFIERS



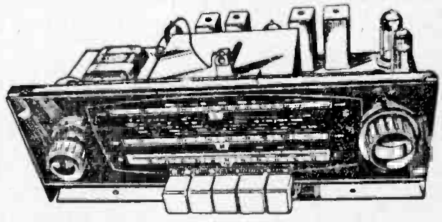
PRINTED CIRCUIT. 5in. x 2in. x 1½in., over transformers. Output for 3-ohm speaker. Suitable for microphone, record player, guitar and radio input. 9-12 volt battery required. Frequency range 100 c/s. to 25 Kc/s. Push/pull output single ended. Instruction sheet provided. Fully wired ready for use: Two types available, ½W output. 35/-. 1½ watts 41/-. P. & P. 2/6.

TOP QUALITY RECORDING TAPE (Guaranteed)

(1/- per tape, six or more post free).

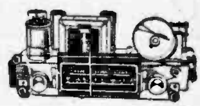
4in.	600ft.	12/6	5¾in.	1200ft.	17/6
5in.	600ft	12/6	5¾in.	1800ft.	35/-
5in.	900ft.	17/-	7in.	1200ft.	17/6
5in.	1200ft.	30/-	7in.	1800ft.	26/6
5¾in.	850ft.	15/-	7in.	2400ft.	45/-

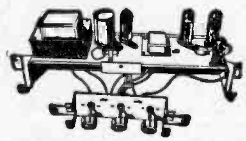
BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £12.12.0 (Carriage Paid)



A.C. ONLY. Chassis size 15 x 6½ x 5½in. high. New manufacture. Dial 14½ x 4in. in 2 colours, predominantly gold.
Pick-up Ext. Speaker, Ae. E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1000-1900 M.; 200-500 M.; 88-98 Mc/s. Valves EZ80 rect.; ECH81, EF89, EABC80, EL84, ECC85. Negative feed-back circuit. Speaker and Cabinet to fit chassis (table model). 47/6 (post 5/-).
9 x 6in. ELLIPTICAL SPEAKER, 20/-, to purchasers of this chassis.
TERMS: (Chassis) £3.10.0 down and 5 monthly payments of £2.
Cheap Room Dipole for V.H.F., 12/6. Feeder 6d. yd. Circuit diagram 2/6.

SELF-POWERED VHF TUNER CHASSIS. Covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½ x 4½ x 5in. high ECC85 and 3—EF91 and 2 diodes. Metal Rectifier. Mains transformer. Fully wired and tested. Only £7.7.0 (carr. paid). Room dipole 12/6 Feeder 6d. yd.



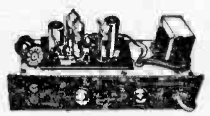


PUSH-PULL AMPLIFIER £5.5.0

(5/- Carr.)

Brand new 200-240 A.C. mains. Bass, treble and vol. controls. With valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 x 3½ x 3½in. With o.p. trans. for 2-3 ohm speaker. Front panel (normally screwed to chassis) may be removed and used as "flyingpanel." Stereo version 2 x 4 w, same price. Fixed panel. Tone & Vol. Controls.

TAPE RECORDER AMPLIFIER



Type TR3. Fully built, high gain, low noise, printed circuit. Attractive grey and gold front panel 13 x 1½in. Height 5½in. overall. Front to back 5½in. Vol. and on/off tone. Mike, radio and ext. speaker jacks. Valves ECC83, ECL82, EZ80, plus DM70 (magic eye). Mains trans. Ready to bolt to B.S.R. Deck. Complete with switch wafer wired. Our Price ONLY £6.15.0 (6/- Packing and Carr.). Also available for Collaro Deck at 5/- extra.

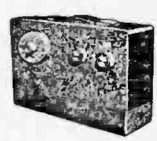
6-TRANSISTOR KITS AND SETS

All brand new parts. Rexine and Vynair Cabinets. Different colours. All holes drilled in printed circuit boards. Full M.W. and L.W. coverage. Car aerial socket. Alignment service, 17/6, inc. return post. All parts supplied separately. Built in 2/3 hours. 500 mW. output. Booklet 2/6, refunded on purchase of kit.

THE "SCALA"

"Scala" Kit £4.19.6. (Post 3/-). Size 8½ x 2 x 5½in. high and 3½in. speaker; or fully built £7.10.6.

THE "MILAN"



"Milan" Kit £5.17.6. (Post 3/6) Size 9 x 3½ x 7in. with 8 x 2½in. speaker

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Terms Available on Items over £5. Send 6d. (stamps will do) for 20-page illustrated catalogue. Delivered by return C.O.D. 2/-extra.

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GLADSTONE RADIO

"SCALA", CAMP RD., FARNBOROUGH, Hants.

Farnborough 3371) FARNBOROUGH CLOSED SATS.

Practical Wireless

Vol. XXXIX No 677 JULY, 1963

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Contents

The Editor will be pleased to consider articles of a practical nature. Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Owing to the rapid progress in the designs of wireless apparatus and to our efforts to keep readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

Keys to Success

WHY can Joe Brown construct an elaborate piece of equipment which looks like a professional product, while Jack Smith gets tied up in knots trying to build a simple three valver?

No doubt some have electronic "green fingers", but the reason is usually less fanciful. Also, of course, experience plays its part. And the fact that some learn faster than others. But disregarding the particular for the general, there are several important reasons for the wide divergence in constructional skill and the results obtained.

(1) Tools. There is a bare minimum of tools without which the enthusiast should not embark upon any regular constructional work. These should be maintained in optimum condition, and added to when the need arises and finances permit.

(2) Test Gear. The amateur does not have to equip a laboratory, but he should obtain as early as possible certain basic essentials, such as a reliable test meter. To contemplate serious constructional work without even this indispensable item can only lead to frustration and disappointment.

(3) Theory. It is not necessary to be an academic genius to get fun out of our hobby, but if one is to be versatile and progressive, a good basic working knowledge is essential.

(4) Patience. This attribute is not always easy, when one is keen, but it should be cultivated. It is, for instance, courting trouble to attempt a communications receiver after having only built one or two portables.

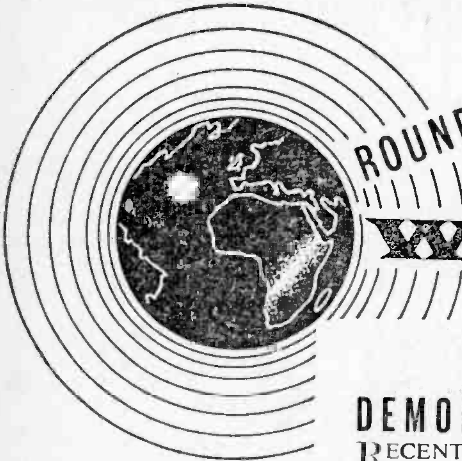
(5) Confidence. This may be even more difficult! But with reliable tools, some testing equipment and a working knowledge of theory, the enthusiast is half way home. But the real key is the willingness and ability to *experiment*.

Having built one or two pieces of equipment from the magazine point-to-point wiring diagrams, the newcomer should attempt one or two simple items using only the theoretical circuit diagram.

Mistakes would be made, but mistakes are the food on which knowledge grows and soon the newcomer would gain the confidence to plan his own layouts.

We know that some readers, even after many years of building, still prefer everything planned for them, and we shall continue to cater for them. But for those who wish to progress, the moral is the well used but true phrase: there is no substitute for experience. The keys to success are there—ready to open the doors to advanced construction—for those with the confidence to try.

Our next issue dated August will be published on July 5th



ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

EQUIPMENT AT PARIS AIR SHOW

AT this year's Paris Air Show, Marconi's Wireless Telegraph Company Limited are exhibiting a full range of their products designed for aeronautical use. The Sixty Series radio equipment will be a feature of the display, as will their new "daylight radar display".

The exhibit also includes the type AD722 lightweight radio-compass and a navigation computer and display unit.

DEMONSTRATION OF LOCAL RADIO

RECENTLY, the South Coast Broadcasting Co. Ltd. invited the public to a demonstration of local independent radio at its headquarters at Castle Goring, Worthing. For six days features of the demonstration included local news and events, music and record request programmes, weather and traffic information.

When the Pilkington Committee on broadcasting was studying the possibility of the introduction of local commercial radio, S.C.B.C., whose programme controller and managing director is Mr. Ian Collins, was the only independent company to present trial local programmes.

Proposed programmes would be devoted to all local affairs and would include regular school's broadcasts. Also planned by the company is a night service.

Contributions towards the demonstration programmes came from many local bodies, including the police, schools and civic authorites.

Radio Equipment for new Transport Planes

WHEN the Royal Air Force Transport Command has completed its latest re-equipment programme, three new types of aircraft will be seen for the first time in R.A.F. colours. The three types of aircraft—the Vickers VC10, the de Havilland DH125 and the military freighter version of the Avro 748—will all be fitted with the Marconi Sixty Series of aircraft radio equipment.

In both the VC10's and the 748's, dual installations of Marconi v.h.f. communications systems and v.h.f. navigation systems have been specified. In the DH125's, single installations of both systems are required.

The Sixty Series equipment will also be installed in a number of aircraft already in service with the R.A.F.

Electronics in the Navy

THE growing importance of electronics and the increasing need for electrical specialists, was underlined recently when the Admiralty announced that more electrical officers will be required for each new warship that is commissioned. This is because of the increased complexity of the electrical equipment which is included in the Navy's new ships.

As a result, new regulations are to be introduced governing the entry of electronic specialists into the service and also a system whereby officer entrants will be given seniority "credits", based on their previous experience in outside industry and also for their academic qualifications.

In many new ships now coming into service, electrical and electronic equipment installed may well account for up to 50% of the total cost of the warship, and these ships may now expect to carry three or four times as many electrical officers as earlier vessels.

RECTIFIERS FOR NEW POWER STATION

FOUR sets of silicon rectifier equipments have been ordered from Westinghouse Brake and Signal Company Ltd., for use in the excitation of four 500MW generators which are being built for the Central Electricity Generating Board's Ferrybridge "C" power station. The order, which was placed by C. A. Parsons and Co. Ltd., is worth £64,000.

Westinghouse silicon rectifiers will be used extensively for the large generators recently ordered under the C.E.G.B.'s current plans to expand electric power generation.

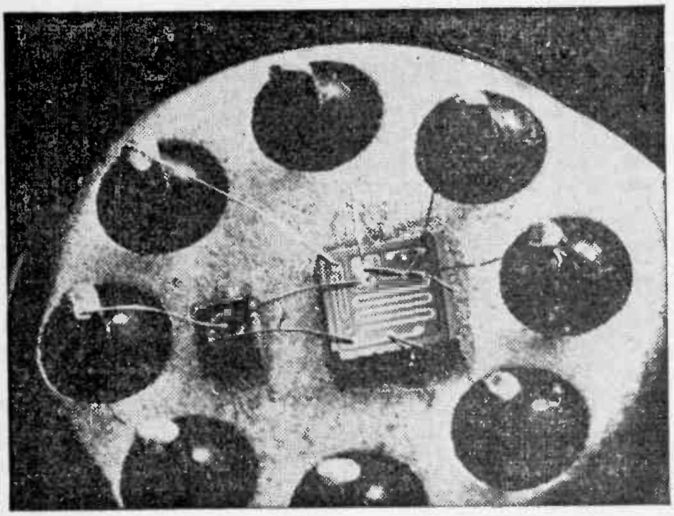
SOLID STATE CIRCUITS ON SHOW

FOR years electronic components have been getting smaller and smaller until they can be made no smaller and still remain as single items. The next logical step has been taken already and among other exhibits, Ferranti Ltd. showed some of their developments in silicon solid state integrated circuits, at this year's Radio and Electronic Components Show, which was held recently in London.

The techniques used in the production of these circuits enables a number of planar silicon transistors (or diodes) and resistors to be contained within one or two tiny pieces of silicon and to be sealed in an encapsulation of reduced dimensions which would normally hold but one transistor! The circuit illustrated, for example, is a ZLAIA linear amplifier from the "Microlin" range of elements. Contained in this eight-lead encapsulation, which measures only 0·36in. in diameter and 0·18in. in height, is a silicon integrated circuit consisting of six resistors and two transistors.

These integrated circuits are manufactured by producing a number of separate minute regions which function as components (resistors, capacitors, diodes or transistors) within one or more pieces of semiconductor material. The regions are interconnected by evaporated layers in the basic material, and isolated by p-n junctions. Connections to other circuits lead off from the case, and the complete circuit is hermetically sealed in a metal container which provides a stable enviroment and ensures a high standard of reliability.

Ferranti Ltd., have concentrated on the development of this technique for two separate functions — linear amplification and high speed logic circuitry—and demonstrations of both types of circuits were included on their stand.



This photograph shows a Ferranti silicon integrated circuit magnified 20 times.

Aerials for New Forfar V.H.F. Station

AS a result of their decision to go ahead with the plans for a new transmitting station near Forfar, Angus, the BBC has placed an order with EMI Electronics Ltd. for the supply and erection of the v.h.f. and TV aerials. This station will improve reception and extend the coverage of television and radio programmes in East Scotland.

The v.h.f.-f.m. aerial will be mounted below the television aerial on the mast, and will transmit the Home, Light, Third and Network Three programmes in Band II. This array, which will be horizontally polarized, will include eight stacks of unipoles, mounted on the north-west and south-west corners of the mast.

VENEZUELAN MINISTER TOURS WOOLWICH FACTORY

AS part of his tour of Standard Telephones and Cables, Woolwich factory, Sr. Ingeniero Pablo Miliani, saw the workshop where repeaters for undersea telephone cables are made. In this dust-free, air conditioned workshop, where everyone entering wears special clothing to prevent contamination, the repeaters are constructed to operate continuously for more than 20 years on the sea bed.

Sr. Miliani, who is visiting Britain at the invitation of the President of the Board of Trade, also inspected the producton of microwave radio link equipment for carrying large numbers of long-distance telephone circuits and television channels.

Three Brands of Valves on Show

AT this year's R.E.C.M.F. exhibition, Thorn-AEI Radio Valves and Tubes Ltd. made their first ever appearance. On their one stand they exhibited three brands of valves—Mazda, Ediswan and Brimar.

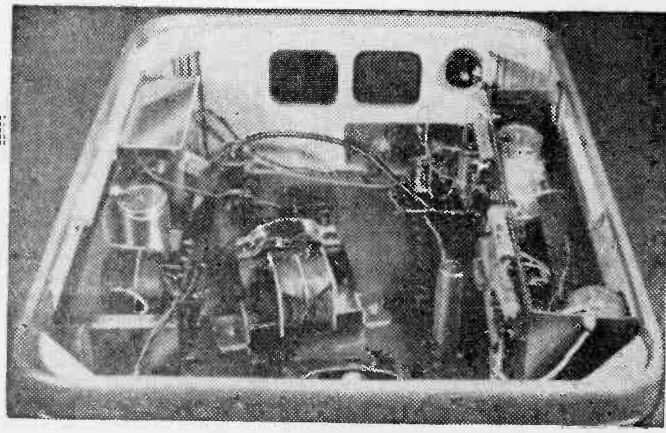
The Brimar valves were mainly of the entertainment equipment type, although range of low power industrial and professional types was also on show.

Entertainment valves and c.r.t.'s were the types exhibited under the Mazda brand-name, and of special interest was the newly developed television valve 30C18 (PCF805).

The Ediswan brand represented the overseas sales of Mazda valves, but also included was a selection of industrial valves.

THE MALVERN TAPE RECORDER

* * * * * * * * * * * *



By
T. Snowball

THIS is a mains driven tape recorder using semiconductors throughout and is based on a design by G.E.C. in their application report No. 24.

The design as given here is matched to the small loudspeaker contained within its portable cabinet, but with a few modifications the recorder can be designated Hi-Fi and will drive larger external loudspeakers such as in a permanent installation. The specification gives 2 watts output from a transformerless output stage feeding a 3Ω loudspeaker, with a frequency response of up to 6kc/s at $3\frac{3}{4}$in./sec. using a B.S.R. Tapedeck.

The supply circuits were designed to run from a 12V mains-derived power supply so that if a d.c. motor, or a transistor invertor for the motor, were used the unit could be operated from batteries.

The audio output from a radio tuner can be applied to the input of the recorder—which will then provide high quality amplification with a frequency response from 30c/s to 30kc/s.

The complete circuit diagram is given in Fig. 1. The first pair of transistors (Tr1, Tr2) are in a feedback circuit, the frequency response of which can be readily altered in order to compensate for recording or playback, according to the setting of the function switch S1.

The third transistor Tr3 is used as an additional amplifier with a treble boost network in its collector circuit.

The combined driver/output stage (Tr4-Tr8) delivers 2W to a 3Ω loudspeaker without the use of any transformers, thus giving extremely good frequency response, with very little phase shift. The output stage also drives the recording head via a transformer (T1) and series resistor.

The erase and bias oscillator is separate and is built in a screened box to prevent radiation. It provides 2 watts at 60kc/s.

The current consumption varies from 12 to 300mA on playback, and from 300 to 500mA on record.

THE MAGNETIC RECORDING PROCESS

A few words on tape recording requirements will probably help some constructors.

The aim of recording on magnetic tape is to record the signal as large as possible without excessive distortion; and constant in amplitude throughout the entire frequency range. This is the condition that gives the largest playback signal and so gives the best signal to noise ratio for the recording process.

So at first look it appears that because the magnetic field is proportional to ampere-turns, the need is a constant current through the record head for all frequencies. This is indeed what is done in the output stage as described below.

As the recording head is an inductor its impedance XL will rise steadily with an increase in frequency.

$$XL = \frac{1}{2\pi fL}$$

So for the head on the B.S.R. deck where L approximately equals 400mH, XL at 50, 500 and 5,000c/s is 100Ω, 1kΩ and 10kΩ respectively. So in order to keep a constant recording current flow-

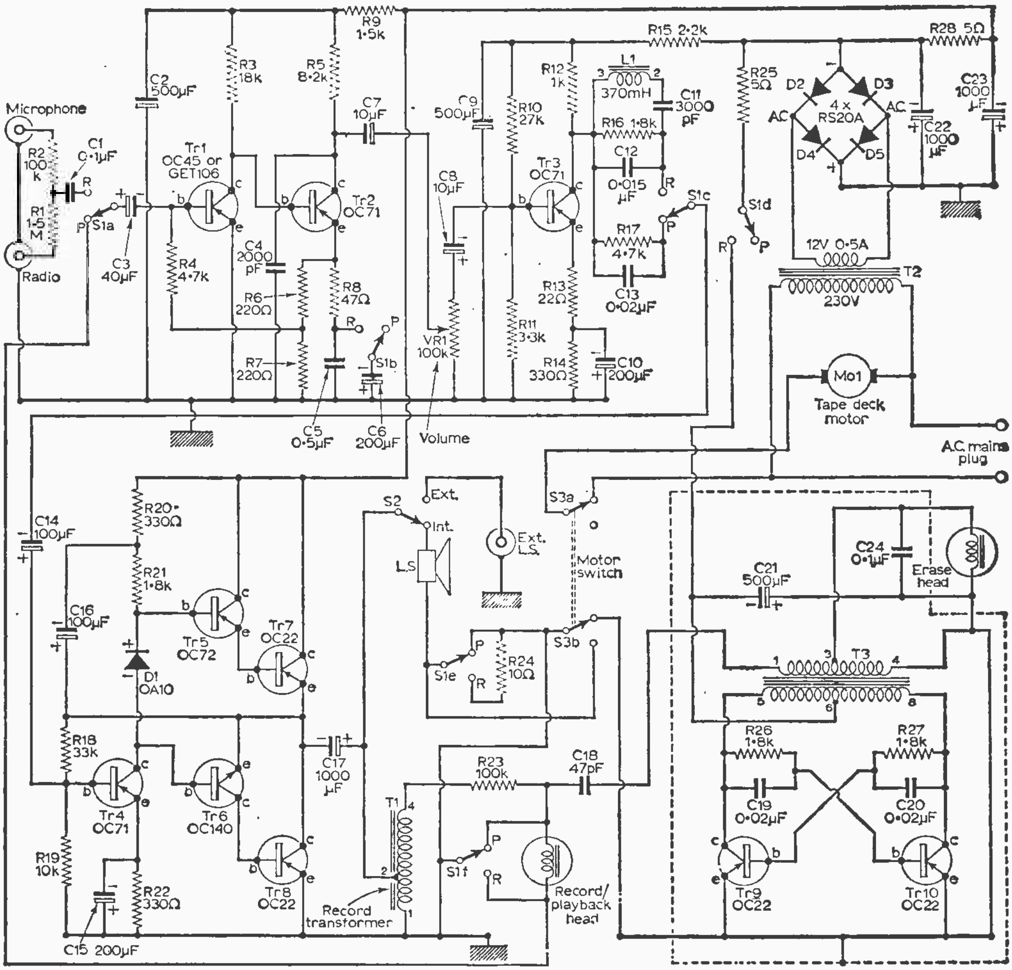


Fig. 1: The complete circuit of the recorder.

ing for, say 15V r.m.s. output at all frequencies, it is normal to feed the head through a large resistor. In this case a 100kΩ resistor is used: thus at 50, 500 and 5,000c/s the total impedance is 100,100Ω, 101,100Ω and 110,000Ω, making of course for all practical purposes a constant current of 150μA.

Unfortunately this simple expedient is not the whole answer to recording, because as the frequency is raised, the losses in the tape and head increase sharply. So in order to keep the recorded signal constant at the top audio frequencies, the amplifier stages boost these frequencies by as much as four times or 12dB. The exact figures of boost, and the frequency at which it occurs, vary with different types of head and with tape speeds. But with the B.S.R. deck and small loudspeaker this circuit gives 6dB at 5kc/s. The actual response is shown in Fig. 2.

Playback, having once recorded the tape, is also somewhat difficult.

As the recorded signals go past the playback gap, the voltages induced head are proportional to the number of cycles per sec. that go past. So at low frequencies the output will be much smaller than at high frequencies. If all were perfect then the output would rise linearly all the way; that is, the output should double for each doubling in frequency, or to state this in the more conventional manner, rise at 6dB per octave.

But once again at high frequency the output drops due to eddy currents in the head, spacing between head and tape, head gap width, etc. So instead of rising all the way, after about 1kc/s the output remains constant within 3 or 4dB, up to 5kc/s.

So the required playback response needed is shown in Fig. 3.

The erase and bias oscillator also comes into the recording story, in that as an erase oscillator it saturates the tape with a very strong signal at 60kc/s as it passes under the erase head. And as the tape moves away from the head the field slowly reverses on each half cycle of oscillation, until it decays away to zero, leaving the tape "empty" and noise free. Considering the function of the bias oscillator, a simple explanation of a complicated subject is that the oscillator moves the point of magnetisation of the tape, so that the audio signals are recorded without distortion.

The final result of all these adjustments would be to give a constant output voltage to the loudspeaker on playback, from 50c/s to 5kc/s. if a constant voltage at all frequencies were fed into the recording amplifier.

The various ways in which these operations are carried out in this tape recorder will now be described.

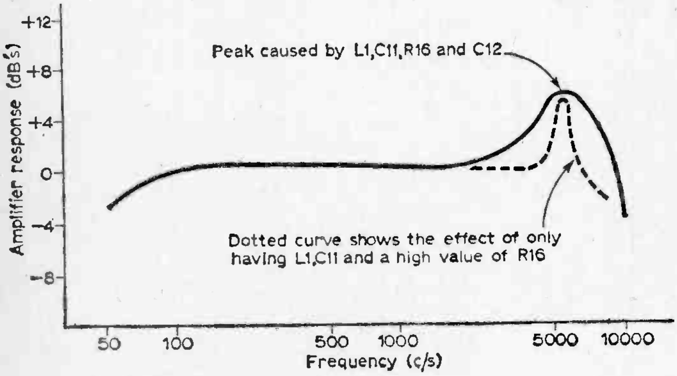
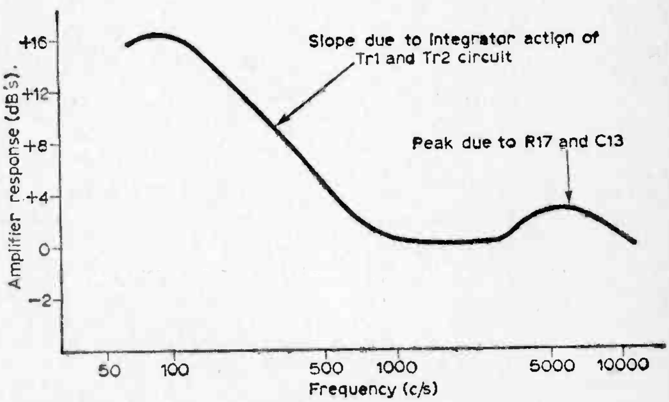


Fig. 2 (above): The record response curve.

Fig. 3 (right): The playback response curve.



THE RECORDING CIRCUIT

Bias and Erase Oscillator

As the tape passes through the recorder it is first erased by the sine wave oscillator consisting of Tr9 and Tr10 which are connected together in a class "C" condition. The transformer T3 connected in the collector circuit of Tr9 and Tr10 has a secondary winding which feeds the erase head and also the recording head (bias) via a small capacitor C18.

The oscillator operates at approximately 60kc/s and the erase head and transformer T3 are tuned by the 0.1μF capacitor C24 to increase the erase current in the head.

As mentioned in the G.E.C. report, the transformer can be purchased from various companies, i.e. Belclere TF2547, Colne Electric 06042, Parmeko P3007. However, it is easy to construct on a Mullard LA2 or G.E.C. GA110B ferrite core, and winding details will be given later.

As this circuit is, effectively, quite a powerful transmitter on 60kc/s, it is suggested that construction is carried out in a screened box: otherwise the main amplifier can be saturated because of stray pick-up.

Various transistors can be used, but for maximum efficiency, types which oscillate easily at 60kc/s. without excessive loss, are necessary. Mullard OC22 or G.E.C. GET116 are most suitable.

Indication that all is well is the existence of approximately 25V r.m.s. across the erase head. Read this on the a.c. range of a good voltmeter with extended h.f. response, such as the *Practical Television* Testmeter, Oct., Nov. '61; or a valve voltmeter. Otherwise, if the current consumption is 300-400mA at 10-12V the circuit is probably working correctly.

