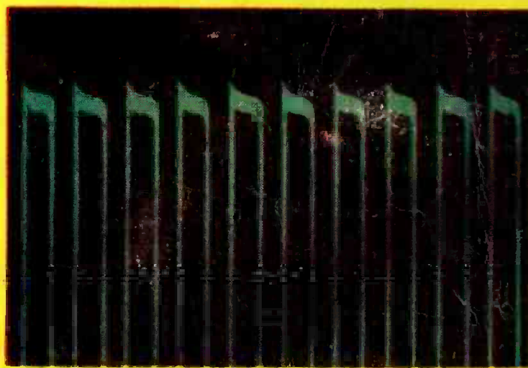
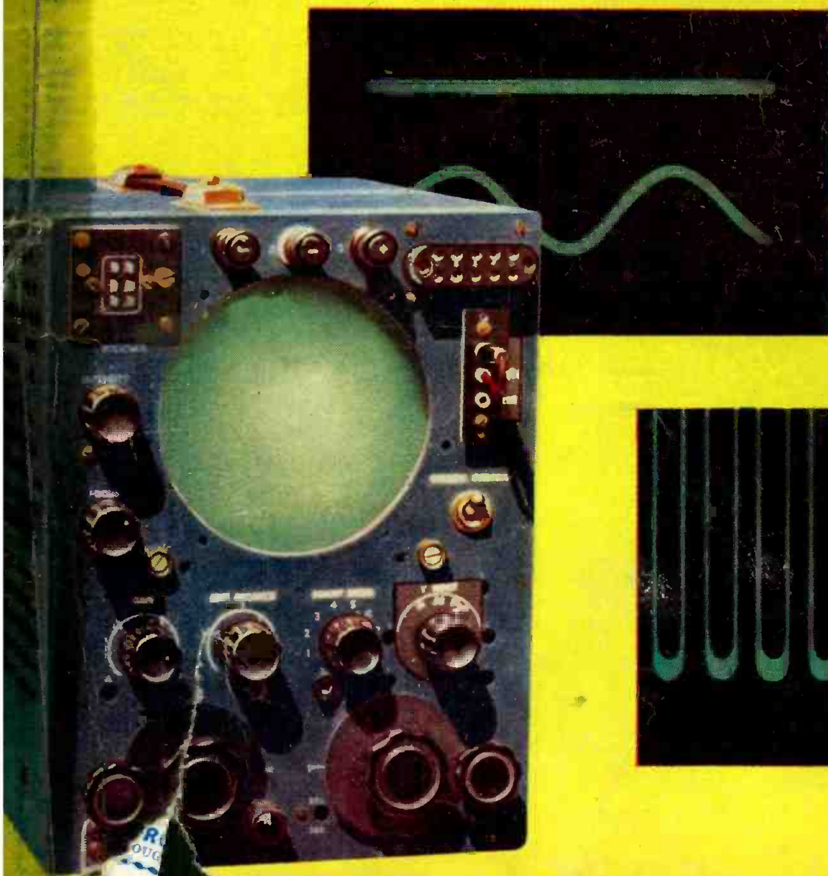
SEPTEMBER
1963

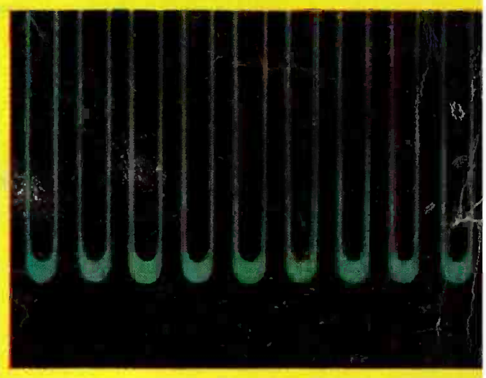
# Practical WIRELESS

2/-

## VERSATILE DOUBLE-TRACE OSCILLOSCOPE





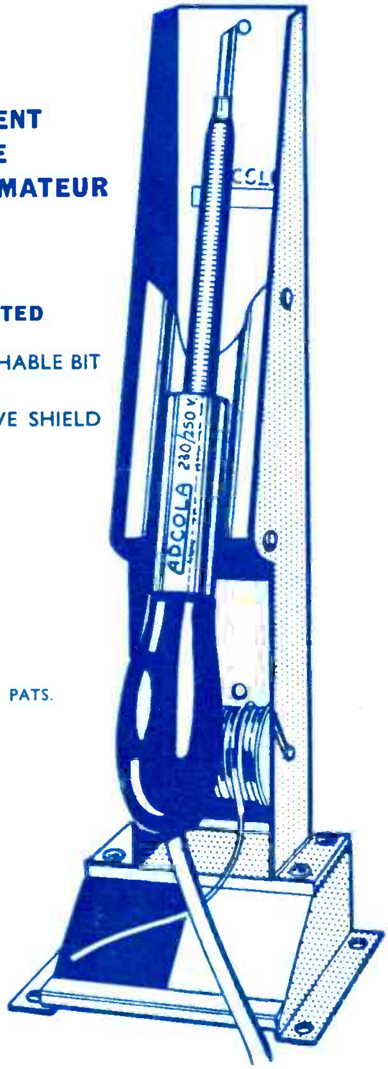


UR-STAGE PROGRESSIVE CONSTRUCTION

# ADCOLA

(Regd. Trade Mark)

## SOLDERING INSTRUMENTS




**EQUIPMENT FOR THE RADIO AMATEUR**

**ILLUSTRATED**

List 64.
3/16" DETACHABLE BIT
IN
PROTECTIVE SHIELD
List 700

BRIT. & FOR. PATS.

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**ADCOLA HOUSE**
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Telephones MACaulay 4272 & 3101
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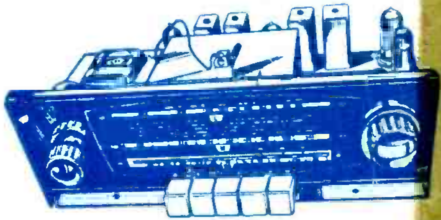
## BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (Carriage Paid)



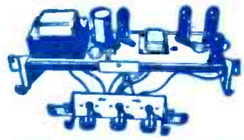
A.C. ONLY. Chassis size 15 x 6¾ x 5¼in. high. New manufacture. Dial 14½ x 4in. in 2 colours, predominantly gold.
Pick-up Ext. Speaker. Ae. E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1000-1900 M.: 200-500 M.: 88-98 Mc/s. 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.

## THE "VERONA" SPEAKER CABINET ONLY £5.9.6. (carr. 7/6).

Beautifully finished in semi-matt medium walnut, 23½in. high x 11¾in. x 13½in. Takes 8in. speaker with room below (11¼ x 10in.) for amplifier, if desired. (Our 5 W. amplifier price 60/-, post paid, suits). Speakers from 18/6 to £4. SPECIAL OFFER of 18/6 Speaker, Cabinet and Amplifier for only £9 carriage paid.

## 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 3¼in. With o.p. trans for 2-3 ohm speaker. Front panel (normally screwed to chassis) may be removed and used as "flying panel". 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 1¾in. Height 5½in. overall. Front to back 5½in. Vol. and on-off tone. Mike radio and ext. speaker jacks. Valves magic eye, ECC83, ECL82, EZ80. 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.

## SUPERHET CIRCUITS

### THE "SCALA"

"Scala" Kit £4.19.6. (Post 3/-). Size 8½ x 2 x 5½in. high and 3¼in. speaker; or fully built £7.10.6.

### THE "MILAN"

"Milan" Kit £5.17.6. (Post 3/6). Size 9 x 3¾ x 7in., 8 x 2¼in. speaker.

100 mF. + 200 mF. ELECTROLYTIC. New 275 v. (350 v. surge). 4in. x 1¾in. dia., 5/- each. (Post 1/-).
**ALL ITEMS ARE NEW AND FULLY BUILT UNLESS OTHERWISE STATED. TESTED BEFORE DESPATCH.**
Terms Available on Items over £5. Send 6d. (stamps will do) for 20-page illustrated catalogue. Delivery by return C.O.D. 2/- extra.
**ALL ITEMS GUARANTEED 12 MONTHS VALVES 3 MONTHS**

# GLADSTONE RADIO

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

Farnborough 3371 FARNBOROUGH CLOSED SATS.

**R.S.C** (Manchester) Ltd.

*MAIL ORDERS to 5 County Arcade, Leeds 1. Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries please.*

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| Half-day Thursday | (Opp Snow Hill Sta) No half-day | Half-day Thursday | | Half-day Wednesday | | No half-day | No Half-day |

## FANE HEAVY DUTY HI-FI SPEAKERS

12in. 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.
122/10 20w., 5 gns. 122/10A 20w., 6 gns.
122/12 20w., 8 gns. 122/12A 20w., £7.19.6.
122/14 22w., 9 gns. 122/14A 22w., 10 gns.
122/17 25w., 11 gns. 122/17A 25w., 12 gns.
15in., 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.
152/12 20w., 12 gns. 152/12A 20w., 13 gns.
152/14 27w., 14 gns. 152/14A 27w., 15 gns.
152/17 35w., 16 gns. 152/17A 35w., 17 gns.
"A" indicates dual cone type, 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

## 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. Send S.A.E. for leaflet.

**11 Gns.** Carr. 10/-

**TERMS: DEPOSIT** 33/9 and 9 monthly payments of 33/9.
Suitable microphones and speakers available at competitive prices.

**WE STOCK ARMSTRONG, DULCI, LINEAR, ROGERS, LEAK 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.

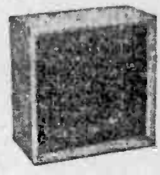
**TWEETERS.** Plessey 3Ω 19/9. 15Ω 25/9.

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

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

**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 x 5 x 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 379.**

**LINEAR LG34 GRAM AMPLIFIER** High quality. Separate Bass and Treble controls. Handsome appearance. 5 gns.

## 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 26 Osmaston Road THE SPOT DERBY**

**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.

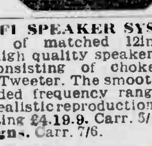
**R.S.C. JUNIOR HI-FI REPRODUCER.** The very latest Goodmans Axiette 8 High Fidelity loudspeaker (retailing at approx. 5 gns.) fitted in a specially designed Bass Reflex cabinet size 12 x 18 x 10in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency 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 for 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**

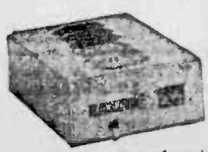


Polished walnut veneer finish. Pleasing design. **JUNIOR MODEL.** Size 20 x 11 x 8in. for 8 x 5in. or 10 x 6in. speakers. £2.9.9. **STANDARD MODEL.** Size 27 x 13 x 12in. for 8 or 10in. speakers, £4.11.9. **SENIOR MODEL.** Size 30 x 20 x 15in. for 12in. Speaker. Suitable Speaker systems below. Only 7 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.

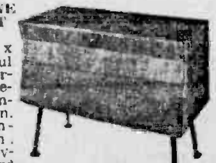
## R.S.C. BATTERY TO MAINS CONVERSION UNITS

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.

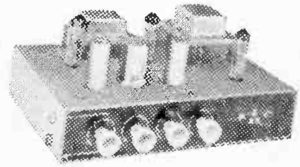
**REALISM AT INCREDIBLY LOW COST. CAN BE ASSEMBLED IN AN HOUR** Incorporating the latest Collaro Studio Tape Transcriptor. The audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, size 14½ 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.

## HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

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



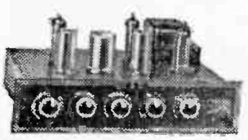
Two input sockets with associated controls allow mixing of "mike" and gram., as in A.10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. 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 pi-k-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 200-250v. 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 3 ohm 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.
**MARRIOTT RECORDING HEADS** High Impedance, Record/Playback 15/-. Low Impedance, Erase, 10/-.
**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 11¾ x 2½ x 2¼in. Controls: Vol. and Tone with switch. Only 59/6.

## SENSATIONAL STEREO OFFER

A complete set of parts to construct a good **(4 Gns.)** 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.

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

## R.S.C. BATTERY CHARGING EQUIPMENT

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

**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.

**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
6 v. or 12 v. 1 amp. ........ 22/9
As above, with Ammeter 28/9
6 v. 2 amps ........ 19/9
6 v. or 12 v. 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

**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 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, 5000Ω to 3Ω .. .. 4/6
Small Pentode 7/8,000Ω to 3Ω .. 4/6
Standard Pentode 5,000Ω to 3Ω .. 5/9
Standard Pentode 7,000Ω to 3Ω .. 5/9
10,000Ω to 3Ω .. 5/9
Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω .. 9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 to 15Ω .. 19/9
Following types for 3 and 15Ω 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 2¾ x 2¼ x 2¼ins.
**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. 5a., 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.

Stern's

POSTAL ENQUIRIES and MAIL ORDERS TO Dept. P.W.
**STERN RADIO LTD.**
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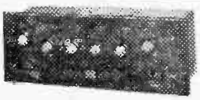
# MULLARD DESIGNS

## MULLARD 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

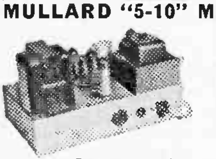
Employing two EF86 valves and designed to operate with the Mullard AMPLIFIERS but also perfectly suitable for other makes.
★ Equalisation for the latest R.I.A.A. characteristics.
★ Input for Crystal Pick-ups and variable reluctance magnetic types.
★ Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
★ Sensitive Microphone Channel. ★ Wide range BASS and TREBLE Controls.
KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£9.10.0** (Carr. & Ins. 5/-).



## MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Designed mainly for Mullard Range of Amplifiers, also suitable for any Amplifiers requiring input up to 250 mV. Incorporates 5 input Channels, including for Tape and Magnetic Pickups. Separate Bass and Treble controls. High pass filter 20 to 160 c/s. low pass filter 5-9 Kc/s. Totally enclosed in case size 11½"×4½"×4".
KIT OF PARTS **£10.0.0** ASSEMBLED AND TESTED **£13.13.0** (Carr. & Ins. 5/-).

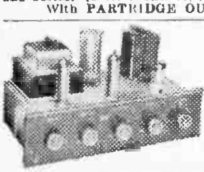
## MULLARD "5-10" MAIN AMPLIFIER



For use with MULLARD 2 or 3 valve pre-amplifier with which an undistorted power output of up to 10 watts is obtained. SPECIFIED COMPONENTS AND MULLARD VALVES including PARMEKO MAINS TRANSFORMER and our choice of PARMEKO or PARTRIDGE Output Transformer. COMPLETE KIT (Parmeko Output trans.) **£10.0.0**
(Carr. & Ins. 6/6.) ASSEMBLED & TESTED **£13.10.0**
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

## COMBINED PRICE REDUCTIONS

(a) The KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-valve Pre-amplifier .......... **£15.15.0**
(a) The "5-10" and the 2-Valve Pre-amplifier both Assembled and Tested. (Carr. & Ins. 8/6) .......... **£21.10.0**
(b) KIT OF PARTS to build the "5-10" Main Amplifier and 3-Valve Pre-Amplifier .......... **£19.10.0**
(b) The "5-10" and the 3-Valve Preamplifier both Assembled and Tested. (Carr. & Ins. 10/-) .......... **£25.10.0**
With PARTRIDGE OUTPUT TRANSFORMER £1.6.0 extra.



## THE MULLARD "33/RC"

A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN.
KIT OF PARTS **£8.8.0**
ASSEMBLED AND TESTED. (Carr. & Ins. 6/6). **£11.10.0**
Complete to the MULLARD specification including PARMEKO OUTPUT TRANSFORMER. Switched inputs for 78 and L.P. records plus a Radio position. Power to drive a Radio Tuner is also available.

## THE "MONO-GRAM"

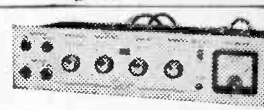
A small Amplifier of genuine high quality performance. Incorporates new MULLARD ECL86 Valve, separate BASS and TREBLE controls and produces up to 3 watts undistorted output. (Carr. & Ins. 3/6).
Kit of Parts **£4.10.0** Assembled and Tested **£6.0.0**

Perfectly suited for Portable Installations for which purpose we offer PORTABLE CASE £3.10.0. the AMPLIFIER (Kit) and 8×5in. SPEAKER (£1.0.0). All for **£9.0.0**
Alternative with ASSEMBLED AMPLIFIER .......... **£10.0.0**
(Carr. & Ins. 10/-).
The case quoted above will accommodate some 4-speed Single Record Units. A larger model for autochanger is available for extra 10/-. With this Equipment a COMPLETE PORTABLE RECORD PLAYER CAN BE BUILT for .......... **£14.0.0**

## MODEL CR3/S TAPE RECORDER

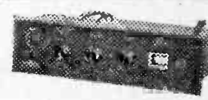
MODEL CR3/S incorporates the HF/TR3 Mk. II Tape Amplifier (described below) and the Collaro "Studio" Twin Track 3-speed Deck operating at 1⅞in., 3¾in., and 7½in. speeds. Complete with microphone and 1,200ft. tape.
PRICE **£43.0.0**
COMPLETE KIT **£33.8.0**
(Carr. & Ins. 15/-).

## STEREO TAPE PRE-AMPLIFIER



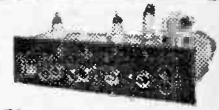
Model STP-1. For use with current TRUVOX, BRENNELL or COLLARO "STUDIO" ¼ and ½ track Stereo Decks. Incorporates Ferroxcube Oscillator, 4-speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.
KIT OF PARTS **£22.0.0** (Carr. & Ins. 8/6). ASSEMBLED AND TESTED **£28.0.0**

## MULLARD TYPE "C" TAPE PREAMPLIFIER



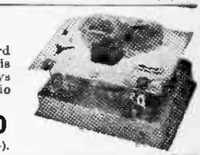
Suitable for most ½-track Mono Tape Decks. Incorporates Ferroxcube Push-Pull Oscillator, Treble Inductor, and 3-speed equalisation. Includes separate Power Unit.
KIT OF PARTS **£14.0.0** ASSEMBLED **£19.10.0** (Carr. & Ins. 7/6).

## MULLARD TAPE AMPLIFIER
(MODEL HF/TR3)



Based on Mullard's Type "A" design and suitable for most ½ track Mono Tape Decks. Incorporates Ferroxcube Treble Inductor, Gilson Output Transformer, and 3-speed equalisation. Includes separate Power Unit.
KIT OF PARTS **£13.13.0** ASSEMBLED **£19.0.0** (Carr. & Ins. 7/6).

## STERN'S "ADD-A-DECK"



A self contained Unit consisting of Garrard Deck and matched Pre-Amplifier on one chassis Provides full tape recording facilities and replays through Pick-up Sockets of standard Radio Receiver or Amplifier.
PRICE, includes complete Tape Magazine. **£18.18.0**
(Carr. & Ins. 10/-).

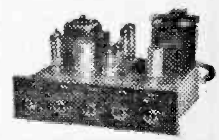
## !! COMBINED PRICE OFFERS !!

Includes small charge for special testing and PRECISE MATCHING of the ASSEMBLED PRE-AMPLIFIER (or Amplifier) to TAPE DECK.

| | | | |
|---|---|---|---|
| STP-1 (Kit) and "STUDIO" Deck | £39. 0.0 | Assembled | £46.0.0 |
| STP-1 (Kit) and Brenell Deck | £66. 0.0 | Assembled | £75.0.0 |
| STP-1 (Kit) and Truvox Deck | £51. 0.0 | Assembled | £59.0.0 |
| TYPE "C" (Kit) and "STUDIO" Deck | £26.10.0 | Assembled | £33.0.0 |
| TYPE "C" (Kit) and BRENELL Deck | £43. 0.0 | Assembled | £50.0.0 |
| TYPE "C" (Assembled) and WEARITE Deck | £70. 0.0 | (Inc. Head Lift Transf.) | |
| HF/TR3 (Kit) and "STUDIO" Deck | £26. 0.0 | Assembled | £33.0.0 |
| HF/TR3 (Kit) and BRENELL Deck | £43. 0.0 | Assembled | £50.0.0 |
| HF/TR3 Assembled) and WEARITE Deck | £70. 0.0 | (Inc. Head Lift Transf.) | |

(Carr. & Ins. on above, 15/-).

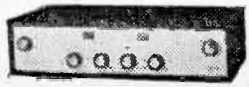
## THE MULLARD "510/RC" AMPLIFIER



The popular complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction with an input of 600MV. Specified components and new MULLARD VALVES. Includes PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE Output Transformers.
COMPLETE KIT **£12.0.0**
ASSEMBLED AND TESTED **£16.0.0** With PARTRIDGE OUTPUT TRANS. £1.6.0 extra. (Carr. & Ins. 7/6).

## THE "TUDOR" STEREO AMPLIFIER

PRICE **£15.0.0** (Pkg. & Carr. 7/6)



A self-contained Shelf-mounting Amplifier designed to provide high quality stereophonic and monophonic reproduction. Each channel provides a rated output of 6 watts and for monophonic operation approx. 12 watts is produced. Separate BASS and TREBLE CONTROLS. The Cabinet is finished in Black Crackle. Size 14 x 8 x 4in. Send for full specification.

WE ARE PLEASED TO ANNOUNCE THAT ALL STERN'S PRODUCTS are NOW AVAILABLE from **CLYNE RADIO LTD.**
12 SUFFOLK HOUSE
GEORGE STREET, CROYDON
Telephone: MUN 3250

# 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 EZ80. Complete with all plugs, sockets, panels, 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 7 x 4in. speaker, two-tone grey** .......... £4.4.0

**Complete Kit as above, with Tape and Microphone** .......... £22.0.0
Deposit £2.4.0 and 12 monthly .......... £1.16.6

**Collaro Studio Deck.** Very latest model, 3 speeds. 7in spools .......... £10.19.6
Deposit £1.2.0 and 8 monthly .......... £1.7.3

**Tape Amplifier for Studio Deck,** with ready wired printed circuit, control and input panels, mains and output transformers, knobs, plans, screws etc. EF86, ECC83, EM84, EZ81 and 2-EL84, 3 watts output. Magic eye, Radio and Mic., inputs Ex L/S socket, Tone and Monitor controls. Can be used as amplifier .......... £11.11.0
Deposit £1.4.0 and 12 monthly .......... 19/-

**Case for above,** with 9 x 5in. speaker, two-tone grey .......... £5.5.0

**Complete Kit, with Tape and Microphone** .......... £29.0.0
Deposit £2.18.0 and 12 monthly .......... £2.8.2

**Building instructions available at 2/6 each kit (refunded if kit bought)**

### QUARTER TRACK

**B.S.R. TD2.** Marriott heads. L series .......... £11.11.0
Deposit £1.4.0 and 12 monthly .......... 19/-

**Tape Amplifier,** as opposite, 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,** with tape and microphone .......... £25.0.0
Deposit £2.10.0 and 12 monthly .......... £2.1.6

**Collaro Studio Deck.** Marriott X series heads .......... £17.17.0
Deposit £1.17.6 and 12 monthly .......... £1.9.5

**Tape Amplifier.** as over but quarter track .......... £12.12.0
Deposit £1.7.0 and 12 monthly .......... £1.0.8

**Case,** with speaker, two-tone grey .......... £5.5.0

**Complete Kit,** with tape and microphone .......... £35.0.0
Deposit £3.10.0 and 12 monthly .......... £2.18.2

**Tape Pre-amplifier for Collaro Studio Deck.** with power supplies. ECC83, ECL82, EZ80 and EM85. Radio and Mic sockets, gives an equalised output of 400mV

**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

**TAPE HEADS**

**M.S.S.** Quarter track, Record/Playback and Erase Set .......... £3.3.0

**Bradmatic** Half track Record/Playback head only .......... £1.12.6

**Bradmatic** Half track Record/Playback and Erase as Studio, Set .......... £1.19.6

**Collaro** pressure pad for third head position .......... 4/-

**Brenell Mk. 5 Series 2** 4-speed deck half track .......... £32.11.0
Deposit £3.5.0 and 12 monthly .......... £2.14.0

**Brenell Mk. 5 Tape Amplifier with power pack** .......... £26.0.0
Deposit £2.12.0 and 12 monthly .......... £2.3.2

### JASON F.M. TUNERS

**FMT1,** complete with 4 EF91 valves .......... £6.15.0
Deposit £1.0.0 and 6 monthly .......... £1.2.6

**FMT2,** less power, complete with 4 EF80 valves .......... £8.7.6
Deposit £1.0.0 and 8 monthly .......... £1.1.0

**FMT2,** with power, complete with 4 EF80 and 1 EZ80 .......... £10.5.0
Deposit £1.5.0 and 10 monthly .......... £1.0.0

**FMT3,** Fringe, complete with valves, less power .......... £10.5.0
Deposit £1.5.0 and 10 monthly .......... £1.0.0

**FMT3,** with power, complete with all valves .......... £12.0.0
Deposit £1.4.0 and 12 monthly .......... 19/10

**JTV/2,** switched F.M. and TV sound, self powered, all valves .......... £14.17.6
Deposit £1.12.0 and 12 monthly .......... £1.4.5

**Mercury 2,** as JTV/2 but less power, all valves .......... £10.12.6
Deposit £1.3.6 and 12 monthly .......... 17/5

**nstruction book is included in all kits, but otherwise 2/6 and 3/6.**

### RADIO TUNERS

**Armstrong T4C** V.H.F. Tuner, self powered .......... £17.19.0
Deposit £1.19.6 and 12 monthly .......... £1.9.5

**Armstrong ST3 Mk. 2** A.M./F.M. Tuner, self powered .......... £25.12.0
Deposit £2.13.0 and 12 monthly .......... £2.2.4

**Armstrong AF208** A.M./F.M. 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 Mk. 2** A.M./F.M. push-pull output stage .......... £28.5.0
Deposit £2.16.6 and 12 monthly .......... £2.6.11

**Armstrong Stereo 55** A.M./F.M. Radio chassis, with stereo gram .......... £29.18.0
Deposit £3.2.6 and 12 monthly .......... £2.9.5

**Armstrong Stereo 12 Mk. 2** A.M./F.M. Radio chassis, stereo gram and push-pull output stages .......... £40.5.0
Deposit £4.0.6 and 12 monthly .......... £3.6.11

**Brass escutcheon available for AF208 and Jubilee Mk. 2** .......... 7/6

### AMPLIFIERS (MONO)

**Linear L45** 3 watt, 3 valve .......... £5.19.6

**Linear Diatonic,** 12 watt, suitable Mic. or Guitar .......... £12.12.0
Deposit £1.7.0 and 12 monthly .......... £1.0.8

**Linear Concord,** 30 watt, ideal Guitar amp., with case .......... £18.0.0
Deposit £1.16.0 and 12 monthly .......... £1.9.10

**Dulci GA5,** integrated amp. and P.A., 5 watt, ECL86 valve .......... £13.2.6
Deposit £1.8.6 and 12 monthly .......... £1.1.6

**Dulci DPA15,** 15 watt with 2 valve pre-amp .......... £25.4.0
Deposit £2.10.6 and 12 monthly .......... £2.1.11

**Tripletone Hi-Fi Major** with pre-amp. Guitar or Mic .......... £15.18.9
Deposit £1.15.3 and 12 monthly .......... £1.6.1

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

**Leak Varislope III** pre-amplifier .......... £15.15.0
Deposit £1.11.6 and 12 monthly .......... £1.6.1

**Quad,** 15 watt Main amplifier only .......... £22.10.0
Deposit £2.5.0 and 12 monthly .......... £1.17.4

**Quad** pre-amplifier Mono .......... £19.10.0
Deposit £1.19.0 and 12 monthly .......... £1.12.4

### GRAMOPHONE UNITS

**Garrard SRP10** with GC8 cartridge, Mono, single player .......... £5.9.11

**B.S.R. UA14** with TC8 cartridge, Mono, 4-speed changer .......... £6.19.6
Deposit £1.0.0 and 6 monthly .......... £1.3.3

**Garrard Autoslim,** Mono GC8 cartridge, 4-speed changer .......... £6.19.6
Deposit £1.0.0 and 6 monthly .......... £1.3.3

**Garrard AT6 Autoslim de Luxe,** GC8 Mono cartridge .......... £11.9.0
Deposit £1.6.6 and 9 monthly .......... £1.4.9

**Philips AG1016,** Stereo cartridge, will change 7in. records .......... £12.12.0
Deposit £1.7.0 and 12 monthly .......... £1.0.8

**Decca Deram Arm and Plug-in Shell** .......... £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 arm .......... £17.14.0
Deposit £1.19.0 and 12 monthly .......... £1.9.0

**Goldring GL55X,** as GL58 but less pick-up arm .......... £13.1.7
Deposit £1.7.7 and 12 monthly .......... £1.1.6

**Garrard 4H/F** with Mono GC8 cartridge .......... £17.0.0
Deposit £1.14.0 and 12 monthly .......... £1.3.2

**Garrard Lab Type "A"** Transcription auto-changer, Mono GC8 .......... £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

### 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 Mk. 2** with pre-amplifier, 4 ECL86 valves .......... £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 III,** stereo pre-amplifier .......... £25.0.0
Deposit £2.10.0 and 12 monthly .......... £2.1.6

**Quad 22 Stereo Control Unit** .......... £25.0.0
Deposit £2.10.0 and 12 monthly .......... £2.1.6

For **Quad Main Amplifiers** see **Mono section above.**

### LOUDSPEAKERS

**Goodmans Axiette 8** .......... £5.5.7

**Goodmans Axiom 10** .......... £6.5.11

**Goodmans 5K/20/XL** .......... £7.0.0

**Wharfedale Super 8/RS/DD** .......... £6.14.2

**W.B. HF1012** 10in. .......... £4.7.6

**R.T.C.** 12in. Unit, 15 watt .......... £5.5.0

**R.T.C. Hi-Fi Master** .......... £8.8.0

**Goodmans XO 5000** cross-over .......... £1.19.0

**Goodmans Axiom 201** 12in. Unit .......... £10.7.0
Deposit £1.1.0 and 9 monthly .......... £1.5.9

**Goodmans Axiom 301** 12in. Unit .......... £14.10.0
Deposit £1.9.0 and 12 monthly .......... £1.4.0

**Wharfedale W12/EG** 12in. 15 watt Guitar speaker .......... £10.10.0
Deposit £1.1.0 and 12 monthly .......... 17/5

**Wharfedale Super 10/RS/DD** 10in. high quality unit .......... £10.18.0
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**Wharfedale RS/12/DD** 12in. 15 watt Hi-Fi speaker .......... £11.10.0
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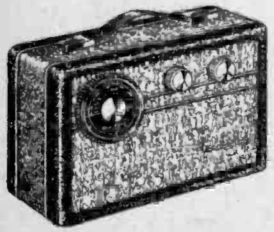
## The "AIR KING"

Our new highly successful Six transistor luxury portable with the "SLIM LINE" look. To build yourself, with printed circuit chassis for reliability and simplicity in construction. May be used as Car Radio, with full MEDIUM wave and LONG wave coverage.
**Look at these features!**



★ 500 milliwatt output to high flux 7 x 3½in. high fidelity loudspeaker. ★ **Six selected Mullard Transistors** in latest super sensitive circuit, plus germanium diode. ★ Compact size—only 9¼ x 3½ x 6½in. (high). ★ Attractive three-tone cabinet. Black, Dark Grey, and Silver Grey, with gilt control knobs and all gilt fittings. ★ Coax socket for car aerial. ★ Brand new guaranteed components. ★ Push pull output. ★ Automatic volume control. ★ Long life battery. ★ Super sensitive internal ferrite rod aerial. ★ Nothing more to buy. Cabinet included.
Special inclusive price for all required components. **£7.19.6** Plus P. & P. 4/-.
Alignment service available. Full assembly details and individually priced parts list, all of which are available separately, price 1/6 post free.

## The "HIGHWAYMAN"

**At last a quality Car Radio to build yourself, at an economical price.**
Look at these features:—
★ Attractive styling. ★ Push-pull output. ★ 3 latest Mullard transistors plus valves type EBF83 and ECH83. ★ No Buzz. High Output and sensitivity. ★ Printed circuit (newest type). 7" x 4" High flux p.m. speaker. ★ Medium and Long Waves. ★ Push Buttons for fingertip control. ★ Extremely low Battery consumption (less than ½ amp.) ★ Easy to fit any make car (Positive earth only). ★ 12 volt operation. ★ Compact size measures only 7" x 7" x 2" deep. ★ Easy assembly. Supplied with dial and drive already mounted.

All parts available separately but if purchased at one time, the whole will be supplied at a special inclusive price of only **£10.19.6** Plus 4/- P. & P.
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(One minute from East Croydon Station)
**OPEN ALL DAY SATURDAY**

## MODEL TK.20A

Size 3½" x 2½" x 1½". Meter size 2¼" x 1½". Sensitivity 1000 o.p.v. on both A.C. and D.C. volts, 0/15, 0/150, 0/1000 volts. D.C. Current, 0/150 mA. Resistance. 0/100K. Complete with test prods, battery and full instructions. OUTSTANDING VALUE at **42/-** Plus 1/6 P. & P.

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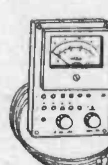
Size 5" x 3½" x 1½" 1000 ohms per volt AC/DC. DC Current 1-250 mA DC and AC volts. 10, 250-500 and 1000 v. Resistance 0-10K. 0-100K. Complete with test prods, battery and full instructions. Outstanding buy at **57/6** Plus 2/6 P. & P.

## The SINCLAIR SLIMLINE

A new miniature 2 TRANSISTOR printed circuit pocket radio. Completely portable and the smallest of them all—only 2¼" x 1½" x ½". Uses latest Micro Alloy Transistors and with built in ferrite aerial will receive all stations on Medium Wave—B.B.C., 208, etc. Easy to assemble—no alignment problems. All required components, including earpiece ONLY **49/6** P. & P. 1/6.
All parts sold separately.

