THE **Radio Constructor**

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 16 NUMBER 4
A DATA PUBLICATION
PRICE TWO SHILLINGS

## November 1962

# Double-Two "Sky Ranger" S.W. Receiver

*Also featured*

Oscillator Checker for Transistor Radios

●

27Mc/s Transistor Transmitter for Radio Control

●

Method of Obtaining Variable Selectivity in Double Superhets

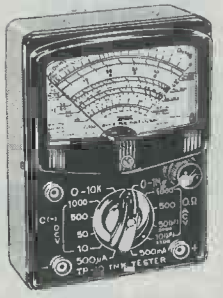
etc., etc., etc.

**PCR COMMUNICATION RECEIVERS**

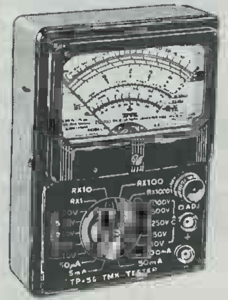
Manufactured by **Pye and Philips.** One of the Army's most versatile and sensitive sets. RF stage and 2 of IF, using 6 British I.O. type valves Large 180 degrees. Illuminated and Calibrated Dial. Flywheel tuning with locking device. Aerial trimmer. Tone and volume controls. Band switch from panel jacks for speaker or phones. In black metal case, size 17" L x 8" H x 10" D. Model PCR covers 6–18 Mc/s, 200–550 metres and 850–2,000 metres and has internal 5" speaker. **£6.19.6. Model PCR2** has similar L & M waveband coverage. Short wave 6–22 Mc/s, but no speaker. Used but excellent condition, **£5.19.6.** Every receiver aerial tested before despatch. Add 10/6 carr. all models. Designed to operate from bulky EXTERNAL power supply, but any set can be fitted with BRAND NEW COMPONENTS INTERNAL PACK for 200/250V a.c. at extra cost of **£2.**

*S.A.E. FOR ILLUSTRATED LEAFLET*

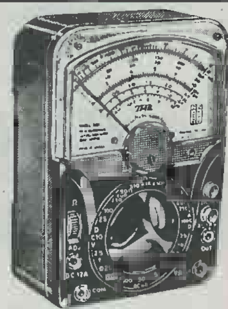
# TEST METERS FOR EVERY PURPOSE & POCKET




**2,000 O.P.V. MODEL TP-10.** Reads A.C. and D.C. volts up to 1,000; D.C. Current to 500mA; resistance to 1 Meg; Capacitance to 1μF; Decibels from —20 to +36; Output jack for Audio Measurements. Size 3½" x 5" x 1½". **£3.19.6**




**20,000 O.P.V. MODEL TP-5S.** Reads Voltage up to 1,000; D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. Current to 500mA; Resistance to 10 Meg.; Capacitance to 0.1μF; Decibels from –20 to +36. Size 3½" x 5¼" 1¾". **£5.19.6**



**30,000 O.P.V. MODEL 500.** Volts to 1,000: D.C. at 30,000 o.p.v., A.C. at 20,000; 12 Amps D.C. Current; 60 Meg. Resistance; –20 to +56 Decibels; Internal buzzer short circuit warning. Size 3 5/16" x 6 3/16" x 2¾". **£8.19.6**

**All new stock, with leads, prods & internal batteries. 6 mths. guar. backed by full service facilities. Details S.A.E.**

**AMERICAN AR88D RECEIVERS.** Fresh release of these renowned sets. 14 valves, 6 wavebands, covering 500 kc/s–32 Mc/s. Incorporate every possible refinement and have internal A.C. mains pack for nominal 115/230V. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. ONLY **£35** (add carriage 30/– and 50/– deposit on returnable transit case).

**COMBINED VIBRATOR/MAINS UNIT.** The Power Pack section of the Army R.107 Receiver. Has Vibrator for 12 volts DC operation, and Mains Transformer for 100/250 colts AC. Output 12.6 volts 3 Amps LT, and 250 volts 100mA HT. Complete with Vibrator, 6X5G Rectifier, and connecting data. Ideal for driving TCS or Type 52 Receivers, etc., or Mobile Equipment. BRAND NEW IN MAKER'S CARTONS, ONLY 45/– (carr. 5/6).