The overwind on the transformer for the bias supply gives 400V r.m.s. output and is applied through a small capacitor to the recording head. This is in order to allow variation of bias current by means of varying the capacitor, and at the same time to allow a small value of "C", thus avoiding a heavy load on the oscillator or shunting of the audio signals which are being applied to the head, at the same time.

The usual bias current is normally between 0·4 and 1·2mA, and with the value of C18 at 47pF will give about 1mA, but variations can occur mainly due to the screened leads absorbing the power.

After erasure the tape passes the recording head, when the bias affects it, as previously described. At this point, the audio signal currents are added in via the head transformer T1, and series resistor R23.

Record Head Transformer

This head transformer T1 can be wound on an LA1 or GA110A ferrite core, as will be described later. Alternatively it can be purchased as Belclere TF2550, Colne 06040 or Parmeko P3005. It is best situated near the Record/Playback switch and bias oscillator, in order to ensure that leads with higher voltages are kept short.

COMPONENTS LIST

Resistors:

R1	1·5MΩ	R13	22Ω
R2	100kΩ	R14	330Ω
R3	18kΩ 5% H.S.	R15	2·2k
R4	4·7kΩ 5% H.S.	R16	1·8k
R5	8·2kΩ 5% H.S.	R17	4·7k
R6	220Ω 5% H.S.	R18	33k
R7	220Ω 5% H.S.	R19	10k
R8	47Ω	R20	330Ω
R9	1·5k	R21	1·8k
R10	27k	R22	330Ω
R11	3·3k	R23	100k
R12	1k	R24	10Ω
R25	5Ω ½W or 2 x 10Ω in parallel		
R26	1·8k	R27	1·8k
R28	5Ω or 2 x 10Ω in parallel		

All ¼W, 10% carbon, unless otherwise stated.
VR1 100kΩ potentiometer

Capacitors:

C1	0·1μF paper 200V
C2	500μF electrolytic 12V
C3	40μF electrolytic 3V
C4	0·002μF paper 100V
C5	0·5μF paper 100V
C6	200μF electrolytic 3V
C7	10μF electrolytic 10V
C8	10μF electrolytic 10V
C9	500μF electrolytic 10V
C10	200μF electrolytic 3V
C11	0·003μF paper 100V
C12	0·015μF paper 100V
C13	0·02μF paper 100V
C14	100μF electrolytic 10V
C15	200μF electrolytic 3V
C16	100μF electrolytic 6V
C17	1,000μF electrolytic 6V
C18	47μF mica or ceramic 350V
C19	0·02μF paper 100V
C20	0·02μF paper 100V
C21	500μF electrolytic 12V
C22	1,000μF electrolytic 15V
C23	1,000μF electrolytic 15V
C24	0·1μF paper 100V

Transformers:

T1	Recording head autotransformer—see text. Alternatively can be purchased (Belclere TF2550; Colne 06040 or Parmeko P3005).
T2	Mains transformer. Tapped primary. Secondary 13·3V 0·6A (Radiospares).
T3	Bias and erase oscillator transformer—see text. Alternatively can be purchased (Belclere TF2547, Colne 06042 or Parmeko P3007).

Inductor:

L1	Treble boost coil 370mH, 60Ω, 1,000 turns of 40 s.w.g. en. wire on ferrite core LA1 or GA110A. Alternatively can be purchased (Belclere TF2549; Colne 06039 or Parmeko P3004).

Switches:

S1	6-pole 2-way rotary switch. (Two wafers, each 4-pole, 2-way).
S2	Toggle switch 1-pole, 2-way.
S3	Toggle switch 2-pole, 2-way.

Transistors:

Tr1	OC45, GET106 or NKT246.
Tr2	OC71, GET103, NKT244 or GET114
Tr3	OC71, GET114 or NKT244
Tr4	OC71, GET114 or NKT244
Tr5	OC72, GET104 or NKT243
Tr6	OC140, OC139 or NKT751
Tr7	OC22, GET116 or NKT304
Tr8	OC22, GET116 or NKT304
Tr9	OC22, GET116 or NKT304
Tr10	OC22, GET116 or NKT304

Diodes:

D1	OA10
D2, D3, D4, D5	RS20A, SX641, ZS30B, GEX541 or GJ3M

Loudspeaker:
LS Elliptical p.m. unit, 7 x 4in., 3–5 ohms

Tape Deck:
BSR TD1 or TD2

"Veroboard" (see text) is available from Vero Electronics, Regents Park, Southampton.

The transformer has a ratio of 8:1, and as the amplifier will produce 3·8V r.m.s., a maximum output of 30V r.m.s. is available for recording. So with the series resistor of 100kΩ this makes a maximum recording current of 330μA; as the normal recording current is only 150μA, at which point the output is only 14V r.m.s., it thus allows a good safety margin for peak signals and high frequency boost.

Loudspeaker Monitoring

The internal loudspeaker can be connected across the output when recording, in series with a resistor of approximately 10Ω, which reduces the volume and loading of the output stage. In this way it is easy to check that the signal being recorded is suitable, and warning is given when recording radio shows, etc, that the item is likely to finish. Also, with some practice, the loudspeaker obviates the necessity of a recording level meter, as one soon becomes quite expert at judging recording levels. Of course, when using the microphone, the loudspeaker has normally to be switched off in order to avoid audio feedback.

Complementary Pair Output

The output stage, which is used unaltered for playback and record functions, consists of four transistors in Class B output. Actually it is a complementary pair, the OC140 (Tr6) and the OC22 (Tr8) forming one high gain NPN transistor, and the OC72 (Tr5) and the OC22 (Tr7) a large high gain PNP transistor.

The NPN (Tr6, Tr8) takes care of the positive parts of the signal and the PNP (Tr5, Tr7) handles the negative portions. Because of the large current gain and low impedance of this combination the loudspeaker can be driven direct without a transformer and any normal 2 to 5Ω loudspeaker is suitable, a 7in. x 4in. elliptical one being used in the author's model.

TO BE CONTINUED

Local Station F.M. Receiver

by J. G. Ransome

THIS receiver was designed with three objects in mind, namely that the set should be easy to construct, it should produce reasonable quality sound and that it should be cheap to build. It is felt that this design has satisfied these requirements. Originally the set was designed for the reception of the London transmissions at a range of about ten miles, but later the receiver was modified to receive these transmissions at about 30 miles from the transmitter.

The prototype was constructed in three stages—each a complete entity in itself. Initally only that section shown in Fig. 1 was constructed, this being used to feed a high quality a.f. amplifier, later an extra i.f. stage was added to increase the sensitivity of the set for use at the increased range, and finally the a.f. amplifier was constructed to make the complete receiver. It will be convenient therefore to describe the construction of the set "in historical order".

1. THE F.M. TUNER

R.F. Section

There is nothing unduly special about the r.f. section. The aerial is coupled to the centre of L1 by C1, this capacitor helping to prevent break through at the i.f. frequency (10·7Mc/s). L1 in turn takes the signal to the grid of V1a which is the pentode section of the ECF82. As L1 is extremely heavily damped by the valve the tuning of the coil will be extremely broad and there will be very little advantage in trying to tune the coil manually, so in this case the core of L1 is adjusted for the best results for the centre frequency of the three stations to be received, and sealed in this position. V1a acts as an r.f. amplifier and mixer, the resultant signal at 10·7Mc/s being coupled via IFT1 to the grid of V2.

The Oscillator

The oscillator is constructed around the triode section of the ECF82 (V1b). A very reliable circuit form has been adopted and hence the usual troubles associated with v.h.f. oscillators have been avoided.

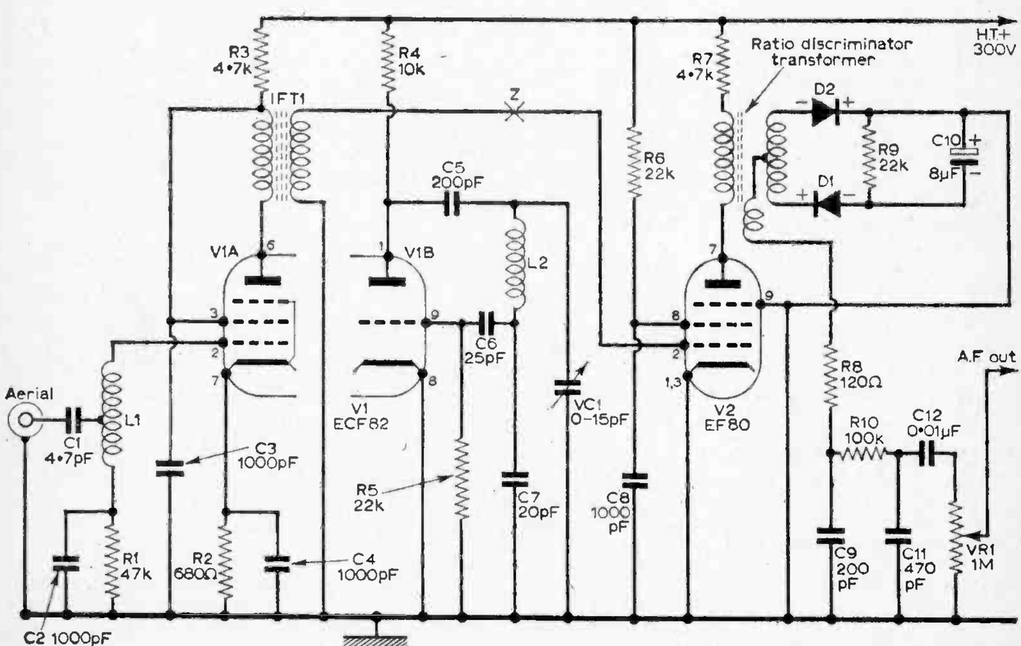


Fig. 1: The main circuit.

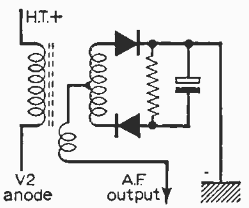
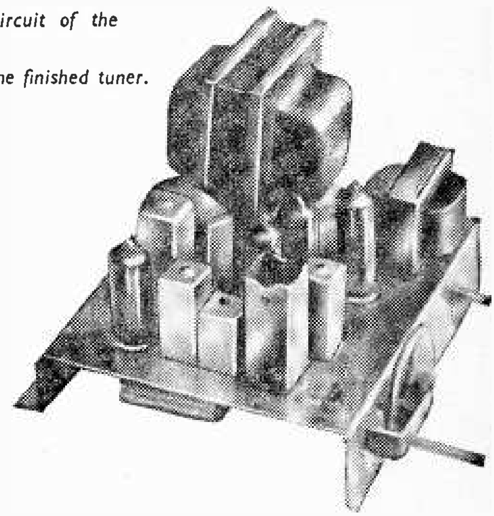


Fig. 2 (left): The basic circuit of the detector.



Right: The finished tuner.

In an attempt to overcome frequency drift, so common in receivers of this type, C7 is specified as a negative temperature co-efficient component. The use of such a capacitor has the advantageous function of counteracting the capacitance changes which take place in the valve as it warms up, which would otherwise tend to cause the set to keep drifting off frequency during the first half hour of the operation, after switching on.

The oscillator contains the only continuously variable tuned circuit in the whole receiver. The oscillator runs at 10·7Mc/s below the signal frequency and so by varying the oscillator frequency we can vary the received r.f. frequency. There is no direct coupling between V1a and V1b as it was found that strong capacitance coupling was more than enough for satisfactory operation. However, should this not prove to be the case (and this is very unlikely) the anode of V1b should be coupled to the grid of V1a by a capacitor having a value of 1-2pF; alternatively a short piece of 20s.w.g. wire (about 1in. long) should be soldered to pin 1 of V1 and a similar piece of wire soldered to pin 2 of V1. These wires should be sleeved completely and twisted together ensuring that they *do not* make

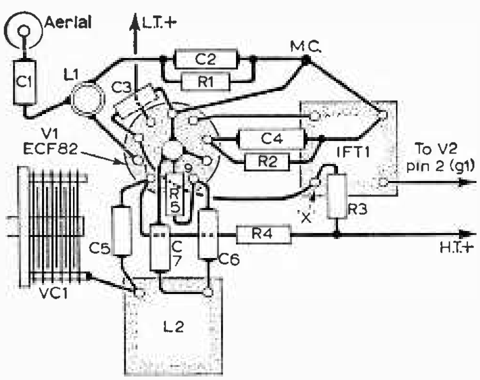


Fig. 3: The wiring of the r.f. and oscillator stages.

electrical contact. This will provide an adequate coupling between the two stages.

I.F. and Demodulation

V2 has two functions as its acts as an i.f. amplifier and partial limiter for the ratio detector stage. As this tuner will be used as a local station receiver very little limiting of interference pulses will be required as the set is quite insensitive to everything but the strongest of signals, and so V2 is allowed to draw more anode current than is usual in this type of circuit, to enhance the i.f. gain at the expense of full limiting action. The i.f. amplifier is otherwise quite straightforward, the i.f. signal from IFT1 being coupled to the grid of V2 which amplifies the signal and passes it on to the ratio detector for demodulation.

The ratio detector is a little unusual since it is of the unbalanced type rather than the more familiar balanced type. The unbalanced detector has the advantage of using fewer components than its balanced counterpart whilst at the same time being less critical of component tolerances.

The basic unbalanced detector circuit is shown in Fig. 2. Basically the operation of the circuit is as follows:

The capacitor and resistor in parallel constitute a circuit with a large time constant. This circuit is charged with d.c. by the two diodes to a level proportional to that of the i.f. amplitude. On the arrival of a large interference pulse at the circuit the resistor capacitor combination, having a large time constant, takes a long time to charge up to a value equivalent to that of the pulse, and so tends to absorb the pulse with very little change in d.c.

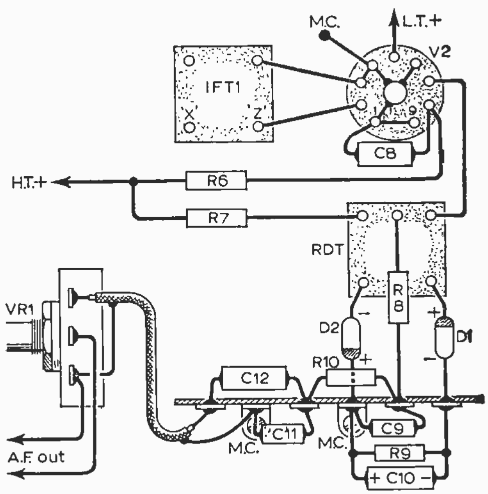


Fig. 4: The i.f. and detector stages wiring diagram.

level across the circuit. Thus the effect of the interference pulse is limited and reduced.

However, as it stands, the circuit of Fig. 2 would not satisfactorily meet our requirements. Firstly the "r.f. output" is not pure r.f., but contains a large measure of i.f. signal which if it were passed on to the a.f. section might have some unfortunate results. We have, therefore, to remove the unwanted i.f. signal whilst preserving the required a.f. component. This is done quite simply by including a capacitor (C9 Fig. 1) which is of such a value as to present a low impedance path to a.f. A suitable value is 200pF.

The second modification which has to be made to the basic circuit is the inclusion of the de-emphasis circuit (R10, C12 Fig. 1). The f.m.

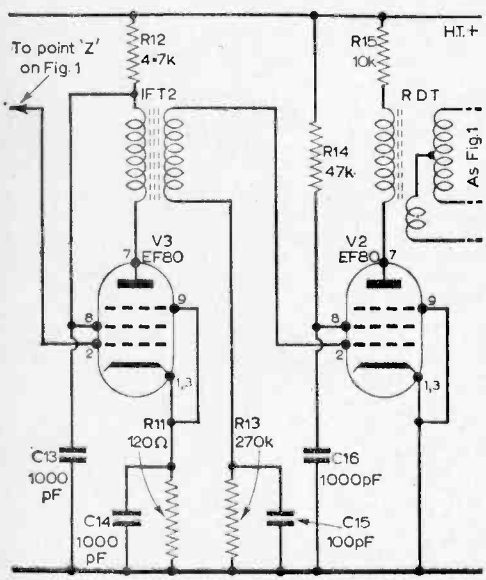


Fig. 5: The circuit employing an additional i.f. stage.

broadcasts in this country are transmitted with a boosted or emphasised treble characteristic and this must be equalised at the receiving end to level the a.f. output of the set. The boosted treble transmission with its subsequent de-emphasis at the receiving end has the advantage, amongst others, of improving the signal to noise ratio of the system. The degree of emphasis given to the treble at the transmitting end is given in terms of a time constant—this being the time constant of the circuit to be used in the receiver to de-emphasise the treble. The BBC quote a figure of 50μsec for this time constant and this is satisfied by making C11 equal 470pF and R10 100kΩ (Fig. 1).

The last modification to be made to the basic circuit is the inclusion of the resistor R8 (Fig. 1) which modifies the limiting action of the ratio detector a little. The inclusion of this resistor enables the detector circuit diodes (D1, D2) to do

COMPONENTS LIST

Resistors:

R1	47kΩ	R11	120Ω
R2	680Ω	R12	4·7kΩ
R3	4·7kΩ	R13	270kΩ
R4	10kΩ 1W	R14	47kΩ
R5	22kΩ	R15	10kΩ 1W
R6	22kΩ	R16	2·2kΩ
R7	4·7kΩ	R17	150kΩ
R8	120Ω	R18	47kΩ
R9	22kΩ	R19	1MΩ
R10	100kΩ	R20	120Ω

(All ¼ or ½W unless otherwise stated)
VR1 1MΩ carbon potentiometer

Capacitors:

C1	4·7pF mica or ceramic
C2	1,000pF ceramic
C3	1,000pF ceramic
C4	1,000pF ceramic
C5	200pF ceramic
C6	25pF mica or ceramic
C7	20pF ceramic (neg. temp. co-efficient)
C8	1,000pF ceramic
C9	200pF ceramic
C10	8μF electrolytic 150V
C11	470pF ceramic
C12	0·01μF paper
C13	1,000pF ceramic
C14	1,000pF ceramic
C15	100pF ceramic
C16	1,000pF ceramic
C17	25μF electrolytic 12V
C18	8μF electrolytic 450V
C19	0·01μF paper
C20	16μF } electrolytic 450V
C21	16μF } electrolytic 450V
VC1	0–15pF air variable

Inductors:

L1	Aerial coil, see text
L2	Oscillator coil, see text
L3	L.F. choke 10H, 100mA
IFT1, 2	10·7Mc/s i.f. transformer (Denco IFT11/10·7)
RDT	Discriminator transformer (Denco RDT1/10·7)
T1	Output transformer 40 : 1 (for 3Ω loudspeaker)
T2	Mains transformer with tapped primary. Secondaries: 300V 100mA (h-w); 6·3V 2A

Valves:

V1	ECF82	V4	EF86
V2	EF80	V5	EL84
V3	EF80		

Diodes:

D1, 2	OA81 germanium diode (or similar)
D3	3 x RM2 selenium power rectifier

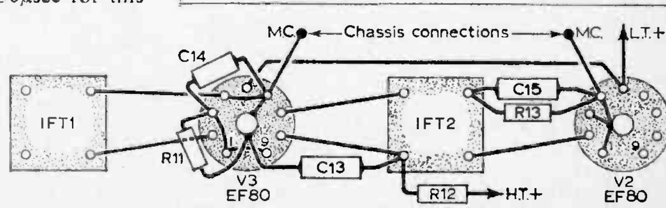


Fig. 6: The wiring of the additional i.f. stage.

their job effectively even when they are working well into the non-linear portions of their characteristics.

The a.f. signal is taken from the junction of R10 and C11 via C12 to VR1 and thence to the a.f. amplifier. The function of C12 is to act as a d.c. blocking device preventing the d.c. which appears at the tertiary winding on the ratio detector, as a result of the rectifying properties of D1 and D2, from appearing across VR1 which would cause the volume control to be noisy in operation.

Construction

The full layout of the prototype is not shown as it was not really a model of its kind! A rough idea of the original layout may be had from the photograph, but that chosen by the reader will undoubtedly reflect his neatness—or otherwise, and the size of the components to hand. The only critical section is the r.f. and oscillator section where the wiring should be short and point to point. No attempt should be made to make the wiring "look pretty".

R.F. and Oscillator Stages

A wiring diagram for these two stages is shown in Fig. 3. It must be emphasised that the wiring must be short and direct. Coil L1 is wound on a $\frac{5}{16}$in. dia. iron-dust cored former and consists of $5\frac{1}{4}$ turns of 20s.w.g. wire, each turn being spaced from the next by a distance equal to the diameter of the wire. The coil is tapped at exactly its mid-point. The coil is mounted beneath the chassis and may be left unscreened.

Coil L2 consists of six turns of 20s.w.g. wire on a $\frac{5}{16}$in. dia. iron-dust cored former being wound, as L1, with each turn separated from the next by the diameter of the wire. This coil should be fitted with a screening can.

The wiring may now be undertaken as shown. It is recommended that in these two stages only components of the type specified should be used as the use of inferior components, especially in the by-pass and decoupling circuits, can result in instability or alterations to the response characteristic of the receiver, causing an asymmetrical operation of the detector stage and thus a distorted audio output. To avoid unfortunate capacitance effects VC1 should be mounted as close as possible to L2. (In the original this was not done—this resulted in extremely poor frequency stability which was cured immediately on removing C7 to a point proximate to L2.)

I.F. and Detector

This is a very straightforward piece of construction. It is recommended that the i.f. by-pass and de-emphasis circuits be mounted on a tag strip as shown in Fig. 4 as this makes for a reasonably neat layout and helps to avoid hum pick-up. Screened wire should be used to take the output from the detector stage to the volume control to eliminate 50c/s hum. Another useful precaution in this respect would be to keep the leads carrying the heater current well away from all a.f. points.

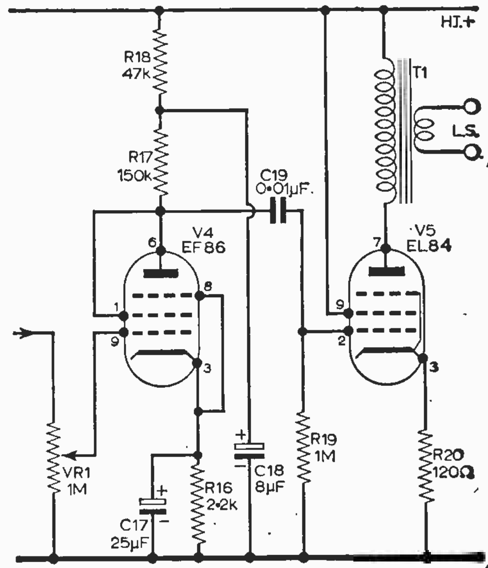
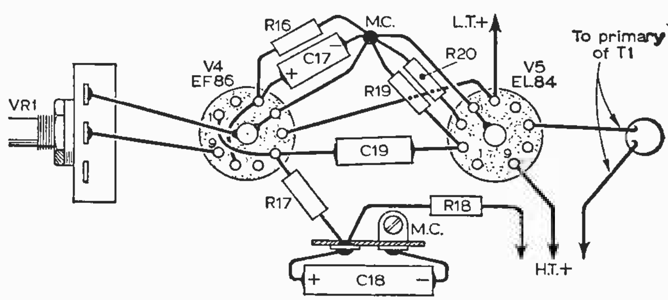


Fig. 7 (above): The a.f. amplifier circuit.

Fig. 8 (below): Wiring of the a.f. amplifier.



The unit now, as it stands, may be used as a local station tuner by connecting it up to a suitable power unit (250-300V d.c. at 25mA and 6·3V at 0·6A). The setting up and test procedure is exactly the same as for the more sensitive receiver (except, of course, that there is one less i.f. coil to align).

However, as stated earlier in this article, it will be found that the set is too insensitive for satisfactory results at a range above that of ten miles from the transmitter and so for areas of weaker signal strength another i.f. stage will have to be added. Also, since the signal strength will be less at this greater range the effect of interference will be greater, and so we shall have to increase the limiting action of the circuit to overcome this difficulty. The improved circuit for increased sensitivity is shown in Fig. 5 where the r.f. and oscillator sections remain intact, the new circuit continuing from point Z in Fig. 1.

2. THE IMPROVED CIRCUIT

It will be seen from Fig. 5 that the improved circuit has several additional features beyond merely that of an additional i.f. stage. Looking first at the detector stage we see that the anode and screen loads of V2 are each doubled in value—R15 (R7 of Fig. 1) becoming 10kΩ and R14 (R6 of Fig. 1) increasing to 47kΩ. This has the effect of lowering the anode and screen voltages of the valve and thus reducing the current that the valve draws, which improves the a.m. limiting properties of the circuit. The rest of V2 circuitry is retained in its original form.

The extra i.f. gain is obtained from V3 and its associated network. The only circuitry of interest here is the combination of C15 and R13. This circuitry has a time constant tof 27μsec and provides a certain amount of standing bias on the grid of V2. This circuit has a limiting action and thus aids V2 in a.m. interference suppression.

The wiring diagram for the additional i.f. stage is shown in Fig. 6 and indicates only the wiring for V3 (the wiring for V2 is exactly the same as in Fig. 4, save for the change in values of R6 and R7, making them R14 and R15 respectively.) The alignment and testing of the tuner is described under the heading of "Testing and Tuning".

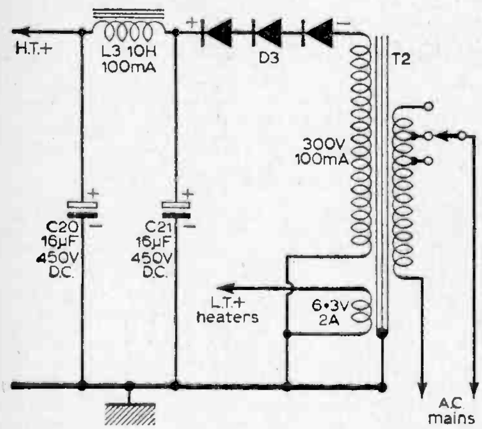


Fig. 9: The power supply circuit.

3. THE A.F. AMPLIFIER

The a.f. amplifier may take several forms. A simple circuit built around a single ECL82 would be quite satisfactory for ordinary domestic use if a little can be sacrificed in the way of quality. The circuit of the a.f. stage used in the prototype is shown in Fig. 7. It will be seen that this is quite an ordinary circuit form—pre-amplification being given by a triode connected EF86 feeding a single-ended output pentode (EL84). An EF86 was used here as it is intended at a later date to add feedback tone controls, in which case the extra gain given by a pentode configuration for the EF86 will become necessary.