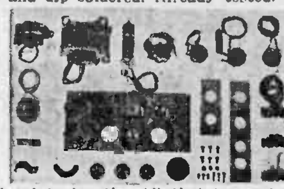
## AN ALL BRITISH PRECISION TEST METER
(To build yourself)



Designed for Test bench and produced for us by one of Britain's leading technical training organisations this instrument covers the following nineteen basic ranges: D.C. Voltage 0-2.5, 0-10, 0-50, 0-100, 0-500, 0-1000. (All ranges 5000 ohms per volt). A.C. Voltage 0-10, 0-50, 0-100, 0-500, 0-1000. (All ranges 5000 ohms per volt). D.C. current 0-200 microamps. 0-10 ma., 0-100 ma., 0-250 ma., 0-500 ma., A.C. current, 0-200 microamps. Resistance, 0-200,000 ohms. (Easily extendible to 2 megohms.) Accuracy, 3% of F.S.D. on D.C. ranges, 4½% on A.C. ranges, any frequency between 15-20,000 C.P.S. (Sine wave) 5% on resistance range. Positive Range selection by means of plug and socket. Easily constructed, full instructions being given with each assembly. All necessary components offered at the ABSURDLY LOW PRICE OF 59/6, P. & P. 2/6. Strictly limited quantity!!

## TAPE RECORDER CONSTRUCTORS

**LATEST COLLARO STUDIO TAPE TRANSCRIPTOR.** Latest type incorporating Record, Interlock, Lever, Button, 3 motors 3 speeds, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. **NEW LOW PRICE, OF £10.10.0 ONLY!** plus 7/6 P. & P. Usual H.P. facilities.
**NEW TAPE RECORDER AMPLIFIER TYPE 8311-V.** Sub-assembled—anyone can build! Printed Circuit, all components mounted and dip soldered. Already tested. Each



lead cut to length. All that is required to complete the tape recorder is for a few components to be mounted in the cabinet and the free ends of the leads soldered to terminals which are clearly marked, everything supplied, all you need is solder iron, pliers and screwdriver. Valve line-up: EF86, ECC83, 2 x EL84, EZ81 and EM84 magic eye. Monitoring facilities, output socket for feeding to high quality amplifier, can be used as "straight" amplifier for record reproduction. EQUALISING ON TWO SPEEDS. OUTSTANDING VALUE AT £11.11.0 plus 2/6 P. & P. including all necessary instructions.
**ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE.** Suitable for above amplifier and Collaro Studio deck. Fitted with 9in. x 5in. High Flux P.M. speaker for high quality reproduction. Inclusive price £5.5.0 plus 5/- P. & P. *Full list of competitively priced mics (and stands on request).* **The above 3 items purchased at one time, SUPPLIED** CARR. PAID.
**NOW AVAILABLE!** FOUR TRACK STUDIO DECK AS ABOVE, FITTED WITH HIGH-FI FOUR-TRACK HEADS. **PRICE** £13.19.6 plus 7/6 P. & P. Four track heads supplied separately, complete with mounting bracket for Studio Deck at 92/6 pair, plus 2/6 P. & P.
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**PRE-AMPLIFIER KIT TYPE 8312-CP.** Complete high quality pre-amplifier kit for use with Collaro Studio Deck. **Price** £8.8.0 plus 2/6 P. & P.
**N.B.** Four-track deck and amplifier fit the above case without any modification whatsoever.
**TELEPHONE PICK-UP COIL.** Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5 ft. shielded cable. ONLY 14/-. Post free.

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*For the first time in this country Canada's HI FI Magnetic Recording Tape. Made by "Bel-Cleer" of Canada.*

Following sizes available, others to follow. **Brand New, NOT Sub-standard.** High grade Acetate base, attractively boxed, fitted leaders, fully guaranteed.
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**THE NEW R.C. TRANSISTOR TAPE TUNER.** May be used with most Tape Recorders. Full Medium wave coverage, ferrite rod aerial, sensitivity control. Attractive case size only 3¾ x 2¾ x 1⁵⁄₁₆in. deep. Carded components for easy identification. Solder, wiring wire, PP3 battery and step-by-step instructions supplied. SPECIAL INCLUSIVE PRICE FOR ALL COMPONENTS inc. battery 27/6 P. & P. 2/6. Itemised price list and instruction leaflet 9d. post free. All parts available separately.

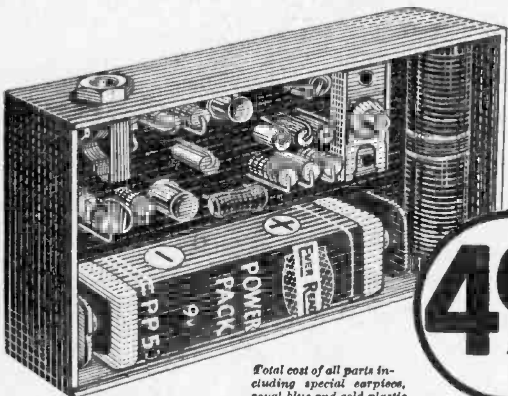
# ACCLAIMED THE MOST AMAZING RECEIVER EVER


You've never seen or heard transistor set design like this before. Small enough to conceal in one hand, the Sinclair "Slimline" gives choice of British and European programmes with staggeringly good quality from its own internal ferrite rod aerial. With its entirely new R.F. Reflex Circuit, superhet selectivity is achieved without any of the latter's problems of alignment. And it's so easy to build with its neat printed circuit board and well illustrated and presented instructions. Success is assured before you begin to build even if you are new to receiver construction.

***Such dramatic new standards within even smaller dimensions are made possible through the wonderful new MAT Transistors in circuitry developed exclusively to exploit their amazing characteristics—yet it costs so little to build this minute receiver with its giant performance—so send for yours NOW!***

**THE PERFECT SET FOR YOUR HOLIDAY!**

## *THE SINCLAIR "SLIMLINE" MICRO-RADIO RECEIVER*




**49/6**

*Total cost of all parts including special earpiece, royal blue and gold plastic case and instructions.*

**BUILT IN A COUPLE OF HOURS**

**2¾" x 1⅝" x ⅝" COMPLETELY SELF-CONTAINED**

**RECEIVES HOME, LIGHT, THIRD AND COUNTLESS EUROPEAN STATIONS WITH FANTASTIC EASE AND QUALITY**

**A SINCLAIR GUARANTEED DESIGN**

**Comprises brand new sub-miniature components, genuine MAT TRANSISTORS, elegantly designed plastic case and calibrated tuning control with high quality featherweight earpiece; also thoughtfully presented step-by-step instructions.**

***Enthusiastic testimonials continue to pour in. Here are more typical examples.***

*"Building was quite easy. I have used my 'Slimline' in cars and on trains and it has been remarkably efficient."* C.V.L., Gillingham.

*"The quality from the earpiece provided is excellent. Have brought in dozens of stations on this set . . . a most companionable little receiver."* T.L.B., London, N.8.

*"Quite fantastic. I would never have thought quality, selectivity and volume could be so good from so small a set. It looks smart, too."* E.K.H., Basingstoke.

## MAT TRANSISTORS

**MAKE THIS WONDERFUL PERFORMANCE POSSIBLE**

*Gold-plated leads assure perfect contact*

These amazing new Micro Alloy Transistors take transistor performance into entirely new fields by their coverage of A.F., I.F., R.F. and V.H.F. frequency bands. They provide far greater gain for less power consumption so that two MAT Transistors can do the work of three ordinary types with considerable saving in space, components and cost. Each one is carefully tested before leaving the factory. For full description, send for our book "22 TESTED CIRCUITS USING MICRO-ALLOY TRANSISTORS", price 5s. 9d. inc. postage.

MAT 100, MAT 120 **7/9** each — MAT 101, MAT 121 **8/6** each

See our other advertisement on page 451

**SINCLAIR radionics LTD.**
**69 HISTON ROAD, CAMBRIDGE**

**To SINCLAIR RADIONICS LTD., 69 Histon Rd, Cambridge**

*Please send* Parts for building SINCLAIR "SLIMLINE" RECEIVER....
"22 Tested Circuits Using Micro Alloy Transistors"....
....MAT 100: ....MAT 120: ....MAT 101: ....MAT 121 Transistors
*for which I enclose Cash/ Cheque/ Money Order for £*.....................
*Mark off items required*

NAME ..................................................

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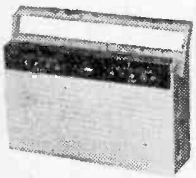
# LASKY'S RADIO

## The finest range of Transistor Receivers available for home construction

### "COROVER" 'SIX'



★ A 6-transistor plus 2-diode superhet receiver using the latest circuitry. ★ Three Mullard AF117 alloy diffused transistors are used with OA79 and OA91 diodes followed by OC81D and two OC81's in push-pull. ★ I.F. frequency 470 Kc/s. ★ Covers the full medium and long wavebands. ★ Sockets provided for personal earpiece or tape recorder, and car radio aerial. ★ Large internal ferrite rod aerial give high sensitivity. ★ Uses four 1.5 v. pen torch batteries. ★ All components mounted on a single printed circuit. Simple stage by stage instructions. ★ Cabinet size 6¼ x 4 x 1¾in. With carrying handle. ★ All coils and I.F.'s ready wound.

ALL COMPONENTS AVAILABLE SEPARATELY. *Data and instructions separately 2/6. Refunded if you purchase the parcel.*

CAN BE BUILT FOR **£5.7.6** P. & P. 4/- ex. Batteries 1/4.

### "SPRITE"

Inclusive price of

**79/6**

P. & P. 3/6 extra.

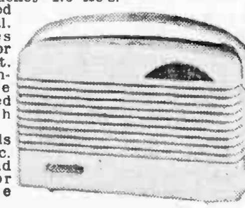
★ Six-Transistor Superhet Miniature Personal Pocket Radio. ★ Tunable over Long and Medium wavebands. ★ Uses PP3 battery. Ferrite Rod aerial. ★ I.F. Frequency 470 Kc/s. Transistors: 3 Philco 2067's, 2 Mullard OC81 M OC81 DM and OA90 diode. ★ 3 inch speaker. ★ Printed circuit 2¼ x2in. ★ Slow Motion Drive. ★ In Plastic Case. Size 4 x 2½ x ¾in.

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and I.F. stages. Driver and Output stages ready built with all components ready mounted on the printed circuit. To complete assembly you only have to fit the wavechange switch, tuning condenser and drive, volume control, earphone socket and aerial rod, the remaining components all having been prefitted at the factory for you. The SPRITE is offered as above, pre-assembled, plus cabinet, speaker and all components for final construction, at the inclusive price of 79/6. Postage and packing 3/6 extra. Data and Instructions separately, 2/6. Refunded if parcel is purchased. Real calf leather case, wriststrap, personal earphone and case for earphone and battery 12/6 the lot extra. Make no mistake this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

### "REALISTIC" 'SEVEN'

**STAR FEATURES ★★★★**

★ 7 Transistor Superhet. 350 Milliwatt output into 4-inch high flux speaker.
★ All components mounted on a single printed circuit board, size 5¼ x 5¼in. in one complete assembly.
★ Plastic cabinet, with carrying handle, size 7 x 10 x 3½in. in choice of colours:
★ Red/Grey, Blue/Grey, all Grey.
★ Easy to read Dial.
★ External Socket for car aerial.
★ I.F. frequency 470 Kc's.
★ Ferrite rod int'l aerial.
★ Operates from PP9 or similar batt.
★ Full comprehensive data supplied with each Receiver.
★ All coils and I.F.'s etc. fully wound ready for immediate assembly.



An Outstanding Receiver. Lasky's Price for the complete parcel including Transistors, Cabinet, Speaker, etc., and Full Construction Data: **£5.19.6** P. & P. 4/6.

PP9 Battery 3/9. Data and instructions separately 2/6. Refunded if you purchase the parcel.

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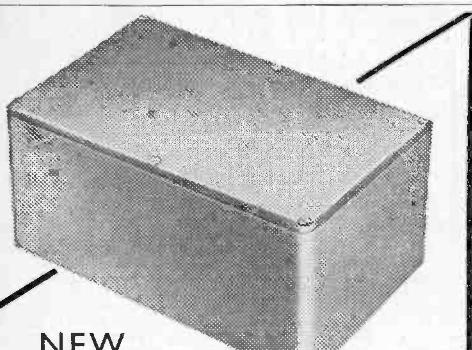
*BOTH OPEN ALL DAY SAT. Early Closing Thurs. Mail Orders to Dept. P.W., Edgware Rd.*



## NEW EDDYSTONE DIECAST INSTRUMENT BOX

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No. 896. 4⅜in. x 2⅜in. x 1in.
No. 650. 4¹¹/₁₆in. x 3½in. x 2in.
No. 845. 7⅜in. x 4¹¹/₁₆in. x 2in.

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**STRATTON & CO. LTD. BIRMINGHAM 31**

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| 6AT6 | 5/- | 12AH8 | 10/- | DF96 | 6/6 | EF41 | 9/- | PL81 | 9/6 | Z77 | 4/- |
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High Stability Resistors ¼W 5% 50Ω to 1M, 9d. Midget Ceramics 500 v., 9d. Coax. Super Quality ¼in., 6d. yd. Plugs 9d. Sockets 9d. Silicon H.T. Rects. 250 v. 300 mA ½in. x ¼in. 8/6. Contact Cooled 250 v. 50 mA 6/6. 85 mA 8/6, NEW TRANSISTORS BY MULLARD. OC19, OC26, OC66, 25/-; OC44, OC45, 5/-; OC70, 6/-; OC71, 5/-; OC72, 6/-; OC72 Matched pair. 12/-; OC74, OC75, OC78, 7/6; OC81, 6/-; OC81 Matched pair. 12/-; OC170, OC171, 7/6.

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UCH42, EF41, EBC41, UL41, UY41......35/-

Postage and packing 6d. Over £1 post free. C.O.D. 4/-.

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Guaranteed perfect working order. Supplied complete with leads, batteries and instructions.

Model "D" 34 range £8.19.6

Model "7" 50 range £11.0.0

Registered Post 5/- extra.

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0-500 microamps. 2½in. circular flush panel mounting. Dials engraved, 0-15, 0-600 volts. BRAND NEW. BOXED. 15/-. P.P. 1/6.

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4½ x 3in. dia., 90 watts, 5,000 r.p.m. ½in. spindle. 22/6. P.P. 1/6.

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24 amp., 230 volt primary, 185 to 250 volt output, £12.10.0. Carriage 10/-.

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Sound powered, generator bell ringing, 2 line connection. Fully tested. £4.19.6 pair. Carr. 5/-.

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0-115-230 volts, step-up or step-down. Brand new, boxed ex-U.S.A. £7.10.0 each. Carr. 10/-.

## PANEL METERS

| | | | | |
|---|---|---|---|---|
| 100µA | 2½" | F.M. | D.C. | 42/6 |
| 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 |
| 350 mA | 2½" | F.M. | D.C. | 10/6 |
| 300 v. | 2½" | Proj. | A.C. | 19/6 |
| 300 v. | 2½" | F.M. | A.C. | 25/- |
| 500 v. | 2½" | F.M. | A.C. | 25/- |
| 120 v. | 3½" | F.M. | D.C. | 32/6 |

Postage Extra.

## FIELD TELEPHONES TYPE "F"

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800-2,000 metres. 190-550 metres 6-22 Mc/s. output for phones or 3 Ω speaker. As new £5.19.6. Carr. 10/6. PCR3 as PCR2 but covers 190/550 metres, 2-7 Mc/s, 7-22 Mc/s, including top band. As new £8.8.0. Carr. 10/6. All above models can be supplied with internal power unit to operate on 200/250 v. A.C. at 39/6 extra or alternatively plug-in external power units are 35/-.

## AVO WIDE RANGE SIGNAL GENERATORS

Frequency coverage 50 Kc/s to 80 Mc/s in six turret operated ranges. For use on standard A.C. mains. Packed in original transit cases with accessories. Supplied in as new condition, fully checked before despatch, £15. Carriage 10/-.

## NATIONAL H.R.O. RECEIVERS

**SENIOR MODEL.** Supplied complete with full set of 9 coils covering 50 kc/s. to 30 Mc/s. Each receiver thoroughly checked and available as follows:
TABLE MODEL. As new condition £25.
TABLE MODEL. Extremely good used condition £19.19.0.
RACK MODEL. Extremely good used condition £18.18.0.
Carriage £1 extra.

200/250 volt A.C. power packs for above receiver, also sold separately. 59/6. Carr. 5/-.

## PRECISION COMBINATION VOLTMETER/AMMETER FOR A.C. AND D.C.

Two separate instruments housed in polished wood case, 6in. scales with knife edge pointers.
Ranges:
Volts A.C. and D.C. 160-300-600 v.
Amps. A.C. and D.C. 25-50-150-200 A.
Supplied complete with all current shunts, leads and leather carrying case. Manufactured by Elliott Bros. Supplied brand new. £9.19.6 each. Carriage 7/6.

## HALLICRAFTER S-36 V.H.F. RECEIVERS

F.M./A.M. 27-143 Mc/s. 110 volt A.C. (transformer supplied for 230 v. A.C.) Improved version of S-27. Tested before despatch. Brand new boxed with instruction manual. **£40** each. Carr. £2

## MINE DETECTOR No. 4A

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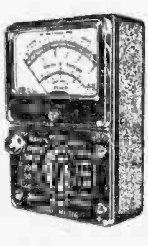
0/50K/500K/5 meg., etc. 97/6. P. & P. 2/6.



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0/10/50/250/500 v. A.C.
0/50µA/0/10/250 mA. D.C.
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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.
0/10K/100K/1 meg./10 meg., etc. £7.10.0. P.P. 2/6.

**100,000 Ω/VOLT**
.5/2.5/10/50/250/500/1,000 v. D.C.
2.5/10/50/250/1,000 v. A.C.
10/250µA/2.5/25/250 mA/10 amp. D.C.
20K/200K/2 meg./20 meg. ohm. etc.,
£6.19.6 post paid.

## MARCONI CR100/8 RECEIVERS BRAND NEW

Packed in original transit cases and complete with handbook/manual. 60 Kc/s to 30 Mc/s. 200/250 volt A.C. operation. Tested before despatch.

**£35** Carriage £2.

## COSSOR 1035 DOUBLE BEAM OSCILLOSCOPES

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| | | | | | |
|---|---|---|---|---|---|
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| 12/18v. | 2.5A. | 6/3 | 24/36v. | 6A. | 27/6 |
| 12/18v. | 4A. | 8/3 | 24/36v. | 15A. | 45/- |
| 12/18v. | 6A. | 12/3 | 36/48v. | 2A. | 19/6 |
| 12/18v. | 10A. | 22/6 | 36/48v. | 4A. | 29/6 |
| 12/18v. | 15A. | 37/6 | 36/48v. | 6A. | 32/6 |
| 24/36v. | 1A. | 7/3 | 48/60v. | 2A. | 21/- |
| 24/36v. | 2A. | 13/6 | 48/60v. | 10A. | 82/6 |

Please add postage.

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All primaries tapped 200/250 volts
1 Battery Charging. 3.5, 9 or 17 volt, 1 amp., 9/9. Ditto 2 amp., 14/3. Ditto 4 amp., 16/6. 9 or 17 volt, 6 amp., 26/-.
2 Model Type 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt, 2 amp., 18/6. Ditto 4 amp., 30/-. Ditto 5 amp., 37/6. Add Postage.

## MINIATURE MODEL ACCUMULATORS

Lead Acid. BRAND NEW. 2v. 1.5 A.H., 4 x 1½ x 1in., 1lb., 5/6. P.P. 1/3. 12v. 0.75 A.H., 4 x 3 x 1½in. 2lb., 15/6. P.P. 1/6.

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## DUMONT K1051P1 DOUBLE BEAM C.R.T.

Twin Gun. Brand new, boxed. 59/6. P.P. 3/6.

## 1.2 Ohm 12 Amp RHEOSTAT

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

## SILICON RECTIFIERS

70v. P.I.V. 1 amp. 3/6
400v. P.I.V. 500mA. 3/6
200v. P.I.V. 6amp. 5/6
post extra.

## MINIATURE PANEL METERS

For 1½in. dia. panel hole.

| | | | |
|---|---|---|---|
| 0-50 µA | 39/6 | 0-300 v. D.C. | 27/6 |
| 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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# Practical Wireless

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## Contents



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## 50 Years On

THIS year, the Radio Society of Great Britain celebrates its Golden Jubilee. We are sure that readers will want to join us in congratulating the R.S.G.B. in reaching this landmark and in offering our good wishes for the future.

In those 50 years, the R.S.G.B. has gained not only materially by continuously increased membership, facilities and activities. It has gained in prestige as our National amateur radio society and as our representative at home and at international conferences where the interests of amateur radio are at stake. It has been the guardian of those privileges and facilities necessary for the continuance of amateur radio and we must all be grateful for their stalwart efforts through the years.

The achievements and successes of the R.S.G.B. have been made possible by both members and officials of the society, acting both individually and collectively. And almost everyone has benefited—from the transmitting amateur to the short wave listening enthusiast—whether they are members of the society or not.

1913-1963! Very few enthusiasts can claim to have been active in the hobby during the entire period. Those that have, can look back on remarkable changes: from a handful of dedicated experimenters groping into the virtually unknown, to the hundreds of thousands (probably millions) of enthusiasts today with the knowledge of 50 years of pioneering to draw on. They can compare today's sophisticated equipment with the crudity of the early days. They can recall having seen radio transform the world's social habits, particularly in that branch we call television, and the world's communications systems.

It seems improbable that the next 50 years could see such revolutionary and stirring changes and developments. Yet, 50 years ago people were probably thinking much the same! Or at least, some were not—those inspired to tackle the seemingly impossible—hence the major breakthroughs, including that of radio communications.

Although in these commercial and highly organised days we do not expect the isolated amateur to influence major research fields, the collective results of amateur activity can be important.

Even for the humblest enthusiast new spheres of exploration constantly develop. For those with more experience the field is considerably larger and we need go no further than to consider the video scene. Here we have the prospect of transistor TV receivers, closed circuit TV set-ups, amateur TV transmitting, video tape recording, etc. None of these things are "new" in the strict sense but they are all lines of interesting experiment. In some of these fields at least, our sister journal PRACTICAL TELEVISION is actively interested and constructional articles are planned for the near future.

Those early experimenters of 50 years ago were fired by the stimulus of comparatively untried and unfamiliar spheres. We like to think that at least some of the spirit survives today.

Our next issue dated October will be published on September 6th

# ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

## New Scientific Attache in Washington

DR. JOHN A. SAXTON has been appointed Director of the United Kingdom Scientific Mission in Washington D.C., and Scientific Attache at the British Embassy there. He will take up his duties early in 1964, replacing Dr. Harry Hookway who will be returning to the United Kingdom on completion of a three-year tour of duty.

Dr. Saxton, who is 49, has been Deputy Director of the radio research station of the Department of Scientific and Industrial Research, since 1960. He joined DSIR in 1938, working in the Radio Division of the National Physical Laboratory. His work on the dielectric properties of the atmosphere and on studies of radio wave propagation at very high frequencies has made him well known in Europe and North America.

He has also been actively concerned in the affairs of the International Scientific Radio Union and the International Radio Consultative Committee (CCIR). In 1945 and again in 1950 he undertook a tour of duty in the U.K. Scientific Mission as radio physics liaison officer, and in 1961, at the invitation of the University of Texas, he spent a year there as visiting Professor of Electrical Engineering.

## Transmitters for Radio Free Europe

THE transmitting power of Radio Free Europe will be increased considerably when four new short-wave transmitters, recently ordered from the U.S. firm of General Electric, begin operation. These new transmitters—each with a rated output of 250kW—will double the transmitting power of Radio Free Europe in Portugal, where they are to be installed.

The high-power transmitting valves employed in the new equipment are modern vapour-cooled components which are superior to the bulky conventional water-cooled variety.

## *BRITISH EQUIPMENT FOR NORWAY*

SPITZBERGEN is a flourishing Norwegian coal mining centre situated on a group of islands 600 miles due north of Harstad, on the northern mainland of Norway. These two towns are linked by a short-wave radio communications system, but as a result of noise, fading and interference (especially that caused by the Aurora Borealis occurring in these latitudes) telegraph messages relayed by the system are susceptible to errors. To help prevent these errors and correct those that remain, the Norwegian Telegraph Administration recently ordered a new type of automatic error-correcting equipment from the Marconi Company.

The Autospec equipment, as it is called, automatically changes ordinary telegraphic signals into a special code before they are transmitted by radio. At the receiving end, the Autospec terminal can determine whether an error has occurred, and in the majority of cases, decide what the error is and automatically correct it. In cases where automatic correction is not possible, the presence of an error is indicated by a special character which is printed in the received message.

## TRANSCEIVERS FOR THE CITY'S POLICE

THE City of London police recently carried out a series of evaluation tests on miniature transceivers designed for the use of police officers on patrol. The sets are small enough to be accommodated in a constable's pocket and each has a range adequate for the City area.

If adopted for regular use, the transceivers will enable the officer on duty to maintain continuous contact with his headquarters.

*Right: A City of London police officer holding one of the portable transceivers which may soon be in general use.*

## New Relay Station for Scotland

BUILDING work commenced recently on the BBC's new v.h.f. sound and television relay station to serve Shetland. The station is situated three miles south-east of Lerwick, at Ward of Bressay. The associated receiver station is sited at Fitful Head, where programmes will be received from Orkney prior to re-transmission.

## "JAMBOREE-ON-THE-AIR"

THE dates of this year's "Jamboree-on-the-Air" have been announced recently by the organisers of this important event. October 19th and 20th are the chosen dates when amateur operators with any past or present connection with the Boy Scout movement, will be attempting to contact other "scouting-hams" throughout the world.

Participation Certificates will be awarded to all those qualified amateurs who forward reports of contacts to their National Organiser as will all short-wave listeners who submit reports. Once again this year, the Boy Scout World Bureau Station in Ottawa (VE3WSB) will be active during the event.

# R.S.G.B. GOLDEN JUBILEE CELEBRATIONS

ONE of the events marking the occasion of the R.S.G.B.'s Golden Jubilee was a reception held at Mullard House in London, when members of the R.S.G.B. council were the guests of Mullard Ltd. The reception, which was held on July 1st, was preceded by a special programme of demonstrations and films arranged by Mullard for the council members and other well known figures in the field of amateur radio.

Among the distinguished company at the reception were the Mayor of Holborn (in whose borough the Society's H.Q. is based) and Mr. J. Clarricoats, O.B.E., who is the R.S.G.B.'s general secretary. A special cake, which had been prepared for the occasion, was cut by Mr. Norman Caws, the president of the R.S.G.B.

*This photograph taken at a reception held at Mullard House, shows (left to right) Mr. N. Caws, president of the R.S.G.B., Dr. F. E. Jones, a director of Mullard, and the Mayor of Holborn.*

## Telemetering Conference in London

EXPERTS in the field of telemetering will gather in London later this year, to attend the first International Telemetering Conference. The Conference has been fostered by three American societies who have previously sponsored a national conference in the U.S. As Britain is to be host country, the British Institution of Radio Engineers and the Institution of Electrical Engineers will both play important parts in the organisation of the event.

The Conference sessions will be held entirely at the I.E.E. headquarters in London.

## *International Radio Show*

THE 1963 Paris Radio and Television Show will be, for the first time this year, an international event. Since it is usual for such exhibitions to be exclusively national events, the French organisers have taken an unprecedented step forward, in what may well prove to be the path to be taken by the authorities of other countries.

This move towards an international rather than national event has been welcomed by both the French radio industry and the many foreign firms who have applied for space at the exhibition.

All fields of the industry will be represented at the show, which will last for 11 days, from September 5th to the 15th.

## *TRANSLATION BY RADIO*

IN future, foreign visitors to the Westminster theatre, London, will be able to listen to the dialogue of the play in their own language. Translations of the play will be relayed from the theatre's projection room and picked up by a transistor receiver which will be supplied to each visitor. The receivers are equipped with earphones and a switch, which will enable the visitor to select any one of four languages.

The equipment has been installed by Philips.

The theatre management decided to use the equipment permanently after hired equipment had been employed successfully to provide a party of visitors with a German translation of the play.

# A Versatile DOUBLE-TRACE OSCILLOSCOPE

## By J. H. B. Gould

**This series deals with the construction of instruments based on the 5in. and 6in. cathode-ray tubes currently available on the surplus market. This and succeeding articles cover the basic instrument and progressively more advanced versions that incorporate a timebase, a.c. amplifiers, a square-wave generator and double-trace facilities. The individual constructor can decide for himself how far to go—according to his inclination and requirements. A further article will deal with the use of the instrument as an oscillograph.**

MOST general-purpose oscilloscopes have screen diameters in the range 1in. to 6in. Where the physical size of the instrument is of secondary importance, the larger size screens provide a much better service than their more diminutive cousins. A wide range of 5in. and 6in. c.r. tubes are available at the present time, and the types quoted here have been selected on the basis of low anode voltage:

5in. screen tubes: 5AP1; 5BP1 (CV 601); 5HP1.
6in. screen tubes: VCR97; ECR 60; E4504-B-16.

These all have medium-persistence phosphors, suitable for oscilloscope duty, and give a green trace although most types are also available in blue or white (a blue trace has advantages for oscillography).

Should a *long*-persistence trace be required for any reason, a type VCR517 or VCR517B would be suitable. Both have 6in. screens.

The tubes mentioned all operate satisfactorily at e.h.t. voltages between 1,500 and 2,000. The "Y" deflector plates need between 50 and 130V for maximum deflection, depending upon the e.h.t. voltage and the colour of the screen phosphor. Deflection sensitivities can be improved by lowering the anode voltages, but this tends to decrease the definition of the spot obtained and it also limits the brightness of the trace. If the e.h.t. voltage is reduced too far, the instrument would have to be viewed in a dark room!

As the two sets of deflectors within the tube are located at different distances from the screen, one set (D3, D4) is considerably more sensitive than the other. There is usually plenty of voltage available from the sweep generator for the "X" plates whereas the "Y" plates, being supplied from the circuit undergoing examination may find themselves short of deflection voltage. For this reason, it is customary to operate the tube with the more-sensitive plates deflecting vertically. This is the case when the locating pip on the tube base points upward.

### *Body of Instrument*

Whether the case, chassis and front panel are acquired ready-made (the author adapted a Loran indicator for this purpose—see photographs) or whether they are built up from scratch, there are a few points which must be borne in mind.

In view of the high voltage involved, all main structural parts *must* be of metal (preferably thin sheet steel, as this assists in magnetic screening).

The main factors fixing the size of the instrument are the length of the tube, the size of the transformers that have to be accommodated and the areas of front panel necessary for the controls. The smallest overall dimensions at which constructional difficulties can be avoided will be about 12in. by 9in. by 18in. deep.

### *Tube Mounting Arrangements*

Cathode-ray tubes are by their nature very susceptible to the presence of magnetic fields; for this reason, the transformers are best housed behind the

**TABLE 1 PIN CONNECTIONS & RATED HEATER VOLTS**

<table>
<tr><th rowspan="2">Screen Diameter</th><th rowspan="2">Heater Voltage</th><th colspan="10">Pin No.*</th></tr>
<tr><th>H</th><th>H</th><th>K</th><th>G</th><th>A2</th><th>A1</th><th>D1</th><th>D2</th><th>D3</th><th>D4</th></tr>
<tr><td>6in.</td><td>4.0</td><td>4</td><td>3</td><td>2</td><td>1</td><td>6</td><td>5, 7<br>10</td><td>11</td><td>9</td><td>12</td><td>8</td></tr>
<tr><td>5in.</td><td>6.3</td><td>1</td><td colspan="2">11</td><td>10</td><td>7</td><td>4</td><td>3</td><td>8</td><td>9</td><td>6</td></tr>
</table>

* Counting clockwise from locating pip.

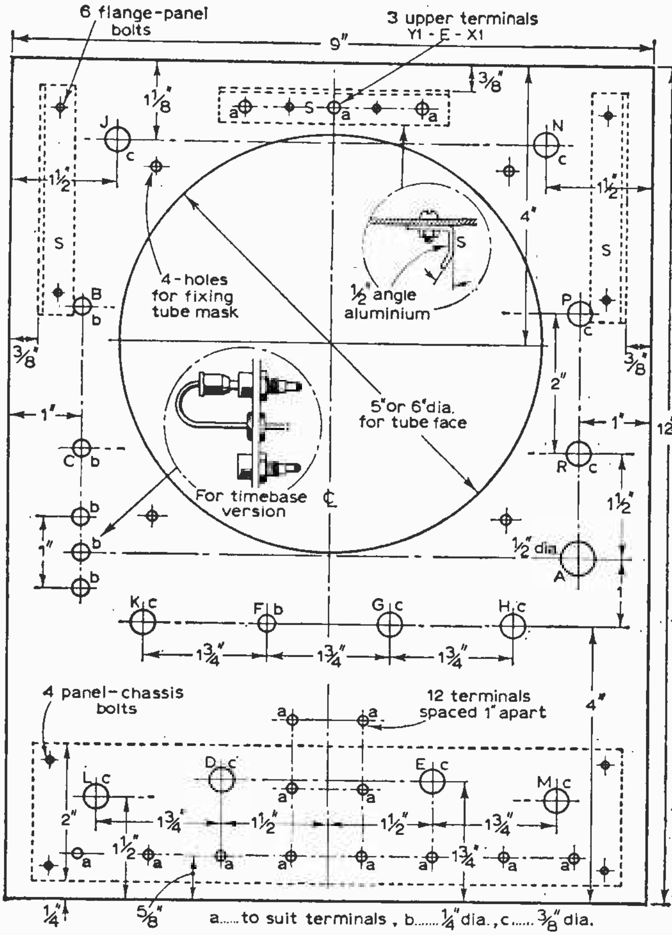



*Fig. 1: Drilling details of the front panel.*

tube where leakage flux can do the least harm. Nevertheless, tubes like the VCR97 can tolerate a transformer mounted immediately beneath the electron gun, provided a magnetic shield (obtainable with the tube) is used.