**AMPLIFIER TYPE A1413.** Ex-R.A.F. For normal A.C. mains use. 5Z4 rectification with 6V6 output. Input and output jack sockets, gain control, fully fused. 600 ohms output transformer, easily changed for 3 ohms type. Standard rack mounting size 19" x 7" x 6". Used, good condition. ONLY **59/6** (carriage, etc., 10/6).

**POWER UNITS TYPE 234.** Primary 200/250V 50 cycles. Outputs o 250V 100mA and 6.3V 4A. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19" x 7". Fitted input and output voltmeter, **79/6**, or model less meter, **59/6** (carriage either type 10/6).

**12 VOLT AMERICAN DYNAMOTORS.** Deliver 220 volts at 100mA. Size 5½" x 3½" diameter. Ideal for running Electric Shaver, etc., from car battery. ONLY **32/6** (post 2/6).

**AVOMETER MODEL 7 LEATHER CASES,** fitted with carrying handle and long strap. **BRAND NEW. ONLY 32/6** (post 2/6).

## "P.W. TROUBADOUR" 7 Transistor Personal Receiver

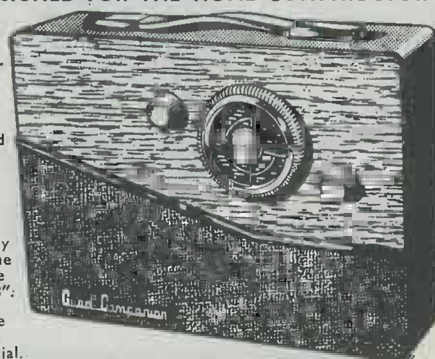
Designed by the technical staff of *Practical Wireless*: easy to build, using printed circuit and 1st grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speakers. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/6. TOTAL COST INCLUDING BATTERY AND CABINET **£8.10.0.** "P.W. 6" **£7.19.6.** Parts List S.A.E.

## THE "GOOD COMPANION" Mk. II

**Using transfilters, the latest manufacturing technique to save alignment difficulty.**

As described in "*THE RADIO CONSTRUCTOR*", August issue

**THE FINEST COMBINED PORTABLE and CAR RADIO YET DESIGNED FOR THE HOME CONSTRUCTOR**




★ 750mW output.

★ 6 transistors and 2 diodes.

★ Full Medium and Long Wave coverage.

★ Quality speaker.

★ Brilliantly styled 2-tone cabinet, size 11" x 8" x 3".

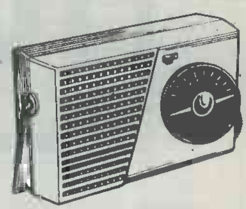
★ Very fine tuning with calibrated dial.

★ Latest printed circuit. ★ Internal high gain aerial with car aerial socket. Easy to follow construction data (available separately 3/6).

All parts sold separately and full illustrated details will be sent on request. Total Cost **£9.19.6**

With alternative luxury cabinet using 7" x 4" speaker, **£10.19.6.** Either type, plus 5/– post and ins. (Battery 3/6 extra.)

## "POCKET 4" TRANSISTOR RECEIVER



Uses miniature speaker, proper tuning condenser, and volume control. Built-in aerial makes unit efficient and portable. Ideal for the beginner. Full medium wave coverage. All components and case for only **42/6** (p. & p. 2/6). Ten-page constructional book free with parts or separately 1/6. S.A.E. for parts price list.