Construction of this stage should follow normal high gain a.f. practice—especially in that heater leads should be kept well away from control grid leads and associated components; otherwise the layout may be as convenient. A wiring diagram for the a.f. stage is given in Fig. 8.

A suitable power pack for use with the completed receiver is shown in Fig. 9. Any power unit capable of giving 250-300V at 80-90mA and 6·3V at 1·5A will, however, be suitable.

Table I
TEST VOLTAGES

Pins	V1	V2	V3	V4	V5
1	100	1·5*	1·2*	50	—
2	—	—	—	—	—
3	200	1·5*	1·2*	1·0*	5·5*
4	a.c.†	—	—	—	—
5	—	a.c.†	a.c.†	a.c.†	a.c.†
6	200	—	—	50	—
7	4*	200	110	—	200
8	—	200	120	—	—
9	−4·5*	—	—	—	210

H.T. line 210V †L.T. 6·3V a.c.

All voltages measured with 20,000ohm/volt meter on 1,000V range (* on 10V range).

4. TESTING AND TUNING

Initially the whole of the wiring should be checked for wrong connections against the diagrams and the h.t. and l.t. leads examined for shorts to the chassis. If available, a milliammeter (0-100mA) should be inserted in the h.t. lead and all valves (except the rectifier—if used) should be removed and the set switched on.

After allowing the set to warm up the milliammeter should indicate that there is no current flowing in the h.t. circuit. Plug in the EL84. About half a minute after doing this the h.t. current should rise to about 50mA (±10%). Next plug in the EF86. The valve should light up (faint heater glow) but there will be little or no noticeable increase in current. There should be a general "liveliness" about the set now with a very faint hum in the loudspeaker. On touching pin 9 of the EF86 with a long-bladed screwdriver there should be a very loud noise from the loudspeaker (make sure that VR1—the gain control—is full up) and the h.t. current should fluctuate. If all is well the a.f. section may now be used as a gramophone amplifier if so desired. The tuner section may now be tested.

If only the tuner section has been constructed it should first be connected to an a.f. amplifier and a suitable power supply with, if at all possible, a milliammeter in series with the h.t. lead. We will

—continued on page 257

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3'6 EACH

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Switch-tuned Radio/Amplifier

BY R. MURRAY-SHELLEY

ALTHOUGH using only two valves together with a rectifier, this unit embodies the functions not only of a switch-tuned local station radio receiver but also of an audio amplifier capable of producing over three watts of power at quite reasonable quality.

At first glance the circuit may appear to be a little complicated, though it is in fact quite straightforward. Provision is made for the reception of two programmes: in the case of the prototype these were the Home Service on the medium wave band, and the Light Programme on long waves. In theory any two selected stations could be received but it should be pointed out that the selectivity and sensitivity of the circuit is necessarily limited to a certain extent—it is essentially a local station instrument. Stations are selected by means of a three-position switch. The third position converts the unit into a two-stage amplifier.

The Radio Circuit

Only one tuned circuit is employed in this design for each channel, therefore the initial alignment of the equipment is greatly simplified. Leaky grid detection together with a measure of positive feedback ensures a reasonable level of sensitivity. This positive feedback is regulated by adjusting the voltage on the screen grid of V1, the cathode of this valve being connected to a tapping on the tuning coil—in this way a very stable adjustment can be achieved.

The value of the grid leak resistor R3 calls for some comment. It is usual to find a resistor of several MΩ in this position, however in this design the component doubles as the grid leak resistor for the first stage of the audio amplifier, and thus a smaller value of resistance has to be used. In fact it is found that in practice the specified value of 220kΩ is quite suitable.

The operation of the output stage, V2, is the same on both radio and amplifier functions. The volume control VR3 is included in its grid circuit. A measure of tone correction is introduced by the capacitor C7; this together with the slight degree of negative feedback produced over the first stage (in the "amplifier" position) by the elimination of the usual by-pass capacitor for R4, leads to a very satisfactory performance.

The Amplifier Circuit

The input to the amplifier is made via a jack plug and socket. This socket has integral switching contacts whose function can be clearly seen from the circuit diagram (Fig. 1). It should be noticed that in order to convert the unit from a radio receiver to an amplifier it is necessary to switch the selector switch S1 to position three, and then to plug in the jack plug.

This plug must be removed before the unit can again be used as a radio receiver. This slight inconvenience was thought to be justifiable since it avoids complicating further the selector switch connections. Again too much switching of signal circuits always brings with it problems of instab-

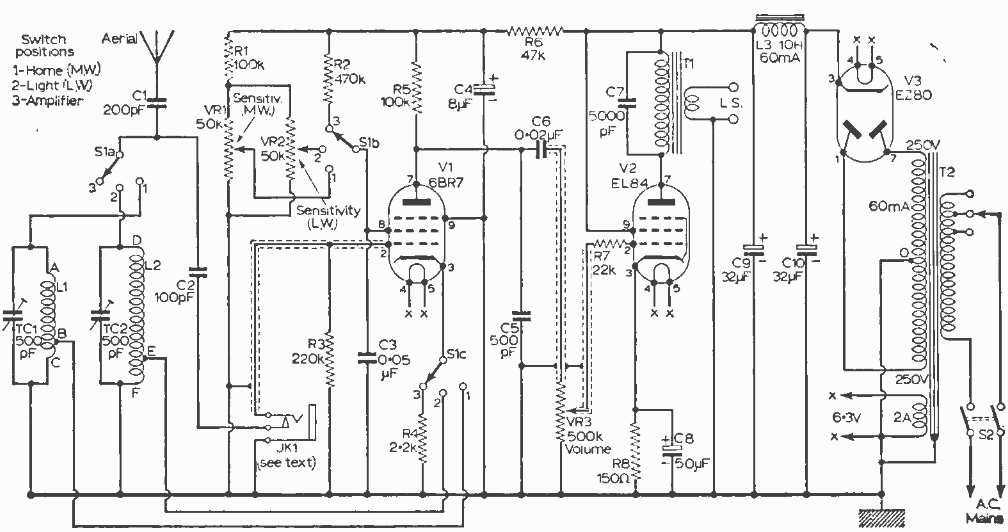

Fig. 1: The circuit.

ility and feedback which might prove difficult to counter. The amplifier input is at high impedance.

Power Supplies

The power-pack is quite conventional. Although the power consumed by the unit is not large (about 50-60mA h.t.) a mains isolating transformer is used in the interests of safety. Full wave rectification, large value smoothing capacitors and a smoothing choke all contribute to a low hum level.

The rectifier valve used is an EZ80 having a 6·3V heater. An EZ81 is equally suitable, though if other valves are used then C10 should be reduced to 16μF capacity. The chassis should be earthed.

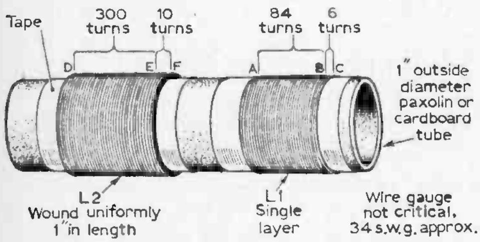

Fig. 2: Details of suitable tuning coils.

Construction

The unit is constructed on an aluminium chassis size 7in. x 5in. x 2in. deep. The drilling details for this chassis are given in Fig. 4. It would not be practicable to use a chassis of smaller dimensions than the one specified.

The valveholders, transformers and smoothing choke are mounted first together with the three variable resistors, group board, and the reservoir and smoothing capacitors (C9 and C10). Earth connections are made to an earth busbar which is connected to the chassis at one point only. This busbar is conveniently made of a length of 16 or 18s.w.g. tinned copper wire, and it is mounted as shown in the wiring diagram (Fig. 3).

The heater wiring and the wiring to the mains switch S2 should be completed next. This wiring which carries alternating current should be twisted together tightly as shown and pressed hard against the chassis. The power supply should now be wired, followed by the output stage and last of all the first stage. The valves should not be inserted into their holders until all the wiring has been completed.

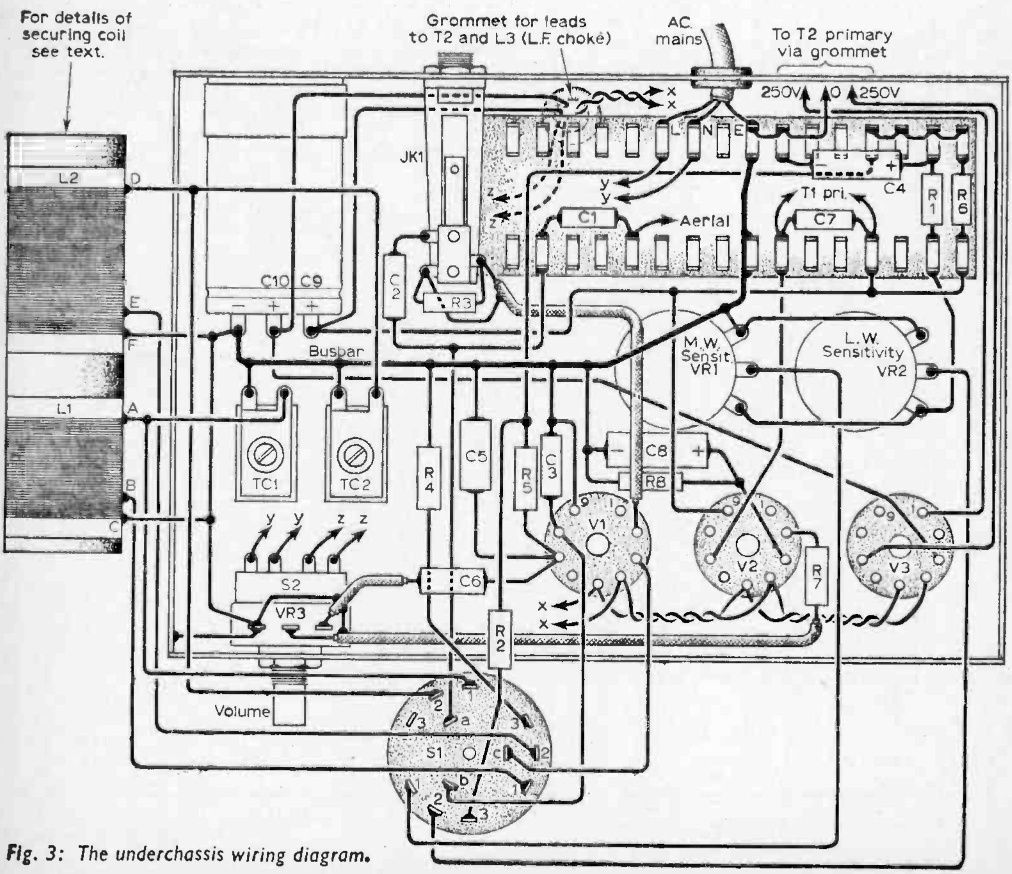

Fig. 3: The underchassis wiring diagram.

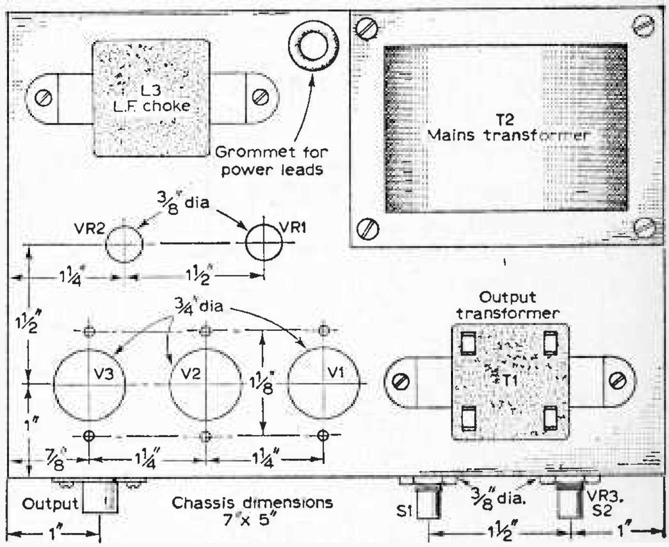

Fig. 4: Dimensions and drilling details of the chassis.

Screened lead should be used where it is shown in the circuit diagram. A determined effort should be made to keep all the wiring as short as is practicably possible. This particularly applies to the first stage. This method of construction leads to a less tidy arrangement than might otherwise be possible, but it pays dividends in that less trouble is experienced from instability.

The grid stopper resistor R7 should be connected as close to its appropriate valve pin as possible.

A suggested wiring plan is given in Fig. 3. Notice that here the selector switch has been turned through a right angle in order to clarify the wiring. The output from the unit was taken via a coaxial socket since this was to hand. Any other type of loudspeaker socket could, of course, be used. One side of the output is earthed as is one side of the heater wiring.

The connections to the jack sockets are shown in Fig. 5. The metal ferrule on the socket must make a good contact with the chassis. The trimmers TC1 and TC2 each have one of their tags soldered to the earth busbar which then serves as a mechanical support for these components.

COMPONENTS LIST

Resistors:

R1	100kΩ	R5	100kΩ
R2	470kΩ	R6	47kΩ 1W
R3	220kΩ	R7	22kΩ
R4	2·2kΩ	R8	150Ω 5W

All 10%, ½W unless otherwise stated.

VR1 50kΩ potentiometer, preset, log.
VR2 50kΩ potentiometer, preset, log.
VR3 500kΩ potentiometer, midget type with d.p. switch (S2)

Capacitors:

C1 200pF mica
C2 100pF mica or ceramic
C3 0·05μF paper 350V
C4 8μF electrolytic 350V
C5 500pF ceramic
C6 0·02μF paper 1000V
C7 5,000pF paper 350V
C8 50μF electrolytic 50V
C9 32μF electrolytic 350V
C10 32μF electrolytic 350V
TC1 500pF compression type trimmers
TC2 500pF compression type trimmers

Inductors:

L1, L2 (see text and Fig.2)
L3 Smoothing choke 10H 60mA

Transformers:

T1 Output transformer 3·5W (see text)
T2 Mains transformer tapped primary. Secondaries: 250-0-250V 60mA; 6·3V 2A
S1 Rotary switch 3-pole, 3-way
S2 Toggle switch s.p. s.t. (see VR3)
JK1 Jack socket, closed-circuit type (Bulgin J12)

Valves:

V1 6BR7 V2 EL84 V3 EZ80

Miscellaneous:

Coaxial socket. Three B9A valveholders. Screened lead. Wire for coils (see text). Connecting wire and sleeving.

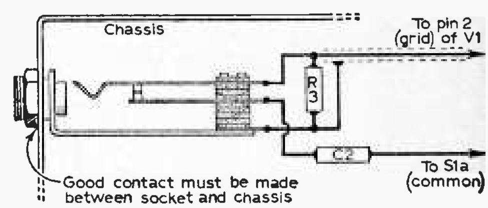

Fig. 5: Connections to the jack socket, JK1.

Construction of the Tuning Coil

The coils used in the prototype equipment were home made. Details of this construction are given in Fig. 2. The former used was a length of 1in. outside diameter paxolin tubing. Cardboard tubing or even a tube made from gummed paper would serve equally well. The wire gauge is not particularly critical, 34s.w.g. enamelled copper wire being suitable. On completion the coils should be varnished or preferably waxed.

The coils were fixed to the chassis in the prototype using a clip made from cardboard reinforced with plastic tape. A metal clip is not suitable. Care should be taken to see that the coil is not placed hard up against the chassis or other metal components.

Commercially made coils could certainly be used in this circuit, but they would have to be modified in order to incorporate the cathode tapping. This is most easily done by winding a few more turns on to the coil in the same direction as

—continued on page 232

by G.M. and E.C.D.

semiconductors

TALKING POINTS ON CIRCUIT PRACTICE

No. 6—More on R.F. Operation

Continued from page 149 of the June issue

TO predict the behaviour of transistors at radio frequencies without involving oneself in mathematics is extremely difficult. It is more than doubtful if any of the old, well-tried "single-valve" circuits really offers fruitful ground for experimenting with "single-transistor" techniques. Completely new techniques hold the best possibilities of success in this field.

The fact of the low impedance of transistors as compared to valves; the fact that they amplify current rather than voltage, the existence of an internal feedback path which is variable to frequency and which must therefore require a cancellation procedure which is also variable to frequency and which must of necessity upset "reflex" calculations; combined with the difficulty of avoiding "pulling" and therefore the de-tuning of the aerial circuits by the reflex circuits if modern high efficiency solid core inductances are used, all combine to make the design and operation of "freak" circuits at once a challenge and a problem, with transistors, if they are to be tunable over a wide band of frequencies, as must be a receiver intended for broadcast reception.

For single-channel reception the problem would not be so difficult nor the mathematics so involved.

Even with the superhet certain precautions are necessary. There may be feedback in the supply lines, which may require decoupling. The full supply voltage is rarely needed in the early stages, so the decoupling may also drop the supply to a lower voltage than is taken by the output stages.

PRACTICAL ASPECTS

Transistors tend to be noisy, though a mixer-oscillator will demodulate its own noise on signal; resistance and capacitors in the first stages should be of high quality and guaranteed stability whatever may be used in the later stages; and, of course, non-inductive. Decoupling capacitors are normally of some 100μF or more as far as the supply line is concerned, and they can vary from 0·1μF to as much as 8μF according to position elsewhere. Electrolytics with "can negative" must be insulated from deck, of course.

Since these devices, as well as their associated components, are so small it can be quite a job to service a receiver which does not work—more especially so if it is of bird's nest construction. A bold layout, on breadboard lines, will repay the builder . . . it is simple enough to finalise and "box" it after one has made sure it operates successfully.

For work at broadcast frequencies, start with a fully-fledged superheterodyne circuit, you will then "duck" nine tenths of the problems, and get acceptable results into the bargain. For experiments with freak circuits use an outdoor aerial and air-cored inductance coils. This may sound pessimistic advice, but would you expect (if using valves) to operate a "single-valver" on an 8in. frame aerial with much success? It is as well to remember that commercial portables normally use five or more valves, while commercial transistor portables commonly have seven stages: six transistors and a diode.

Remember the low input impedances you will be dealing with, and that matching is normally a step-*down*; that it is not voltage amplification you require from each stage . . . you are likely to get more of that than you want if you are not to overload the following stage—but *current* swing, which in any case must not be more than the output current of that stage can take, after amplification in the transistor itself, without causing more voltage drop over the collector load than you have volts to drop.

Intelligent use of the published curves and data should make the difference between valve technique and transistor technique understandable.

Transistors are not really difficult—apart from the mathematics and this aspect of their use has probably been done to death—they are just "different". Once they are approached as devices in themselves, and not as substitutes for valves operating much in the same way that valves do, an entire fog of misapprehension and frustration is likely to dissolve.

They are probably most tricky in their high frequency application; if one can obtain a signal from one's first stage then it can always be amplified afterwards . . . but the tuning of transistorised aerial stages, other than in superheterodyne circuits, is still a field in which there is much to be done.

We realise that we are likely to be very unpopular for suggesting that freak transistor circuits more often do not work than they do, and we are quite certain that numerous people will reply angrily that they have got Pekin with no trouble at all on one transistor and a safety-pin used for an aerial, and on medium waves at that. Nevertheless, we are in company with the professionals when we say that the superheterodyne circuit is the one to be preferred for transistor radio applications at the present state of knowledge. And we hope that we have given sound reasons why in fact this is so. It follows inevitably from the theory of transistors.

We have not considered f.m. applications and a whole host of other possibilities, nor dealt in practical circuits because rather than add to the legions of circuits already published our aim is to enable the reader to understand those that are. These articles are in the main theoretical. To talk glibly of "Neutralisation", "Unilateralisation" and so on is all very well . . . but what do these terms mean? And why are the procedures to which they refer necessary? We could write down the formula for K; the stabilising factor for transistors, for instance; but we would require a book, or a course at a technical college to *explain* that formula to the non-technical. Even at that we may attempt it some day.

We are very conscious of all the things we have still managed to miss out; but at least with the explanation given above of the peculiarities of transistors and diodes in operation at radio frequency we hope we have supplied the clue which may explain hook-ups that have failed to work and at the same time enable a clearer understanding to be gained of the general principles involved.

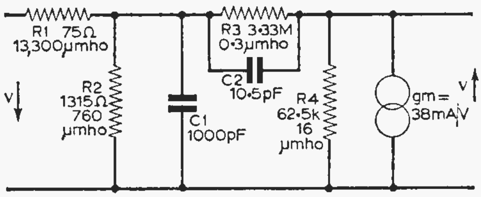

Fig. 1: Hybrid π circuit for OC45 at any frequency.

BASE POTENTIALS

In the first article of this series, published in February, 1963, it was suggested that in order to obtain a base current of 200μA, the potential required on the base would be 200μV.

This implies that the input resistance (base to emitter) of a transistor is of the order of 1Ω. However, this is not so in practice, since the input resistance of a transistor in the common-emitter mode of operation is likely to range from 500Ω to 1,000Ω.

It follows from this that the base potential required to obtain 200μA base current will range from 100mV to 200mV.

It should now be clear that where 200μV is mentioned in the text and also in the accompanying diagrams Figs. 2, 3 and 6, this should be amended to read 200mV (millivolts NOT microvolts).

The amendment also applies to the second article in the series (March issue) where the base voltage is referred to on pages 1026 and 1029.

One last word in this connection: although evaluation of the voltage on the base was referred to as completing the theoretical picture, if the problem be considered in terms of current as recommended it will be appreciated that the total resistance required to limit the value of Ib to microamperes is such that the resistance of the device itself plays only a very small part in it. The makers' data therefore should, as stated, always be referred to for actual values, or a meter used in the emitter.

NEUTRALISING INTERNAL FEEDBACK

The formulae for calculating the value of internal feedback are rather beyond the scope of these articles. We show in Fig. 1 the equivalent circuit of an OC45 at any frequency working at a Vce of −6V and an Ie of 1mA. The calculations can be made from the values given, by those with the mathematical knowledge.

If the transistor is only working at one frequency, as in the case of a superhet i.f. stage—say 470kc/s, then the π equivalent circuit shown in Fig. 2 can be used and it will be seen that the calculation becomes a much simpler proposition.

In the hybrid π circuit of Fig. 1 the values of all the components can be regarded as independent of frequency providing the operating frequency is always considerably lower than that of f=the cut-off frequency.

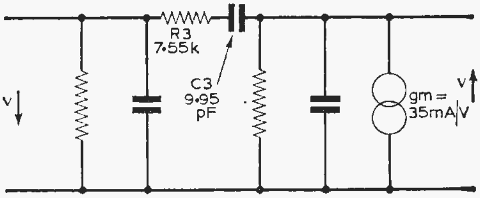

Fig. 2: π circuit for OC45 at 470kc/s only.

In the π equivalent circuit of Fig. 2 all the components depend on frequency. We see that the feedback circuit within the transistor itself consists of R3 and C3—which Messrs Mullard give as R3=7·55kΩ in series with C3=9·95pF (micro-microfarads) for the OC45 working at the frequency and conditions stated.

To neutralise this feedback we require an equal and opposite feedback to be erected externally, to cancel it out. At the values given for R3 and

C3, then the neutralising values would theoretically be 7·55kΩ and 9·95pF, similarly. But we must remember that the external feedback has to be connected from the secondary of the interstage coupling transformer in order to reverse its phase in relation to the internal feedback, and this transformer is normally a step-*down* ratio in order, as we have already seen, to match the high impedance output of the transistor to the low impedance input of the (base of) following stage.

Supposing this transformer to be a ratio n:1 then the values for the external feedback elements will be nC3 and R3/n. At a ratio of 6:1; Rf=1·26kΩ and Cf=59·7pF. The equivalent circuit with both internal and external feedback paths is in Fig. 3.

It will further be realised that the addition of this external neutralising pathway must alter the original values of input and output impedance of the transistor itself and that these changes will also require to be worked out. They will not present any great difficulty to those familiar with evaluating π and hybrid-π equivalent circuits but, as we have said, they are beyond the scope of this article.

The purely practical man can obtain the actual values for individual types of h.f. transistor as applying to the voltages and frequencies at which they will be operated in commonly preferred circuits, by reference to the published data issued by the transistor manufacturers themselves. If he wishes to experiment outside these more or less established circuitry conditions then he will perforce have to work out the answers himself.

The values given here are for the Mullard OC45, which is an h.f. transistor; they would be different again of course for the OC170.

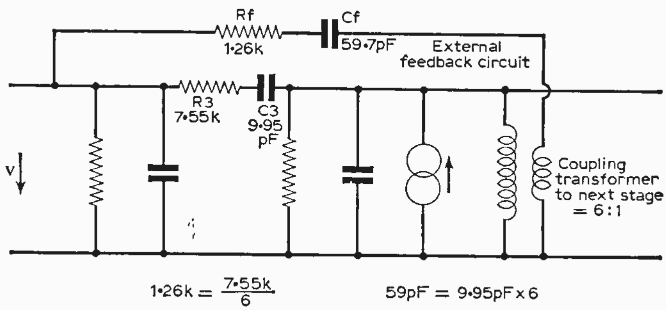

Fig. 3: Equivalent circuit for OC45 at 470kc/s, showing neutralising components.

If one obtains the basic values for the type of transistor in question. from the maker's published data or from the makers themselves if necessary, the required feedback constants at all frequencies, or at a single preferred frequency, can be worked out from the data given above. From those calculations the final impedance, input and output can then be calculated so that matching can be done with some precision and regeneration applied, if required.

SERIES CONTINUED NEXT MONTH

SWITCH-TUNED RADIO/AMPLIFIER

—continued from page 229

the original winding. The end of the original winding then becomes the cathode tapping. About four or six turns would be required in the case of a medium wave coil and eight to ten turns for a long wave coil.

Components

The valves specified are all miniature B9A based components. Older international octal based types could be used. however. In this case a 6J7G should be substituted for V1 (the 6J7 and 6BR7 are electrically almost identical), and a 6V6G for the EL84. The output obtainable from the unit would be reduced, however, since the 6V6 has a lower slope than the EL84. If a 6V6 is used the value of R8 should be increased to 270Ω. A larger chassis will probably be required if octal valves are employed.

Using the EL84 output valve the output transformer should have a ratio of 40:1 for a 3Ω loudspeaker, or 15·5:1 for a 15Ω loudspeaker. (For a 6V6 the ratios are 50:1 and 23:1 respectively.) the transformer should have a power rating of 3·5W and the primary should be rated for a d.c. current of at least 40mA.