In this model, the method of mounting the tube is as follows: its main weight is carried on a rubber or padded-metal collar fixed to the front panel, the rear being supported by the base socket which is itself clamped by a single centre screw to a bridge erected on the chassis. This arrangement allows the whole tube to be rotated for alignment of the deflection axes. The tube shown is of the 6in. variety. Five-inch tubes rely for support at the rear on a saddle clamped over the base socket, allowing much the same freedom of movement for adjustments.

If a transformer *has* to be mounted below the tube, it should lie exactly on the centre line of the chassis, as far to the rear as possible, flat and with its winding limb aligned along the long axis of the tube. If a sharply-defined spot cannot be found with this arrangement, the situation can usually be improved by rotating the tube shield through a few degrees one way or the other *(but not with the instrument switched on).*

### Types of Instrument

The four types of instrument to be described are:

(1) A simple, basic oscilloscope.

**TABLE 2 KEY TO FRONT PANEL DRILLING**

| TYPE OF INSTRUMENT | 'LIVE' TERMINALS | CONTROLS | |
|---|---|---|---|
| 1 Basic Oscilloscope | X a.c. | Mains Switch (S2) | A |
| | X d.c. | Intensity (VR4) | B |
| | Y a.c. | Focus (VR3) | C |
| | Y d.c. | Y-Shift (VR1) | D |
| | Mod. (Intensity) | X-Shift (VR2) | E |
| 2 Timebase Version | External Sync. | X-Selector (S3) | F |
| | Dummy for above | Sweep Amplitude (VR6) | G |
| | Calibration | Sweep Frequency (VR7) | H |
| | Sweep-generator output | Sweep Sync. (VR5) | J |
| 3 Amplifier Version | Trace-Splitter Sync. | Y-Selector (S4) | K |
| | Dummy for above | A1 Gain (VR8) | L |
| | | A2 Gain (VR9) | M |
| 4 Trace-Splitter Version | | Trace-Splitter Sync. (VR12) | N |
| | | Trace-Splitter Frequency (S5) | P |
| | | Trace Separation (VR10) | R |

Plus earth terminals as required. Alternatively, the mains switch may be incorporated with the intensity control.

(2) As (1), but with time-base.
(3) As (2), but with a.c. amplifiers.
(4) As (3) but with square-wave generator and beam splitter circuit.

One type can become the next, merely by acquiring the necessary components. However, it is not an easy matter to cut holes in the chassis or panel for additional components when the 'scope is partly constructed; therefore it is a good idea to decide what will eventually be required right at the beginning, and carry out the necessary panel and chassis drilling before attempting anything further. Figs 1 and 2 and Table 2 give this information for each type of instrument.

### *Front Panel*

With the exception of the intensity and focus controls (see below), the layout of controls and terminals on the front panel is a matter of convenience and personal preference. The arrangement indicated in Fig. 1 is recommended as having proved very satisfactory in practice. It should be noted that all the drilling required for stages 1 to 4 inclusive is given on this diagram. As previously mentioned, it is prudent to consider carefully one's likely future requirements, and so to provide for the fitting of additional components — although maybe it is intended only to proceed as far as stage 1 or 2 for the present.

The purpose of the various holes can be established by referring to Table 2.

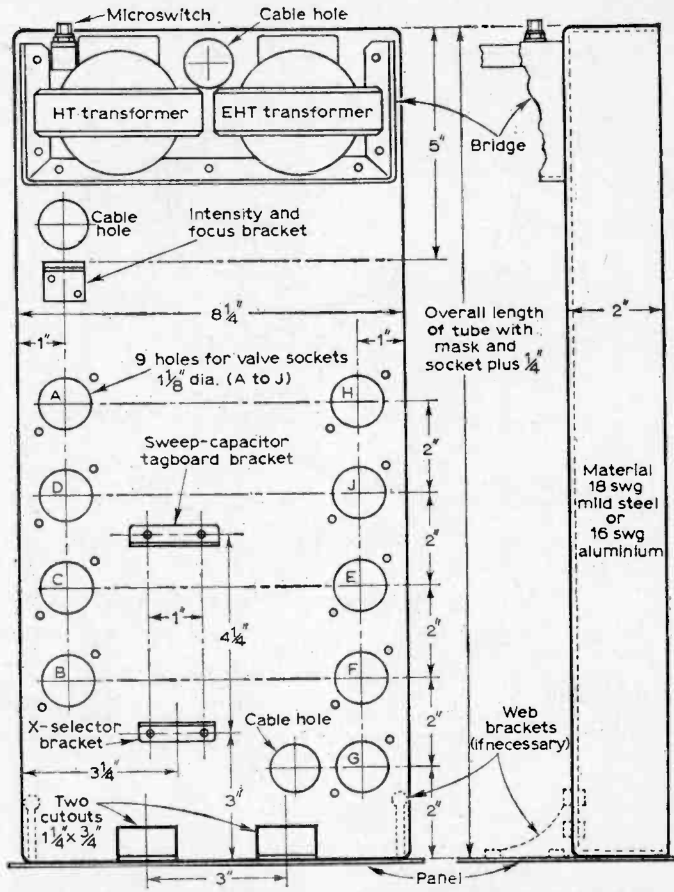



*Fig. 2: Chassis dimensions. The two brackets in the lower centre of the chassis are required for instruments type 2, 3 and 4.*

### *Rotary Switches*

Table 3 gives details of the selector switches required for the different type of instrument. Using this information in preference to that appearing on the circuit diagrams will prevent fitting a switch that is inadequate for its final task.

### *The Chassis*

The most convenient place for the octal valveholders is near the sides of the chassis where they are easy to get at. The e.h.t. rectifier is conveniently mounted on an insulation-strip "sub-chassis" fixed to the tube base support bridge. This valve requires a "B4" type of valveholder.

In addition to the e.h.t. transformer, instruments

**Key to valve sockets in Fig. 2: instrument type (2)—A h.t. rectifier; B sync amplifier; C sweep generator; D sweep amplifier: type (3)—E and F amplifiers: type (4)—G trace-splitter: H and J spares.**

**TABLE 3 ROTARY SWITCHES**

| Type of Instrument | S3 | S4 | S5 |
|---|---|---|---|
| 1 | — | — | — |
| 2 | 2-pole 7-way | — | — |
| 3 | 3-pole 7-way | 3-pole 4-way | — |
| 4 | 3-pole 7-way | 4-pole 4-way | 2-pole 4-way |

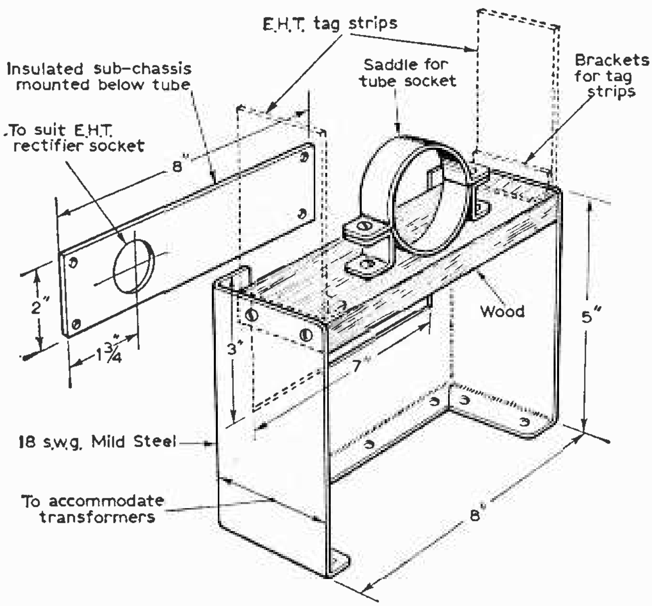



*Fig. 3: Bridge assembly for American type tubes.*

of type 2 and above will require an *h.t.* transformer, for which space must be found.

In Fig. 2 are full details for making and drilling the chassis.

The construction of two different types of bridge assembly for supporting c.r.t.s of either British or American manufacture is covered in Figs. 3 and 4.

### *Tube Supply Network*

The best place for the high-voltage members of the tube resistor chain is at the rear of the instrument, near to the tube base, and rigidly supported (on a tag-strip, for example). This chain includes the focus and intensity controls (VR3 and VR4) which stand at over 1,000V above earth. These controls can take the form of ordinary potentiometers as long as they are mounted, *not* on the front panel, but on an insulating strip fixed near the back of the instrument with the rest of the e.h.t. chain. Drive from the control knobs is carried along two, ¼in. diameter paxolin rods which pass through bushes on the panel, along the length of the tube and are then coupled to shafts of the potentiometers.

### *E.H.T. Supply*

The e.h.t supply is derived from a transformer having a 1,250 to 1,650V secondary, with 2V and 6·3V (tapped at 4V) windings for the e.h.t rectifier and the c.r.t. heaters respectively. A half-wave valve rectifier is specified. If an e.h.t. metal

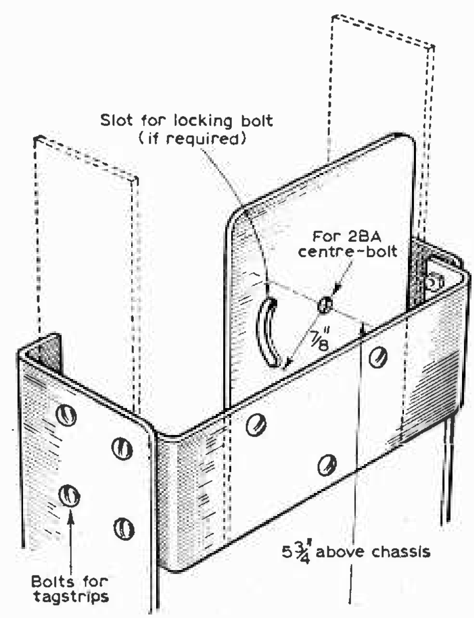



*Fig. 4: Construction of the bridge mount for British tubes.*

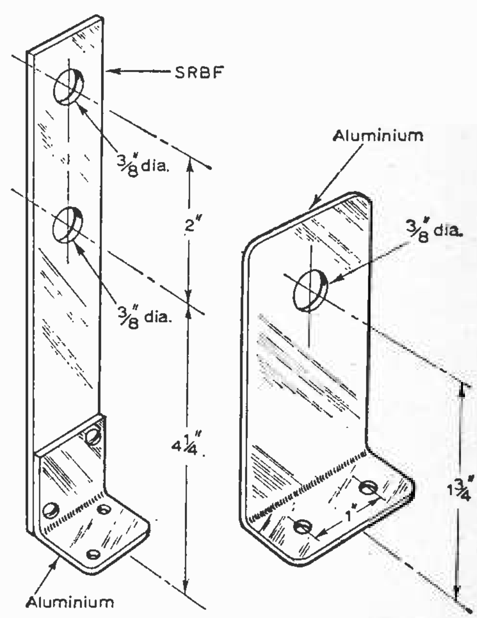



*Fig. 5 (left): The bracket for the intensity and focus controls.*
*Fig. 6 (right): Bracket for the X-selector switch.*

rectifier is preferred, the " + " or red side should be connected to the transformer; no 2V winding is then necessary. The circuit diagram of the e.h.t. section appears in Fig. 8.

### *Precautions—*

*The voltage on the tube is between 1,500 and 2,000V and would certainly be lethal if mishandled. The mains plug MUST be removed from its socket before any adjustments are carried out. It is also a good idea to include the interlock switch of Fig. 8. This takes the form of a normally-open microswitch, mounted at the extreme rear of the chassis in such a way that its plunger bears against the back wall of the case. It does not isolate the instrument from the mains, but at least it removes the most dangerous voltages should the case be opened with the mains plug inadvertently left in.*

*If the oscilloscope develops a fault of the "no-trace" variety, short-circuit the live side of the e.h.t. smoothing capacitors to the chassis with a well-insulated tool before investigating the trouble. The fault could be due to a break in the voltage-divider network, which would leave a dangerous charge on these capacitors for some time after the instrument has been switched off.*

### Shift Controls (Simple Oscilloscope)

The circuit given in Fig. 7 is for instrument types 2 and above. If an instrument of type 1 only is required, there is one difference in this circuit and it concerns the shift controls.

Oddly enough, adjusting the position of the spot in the simple form of oscilloscope presents more difficulties than it would if the instrument were equipped with a timebase. This is because there is no h.t. to balance the shift voltage.

There are two possible alternatives: If the oscilloscope is to be used for comparing a.c. values only, the positive end of the shift potentiometer should be connected to earth; R6 of Fig. 7

—continued on page 461

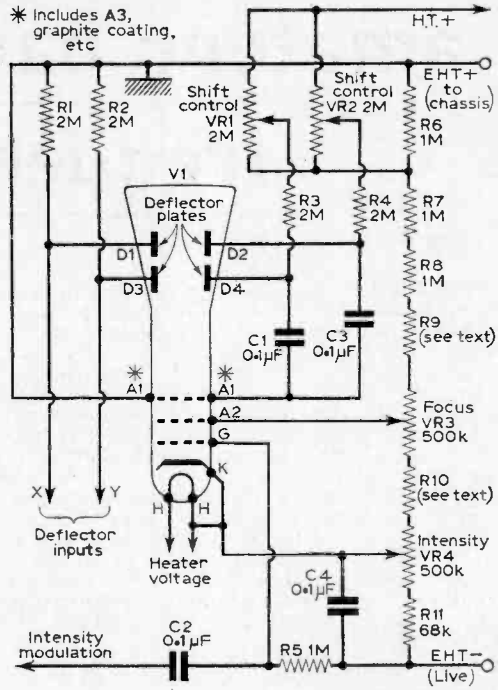



*Fig. 7: Supply network for the cathode-ray tube.*

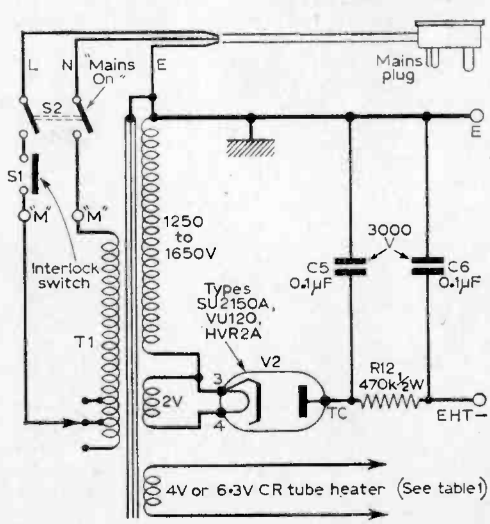



*Fig. 8: The e.h.t. power supply.*

**COMPONENTS LIST FOR INSTRUMENT TYPE I**

(basic oscilloscope Figs. 7 and 8)

**Resistors:**

| | | | |
|---|---|---|---|
| R1 | 2MΩ | R7 | 1MΩ |
| R2 | 2MΩ | R8 | 1MΩ |
| R3 | 2MΩ | R9 | see text |
| R4 | 2MΩ | R10 | see text |
| R5 | 1MΩ | R11 | 68kΩ |
| R6 | 1MΩ | R12 | 470kΩ |

All 10%, ½W carbon

- VR1 2MΩ carbon potentiometer
- VR2 2MΩ carbon potentiometer
- VR3 500kΩ carbon potentiometer
- VR4 500kΩ carbon potentiometer with d.p. switch (S2)

**Capacitors:**

| | | | |
|---|---|---|---|
| C1 | 0·1µF paper 350V | C4 | 0·1µF paper 350V |
| C2 | 0·1µF paper 350V | C5 | 0·1µF paper 3,000V |
| C3 | 0·1µF paper 350V | C6 | 0·1µF paper 3,000V |

**Valves:**

- V1 5AP1; 5BP1 (CV601); 5HP1 (5in. screens) VCR97; ECR60; E4504-B-16 (6in. screens)
- V2 SU2150A; VU120; HVR2A

**Transformer:**

- T1 Mains (e.h.t.) transformer. Tapped primary. Secondaries: 0 to 1,250—1,650V 5mA; 2V 1·5A; 6·3V (tapped at 4V) 1A.

**Switches:**

- S1 Microswitch
- S2 d.p. on/off switch (may be incorporated in VR4)

# amateur band frequency checking

## By F. G. Rayer

SHORT-WAVE listeners often use some means of locating the exact limits of an amateur band as the tuning scale calibration of many receivers is not sufficiently accurate for this purpose. When transmitting, an accurate means of frequency checking is essential to avoid operating outside the permitted bands. Various methods of frequency checking are thus very useful, for both receiving and transmitting, and especially with home-built equipment.

For locating amateur bands and harmonics a wavemeter or absorption frequency meter is often employed. When accurate checking over a very narrow band of frequencies (such as a single amateur band) is needed, some form of heterodyne frequency meter is generally used in conjunction with a receiver. This also allows calibration for receiving purposes.

### Absorption Meter

This is extremely useful for checking oscillator, multiplier and output stages of a transmitter to see that circuits are tuned to the correct harmonics. For example, a 1·85Mc/s oscillator might be followed by a doubler for 3·7Mc/s working. With home-built equipment and home-wound coils the 3·7Mc/s circuit might easily be tunable to the third harmonic of 5·55Mc/s as well as the required second harmonic (3·7Mc/s). To avoid this the absorption meter may be used to give a quick check.

The usual absorption meter circuit is shown in Fig. 1 and it may be built with a fixed coil or plug-in coils. With 1¼in. diameter formers, eight turns occupying about 1in. will cover approximately 40Mc/s—10Mc/s, while 26 turns will cover about 10Mc/s—3·3Mc/s. Other coil sizes and capacitor values are equally suitable.

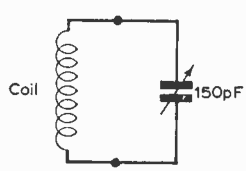



*Fig. 1: The absorption frequency meter.*

To check oscillator, multiplier or p.a. stages the absorption coil is held in line with the equipment coil. When the absorption meter is tuned to the correct frequency it draws power, thus causing a small movement on the grid or anode current meter of that stage. The meter is best calibrated for 3·5, 7, 14, 21 and 28Mc/s bands. It will then show at once that multiplier or other stages are working on the harmonics required to avoid out-of-band operation.

If a t.r.f. receiver is adjusted until its detector is just oscillating the absorption meter will stop this oscillation when it is tuned to the same frequency as the receiver. This offers a simple method of finding amateur or other bands on a home-built t.r.f. receiver.

### Indicating Device

An indicator may be added to the absorption meter, using either of the circuits in Fig. 2. The instrument is then suitable for checking circuits not equipped with a grid or anode current meter.

Care is needed if a 1mA or similar meter is used, as sufficient r.f. can easily be picked up to damage the meter. Sensitivity may be reduced by adding a resistor in one meter lead. The instrument is particularly useful for low power oscillators.

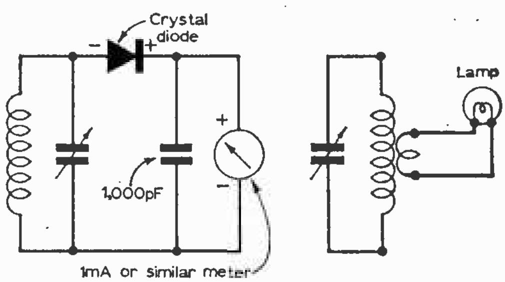



*Fig. 2: Two absorption meter circuits including some form of indicator.*

If a lamp is used this can be 6V 0·06A for low-power circuits or 6·3V 0·3A for average purposes. The instrument can be built in very portable, compact form and is useful for quick checking of oscillator, buffer, multiplier and output stages.

Absorption meters give reasonably accurate indications if loosely coupled to the circuit being checked. They are, however, really intended for location of the tuning position of any band or for ascertaining harmonics, not for exact calibration within a single band. Loose coupling increases accuracy of readings.

### Crystal Standard

For exact measurement within a single band a crystal marker is most often employed in conjunction with the station receiver. This allows calibration of the receiver or of a transmitter variable oscillator.

A typical marker circuit, incorporating a 100kc/s crystal, is shown in Fig. 3. The harmonic amplifier stage V2 is optional. If it is omitted

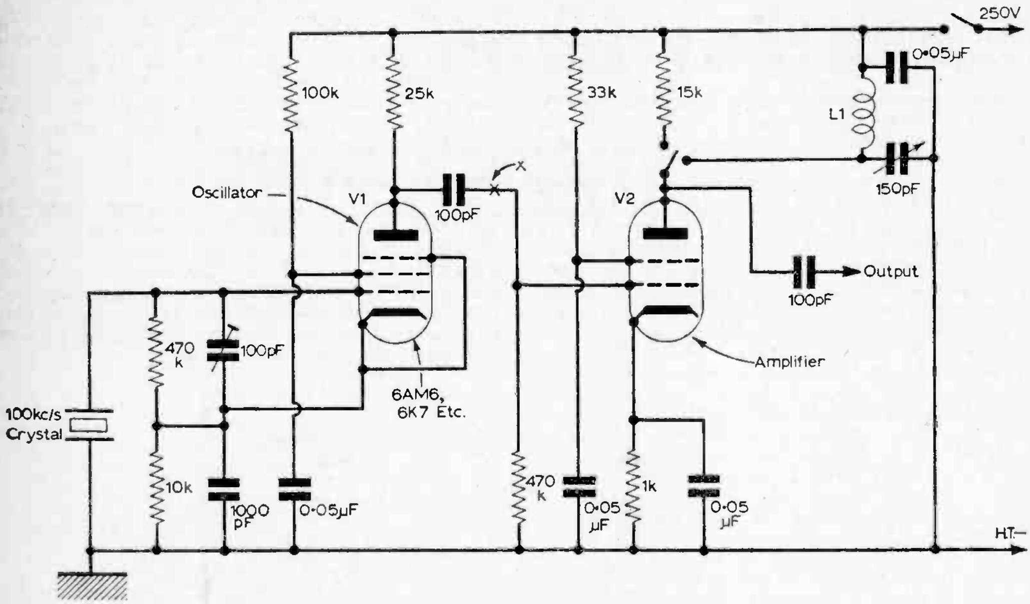



*Fig. 3: A crystal marker circuit with optional harmonic amplifier.*

the output is taken from the 100pF capacitor at X. In these circumstances harmonics of a 100kc/s crystal may be heard up to perhaps 10Mc/s to 15Mc/s or so with a sensitive receiver. With a less sensitive receiver harmonics may be lost much earlier, so that they cannot be found beyond 2Mc/s to 4Mc/s or so.

### *Optional Amplifier Stage*

If the harmonic amplifier is added it may be left unused by employing the 15kΩ resistor as anode load. To increase harmonic output L1 is switched in and roughly tuned to the harmonics needed. If increased coverage is required, further coils can be used at L1. The amplifier can be any high-gain tetrode or pentode.

Power for a crystal marker can usually be drawn from the receiver: alternatively a small power pack may be used if available. If required a power unit may be constructed especially for the marker. A suggested simple circuit is shown in Fig. 4.

If the marker employs a 100kc/s crystal (which is generally convenient) its output will be on 100kc/s and multiples of 100kc/s. Early harmonics, such as 600, 700, 800, 900 and 1,000kc/s (1Mc/s), will be heard throughout the medium waveband. For amateur band calibration the harmonics of interest will be those on 1·8, 1·9 and 2Mc/s (160m band); 3·5, 3·6, 3·7 and 3·8Mc/s (80m band); 7 and 7·1Mc/s (40m band); 14, 14·1, 14·2, 14·3 and 14·4Mc/s (20m Band); 21, 21·1, 21·2, 21·3 and 21·4Mc/s (15m band) and from 28Mc/s upwards (10m band).

The oscillator may be tuned to zero beat with the 200kc/s Light Programme or to the 2·5Mc/s National Physical Laboratory station by adjusting the 100pF trimmer. A short aerial is used and coupling from the marker is adjusted, if necessary, so that the marker signal is of similar strength to the station tuned in. Any difference in frequency between the station and marker harmonic will be heard as a rapid fluttering sound or will produce a rise and fall on the receiver tuning indicator if fitted. The difference is reduced to the minimum by adjusting the trimmer. The degree of accuracy achieved can easily be much higher than demanded by the GPO for amateur transmitters.

To calibrate a receiver the required harmonics are tuned in and the receiver dial is marked. To

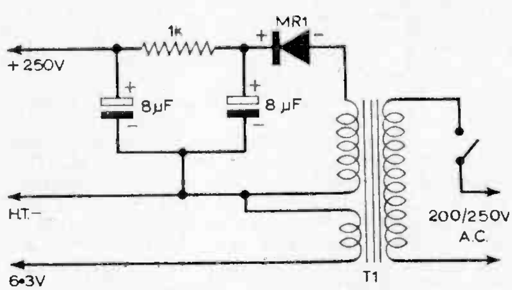



*Fig. 4: A power pack for the crystal marker.*

calibrate a transmitter v.f.o., tune in the required marker harmonics on the receiver and adjust the v.f.o. to zero beat with the marker signal. The v.f.o. dial can then be drawn up to suit. Where the edge of a band falls between two marker harmonics the dial can be equally divided, to arrive at this point, provided the capacitor is not near either extreme setting.

### *Crystal Calibrator No. 10*

The surplus crystal calibrator No. 10 is equipped with a 500kc/s crystal, mixer and tunable oscillator and harmonics may be heard up to 10Mc/s to

30Mc/s according to receiver sensitivity. The h.t. supply required is up to about 300V at 10mA to 15mA and this can generally be taken from the receiver.

In its original form the calibrator required 12V at 0·3A for the valve filaments. This supply may be obtained from dry batteries but is a little inconvenient.

The valve filament requirements may be reduced to 3V at 0·3A by disconnecting R19, VR1 and R20, as shown in Fig. 5. A two-cell dry battery may then be used. The valves actually have 1·4V 0·1A filaments, but the filament chokes are 30 ohms, so operation from a two-cell battery is in order. Power connections are as in Fig. 5. V1 (not shown in the diagram) is a neon modulator and therefore requires no filament supply.

value at first. A preset r... further smoothing capacitor is convenient. No ... R2 because it would charge... sed in parallel with ... if the calibrator switch were ... a higher voltage ... always to switch off by disc... it is preferable ... from the 6·3V supply, thus the rectifier ... excessive filament voltage. ...momentary

### *Using the Calibrator*

The calibrator is used in the ... described for the 100kc/s mark... crystal harmonics are heard at 500... These may be used as calibration ... already explained. With the tunab... switched in, the dial indicates megacy... decimal places and this will allow ... through a particular amateur band.

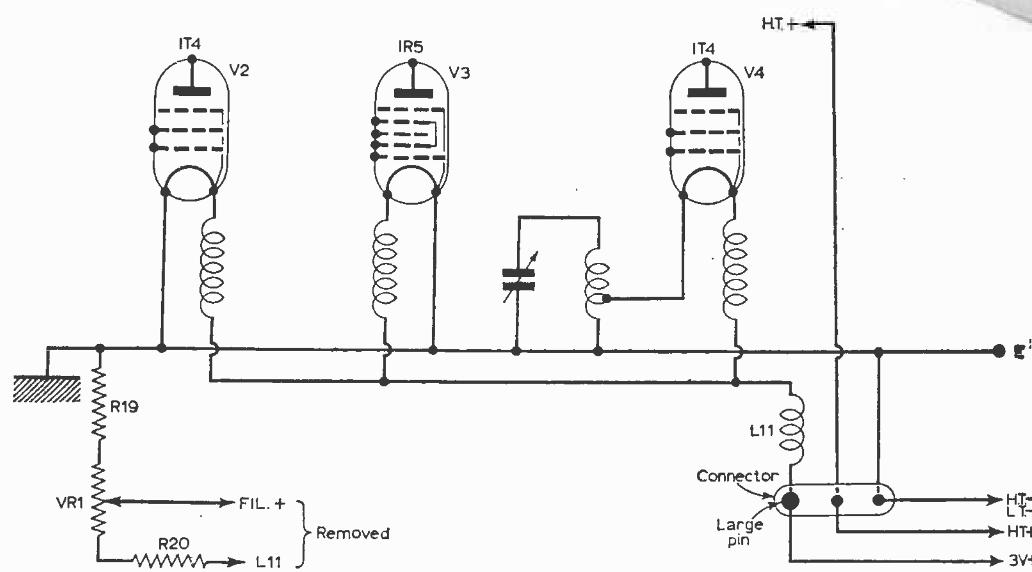



*Fig. 5: The crystal calibrator No. 10 power supply circuit.*

To avoid the use of any battery filament current can be taken from the circuit given in Fig. 6. This is connected to the 6·3V heater line of the receiver, which will also be used to provide h.t. In a unit of this kind, built for the No. 10 calibrator, MR1 was a 12V 0·5A rectifier. R2 is 470 ohms and R1 is adjusted until the filaments receive approximately 1·3V. In the unit built R1 was 17 ohms, but it would be wise to check the voltage with a higher

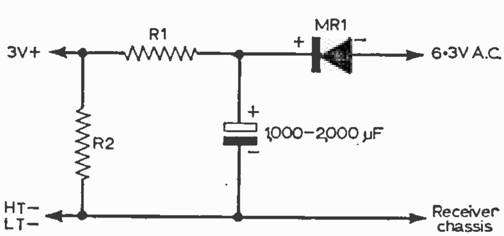
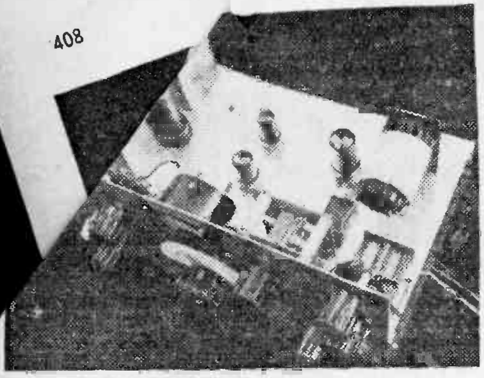



*Fig. 6: The calibrator filament supply.*

The amateur bands are 1·8—2, 3·5—3·8, 7—7·1, 14—14·35, 21—21·45 and 28—30Mc/s.

A receiver should be switched on at least 15-20 minutes before calibrating it, and this also applies to a v.f.o. if not temperature compensated. When calibrating a v.f.o. with a crystal marker the receiver calibration is of no importance as the receiver is merely used to find zero beat between the v.f.o. and marker harmonic. The marker in Fig. 3 produces c.w., so the usual b.f.o. is required to obtain an audible tone. With a t.r.f. receiver an audible tone will be heard if the detector regeneration is sufficiently advanced to cause oscillation.

Occasionally an amateur band crystal is used to identify one edge of the usual amateur bands. For example, if a 3·5Mc/s crystal oscillator is employed its fundamental will be heard on 3·5Mc/s and harmonics on multiples of this frequency, which include 7, 14, 21 and 28Mc/s. Failing this, a listening check will soon show if the correct 100kc/s (0·1Mc/s) harmonics to calibrate a band have been used.



# A Top Band R.T. Transmitter

## By G3OGR

Continued from page 324 of the August issue

FIG 4 shows the underside of the chassis, components in each stage being kept clear of those in other stages, to avoid instability. In these circumstances, no neutralising is required.

All leads carrying r.f. should be short and direct. Bypass capacitors and associated resistors should be near the valveholder tags, and all construction should be rigid.

### *Constructing the V.F.O.*

The v.f.o. coil L1 is a single winding medium wave oscillator coil, with adjustable core permitting variation on inductance from about 70 to 130$\mu$H. Adjustment of the frequency coverage obtained by VC1 is possible by means of TC1, and modification of the core position. The aim is to get a coverage of approximately 1·8-2Mc/s with the full 180 degrees rotation of VC1. As the exact values of C4 and C5 have some influence on frequency coverage, it might in some cases be necessary to replace C1 by a fixed capacitor of other value than that shown.

When wired, the v.f.o. can be tested by listening for the carrier with a receiver, and this allows frequency coverage to be adjusted. Space is available to fit a ball drive to VC1, but this was found rather unnecessary, if a large control knob is used. The knob has a cursor, reading against a scale cemented to the panel. Final calibration of this scale should be left until construction is finished

In Fig. 4, lead Y from R3 passes along against the chassis and front runner, to tag Y of the "Tune" switch, so that h.t. is applied to v.f.o. and buffer, when this switch is closed.

### *Buffer Stage*

Tag 6 of V2 is connected by the lead A to the slider of the drive potentiometer VR1. Tag B on VR1 goes to R6, as in Fig. 4.