# HARRIS ELECTRONICS (LONDON) LTD

**(DEPT. M)**

**138 GRAY'S INN ROAD LONDON WC1** *Telephone* TERminus 7937

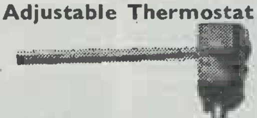
*Please include carriage costs on ALL items.*

*(Open until 1 p.m. Saturdays.) We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.*

## The J.B. Tangential Heater/ Air Conditioner

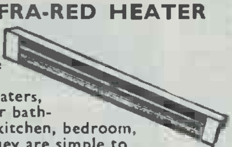
The displacement caused by the new Tangential fan is quite amazing, but what is more amazing is the almost complete absence of noise.
Stand the J.B. Air-Conditioner on a window ledge near an open window, and you can have either extraction of bad air, or input of clean, new air, depending upon which way you turn it.
In addition to a fan for moving the air, the unit also contains a heater and control switch, wired such that 500, 1,000 or 2,000 watts of heating may be used.
The total building cost of this air-conditioner is **£7.10.0**, plus 5/– carriage and insurance. The case is very nicely finished in hammered enamel, and when assembled, the unit is indistinguishable from those selling at **£12** and more.

## Adjustable Thermostat



Suitable for Industrial or domestic purposes, such as controlling furnace oven, immersion heater, etc. Can also be used as a flamestat or fire alarm. Made by Sunvic these are approximately 17" long and adjustable over a range 0 to 550° F. The contacts are rated at 15 amps., 230 volts, and the adjustment spindle, which comes to the top, can be fitted with a flexible drive for remote control or just a pointer knob for local control. Listed at **£3** or **£4** each, these are offered at only **12/6** plus 2/6 postage and insurance.

## INFRA-RED HEATER



Make up one of these latest type heaters, ideal for bathroom, kitchen, bedroom, etc. They are simple to make from our easy to follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750-watt element and instructions, 15/6 plus 2/6 post and insurance

## Bargain for Service Engineers

You often come up against the old set that won't be parted with. For these we can offer bargain parcel of rectifiers MU12 replacement and ID5 replacement. Ex-government of course, six of each for **£1**, post paid.

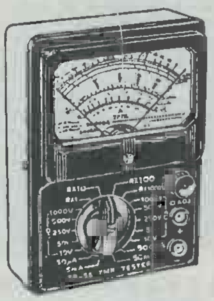
## This Month's SNIP!

### CABINET AND PICK-UP

An extremely fine looking cabinet, must have cost at least £2 to make. Complete with handle and fasteners as illustrated. Also included is a Cosmocord pick-up with crystal cartridge and sapphire stylus. Both items new and perfect.

**ONLY 19/6** Plus 4/6 post and insurance.

## MULTI-METER BARGAINS



**MODEL TPS5.** (Illus. on left). 20,000 ohms per volt. D.C. volts, 5 ranges up to 1,000. A.C. volts, 5 ranges up to 1,000, resistance, 2 ranges up to 10 meg., capacity, 2 ranges up to .1 decibels —20 to 26. One switch control, really beautifully made precision instrument, size only 3½" x 5½" x 1¾". Price only **£5.19.6.** Post free.

**MODEL TP10.** Similar in size and appearance to TPS5, but sensitivity 2,000 ohms per volt, price **£3.19.6.** Post free.

## The "Good Companion" Mk. II Using Transfilters

In the "de-luxe" cabinet as illustrated it cost **£10.19.6** to build—but what a set!
Scan these pages and you will find nothing to compare with its specification. It uses transfilters instead of I.F. transformers, has variable feedback as well as all the usual features. A.V.C., Push-pull output. Ferrite Aerial, Slow Motion Tuning, etc., etc., and is a very powerful Medium and Long Wave set, conservatively rated at 750 mW. Every component used is by a famous maker, such as American Philco, MADT R.F. transistors—Mullard A.F. transistors—Jackson Brother's tuning condensers—Rola-Celestion loudspeaker—Dubilier—T.C.C. Morganite resistors and controls. Also full after-sale service available.
**You will definitely be doing the right thing if you buy a GOOD Companion.**