All resistors are ½W rating and 10% tolerance, unless otherwise stated in the components list. The valveholders should preferably be of the nylon loaded type.

Alignment and Testing

On completion, the wiring should be carefully checked. An aerial should then be connected to the receiver. An indoor aerial will suffice in areas of good signal strength, though an outdoor arrangement is of course to be preferred.

The selector switch is then turned to the medium wave band position and the unit switched on. On rotation of the appropriate feedback control (VR1 in this case) a point should be reached where the set starts to oscillate. The control is then turned back until the oscillation just ceases. The trimmer capacitor TC1 is now adjusted to tune in the local Home Service broadcast. VR1 is then re-adjusted for best reception.

The same procedure is repeated for the Light Programme, in this case VR2 and TC2 are adjusted. The amplifier circuit requires no initial adjustment. ■

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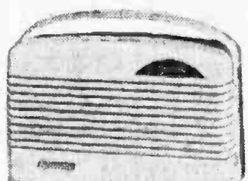

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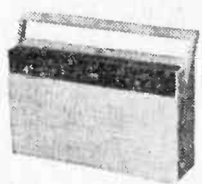

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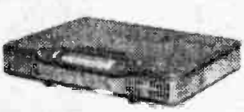

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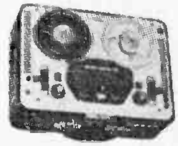

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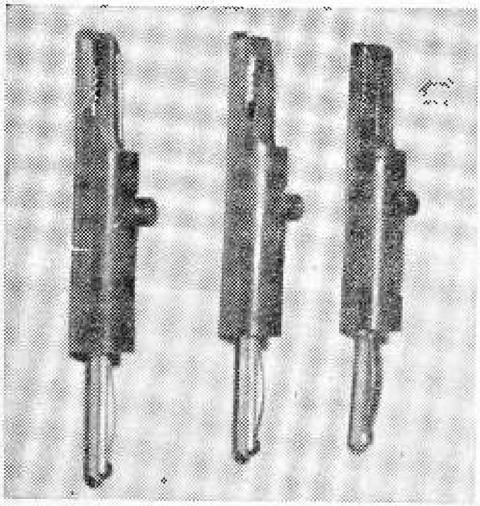
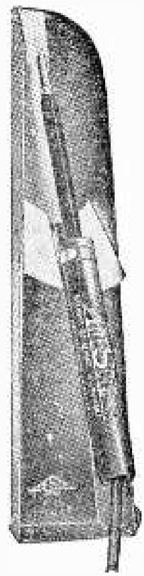




Magnetic Pickup

FOR AN ACOUSTIC GUITAR

incorporating a transistor pre-amplifier

by J. Banthorpe

THE electric guitar has gained much popularity of late owing to its prominence in popular music. Many people, who already play a conventional acoustic guitar, would like to change to an electric guitar, for greater versatility, but are deterred by the cost.

The alternative is to modify the acoustic guitar by the addition of a pick-up. The magnetic pick-up described here has none of the following disadvantages associated with the more usual contact microphone type of pick-up.

1. Acoustic feedback if used too close to the loudspeaker.
2. Sensitivity to extraneous noises.
3. Inadequate frequency response.

It is essential however that steel strings be used on the guitar.

Construction

Three small button magnets,* each drilled to take a small screw, are required. These are bolted to a paxolin board so that one magnetic pole lies under each string, as shown in Fig. 1.

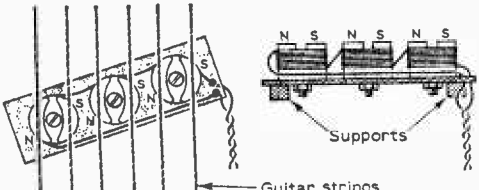


Fig. 1: (above).

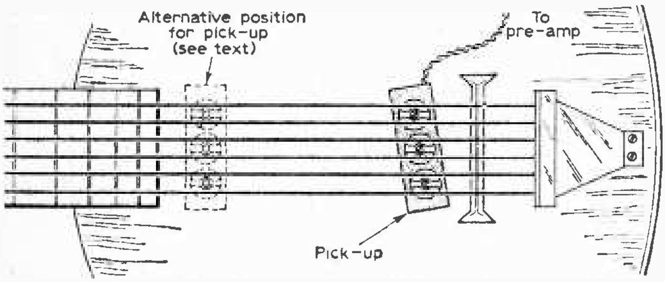
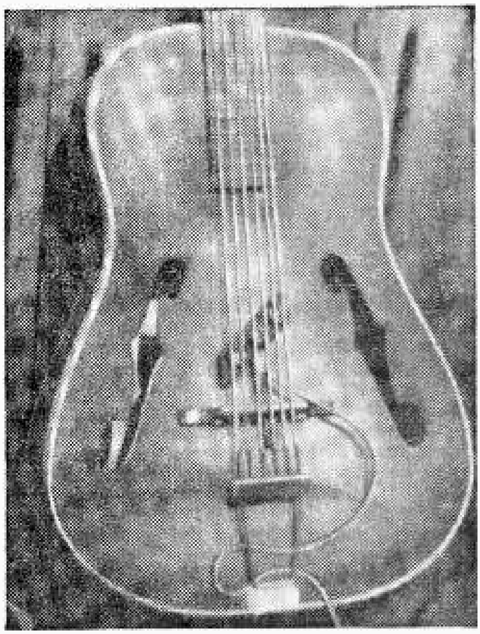


Fig. 2: (below).

*Suitable button magnets are manufactured by Eclipse Ltd. and are on sale in many tool and hardware shops.


The pick-up in place on a guitar

Each magnet is wound with 20-30 turns of 32s.w.g. enamelled wire. The gauge of wire is not critical. The pick-up is mounted on the guitar body as shown in Fig. 2. With the pick-up mounted near the fret-board a mellow sound is produced.

If, however, it is mounted near the bridge, several harmonics of the original note are picked up and produce the popular "twangy" sound.

The steel strings are magnetised by the underlying magnets and when plucked, the resultant change of magnetic flux induces an e.m.f. in the surrounding coils.

The pick-up is connected to an amplifier via a matching transformer. A small pentode output transformer is suitable for this purpose. It is advisable to keep the matching transformer well away from the amplifier since it is sensitive to "hum" radiated by mains transformers.

The pick-up may be connected to the transformer by up to 5yd of twin flex with negligible hum pick-up. If greater lengths are required screened cable should be used. Screened cable should also be used from the transformer to the amplifier.

Extra Gain

The output from the matching transformer is some 5-10mV. It is therefore not possible for those not possessing a high-gain amplifier, to connect the transformer output directly to the gram sockets of a radio receiver or to a gramophone amplifier.

In order to use the pick-up in conjunction with a gram amplifier,

—continued on page 274

pocket SIGNAL INJECTOR

BY R. W. KNEESHAW

NO claim is made by the author with respect to the originality of the circuitry, as this is purely a free running multivibrator (collector coupled). The circuit diagram is shown in Fig. 1.

All the author claims is, perhaps, some originality in the novelty of constructing such a multivibrator in a small penlight torch container, which is readily obtainable at 1s. 10d. from Woolworths. This container is readily adaptable without any physical modification, especially since it has a shaped plastic "nose cone" which allows neat professional streamlining of the probe tip to be obtained.

The whole unit costs about 25s. to construct, and is as professional in appearance as those signal injectors which are available on the market costing about £4.

The output is of square wave form at a fundamental frequency of about 2kc/s and thus is rich in harmonics, and so provides a continuous note when injected into any receiver, up to about 25Mc/s.

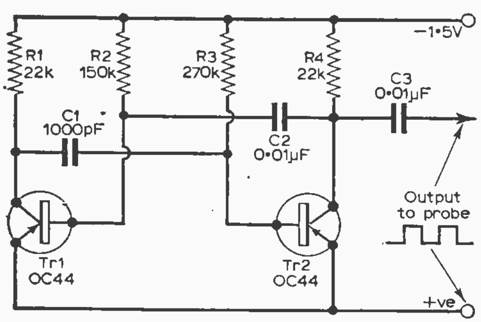


Fig. 1: The circuit of the instrument.

The power supply is entirely self-contained and is very inexpensive comprising of a single 1·5V leak-proof U7 penlight cell, the life of which is probably only determined by its deterioration with time.

Construction

The complete multivibrator is constructed on a small rectangular chassis of paxolin 1¾in. long and $\frac{9}{16}$in. wide, and $\frac{1}{32}$in. thick. Celluloid or Perspex or similar material is not suitable since during the construction this would more than likely become twisted or burnt by the heat of the soldering iron. This chassis must have a number of holes bored in it at specific points, as in Fig. 2.

Holes A, B and C are of $\frac{3}{32}$in. diameter and should be bored using a twist drill, all the other holes however are quite small and in fact were pierced by means of a red-hot sewing needle, in the positions indicated.

Next cut a piece of spring brass or phosphor bronze of about $\frac{1}{32}$in. thickness to the dimensions shown in Fig. 3. Such a piece of spring brass is easily obtainable from the brass terminal strips found on some 4·5V torch batteries.

Now bend this brass strip in a gentle curve and attach it to the paxolin chassis by pushing the thin tongue at the end of the strip through hole B and bending it over. Also attach two paper clips to the chassis i.e. one at either end. This is done by snipping off about half of the length of the "legs" of the paper clips and bending the remaining part of the legs through the holes A and B.

The "legs" of the paper clips after bending should be tightly squeezed to the chassis by means of pliers, and then soldered so that the clips remain firmly attached and do not work loose. The attachment of the paper clips and brass "leaf spring" is shown in Fig. 4.

Wiring

Take resistors, R1, R2, R3 and R4 and cut all their connecting wires until in each case the wires left are about $\frac{5}{16}$in. long. Tin these remaining wires very lightly. All resistors should be of the miniature ¼W type in order that they will not impede the chassis when it is finally pushed inside the penlight casing.

The resistors should have their leads bent and passed through certain specific holes in the chassis and should be so disposed as shown in Fig. 5.

The first thing to be soldered is the lead of R2 to paper clip "A" (see also Fig. 6). Solder next the emitter leads of both Tr1 and Tr2 to the bent-over tongue of the previously mentioned brass strip. A heat sink *must* be used when soldering all connecting wires of transistors and the author found that a pair of metal tweezers with pointed ends were sufficient in soldering the transistor leads on this tiny chassis. The tweezers, of course, should always grip the wire between the transistor and the point of soldering.

Next the base and collector wires must be fed through the correct holes in the chassis (as shown in Fig. 5) and soldered lightly and quickly to their respective resistors (the soldering being done under the chassis, of course).

C1 must now be soldered in place. It is placed in position across the chassis in the space now existing between the two transistors. The leads of

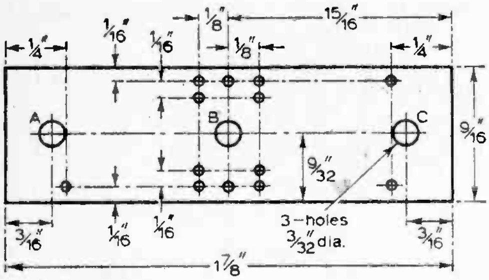


Fig. 2

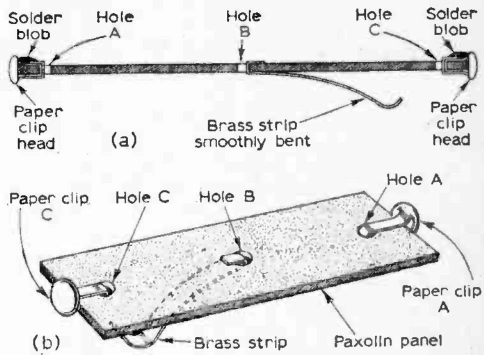


Fig. 4

Fig. 3

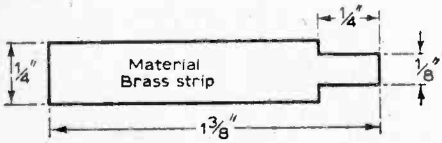
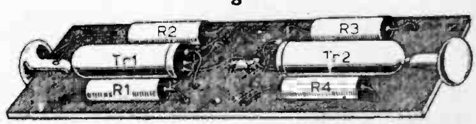
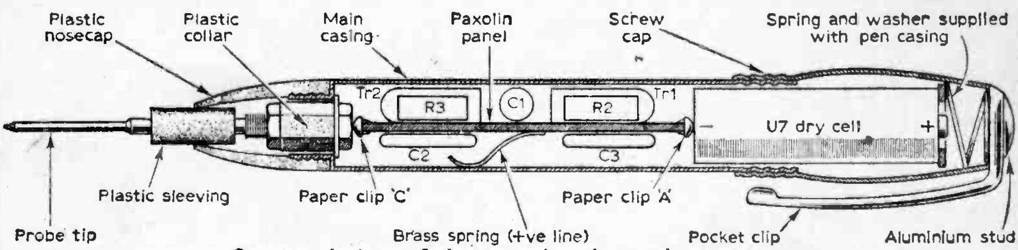


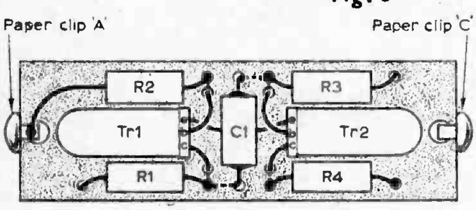
Fig. 5





Sectional view of the completed signal injector.

Fig. 6



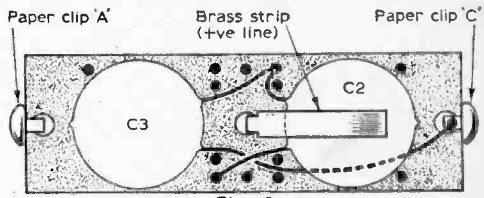


Fig. 8

Fig. 7

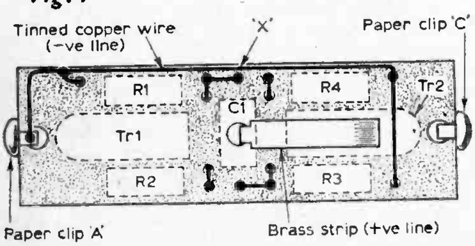


Fig. 9

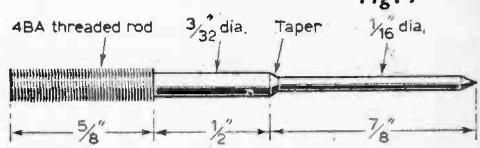
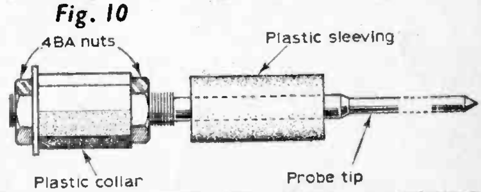


Fig. 10



C1 must be threaded through the two remaining holes in the chassis and one lead soldered underneath the chassis to the junction of R3 and the base of Tr2, the other lead being connected to the junction of Tr1 collector and R1. The mounting and connecting of C1 is shown in Fig. 6.

Now the underchassis wiring must be completed. A piece of thin gauge tinned copper wire (the −ve battery line) must be run along the underside of the chassis as shown in Fig. 7. It must first be soldered at paper clip "A" and terminated at the underside connection to R3 and, as seen in Fig. 7, during its run it is soldered to R1 and R4 (to the ends of these resistors, which are as yet unconnected). In the region of "X3" (Fig. 7) this copper lead must be bent outwards slightly to prevent it from touching the other underchassis connections to R1 and R4 so that it does not short out these two resistors.

All that remains to be done now is to wire in capacitors C2 and C3. These are both of the "disc" type and must be as small as possible. Such capacitors were found to be more suitable, since the tubular type will probably be too large and prevent the chassis from being pushed into the penlight casing.

The connecting wires of C2 and C3 should first be lightly "tinned" and then insulating sleeving slipped over them. Fig. 8 shows how C2 and C3 are connected. These of necessity must be laid flat against the underside of the chassis. One wire from C3 and one from C2 are both connected to R4 at the point shown and the other lead of C2 is connected to R2. The other lead of C3 is soldered to paper clip "C".

The chassis is now completely wired together.

Fitting the Chassis into the Casing

The penlight casing actually forms the connection from the battery positive terminal to the chassis via the brass spring fixed to the chassis. It is therefore imperative that the inside of the case must be clean to ensure good contact between it and the brass spring. To ensure this, scrape the inside of the "bulbholder"-half of the penlight case with a small round file, especially at the point where the brass spring contacts the casing.

In the "bulbholder"-part of the casing is a small spring. This should be extracted and placed inside the screw cap instead.

The chassis may now be pushed inside the "bulbholder"-part of the casing and if the chassis dimensions have been carefully adhered to it should make an easy but rigid fit.

Paper clip "C" should be made to enter first, and care should be taken to ensure that the brass strip enters the casing properly. The chassis should then be pushed right down to the end of the casing by means of a pencil pushing against paper clip "A". The U7 penlight cell must now be pushed into the casing until its −ve terminal (the bottom of the zinc container) is hard against paper clip "A". The penlight cap may then be screwed over the lower casing.

Preliminary testing

Although the probe tip has not yet been built the injector should now be working and, to ensure that it is, place a piece of wire into the aerial terminal of any available radio receiver and touch the other end of the wire on to paper clip "C", which may be exposed at the bottom of the casing if the plastic "nose cone" is unscrewed.

A continuous note should then be heard in the radio receiver. If no note is heard, probably the screw cap is not screwed on far enough and should be screwed on further. If this is done and a note is still not heard in the receiver it is quite likely that the brass strip is not making good contact with the inside of the casing. To cure this the chassis should be removed (by pushing on paper clip "C" with a pencil) and the inside of the casing scraped some more with a small, round file or sandpaper. Also bend the brass strip very gently out a bit further.

If this still doesn't produce a note in the receiver then there must be a mistake or bad connection in the chassis wiring, which should be rechecked.

The next job is to construct the probe tip.

Making the Probe Tip

The probe tip is made from a piece of 4B.A. brass screwed rod which is easily obtainable from a local "hobbies" shop. Alternatively a long 4B.A. bolt (longer than 2in.) may be used.

A 2in. length was sawn off the brass screw rod and placed in the chuck of a hand drill, which was clamped in a vice. The hand drill was used as a crude type of lathe and, apart from doing the job on an actual lathe, an electric drill would make this part of the operation a little easier. However, the brass rod was fairly soft and even using the hand drill the probe tip was correctly fashioned in about half an hour.

The brass rod was thus filed to the correct shape while being turned as fast as possible in the chuck of the hand drill. The shape to which the rod is turned is shown in Fig. 9.

The original 4B.A. thread is left on for $\frac{5}{8}$in. of length (this part was in the chuck of the drill). The next $\frac{1}{4}$in. is turned down to $\frac{3}{32}$in. diameter and the next $\frac{7}{8}$in. is turned down to $\frac{1}{16}$in. diameter.

Next obtain a standard type aerial plug. These are readily obtainable from any radio shop. Saw the plastic screw cap portion of this aerial plug about $\frac{3}{8}$in. from the top (cable entry end). Fix this portion of the plug cap over the probe tip by means of two 4B.A. nuts as shown in Fig. 10.

Strip about $\frac{1}{2}$in. of plastic sleeving off a piece of thick plastic-covered wire (such as is used to take the e.h.t. to the tube in TV sets) and slip this sleeving over the probe tip to the position shown.

Alternatively, obtain a polystyrene ink cartridge of the type used in certain types of fountain pen these days. These are readily obtainable from any stationery shop for 4d. Puncture both ends of this cartridge and empty it of ink and then cut off a portion 7/10in. long from the "stepped" end. Slip this portion over the constructed probe tip.

Assembling the Injector

The probe tip is now complete and the chassis should now be removed from the casing and the probe tip dropped in point first until it protrudes through the original "bulbholder" section. The chassis may now be replaced inside the casing (paper clip "C" entering first), the battery then being correctly positioned and the screw cap replaced.

The plastic "nose cone" may now also be screwed in place, being threaded over the protruding probe tip. The probe tip and plastic "nose cone", both correctly positioned, are shown in the illustration on page 237.

The finished signal injector is extremely small and light and may be easily clipped into a pocket. The injector is switched on by screwing the pen-light cap fully on and the instrument is switched off by unscrewing this cap half a turn or so.

Warning

One point must always be remembered. *Never insert the battery the wrong way round, otherwise damage to the transistors will result. The battery must always be inserted such that its positive terminal enters the screw cap of the container first.*

It must also be understood that the squarewave output from the injection appears across the output

However, this injector may also be employed as a fault-finding aid in mains operated equipment, where quite often it is found that the chassis of such equipment is live. The user of the injector should thus remember that if he then connects the penlight casing to the chassis of the equipment under test he is in danger of obtaining a shock from the injector.

This danger can be alleviated in such circumstances if, for the purposes of testing on such live equipment, the user completely wraps or binds the injector with insulation tape, which can quite easily be peeled off later when the job is completed.

USING THE SIGNAL INJECTOR FOR FAULT FINDING

It is not claimed that the injector is infallible as a fault finder as, for instance, it probably will be of no use if the fault is a transistor that has for some reason lost its gain but is not in any way open circuit. When this occurs the signal from the injector would still pass through the faulty transistor, although it would not be amplified by

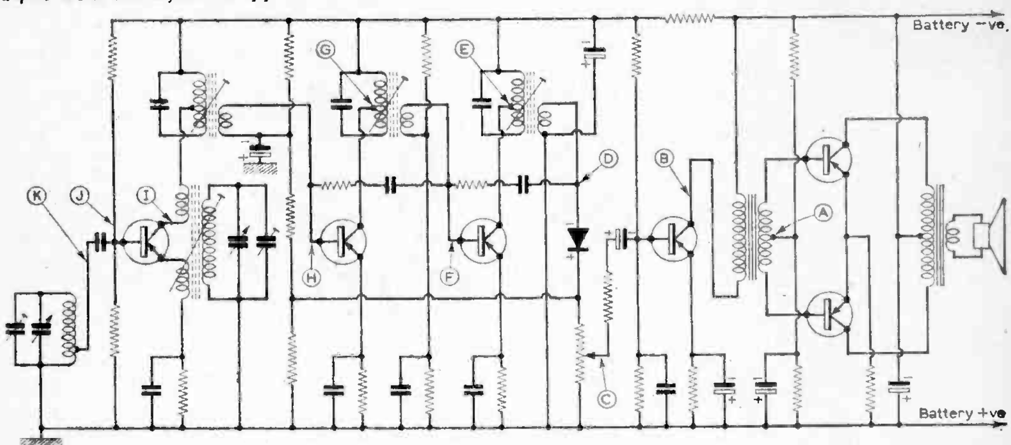


Fig. 11: A typical transistor superhet circuit.

probe tip and the −ve battery line (the penlight casing) and so, when injecting the signal into a receiver or other piece of apparatus, it is not sufficient for the probe to be placed on the point of investigation. The penlight casing must be connected also to the −ve or earthline chassis of the equipment being tested. To facilitate this a small connecting lead must be constructed which is merely a piece of plastic-covered flex (about 18in. long) with a crocodile clip (of the miniature type which are readily available these days) fixed to each end.

When testing circuitry one end of this lead must be clipped to the −ve line or chassis of the equipment under test and the other end should be clipped on to the metal pocket clip attached to the screw cap of the penlight casing.

This injector was primarily constructed for use as an aid to servicing transistorised equipment where in a majority of cases no voltage exists which make it dangerous for the main casing of the injector to be connected directly to the chassis of the equipment being repaired.

it. The reason is, of course, that such a faulty transistor is still a good electrical connection between its preceding stage and its succeeding stage (unlike a valve which, when it has lost its emission completely, would isolate the two stages by virtue of the non-conducting vacuum existing between its anode and cathode).

However, the device is very useful for faults which are of the "broken circuit" nature (i.e. open circuit resistors or capacitors or poor connection on to a printed circuit board) and in such cases can be used to isolate the stage in which the fault is present very quickly. How it may be used to do this is described below.

Consider the fault to exist on a typical transistor superhet receiver the circuit of which is shown in Fig. 11. Assume that the obvious initial precaution of checking the battery voltage has been carried out with a voltmeter and shown the battery to be satisfactory.

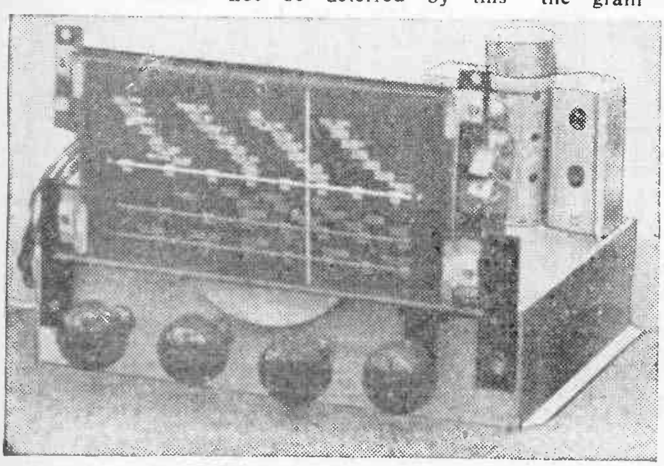
Then clip the wander lead of the injector on to the +ve battery line of the set and place the probe

—continued on page 270

7 VALVE STEREOGR

By J. B. Willmott

THIS is a reasonably simple receiver capable of reliable reception of the long and medium wavebands, and having a good standard of reproduction from gramophone records (both mono and stereo), yet without a multiplicity of variable controls. In order to keep costs down, "single ended" a.f. amplifiers are used on both channels, and, as an output of 3W per channel is more than adequate for domestic listening, low h.t. consumption output pentodes of the EL32 type (now readily obtainable at very low prices from advertisers in this magazine) were chosen, and the total h.t. consumption of the receiver was found to be just under 100mA, and therefore within the limitations of a mains transformer of modest size and cost. The first stage of a.f. amplification on each channel is provided by one half of a 6SL7 valve; a dual-gang potentiometer in the grid circuits provides simultaneous control of the volume of both channels, whilst a further dual-gang potentiometer, one half of which is connected "in reverse", controls the input to the EL32s and thus acts as a balance control. Fixed tone correction is provided by a simple resistor/capacitor combination across the primary of each output transformer, thus reducing the number of panel controls, and this has been found perfectly satisfactory in practice. With the moderate amount of stage gain available in the simple a.f. amplification circuits used, there is insufficient to spare for more elaborate tone correction methods. Intending constructors should not be deterred by this seemingly ultra-simplified audio circuitry—the results on both radio and gram are quite pleasing; well up to the standard provided by the average commercially produced radiogram in the medium price range.