L3 is a medium wave single winding aerial coil, with core, and inductance adjustable from about 130-215$\mu$H. Stray circuit capacity allows the coil to be resonated at about 1·9Mc/s. This is done, when the r.f. section is complete, by switching the

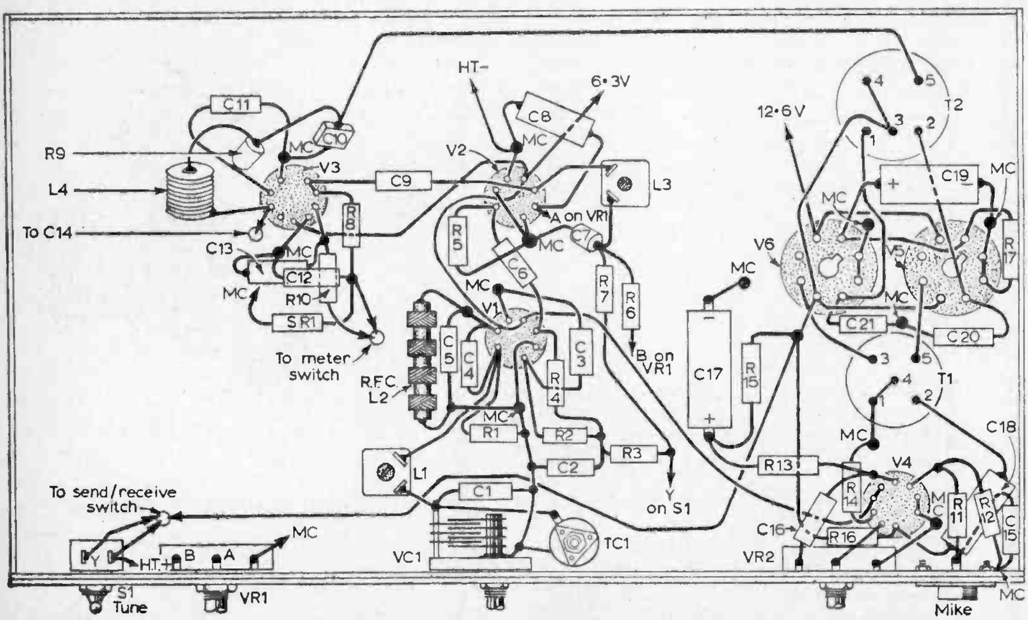



*Fig. 4: The complete underchassis wiring diagram.*

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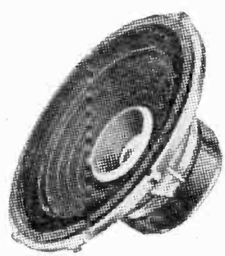

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Ceramic Magnet.
Flux density 14,500 oersteds.
Total flux 60,000 maxwells.
Aluminium Voice Coil.
Max. input 6 watts rms
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Frequency range 40-20,000 c/s.
Bass resonance 50/60 c/s.

**Price:** 134/2 inc. P.T.

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Impedance 10/15 ohms.
Flux density 16,000 oersteds.
Max. input 10 watts rms
or 20 watts peak.
Frequency range 30-20,000 c/s.
Aluminium Voice Coil.
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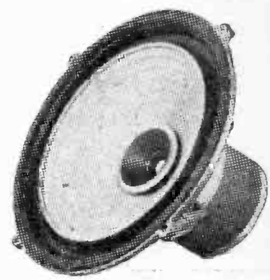

## SUPER 12/RS/DD

Impedance 12/15 ohms.
Flux density 17,000 oersteds.
Total flux 190,000 maxwells.
Aluminium Voice Coil.
Max. input 20 watts rms
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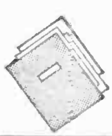
Frequency range 25-20,000 c/s.
Bass resonance 26/32 c/s.

**Price:** 350/- (no tax).



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meter to read grid current. The v.f.o. is adjusted to 1·9Mc/s, and the core of L3 is rotated until maximum grid current is obtained. Tuning should be quite flat, and if the v.f.o. is adjusted to 1·8Mc/s or 2Mc/s there should only be a small drop in grid current.

V2 is also operating when the "Tune" switch is closed. VR1 is adjusted so that the meter shows the correct grid current for V3.

### Power Amplifier

The power amplifier is V3. The r.f. choke L4 is fitted vertically. A hole is drilled as near to tag 7 of the valveholder as possible, and the anode lead goes directly through this hole to C14. The tank coil L5 consists of 55 turns of 24s.w.g. or 26s.w.g. wire, on a 1¼in. diameter or similar former. The former is bolted to a strip of paxolin, mounted vertically above the chassis by a bracket (Fig. 3).

VC2 needs to be 250pF or larger, and a receiver type tuning capacitor was found satisfactory. A midget component, with very small spacing between plates, is unsuitable. A capacitor of average size, if clean and correctly spaced, should not spark over. If it does so, it may need cleaning, or adjusting.

VC3 is a 2-gang or 3-gang broadcast receiver type capacitor, and as this will generally be adjusted for a fairly low impedance output, no possibility of sparking over should be expected. A total capacity of at least 1,000pF (2x500pF) is required for many aerials. If a 3-gang capacitor is to hand, the extra capacity may be useful, with some aerials. But if any particular aerial requires an increase in capacity here, this can be made up by shunting a fixed mica capacitor across VC3. VC2 and VC3 are both bolted to the panel.

### The A.F. Modulator

This section is very straightforward. A screening can is used over the double-triode V4. With the driver transformer T1, tags 1 and 2 are the primary; tags 3, 4 and 5 are the secondary, tag 4 being the centre tap. Other push-pull input transformers can be wired in the same way once the terminations have been identified.

The primary of the modulation transformer T2 is tags 1, 2 and 3, tag 3 forming the centre tap; tags 4 and 5 are the secondary winding. If other modulation transformers or modulator valves are employed, the ratio may readily be found. To do this, divide the p.a. stage h.t. voltage by the current drawn by the p.a. valve. Divide the resultant figure by the optimum load specified by the valve data for the valves V5 and V6, and extract the square root. This is the required ratio.

A coaxial socket is fitted to the panel, for the microphone lead, which is screened in the usual manner. The gain control VR2 is adjusted so that adequate modulation is achieved, at normal voice level, with the microphone at a convenient distance.

### Meter Switch and Shunts

The meter switch S2 has two positions, so that grid current or cathode current may be read. When reading grid current, the positive meter terminal

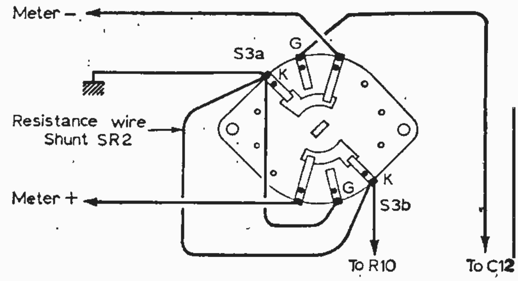


*Fig. 5: The wiring of S3.*

goes to chassis. Shunt SR1 is in parallel with the meter, and also serves to complete the grid circuit, when the meter is reading cathode current. When cathode current is observed, the negative meter terminal is connected to the chassis, and shunt SR2 provides a suitable full-scale deflection.

Fig. 5 shows the meter switch wiring. The meter may be a 1mA, 2mA, 5mA, or even 10mA instrument. If the meter is suitable for grid current readings without a shunt, then resistor SR1 can be 1kΩ, which will have little effect on meter readings. But if a 1mA or other fairly sensitive instrument is fitted, SR1 must be selected to give a suitable range. The value of SR1 may be found by trial, or can be calculated as follows: subtract 1 from the number of times the full-scale deflection is to be increased, and divide the meter resistance by the resultant number. This gives the shunt value in ohms.

Shunt SR2 has to be of very low value, and is soldered directly to the switch, as in Fig. 5. A short piece of 24 s.w.g. or similar resistance wire can be used, the length being adjusted until the meter range is suitable for the cathode current.

Ranges of 0-5mA for grid current, and 0-100mA for cathode current, would do well. The meter actually fitted was a converted thermocouple instrument, with the thermocouple removed. As shunts were being made, it was decided to provide ranges of 0-4mA and 0-80A, so that normal operating points of 2mA and 40mA would give a half-scale reading.

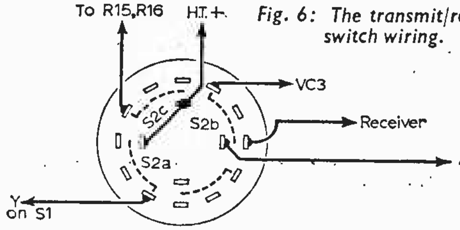


*Fig. 6: The transmit/receive switch wiring.*

### Transmit-Receive Switch

Wiring to the transmit-receive switch S2 is shown in Fig. 6. One pole switches the aerial to L5 for transmitting purposes, and to the receiver aerial terminal, for receiving.

Two poles switch the h.t. positive circuit, so that h.t. is applied to the h.t. modulator line, and to V1 and V2, when the switch is in the transmit position.

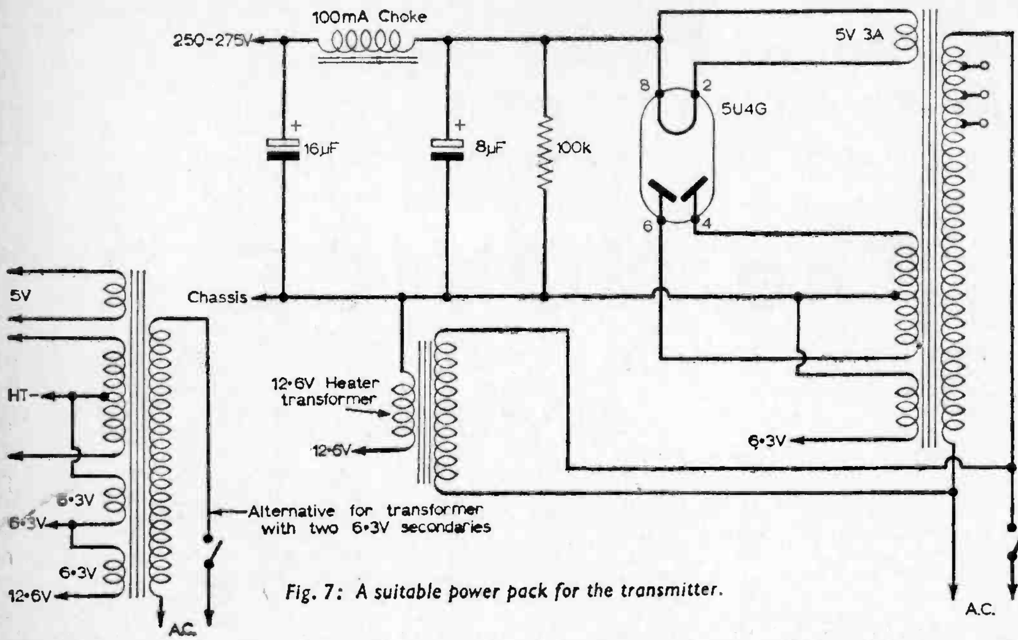


*Fig. 7: A suitable power pack for the transmitter.*

### "Tune" Switch

The "Tune" switch S1 is in parallel with one section of the transmit-receive switch, so that h.t. may be applied to V1 and V2 only, for tuning-up purposes.

If desired, any spare contacts on the switch can be wired to the receiver loudspeaker, to silence this when the transmitter is working. Whether this is required depends to some extent on the layout of equipment, type of receiver, etc. Feedback from loudspeaker to microphone will cause howling, unless volume is kept low.

### Power Pack

This can be of usual type, and a suitable circuit is shown in Fig. 7. The h.t. requirements are about 80-100mA at 250V to 275V. The l.t. requirements are 6·3V and 12·6V for heaters.

The power pack can be situated anywhere convenient, and coloured flexible leads or a 4-pin plug and socket, appropriately wired, may be used for connecting purposes.

Power pack and all heaters are left running continuously, in the normal way, when the equipment is in use.

### Operating

As a fairly large number of amateurs begin working on top band, some details on operating may be useful.

The transmitter may be tested with a dummy load, such as a 15W or 25W household lamp. The lampholder is wired from aerial lead to transmitter chassis. VC3 is closed.

The v.f.o. is adjusted to the frequency required, and the "Tune" switch is closed. The meter is switched to read grid current, and VR1 rotated to obtain approximately 2mA. The "Tune" switch is then opened.

The meter is next switched to read cathode current, and the transmit-receive switch is turned to the transmit position. A rather high current reading will probably be obtained, and VC2 should be rotated to find the dip in cathode current, which will be very much lower. The lamp load should glow, showing that r.f. current is being produced. To increase loading, VC3 is slowly opened, VC2 being re-adjusted as necessary to keep the p.a. tuned for minimum current. As loading is increased in this way, the minimum current will increase, and the lamp will light more strongly. Loading is adjusted until the p.a. draws 40mA, if a 250V supply is used. This represents a little under 10W input. Sufficient r.f. should be produced to light a 15W lamp quite well.

In normal operation, a reply can be made to a station calling CQ. To do this, tune the v.f.o. to the calling station's frequency, and adjust the loading. When the station stands by, the transmitter is swiched on, and a reply made.

Alternatively, a clear space in the band may be sought on the receiver, and the v.f.o. then be tuned to this frequency, by listening for the carrier on the receiver. The transmitter is then switched on and loaded up, and a CQ call can be made. The switch is then turned to receive, for replies.

Any usual transmitting aerial can be employed. End-fed wires are quite often used. Loading, with the aerial, is adjusted in the same way as described for the lamp. It must be appreciated that the impedance of the aerial, which depends on the aerial length and other factors, will influence the setting of VC3. ■

*No soldering is necessary to construct this portable receiver and it will thus prove to be an ideal set for the beginner to build*

# The NOVICE 3

## By D. B. Pitt

THIS receiver is a pocket-size, three-transistor, reflex, medium-wave receiver whose sensitivity should be good enough for local station reception in most areas. A long waveband may be added later. A simplified version for *good reception areas* is described at the end of this article.

There is nothing particularly novel about the circuitry, but some of the practical methods used in construction may be of interest and offer some new ideas to the reader.

The circuit is laid out on a wooden baseboard and pressure contacts may be used for all but five of the twenty or so junction points.

Alternatively, solder tags may be used instead of brass washers for the various points on the board and all components soldered into position to make a more permanent job of the receiver.

Some readers who are still not too sure of their skill with the soldering iron may care to make it in the first way to gain confidence, then substitute soldered junctions at a later stage.

A detailed list of all components needed is provided.

### The Chassis

The chassis consists of a piece of good quality softwood such as deal, and the measurements must be very carefully adhered to and the wood cut with fair accuracy as it is to fit into a small plastic box of a definite size.

First, the main shape, 4in. x 2¼in. x ½in. (planed) is cut out as in Fig. 1. Then three pieces are removed at X, Y and Z, using a fine saw so as to make as neat a cut as possible. Piece Y will have to be removed, of course, with two sawcuts followed by a chisel-cut along the third side.

The baseboard can now be smoothed where necessary with fine sandpaper and tried out for a neat fit in the bottom of the plastic case.

This case is one of the small boxes often used for pieces of amateur equipment as described in this and other radio publications. It is of coloured opaque polystyrene, is manufactured by the Plastic Box Co., Market Rasen, Lincs., and is available for very little cost from many advertisers in this magazine. Its size is roughly 4¼in. x 3in. x 1¼in.

The fifteen small brass washers (or solder tags if needed) can now be fitted on to the board with small round-headed brass wood screws. A suitable

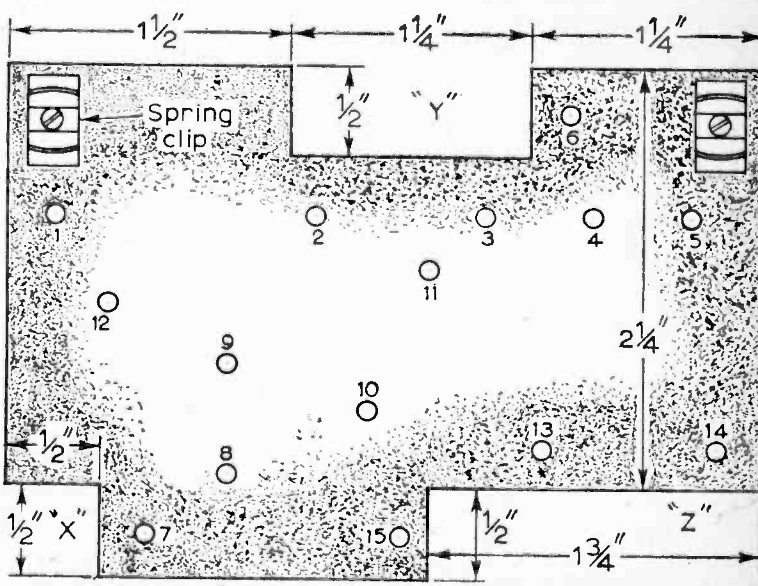


*Fig. 1: A full-size chassis drawing which may be used as a template.*

size will probably be $\frac{3}{8}$in. No. 2 gauge (a broader gauge may introduce the risk of splitting the wood at the edges), but if solder tags are to be fitted, $\frac{1}{4}$in. screws of the same gauge will be quite adequate for the purpose.

The layout of the contact points is important, as might be guessed when using so small a baseboard. For this reason Fig. 1 has been reproduced *exactly full size* so that the page may be carefully laid on the baseboard and the points pricked through the paper with a sharp point.

The washer at point 15 can be seen to overlap the edge of the wood a little. This is deliberate and its purpose will be explained later. The two Terry clips are of the smallest size (gauge 000) and are supplied with their own special wood screws. They may be a rather tight fit on some of the broader types of ferrite rod, but a certain amount of straining seems to have no harmful effect on these very useful little clips.

### *Fitting the Main Components*

All the components used should be the smallest obtainable as this makes for easy construction.

If the reader is offered the choice of two components with different gauge wire leads he should choose the one with the *thinner or more flexible wires* as these give much less trouble when fitting.

The largest currents flowing in this circuitry are so small that thin wires are no disadvantage electrically.

There are a few points which are perhaps not immediately apparent from Fig. 2 which should be used as the main guide for mounting the smaller components.

(1) All resistors and capacitors (condensers) should be mounted flat on the board, the wires

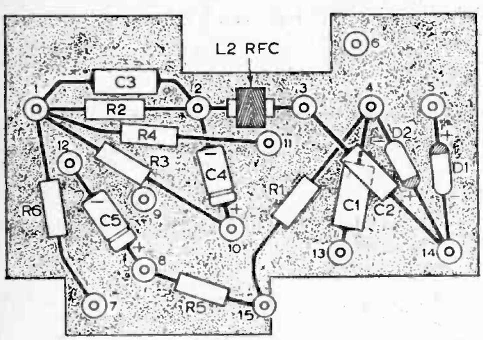


*Fig. 2: Showing the arrangement of the majority of the components.*

being shortened only as much as is necessary to give a firm but tidy contact.

(2) The wires of the small r.f. choke (L2) should *not* be shortened but bent to form a double crank so that the coil stands *clear of the board* roughly level with the ferrite rod.

(3) The electrolytic capacitors and the diodes *must* be connected the proper way round, the correct polarity (+ or −) being shown in Fig. 2.

For guidance the can of the electrolytic capacitor is always negative (−) and the wire emerging through an insulating bush is always positive (+).

The red end of the diode indicates positive, the black or colourless end denotes negative.

(4) A short length of p.v.c. sleeving (stripped off a piece of standard connecting wire) should be slipped over the left-hand wire lead of the 100pF capacitor C2 where this passes over the 0·005μF capacitor C1 and the 100kΩ resistor R1 (or their leads).

A similar piece of sleeving should be slipped over the right-hand wire lead connecting the 4·7kΩ resistor R4 to point where it passes over the 8μF electrolytic capacitor C4 (or its lead).

### *The Three Connecting Wires*

There are only three formal connecting wires on the board. These should be of p.v.c. insulated wire (preferably miniature gauge as this is more flexible and less bulky).

The three wires are connected as follows, passing in as short a path as possible *under* the other

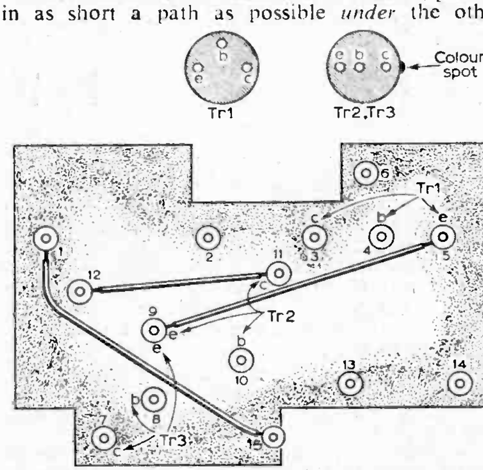


*Fig. 3: The positions of the connecting wires and transistor base details.*

components or their leads directly from:

Point 1 to point 15
Point 5 to point 9
Point 11 to point 12

It is important that these connecting wires should be in close contact with the board by passing *under* the other components as, in this position, accidental breakage whilst handling is much less likely to occur (see Fig. 3).

### *The Transistors*

The transistors are connected to the points as numbered in Fig. 3. Note that the emitters of both a.f. transistors share a common junction (point 9) and that the two paint spots which mark the collectors face away from each other. Note also the special arrangement of the r.f. transistor leads.

The transistor wire leads should not be shortened but all the wires curved gently over so that the body of each transistor rests its *side* against the lid of the case when it is closed. This curling of the leads gives a useful "shock-absorber" effect.

If at any time the transistors are soldered into position a "heat-shunt" should be used and the connection made as quickly as possible. A pair of pliers gripping the lead between the transistor body and the point of soldering is effective for this.

When soldering the transistors the soldering iron must be *properly earthed* or switched off just before the join is made if earthing happens to be difficult.

### The Earpiece Socket

The crystal earpiece recommended for this receiver is an inexpensive one generally available through numerous advertisers in this magazine.

It is supplied complete with a miniature jack-plug and socket and this latter part must be modified slightly before use. The constructor should move the jack-plug in and out of the socket a few times and note how it works.

The plug terminals make contact with the tube part of the socket and with a small springy arm which clicks into a groove towards the end of the jack stem.

Besides these two essential parts there is an extra arm that extends rigidly outside and beyond and finally hooks round the end of the springy arm.

When the jack is inserted the springy arm moves slightly away from the larger, fixed one, the resulting gap breaking the electrical contact between the two arms.

This crystal earpiece is intended for use with a small loudspeaker radio and the extra contact is provided so as automatically to switch off the loudspeaker when the earpiece is being used for private listening.

The required modification is quite simply performed. The "hook" part of the outer *fixed* arm is slightly straightened so as no longer to embrace the end of the smaller springy arm. It is then strained upwards away from the springy arm and the hook part then rebent to its former shape.

This outer arm is the *only* part which needs to be moved and when correctly adjusted should *just fail* to touch the springy arm when the jack is absent but make a good contact when the jack is inserted. The action of the switch has, in short, been directly *reversed*. Fig. 4 should make the whole operation clear. Although it may sound complicated it is, in fact, a matter of a minute's work with tweezers or sharp-nosed pliers.

The socket is provided with three perforated tags and a 4in. length of insulated (preferably miniature) connecting wire should be soldered to each, using the minimum of solder (Fig. 5c).

### The Tuning Capacitor

The tuning capacitor is a small, compression-type, solid dielectric trimmer of around 500pF capacity.

These variable capacitors have the advantage of cheapness, small size, mechanical stability and, when used with a knob of fairly large diameter, a built-in slow-motion drive effect—a useful property which is often forgotten.

Unfortunately they are difficult to calibrate with numbers or station names, but in a set of this sort the disadvantage is a minor one.

The screw must first be removed along with its two washers, one brass, one mica or transparent plastic. The screw and the mica washer are discarded and a longer screw of the same gauge (6B.A.) is substituted, the original brass washer being replaced before screwing in. The new screw

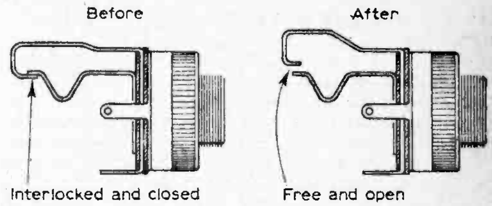


*Fig. 4: The earpiece socket before and after modification.*

should be about 1in. in length.

It is important that the transparent washer should *not* be replaced as its presence would make the receiver next to impossible to tune correctly.

Notice that the capacitor is *not* exactly symmetrical. One of the brass strips is flat whilst its neighbour has a small "hump" to provide a point of easy flexion (Fig. 5b).

It is important to distinguish between these terminals when the tuner is connected up and the term "humped" will be used to make the difference quite clear.

The two brass tags should now be bent double to touch the porcelain base (this saves space) and

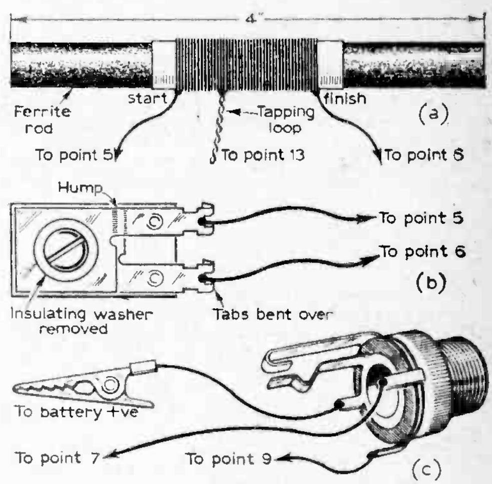


*Fig. 5: Showing connections from (a) the aerial, (b) the tuning capacitor and (c) the earpiece socket.*

a 4in. length of insulated connecting wire soldered to each.

This completes *all* the *essential* soldering, i.e. five fly-leads in all, three on the earpiece socket and two on the tuning capacitor.

### The Aerial Coil

The signal pick-up device is a 4in. length of ferrite rod, wound with a suitable coil.

If the ferrite rod needs to be shortened to give exactly 4in. it is best done by filing a fairly deep groove all the way round to form a ring. The rod can now be clamped in a vice between two pieces of softwood to act as jaws and, provided the groove lies exactly at the edge of the wood, a steady pressure on the protruding end will snap it off precisely where desired without risk of failure.

Adepts at the art of breaking a ferrite rod can snap it confidently at the groove, using their fingers, but beginners are warned that, like an expensive vase, it is *easier to break than to unbreak!*

To wind the coil (medium waveband) make a small paper sleeve on the middle of the rod and, leaving 6in. to start, wind on ten turns of approximately 30s.w.g. enamelled wire. Form a loop about 4in. long (twist this to make it secure) and carry on winding a further 35 turns in the same direction, leaving a final 6in. free at the end.

The first and last turns will have to be anchored in some way, preferably with a band of Sellotape. "Pile-winding" should not be used; it is recommended that a single layer should be wound with each wire touching its neighbour. This is a little slower work but the resulting coil is neater and more reliable. It is termed "close-winding" (Fig. 5a).

**LIST OF COMPONENTS**

**Resistors:**
R1 100kΩ
R2 2·2kΩ
R3 330kΩ
R4 4·7kΩ
R5 220kΩ
R6 4·7kΩ
(R1–R6: Sub-miniature, lowest wattage ($^1/_{10}$ or $\frac{1}{4}$W), 10% tolerance)

**Capacitors:**
C1 0·005μF
C2 100pF
C3 0·01μF
(C1–C3: Any type, smallest possible)
C4 8μF
C5 8μF
(C4, C5: Electrolytic, at least 3 volts wkg sub-miniature)

**Semi conductors:**
D1, D2 Crystal diodes (OA81)
Tr1 R.F. transistor (SBO78)
Tr2, 3 Audio transistors (OC71)

**Miscellaneous:**
Crystal earpiece with plug and socket (C.R.-5)
L2 Miniature r.f. choke, wire-ended. 1 to 2mH (2 to 3mH if both wave bands required)
VC1 500pF compression-type trimmer (Radiospares)
Plastic case (see text)
Softwood board 4in. x $2\frac{3}{4}$in. x $\frac{1}{2}$in.
No. 1450 battery (3 volts)
Screws, washers, miniature croc-clip, wire, etc.

***Final Steps***

The two holes required can now be drilled in the plastic case. By placing the tuning capacitor on its *side* and sliding it along the floor of the case so that the screw point touches the back wall the correct level for drilling can be found. It is roughly $\frac{3}{8}$in. from the floor and midway along the back. A $\frac{3}{16}$in. drill is needed.

The other hole (for the earpiece socket) is in the left wall of the case towards the front, so that the "works" of the socket occupy a position just above the $\frac{1}{2}$in. x $\frac{1}{2}$in. missing corner of the base.

This piece of wood has, of course, been removed so that the baseboard can be taken out of the case, if necessary, without the need to remove the socket.

A $\frac{1}{4}$in. hole is required to accommodate the socket screw.

The chassis can now be lowered into the case and the fly-leads from socket and tuner connected to the correct points (see Fig. 5). *Note* that the "*humped*" tuner terminal *must* be connected to point 5. The socket and tuner are coupled tightly to the case, using the nuts and washers provided, and all that remains to connect are the three coil terminations, which can now be fixed. These wires may be shortened a little where necessary and beginners should remember that the ends of enamelled wire need to be scraped or burnished clean before a connection is made. The ferrite rod may now be fitted gently into its two clips.

The tuning capacitor will need a knob of some sort, of course, and although these can be bought it is more interesting to seek out an attractively coloured plastic button, bottle cap or toothpaste cap which can be drilled with a small hole to fit over the screw. The knob is quite simply retained in position by clamping it tightly between two 6B.A. nuts towards the end of the screw. Note that the tuner tags point *away from* the earpiece socket, i.e. to the right.

***Testing the Receiver***

Take a 1450-type three-volt battery and after making sure that the longer brass strip lies parallel to its top surface and the shorter one perpendicular to it, push the battery into the large space in the corner of the baseboard so that the short strip is uppermost and the longer strip makes contact with the edge of washer No. 15. If this washer has been left overlapping the wood by $\frac{1}{16}$in. or so, as previously mentioned, it will make a good contact with the longer (negative) strip (Space Z, Fig. 1).

The reader will have noticed in Fig. 5c that one of the fly-leads from the earpiece socket does not go to one of the board junctions but terminates freely in a miniature crocodile clip or similar contact device.

This clip must now be connected to the shorter (positive) strip of the battery and the earpiece jack-plug inserted. Not until this has been pushed fully home will any sound be heard in the earpiece because of the battery switching device which has been constructed from it by the modification previously described.

A slight hiss in the earpiece indicates that current is flowing through the transistors. The r.f. choke must now be pushed as close as possible to the aerial coil wound on the ferrite rod. When the reader turns the tuning knob through its full range of movement a number of heterodyne squeals should be heard as various stations are tuned through.

If no such sounds are heard there is no need to worry. The ferrite rod should be simply eased from its clips, turned through half a circle, then clipped back into position facing the opposite way.

If all components and all contacts are correct the heterodyne notes will now be heard on turning the knob.

The only thing which remains to do is to move the r.f. choke further away from the tuning coil, little by little, until the local stations are heard clearly and without distortion. The pocket receiver is now complete.

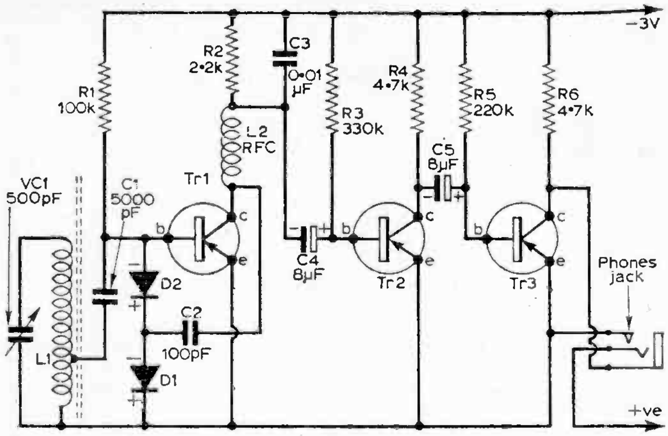


*Fig. 6: The complete circuit.*

(1) Proceed exactly as before but when the 45th turn is reached do *not* cut the wire, but, instead, form a *second* loop 4in. long and twisted as before.

(2) Place a *second* paper sleeve on the rod as close to one of the clips as possible, lead the wire to this sleeve and on it wind 100 turns in a deep bundle or pile, leaving 6in. free at the end and anchoring the last turn firmly. Both coils are wound in the *same direction.*

The first loop (tapping at the 10th turn) goes to point 13 as before. The second tapping (45th turn) goes to one terminal of the on/off switch. The end of the coil (145th turn) goes to point 6. A piece of connecting wire must now be fixed between point 6 and the other terminal of the switch.

To switch off simply extract the jack-plug from the socket.

Although a very simple receiver to build, well within the scope of a beginner, it should give plenty of entertainment and can be put together in quite a short time.

The prototype was designed using the cheapest possible materials. Apart from the screws, washers and wood all were obtained from various component stockists advertising in this magazine.

### Adding a Long Waveband

Many readers, having constructed this receiver, will be interested in adding a long waveband, principally to receive the Light Programme on 1,500m.

For this all that is required is a small on/off switch of some sort and some extra coil wire.

The existing coil should be unwound and started again according to the following instructions:

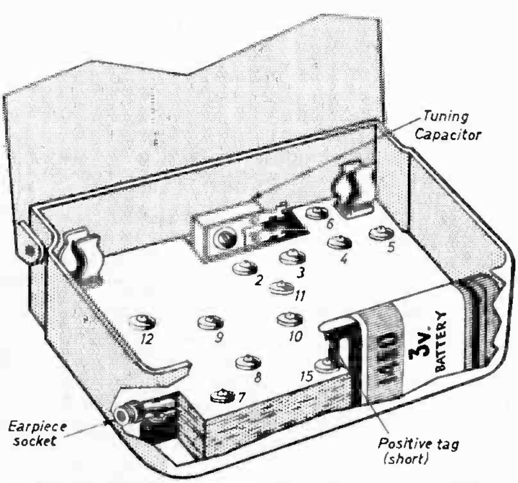


*Fig. 7: A view of the chassis mounted in its case, showing the positions of the battery, tuning capacitor and earpiece socket.*

As there is plenty of room on the case for fitting a small switch of one of the various types sold the reader can make his own arrangements for fixing it.