## The "POCKET COMPANION"

**"A jolly fine set, but deserving a better case"**


This is a comment which many constructors have voiced and therefore we now offer a **De-luxe** version of the **Pocket Companion.** This uses a solid hide case of very pleasant red with gold lettering and our Pocket Companion now has the 15-guinea look.
The most up-to-date Superhet portable of its type, it uses a transfilter in conjunction with Philco R.F. transistors and Mullard output transistors. Complete building costs with plastic case **£6.15.0** or with solid hide case, **£7.15.0.**
If you have already built and want to change your case, then return the plastic case with a postal order for £1, or if you wish to retain the plastic case then send **26/–** plus 1/6. Post and insurance for the hide case only.

## MINIATURE CIRCUIT BREAKER

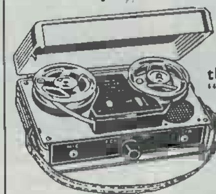
**(or repairable fuse)**

You will have experienced the annoyance of having to repair a fuse, especially in the middle of an experiment or repair job. Save yourself this bother by installing a simple circuit breaker. All you have to do then (if you touch the wrong wires together) is to re-set (push in) the circuit breaker. Offered with instructions at **15/–** each. (Will save its cost in time and temper in no time).

## Hi Fi Speakers

E.M.I. Ceramic magnet 12,000 lines, size 13" x 8" (roughly equivalent to 12" round speaker). Handles up to 10 watts. Price **33/6**, plus 5/– carriage and ins. State whether 15 ohm or 3 ohm. Similar model but specially designed and hand-made, for very low frequencies (40 to 55 cycles). Price **£7.10.0.**

## Tape Recorders



One of the easiest ways to learn anything, is to "tape" it and then keep playing it back. The industrious Japanese have really gone to town on tape recorders this year and many bargains are on offer. It is the writer's opinion that there is bound to be a big demand for them as Christmas presents so there is a good reason why you should buy your tape recorder immediately. Prices range as follows:

| | |
|---|---|
| **Child's Model** .............. | **£4.19.6** |
| **Assemble yourself Model** | **£6.19.6** |
| **Model No. Hil-3** ............ | **£7.15.0** |
| **The "Treasurer** ........... | **£8.19.0** |
| **The "Pocket Secretary"..** | **£14.14.0** |

The first two are not really good enough for music but they are quite good for speech. The last three are reasonable also for music. All have a value out of all proportion to their cost. Try this new learning technique—you will be amazed.

**Limited Quantity Only!**
**Waterproof heater wire.** 16 yd. length. 70 watts. Self regulating temperature control. 10/–, post free.

## Gramophone Motor

E.M.I. 4 speed with turntable and pick-up on control board **£4.5.0**, plus 5/– post and ins. Plinth for mounting same in cupboard or drawer, **12/6.** Post free if ordered with motor.

## Triple Purpose Auto Transformer

Ministry reference 10K/143. This will convert 230V to 110V or 230V to 460V. Use it also as a filament transformer 230V to 6.3V 5 amps. or 230V to 12.6V 3 amps. Price **12/6.** Post and packing 2/6.

## Ice-Stat

This is a small thermostat which cuts on and off at around freezing point. Has many uses, one of which could be an ice warning device to be fitted under your motor car. Price 7/6. Post 1/–.

## 15 amp. Thermostat

**(Sunvic)**

Adjustable over a fairly wide range of temperatures but set for 70°F. suitable for wall mounting to control room heaters. Exceptional bargain at 9/6, plus 1/– post and ins. Crackle finished and calibrated ease, suitable for mounting this (only minor adjustment), 5/– extra.