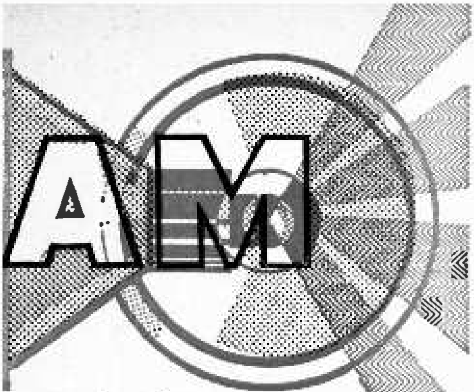


The finished tuner and amplifier chassis.

Radio Circuit

The radio section has been accommodated on the same chassis as the audio amplifier circuits. Simplicity is again the keynote. The first valve, an ECH35, is used in a conventional frequency changer circuit: in order to simplify switching arrangements, and to select long or medium wave radio, or changeover to gram reproduction, yet use only a single wafer 4-pole 3-way switch, a certain amount of ingenuity in design was needed. The aerial is bottom-capacity coupled to the tuned windings of the long and medium wave aerial coils L1 and L2 (see Fig. 1), which dispenses with the need for switching the aerial to the respective primary coupling windings. In order to eliminate modulation hum, often troublesome in bottom-capacity coupled circuits, the resistor R1 is provided. Note that C2, 0·0025μF, is a critical component as it acts both as bottom-capacity coupler to the coils and also as the decoupling component for the a.g.c. line. Hence, the value specified must be used.

The tuned windings of L1 and L2 are selected by the first section of the switch, S1a, for application to the mixer grid of V1. Note that in the "gram" position of the switch, the mixer grid is connected direct to earth in order to silence any incoming radio signals. In the oscillator section of V1, only a single oscillator coil, L3, is used on both wavebands, by virtue of the fact that when S1b is set to the long wave position, the additional capacitor PC2 is brought into play in parallel with the main tuning capacitor (VC1b). This provides correct tracking over both wavebands. A value of 390pF was found suitable in the prototype, but this may require slight variation to compensate for stray circuit capacities in individual units. Note that the medium wave fixed padder capacitor PC1 (470pF) remains in circuit on both wavebands. As in the "mixer" section, with the switch in the "gram" position, earthing of the grid (in this case the oscillator grid, of



course) is carried out to prevent any danger of radio break-through.

'Common' Resistors

Standard iron-core tuner IFT's designed for 465kc/s operation are used for i.f. coupling—V2 is an EF39 valve acting as a conventional i.f. amplifier. It will be noticed that certain economies of components have been made by using "common" resistors and decoupling capacitors for screen grid and cathode circuits of V1 and V2; this considerably simplifies the wiring up of these stages and in no way detracts from the performance. At the anode of V2, part of the signal is tapped off by C7, and applied to one of the diode anodes of V3 (which is a 6H6 valve) to produce a.g.c. voltage across R8, which is then applied to the control grids of V2 and V1. As the cathode of V3 is connected direct to chassis, a.g.c. is of the non-delayed type, which is quite satisfactory for l.w. and m.w. reception conditions.

The second half of V3 acts as signal demodulator, the resultant a.f. voltage being filtered by R9 in conjunction with C9 and C10, developed across R10 and fed via the d.c. blocking capacitor C20 to the "radio/gram" changeover portion of the switch. The two remaining poles, S1c and S1d, are used for this purpose, and are so wired that on "radio" (long or medium wavebands) both a.f. amplifier channels are connected in parallel and mono reproduction of radio signals is given by the two loudspeakers. In the "gram" position, each channel is fed separately from the left-hand and right-hand socket of the stereo pick-up input panel, and stereo reproduction of records is achieved. Ordinary "mono" records can, of course, be played using the same pick-up, in which case both channels will carry equal and identical signals, giving balanced mono reproduction from the two loudspeakers.

Components and Layout of Chassis

The entire radio tuner section and twin channel audio amplifier is easily accommodated on an aluminium chassis measuring 12in. x 9in. x 2½in. (this being a standard size obtainable ready made from a number of advertisers in this magazine); the power supply components are mounted on a separate chassis, measuring 11in. x 6in. x 2½in., and this can conveniently stand on the "floor" of the cabinet which houses the completed instrument. Power supplies are taken via an octal plug and socket mounted on the latter chassis, and a colour coded 4-way cable conveys h.t. and l.t. supplies to the main chassis.

It will be observed that no "on-off" switch is positioned on the receiver chassis; instead, a separate switch of the toggle type is inserted in one of the mains leads and mounted at a convenient point, either adjacent to the receiver controls, or, as in the author's case, on the rear cover of the cabinet. Isolation of the function of "on-off" switching from all other controls, enables volume and balance controls to remain undisturbed when switching the receiver on and off, and this considerably reduces wear of the volume control. Care should be taken to see that the mains supply to the gram motor is taken off "after" the toggle switch, so that the latter is entirely disconnected from the mains when the receiver is switched "off".

Potentiometers

There were no specialised components used in the prototype, and there is no reason why components of any reputable make should not prove satisfactory. It is, however, emphasised that the correctly matched dual-ganged potentiometers specified for VR1 and VR2 positions, designed for stereo amplifier circuits, must be used. VR1 should be a dual 1M log/log component, whilst VR2 should be of the 500k log/antilog type. Suitable alternative valve types for V1, V2 and V3 are suggested in the components list. For the remaining valves the specified types should be used, except if a mains transformer having a rectifier heater winding giving 4V is used, an MU14 (VU39A) can be used instead of the 5Z4. Any reliable make of mains transformer rated at 250-0-250V 100mA h.t., and 6·3V at 2·1A (or more), plus 5V (or 4V) at 2A, will suffice. In the prototype, a component of the totally shrouded top chassis mounting pattern was used. All resistors and capacitors should be within the ratings shown on the components list,* and, of course, it cannot be too strongly emphasised that all capacitors must be in first-class condition. Use of dubious components stripped from long-stored government surplus units should be avoided. It is far wiser to pay a few coppers extra for new capacitors in the first place, than to face hours of tedious fault tracing later.

The tuning coils specified are small in size, and easy to mount (a single 6BA screw), and their connections are clearly colour coded. The coupling windings, connected to the green and black tags, are not used on the aerial circuit coils, and are ignored. Adjustable trimmers of 0-50pF are wired across the tuned winding of each coil, and if a "triple bank" (i.e., three trimmers mounted side by side) is obtainable, as was used in the original, these are easily and neatly mounted adjacent to the coils. Actual mounting positions are not shown in Fig. 2, as this will depend on the component(s) used. It is absolutely essential that the oscillator coil, L3, be correctly wired into the circuit, together with its associated trimmer and padder capacitors. An error here will almost certainly prevent signals of any kind from being received.

Chassis

The layout and drilling dimensions of the main chassis are given in Fig. 2. Note especially the orientation of the valveholders as given by the position of the locating spigots. The diagram

* *The Components List will appear in the following issue.*

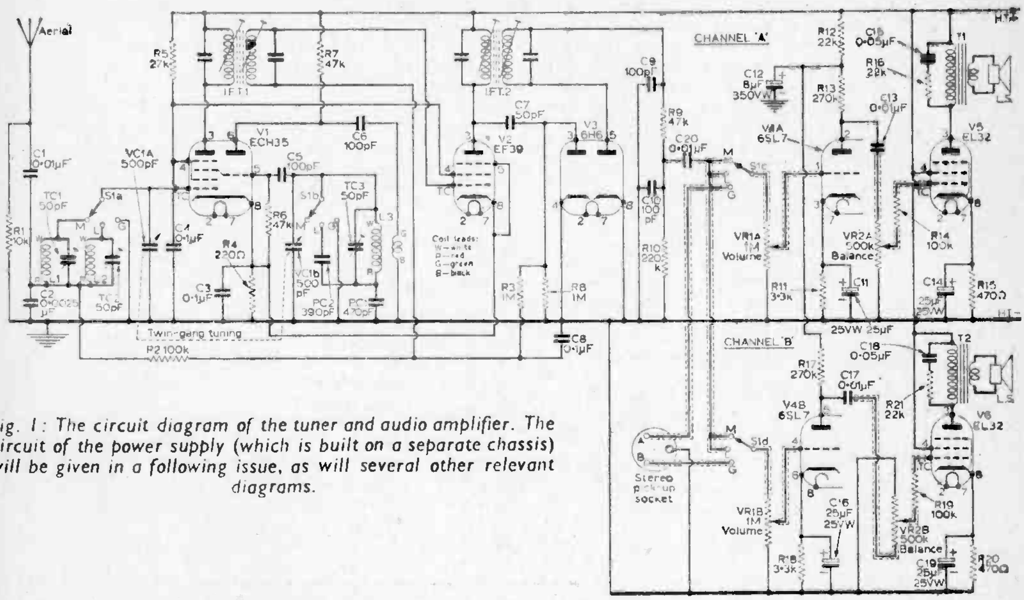
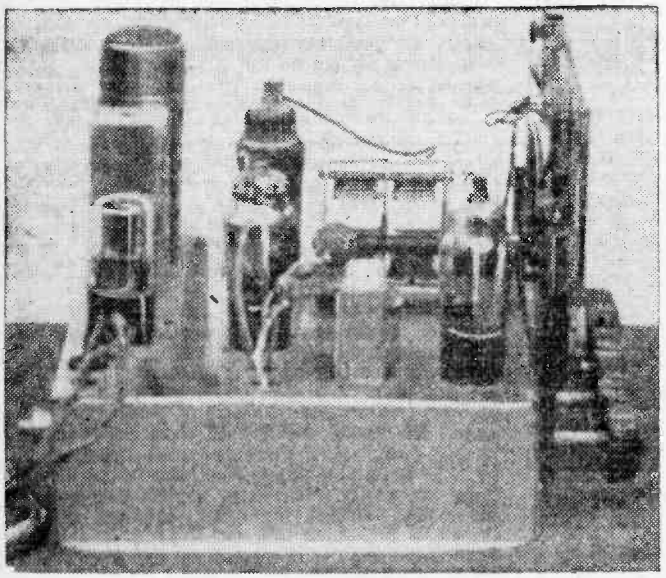


Fig. 1: The circuit diagram of the tuner and audio amplifier. The circuit of the power supply (which is built on a separate chassis) will be given in a following issue, as will several other relevant diagrams.



A side view of the 'main' chassis.

represents the top view of the chassis, and should be consulted when mounting the components, but it is often advisable to use the actual components as templates for marking the exact position of fixing holes on the chassis. The drilling size of the principal holes is clearly shown, except in the case of the valveholder fixing holes, which are all of 6B.A. clearance, but for clarity, size has been omitted from the diagram.

Dial Assembly

When satisfield that all holes have been drilled, the mounting of components may proceed. There is no hard and fast rule as to the order in which this should be carried out, but it is suggested that the valveholders be fixed in position first; a single 6B.A. soldering tag is attached to the fixing bolt nearest the locating spigot in each case, to form a convenient anchoring point for earth connections. This can be followed by mounting the various socket panels on the rear chassis runner, and the balance, volume and wavechange controls on the front runner. The dial assembly is then fixed in position, by first removing the flywheel from its drive spindle, in order that the spindle may pass through the hole provided in the chassis runner. The flywheel is then remounted on the inside of the chassis. The dial used has waveband markings for the short waveband (16-50m) in addition to the long and medium wavebands, but it is a simple matter to remove the s.w. markings from the glass dial—a gentle rub with a coarse cloth soaked in detergent will be found quickly to remove the lettering without scratching the glass. There is, of course, no reason why the markings should not remain if the constructor prefers.

The 2-gang tuning capacitor should next be bolted down, making sure that its spindle engages with the hole provided in the drive drum on the dial assembly without straining. The dial should be so adjusted that with the pointer opposite the 550m mark, the plates of the variable tuning capacitor are fully closed. Mounting of the remaining components may now proceed, noting that the output transformer for Channel A is mounted below chassis towards the rear, and that for Channel B is mounted above the chassis towards the front. Rubber grommets should be inserted in the hole providing access for the power supply and in the three holes through which pass the leads to Channel B output transformer, and the top cap (grid) connections of V5 and V7. The two tagboards, which are used in the construction, should not be mounted until the associated resistors and capacitors have been soldered to them.

TO BE CONTINUED

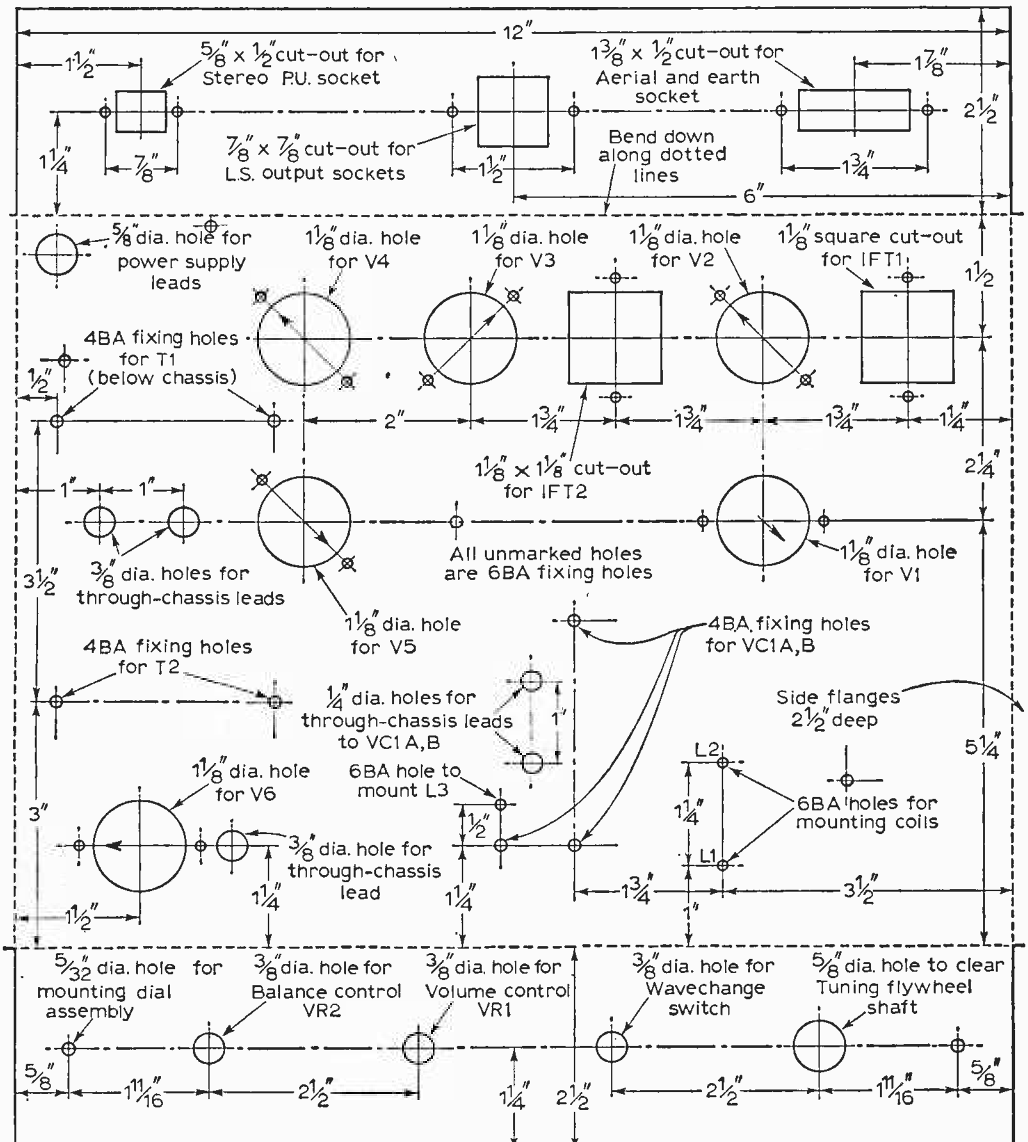


Fig. 2: The dimensions and drilling details of the main chassis.

more about

CATHODE FOLLOWERS

SOME NOTES ON USING CATHODE FOLLOWERS AS AUDIO OUTPUT STAGES AND AS SIGNAL STAGES FEEDING LONG RUNS OF SCREENED OR COAXIAL CABLE

by E. McLoughlin

IN the series of articles on Cathode Followers (Jan-March, 1962) it was stated, quite correctly, that the effective output impedance of a cathode follower is 1/gm. It was then further stated that, accordingly, maximum power output into a consumer load is obtained when this load has an impedance also equal to 1/gm of the cathode follower valve, in common with the same rule for power generators of any kind.

As some readers pointed out, this statement should have been amplified to read, in the case of the cathode follower, that maximum power-output *for a given input-signal drive at the grid* is obtained when the load impedance is 1/gm, provided also that the applied drive does not lead to excursions beyond the linear portion of the valve characteristic.

Now it is in practice a fact that, for normal valves, the acceptable grid-drive is very small in a cathode follower using such small output-loads as 1/gm. Some considerably higher load may thus give more *realisable total output power*, even though the power developed per volt of input drive is much less than in the matched condition. The much greater acceptable drive voltage then more than compensates. Thus (Fig. 1) one finds loads of several thousand ohms or thereabouts "ideal" for cathode follower audio-output stages, instead of a few hundred ohms, as would be dictated by the matched-load condition R = 1/gm.

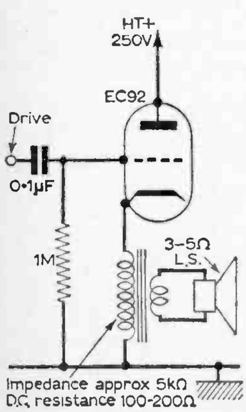


Fig. 1: A typical low-power cathode follower output stage for use in audio frequency applications.

These facts were, of course, correctly embodied in the practical circuits of the original articles mentioned. A practical circuit as shown in Fig. 1 can thus be arrived at simply by moving the normal output transformer from the anode circuit of a conventional output stage (Fig. 2) to the cathode circuit. Some adjustment of primary tappings may be required for optimum results, and the d.c. resistance of the transformer primary should be about equal to the normal cathode resistor, to set the normal d.c. operating point of the valve.

Normal Loading Law

It is not difficult to see why a cathode follower apparently disobeys the "normal law" for maximum power loading. The basic function of the cathode follower—basic circuit Fig. 3—is to attempt to reproduce a voltage *change* across Rk about equal to the voltage *change* applied across Rg. Now if Rk is extremely small, as it would be if it is equal to 1/gm (reciprocal of the slope of the valve), a very large current change is needed through it to produce a voltage drop change across it equal to even a moderate grid voltage drive. Such huge current excursions rapidly drive the valve beyond its linear range, unless the input drive is kept very small. If, however, the value of Rk is large, only small current excursions are required through it to follow even large grid drives, so that operation remains within the linear portion of the characteristic even for large drives.

The ultimate reason, therefore, why a cathode follower departs from the usual law for extracting maximum power from a generator is that it does not obey Ohm's Law for *all* conditions of operation. Ohm's Law simply requires that an electrical component have a constant effective resistance, given by the ratio of applied voltage and resulting current under all circumstances. This is true for a valve *only* as long as the operating point does not run beyond the linear range of the characteristic.

When one looks at the matter even more closely, one finds that the simple matching law for maximum power output in fact hardly ever applies for valve circuits. Thus a pentode output valve has an anode impedance much greater than the optimum anode load for maximum achievable output power in a conventional circuit. Beyond the normal linear portion of the pentode characteristic the anode impedance is very much less; we would thus expect a "mean" to indicate lower loading impedance for optimum power output—as is also in fact the case. However, this way of looking at it is rather pedantic; consultation of the characteristics in conjunction with load lines for proposed load values, in the normal manner, is always the simplest practical design-method.

The Transistor Equivalent

It is interesting to point out that, in the case of the Emitter Follower, which is the rough transister equivalent of the cathode follower (Fig. 4), the effective output impedance is given by the impedance of the base drive generator Gb divided by the current gain of the transistor in earthed emitter arrangement (about 10 to 50 for most normal transistors). Provided that the impedance of Gb is not too low, there may certainly be enough linear current excursion within the characteristic of a high-current transistor to make the matched load (Gb divided by current gain) also about equal to the optimum achievable power load. These facts led to the unusual possibilities with emitter followers as exemplified in our recent constructional article "A Central Control Amplifier" (Nov. 1962—Jan. 1963).

A matched cathode follower or emitter follower always generates a total output e.m.f. equal to the input drive. This is distributed in direct proportion between the effective internal output impedance and the actual output load. In the matched condiion, when both impedances are equal, the voltage across the output load is naturally exactly one half of the input drive voltage.

In the case of a cathode follower load with a very much higher output load, to give maximum achievable power, the drop across the internal impedance is negligible, and the output voltage is virtually equal to the input drive voltage. If the normal d.c. anode current rating of the valve is ImA and the load resistor is R kilohm, much greater than 1/gm, then the acceptable linear drive will allow, very roughly, excursions from zero anode current to double the standing value. The peak-to-peak voltage excursion across the output load is thus 2 x IR volts, which is also the required grid-input drive. This can be very considerable for example, if I=10mA and R=5kΩ the peak-to-peak grid drive required for full undistorted output comes out as about 100V on these considerations. If the drive is a sinewave, the r.m.s. current swing thereby represented is, as always, about a third of the peak-to-peak swing, i.e. some 6mA in our example. We know that 6mA flowing in 5kΩ, develops some 180 milliwatts of power, which is therefore roughly the actual power output to be expected in our example. This example corresponds roughly to that which would be achievable with a EC92 valve, and shows in general how to calculate expected power output in designing such cathode followers.

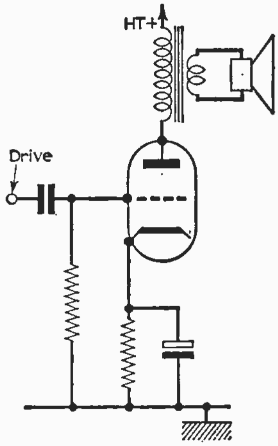


Fig. 2: A conventional anode-loaded output stage for comparison with Fig. 1.

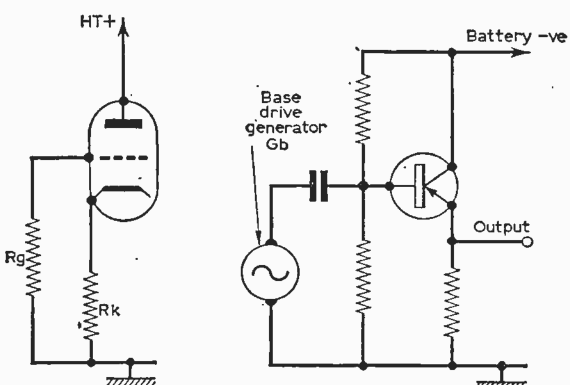


Fig. 3 (left): Basic circuit of a cathode follower circuit.
Fig. 4 (right): Basic circuit of an emitter follower circuit.

Capacitive Loading

A reader raised the further important question of the effect of large capacities in parallel with the output load of a cathode follower, such as present with long runs of coaxial or screened cable carrying the output signal to distant apparatus. The reader maintained that loads of this nature cause severe distortion unless the drive is drastically reduced. This statement, as it stands, cannot be correct, because it is well known that the cathode follower is an *ideal* output stage for feeding long runs of cable having considerable capacity.

If we desire to pass a signal through a load afflicted with large parallel capacity, yet maintain all rapid transients of the signal waveform across the load, then clearly the signal source must have *very low output impedance*, so that it can deliver the huge surge currents needed to *force* the voltage on the parallel capacity to follow sufficiently rapidly.

It is thus obvious that the cathode follower, with its essentially low output impedance, is eminently suitable for this purpose, within limits. And these limits are now clearly seen to be an imposition of a maximum *frequency* of permissible operation, not a primary limitation of the usable input drive. The signal frequency must not exceed the value where the parallel capacity charging time becomes an appreciable fraction, say more than a tenth, of one cycle.

Now this characteristic charging time, or time constant as it is more usually called, is given as usual by the product of resistance and capacity in the charging circuit—here the product of cathode follower output impedance (1/gm) and capacity parallel to the load.

These considerations, expressed as a simple practical formula, lead to the result that the signal frequency must not exceed gm/10C kc/s, where gm is the slope of the valve in mA/volt and C is the capacity parallel to the output load, expressed in microfarads. One can use this formula to determine the maximum tolerable capacity for a given proposed signal frequency or vice versa. Taking a typical value of 10mA/volt for gm, and 50kc/s as uppermost frequency limit for a hi-fi audio amplifier, some 0·02μF is tolerable in parallel with the output load of such a valve used as a cathode follower stage. Using screened cable of capacity about 1pF per inch, about a quarter of a mile thereof is quite tolerable!

When using cathode followers for r.f., however, conditions could be more critical. Here the "White Cathode Follower" is sometimes used (Fig. 5), where another valve is used as cathode load in place of a resistor, this valve being also driven from a small anode load on the main valve giving an anode-gain of A times. The output impedance is then only 1/A of 1/gm, so that A times as much parallel capacity is tolerable in the output load.

If, however, one does go beyond the imposed limits, i.e. applies any signals with transients equal to or faster than the cathode time constant, then such transients act *in full* at the grid, without the negative feedback characteristic of all cathode followers. If positive, they then drive the valve momentarily up to huge anode and grid currents (unless the drive voltage is kept very small); the grid current can then cause a subsequent lengthy blockage on the grid drive input blocking capacitor and associated gridleak time constant. If the impermissible transients are negative, they can momentarily cut the valve off, without any after-effects, in general.

If the cathode follower stage is intentionally an audio output stage, and design considerations have been correctly applied for such frequencies, it is nevertheless clearly most important to watch that unwanted higher frequencies cannot inadvertently stray in! These could cause severe cross modulation distortion on the wanted signal, by methods as just described. Note, for example, that for this reason a top-cut filter was placed between the Y-amplifier and the cathode follower output stage of our recently published "Auditron" circuit.