The position of the r.f. choke may now have to be adjusted slightly, but apart from this the set should function immediately as a two-waveband receiver.

### Two-Transistor Version

In areas of *good* reception, the third transistor (Tr3) and its associated components may be conveniently omitted. This saves considerably in costs and avoids the possible danger of instability through attempting high a.f. gain where it is not really needed.

The simplified version is obtained by simply omitting Tr3, R5, R6 and C5, and connecting the fly-lead which is shown in Fig. 5 as leading to point 7, *to point 11 instead.*

Washers 7, 8 and 12 will now be unnecessary, as will also the wire in Fig. 3 shown as connecting points 11 and 12.

### The Theoretical Circuit

The theoretical circuit appears in Fig. 6 and functions as follows:

The signal is selected by the tuned circuit and capacitor-coupled to the first r.f. transistor. The amplified signal is deflected by the high r.f. impedance of the choke and applied to the junction of the two diodes via the 100pF capacitor. The a.f. resulting from rectification appears *directly* at the base of Tr1 and, after being amplified, meets the high a.f. load of the $0{\cdot}01\mu F$ capacitor and $2{\cdot}2k\Omega$ resistor in parallel and passes to the base of Tr2 (a.f. transistor) via the electrolytic capacitor. This second transistor is in its turn R-C coupled to Tr3, whose output drives the crystal earpiece.

Although extremely economical of components, the circuit functions very efficiently at the given supply voltage. ■

# The PHOTOPHONE

By M. L. Michaelis

**Experiments with light waves - a new interest for the amateur electronics interest.**

*Continued from page 311 of the August issue*

ON first appearances, one might imagine that the counting function could be achieved easily. With S1 still in the position labelled "audio", i.e. making contacts "a", C3 couples any audio or other modulation component of the incident light out to P2, the a.c. output socket. The relay is disconnected, thus cannot energise, and contact RC is thus open in this state, so that nothing else is connected to P2.

If a beam of light is switched on or off, this will give a sudden change of voltage at P2, which one would at first think already constitutes a suitable pulse for operating a digital counter. The author made the mistake of this assumption initially, and was surprised that, in most cases, it did not work! It was observed that pointing a pocket torch at the photocell and switching it on and off never produced any response whatsoever in the digital counter connected to P2 in this "audio" setting. Leaving the torch switched on, and waving the beam as fast as possible across the photocell window still failed to produce any response whatsoever in the digital counter.

It was then tried holding the photophone close to the workshop fluorescent lighting tubes, and switching these on and off, with the digital counter connected to the "audio" output. This produced the first results, in that the counter sometimes, and rather erratically, counted the starter flickerings of the lamps. The final experiment in this series was to fire an electronic photographic flash unit in the workshop. This *always* worked, cleanly, exactly, and reproducibly. The digital counter registered one count for every flash, even if it was pointing in a different direction than at the photophone.

These experiments already make their own explanation pretty clear. It is not a question of intensity, but one of *pure speed* for getting this type of operation. The digital counter, on account of its differentiating circuits, can respond only to true fast pulses, and not to any form of sluggish rise and fall of voltage. The rising flank of an input signal to the counter must take no longer than at the most some 50$\mu$sec, corresponding to an effective flank frequency of at least 5kc/s, if the digital counter is to accept it with certainty as a "proper" pulse. All slower signals are rejected by the counter circuitry, a most necessary function to prevent all sorts of erratic countings from capacitor fluctuations, mains kicks, etc.

If, therefore, the a.c. output from the photocell is to be capable of operating the counter direct, the light input must rise very suddenly indeed to full brilliance. Only the electronic flash-unit meets this requirement with certainty. The flashes when fluorescent tubes are switched on clearly meet the requirement approximately, and are thus sometimes counted in this arrangement. But no incandescent filament lamp satisfies the demand. The filament takes at least a hundredth of a second to light up, which is far too slow. Furthermore, even the fastest human movements are also still too slow, so that waving the lit torch about also failed to produce a counter-response.

### *Flank-accelerating Amplifiers*

At this point another experiment was tried, namely feeding the slow a.c. outputs from P2, obtained by waving the torch about, into a high-gain audio amplifier of conventional type, then in turn connecting the digital counter to the output of this amplifier.

This produced good responses of counting, even when the torch was waved about relatively slowly. The explanation is here that over-driving an amplifier with any waveform whatsoever always produces fast flanks in the output, as the amplifier is rapidly swung from cut-off to saturation on a tiny portion of the excessive input amplitude. This treatment is, if prolonged, certainly not good for an ordinary amplifier, and produces various side-effects of an erratic nature due to grid current blocking. However, it is common practice in electronic-circuit techniques to use specially designed amplifiers for this signal flash speeding-up function, and such a circuit could be used here—although extremely clumsy in comparison to the simple solution finally adopted.

It is merely necessary to use the *d.c. changes*, which are not limited to any great extent by the exact speed of light beam switching, to operate a small relay, whose contacts switch a d.c. voltage into the counter every time the relay energises. Although the complete energising action of a relay is again a relatively slow process, taking some hundredth of a second or thereabouts, the actual moment of electrical connection on the contacts is always a very fast action, fully accepted by the digital counter as "a pulse".

The only new danger here is that, after first making contact, the relay suffers a momentary mechanical rebound, so that the contact is broken again for a brief interval, to be immediately made anew. Such effects, of course, may cause the counter to register two or more counts each time. A digital counter of the type already published in this journal should not show this effect with any relay in good condition, as its own dead-time subsequent to an initial pulse it as least as long as any relay-contact vibrations take to die out. Experiments with a fast pulse-scaler input, as in the advanced digital register already published in this journal, also in fact showed virtually no double-counts with a good relay, but some trouble with older, dilapidated specimens. Thus, although the reader is warned of the possibility of such effects, the dangers of multiple counting are really negligible, if the ordinary digital counter circuit published in this journal is employed, and if care is taken to procure a really sound relay.

### *Circuit Arrangements for the Pulse Relay*

When S1 (Fig. 1) is switched over to "Pulse", contact "a" is broken, so that the direct a.c. output from V2 cathode is disconnected from P2. Contact "b" is now made, so that the midget relay forms the principal cathode load of V2.

When intending to use this function, S1 should, initially, be still at the "audio" setting, and the intended lamp should be set up and directed at the photocell, all being finalised and fixed in the arrangement where a passing person or object can interrupt the beam, for counting. With a meter connected to P1, VR1 should be set for balance (zero reading) with the *lamp operating*. S1 should then be switched over to "pulse", and *only then*. A final adjustment is then made to VR1, to restore zero reading on the meter, with the lamp still operating into the photocell. This assures that V2 is resting virtually cut-off in the steady state where the beam is waiting to be interrupted, and thus a minimum of strain on the components.

Now consider what happens when the beam is interrupted. As soon as it is cut off, V2 is biased heavily negative, by an amount equal to the d.c. photoelectric signal due to the lamp reaching its grid in the steady state. This d.c. steady-state signal is always half of the actual signal from V1, on account of the 1:2 voltage-divider action of R5/R6. When the beam is interrupted, therefore, V2 is heavily cut off, and the relay does not yet respond. However, as soon as the interrupting object has passed and the beam is restored to the photocell, the *whole* of the signal is passed on to V2 from V1 at first, by virtue of C1 shorting-out R5 for transients. V2 grid is thus suddenly driven very positive, leading to a surge of current through the relay, causing it to energise at once. The contact RC closes, switching the +90V supply to the digital counter, which registers a count.

As soon as C1 has charged on the time constant given by C1, R5, R6, which is about half a second, the circuit returns to the balanced d.c. resting condition, with the relay de-energised again, and V2 resting around cut-off. The fact that the count is registered at the re-make instead of the break of the beam is quite unimportant, as the one must logically follow the other in one-to-one correspondence!

It is very important to operate this circuit only after proper adjustment of balance, or slight resting cut-off, under conditions of a steady beam. Too positive settings of VR1 can cause excessive standing anode current in V2, leading to rapi destruction. This danger does not exist in th "audio" setting, because of the much greate cathode load, R4, then operative. In this setting no adjustment of VR1 whatsoever can lead to a dangerous condition.

Those constructors fearing accidental misadjust ment of VR1 on "pulse" operation, or due to tampering from uninitiated persons, should mak S1 a double-pole type, using the second pole to switch another VR1 into circuit on "pulse" setting, which can be in the form of a screwdrive preset inaccessible to unauthorised persons.

This additional control is first set with the slide at the chassis-end before switching over to "pulse" and then, using as powerful and concentrated a light beam as possible, gradually advanced unti counting of every interruption is just certain. I the light beam really is good and strong, in the form of a small, properly focused spotlight, it wil be found that the resting-point is then not a balance, but in fact with V2 quite considerabl cut-off, as should be checked with a meter at P1 This condition is very safe.

### *Speed Limitations*

There are two requirements for this beam-interruption counting, if reliable performance is to be certain. Firstly, the re-make of the beam mus be fast enough compared with the time constan on C1, R5; secondly, the time of interruption mus be long enough to allow C1 to discharge. The exact value for C1 can be adapted to the shape and speed of passing of the objects to be counted, and if necessary, the resting point must be shifted up to a maximum of about 5mA standing current in V2.

If a relay of about 1 to 3 mA operating-sensitivity can be obtained, then V2 can be given an *anode* load in the form of a resistor of about 47kΩ 5W, which would limit the maximum anode current to a safe value under all circumstances, and the circuit can be adjusted for balance on VR1 under conditions of darkness. The resting-state with a beam of light is then with the relay energised, each interruption de-energising it and giving a count upon return of the beam.

This mode of operation works solely on the d.c. signals, and is thus equally effective at any speed of beam interruption; it was originally intended, and is still envisaged, for the prototype as soon as a suitable relay can be obtained. In the former days, when model aeroplane radio control sets worked entirely with valves, relays of this high sensitivity were very easy to obtain from model stores. But today such model control sets have gone over to the higher-current lower-voltage transistors, so that at the time of production of this article and the prototype the writer was unable to obtain a midget relay more sensitive than 10mA. Those relays of considerably greater sensitivity which were available were rather large units.

### *Audio-Frequency uses of the Photophone*

We now come to the third group of uses of the photophone, which really gave rise to the choice of name. Whilst these "audio" uses are less common in the conventional run of amateur experiments, they probably provide some of the most interesting new fields for the keen reader out for

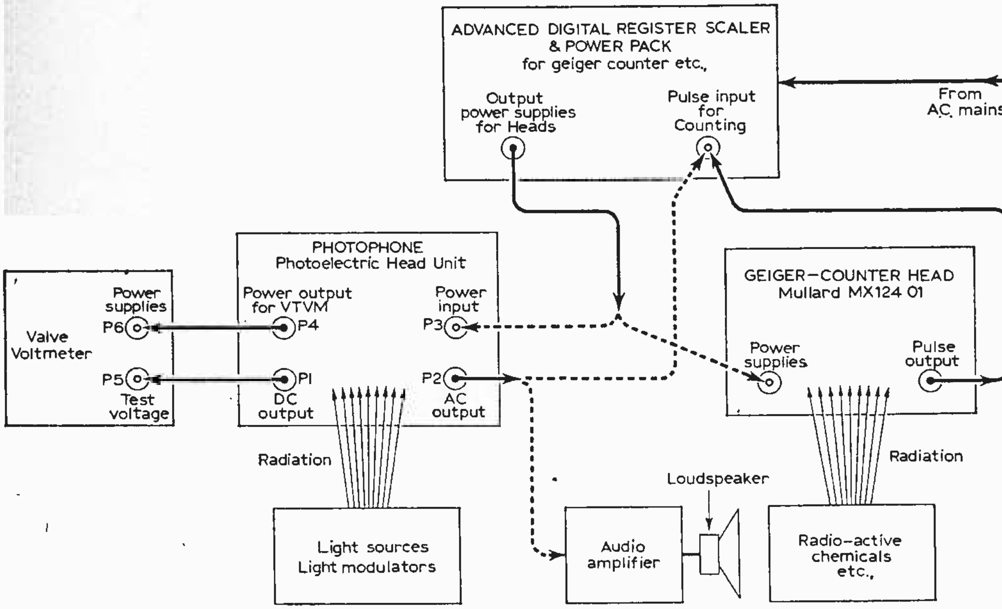


*Fig. 3: A block diagram showing how certain apparatus is used in conjunction with the photophone.*

new ideas to experiment with. They involve production of amplitude-modulated beams of light, possibly transmission of these over very considerable distances by means of lenses or parabolic-dish mirrors, on the familiar "searchlight" principle, and subsequent reception in the photophone set to "audio" operation. The audio output from P2 can then be fed to any available amplifier, the gramophone terminals of the domestic radio being admirable for the purpose.

### Sensitivity

The author initially expected considerable demands to be placed on a light-beam modulator capable of producing a modulated light source giving usable audio output from the photophone, expecting large vibrations of light-slit shutters, driven by some form of powerful loudspeaker-movement system, to be necessary.

Initial experiments showed these fears to be fully unjustified; the actual sensitivity is quite astonishingly high. Thus, if an ordinary open torch bulb, without mirrors, lens, or any sort of concentrating device, is held about 3in. in front of the photophone window, an ordinary rubber band stretched between the fingers held such that the shadow falls on the window, then the rubber band is lightly strummed with the fingers the audio output is about equal to that of a gramophone pick-up.

If a good point-focus pocket torch is beamed into the photophone, and the gain turned up reasonably on the amplifier, it is virtually as difficult as with any ordinary microphone to prevent the familiar acoustic feedback howls and whistles. The sound vibrations from the loudspeaker rattle the batteries and metal of the torch, giving sufficient modulation to the light emitted to produce new sound in the loudspeaker to complete the feedback circle. If the same torch is beamed at a range of some dozen yards or more into the photophone, and tapped with the fingertips, the tapping sounds and rattlings appear strongly amplified in the speaker. It is easy to see that a rubber band stretched across the path of a beam of light entering the photophone, having a suitable paper cone attached, would function as a simple photo-microphone for modulating speech and music on to light beams, and mechanically minded readers can easily think up improved arrangements for getting greater sensitivity out of this kind of gadget.

### The Optical Siren

Another type of modulator easily constructed by the amateur is afforded by the *optical siren*. A very simple example of such a device was built by the writer during initial tests and for demonstration purposes. A small cardboard disc is fixed to the spindle of a high-speed toy motor, with a circular ring of 24 equally-spaced holes near its periphery, arranged such that a small torch bulb shines through each hole in turn as it passes when the disc is revolved by the motor.

If this device is properly adjusted and directed near to the photophone an audio output more than enough to fully load any ordinary amplifier is easily obtained. Still clearly audible output in the speaker was obtained at a range of 10yd with this device, without any form of focusing at all, just the bare torch bulb behind the rotating disc.

The photograph also shows a simple mount of rubber bands for demonstrating the "string modulator" principle.

Experimenters could investigate the possibilities of using a lamp shining across the strings of musical instruments into the photophone for purposes of pick-up. It would be amusing to try this inside the casing of a piano! Certain notes of the piano could be selected in preference to others by suitable positioning of light beams, so that numerous interesting possibilities are open to musically minded tape recorder enthusiasts. These possibilities are not easily available in the same *selective* manner with ordinary microphones.

For those experimenters mainly interested in electronic circuits the optical siren provides interesting potentialities. If the siren disc, instead of being fitted with a ring of holes, has any desired waveform cut round its periphery, then that waveform will be faithfully produced as output from the photophone and can be amplified in the usual manner. This is one of the simplest methods of constructing a signal generator for complicated waveforms. Thus, taking a typical example, a signal where one "cycle" is to consist of two sinewaves followed by a squarewave, then a sawtooth wave, then a brief space followed by a pulse, then repeat, would be rather awkward, though possible, to produce in oscillator circuits.

The optical siren, however, can manage this task easily. Just draw the desired waveform round the periphery of a piece of cardboard, cut out and rotate in front of the lamp. The frequency is determined by the speed of the motor (variable resistance) and the number of times a complete cycle is contained round the disc. An amusing party game in experimenter circles would be to observe the appearance of certain vowels or simple sounds on an oscilloscope and then try to draw and cut out a siren disc *from memory* which will speak this sound. This will probably not be possible for complete words unless discs of very large diameter are used, but various continuous sounds could be attempted.

### Optical Transmitting and Receiving Apparatus

Where the aim is to transmit modulated light messages over distances large compared to the dimensions of the actual apparatus at each end, i.e. at least the length of the garden, familiar optical principles may be used. The cheapest system capable of sufficient effective aperture, and thus probably more effective for amateur purposes than the use of lenses, is afforded by a pair of parabolic mirrors. These should be at least 1yd in diameter and are best made of paper-mache subsequently painted inside, smoothed and given a coating of aluminium paint.

A suitable parabola is drawn initially on a piece of stout cardboard, cut out and pressed into the raw dish in all orientations to give the final parabolic shape before drying. The transmitting light source and its modulating device should be as small as possible compared to the transmitting dish and situated at its focal point. The photophone is situated at the focal point of the receiving dish, with the window facing the dish. The axes of both dishes must be aligned such that they are in line and accurately facing each other. The author has heard of equipment of this kind, of amateur construction, attaining workable ranges between 10 and 30 miles, though that is extremely difficult.

### Microwave Transmissions

The observant reader will have noticed the extreme similarity of this form of wireless equipment for visible light frequencies to the arrangements in familiar use at microwave radar and telecommunications frequencies, so that the link to conventional radio is particularly clear. It would thus be useful to conclude this article with a brief discussion of the relationships between these various fields, particularly as a recent letter in this journal from a reader mentioned the question of using photon-transmission to overcome the limitations of microwave transmissions to optical line-of-sight paths.

Looking at the last question more closely it is seen to be a mere play of words, because the transmission of "photons" (particles having energy quantum and definite mass attributable to them) and the transmission of electromagnetic waves (linked electric and magnetic fields moving through space) amount to one and the same thing and thus go hand in hand, whatever the frequency of operation, right from the longest of long waves, through microwaves, light, X-rays and down to the excessively short-wavelength atomic gamma rays.

The two transmissions, treated as separate phenomena in a conventional way of thinking, are indisputably shown to be merely two different ways of looking at the same actual single effect on the basis of modern scientific research. This may seem rather hard to believe or to visualise but that is the fault of the very limited capacity of the human brain in visualising things, because it can only work with analogies and is never able to perceive things absolutely directly—and no analogy can be a perfect representation of the thing itself. This may all sound somewhat theoretical, yet it is nevertheless most important for the ambitious practical radio experimenter in these modern times who "really wants to know". One is faced with so many new devices and words nowadays in this field that it is most useful to grasp some of the more basic ideas firmly.

If we want to treat a certain radiation as electromagnetic waves then we have the familiar quantities of frequency and wavelength to use whose product gives the velocity of light, which is common to all electromagnetic radiations. If, on the other hand, we wish to treat the radiation as a machine-gunning of particles, called "photons", out of the transmitting aerials into space there is absolutely no *fundamental* reason against doing this, even at medium and long wave broadcast frequencies except one of convenience and custom. However, the operative relations then to be used will appear unfamiliar. The effective mass of each photon is, for example, given by the frequency of the corresponding wave radiation divided by the *square* of the velocity of light, apart from a certain constant factor of multiplication. It is thus easy to see that this mass will be exceptionally tiny unless the frequency is very huge indeed, so that at all reasonable frequencies represented by normal radio waves right down to microwaves it is far more convenient to think of a continuous stream, more easily represented on the basis of the wave radiation picture, and to forget that this could also be considered as broken up into a vast mass of exceedingly tiny individual particles known as photons.

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THE CONCLUDING INSTALMENT OF THIS ARTICLE WILL APPEAR NEXT MONTH

# A SIMPLE STROBOSCO

by L.E. Profaze

THE stroboscope is a useful tool in the laboratory and workshop and it forms an interesting exercise for the home-constructor who wishes to build something rather different from radio receivers. Few components are required apart from the special discharge tube which is obtainable, inexpensively, from the surplus market.

### *Function of the Stroboscope*

In operation the stroboscope produces a continuous series of short-duration, intense flashes of light, the repetition frequency of which can be varied from about 6 to 250c/s for the tubes specified. If a vibrating or rotating mechanism is viewed with the aid of this pulsating light its apparent rate of motion can be reduced until at the point of synchronism the object will appear stationary.

When attempting to detect mechanical faults in machines whose parts move too fast for detailed observation by the unaided human eye, or in research work where it is desired to examine the behaviour of an object under oscillatory conditions, the stroboscope can be of great assistance. The stroboscopic disc, found on many gramophone turntables is an example where the principle is used to check the speed and constancy of rotation of a mechanism by reference to a known and fixed frequency light source, in this case the flashes from a lamp energised by the 50 cycles per second mains supply.

### *The Discharge Tube*

The heart of the instrument is a special gas-filled tube which contains four electrodes to form two discharge-gap systems. The main gap is between two of these, the anode and cathode, while the remaining pair, known as the trigger electrodes, initiate the breakdown of the main gap when, with a suitable positive potential applied to the anode, relative to the cathode, an appropriate potential difference is created between the triggers.

The tube functions in a manner closely similar to the three electrode cold cathode tubes which are commonly found in computers and electronic photo-flash guns. In its quiescent state the anode to cathode resistance is of a high order and providing the critical anode voltage is not exceeded this condition will be maintained.

If, however, an increase in the anode voltage occurs, to a point above this critical level, a discharge will take place and the resistance will fall to a very low value.

With the anode held just below the critical voltage value a suitable positive voltage pulse applied to the trigger electrode will also initiate the main discharge, thus the small amount of energy in the trigger pulse is able to release the principal discharge which though it may last perhaps only 10$\mu$ seconds its peak current may reach a value of 200—400A.

Activation of the trigger gap causes electron emission from the specially prepared cold cathode. These electrons create a condition of ionisation within the gas and positive ions thus produced strike the cathode surface and set free further electrons; an effect which is cumulative. If the anode is held at a positive potential with respect to the cathode a discharge will take place between

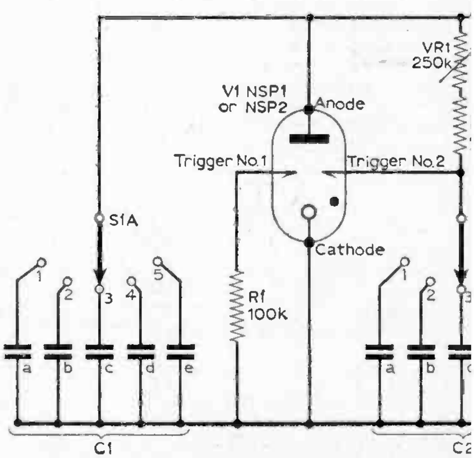
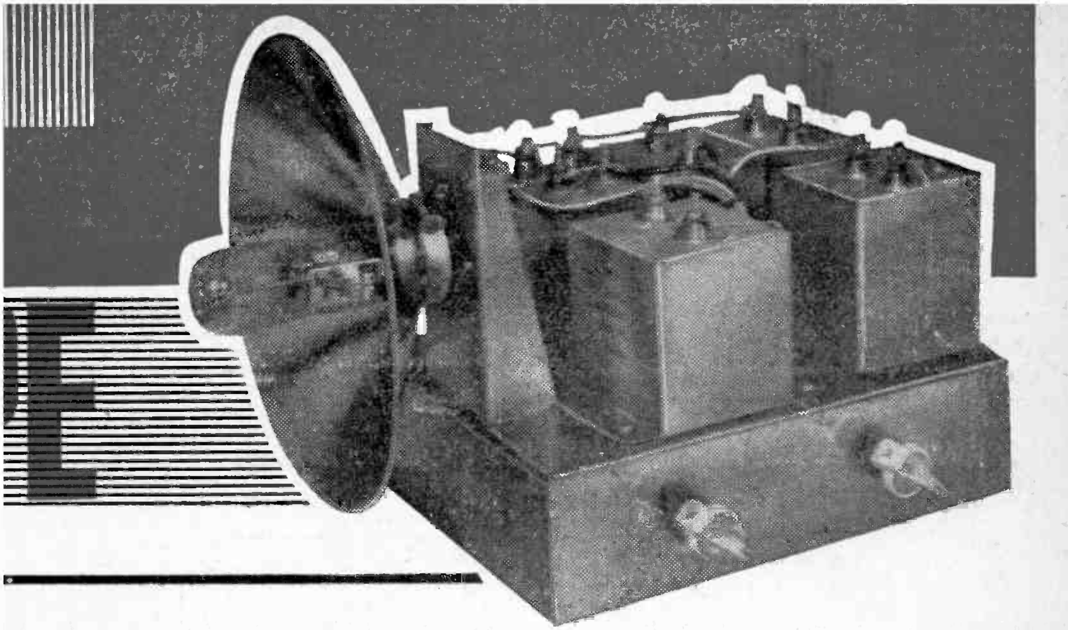



*Fig. 1: The complete circu*



these two electrodes which is accompanied by the generation of light having the characteristic colour due to the neon gas used.

In the stroboscope tube the initiating discharge is created between two trigger electrodes, instead of between a trigger and the cathode for the sake of stability at high sensitivity.

### *Self-triggering*

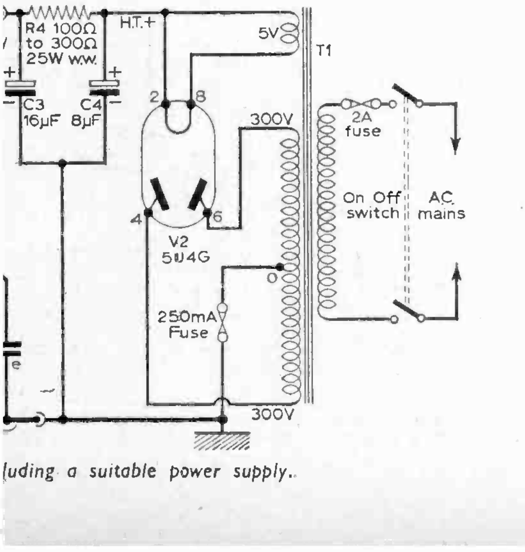
A suitably shaped voltage pulse can be applied to the trigger electrodes from an external generator, such as a multi-vibrator, but it is also possible for simplicity to use a continuously self-triggering arrangement. The instrument described in this article employs the latter system and from the photographs the general construction is visible.

A rudimentary but adequate tin-plate reflector soldered to the lugs of a capacitor clip is attached to the base of the lamp and the general constructional plan follows that outlined in an article in PRACTICAL WIRELESS (May 1963 issue) which advocated the use of tin-plate for this type of work. The final form and the materials used, however, are in no way critical and are largely a matter of what is available or to suit individual preference.

The banks of capacitors, above and below the chassis, are selected in pairs by a switch adjacent to the fine frequency potentiometer and provide five frequency ranges. The high wattage series charging resistor is clearly visible to the left of the potentiometer. As they are plentiful and cheap, block-type capacitors have been used for the higher capacity values and it is suspected that many amateurs possess this pattern but seldom find a use for them.

The essential factors governing their selection are correct capacity value, adequate working voltage (not less than 400V) and good insulation resistance. Electrolytics are not recommended.

The capacitor connected between the anode and cathode stores and furnishes energy for the main discharge and its capacity value must be chosen with care for maximum light output and freedom from instability. Between flashes this capacitor must recharge almost completely and at the higher frequencies there is a risk of producing spurious discharges. The values suggested by the tube manufacturer have been used in the instrument shown which appears to function satisfactorily.




*luding a suitable power supply..*

### *Frequency Range*

The frequency of operation is governed by the value of the supply voltage, the value of the capacitor C2, its associated charging resistor and the characteristics of the discharge gap. Table 1 gives approximate values of C2 with the measured frequency ranges achieved with the prototype.

It is important to remember that with the many variables present it cannot be guaranteed that exactly the same frequencies will be reproduced in other models. The figures given are to be regarded only as a guide and while they can be calculated mathematically the majority of experimenters will doubtless prefer to follow the writer's example and determine them empirically.

It must be recognized that the inherent stability of such a simple circuit will be inferior to that

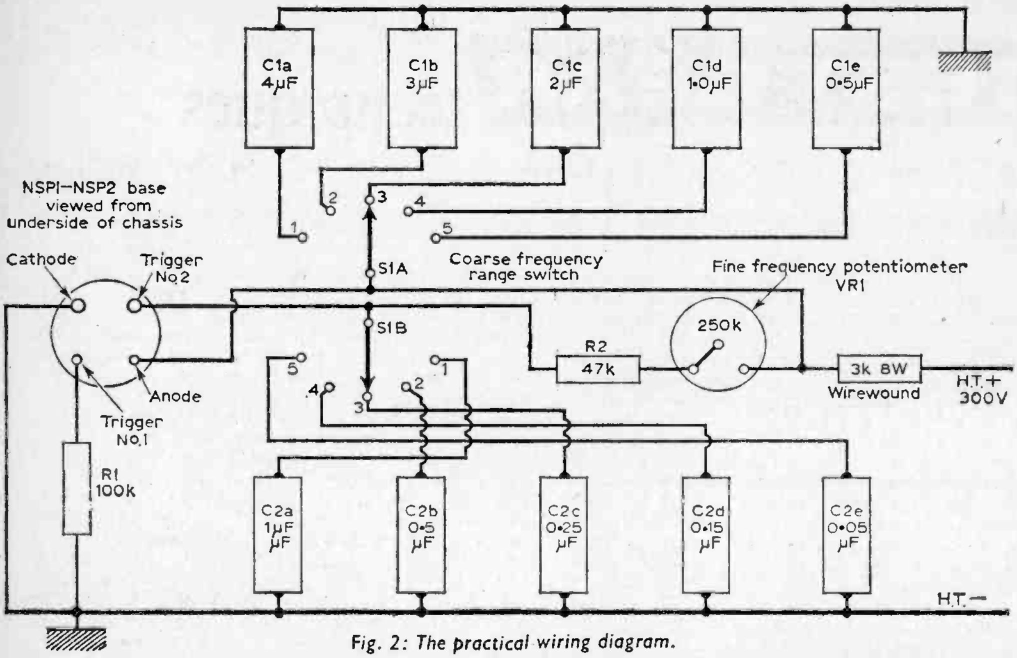



*Fig. 2: The practical wiring diagram.*

resulting from the adoption of a more elegant circuit but it is sufficient for normal practical purposes. The actual values of components often show considerable discrepancy when compared with their nominal values especially if wide tolerances are involved.

It will be seen that the power supply components have not been included on the same chassis as the generator. It was felt desirable to keep the functional part as light as possible to facilitate directing the beam of light at different angles and therefore the heavy power unit components were best kept separate.

As the tube does not have a heater only two supply leads are needed and no doubt the majority of experimenters will have at their disposal a power unit capable of providing about 300V at 50 to 100mA for the occasional use of this apparatus.

### *Practical Applications*

It should not be difficult for the experimenter to find suitable mechanisms upon which to test the completed instrument; anything which rotates is suitable especially if it can be marked with equally spaced black and white lines. Subdued ambient lighting is advised.

An electric fan is an ideal example. Another device which is especially applicable to the radio enthusiast is the loudspeaker cone when energised by a regular waveform. Speech or music is unsuitable due to the lack of uniformity of its wave shape. The loudspeaker should preferably be a large one with a freely suspended cone in which a good degree of movement can be induced with the aid of a signal generator and amplifier.

Some idea of the frequency ranges can be obtained by varying the frequency of the applied signal and adjusting the stroboscope to synchronism to provide calibration points, but care is necessary to avoid confusion with multiples of the signal generator frequency; start at the lowest frequency and keep both the oscillator and the stroboscope in step and it should be possible to carry out the task satisfactorily.

**TABLE 1**

| Value of C1 | Value of C2 | Measured Frequency Range |
|---|---|---|
| 4μF | 1μF | 6-25 c/s |
| 3μF | 0.5μF | 12-40 c/s |
| 2μF | 0·25μF | 25-86 c/s |
| 1μF | 0·15μF | 66-166 c/s |
| 0·5μF | 0·05μF | 125-250 c/s |

### *A Word of Caution*

Gears and other powerful rotating mechanisms should be treated with respect when they are in motion. Since when viewed with light from this instrument they may have no *apparent* motion, it is easy to forget that they may still be capable of causing physical injury if touched with the fingers.

Other uses for these tubes include the photographic recording of the flash as a time marker; cine camera enthusiasts may find them useful for creating special effects when titling.

The well defined high current pulses are excellent for actuating electromagnetic counters and relays. The lowest frequency of the instrument described in this article was, in fact counted with the aid of one of the government surplus counters introduced in series with the h.t. supply.

The very high voltage pulse necessary to trigger the electronic photo-flash tubes can be derived by using one of these stroboscope tubes in series with the primary of a high step-up ratio transformer. ■

# TEST GEAR techniques

## ›ART 7 THE OSCILLOSCOPE CONTINUED

H. W. Hellyer

IN the Miller Transitron timebase of Fig. 5 the problem is largely solved by taking the blanking pulse from the screen grid and the further re- nement of a diode and potential divider, plus the se of a cathode follower which helps avoid the use ıf a blocking capacitor. (The last item has the isadvantage of affecting brightness during sweep eriod.) By using one half of a double triode for his function and the other half as a cathode ollower between the oscillator and the deflection ircuit an economical circuit is obtained.

The second cathode follower (V2 in Fig. 5) has ıe function of improving the flyback time at low weep speeds and reducing the value of com- onents for the suppressor back coupling. Briefly ıe Miller circuit works as a feedback amplifier ʻith a capacitor augmenting the Miller-effect apacitance between anode and grid.