# ELECTRONIC PRECISION EQUIPMENT LTD

★ Orders received by post are despatched from our warehouse, **Dept. 34, 66 Grove Road, Eastbourne,** and to save time, please post your order to this address. Please include enough for postage. Callers, however, should use one of the following addresses: **John Bull**

| | | | | |
|---|---|---|---|---|
| 520 High Street North | 42–46 Windmill Hill | 266 London Road | 29 Stroud Green Road | 246 High Street |
| Manor Park, E.12 | Ruislip, Middx. | Croydon | Finsbury Park, N.4 | Harlesden, N.W.10 |

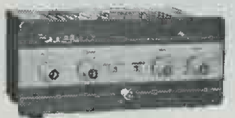
# FINEST ELECTRONIC KITS IN THE WORLD

"GLOUCESTER"

**HI-FI EQUIPMENT CABINETS.** Our four equipment cabinets meet a wide variety of tastes and requirements: the "CHEPSTOW" was designed for those who have little floor space, the contemporary "MALVERN" for the Tape and Gram. enthusiast, and the "GLOUCESTER" Mk. I and II for those with traditional tastes. All parts are pre-cut and drilled for easy assembly, and left "in the white".
Prices from **£11.12.6** to **£18.10.0**

GL-58

**TRANSCRIPTION RECORD PLAYER (STEREO).** Manufactured by Goldring-Lenco. This 4-speed unit is fitted with a G60 pick-up arm. Infinitely variable speed adjustment from 33⅓ to 80 r.p.m. Fixed speed of 16 r.p.m. Its balanced turntable (3½ lb) reduces rumble, wow and flutter to very low level. The unique lowering device fitted provides absolutely safe means of placing pick-up on record **£19.12.6**



S-33

**6W STEREO AMPLIFIER, Model S-33.** 3 watts per channel, 0.3% distortion at 2.5 w/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram., Stereo or Monaural, ganged controls. Sensitivity 100mV. **£13.7.6**

# AT LOWEST PRICES

Truvox D83

**TRUVOX D83 & D84 TAPE DECKS.** High quality mono/stereo tape decks.
D83, 2 track, for highest fidelity. **£31.10.0**
D84 (identical presentation), 4-track, for most economical use of tape. **£29.8.0**

"STUDIO"

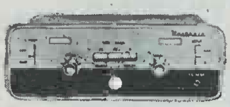
**COLLARO "STUDIO" TAPE DECK.** The finest buy in its price range. Operating speeds: 1⅞, 3¾ and 7½ i.p.s. Two tracks. "Wow" and "flutter" not greater than 0.15% at 7½ i.p.s. Long Term Speed Stability better than 0.5%. **£17.10.0**

**HI-FI STEREO/MONO PRE-AMPLIFIER. Model USP-1.** Extremely versatile unit. Gain may be preset over a wide range. Input 2mV-20mV. Output 20mV-2V **£7.7.6**

**HI-FI SINGLE CHANNEL AMPLIFIER Model MA-12.** 12W output, wide freq. range, low distortion. **£11.9.6**

**TAPE RECORDING AND REPLAY HI-FI AMPLIFIER**

**Mono model TA-1M, Stereo model TA-1S.** For use with most tape decks. Thermometer type recording indicators, press-button speed compensation and input selection, 3-position bias level and printed circuit construction.



TA-1S

| | |
|---|---|
| TA-1M ... ... ... | £19. 2.6 |
| TA-1M & Collaro STUDIO | £30.10.0 |
| TA-1M & TRUVOX D83 ... | £47. 2.6 |
| TA-1M & TRUVOX D84 ... | £45. 5.0 |
| TA-1S ... ... ... | £24.10.0 |
| TA-1S & STUDIO ... ... | £35.14.0 |
| TA-1S & TRUVOX D83 ... | £52. 6.0 |
| TA-1S & TRUVOX D84 ... | £50. 9.6 |

USC-1

**STEREO CONTROL UNIT, Model USC-1.** Push-button selection, accurately matched ganged controls to ±1dB. Negative feed-back, rumble and variable low-pass filters. Printed circuit boards. **£19.10.0**

**VALVE VOLTMETER. Model V-7A.** 7 voltage ranges d.c. volts to 1,500 a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1Ω to 1,000MΩ with internal battery. D.C. input impedance 11MΩ. dB measurement has centre-zero scale. Complete with test prods, lead and standardising battery. **£13.18.6**