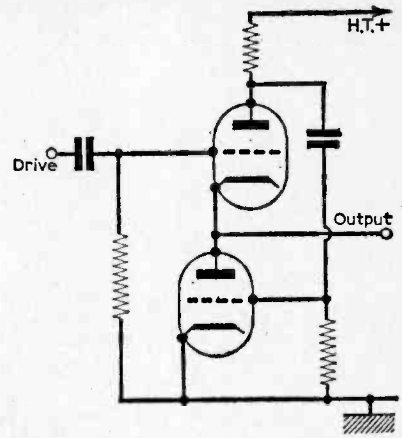


Fig. 5: Basic circuit of a white cathode follower which achieves output impedances much less than the reciprocal mutual conductance of the upper valve. The drawing is basic only—biasing components have been omitted for clarity.

Cable Impedance

We have thus seen that it is, in fact, one of the *principal advantages* of cathode followers that they are capable of driving loads afflicted with quite appreciable stray capacities, such as long coaxial cable runs.

However, it must be remembered that another solution to the problem of sending a signal down a long run of coaxial cable exists at very high frequencies. Such a cable will, namely, have not only distributed capacity along its length, but also distributed inductance. These, in fact, work together at any frequency to compensate each other mutually, leaving merely the effect of a characteristic impedance (around 80Ω for common types of coaxial cable) which is purely resistive in character. Such a cable, terminated with a purely resistive load equal to the characteristic impedance, situated at the far end, will make the input end behave as a pure resistive load of value equal to the characteristic impedance, whatever the frequency and whatever the length of the cable. The generator feeding the cable then sees neither capacity nor inductance in its load, but just a pure resistance. However, we are tied to one particular load value—the characteristic impedance. This form of cable matching is quite essential when the frequency is so high that the length of cable involved is an appreciable fraction, say more than about a twentieth, of the wavelength involved, as otherwise interference between main and reflected signal waves at the points of mismatch would appear.

At lower frequencies one could use characteristic impedance matching, except that the characteristic impedance is generally so low that the usable drive and resulting signal transfer are rather small. It is then better to run the cable unmatched, relying on the tolerance shown by cathode followers for the resulting high capacities "seen" then on long cable runs. Even for the highest audio frequencies the electromagnetic wavelength is so large that at least a mile of cable run is tolerable before this becomes an appreciable fraction of the wavelength and would dictate characteristic impedance matching to avoid interference of main and reflected signal waves travelling down the cable. ■

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PART 5 - F.M. SIGNAL GENERATORS

H. W. Hellyer

THE farther this series of articles progresses, the more evident does it become that space is going to beat us. Several readers have suggested that explanations of principles require expansion, or that circuits need more explicit description, and others ask for less of the foregoing but an expansion of "techniques".

It is impossible to please everybody, but at the risk of repeating information that will be already familiar to many readers, this section must begin with a brief resumé of frequency modulation, and the specifications of the transmissions in this country.

However, it should be understood that the f.m. signal generator, or "wobbulator", as it is called for reasons that will become apparent, is not restricted to the alignment of f.m. receivers. The method of varying the applied frequency at a controlled rate and by a regular amount, enables visual inspection of the response curves of the receiver's tuned circuits to be made on the screen of an oscilloscope, and greatly eases the procedure of adjustment.

This technique is widely used by television service engineers, and more details of this can be found in the expansion to this present series which appeared in the May and June issues of our companion journal, *Practical Television.*

Frequency Modulation

When a carrier frequency is varied about its nominal mean, plus and minus so many cycles, at a regular rate of variation, by a regular amount and with the amplitude of the basic signal remaining constant, the resultant can be considered as a carrier being modulated by a frequency which is the rate of variation, and the amplitude of the modulating signal is represented by the amount of the variation. As an example, if a carrier of 90Mc/s is modulated by a pure tone of constant amplitude and a frequency of 1,000c/s, then the frequency modulated signal becomes a variation above and below 90Mc/s, a thousand times a second. Now, if we fix a limit to the amount we need to "swing" the carrier for 100% depth of modulation, we can work out the actual bands of frequencies that will be transmitted in terms of sidebands. This "swing", which is known as the *deviation* of the signal, is fixed at 75kc/s for 100% modulation by the broadcast engineers.

Thus, if the modulation depth is to be 50%, the carrier will have to swing between 89·9625 and 90·0375Mc/s, a thousand times per second. Increasing the amplitude of the modulation (the loudness of the tone) by a further 50%, but keeping the pitch of the tone as it was before, brings the modulation to full depth (100%) and swings the carrier between the 75kc/s limits, i.e., between 89·925Mc/s and 90·075Mc/s. But again, this swing is at the rate of 1,000 times per second, which is the modulation frequency. Raising the tone an octave but retaining the same loudness, now swings the carrier between the same limits at *twice the rate.*

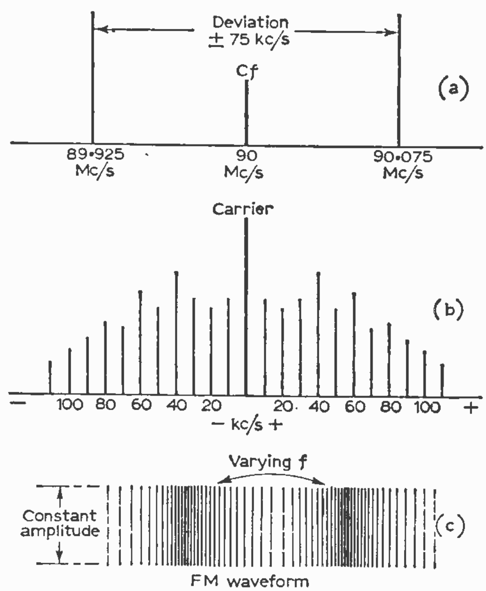

Fig. 1: Basic features of the f.m. waveform as described in the text.

Modulation Index

The ratio between the amount of fluctuation (depth of modulation) and frequency of modulation is known as the *modulation index*. The larger this ratio, the greater the extent of the sideband coverage. A signal varying about a mean frequency sets up pairs of sidebands, as shown in Fig. 1. Here, it can be seen that a 200kc/s bandwidth has been used, but the sidebands towards the outer limits tail off considerably. Remember that these sidebands are not, as with amplitude modulation, simply plus or minus the modulation frequency, but are multiples of the modulation frequency.

Even though the upper audio limit can be taken to be about 15kc/s, and we have a deviation of 75kc/s for 100%, a bandwidth of more than 200kc/s is needed to embrace the sidebands greater than 1½% of the unmodulated carrier. It is

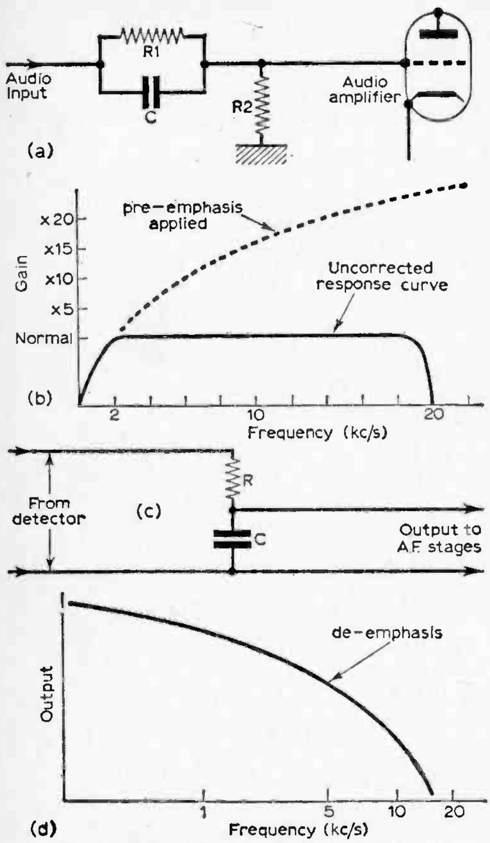

Fig. 2: Pre-emphasis networks and curves.

for this reason that frequency modulated signals are transmitted in the v.h.f. bands. Band II is divided into a number of channels of 220kc/s bandwidth, between 87·5 and 100Mc/s.

Because of the bandwidth available, it is possible to transmit signals with modulating frequencies up to the useful limits of the audio range—although it should be noted that the frequency limitations of land-lines, etc., very often means that full advantage of this extended bandwidth is not gained. However, the upper frequency ranges of the modulating frequencies, which contain the all-important harmonics that we need to retain for high-fidelity, are lower in amplitude.

Pre-emphasis

To overcome this, a measure of *pre-emphasis* is used. This consists of a "distortion" of the response curve at the transmitter, by arranging the circuits so that the amplifier gain increases by a regulated amount as the frequency rises. (This is somewhat similar to the pre-emphasis given to recordings—the purpose being to boost those weaker signals above the inherent noise level of the system, de-emphasising them again at the reproducing end.)

The pre-emphasis is measured in time-constant of a simple RC network, and in the British f.m. system, this is 50μsec. Fig. 2 shows the curves and basic circuits at the transmitter and receiver, with the time-constant determined by R and C at the receiver, and by R1 and C and R2 and C at the transmitter end. (At low frequencies, the high impedance of C has little effect on R1 and the two resistors are effectively in series. At high frequencies, C has a low impedance, shunts R1 and is effectively in series with R2.)

Note that the time constant components are not necessarily as shown in Fig. 2(c). In practice, allowance has to be made for the self-capacitance of connecting leads, especially screened leads, and other circuit parameters that alter the overall impedance.

From all this it can be seen that the shape of the response curve of an f.m. receiver is important, if the advantages of the extended frequency coverage are to be gained.

Typical Response Curve

Fig. 3(a) shows the response curve of a typical a.m. receiver that is tuned to receive a 10kc/s signal with an "ideal" curve superimposed. Fig. 3(b) has an f.m. curve also passing 10kc/s, and it is immediately apparent that the bandwidth is much greater in proportion, almost 170kc/s, in fact.

In general, it can be stated that the bandwidth

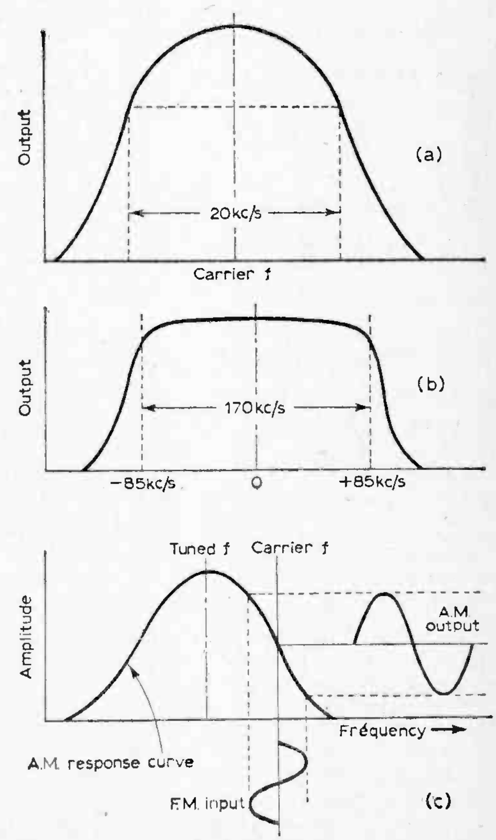

Fig. 3: Response curves of a.m. and f.m. receivers.

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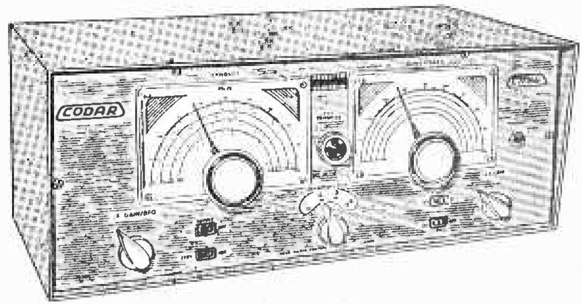

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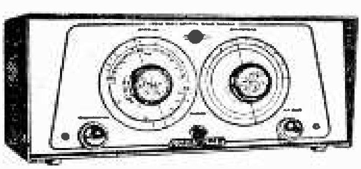

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36/6

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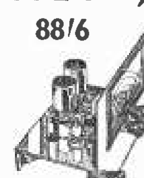

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for an f.m. receiver has to be twice the deviation plus twice the modulation frequency.

We are approaching the point when we can consider that required specifications of the instruments needed to test the f.m. receiver, but first it should be stated that frequency modulation of an a.m. signal and amplitude modulation of an f.m. signal both give rise to distortion. (Readers are referred to an excellent article touching on this subject by my colleague, Gordon J. King, in the March 1963 issue of PRACTICAL WIRELESS.)

It is not necessary to go into the details of limiters, detectors and associated circuits, but it is worth remembering at this point that the most careful alignment of a receiver can be nullified by faulty limiting and detection. As an example, consider the diagram of the response curve of an a.m. receiver operating at v.h.f., which has an f.m. signal applied so that the mean carrier falls on the slope of the r.m. response curve (Fig. 3c). If the a.m. receiver is a superhet, and the carrier of the f.m. signal fluctuates by ±50kc/s, the resultant output from the receiver's tuned stages will be an a.m. signal corresponding to the f.m. modulation frequency—which explains why some viewers are annoyed by "breakthrough" of public-service f.m. broadcasts on a.m. television receivers. The remedy is to increase the selectivity of the set, either by re-alignment to make the sides of the response curve steeper, or enhancing the sensitivity of the receiver, and aerial system.

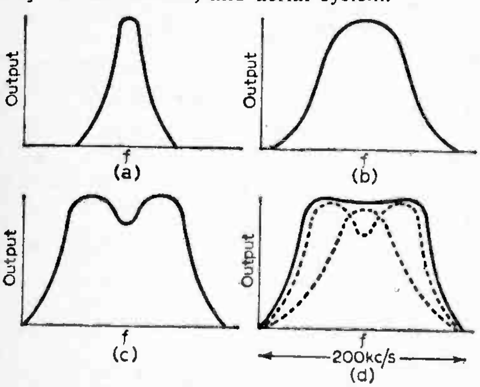


Fig. 4: Effects of coil couplings.

The actual frequency of the modern f.m. receiver i.f. circuits is tuned to a 200kc/s passband around a basic 10·7Mc/s. Some manufacturers have chosen to use a rather higher frequency of 19·5Mc/s.

The choice of frequency is determined partly by the need to keep the second-channel or image frequency outside the acceptance of the aerial and r.f. circuits. For example, taking a transmitted signal of 90Mc/s, and an oscillator tuned to the signal frequency plus the i.f. (which is normal practice for engineering reasons that need not concern us here), if we had a low i.f., such as the 470kc/s used by the a.m. set, the second channel would occur at 90·94Mc/s. This is the signal frequency plus twice the i.f., and such a frequency would fall well within the acceptance range of the "front-end" circuits. By choosing a higher i.f., of 10·7Mc/s, the image frequency is at 110·14Mc/s, where a good degree of attenuation can be afforded by correct pre-oscillator alignment.

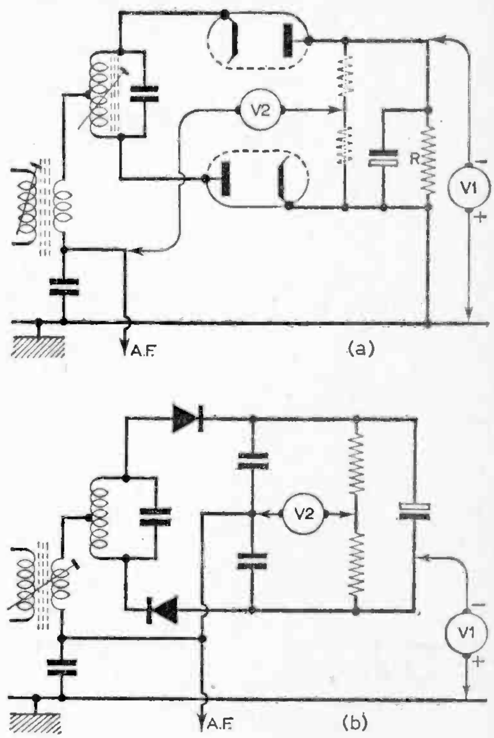


Fig. 5: Unbalanced (a) and balanced (b) ratio detector circuits.

This is aided by the "capture effect" of f.m. reception, where a set will tend to tune to a signal that has an aerial strength more than double the unwanted signal. This exact frequency of 10·7Mc/s was decided by an international conference after protracted and exhaustive consideration of the whole interference problem.

One secondary advantage is that its distance (in frequency) from the 470kc/s intermediate frequency of the a.m. circuits allows the tuned coils of each to be wound in series on the receivers that are designed for a.m./f.m. signals, without the one having adverse effect upon the other.

Coil Coupling

Alignment is affected by the coupling factors of the i.f. coils, and the need to maintain a good, wide, symmetric response curve in order to retain the advantage of the full frequency coverage available. For this reason, the coils may be varied in coupling to produce differing curves, the summation of these giving the desired effect, as seen in Fig. 4. Curve (a) respresents a loosely coupled transformer, (b) shows the "normal", intermediate curve, often found in a.m. receiver circuitry, (c) shows the effect of tight coupling and (d) illustrates the principle of combining the familiar "double-humped curve" of a tightly coupled transformer with the peak of a loosely coupled transformer to obtain a response that is wide, level and symmetrical. This is not quite the same thing as the "stagger-tuned" circuit met with in television receivers, where an i.f. of 35Mc/s and a pass band of 3Mc/s may be encountered.

The last i.f. transformer, the discriminator circuit, is the most critical. The coupling factor has to be carefully adjusted and tuning must be precise for distortionless output.

I.F. Alignment

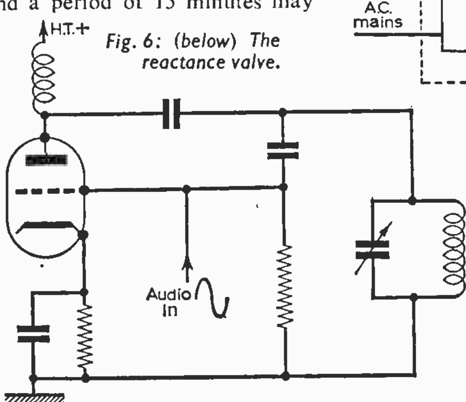
Instruments used in i.f. alignment can be the ones described previously: an amplitude modulated signal generator with a frequency coverage taking in the 10·7Mc/s i.f. and the receiver band of 80-100Mc/s, plus a high resistance voltmeter. With the signal generator connected to the grid of the final i.f. valve, and tuned to the centre frequency, i.e., 10·7Mc/s, the circuits can be tuned for resonance. But to obtain a correct indication it may be first necessary to *detune* the discriminator transformer secondary, returning to this section of the circuit after the i.f.'s have been aligned. Simply unscrew the core of the secondary winding of the discriminator transformer a few turns.

Fig. 5(a) and (b) shows the points to which the high resistance voltmeter should be connected for the ensuing tests.

Unbalanced Ratio Detector

In Fig. 5(a), an unbalanced ratio detector circuit is illustrated. The voltmeter V1 is connected across the load R, with the positive probe connected to chassis. As is normal practice, both signal generator and receiver must be allowed to warm up to obtain stable conditions, and a period of 15 minutes may

Fig. 6: (below) The reactance valve.



be necessary, particularly if the receiver chassis is removed from the cabinet for bench testing.

An unmodulated signal should then be applied from the generator and the primary of the discriminator transformer, then the primary and secondary of the output transformer of the last i.f. adjusted for maximum reading on the voltmeter. The signal generator is then transferred to the mixer, and the first i.f. aligned.

To couple to the mixer, make a loop of stiff copper wire and loosely couple the signal by pushing the loop over the envelope of the valve, or, where a slide-fit screening can is used, connect a crocodile clip to this and slide it up until its chassis connection is open-circuited. Note that where tightly coupled transformers are employed, it will be necessary to damp the winding which is not being adjusted, to reduce interaction. The maker's instructions should be followed closely in these cases.

The discriminator secondary is re-adjusted by connecting a voltmeter V2 between an artificial balancing point formed by the junction of the two resistors shown dotted in Fig. 5(a) and the a.f. take-off point, then tuning for zero reading.

Balanced Ratio Detector

Where a balanced ratio detector is used, as in Fig. 5(b), the connections are as shown, and adjustments are similar: V1 for maximum negative swing and V2 for zero or minimum reading. Note that, in all cases, limiting action should be avoided by keeping the input signal as low as can be employed

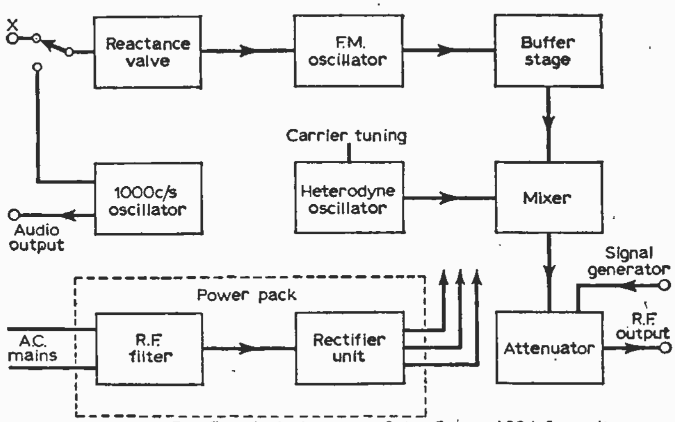


Fig. 7: Block diagram of the Cossor 1324 f.m. alignment generator.

for adequate output readings. Where circuit details are not known, it is a good general rule to tune the i.f. transformers with a damping resistor of about 39,000Ω across the secondary of the final i.f. transformer, removing this before tuning the discriminator secondary.

Foster-Seeley Circuit

A Foster-Seeley circuit can be aligned with an a.m. signal generator by applying the modulated signal and connecting an output meter to the loudspeaker feed, adjusting as before. If, after alignment, the sound appears to lack "top", it may be that the response curve has been narrowed by peaking, and careful detuning of the i.f. circuits may be needed.

Although much can be done without the aid of an f.m. signal generator with sweep facilities, there is no doubt that this instrument, in conjunction with an oscilloscope, gives by far the better, quicker, and more trustworthy results. We shall be

—continued on page 257

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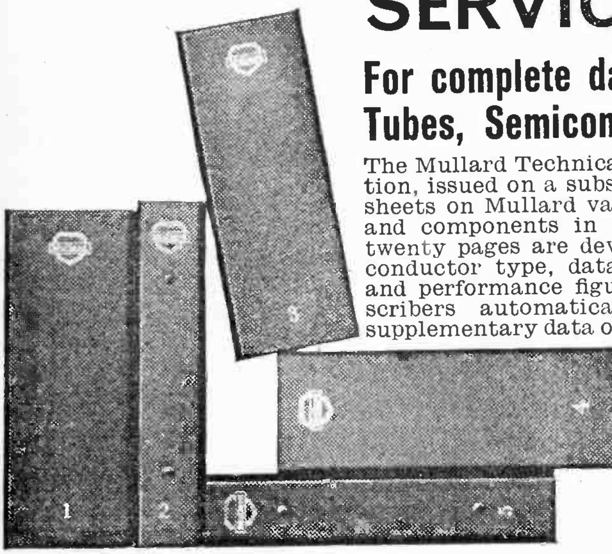

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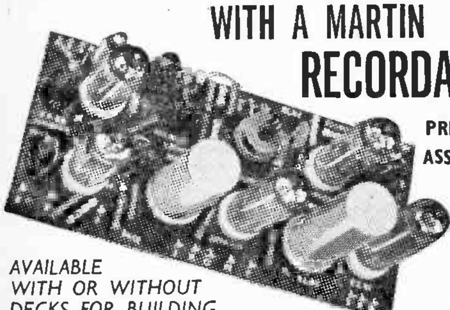

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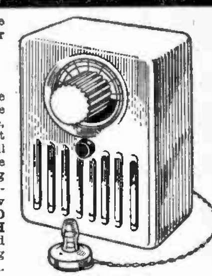

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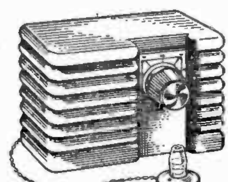

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TEST GEAR TECHNIQUES

—continued from page 254

dealing with the oscilloscope in a subsequent article, but a few details of the sweep generator are needed to clarify the foregoing.

The Sweep Generator

As we have seen, the input signal has to vary at a set speed and about a set frequency. The basic device to obtain this action is the reactance valve, as depicted in Fig. 6. The valve acts as a virtual capacitance and is across the tuned circuit. The r.f. in the grid circuit leads the anode voltage by almost 90°, and the grid-cathode voltage therefore leads the anode voltage by the same angle, resulting in the anode current leading the anode voltage similarly. The magnitude of the capacitance presented by this stage is thus determined by valve constants, circuit parameters, and the d.c. voltage at the grid.

An audio signal is now applied to the grid, effectively varying the d.c. and providing cyclic changes of the capacitance presented by the valve to the basic tuned circuit, thus altering the tuning in much the same way as has been done in some instruments by applying a small motor to a variable capacitor, swinging the frequency about a fixed tuned point.

As a further example, the block diagram of the Cossor f.m. receiver alignment generator, Model 1324 is shown in Fig. 7. It can be seen that the r.f. output is obtained by the mixing of two output voltages from separate oscillators. The frequency coverage at r.f. is obtained by addition of the two outputs and the i.f. signal by their difference. The centre frequency of the f.m. oscillator is 57·5Mc/s, modulated by the reactance valve, whose swing can be determined by the application of an external voltage, such as is available from an oscilloscope, thus tying the two instruments electronically, so that a visual indication can be obtained, as will be explained later.

A deviation of ±75kc/s from the internal 1,000c/s oscillator or from ±25kc/s up to ±400kc/s from an oscilloscope timebase can be obtained. R.F. output of this instrument is from 5μV to 50mV, via the attenuator. An a.f. output is available at 1,000c/s, variable up to 8V peak-to-peak, and a probe unit is provided to give a rectified output from the final anode of the i.f. stages to the Y plates of an oscilloscope, which makes it possible to carry out alignment without using the receiver's detector—often an advantage.