More properly the circuit hown should be called a Miller ntegrator screen-coupled phant- stron. The important CR com- ination here consists of the Cg apacitance with a series of witched capacitors coupled to he cathode follower, whose im- edance acts as the charging esistor. The anode voltage falls inearly as the capacitor dis- harges until the screen grid oltage takes effect. The screen hange is fed to the suppressor rid via the differentiating circuit; he suppressor is driven negative. Anode current is then decreased, ıore cathode current goes via he screen grid, which accelerates he negative-going swing of the uppressor, and a rapid switching equence takes place. This gives linear forward sweep and an brupt flyback—the sawtooth vaveform we require. As both he charge capacitor C and the uppressor feedback component Csupp consist of a bank of switched components ıe balance of the circuit is maintained for various ımebase speeds.

We must note a few of the factors affecting ıe Y amplifier before we discuss the applications f the oscilloscope. The frequency response has lready been mentioned. Equally important is the eflection sensitivity and the rise time.

### Deflection Sensitivity

The deflection sensitivity is the voltage of input o the Y amplifier for unit distance of vertical isplacement of the tracing spot. A typical figure or a direct input might be 5V per millimetre, which is obviously inadequate for the work we need to do where signals are in microvolts. The addition of an amplifier brings the sensitivity to 100mV per centimetre. But these small pulses must be amplified without distortion and, as the waveforms to be investigated can be extremely complicated, a wide bandwidth is required. From this is derived the specification of the frequency response, for the oscilloscope amplifier must be capable of a level output, within small limits, over the whole of the band to be investigated.

Sudden changes in response can result in the phenomenon of "overshoot" that has a drastically distorting effect on the trace, particularly of signals approaching the form of a square wave (perhaps the most difficult waveform to reproduce faithfully). The frequency response of a Y amplifier may be 3dB down at 3Mc/s and 6dB down at

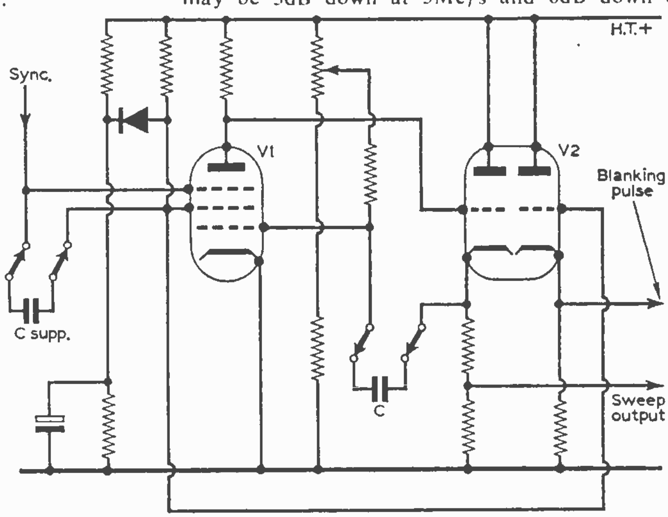



*Fig. 5: Miller-transitron timebase with cathode follower output for blanking pulse and sweep output.*

7Mc/s, which is better than an abrupt dip at the upper end of the frequency spectrum for another reason—the rise time.

### Rise Time

This is the measurement of the time it takes an amplifier to respond to a sudden change in the amplitude of the applied signal. A little thought will show us that this is related to the bandwidth. In fact the bandwidth in megacycles is equal to 0·4 divided by the rise time in microseconds. In practical terms to display a square wave with a rise time of 0·25$\mu$sec accurately the amplifier needs a 0·4/0·25 bandwidth or 1·6Mc/s.

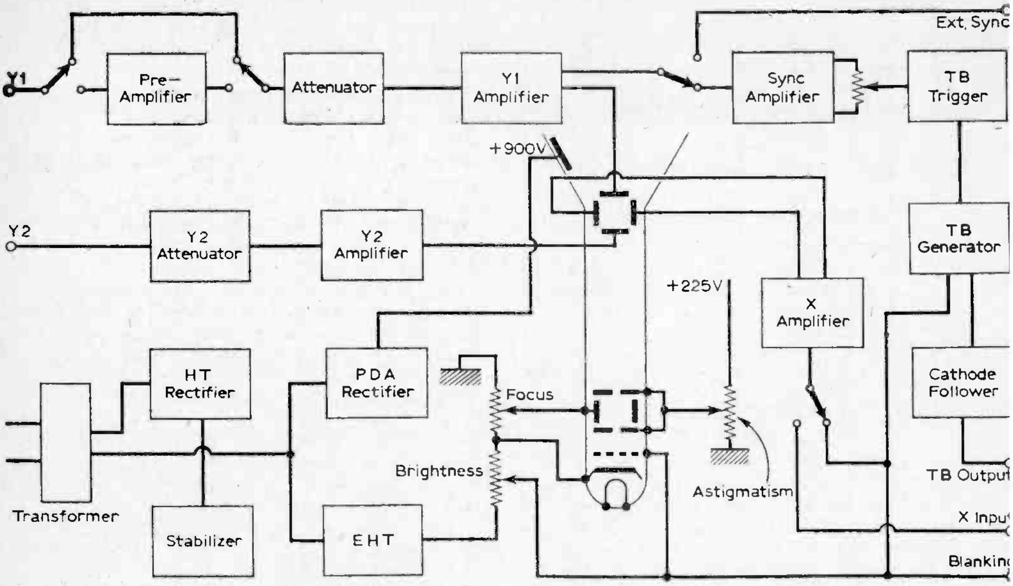



*Fig. 6: Block diagram of the Cossor 1091, double-beam oscilloscope.*

### *Commercial Specifications*

As an example of the type of specifications that may be met in practice consider the quoted figures for one or two differing instruments:

The Philips circuit, Student's Oscilloscope with DG7-6 c.r.t., has a vertical deflection sensitivity of 10mV/cm and a frequency characteristic linear up to 10kc/s and within 6dB at 35kc/s. The timebase frequency range is from 25c/s to 20kc/s.

The "Versatile" model, with the DG7-32 tube and blocking oscillator timebase (convertible to X amplifier for trace expansion), has a similar vertical deflection but the frequency response is linear within −1dB from 0·5c/s to 200kc/s and within −3dB up to 250kc/s.

The Taylor 33A is widely used in general service work; it has a vertical deflection of 80mV/in., a response of 10c/s to 6Mc/s within 0·5−3dB and a timebase covering 10c/s to 500kc/s.

Another favourite is the Beulah 0-12U-F with 10mV/cm, a rise time of better than 0·08μsec, a response of 3c/s to 5Mc/s (2·2dB down at 3·58Mc/s) and a sweep of 10c/s to better than 500kc/s.

One really small instrument with a versatile range of facilities is the Cossor 1039. The Mk II model of the M range has a single-stage Y amplifier with two gain positions: 75, giving a 25c/s to 120kc/s bandwidth, and 20, giving 25c/s to 1·5Mc/s, with a sensitivity on the high-gain position better than 0·15V/mm and on the low-gain position 0·056V/mm and a timebase from 10c/s to 50kc/s.

In the larger range a very widely used oscilloscope is the 1091 double-beam instrument by Cossor. A block diagram of this quite elaborate instrument is shown in Fig. 6. Using a 93D tube or an alternative 93L long-persistence tube, it has a wide range of facilities, including 21 calibrated sweep speeds and a five times trace expansion wit a timebase covering ¼c/s to 200kc/s. Tw identical Y amplifiers operate from d.c. to 3Mc/ (30% down). A minimum deflection of 4cm i obtainable on the 3Mc/s point and the switche attenuator affords a sensitivity of as small a 0·5V/cm with a pre-amplifier in the Y1 channe which increases the sensitivity to 5mV/cm.

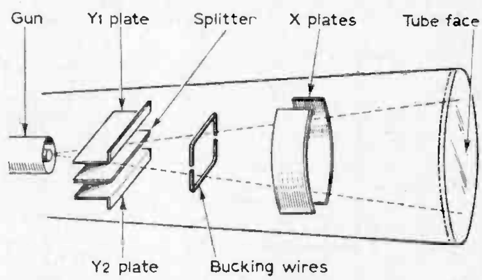



*Fig. 7: A "split-beam" c.r.t.*

This by no means covers the field but it doe illustrate the wide range of differences in instru ments and accents the need for a careful choic of the instrument most suitable for the job i hand.

### *The Double-beam 'Scope*

The most obvious facility of a double-bean oscilloscope is the comparison of traces. This ma be for the purpose of frequency comparison, o to check the input against the output trace whe testing an amplifier's response, for distortio checking, stage gain measurements, etc.

By applying the two signals to the vertical plate in such a way that the horizontal timebase i

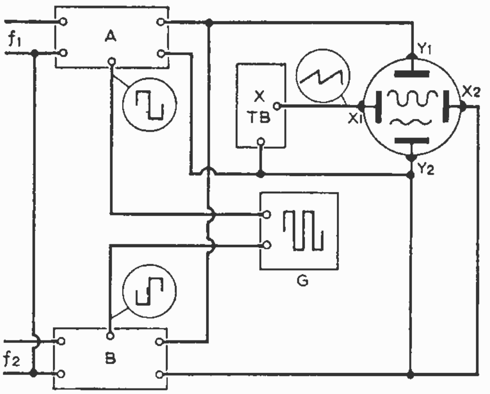



*Fig. 8: Beam-switching principle to obtain more than one trace on a single-beam tube.*

common to both inputs, but two traces are produced, and then varying the amplifier controls until the two traces are superimposed and identical, direct measurement of gain is possible by comparing the Y amplifier control settings.

One method of producing these two beams is to employ a cathode ray tube with a splitter plate between the Y plates, as illustrated in Fig. 7. The electron beam, travelling from the gun towards the screen, is split by this auxiliary plate with each divided portion controlled in the vertical sense by one of the Y plates. Both beams, however, pass within the field of the X plates and thus horizontal deflection is common.

There are refinements to this basic structure, such as the bucking wires shown in Fig. 7, which have the function of cancelling interference between the two beams by adjustment of their potentials. Anti-trapezium devices are fitted (Y-plate deflection will be asymmetric) and shift controls enable the deflecting fields of the two Y plates to be independent. But there is a practical limit to the variation.

An alternative method is the construction of a cathode ray tube with two separate electron guns and deflector systems. This is the double-beam method. It has its logical extension in some very expensive multiple-beam tubes used for special purposes, but which need not interest us here.

The method that does have a direct interest for us is the addition of an electronic switch to a single-beam instrument. By applying to the Y plates two vertical deflecting voltages alternately, at intervals that are short compared with the persistence of the screen phosphors, and using the persistence of vision to aid the illusion, two traces are apparently obtained, displaced by an amount determined by the shift voltages, but still controlled in the horizontal sense by the X timebase. These two traces are actually "dotted in" by the brief switching of the electron beam, but,

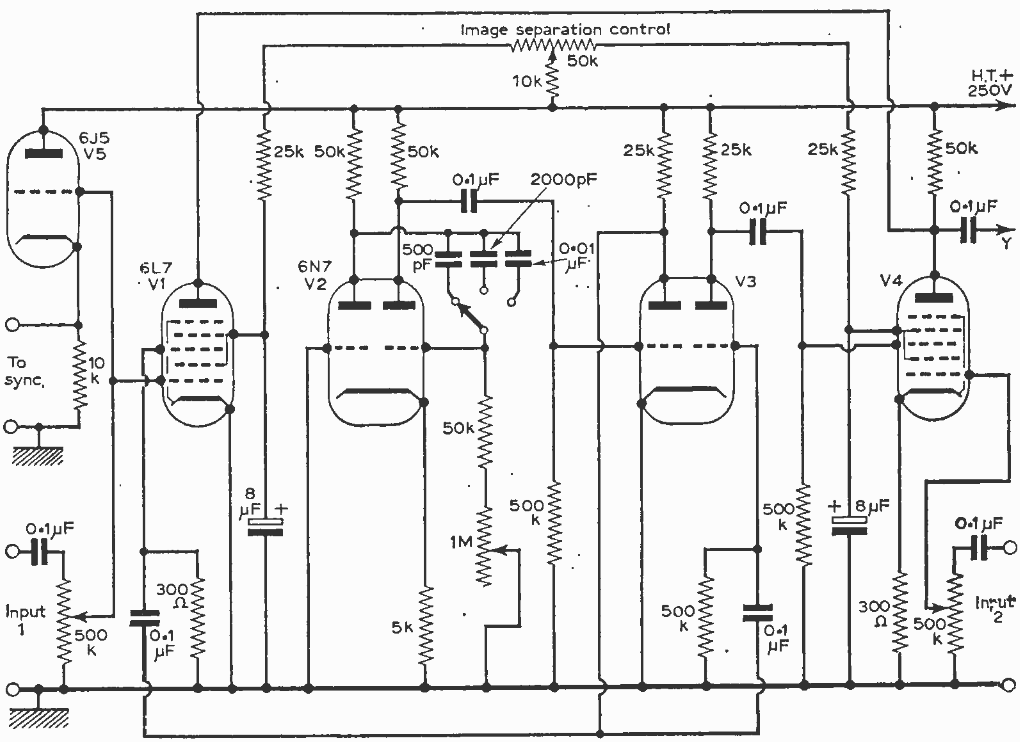



*Fig. 9: Circuit of a beam-switching unit (Haas and Hallows).*

because of the persistence of the phosphors and of vision, they appear as continuous lines.

Two Y amplifiers are required, with a multivibrator generating a square-wave voltage which is applied to the control electrodes of the two amplifiers in antiphase.

Fig. 8 shows the rudiments of this system. The square-wave generator G applies a pulse to each of the two amplifiers, A and B, while the two amplifiers receive separate signals, f1 and f2. The outputs of both amplifiers are connected to the Y plates, and because of the controlling action of the generator, trace their result in succession. To be more explicit, the Y1 signal goes through the A amplifier while the B amplifier is virtually "switched-off" and the Y2 signal grounded. Then the switch reverses, the Y2 signal is allowed to pass through the B amplifier and the Y1 signal is suppressed.

The switching frequency is important, and some method of varying it has to be made, without this variation causing the square-wave to be distorted. However, there are methods of switching which also allow the antiphase pulses to be unequal in length. This has the effect of feeding one amplifier to the plates for shorter working periods and thus the trace becomes dimmer. This can be an aid to direct comparison of individual traces.

At low switching frequencies, say below 100c/s, the trace tends to sparkle as persistence limits are approached—this varying, of course, with the tube being employed. At high frequencies, above 15,000c/s, for example, there is a tendency for the rapidly moving spot to make space between the two traces luminous. Again, the annoyance factor of this effect depends on the type of tube in use.

A little thought will show us that the best frequency must be half the applied sweep, so that the images are traced in turn, with no apparent interruption. In practice, this means that the operator has to make delicate adjustments of the sweep frequency. One pitfall to avoid is that of hitting on a multiple of the sweep frequency, which will give most peculiar broken traces that can be extremely misleading until one knows how to interpret them. This is done deliberately for some frequency comparison tests.

In a well-known commercial version, the Heathkit Model S-3U, the switching rates are in steps of 150, 500, 5,000 and 15,000c/s. A very useful though inexpensive instrument, this Electronic Switch has an amplifier response from d.c. to 100kc/s ±1dB, separate gain and sync controls and an input range from 0·1 to 1·8V, r.m.s.

Image separation can be obtained by varying the above currents of the two amplifiers. In the circuit of Fig. 9 (from *The Oscilloscope at work*, by Haas and Hallows, published by Iliffe and Sons), this is achieved by alteration of the screen grid voltages of the amplifier valves.

In this circuit, the multivibrator is V2, with V3 assisting in the shaping by "slicing" the crests. V1 and V4 are the amplifiers, with the switching pulses applied to their third grids from the two anodes of V3, and thus working in antiphase. Input signals are fed to the first grids. The switching frequency is variable in steps by switch S, which selects the coupling capacitor between the anode of V2A and grid of V2B. Continuous variation is made possible by the 1MΩ potentiometer.

With this type of circuit, it is recommended that signals be amplified to a suitable level before application to the switch unit inputs, because of the difficulty of amplifying a steep-fronted waveform correctly.

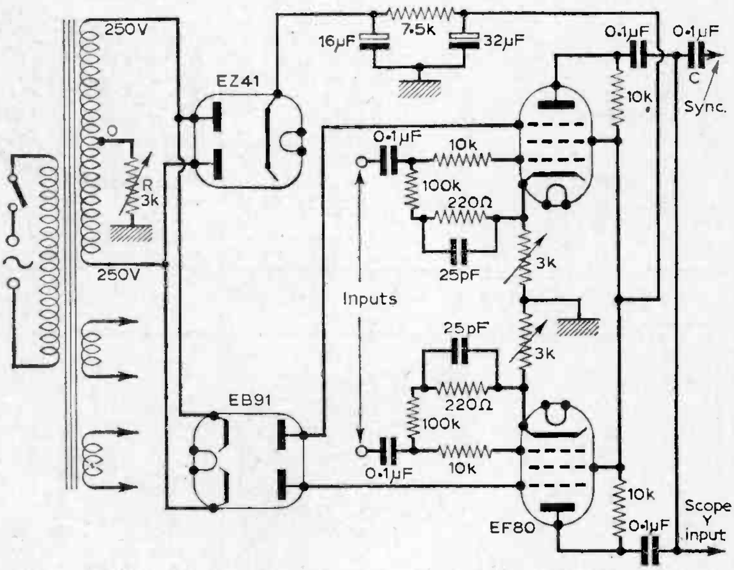



*Fig. 10: Beam-switching unit, employing mains pulses.*

A simplified version of this switching method is depicted in Fig. 10 (*Practical Radio Engineer*, March, 1955). Here, the two amplifier valves have inputs applied to their control grids, and a rectified mains signal provides a heavy negative pulse to each suppressor grid in turn, at 1/50th second intervals.

The X timebase of the single-beam scope (which in the experimental rig was a Cossor) is set to 100c/s. Amplifier gain is adjusted by controlling the negative feedback and the outputs are fed to a common point for take-off to the Y plate, or the Y input of the main instrument. Control of synchronisation is by the coupling C to the oscilloscope sync terminal and pulse rate control within the limits set by the design is effected by variation of the centre-tap potentiometer R.

**PART 8 APPEARS NEXT MONTH**

# *A transistorised* HEARING AID *amplifier*

*By V. H. PIDDINGTON*

A HEARING aid can be an expensive item, but a resourceful constructor is in a position to effect a considerable saving should a requirement for one arise either personally, or among relations and friends. The unit to be described is suitable for those who, while not appearing really deaf, find it difficult to make out speech or conversation. This kind of difficulty is usually caused by a lack of sensitivity to high tones above 1,000c/s, and this unit has been designed to have a falling response below this frequency. For more severe cases of general deafness, the frequency response could, of course, easily be extended downwards by using larger values of coupling capacitor. If there is any doubt, medical advice should be sought first. (This particular unit has also found use in listening for breakdown in high-voltage power supplies!)

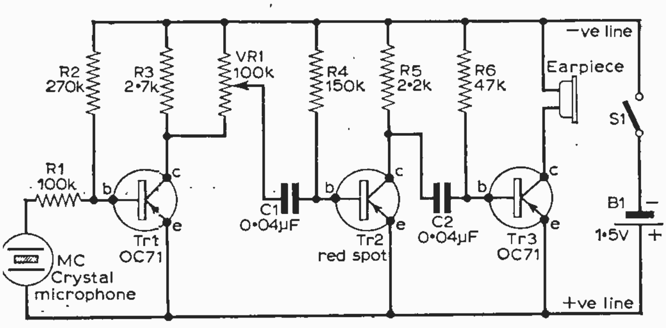



*Fig. 1: The circuit of the amplifier.*

### Circuit

As will be seen from Fig. 1, the amplifier is of the simplest possible design so that the number of components may be kept to a minimum. Three transistor stages are used, and it will be noted that each stage is biased by base current flowing in the resistor connected between base and negative supply.

One of the commonest ways of providing protection against change of transistor characteristics with temperature is to derive the base bias voltage from a potentiometer across the h.t. supply, and to include a bypassed resistor between emitter and positive line as shown in Fig. 2. In this circuit however, the supply is only $1\frac{1}{2}$V, and it hardly seems necessary to include stabilising precautions at a cost of three extra components per stage, bearing in mind that in this application small size is of primary importance. Some degree of stabilisation could be obtained by connecting the base resistors in Fig. 1 directly to collector, instead of h.t. negative, at the expense of some loss in gain. The method used was chosen to give the highest gain, and in practice appears to work reasonably well under conditions encountered in normal use. If the unit becomes very warm (such as when left in the sun), there is some loss of gain, but it is not serious.

### Collector Current

It will be noticed that a red-spot surplus transistor is used for the second stage, while OC71's are used for the other two. This was due solely to availability at the time of building and surplus types could be used throughout. An OC70 would be the best choice of readily available transistors for the input stage on the score of noise, but an OC71 is correct for the output stage.

It is important in transistor amplifiers with low supply voltages to keep the collector current down to somewhere near the minimum necessary for reliable small-signal amplification, which is about 0·25mA for most low power audio transistors normally available. The collector current of the first stage is set to this value, while the second stage is biased a little higher at about 0·3mA to ensure that sufficient output current is available to drive the output stage. If the collector currents on these two stages were not kept low, the voltage dropped across the collector resistor would be so large as to have in-

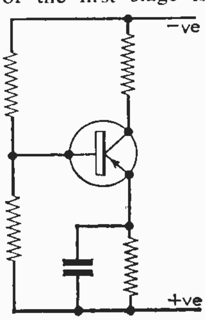



*Fig. 2: Base bias voltage derived from potentiometer.*

sufficient collector-emitter voltage for proper operation of the transistor. It will probably be necessary to select the base bias resistors because leakage current will have a considerable effect on these low levels of collector currents, and readily available transistors are likely to have considerable variations in leakage current.

### Output Stage

The earpiece used is of 1,000Ω impedance and 250Ω d.c. resistance; it is popularly used for transistor pocket radios. With this earpiece, and a supply voltage of 1½, the collector current should be 1·5mA for maximum power output. With the figures quoted, the maximum power output that can be obtained with about 5% distortion is 0·5mW, which is quite sufficient for this application. If it should be desired to power the amplifier from a 3V battery, the output stage should be biased to 3·0mA. For most hearing aid applications, however, the 1·5V cell provides sufficient power, and lasts longer. Incidentally, when using a 3V supply, the collector current of the voltage amplifier stages should be set at the same values as with a 1·5V supply.

### Microphone

The microphone in this unit is a small, square crystal insert which can be obtained from retail suppliers of transistor components, and can be seen in the centre of Fig. 3.

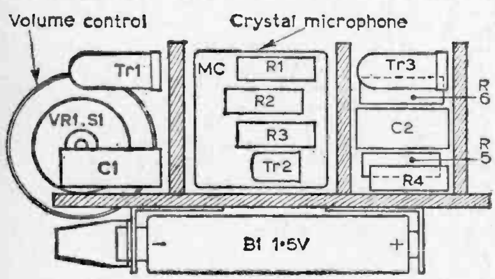



*Fig. 3: Showing the compact layout of components achieved with this design.*

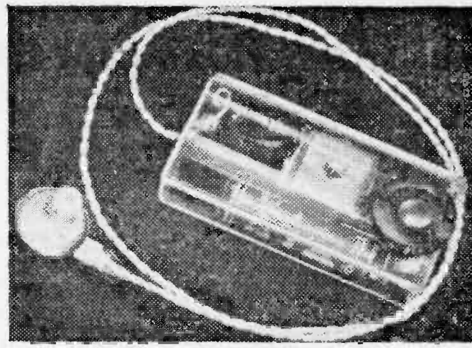
### Construction

The layout is perhaps a little unusual, but can be very useful to amateur constructors when it is desired to pack a number of components into a small volume. Fig. 3 is an underside view of the unit out of its case, and as will be seen the components are supported between small phenolic boards, the lead wires being threaded into small holes drilled in these boards.

The battery bracket is made from a length of tag strip, with all the tags removed. The two end feet have had the tag part cropped off, and are mounted lengthwise along the strip, forming the battery clips. One pole of the on/off switch (on the volume control) is soldered to a bent tag which is in turn screwed to the negative battery clip.

Transistor Tr1 and C1 are in the first compartment; Tr2, R1, R2 and R3 are in the middle under the microphone unit, and Tr3, C2, R4, R5 and R6 are in the last compartment.

Component wires are used for whatever linking is necessary on the support boards. Where it is unavoidable that transistors come close to the boards, the lead wires are taken through the board and looped back through another hole so as to leave some wire available for the application of a thermal shunt (such as pliers) when soldering. The photograph shows the complete unit in its case, which being clear plastic, gives a good view of the "works". The inside should be painted and would give a very pleasant effect. This case has a sliding lid, which has a hole in the end to allow the volume control knob to project outside the case.



*The finished amplifier.*

### Performance

The unit described has a gain of 66dB at a temperature of 25°C, and a maximum power output of 0·5mW. The frequency response of the amplifier is flat above 1,000c/s and falls 12dB per octave below 1,000c/s, but this could, of course, be modified by the use of larger value coupling capacitors. Lower working voltage units are available, physically smaller than the 250V capacitors used in this amplifier.

It should be borne in mind that the overall frequency response is affected by the microphone and earpiece. Earpieces in particular, tend to have a peak between 1,000c/s and 2,000c/s. ■

## CELESTE 7-Transistor Portable Radio

Referring to the blueprint enclosed in the June issue of PRACTICAL WIRELESS, the rod aerial shown in Fig. 1, Fig. 2 and Fig. 5 is Osmor type PW/FR1, plus QXL (external aerial coil)—whereas the Components List specifies Weyrad type RA2W. These two types of rod aerial are not directly interchangeable, and the connections for the RA2W are given below.

**M.W. Section:** BLUE—VC1, GREEN—C1, YELLOW—S1 ("M"), WHITE—Red on L.W. coil.

**L.W. Section:** YELLOW—Yellow on M.W. coil, RED—white on M.W. coil, BLACK—+ve line, WHITE—+ve line.

A 150pF mica or ceramic capacitor must be added between the two Yellow tags and +ve line when using the RA2W.

**Oscillator Coil:** If the specified oscillator coil is used (Weyrad P50/1AC) the following capacitor values should be used: C2, 150pF; C4, 220pF.

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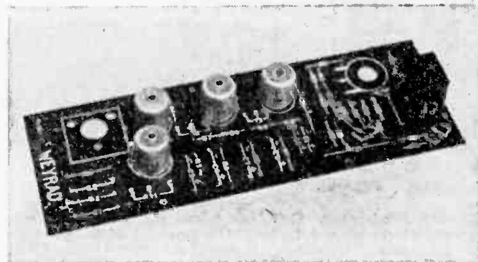


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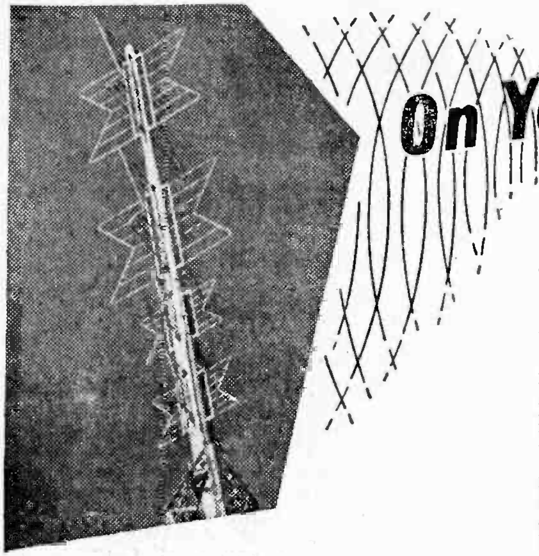

# On Your Wavelength

By THERMION

THE popular interest in stereo reproduction is evinced by the efforts of loudspeaker makers to achieve virtually the impossible—that is to produce a miniature hi-fi reproducer.

In the majority of homes there simply is not space for two free-standing loudspeaker enclosures of normal hi-fi proportions, which means a volume of some 5 to 10 cu. ft for each unit.

Considerable ingenuity has been used in designing two-speaker systems with cabinets measuring 20in. x 11in. x 7in. typically, suitable for standing on a bookcase or shelf, for mounting directly on the wall or even for standing on the floor; completely versatile as you see.

The snag with miniature cabinets lies in the fact that as the volume of a total enclosure is reduced, the resonant frequency of the system is raised, and with the instruments being discussed, this may be in the region of 80—100c/s.

One artifice employed to lower the enclosure impedance and thus the bass resonance is described by the makers as an "acoustic pump". This is actually a drive unit similar to the bass loudspeaker but with a modified cone. The pump is mounted on a panel which divides the interior of the cabinet into two compartments, and the speech coil is connected so that both cones move in phase. Consequently the volume of the main enclosure as "seen by the bass unit remains practically constant and this helps to lower the bass resonance.

The performance of those miniature systems that I have had an opportunity of listening to has been generally satisfactory. The tone range seems well balanced, due no doubt to some restriction of the upper frequency response to compensate for deficiencies at the other end of the scale.

This somewhat curtailed frequency range is hardly likely to give concern, except to those who have become accustomed to the extensive audio range obtained from a full-size hi-fi reproducer.

### *Three Dimensional Sound*

The barometer seems set fair for the loudspeaker trade.

Having recently purchased a second loudspeaker for stereo, it now seems that before long we shall require a third in order to add reverberation to mono or stereo—the total effect being Three Dimensional Sound, you lucky people!

Seriously, I was favourably impressed by a recent demonstration where part of the signal feeding the two normal loudspeakers was fed via a delay unit to a third loudspeaker located at the back of the room.

When, after listening to the two channels for a time, the third unit was brought into operation the effect was quite remarkable. As the music swelled around, the artificial reverberation added tremendous liveliness and it was not hard to imagine that one had been transported into a large auditorium. I must confess that immediately after this experience the normal two channel stereo seemed flat.

So now you know what is in store for you next!

### *Power from the Air*

A receiver powered from a radiated carrier wave is an intriguing prospect that will appeal to the canny no less than to the enquiring technical mind. I am informed that such a device has been tried out on the Continent with moderate success, and the licensing authority concerned has not been able to discover any grounds for declaring this an illegal operation.

The "free running" receiver in fact incorporates two receiving circuits. One is quite simple and employs a diode detector and is tuned to a high power local broadcast station. The d.c. developed across the diode load is fed into the second receiving circuit where it is used to energise transistors. This second circuit is, of course, much more sensitive and can be tuned to distant stations.

It does seem that the advantage of independence from batteries or mains supply is somewhat nullified by the need for a fairly large aerial—unless one happens to be residing under the shadow of a BBC transmitter. Still, it is an idea for experimental work.

There might even be some useful application for a parasitic receiver: think of that short-wave enthusiast living in the isolated countryside, no mains supply and batteries exhausted (last Winter for example) isolated yes—except for that solitary broadcast transmitting station over on yonder hill . . . afraid, though, there wouldn't be any DX hunting between midnight and 6.30 a.m.

# THE MALVERN TAPE RECORDER

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CONTINUED FROM PAGE 349 OF THE AUGUST ISSUE

By T. Snowball

An alternative method of construction is possible using the pre-drilled paxolin sheets called "Veroboard".

These sheets are in various sizes and are $\frac{1}{16}$in. thick. They are drilled with small holes approximately 0·04in. in diameter, spaced at 0·2 or 0·1in. Small silver plated ribbed pins are inserted into these holes wherever a component needs to be anchored. This makes an admirable form of construction, easy to do, and has the advantage that the components can be laid out exactly as the circuit is drawn.

The output transistors should use the chassis as a heat sink and therefore need the mica washers for insulation. The layout is non-critical but short leads are helpful in maintaining stability. Screened leads to the volume control and record/playback switch for the boost inductor are advised. This switch is a two-wafer, miniature Yaxley type, mounted on the tapedeck.

As supplied it is a single-wafer, 4-pole 2-way, but as a 6-pole 2-way is needed, the easiest way is to add another similar wafer, with screen between. The original spindle is long enough to drive two wafers, and other odd items needed are two longer screws and washers or packing pieces to space the wafers.

The working voltage for all the capacitors as given in the components list is the minimum suitable, so of course higher voltage ones are suitable. Likewise the resistors are all ¼W carbon, with the exeception of the higher stability ones in the preamplifier. These are preferred here because normal carbon resistors may be noisy when used in the early stages of a high-gain amplifier, also close tolerances are needed in order to obtain the correct voltages in this circuit.

### Power Unit

The power unit chassis shown in Fig. 9 incorporates a 13V 0.3A heater transformer, such as the type normally supplied as replacement for TV sets, where the c.r.t. heater to cathode shorts or gives low emmision. These transformers normally have a boost winding on them giving about 15V r.m.s.

In the recorder the 13V tap should be suitable but a check of voltages as in Table 1 on load will soon show the correct tap to use. The h.t. rectifiers are silicon junction diodes types RS20A, SX641, ZS30B. Alternatively, germanium diodes type GEX541 or GJ3M will do. As it is a bridge circuit

**TABLE 1**

| Typical Voltages | Record | Playback |
|---|---|---|
| Reservoir Capacitor, C22 | 11V | 17V |
| Output Stage H.T., C23 | 10·5V | 16·5V |
| Erase Stage H.T., C21 | 10V | 17V |
| Boost Stage H.T., C9 | 9V | 11V |
| Pre-Amp. Stage H.T., C2 | 9·5V | 14V |
| **Total Current** Depends on Volume | 300–500mA | 12mA–300mA |

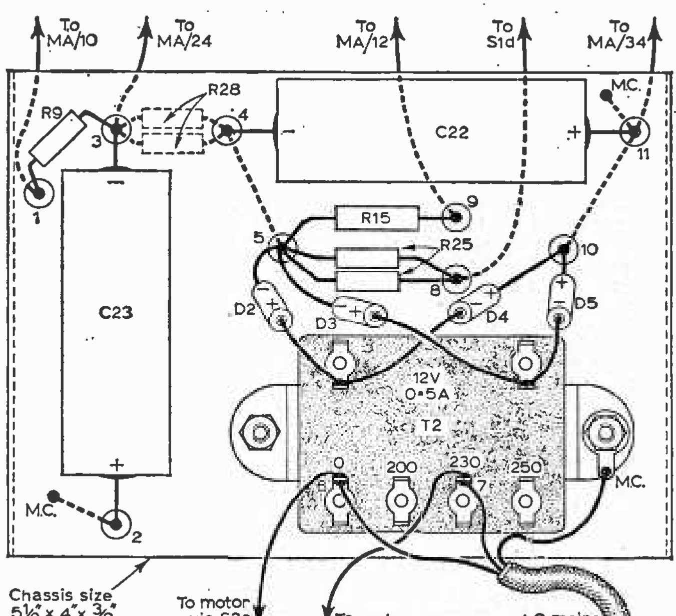


Fig. 9: The layout and wiring of the suggested power unit.

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| 3½ | 9500 | 50 | 10/6 |
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| 4 | 6000 | 3 | 8/- |

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| Diameter in inches | Gauss in lines | Imped. in ohms | Price |
|---|---|---|---|
| 5 | 6000 | 3 | 8/- |
| 5 | 6000 | 5 | 8/- |
| 5 | 7000 | 3 | 8/6 |
| 5 | 7000 | 5 | 8/6 |
| 5 | 7500 | 3 | 9/- |
| 5 | 8500 | 3 | 9/6 |
| 5 | 8500 | 5 | 9/6 |
| 5 | 9500 | 3 | 10/6 |
| 5 | 9500 | 5 | 10/6 |
| 5 | 10000 | 3 | 11/6 |

| Diameter in inches | Gauss in lines | Imped. in ohms | Price |
|---|---|---|---|
| 5 | 6000 | 25 | 10/6 |
| 5 | 9500 | 25 | 11/6 |
| 5 | 9500 | 35 | 11/6 |
| 5 | 10000 | 25 | 12/- |
| 6½ | 7000 | 3 | 11/- |
| 6½ | 7000 | 5 | 11/- |
| 6½ | 8500 | 3 | 11/6 |
| 8 | 7000 | 3 | 12/- |

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

| Elliptical Size | Gauss in lines | Imped. in ohms | Price |
|---|---|---|---|
| 6 × 4 | 8500 | 3 | 9/6 |
| 6 × 4 | 9500 | 3 | 10/- |
| 6 × 4 | 9500 | 5 | 10/- |
| 7 × 3½ | 9500 | 3 | 10/6 |
| 7 × 4 | 7000 | 3 | 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 |

| Elliptical Size | Gauss in lines | Imped. in ohms | Price |
|---|---|---|---|
| 7 × 4 | 9500 | 50 | 11/6 |
| 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/- |

| Elliptical Size | Gauss in lines | Imped. in ohms | Price |
|---|---|---|---|
| 8 × 2½ | 9500 | 5 | 10/- |
| 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 | 9500 | 3 | 10/- |
| 8 × 5 | 9500 | 15 | 13/6 |

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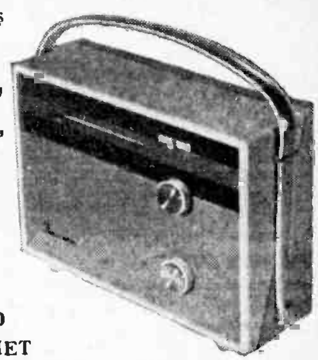

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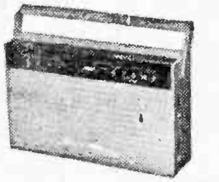

This superhet receiver uses the very latest circuitry, 6 transistors and two diodes and is fully tunable over both medium and long wavebands. First stages uses three Mullard AF.117 alloy diffused transistors with OA79 and OA91 diodes, output—OC81D and two OC81's in push-pull. I.F. frequency 470 Kc/s. Large internal ferrite rod aerial gives excellent reception over all ranges. 3 inch high flux speaker has a maximum output of 330mW. Operates on four 1.5 v. pen torch batteries. All components are mounted on a single printed circuit board. Attractive plastic case with carrying handle—fitted sockets for personal earpieces, tape recorder and car aerial. Size 6½ x 4 x 1½in.

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**P. & P. 4/- extra.** (Data and instructions 2/6, free if all parts bought.)

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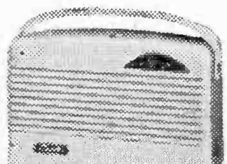

A fully transistorised Portable Receiver made to the highest professional standards—is now available to the home constructor. Comprises 7 Mullard Trans. OC44, 2 OC45's, OC71, OC81D, and 2 OC81's plus OA70 Crystal Diode. Delivers 350 milliwatt output to 4in. high flux speaker—I.F. frequency 470 Kc/s.—fully tunable over medium and long wavebands. All components mounted on single printed circuit board, size 5¼ x 5½in. Attractive two-tone plastic cabinet with carrying handle—size 7 x 10 x 3½in. with easy to read dial and socket for car aerial, choice of Red/Grey, Blue/Grey or all Grey. Complete with full instructions. **All parts sold separately.**

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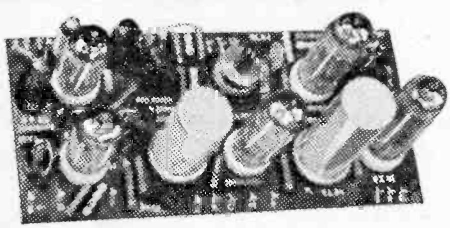

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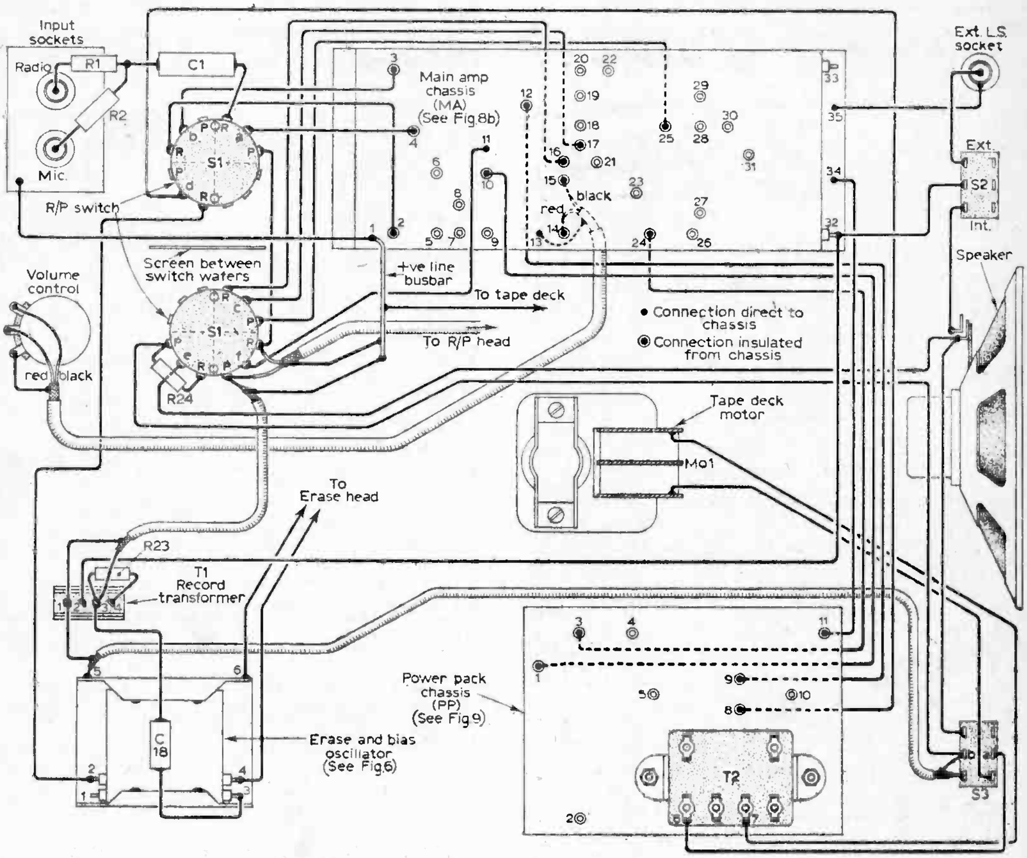



*Fig. 10: The main wiring diagram.*

the minimum requirement for each diode is 16V p.i.v. at 250mA.

Resistor - capacitor smoothing if used as a choke would be rather bulky. Only the two 1,000$\mu$F smoothing capacitors are mounted on the power unit chassis, along with the various smoothing resistors; the other 500$\mu$F capacitors are mounted on the record/play amplifier and on the erase chassis.

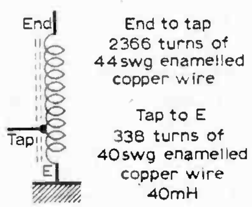
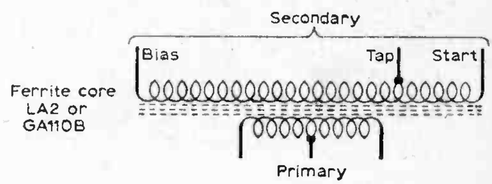



*Fig. 11: Winding details of T1.*




Primary or collector winding
6+6 turns of 28swg enamelled copper wire
bifilar wound 35µH

Secondary (start to tap)
19 turns of 30swg enamelled copper wire

Secondary (tap to bias)
300 turns of 36swg enamelled copper wire
resistance 10Ω

*Fig. 12: The erase oscillator transformer, T3.*

### *Other Wiring*

Finally the motor and loudspeaker switches and the input plugs are mounted directly on the cabinet and wired up after the various chassis have been fitted. All inter-unit wiring is shown in Fig. 10.

Initial testing may be made safer by the inclusion of a 1A fuse in the secondary of the mains transformer. Normally transistors can blow faster than a fuse, but the latter may just save the day.

*—continued on page 458*

# Home Inter-com Unit

By K. Herlock

OFTEN, constructors and handymen alike require some form of communication between house and garage or workshop. Such a form of communication can be made quite cheaply and quickly. There is no need for elaborate apparatus and as long as reliable voice inter-communication and a workable calling system is established, that is all that one requires.

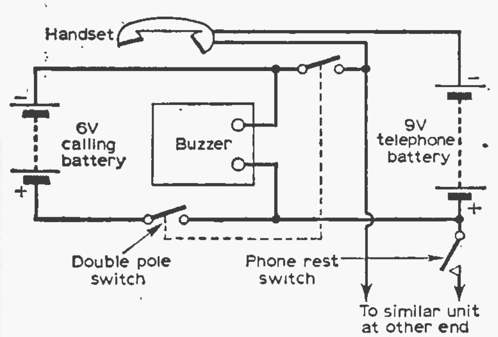



*Fig. 1: The circuit of the unit.*

The unit described here is very simple and, as can be seen from the circuit diagram (Fig. 1), uses only two connecting wires which need be only of thin bell-type flex. The ex-G.P.O. type handsets can be purchased quite cheaply from certain advertisers in this magazine and the 'phone rests can be constructed using three-ply wood.

Two batteries are employed; one for calling and one for the telephone apparatus. A double-pole switch is used, and this effectively isolates the buzzer and battery of the calling system from the telephone handsets. It can be seen from the circuit that this switch has one pole *before* the buzzer and one pole *after;* if both the poles of the switch were before the buzzer, when the telephone was in use the coil windings on the buzzer would short out the telephone.

### Making the Telephone Rest

The telephone rest can be made from a piece of thin aluminium with two small springs soldered on.

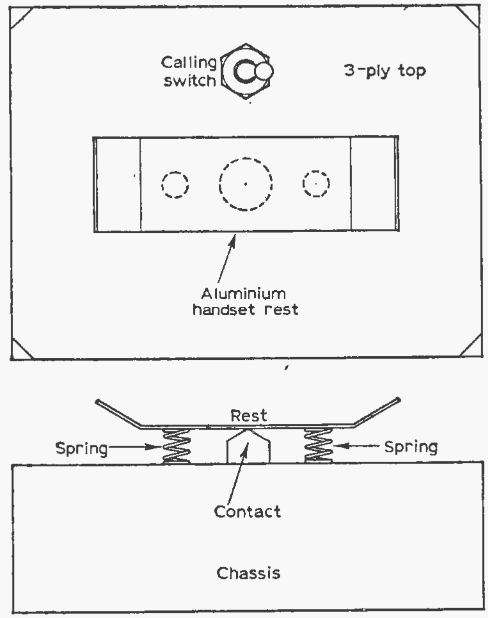



*Fig. 2: Construction details of the telephone rest.*

A piece of pointed brass or similar conductor is fitted to the wooden case so that it makes contact with the rest cradle when this is depressed. This is shown in Fig. 2. The wiring diagram of the unit is given in Fig. 3.

If required, a simple push-button switch could be used instead of the aluminium and brass contact switch. This type of switch would, in practice be much better than the device described here

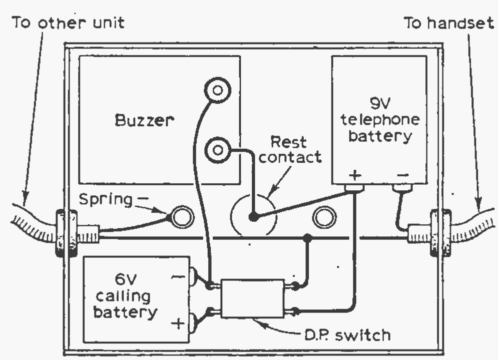
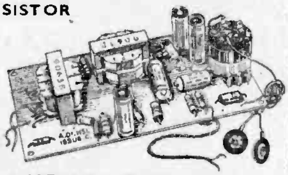



*Fig. 3: The wiring diagram.*

because this would cut the telephone out when it was lifted and so would have to be pushed and held with the hand. This may not be such a disadvantage as the 'phone would not be in use for very long at one time. But this is a matter for the individual constructor.

The whole unit may be made very compact and the connecting wires can be either laid under the ground or above. ■

## HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TAI



● 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.

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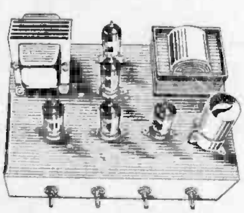

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also 15 ohm 12 inch., 30/-

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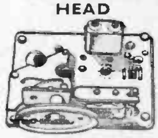

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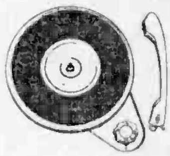
FURTHER HUGE PURCHASE enables us to offer these at **67/6** P. & P. 4/6.



Heavy 8¼in. metal turntable. Low flutter performance 200/250V shaded motor with tap at 45 V for amplifier valve filament if required. Turnover LP/78 head.

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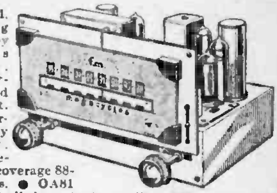

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# BOOKS REVIEWED

## RADIO AND LINE TRANSMISSION: VOLUME I

**By G. L. Danielson, M.Sc.(Tech)., B.Sc., A.M.I.E.E., and R. S. Walker, Grad.I.E.E., Grad.Brit.I.R.E.; published by Iliffe Books Limited.**

**252 pages, 200 diagrams, 5½ in. x 8¾ in. Price 21s.**

THIS is the first volume of a new series of textbooks specially prepared for students taking the Telecommunications Technicians' examination of the City and Guilds of London Institute. It covers the complete syllabus of Radio and Line Transmission A, one of the main subjects for the second year.

Both of the authors are actively engaged in teaching the subject and their intimate knowledge of the requirements of examinees has enabled them to write what appears to be an ideal textbook. The range of subjects covered* may indeed seem a formidable one for a book of some 250 pages—but the depth of treatment has been limited to the needs of the syllabus, to the undoubted benefit of the student. The text is largely descriptive and the lucid style makes it a pleasure to read. Mathematics have been kept to the bare essentials, and worked examples clearly indicate the use and manipulation of the equations. The text is well illustrated with line drawings. A series of questions at the end of each Chapter enables the student to test his assimilation of the foregoing text.

While unhesitatingly recommending this book to students preparing for the above examinations, one feels that it deserves an even wider readership: many others interested in radio communications, but having no inclination (or need, maybe) to discipline themselves to a course of study with a view to sitting for a specific examination, will find this a most readable textbook with no pages to be skipped.

*The contents include an introduction to sound waves and telephones, line and radio communications systems, description of components, circuit theory, modulation and detection, aerials and power supplies.—*F.E.B.*

## RADIO UPKEEP AND REPAIRS

**By A. T. Witts, A.M.I.E.E.; published by Pitman & Sons Ltd.**

**242 pages, 5 in. x 7½ in. Price 18s.**

PUBLICATION of the ninth edition of this well-known handbook is evidence of the demand which exists for information on the essentially practical aspect of radio; also of the considerable developments in receiver design and construction that have occurred in recent years. The text has been extensively rewritten to embrace all types of broadcast receivers in current use.

In his opening words, the author refers to radio servicing as an art. This is a perfectly apt term, for servicing involves the application of fundamental principles to the solving of practical problems. Those who have mastered the rudiments at least, of circuit theory and who wish to become accomplished practitioners in this art will find Mr. Witt's book an invaluable guide and store of information.

The first chapter is devoted to essential test equipment and how to use it, and commences with a detailed description of a simple home-made multirange test meter. Basic information concerning aerials and earthing arrangements is given in the second chapter.

The longest and possibly the most important chapter deals with general principles of testing: the importance of familiarising oneself with the layout of the chassis before commencing any tests; logical sequence of voltage and current measurements, and the interpretation of these readings; and advice on the servicing of printed circuits.

Resistance checks, and signal injection and signal tracing methods with the aid of a signal generator are explained in the following chapter.

Another chapter deals with the extremely important subject of receiver circuit alignment. Detailed procedures are given for a.m. and f.m. receivers with, as indeed throughout this book, attention to both transistor and valve circuits.

The remaining chapters deal with common faults and how to clear them, special problems associated with mains supply equipment, and gramophone pick-up and turntable decks.—*R.H.*

## ELECTRONICS POCKET BOOK

**Edited by J. P. Hawker and J. A. Reddihough; published by George Newnes Ltd., Southampton Street, Strand, London, W.C.2.**

**288 pages, 7½ in. x 5 in. Price 21s.**

ALTHOUGH electronics is becoming more and more specialised, the number of up-to-date and comprehensive text books on the subject remains relatively small. For this reason alone, this book will be welcomed by all those who intend studying the subject. However, with electrical and electronic engineering rapidly becoming divorced from one another, there will be many students of radio and television who will recognise the need to expand their knowledge to embrace electronics, and for them too, this volume will be of value.

Much of the preliminary text will already be familiar to anyone who has studied radio; however only such information as is relevant to the subject is included, so that the reader can grasp the fundamentals first. Later chapters cover all the accepted aspects of electronics that are likely to occur in the industry, and, in keeping with today's trend, semiconductor devices are well to the fore with text covering the thermionic valve taking a representative minor portion of the book. Most of the text provides information on the basic techniques and circuits of electronics, which includes computers and control equipment as well as amplifier, pulse and counting circuits. A chapter on the installation and maintenance gives practical information which will be especially useful to anyone about to enter the electronics industry. Candidates for the Electronic Servicing certificate of the Radio Trades Examination Board and the City and Guilds of London Institute will find in this book much up-to-date information not included in earlier works.—*P.R.R.*

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

# semiconductors

## TALKING POINTS ON CIRCUIT PRACTICE

### No. 8—Transistor Characteristic Curves

CONTINUED FROM PAGE 357 OF THE AUGUST ISSUE

IN transistor circuits there may be more components than just the resistor in an RC coupler effectively in parallel with the collector load, but before we go on let us consider just one more aspect. Let us suppose that in fact we *require* a 2V swing in our output. How may we get back to conditions where a 2V swing is possible *with* the RC coupling resistor?

First, if we can create conditions in which the two resistances in parallel total the necessary value to produce a 2V swing—in this case 1kΩ—we shall be all right. Raising both values to 2kΩ would achieve this if that be feasible.

Secondly, if we can move the Ic over twice the range . . . from 0mA to 4mA, then as the loadline in Fig. 1 shows we would get a 2V swing in volts across even a 500Ω load. This would entail doubling the amount of drive available on the base in the form of incoming signal, but worse than that it would—in the purely theoretical graph we have drawn—move the characteristic into the knee-volts area on the upward swing, resulting in non-linear transfer, which rules out that expedient even were the increased drive available.

Suppose we increase the value of our supply to 8V, thus moving the entire loadline over to the right, Fig. 2. The 1kΩ load to d.c. drops 2V, so the transistor is seated d.c.-wise at 6V with 2mA standing Ic for a quiescent base-bias of 40μA. Given sufficient drive on the base to swing the base bias current up to 80μA, the dynamic loadline with Ic swing up to 4mA (and down to 0mA on the opposite half of the wave) will move as shown by the solid line in the figure between A and B, driving into the 500Ω (to a.c. load) and the required voltage swing will be developed.

The d.c. loadline is superimposed in dotted line, so that we can see that the swing between A and B, which is what we obtain to a.c. over the load which at a.c. becomes 500Ω, could be obtained under d.c. (1kΩ) conditions by a swing between X and Y, requiring much less drive on the base.

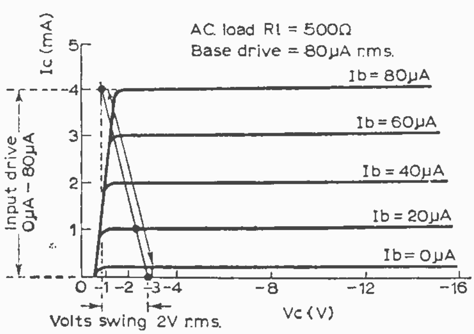



*Fig. 1: Increasing the base drive current causes distortion on the upward swing, due to the "knee" of the characteristic.*

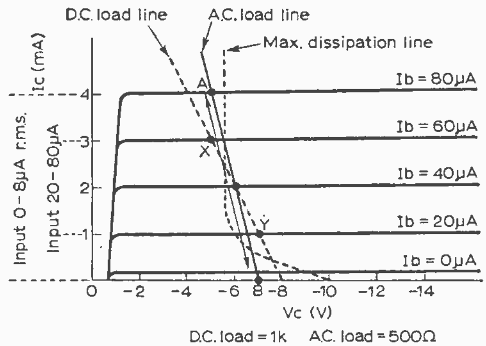



*Fig. 2: Supply raised to 8V resulting in movement of loadline to the right, away from the "knee".*

The method of increasing the supply voltage may not, however, be possible either.

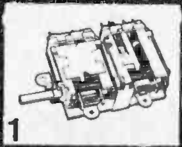
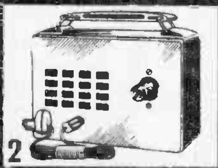
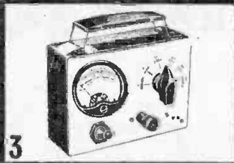
## MAXIMUM DISSIPATION

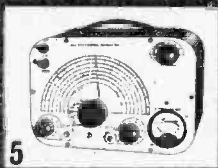
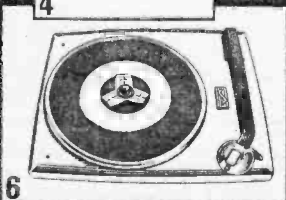
Another of the curves published for transistors is one which plots maximum dissipation against maximum collector volts.

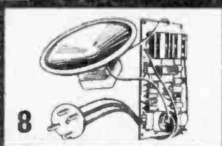
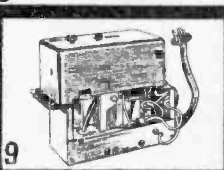
This is the value at which the avalanche effect commences for the particular transistor in question. We have shown it transferred to our Output Family of Curves, in Fig. 2, in the form of a dotted curve.

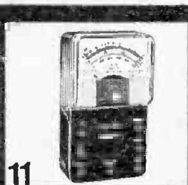
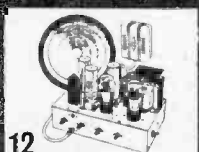
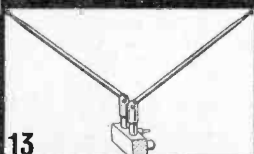
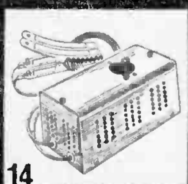
It is essential that the loadline shall not cut this maximum dissipation curve if the current is not to rise to fantastic values out of all relation to those we have planned for. As we have drawn it the loadline has been moved so far over to the right, by increasing the supply volts, that it does

# *Just a few of our* BARGAINS

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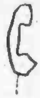

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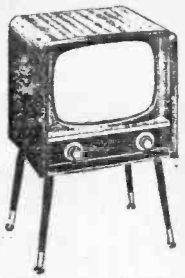

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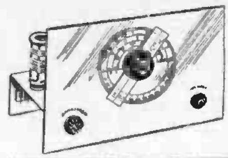

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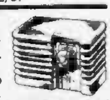

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cut this curve and, therefore, this loadline cannot be used in practice either.

It may be that the volts output swing we require cannot be obtained at all with this particular transistor, using a dynamic load as low as 500Ω, and that if the load cannot be increased a transistor with a higher maximum dissipation must be chosen. Or a loadline may be possible midway between the extremes we have illustrated.

Referring to Fig. 3, which is the same set of curves, working the transistor at Vc quiescent = 4·5V and Ic quiescent = 1·5mA, which can be achieved by making the d.c. load = 3kΩ, then the base can move up to approximately 55μA and down to 4μA without taking the loadline into the knee at one end or the avalanche curve at the other. The collector volts swing will be approximately from a little under 1mA to a little over 3mA, as we have drawn it, and the output voltage will swing from 1V approximately to V7, which is more than we required.

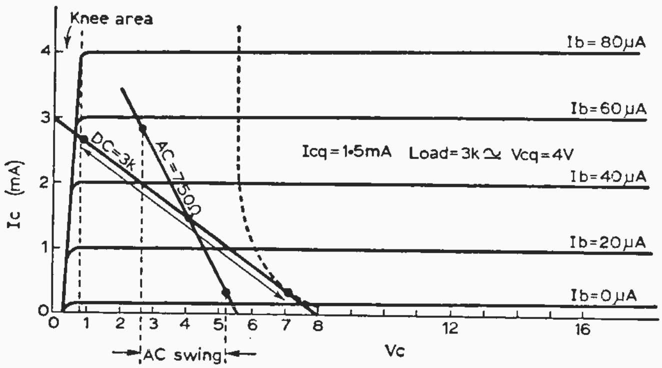



*Fig. 3: Illustrating the use of higher dynamic load to avoid the avalanche effect.*

With the load reduced to a.c. by a parallel resistor as before the 3kΩ becomes 750Ω (3kΩ and 1kΩ in parallel) and this a.c. loadline is shown dotted, the volts output swing reducing to between 3V and 5V, which still gives us the required swing.

All these curves and calculations and figures are purely imaginary for the purpose of explaining how the thing works. They have no counterpart in reality, but they should enable the basic principles of output characteristic curves and loadlines to be understood.

Now to take the other angle and translate what we have learned into practical politics. We have our output curves for whatever transistor we propose to use. We understand the principle of the loadline and we appreciate that the d.c. loadline may not necessarily be the a.c. (dynamic) loadline which will represent actual conditions under signal drive.

The use of output curves can fairly be likened to the process of evaluating I=E/R; in other words, knowing one factor, how do we obtain the others?

This is where the greatest difficulty seems to be experienced. What is it that we know? And what is it that we want to know? We may, for instance, know approximately what the value of our input signal will be—for instance, if it is to come from a pick-up or some similar device delivering a rated output which we shall feed into the first transistor of our apparatus. Our problem may be, therefore, to work out what value of load will be required in the collector in order to accept this input and what value of standing bias to put on the base.

Or we may know what output we require—for instance, in the case of a final stage in an audio amplifier which is required to drive a loudspeaker which needs a rated input to load it; in which case we have selected a transistor which will cope with the required output and we require to work out where to "sit" it, what load to use and what input drive will be required to give it full drive . . . from which it follows also, how many prior stages are going to be necessary in order to build up to that final drive required.

And furthermore, we must distinguish between voltage output and current output and know which we require, for the conditions will be entirely different.

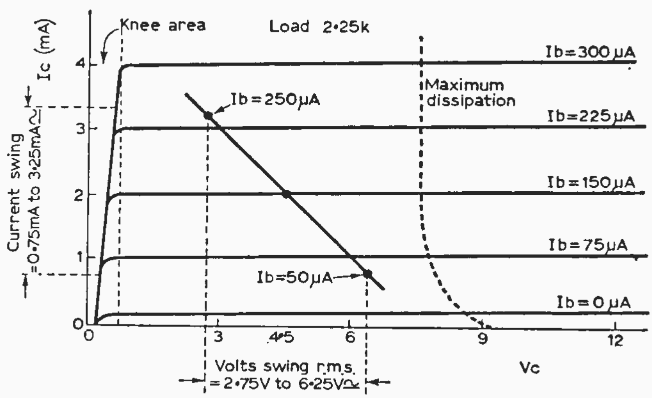



*Fig. 4: Typical output curves.*

## INPUT SIGNAL KNOWN

Taking these possibilities in turn, suppose then that we have a known value of signal which we are going to feed into our transistor, and suppose we know that this available drive is such that it will swing the base of the transistor over a 200μA range. (We will see later how we relate volts input to microamps input.)

If the base must swing $100\mu A$ above and $100\mu A$ below a mean it is obvious that the standing bias cannot be less than $100\mu A$—were it, say, $50\mu A$ the base could not swing 100 down, for it would cut out as soon as it had swung 50 down.

So we choose a value of $150\mu A$, or more, for our standing bias. The transistor will now handle the stated input. Presumably we know what our supply battery is going to be . . . let us say 9V. We shall select a value of collector load which will drop our transistor, d.c.-wise, to half supply voltage, as explained previously, for reasons of thermal stability.

Looking at our output curves, Fig. 4, we find that the value of Ic at base $150\mu A$ is 2mA. We require, therefore, a collector load which will reduce 9V to 4·5V at 2mA, which is 2·25kΩ. We can now draw the loadline. The voltage swing can be read off the horizontal axis (assuming the load to a.c. is the same as the load to d.c.—if not, a dynamic loadline will have to be drawn for the a.c. load value, whatever it may be) and the current swing read off from the vertical axis . . . or calculated, since it will be the input swing multiplied by the gain of the transistor.

It can be seen at once whether the loadline, or that part of it on which we shall be operating, remains within the straight portion of the curves or not—whether it cuts into the knee-voltage area or the avalanche area on the other side. Increasing the value of the load will make the slope of the loadline incline more to the left, decreasing it will make it more vertical.

It may be that a value of 2mA standing Ic is more than would be necessary to cope with the expected input if this is to be small; in which case, since there is no value in using more current than necessary, we would increase the load so as to "sit" the transistor, say, at 1mA standing Ic, with consequent saving in current. Conversely, it could occur if the expected signal were large that a standing Ic of 2mA was insufficient to allow the output to swing sufficiently . . . in which event we would choose a higher value for standing Ic (and consequently a larger value for standing base-bias), *reducing* the load to the value necessary to reduce 9V to 4·5V at the larger Ic.

## PREDETERMINED OUTPUT

On the other hand, if we were dealing with an unknown input but knew what our output was desired to be, then we would proceed differently.

Let the required output be 10V r.m.s.—that is, 5+ and 5− the mean ±. Here we must obviously have at least 10V collector maximum supply to start with and we must "seat" the transistor at a standing collector voltage of 5V, being the mean, to enable it to swing by 5V up and 5V down at *any* load. In practice, since we cannot use the odd few tenths of a volt below the knee-voltage, we would have to plan for more than 10V supply and a working point of more than 5V.

We might select, then, 12V for Vc and desire to work the transistor at a standing voltage of 6V. The load in the collector needed to reduce 12V to 6V will depend upon the mean quiescent Ic flowing, which we do not as yet know. But we do know that in order to provide a volts swing of 10V with a 12V supply the loadline will have to slope at 45° (a glance at the various figures will illustrate this).

There are several ways we can approach this. Suppose our transistor has a maximum Ic (rated) under working conditions of 100mA. If we connect the 100mA mark on the vertical scale to the 12V point on the horizontal scale by a straight line, Fig. 5, and plan to work the transistor on the halfway point as regards Ic, namely 50mA, then collector current will be free to swing down to 0mA and up to 100mA on signal. With 50mA as the quiescent Ic, the load to drop 12V to 6V at 50mA works out at 120Ω.

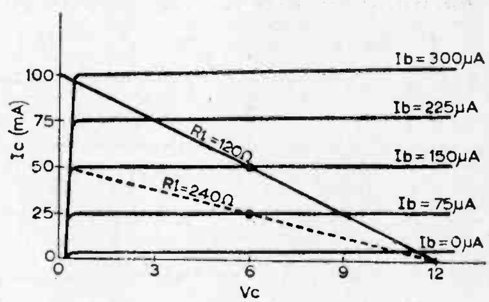



*Fig. 5: Establishing the load required to give a predetermined output.*

Our voltage swing will be more than the 10 we wanted without entering the knee area. And in order to obtain it a drive on the base will be needed which will move it from $0\mu A$ to $300\mu A$ over the mean quiescent bias of $150\mu A$, which corresponds to the 50mA output Ic quiescent selected.