Many more comprehensive instruments are on the market, with expanded frequency coverage and sweep facilities suitable also for television alignment, but the above notes should make it clear that the fundamental need for a "wobbulator" when working with frequency modulated equipment makes this instrument more than a "luxury extra". As we have attempted to explain, alignment of wide passband circuits can be carried out—with sufficient patience—by the aid of a standard signal generator and a good meter, but as we shall see, the great facility of adjusting while watching a visual trace, with the air of a wobbulator and oscilloscope, more than justifies the use of this versatile instrument.

PART 6 OF THIS SERIES APPEARS NEXT MONTH

Local Station F.M. Receiver

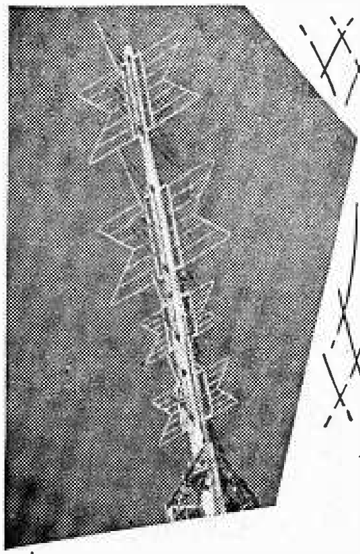
—continued from page 224

assume that the a.f. amplifier is switched on and running, and that the h.t. and l.t. supplies to the tuner are on. Plug in the ECF82. The valve, on warming up, should take between 15 and 25mA anode current. On rotating VC1 it will be found that the h.t. current varies over a fairly wide range.

Plug in the other valves (V2, V3—were used), the increase in h.t. current should be in the order of 15 to 20mA. A "rushing" sound will now be heard from the a.f. amplifier indicating that the oscillator is functioning. Connect a piece of wire (2ft to 3ft long) to pin of V1, when heavy morse signals, whistles etc., will probably be heard if the i.f. amplifiers are working properly. Remove the wire fron pin 2 and connect a proper f.m. aerial to the aerial input socket, and rotate C7 when the local f.m. broadcasts should be heard. Decrease VR1 until the station can only just be heard and adjust the i.f. coils for maximum performance, reducing VR1 as necessary (very little adjustment will be required as the i.f.s are pre-aligned at the works).

Adjust L1 for maximum signal finally trimming RDT for maximum output. L2 should now be set so that the centre frequency station is received with C7 half closed. Set the core in place with adhesive. If the coils have been properly aligned the set will now function as designed and a reasonable quality sound output will be obtained.

Voltages on the valve electrodes of the prototype are show in Table 1. ■



On Your Wavelength

By THERMION

I FEEL that I ought to start this month's notes with a general "thank you" to all those readers who continue to write to me—either giving notes about various electronic games, or hints which they feel might be of general use. I want to take this step as I receive so much correspondence that I find it impossible to thank everyone individually, and only where the reader encloses a stamped and addressed envelope do I make a serious effort to write to him. I do, of course, have work other than the writing of these notes and whilst I am at all times anxious to drop a line to all those kind readers who go to the trouble of writing or sending me valuable information, it is impracticable to write to all of them. So I must take this opportunity of making a general acknowledgment to all of them and point out that I am deeply grateful for the many letters which I have received, and hope the above notes will explain why I have not written individually to everyone.

Transistors

I some time ago carried out a most enlightening series of experiments with transistors, after hearing of the interesting, and almost unbelievable, experiences of a reader.

Some time ago we published a design for a transistor amplifier in which some well-known proprietary transistors were recommended. A month or so after this, when the Radio Show was being held, a reader called at our stand and thanked us for the particular design, and pointed out that he had built the amplifier and that its performance had astounded him. He also pointed out that after being so impressed by the results obtained using cheap 2s. transistors, he bought and incorporated the more expensive recommended components, only to find that the performance with these was inferior! Once or twice before, I had heard of similar experiences and so I decided to carry out my own experiments along the same lines. I must admit that up to a point, I discovered this anomaly to be true.

In my particular series of tests I also found a number of other interesting facts. Firstly, standard resistors of the same apparent value, give quite different performances on the test set-up, and on measuring it was found that some of these were over 25% out in the rating. Obviously where three or four such resistors are used, the tolerances can be all one way, and give quite a variation in performance. One hopes, of course, that the variations will be "each way," so that overall the effect will not be so noticeable, but the possibility of accumulated differences in values remains and this could make a considerable difference to the operation of a circuit, especially where the cheaper transistors are used.

I shall be hoping to give some further notes on these tests with the types of transistor, etc., at a later date, but would point out here that if you are bent on getting the best from a circuit, don't be tempted to save money on the transistors as I am certain that the above results proved the exception rather than the rule.

More Hints

The really keen amateur is always on the look out for ideas which will be of use in his hobby, and what is more important, trying to find items which can be adapted for his use and which are, in consequence, cheap or easy to obtain. No doubt most of my readers are aware of the use of the rather large tapered screw-tops from bottles, which make good looking and effective control knobs—provided you can find some method of fastening them to the appropriate spindle.

However, I have quite a number of new suggestions from readers, which indicates that this idea of looking round for articles to adapt is still with us, although I must confess I had thought it went out many years ago when components became cheaper.

As an instance I would mention a letter I recently had from a Mr. Bulbeck of Bognor Regis, who is obviously a short-wave fan. He has located the "hair curlers" at a popular department stores, and points out that these make ideal short-wave coil formers! The curlers are made of plastic, are "skeletonised," and have small spikes round the periphery, which makes them ideal for spaced or bank winding. They are available from about ½in. to 1½in. in diameter, and are about 3in. long. They cost only a few pence each, and in the hands of the real enthusiast could, no doubt, form the basis for a really efficient set of coils, either for a receiver or transmitter, or even for items such as signal generators or wavemeters.

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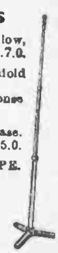

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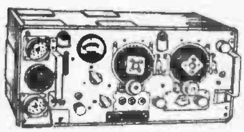

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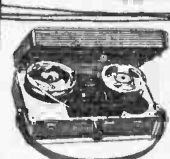

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Continued from page 142 of the June issue.

Double Conversion Communications Receiver

SETTING-UP AND ALIGNMENT

BY P. R. LEWIS

WITH a receiver of this complexity, it is advisable to check the completed wiring against the circuit diagram most carefully before switching on.

When satisfied that all is correct, insert a 250mA h.t fuse and switch on the mains, with the h.t. switch S6, in the "Stand-by" position. Measure the heater voltage and check that all heaters are glowing. Measure voltage at V12 cathode, which under these conditions should be about 340V.

Leave meter probe on V12 cathode and switch on the h.t. The voltage should drop to approximately 250V as shown in voltage table (Table 1).

With a.v.c. "off", noise filter "out" and diode detector in circuit, turn up the i.f. and a.f. gain controls. The loudspeaker should show signs of life and there should be no sign of instability. If instability is present the source can usually be traced by bypassing possible "hot spots" (e.g., screen and cathode resistors, h.t. feeds) with a large capacitor (say 0·5μF paper) or by placing an earthed metal screen between stages. When the faulty stage has been located, rearrangement of wiring may effect a cure. If not, the remedial capacitor or screening will have to be made permanent.

Check again for instability with noise filter "in" and triode detector in circuit.

Next, with conditions as in first instance, check voltage against those shown in Table 1. After this, feed an a.f. voltage from a signal generator via 0·1μF capacitor to the top of the a.f. gain control to check audio amplifier.

Second I.F. Alignment

If this is satisfactory remove coil set and place shorting strap across grid winding of L6. Connect 0—100V d.c. meter across VR5. Feed a 465kc/s modulated signal on to grid 1 of V5 and adjust both cores of IFT5 for maximum reading on meter. Now feed the signal at the same frequency to the control grid of V4 heptode (pin 2) and adjust IFT4 cores for maximum reading, reducing signal generator output as necessary.

The signal may be fed in via a 0·1μF capacitor if desired but a more satisfactory method is to wire a 2in. length of stiff wire to the appropriate valve pin. A rather longer length of stiff wire is erected from the output terminal of the signal generator to serve as a radiator. This system gives, by moving the generator position relative to the receiver, an easily variable input and enables the signal to be kept at the minimum strength necessary for accurate lining up.

Note.—To avoid inconsistent results the receiver chassis and generator case must be well bonded together.

TABLE 1

	Anode	Screen	Cathode
V1	170	117	2·0
V2	243	105	1·0
V3, 5	237	115	1·4
V4 heptode	241	100	1·5
V4 triode	100		
V9	85	80	2·1
V10	248	247	8·4
V11	105	—	—
V12	245 a.c.	—	255
V13	148	—	—

Table of voltages.
H.T. at C66=248V at 135mA.
Mains current=290mA at 240V a.c.

All measurements made with an Avo model 8, no signal input and i.f. gain controls fully up.

Beat Frequency Oscillator

The b.f.o. is now adjusted. Switch on by S3 and feed a 465kc/s unmodulated signal on to pin 2 of V4. Adjust core of L5 until beat note is heard in loudspeaker. If the note is weak insert a coupling capacitor (C62) of 5pF between anodes of V7b and V5. In most cases, however, the pick-up level due to stray capacitance will be adequate.

Second Oscillator

The second oscillator now requires adjusting to run at 2·065Mc/s. Remove shorting link from L6, set generator to 1·6Mc/s modulated, feeding in at same point as during previous two operations. Adjust can of L6 until signal is heard in loudspeaker and the meter reading peaks.

TABLE 2

Range	Low frequency tracking point	Centre tracking point	High frequency tracking point
3	1·84 Mc/s	2·64 Mc/s	4·5 Mc/s
4	5·5 Mc/s	7·93 Mc/s	13·5 Mc/s
5	11·55 Mc/s	16·65 Mc/s	28·36 Mc/s

Tracking points for alignment.

It is possible but unlikely that two responses will be heard. If this does occur adjust to the one for which the core is furthest out of the coil.

Finally, to check that the oscillator is in fact running at the correct frequency, use generator with unmodulated output and sweep until a beat note is heard. This should occur at 2·065Mc/s on the generator dial.

1st I.F. Alignment

The cores of IFTs 1, 2 and 3 are now lined up by feeding in 1·6Mc/s modulated at the control grids of V3 (pin 1) and V2 (pin 7) in turn, reducing coupling and/or second i.f. gain control as required.

All cores should be held in position when adjusted, preferably by dropping in a spot of melted wax. It is important to remember that when adjusting a two-cored i.f. transformer, movement of the second core may upset the alignment of the first. Therefore the cores may have to be adjusted alternately several times until correct alignment is achieved.

R.F. Circuits

Full lining-up data for the r.f. coils is supplied by Messrs. Denco, including the ideal tracking points as shown in Table 2.

Following this normal procedure insert one coil set and set the generator to the low frequency

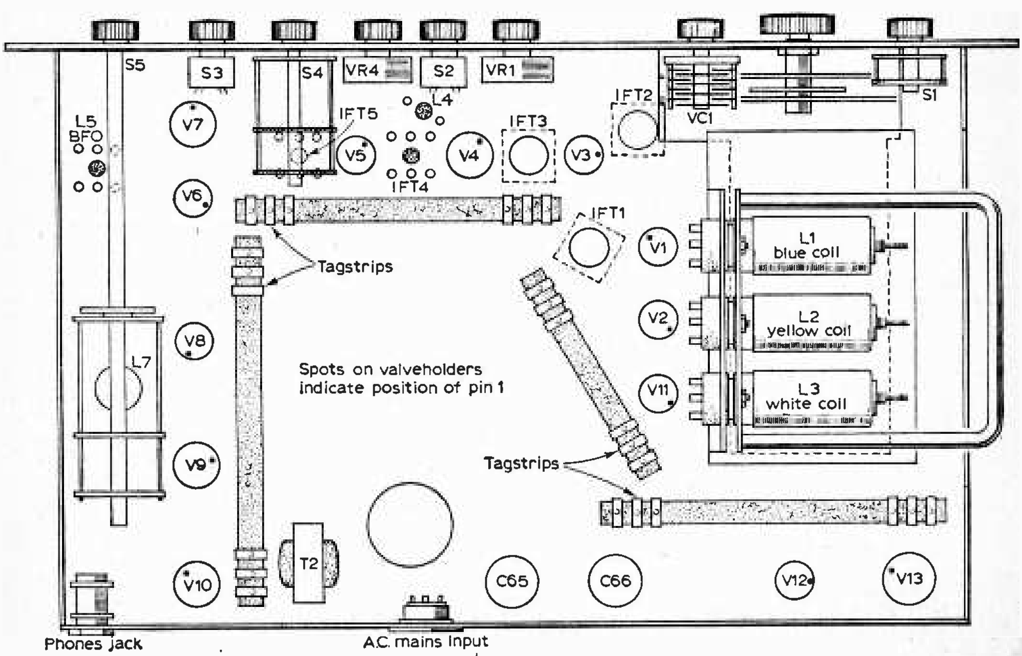

Fig. 6: Under-chassis layout of components.

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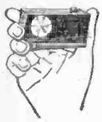

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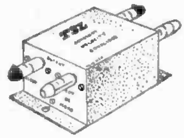

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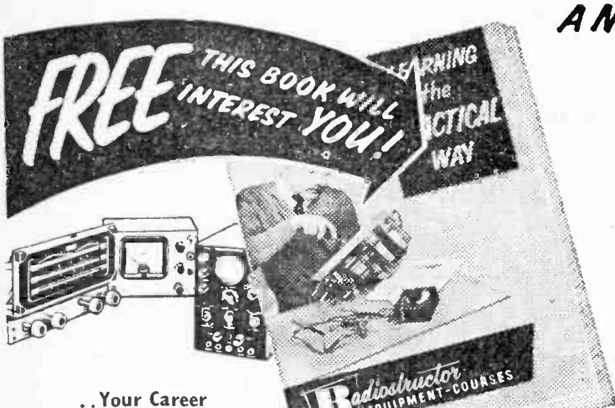

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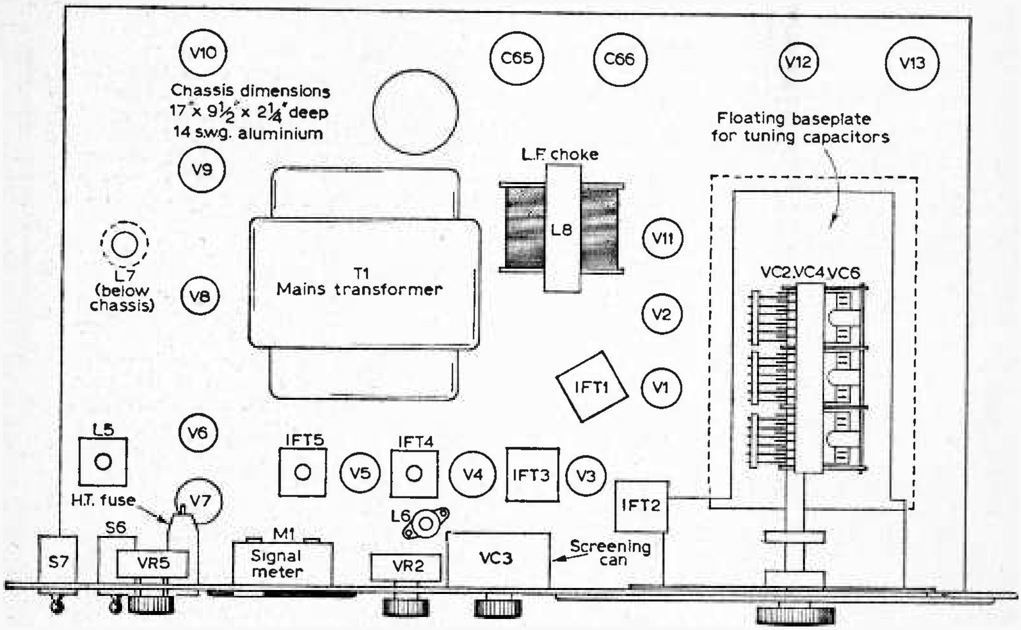


Fig. 7: Above-chassis layout diagram.

tracking point for the range chosen. Adjust the main tuning control until the pointer is at this frequency (either engraved on scale or calculated point if log scale is used) and feed in signal to signal grid of V2 (pin 7) or, to save time, to the aerial input. Adjust oscillator core L13 until a signal is heard and the meter peaks, then similarly adjust L1 and L2.

Now move signal generator frequency to the high frequency tracking point and adjust main tuning control to this frequency. Adjust the oscillator trimmer TC1 until a signal is heard and the meter reading peaks, then similarly adjust the r.f. panel mounted trimmers VC1 and VC5.

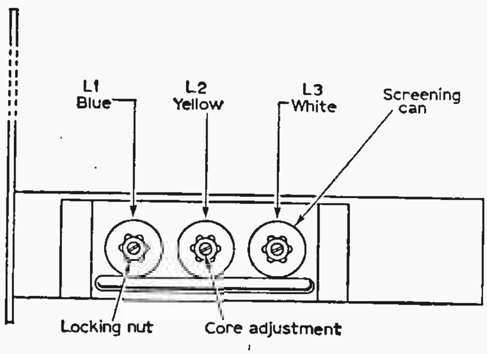
Fig. 8: A side view showing the location of the coil set.

These latter adjustments will have undoubtedly altered the tracking at the low frequency, so this must now be returned to and the cores of L1, L2 and L3 readjusted. Continue the two procedures alternately until no further improvement can be obtained at either point, after which the generator is set to the centre tracking point to check if signal level is approximately the same as at the two other tracking points.

The whole alignment procedure is now repeated for the other coil sets and the first settings of the two panel trimmers noted in each case. The trimmers must, of course, be altered to the appropriate settings whenever during operation a change of band is made.

However, if a dial with a purely arbitrary marking is used (e.g., 0—100, and therefore no oscillator trimming capacitor is used) alignment is much simplified since no dial reading need exactly coincide with a particular frequency. In this case set the panel trimmers to the centre position, set the main tuning control to an approximately calculated setting for the centre tracking frequency and feed in a signal at this frequency. Adjust L1, L2 cores until the signal is heard and the meter peaks.

If a particular coil set does not appear to cover



the specified band, experiments can be made by choosing a slightly different dial mark for the centre tracking frequency and adjusting the cores to it or by wiring a small capacitor (10—20pF) across the grid winding of the oscillator coil inside the can. Either method will result in an alteration of the band covered.

During operation, with either method of alignment, the panel trimmers will need to be adjusted to peak the signal. However, with the latter method a greater variation will be noted from one end of the band to the other, but this is no disadvantage.

One final check needs to be made to ensure maximum efficiency of conversion in the first mixer V2. Insert 0—1 d.c. meter in the earthy end of the injection grid resistor R7.

With Band 4 coil set in position and tuning control in mid-position the meter current should be 500mA, this corresponding to the correct oscillator output. The current may vary about this value, being greater when the receiver is tuned to lower frequencies and vice versa, but the use of the r.f. choke L4 to load the oscillator anode ensures that it is of the right order (without the choke it may well be below 100mA). If the mean current is low, take the oscillator feed from the anode (C55 to pin 5, V11).

Curing Instability

The possibility of instability during i.f. alignment has been mentioned earlier. With the insertion of coil sets, however, and the bringing into operation of the front end further instability may become apparent. The use of stabilised h.t. lines, grid stoppers and separately decoupled h.t. feeds should have minimised the possibility, but nevertheless further screens may be necessary between the input and output circuits of V1 and V2. This should cure any instability when tuned to the higher frequencies. If trouble is apparent at low frequencies it may well be due to i.f. radiation from the detector stage getting back to the front end and screening in this direction may be useful.

Also, if in operation the bandwidth seems greater than expected it may be worth interposing a screen between the flying leads of IFT1 and IFT2 to ensure that they cannot "see" each other and that the only coupling between them is via C9.

Operating the Receiver

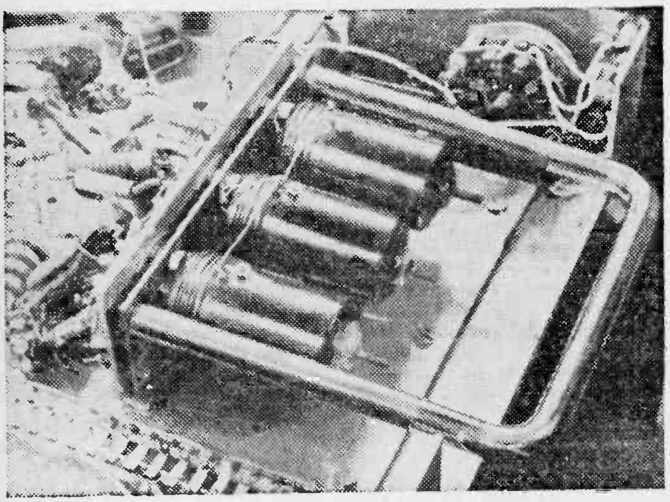
The receiver is now ready for air testing, when the merits of the various modes of a.g.c., with its variable time-constants, and of the noise filter will become apparent.

The signal meter should be set to zero with the aerial input socket shorted to earth and sensitivity adjusted as required. Gain should be controlled by the first i.f. gain control wherever possible since alteration of the second i.f. gain control renders the signal meter virtually useless. Switch over to the triode detector when a very weak signal is heard, whereupon a marked increase in sensitivity will be observed.

A.G.C. Time-constants

Finally, if any further values of the a.g.c. time-constant are required the size of capacitor can be calculated quite simply as below:

Time-constant of a.g.c. circuit=sum of the products of all resistors in the a.g.c. circuit and the total capacitance following them in the circuit.



A close-up view of the coil set mounted in the receiver.

To simplify this with an example the time-constant in position 1 of S2=R62 (C25+C29 +C16+C12)+R16(C16)+R11(C12)

$= 1{\cdot}2\times106\ (0{\cdot}01\times10^{-6} + 0{\cdot}05\times10^{-6} + 0{\cdot}01 \times10^{-6} + 0{\cdot}01\times10^{-6} + 100\times10^{3}\ (0{\cdot}01\times 10^{-6}) + 100\times10^{3}\ (0{\cdot}01\times10^{-6})$

$= (1{\cdot}2\times{\cdot}08)+0{\cdot}001+0{\cdot}001$

$= 0{\cdot}098$ seconds $\Omega 0{\cdot}1$ seconds.

CORRECTIONS

Two small corrections are required with respect to the first part of this article, which appeared in the May issue.

(1) In the description of the First Mixer Stage (page 49) the seventh line of the second paragraph should read: "of the *grid* circuit, this once again reducing any . . .".

(2) In Fig. 2(c) (page 52) C44 was wrongly marked as 1,000pF. This capacitor has, in fact, a value of 0·01μF, as indicated in the Components List.

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100µA	3½"	F.M.	D.C.	62/6
1 mA	2½"	F.M.	D.C.	25/-
30/0/30 mA	2½"	F.M.	D.C.	9/6
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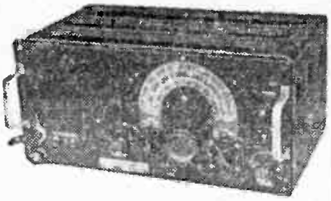

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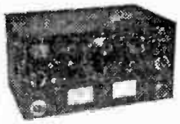

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Carriage £1 extra.
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Amps. A.C. and D.C. 25-50-150-200 A.
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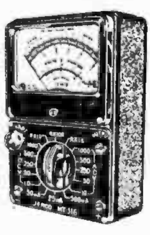
0/250µA/0/25/500 mA. D.C.
0/30K/300K/3 meg., etc.
59/6. P. & P. 2/6.



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0/50µA/0/25/500 mA. D.C.
0/50K/500K/5 meg., etc. 97/6. P. & P. 2/6.

30,000 Ω/VOLT
0/½/1/10/50/250/500/1,000 v. D.C.
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0/½/1/2½/10/25/100/250/500/1,000 v. D.C. and A.C.
0/50µA/5/50/500 mA/0/12 amp. D.C.
0/60K/6 meg./60 meg., etc. £8.17.6. Post paid.

50,000 Ω/VOLT
0/10/50/250/500/1,000 v. D.C. and A.C.
0/25µA/2.5/25/250 mA. D.C.
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12/18v. 6A.	12/3	36/48v. 4A.	29/6
12/18v. 10A.	22/6	36/48v. 6A.	32/6
12/18v. 15A.	37/6	48/60v. 2A.	21/-
24/36v. 1A.	7/3	48/60v. 10A.	82/6

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1.2 Ohm 12 Amp RHEOSTAT

Geared slider type, new boxed, 15/6 each. P.P. 3/6.

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0-500µA	32/6	"S" meter	35/-
0-1 mA	27/6	"VU" meter	42/6
0-5 mA	27/6		

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Trade News

The model RA-1 receiver, new from Heathkit.

Amateur Bands Receiver

A NEW kit is now available from Heathkit, which is described as a basic amateur bands receiver. This set (model RA-1) covers 160 to 10m in six bands. The circuit employs eight valves and to overcome the problem of alignment, the complete "front end" of the r.f. and mixer sections is supplied ready assembled, aligned and tested.

Several desirable features are included in the design of the RA-1, one being a signal strength tuning meter which is mounted on the front panel alongside of the illuminated slide rule scale.

Daystrom Limited, Gloucester are the makers of the kit.

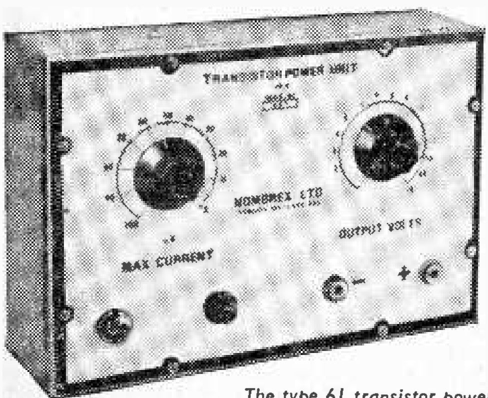
Transistor Power Unit

SERVICING and testing transistor equipment is much simplified if correct power supplies are available, so eliminating the need for batteries. Nombrex Ltd. have just released a new power unit for this purpose, which delivers a d.c. output voltage which is continuously variable from 1 to 15V, at mean currents up to 100mA.