It is true that we could obtain the same results with less drive if we slanted the loadline over to the left, but this would take it into the knee-voltage area if we went too far with that procedure as well as being non-linear.

Now in all these cases we have been assuming that we required a voltage swing in the output. For normal purposes, however, it is very rarely voltage swing that is required with transistors. As has been previously explained, the input impedance of the average transistor is so low that if much more than 1V is put on the base (with respect to emitter) the current flowing would be of a very high value indeed. With valves it is normal to use step-up transformers or other devices for inter-valve coupling because the maximum *voltage* gain possible is required to pass on to the following stage in the form of grid-drive. Values of 30V or more are not exceptional even in normal radio work.

Working with transistors the voltages we shall wish to pass on to the base of the following stage will be normally of the order only of millivolts. It follows from this that the voltage swing over the load in the previous collector is going to be far more than we want, and steps must be taken not to step it up but to step it *down* and, therefore, inter-stage transformers in transistor technique are step-down transformers, not step-up.

This has the important corollary that we do not need to worry about voltage amplification except

*Please see our advertisement on page 389*

in special cases. Consequently it is normal to regard a transistorised amplifier in quite a different light to that of a valve amplifier. In the valve amplifier one is conditioned to think in terms of getting the maximum "gain" out of each and every stage . . . multiplying all along the line until a sizable r.m.s. voltage signal is achieved at the final output. With transistors the mind requires angling to a different approach altogether. It is necessary to think not in terms of volts but in terms of *current*.

The extent of the output current a transistor will pass is stated by the makers. In the final output stage of an amplifier intended to drive a loudspeaker we require the maximum current swing on signal possible. We select perhaps a transistor capable of running at 500mA standing Ic, going up to 1A on peak signal, and in order to swing the collector current through the whole of that range we want a drive on the base large enough to do it. We must find that drive in terms of base current, since output current will be base current multiplied by the gain of the transistor. If the rated gain be given as 1,000, 1mA base current will give 1A collector current. If 100, then 10mA base current will give 1A output.

## THE INPUT CURVE

By reference to still another of the published curves we can find out what is needed in terms of volts to put so many microamperes through the base. This is the "Input-Curve" which directly relates input volts to input current and requires no explaining except that the volts given are those directly across base/emitter. If there is a potential divider on the base which places the base at some value above earth, and an emitter resistor which puts the emitter at another value above earth, then the voltage figures given in the Input-Curve relate to the actual difference between base and emitter which must be achieved.

One hundred mV, for instance, may give a base current of 150$\mu$A which, if the transistor gain is 100, will give $150 \times 100 = 15{,}000\mu A = 15mA$ in the collector.

The base volts needed in small signal transistors will be in millivolts and this will be obtainable even taking into consideration insertion losses from the previous collector without difficulty . . . as has been said, there will be more voltage swing than one can use. One thinks, therefore, in terms of output current and the necessary base-drive to give full collector swing, the collector load having no part to play other than work the transistor at the correct d.c. condition for thermal stability, unless in final stages where matching may become necessary, i.e. where power is required.

The gain of transistors being comparatively small compared to that of valves, where orders of 30,000 and upwards are easily obtainable across the high input impedance common to valves, a considerable number of stages is normally necessary to build up the infinitesimal signals appearing in the aerial system to a final value capable of giving full collector drive to an output stage. In early stages the small input signal multiplied by the gain of the transistor, say 50, will produce only a small current swing in the output and there is no point in running the transistor at a higher value of Ic than is needed to accommodate this. These small changes passed on to the next stage will, after insertion losses, be again amplified by 50 in the next transistor and again the collector current will be limited to a value sufficient to cope with them—so that the early stages may show a value of Icq of some 1mA, increasing in the third or fourth stage perhaps to 1·5mA. Only in the ultimate or penultimate stages will collector Icq reach really significant values when the signal has built up to a respectable value sufficient to cause a sizable swing in the outputs. In these stages the voltage swing may be more than we want and some means of reducing it must be used; a common method is shown in Fig. 6 where part of the load is bypassed to a.c. but the whole of it operates to set the d.c. working point.

Thus it will be seen that the first thing is to know precisely what we want from our transistor

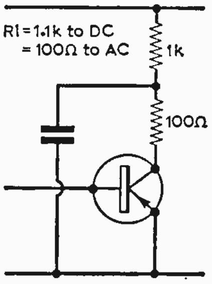



*Fig. 6: Decoupling capacitor used to limit signal output, but does not affect the d.c. operating conditions.*

stage. If it be a given output in terms of current swing then we can proceed simply by selecting a transistor which will handle the current specified. On the output characteristic we will join the value of the maximum milliamps we propose to use, on the vertical scale, to the figure representing the maximum collector volts available on the horizontal. Taking half supply volts we will draw a vertical line upwards, intersecting the loadline we have drawn, and so see what value of collector current will flow at this point; from this we can calculate the value of load required, at this value of current, to drop the supply volts to half supply.

The curves will also give us the value of standing base current, which will give us the mean standing Ic at this midpoint in the loadline, and we can then arrange to feed this value of bias current into the base by referring to the input characteristic which will give us the base bias in volts necessary to produce that base current in microamps. We can also read what value of base drive from the signal will be required, in microamps, to drive the collector current full swing, and this can be converted into millivolts by reference to the input characteristic.

Hence, with some idea of what the original available drive in millivolts is lively to be, one can work out how many stages will be necessary to produce a final drive of the value needed.

Or we can work the other way round and instead of siting the transistor at the midpoint of the output current swing we can site it at the midpoint of whatever may be the known input and select the standing base bias accordingly, which will give us the Ic at that bias. Once again we calculate the load needed to reduce battery volts to half supply volts at that value of Icq and draw the loadline accordingly, remembering always that the d.c. loadline is not necessarily the one over which the a.c. signal characteristic will be developed.

It will be found that in this manner the exact values can be calculated in order to set both the d.c. and the a.c. operation of the transistor at the correct working points, so that the transistor neither bottoms at one end of its drive nor cuts out at the other, while limiting the current to no more than is necessary to achieve this. At the same time the maximum dissipation can clearly be seen, so that there is no fear of exceeding the rated limits. The loadline can then be modified as one thinks fit by altering the load value or the standing bias. There is nothing arbitrary about it except that one must know either the expected input or the required output to have a starting point.

While normally the midpoint will be the quiescent condition it is perhaps unnecessary to mention that in the case of a Class B amplifier the quiescent working point will be somewhere in the region of 0mA Icq and therefore maximum Vc, since the output current will move only one way on signal—upwards. And also, in the case of a transistor fed from a diode, the input signal will be one-way going, so that the working point in that case also will be chosen accordingly.

A point worth noting is that in the case of a valve, where the anode current varies if the anode voltage is varied, it is necessary to work out quite a complicated loadline. For instance, if the output curves show that with anode volts=200 at grid bias, say, −10V, the anode current will be 100mA, and at grid bias −8V anode current will 150mA, we cannot draw a true loadline on that basis. This is because when we reduce the grid bias from 10V to 8V, as the anode current increases so the anode volts decrease (by virtue of the increased voltage dropped in the load at the higher current), so that we no longer have 200V on the anode but some lesser figure, which means that at grid volts −8V the anode current will not be the 150mA shown in the curves but some lesser figure corresponding to the reduced anode volts.

As a transistor maintains substantially the same collector current within its range of operation at all varying values of collector voltage we do not get this phenomenon and therefore the theoretical loadline is effectively the actual one—it is not necessary to compensate for collector current changing as collector volts change by virtue of changes over the load.

This is not to say that there are not finer points to be considered in relation to variable gain at small or large signal currents, temperature effects—especially as they effect leakage current—but these are beyond the scope of an article intended only to make the basic principles understandable, and in any case they are unlikely to enter into practical consideration where the ordinary amateur is concerned, as these devices are not by any means as critical as all that.

The basic thing to remember is that you have only a handful of volts to play with but the current may be considerable . . . and when you have only some 9V available to start with, a load of any sizable value in the collector is capable of dropping all those 9V if the current rises to any significant sum and so leaving you with nothing to operate the transistor. Just as, if the current decreases to any considerable extent, it may leave you with less than the range required. Therefore it is essential to work a transistor *at the correct operating point on its output characteristic* and to *restrict the input to a value which will not overload it*, a task which should present no difficulties if a loadline is drawn first.

The margins of error, of course, are less than those with valves, but this again is largely due to the fact that owing to the small supply volts it is necessary to work with small voltage swings, which means with small output loads through which, however, considerable current swings must be able to take place—the loads being sufficiently small to enable these current changes to take place without greater voltage swings taking place at the same time than the available voltage of the supply can give.

If you only have 9V to start with, then a load of 9kΩ would leave you with no volts at all on your transistor as soon as the collector current rose as high as 1mA. Realising that you may be working with a standing collector current of as much as 500mA, rising to a full ampere on peak signal in some cases, it becomes obvious that to make this possible the collector load would have to be measured in ohms, not in kilohms. Which, of course, is why output transformers for transistors must possess negligible d.c. resistance.

Recognition of these factors will show at once why transistor technique differs from valve technique—and will show why, also, it is better to think of transistors in terms of current than in terms of volts.

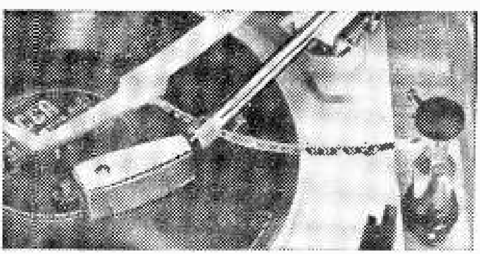
It may be true that it is voltage—however small it may be—which produces current, as it is, of course, true that base bias in microamps must be caused by base bias in potential. We do have to put so many millivolts on the base in order to feed so many microamps into it, but we can far better think in terms of microamps than millivolts, if only because the microamps, multiplied by the gain of the transistor, will give us the milliamps we may expect in the output. ■

# Trade News

### *Pick-up Arm Control*

AUDIO enthusiasts will be interested in a new device made by Auriol Limited which can be added to practically any record deck incorporating manually-operated pick-up arms. Known as the Auriol "pick-up control", it pneumatically lowers the stylus on to the record at any position. The control arm is fitted above or below the pick-up arm depending on whether the record deck is a single or autochange model, the raising or lowering action of the control arm being transferred to the pick-up arm through a special clip. The control arm is accurately calibrated so that the stylus may be raised or lowered in any desired position without the danger of damage to the moving record.

The arm is easily fitted and is available in two models, at £3 11s. 6d. and £4 4s. and the makers are *Auriol (Guildford) Limited, Trading Estate, Farnham, Surrey.*



*The Auriol "pick-up control" can be seen here in place on an autochange record deck.*

### *Diecast Instrument Box*

ANY piece of home-constructed equipment (especially a test instrument) will prove more serviceable if it is assembled in a robust metal case. For some considerable time, Eddystone diecast boxes have provided the amateur constructor with just such cases and now yet another pattern is available.

This new box (catalogue No. 903) is similar in design to a previous model except that an extra 1in. has been added to its depth, making its dimensions 7½in. x 4½in. x 3in.

Aluminium alloy is the metal used for this box, which incorporates a close-fitting lid, held to the body of the box by six 4B.A. screws.

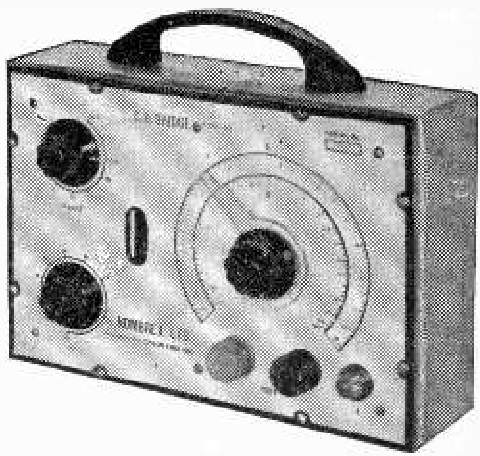
The makers of Eddystone diecast boxes are *Stratton and Co. Ltd., Eddystone Works, Alvechurch Road, Birmingham 31.*

### *Transistorised C.R. Bridge*

THE latest instrument from the manufacturing firm of Nombrex Limited is the transistorised C.R. bridge, model 62. This instrument employs six ranges covering resistance from 1Ω to 100MΩ and capacitance from 1pF to 100μF.

The model 62 uses a standard 9V battery and its total consumption is approximately 25mA. Printed circuit technique is used in the construction of the unit and the housing is of mild steel finished in silver-grey enamel.

The price of the model 62 C.R. bridge is £7 and the makers are *Nombrex Limited, Estuary House, Camperdown Terrace, Exmouth, Devon.*



*The Nombrex model 62 C.R. bridge.*

### *Rectifier Kit*

TO cater specifically for the needs of the radio experimenter, the firm of Electro Automat Limited has introduced a kit containing everything necessary for the construction of experimental rectifier stacks. The kit will prove of interest to many amateur enthusiasts who still enjoy making their own components wherever this proves feasible.

Each kit contains three sizes of rectifier plates, contacts, washers, insulating tube, mounting spindles, etc. The standard kit costs 7 guineas and is made by *Electro Automat Limited, Swinton, Manchester.*

**Continued on next page**

# THE MALVERN TAPE RECORDER

CONTINUED FROM PAGE 441

### *Winding details*

For those who wish to undertake the winding of T1 and T3 rather than to purchase ready made components, all essential information is supplied in Figs. 11 and 12.

The winding details for the treble boost coil L1 have already appeared in the Components List.

### *Recording head impedance*

The formula for indicator impedance is $XL=2\pi fL$ and not as stated on page 216 (July issue). Values for XL given in the same paragraph have however been derived using the correct formula; but they have been 'rounded off' for convenience. (The exact calculated values are 125Ω, 1·25kΩ and 12·5kΩ respectively.)

The important point being illustrated is the fact that the 100kΩ feeding resistor R23 swamps out the value of the recording head inductance irrespective of its changing value (100Ω to 10kΩ approx.) with frequency.

It will be clear that the difference in recording current when using the "rounded off" values as opposed to the exact values is therefore negligible. ■

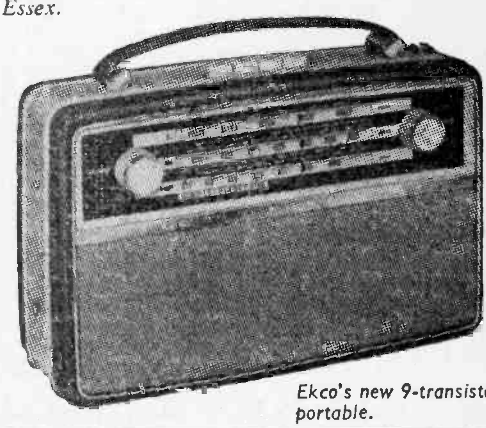
# TRADE NEWS

(Continued from previous page)

### *Nine-transistor Portable*

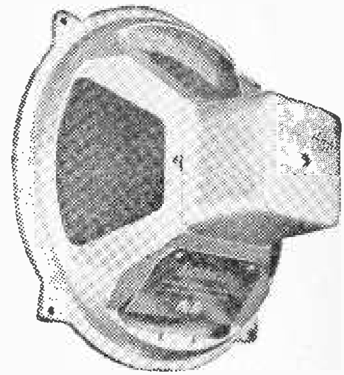
AMONG the latest range of Ekco receivers is the "New Verity" model PT424, nine-transistor portable. Push-button switching is employed to bring in either the medium, long or v.h.f. waveband. The circuit features a transformerless output stage and a telescopic v.h.f. aerial adds to the set's performance.

The PT424 costs 22 guineas and is made by *Ekco Radio and Television Limited, Southend-on-Sea, Essex.*



*Ekco's new 9-transistor portable.*

# WB Stentorian



## NEW MODEL H. F. 1016 'MAJOR'

**This new unit makes use of the high flux density available in the magnet system of the previous H.F.1016 unit. A curved diaphragm is used with a rigid centre section coupled to the voice coil. The rigid coupling and the design of the cone termination give a balanced response over the whole audio range. The unit is specially suitable for use in the smaller type of enclosure having a volume of approximately 1½ cubic feet.**

| Type | Flux Density | Price | Type | Flux Density | Price |
|---|---|---|---|---|---|
| 8″ H.F.816* | 16,000 gauss | £6.0.0 | T.816 | 16,000 gauss | £5.13.6 |
| 8″ H.F.812* | 12,000 gauss | £3.12.9 | T.12 tweeter | 16,000 gauss | £13.4.6 |
| 8″ H.F.810 | 10,000 gauss | £2.14.3 | T.10 tweeter | 14,000 gauss | £4.8.3 |
| 6″ H.F.610 | 10,000 gauss | £2.5.0 Steel £2.6.9 diecast | T.359 tweeter | 9,000 gauss | £1.10.6 |

** These 2 speakers incorporate a universal impedance speech coil.*

*Specification:*
Chassis—die cast aluminium
Cone—graded pulp cambric surround; Cone dia.—10 ins.; Pole dia.—1 in.; Flux density—16,000 gauss; Total flux—64,000 maxwells; Impedance—15 ohms.

**Price: £8.19.6 (inc. tax)**

**WHITELEY ELECTRICAL RADIO CO. LTD. MANSFIELD, NOTTS.**
Telephone: MANSFIELD 1762-5 London Office: 109 Kingsway, London, W.C.2
WA3

## TEST METERS

**20,000 OHMS PER VOLT MODEL TP-5S** (illustrated). Reads voltages 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 500 mA; Resistance to 10 Megs. Capacitance to 0.1μF; Decibels from —20 to +36. Size 3¼ x 5¼ x 1⅞in. **£5.19.6.**

**2000 OHMS PER VOLT MODEL TP-10.** Reads A.C. and D.C. volts up to 1,000; D.C. current to 500 mA; Resistance to 1 Meg.; Capacitance to 1μF; Decibels from —20 to +36; Output jack for Audio measurements. Size 3½ x 5 x 1½in. **£3.19.6.**

**30,000 OHMS PER VOLT MODEL 500.** Reads voltages up to 1,000 D.C. at 30,000 ohms per volt, and A.C. at 15,000 o.p.v.; D.C. current to 12 amps.; Resistance to 60 Megs: Decibels from —20 to +56. Sizes $3\frac{5}{16}$ x $6\frac{5}{16}$ x 2¾in. **£8.19.6.**

**LAVOIE UHF WAVEMETER MODEL 105.** Coverage 375/725 Mc/s. Complete with correct Calibration Chart. First-class condition. Battery operated and portable, size 11 x 8 x 7½in. ONLY **£3.19.6** (carriage 7/6).

**COSSOR TYPE 1035 DOUBLE BEAM OSCILLOSCOPES.** A few only of these modern scopes, overhauled and in perfect order ONLY **£45.** Further details on request.

**HRO SENIOR TABLE MODEL RECEIVERS.** Complete with 9 coils sets covering 50 Kc/s to 30 Mc/s. Used, very good condition, aerial tested. A few late Model 5T with I.O. valves, **£22.10.0** (carriage 30/-).

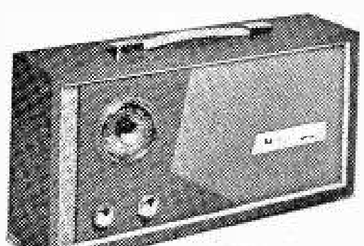
**AMERICAN DESK TELEPHONE,** complete with handset. Non-dial type, but has internal bell. Ideal for extension or inter-com. BRAND NEW. ONLY **30/-.** (Post 4/-.)

**DOUBLE BEAM OSCILLOSCOPE TUBES.** Another purchase of Type CV 1596, equivalent to Cossor 09D as used in Oscilloscopes by Cossor (339 series) and Hartley & Erskine (13 series). Listed £12. Brand new in maker's crates, **25/-** (carr.5/-)

**ACOS 39/1 STICK MIKE** with screened lead and table stand. ONLY **32/6** (Post 1/6.)

**CRYSTAL DESK MIKE** with screened lead and built-in stand. ONLY **15/-.** (Post 1/6).

## P.W. "CELESTE 7" RECEIVER



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**TOTAL BUILDING COST £9.19.6**

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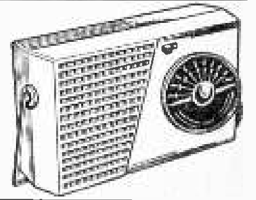

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# CLUB NEWS

**BRADFORD RADIO SOCIETY**
**Hon. Sec.: E. G. Barker, G3OTO, 63 Woodcot Avenue, Baildon, Shipley, Yorkshire.**
At the Society's first meeting for July, held on the 9th, members heard a lecture given by D. Millard (G3OGV) on "Tape Recorder Amplifiers". Later in the month, on the 23rd, a party of members visited a firm in Oldham.

**COVENTRY AMATEUR RADIO SOCIETY**
**Hon. Sec.: A. J. Wilkes, G3PQQ, 141 Overslade Crescent, Coundon, Coventry, Warwickshire.**
The meeting of 8th July was the third in a series of "constructional evenings" to which members could come and use the facilities of the club specifically for the purpose of building 2m converters on the design by member G3NBQ.
For the following two weeks the Society held no meetings but 29th July was "Mobile Night on the Air".

**DERBY AND DISTRICT AMATEUR RADIO SOCIETY**
**Hon. Sec.: F. C. WARD, G2CVV, 5 Uplands Avenue, Littleover, Derby.**
The second "Two Metre" contest was held on 6th and 7th July, and the latest d.f. practice run took place on the 24th. The meeting for 17th July was an open evening.

**NORTHERN HEIGHTS AMATEUR RADIO SOCIETY**
**Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.**
A committee meeting was held on 17th July, but for other members the evening took the form of a ragchew. For the last meeting of July, G8CB organised a treasure hunt.
August began with members arranging a demonstration station at the Warley Club and Institute Charity Gala. This was on 3rd August and was the first of three such stations the Society will arrange during the month.

**READING AMATEUR RADIO CLUB**
**Hon. Sec.: R. G. Nash, G3EJA, "Peacehaven", 9 Holybrook Road, Reading, Berkshire.**
The Club Chairman addressed the assembled members at the July meeting when it was held on the 27th. The subject of his lecture was "Safety in the Shack".

**ROYSTON AND DISTRICT RADIO CLUB**
**G. B. Finney, 103 Cross Land, Royston, Barnsley, Yorkshire.**
All visitors were welcomed at the exhibition of amateur radio equipment staged by members of this Club on 5th August. The exhibition was held in the Royston Welfare Park and the Club station (G3NAH/P) was in operation.

**SHEFFIELD AMATEUR RADIO CLUB**
**Hon. Sec.: D. A. Justice, G3PYL, 9 Leslie Road, Sheffield 6.**
The Club met on Friday, 12th July, to hear a talk given by G3LWB on "Transistors and their Application to Amateur Radio".

**SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB**
**Hon. Sec.: Derek Forster, G3KZZ, 41 Marlborough Street, South Shields, Co. Durham.**
On 7th July the Club's fifth Mobile Rally was held successfully at Bents Park Recreation Ground. Visitors from many parts of the country enjoyed a day of competitions and other events which had been arranged. Apart from the prizes for the winners of the contests held at Bents Park, awards were made for the day's longest distance contact and for the visitor who travelled the furthest to get to the rally.

**STOURBRIDGE AND DISTRICT AMATEUR RADIO SOCIETY**
**Hon. Sec.: R. A. G. MacIntosh, 50 Field Lane, Oldswinford, nr. Stourbridge, Worcestershire.**
Saturday, 6th July, proved to be a busy day for the Society, with some members manning a working station at the Wollaston St James' Summer Fair at the same time as other members were taking part in the R.S.G.B.'s 2m Portable Contest.

**UXBRIDGE RADIO SOCIETY**
**Hon. Sec.: A. Duell, "Treetops", Bakers Wood, Denham, Buckinghamshire.**
This Society meets on alternate Mondays at 7.30 p.m. when lectures, constructional practice, R.A.E. and morse classes and other activities make up the programme of events to which all those interested are invited to attend. The next meeting will be held on 19th August and prospective members should contact the Secretary for details of the meeting place.

**WESSEX AMATEUR RADIO GROUP**
**Hon. Sec.: G. K. Fowle, 138 Surrey Road, Branksome, Poole, Dorset.**
On 28th July members enjoyed a "hare and hound" d.f. contest and mobile rally which lasted throughout the afternoon.

**WEST KENT AMATEUR RADIO SOCIETY**
**R. Trevitt, 28 Dalves Avenue, Tunbridge Wells, Kent.**
On 12th July members had a chance to sell, exchange or auction their surplus gear. Two weeks later members again brought their private equipment along to the meeting, this time to demonstrate to other members any gadget or device that they had found of use around the shack.

## COURSES OF INSTRUCTION

**WESTON-SUPER-MARE TECHNICAL COLLEGE**
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This college offers the following courses of Instruction to people living locally: telecommunication technicians; radio and television servicing; electronic servicing; radio amateurs; ordinary National Certificate (electrical) and telecommunications advanced.

**HEANOR TECHNICAL COLLEGE**
**Ilkeston Road, Heanor, Derbyshire.**
This College offers courses covering the R.A.E. and details are available from the Registrar or Mr. R. Harrod at the College.

**ILFORD LITERARY INSTITUTE**
**Cranbrook Road, Ilford, Essex.**
A course of instruction covering the R.A.E. will begin in September and a morse and codes of practice course will also be run in preparation for the G.P.O. test.

## A Versatile Double-Trace Oscilloscope

*—continued from page 404*

should be replaced by two 500kΩ resistors in series and the tube anode (A1) taken to their mid point. C1 and C3 must then be connected to earth instead of to "A1". This arrangement is not suitable for d.c. inputs for, if d.c. is now applied to a plate, it will cause a current to flow through the valves of R6 and the voltage this develops will affect *both* plates. (With a.c. inputs, practically all this current is by-passed through C1 or C3).

The second alternative which is suitable for d.c. inputs, is to retain the existing shift circuit, but connect the positive sides of the shift controls to earth. In this case, the shifts cover only the −X, −Y quadrant of the tube screen.

If the plates are fed from external d.c. amplifiers, the shift voltages are supplied by the amplifiers themselves, so the problem does not arise.

### *Deflector Polarity*

It is customary, with single-ended inputs, to arrange that *positive* signal applied to the "X d.c." terminal deflects the spot to the *right* and when applied to the "Y d.c." terminal, deflects the spot *upward*. This can be checked by means of a dry cell or battery. If the directions are incorrect, the leads to "D1" and "D2" or "D3" and "D4" can be reversed at the tube base.

**TO BE CONTINUED**

# 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*

## *SCREENING TAPE*

SIR,—I have often used plywood covered with aluminium foil for a temporary chassis, with a good deal of success. However, on trying to screen wires by using strips of foil the results were not so good, as the screening invariably finished up as an inflexible tube of foil which would slide along the wire and short against a solder tag!

Although I have not had time to use the idea myself, I think the answer would be to use adhesive chrome tape which is sold in rolls and much used for embellishing motor scooters. The adhesive backing would prevent unravelling and one end could be held to the chassis by a nut and bolt thus earthing the tape and supporting the wire.—M. FEATHERBY (Sheffield).

## *STEREO DETAILS PLEASE*

SIR,—I intend building my own stereo tape recorder and so I was very interested in the letter of Mr. R. C. Hawkins (April issue) in which he mentions that he had built his own stereo tape equipment at a cost of only £40. I wonder if it would be possible for Mr. Hawkins to supply details of this equipment so that they could be published for the benefit of not only myself but the many other readers who might be intent on building such equipment but not sure of where to begin.—L. J. ALLSOPP (Canton, Cardiff).

## *PROTECTION DEVICE*

SIR,—All transistor receivers carry a notice warning the owner of the consequences of connecting the battery the wrong way round. I have often wondered that no manufacturer has adopted the idea which occurred to me some time ago, of placing a diode between the negative line of the set and the negative post of the battery. Now, with the battery connected the correct way round, current would flow through the circuit. However, if the battery were wrongly connected, then the diode would prevent any current flow, thus saving the transistors from damage.

An improvement on this idea would be an arrangement of four diodes in a bridge circuit, so that, regardless of the polarity of the battery, the receiver circuit would only receive current in the correct polarity.—M. J. BEECHAM (Grantham, Lincolnshire).

## *NOVICE LICENCES*

SIR,—When will these merchants stop bleating and realise that the P.M.G. doesn't make licence regulations just to be awkward?

In my way of thinking, the element of common sense should be cultivated a little more. It is fairly obvious that a transmitter operated in a school or club premises is vastly different from the lone operator in his top back room and due allowance should be made in such cases. Nobody expects any group of enthusiasts to keep completely silent during operations, but one must remember that a little forethought before going on the air makes the ensuing contact all the more enjoyable. How many of us have had to listen to stations complete with one or more children shouting the odds plus TV churning away in the background?

I would suggest that the "chips" be firmly removed from various shoulders and let all those who are genuinely interested in obtaining their licences go about it in the time-honoured fashion of working for it.—E. W. BONSON (London E12).

***Sir,—I would be grateful if any reader could sell or loan me . . .***

. . . the September and October 1956 issues of P.W.—R. G. JOHNSON, 24 Tenterden Road, Sheffield 5.

. . . the issues of P.W. containing the modification details of the R1155 receiver.—E. S. WOOD, 18 Dover Street, Canterbury, Kent.

. . . the circuit diagram and any other information relating to the U.S. Navy receiver, model PR7NA.—COLIN HALL, St. Peter's College, Saltley, Birmingham 8.

. . . the September 1961, January and August 1962, February and March 1963 and the July 1960 to July 1961 issues of P.W.—C. M. BERRY, 15 Homefield, Boxford, Nr. Colchester, Essex.

. . . the instructions on the re-alignment of the P.C.R.3 communications receiver. —E. STARKEY, 35E Delhi Street, St. Thomas, Swansea, Glamorgan.

. . . the circuit and, if possible, wiring diagrams, of the American built command transmitter, CBY 52209 and accompanying modulator.—M. LUCAS, Cripps Hall, University Park, Nottingham.

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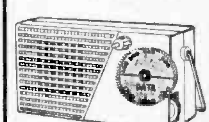

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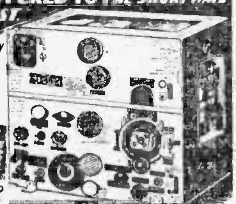

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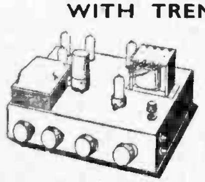

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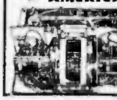

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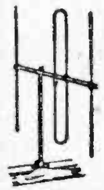

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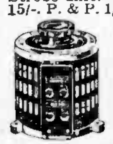

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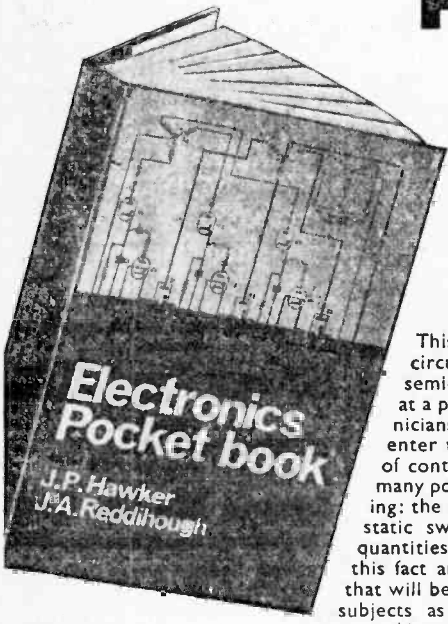


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This work brings together up-to-date information on the basic circuits and techniques used in electronics—with emphasis on semi-conductor devices rather than the thermionic valve. It is written at a practical level so as to be of maximum help and usefulness to technicians in the many branches of electronics and to students about to enter this rapidly expanding field. Recent developments in the fields of control engineering and automation have seen a breaking down at many points of the distinction between electronic and electrical engineering: the inclusion in this book of such subjects as the magnetic amplifier, static switching, electronic techniques of measuring various physical quantities, electro-mechanical devices and motor control systems reflect this fact and provide the reader with the wider background knowledge that will be of increasing value to him. On the purely electronics side such subjects as pulse generation, counting techniques and computers are treated in a manner that will give the reader a thorough grasp of the principles involved and will be of special value to candidates for the **Electronic Servicing** certificate of the Radio Trades Examination Board and The City and Guilds of London Institute.

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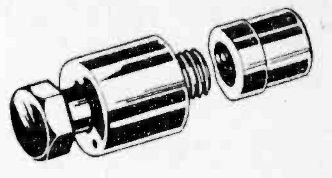

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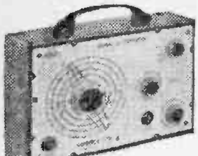

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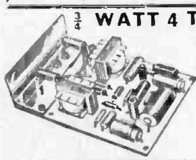

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PRACTICAL WIRELESS, SEPTEMBER, 1963.

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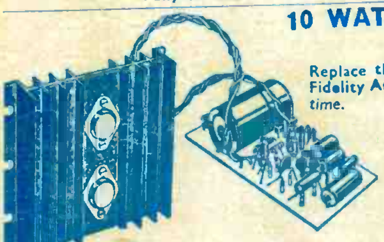

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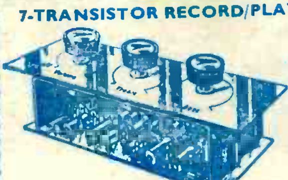

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