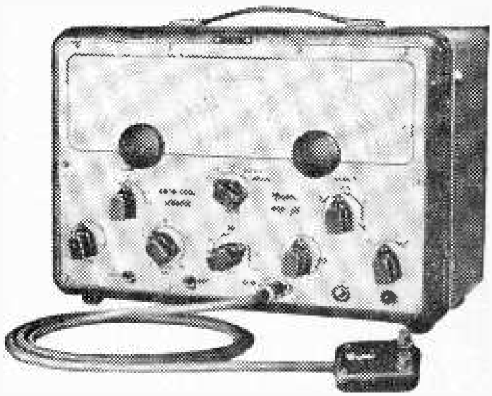
The unit is designated type 61 and sells for £5 17s. A printed circuit chassis is used in the construction and the housing is a robust steel case, measuring 6⅝in. x 4⅝in. x 2⅝in.

Incorporated in its design is a variable overload protection arrangement which serves to protect both the circuit under test and the unit itself. This ensures that transistors cannot be damaged by overload, short-circuits or thermal run-away.

The manufacturers of the type 61 power unit are *Nombrex Ltd., Estuary House, Camperdown Terrace, Exmouth, Devon.*



The type 61 transistor power supply from Nombrex Ltd.



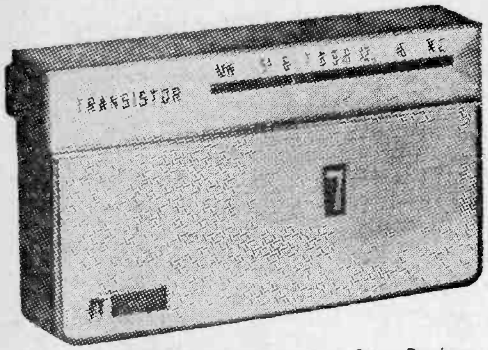
Taylor's new a.m./f.m. signal generator.

A.M./F.M. Signal Generator

THE model 62A signal generator is one of the latest releases from Taylor Electrical Instruments Ltd. The a.m. section of the instrument covers 4Mc/s to 12Mc/s in five bands. The frequency coverage of the sweep generator and f.m. generator sections are the same, being 4 to 45Mc/s in four bands, and 70 to 120Mc/s.

Used in conjunction with an oscilloscope, the 62A provides complete facilities for the sweep alignment of r.f., i.f. and discriminator or ratio detectors in f.m. receivers.

The manufacturers of the 62A signal generator are *Taylor Electrical Instruments Ltd., Montrose Avenue, Slough, Buckinghamshire.*



This is the latest portable receiver from Denham and Morley.

Portable Receiver

THE latest addition to the Denham and Morley range of radios is the model 7 TE-2L, and is named the " Bluebell ". This is a portable receiver employing a seven transistor circuit. The power is supplied by four pen-torch cells and both long and medium wave bands are tunable over the horizontal scale.

The retail price of the " Bluebell " is 10½ guineas, complete with earphone and leather case. The makers are *Denham and Morley Ltd., Denmore House, 173/175 Cleveland Street, London W1.*

Auditron Components

WE would like to bring the attention of our readers to the fact that certain components used by the author of the Auditron article, which appeared in recent issues of P.W., can be obtained from Neoflex Ltd., who are the British agents for Hirschmann products, the makers of the components.

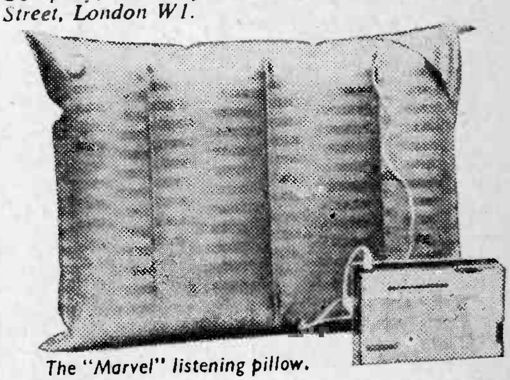
Of special interest are the type AGS 10 crocodile clip (plug type, red or black) and the type BIL 20 panel socket (red or black) which can be obtained in sets of three, at 11s. per set. The address of the agents is *Neoflex Ltd., 115a Cricklewood Broadway, London NW2.*

Loudspeaker Pillow

AN ingenious new accessory is now on the market which will prove of interest to all users of transistor radios. This device, which is known as the " Marvel " listening pillow, allows personal listening without the inconvenience of an earpiece.

The inflatable plastic pillow has a built-in " muted " loudspeaker which is connected to the receiver's earpiece socket by a cable supplied. Deflated, the pillow folds into a pocket-sized pack and the cable and plugs are then accommodated in a small pocket.

The price of the " Marvel " pillow is 38s. 6d. and is available from *New Lines Marketing Company, 11 Dryden Chambers, 119 Oxford Street, London W1.*



The "Marvel" listening pillow.

Change of address

THE radio component retail firm of Henry's Radio Limited, have moved from their old premises in Harrow Road, to new and larger premises at *303 Edgware Road, London W2.*

POCKET SIGNAL INJECTOR

—continued from page 239

tip on point C (volume control slider) and turn the volume control to the full volume position. If a note is heard, then the fault lies in the r.f. or detector stages (i.e. from volume control back to aerial tuning circuit). If, however, no note is heard at point C the fault lies in the a.f. and output stages (i.e. from the volume control to the loudspeaker).

If this proves the fault to be in the r.f. stages, then methodically work back towards the aerial with the probe tip, going to points D, then E, then F, etc., right through to point K. If this is done then one point will be reached where no signal is heard and clearly the fault lies in the stage contained between this point and the one just previously tested. The stage in which the fault exists has been found very quickly and with a meter all components in it should thus be checked. The fault should then be revealed.

Similarly, if when testing at point C initially the fault appears to be in the a.f. or output stages the probe should then be placed to point A, then to point B, working backwards from the loudspeaker. This should be done until no signal is heard at one of the test points, when again one can assume the trouble lies between this point and the one just previously checked and where a signal was heard. The location of the fault has thus been quickly determined in the a.f. stages and the components in the suspected area (i.e. the resistors, capacitors and transistors) should thus be checked using, where possible, a multimeter.

Once the suspect area (in either r.f., detector or a.f. stages) has been so located, the faulty component may in many cases be determined by purely using the injector. This is done by placing the probe tip on all points in the suspected area until one point is touched which doesn't produce a signal in the loudspeaker. The component or components connected to this point should then be checked to determine which one is the culprit or which is anchored to the printed circuit via a dry joint or unsoldered connection.

This should show how useful this little device can be in isolating and quickly cornering the majority of snags that can occur in modern-day equipment. ■

CLUB NEWS

AMATEUR RADIO SOCIETY OF CHESHAM AND DISTRICT
Hon. Sec.: Capt. C. G. Stephenson, G3CLJ/T, 21 Lynton Road, Chesham, Buckinghamshire.

As the stresses of pre-examination studying and training subside, more spare time should be available for members to concentrate on Society business, such as work on the club premises, which remains pressing.

A general discussion open to all members is held at the radio station, Bois Moor Road, on the last Sunday of each month.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

The meeting for May 8th saw the first of a series of three lectures on the subject of "Safety in the Shack and Home". At this meeting and at the meetings of 15th and 22nd May, members heard authoritative talks on first aid, electrical safety, fire prevention, etc.

The second d.f. practice run was held on May 29th, and as usual, the first meeting in the new month was a sale, held on June 5th.

FLINTSHIRE RADIO SOCIETY
Hon. Sec.: Alan Antley, Fairholme, Fairfield Avenue, Rhyl, Flintshire.

The meeting for May was held on the 27th. This meeting began with a half-hour session of slow morse practice, which was followed by GW3PCZ/T continuing his series of lectures, "Simple Hints and Kinks".

The last item on the evening's programme was a talk by W. Davies (GW3PKH/T) called "Using Relays".

LICHFIELD AMATEUR RADIO SOCIETY
Hon. Sec.: V. Hickman, G3LXR, 143 Main Street, Stonnall, near Walsall, Staffordshire.

At the meeting on May 6th, members heard the latest talk in the series on "Transistor Application", being given by John Beamand and Brian Hood.

LOTHIANS RADIO SOCIETY
Hon. Sec.: W. T. Sutherland, GM3JWS, 47 Great King Street, Edinburgh 3.

On May 9th "Railway Communications" was the subject of the lecture given by Ron McInnes. Members who attended the only other meeting in May, on the 23rd, listened to their field day briefing, in preparation for NFD.

MITCHAM AND DISTRICT RADIO SOCIETY
Hon. Sec.: A. L. Thurley, 50 Bruce Road, Mitcham, Surrey.

May 24th proved an enjoyable meeting for all those who attended, as the evening's entertainment was supplied by the showing of the award winning film, "This is the BBC".

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.

On May 22nd members enjoyed an evening's ragchew. The meeting of June 5th was "Any Questions Night" and on the following day members visited the Emley Moor television station.

READING AMATEUR RADIO CLUB
Hon. Sec.: R. G. Nash, G3EJA, "Peacehaven", 9 Holybrook Road, Reading, Berkshire.

The first of this year's "mobile picnics", which have become so popular with members, was held on Whit Sunday, June 2nd. This picnic was held at the Childe Beale Memorial Trust, Lower Basildon.

SHEFFIELD AMATEUR RADIO CLUB
Hon. Sec.: D. A. Justice, G3PYL, 9 Leslie Road, Sheffield 6.

This Club was reconstituted last year and now holds regular meetings in its own clubroom. The second Friday of each month is devoted to a technical meeting and the fourth Friday is always a general meeting.

On May 10th, "Hints and Kinks" was the subject of a discussion.

New members are always welcome and anyone interested in joining the Club should contact the secretary.

SLADE RADIO SOCIETY
Hon. Sec.: D. D. S. Williams, 117 The Boulevard, Wylde Green, Sutton Coldfield, Warwickshire.

On May 3rd. Mr. B. W. Smith gave a lecture on "Amateur Television" in collaboration with J. E. Smith. A demonstration accompanied the lecture, which was well received by all those present.

On May 17th an evening d.f. test was held, and on the 31st, Mr. T. P. Douglas gave a talk entitled "Welsh Safari with Radio".

CONTINUED ON PAGE 274

Just in case you've forgotten—NATIONAL FIELD DAY: JUNE 8th and 9th.

R.S.G.B. Contests for June. *70Mc/s Contest (June 15th and 16th), 1250 Mc/s Tests (June 23rd) and D/F Qualifying Event (July 30th).*

AMATEUR AMBASSADOR

CRITICS of amateur radio often care to observe that the hobby as a whole, and in particular licensed amateurs communicating over the air, serves no useful purpose for the community whose administrative bodies in the first place, sanction their use of the ether. This is an accusation that any enthusiast would, quite rightly, hotly deny the moment it was made, but it might be as well to have prepared retaliatory proof of the hobby's usefulness to hand, as the rantings of an enraged amateur might not, perhaps, be the best way of establishing the truth.

To begin with, it must be conceded that the days of the amateur experimenter treading undiscovered ground in the realms of electronics, ended many years ago, and now industry alone is capable of accumulating new data. Therefore anyone defending the position of the radio enthusiast should not pursue the subject of the advancement of science so much as the spread of radio knowledge, which the Clubs achieve so effectively by the contact between inexperienced beginners and their more learned elders. But all members of radio societies are already fully aware of this educational value of a club.

There is, however, one aspect of the hobby which is never given publicity and one which, quite probably, has never occurred to some. It concerns specifically the licensed operator who may at any time be in contact with amateurs in any country of the world. Every contact made outside these islands must leave an impression on the person contacted. However, this impression will not be confined to forming a mental picture of the British ham he may never meet, but will, in fact, contribute to impressing upon the mind of that foreign amateur, an image of the UK. Thus the manner in which the operator conducts his communications will, in a small way, help to make or mar the image of Great Britain abroad. Every amateur is, therefore, an ambassador for the nation. This is an important responsibility.

It is a responsibility which, if left to just anyone, would no doubt be taken very lightly, to the detriment of the people of the UK. After studying for many months to pass the R.A.E. and morse examinations, a person acquires this sense of responsibility, which is so necessary before communicating freely with other countries.

Yet another good reason why licences should not be there for the asking!

BOOKS REVIEWED

MORE ABOUT LOUDSPEAKERS

**By G. A. Briggs; published by Wharfedale Wireless Works Ltd., Idle, Bradford, Yorks.
136 pages, 5½in. x 8½ in. Price 8s. 6d.**

THOSE who are already familiar with the works of Mr. Briggs will know what to expect from this volume, which is a follow-up to his already well-known *Loudspeakers*. It is, in fact, a gathering together of facts and figures (and comment) relating to developments since the 5th edition of *Loudspeakers* (1958).

To the uninitiated it should be explained that Mr. Briggs has a unique style of writing which is completely unconventional. He gives as his excuse for writing the fact that he is a music lover, but his lighthearted prose is backed by numerous laboratory experiments.

His approach is essentially one of comment and the presentation of tests in an easy-to-read manner. Although at times the text is more or less "thinking aloud", there is a host of information of value to all audiophiles—technical or non-technical.

As the author says, this is not a text book and indeed contains much practical information of the type seldom found in the more ponderous volumes. A must for all interested in sound reproduction.—*W.N.S.*

R.S.G.B. AMATEUR RADIO CALL BOOK

**Published by the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1.
80 pages, 7¼in. x 9¾ in. Price 4s. 6d.**

READERS active either as transmitting amateurs or short wave listeners will know that the R.S.G.B. Call Book lists, in callsign sequence, the names and addresses of all amateur stations in England, Scotland, Wales, Northern Ireland, Channel Islands, Isle of Man, and Eire.

The 1963 edition records 560 new call signs and incorporates nearly 1,000 changes of address. It also includes, for the first time, a list of stations to whom an Amateur (Sound Mobile) Licence has been issued.

Also included is a list of societies and clubs affiliated to the R.S.G.B., a list of amateur radio callsign prefixes (by prefix and by country order) and a list of amateur abbreviations.

Anyone actively interested in amateur radio transmitting or receiving will find this publication of great value.—*D.C.*

MAGNETIC PICKUP

—continued from page 235—

some pre-amplification is necessary. Fig. 3 shows a suitable transistor pre-amplifier which can be easily and cheaply constructed.

The input stage employs the grounded base configuration, giving low input impedance, eliminating the necessity for a matching trans-

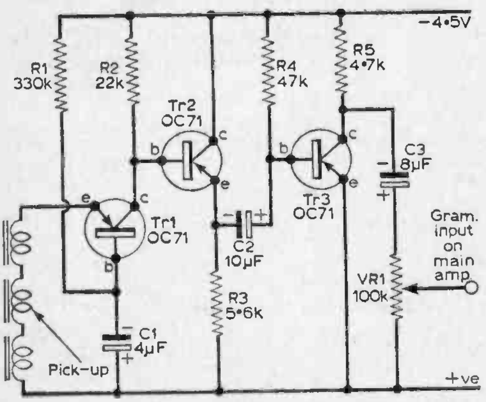


Fig. 3: Circuit of the pre-amplifier.

former. This is followed by an emitter follower and an earthed emitter stage giving a reasonably high output impedance, suitable for feeding a valve amplifier.

The output of the pre-amplifier exceeds 600mV, ample for loading a gram amplifier. For many such amplifiers the first two stages alone should provide enough gain.

The performance of the pick-up compares favourably with many commercial models. If desired it may be encased in wood or coloured Perspex to give a neater appearance. ■

CLUB NEWS—*continued*

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: L. A. Metcalfe, 1a Moorlands Road, Birkenshaw, Bradford, Yorkshire.

The problems of conversion to a 625-line television standard was the subject of a talk given to members on May 2nd, and on May 16th "Guided Missiles" was the title of M. A. Browne's lecture.

STOURBRIDGE AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: R. A. G. MacIntosh, 50 Field Lane, Oldswinford, Stourbridge, Worcestershire.

Members who attended the meeting for May 7th heard a recorded lecture on "Semiconductors." Later in the month, on May 28th, details and plans of the Society's NFD effort were discussed.

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. Seed, G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

May proved a busy month for this Society, starting with a junk sale on the 1st. On May 15th, Mr. Roberts (G3EGX) gave a lecture entitled "Radio Maths Follow-up", and on the 22nd NFD organisation was discussed. A d.f. contest on May 26th rounded off the month's events.

R.S.G.B. GOLDEN JUBILEE MOBILE RALLY
United States Air Force Base, Wethersfield, near Braintree, Essex.

A very full programme provided a wide variety of entertainment for visitors to this rally which was held on June 2nd. Apart from the usual exhibitions and competitions, displays of fire fighting and aircraft, film shows, go-kart racing and much more was included. One of the highlights of the day was the performance of the resident U.S.A.F. band.

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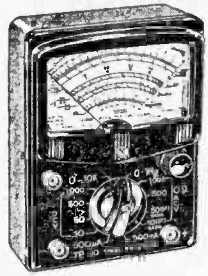

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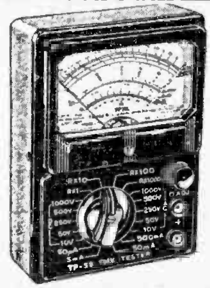

20,000 O.P.V. MODEL TP-5S. Reads voltage up to 1,000 D.C. at 20,000 ohms per volt and A.C. at 10,000 O.P.V.: D.C. Current to 500mA; Resistance to 10 Megs.; Capacitance to 0.1μF; Decibels from —20 to +36. Size 3½in. x 5½in. x 1½in.

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30,000 O.P.V. MODEL 500. Volts to 1,000; D.C. at 30,000 O.P.V. A.C. at 20,000; 12 Amps D.C. Current; 60 Megs Resistance; —20 to +56 Dbs; Internal buzzer short circuit warning. Size 3⁵/₁₆in. x 6⁵/₁₆in. x 2⅛in.

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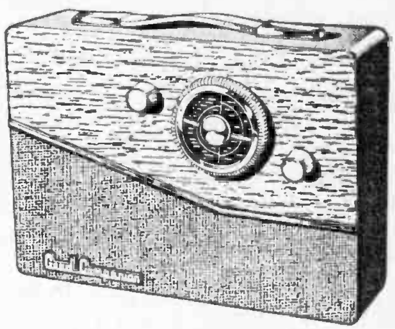

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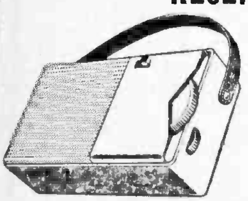

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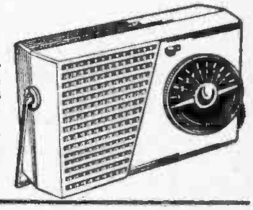

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LETTERS TO THE EDITOR

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying commercial or surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of the cover.

The Editor does not necessarily agree with the opinions expressed by his correspondents

INSTANT AMATEURS

SIR,—Your notes on the Club News page of the May issue, "Instant Amateurs" was enlightening in that it reported an apparently constant request from those wishing to get things the easy way—which seems to be the trend these days.

There would indeed be a muddle if licences were freely granted, and surely any worthwhile hobby warrants a little study? I simply cannot understand how anybody would wish to indulge in a hobby without knowing something about the why's and wherefore's of it.—THOMAS C. DANDS (Northwich, Cheshire).

MORE ON THE LANGUAGE BARRIER

SIR,—I must agree with Mr. A. Jameson (March Letters to the Editor). Mr. Collister (May issue) admits that foreign amateurs speak English "almost fluently"; "almost" being the operative word. I know from personal experience that it is much easier to understand and to be understood by foreigners using Esperanto than using broken English. Moreover, Esperanto is a neutral language, involving no question of national prestige.

I am sure that in the sphere of wireless communication, Esperanto would be an untold boon.—R. M. DHENAU (Sheringham, Norfolk).

SIR,—With reference to recent letters concerning the use of Esperanto, it might be interesting to consider what these two instruments of international communication (radio and Esperanto) have in common. Both, it may be said, are artificial, neutral and international, being scientific adaptions of more "natural" methods of communication, and both are potentially important factors in abolishing insularity and paving the way to international understanding.

The apt motto of the BBC could well become a reality if language were to function as a vehicle, not as an obstacle, of comprehension: it would certainly come nearer being realised if the merits of Esperanto were given more serious consideration.—E. R. HOLT (Billericay, Essex).

SIR,—In reply to Mr. Jameson's letter in your March issue, I have always thought part of the enjoyment of making a contact, is the language barrier. I personally have had very interesting Q.S.O.'s with foreign radio amateurs, sometimes taking up to half-an-hour to get his Q.T.H. and name, and I have always felt highly satisfied having done so.

I would suggest that Mr. Jameson finds some other more rewarding hobby: radio amateurs are governed by enough rules and regulations as it is.—PHILIP G. JUPP (Nairobi, Kenya).

CALCULATOR APPRECIATION

SIR,—Thank you so much for the "Parallel Resistor and Series Capacitor Calculator" (April issue of P.W.).

It is appreciated very much, and will be a very handy tool on our work bench.—HENRY WAGNER (East Chicago, Indiana, U.S.A.).

A SATISFIED CUSTOMER

SIR,—As a reader of P.W. for a number of years, I have built many of the circuits that have been printed. A few months ago, I built Mr. J. Haskell's Main Amplifier which was published in the September 1962 issue. Being very much an amateur, I ran into a few snags when constructing the amplifier. I wrote to Mr. Haskell for advice, and he very kindly gave me all the help I needed.

I hope you will publish this letter, as I would like Mr. Haskell to know how greatly I appreciated his assistance.—DEL GILLAM (Johannesburg, South Africa).

PUBLICATIONS WANTED

SIR,—I would be pleased if some reader would be kind enough to lend or sell me the May and June 1955 editions of P.W., which deal with the construction of a radio telescope.—G. W. JONES, Ael-y-Bryn, Bontddu, Dolgellau, Merionethshire.

SIR,—I should like to know of any reader who would sell me a copy of June 1961 P.W. I need this issue for the article on the pre-amplifier.—P. LEADER, 117 Roundmoor Drive, Cheshunt, Hertfordshire.

SIR,—I would be most grateful if any P.W. readers, who might be able to lend or sell me the following issues, would contact me: January, February and March, 1962; April, May, November, 1961.—I. GREEN, 182 St. John's Road, Woking, Surrey.

SIR,—I wonder if any of your readers would sell or loan me the circuit and wiring details of an ex-U.S. Army BC 348-K receiver?—J. S. MCARRAGLER, 199 Evington Lane, Evington, Leicestershire.

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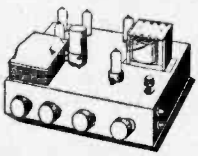

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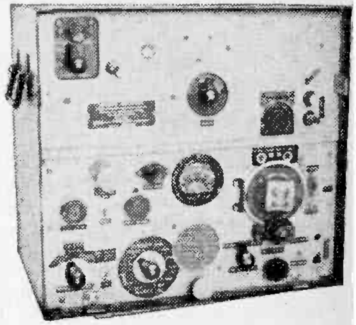

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4	9500	3	9/6
4	9500	5	9/6

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4	7000	25	11/6
4	6000	35	10/6
4	7000	35	11/-
4	9300	35	11/6
4	9500	35	11/6
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4 ,,	7000	3	8/-
4 ,,	7000	5	8/-
5	6000	3	8/-
5	7000	3	8/6
5	7000	5	8/6

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5	8500	5	9/6
5	9500	3	10/6
5	9500	5	10/6
5	10000	3	11/6
5	6000	25	10/6
5	6000	30	10/6
5	6000	40	10/6
5	9500	25	11/6
5	9500	30	11/6
5	9500	35	11/6
5	10000	25	12/-

Diameter in inches	Gauss in lines	Imped. in ohms	Price
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6½	6000	3	10/6
6½	7000	3	11/-
6½	7000	5	11/-
6½	8500	3	11/6
6½	9500	3	12/-
8	6000	3	11/6
8	7000	3	12/-
8	7000	5	12/-
8	8500	3	12/6
8	8500	5	12/6

Elliptical Size	Gauss in lines	Imped. in ohms	Price
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5 × 3	7000	3	8/-
5 × 3	7000	5	8/-
5 × 3	9000	3	8/6
5 × 3	9000	4	8/6
5 × 3	9000	5	8/6
5 × 3	6000	25	9/6
5 × 3	7000	25	10/-
5 × 3	7000	35	10/-
5 × 3	9000	25	11/-
5 × 3	9000	35	11/-
6 × 4	6000	3	8/6
6 × 4	7000	3	9/-
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6 × 4	9500	5	10/-
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7 × 4	6000	3	9/6
7 × 4	7000	3	10/-
7 × 4	7000	4	10/-
7 × 4	7000	5	10/-
7 × 4	8500	3	10/6
7 × 4	9500	3	11/-
7 × 4	9500	4	11/-
7 × 4	9500	5	11/-
7 × 4	9500	30	11/6
7 × 4	9500	35	11/6

Elliptical Size	Gauss in lines	Imped. in ohms	Price
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7 × 4	10000	3	12/-
7 × 4	10000	5	12/-
7 × 4	10000	15	12/6
7 × 4	9500	3*	13/6
8 × 2½	6000	3	8/6
8 × 2½	7000	3	9/-
8 × 2½	7000	5	9/-
8 × 2½	6000	6	8/6
8 × 2½	6000	30	9/6
8 × 2½	8500	5	9/6
8 × 2½	9500	3	10/-
8 × 2½	9500	4	10/-
8 × 2½	9500	5	10/-

Elliptical Size	Gauss in lines	Imped. in ohms	Price
8 × 2½	9500	30	10/6
8 × 2½	9500	50	10/6
8 × 2½	10000	3	10/6
8 × 2½	10000	5	10/6
8 × 5	6000	3	8/6
8 × 5	7000	3	9/-
8 × 5	8500	3	9/6
8 × 5	8500	5	9/6
8 × 5	9500	3	10/-
8 × 5	9500	15	13/6
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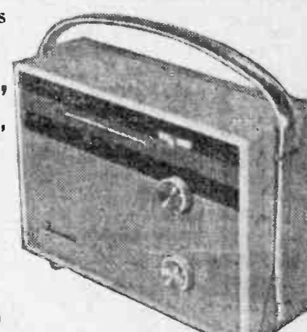

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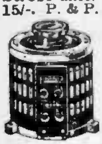

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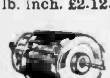

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PRACTICAL WIRELESS, JULY, 1963.

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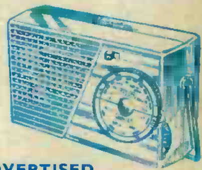

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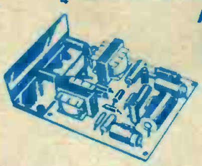

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