V-7A

**MULTIMETER. Model MM-1U.** Ranges 0–1.5V to 1,500V A.C. and D.C.; 150μA to 15A D.C.; 0.2Ω to 20MΩ. 4½" 50μA meter. **£12.10.0**

MM-1U

**R.F. SIGNAL GENERATOR. Model RF-1U.** Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£12.15.6**

**AUDIO WATTMETER. Model AW-1U.** Up to 25W continuous, 50W intermittent. **£15.15.0**

**AUDIO VALVE MILLIVOLTMETER. Model AV-3U.** 1mV-300v A.C. 10 c/s to 400 kc/s. **£14.17.6**

RF-1U

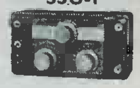
**AUDIO SINE-SQUARE WAVE GENERATOR. Model AO-1U.** Covers 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V, distortion less than 1%. **£13.15.0**

**CAPACITANCE METER. Model CM-1U.** Direct-reading 4½" scale. Full-scale ranges 0–100μμF, 0–1,000μμF, 0–0.01μF and 0–0.1μF. **£15.15.0**

SSU-1

**HI-FI SPEAKER SYSTEM. Model SSU-1.** Ducted-port bass reflex cabinet "in the white". Twin speakers. With legs **£11.19.6.** **£11.5.0**

**HEATHKIT ELECTRONIC WORKSHOP, Model EW-1.** This educational kit will teach and amuse your children. It can make 21 exciting experiments including transistor radios, burglar alarm, radio or TV silencer, intercom., etc. **£7.18.0**



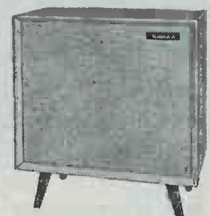
UJR-1

**JUNIOR TRANSISTOR RADIO, Model UJR-1.** Single transistor set. Excellent introduction to radio. An instructive present. **£2.13.6**

S-99

**HI-FI STEREO AMPLIFIER, Model S-99.** 18W output. Ganged controls. Stereo/mono gram., radio and tape recorder inputs. Push-button selection. Printed circuit construction. **£27.19.6**

**THE "COTSWOLD".** This is an acoustically designed enclosure 26" x 23" x 15½" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£23.4.0**



THE "COTSWOLD"

*Prices include free delivery U.K. Deferred terms available over £10*
*Assembled models also available—prices on request*

★ **SEND THIS COUPON NOW FOR FURTHER INFORMATION**
*(Please write in BLOCK CAPITALS)*

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

ADDRESS ..........................................................

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Without obligation please send me (Tick here)

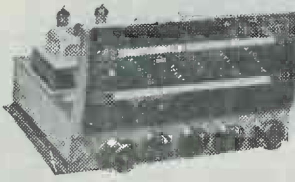
FREE BRITISH HEATHKIT CATALOGUE .......... ☐

FULL DETAILS OF MODEL(S) .......... ☐

**DAYSTROM LTD** DEPT RC11 GLOUCESTER . ENGLAND

A member of the Daystrom Group, manufacturers of the
**WORLD'S LARGEST-SELLING ELECTRONIC KITS**

# ARMSTRONG AF 208 AM/FM RADIOGRAM CHASSIS



★ Full VHF Band (87–108 Mc/s.) and Medium Band, 187–570M. ★ 7 Valves ★ 5 Watts Output ★ 15dB Negative Feedback ★ Separate wide range Bass and Treble Controls ★ 2 Compensated Pick-up Inputs ★ Frequency Response 30–22,000 c.p.s. ★2dB ★ Tape Record and Playback Facilities ★ Continental Reception of Good Programme Value ★ For 3, 7½ and 15 ohm speakers. Send S.A.E. for leaflet.

Price **£22.18.0** Carr. Free

**ARMSTRONG STEREO 12 Mk. 2 CHASSIS** 42 Gns.
Two separate push-pull amplifiers each 8 watts output giving 16 watts total, full coverage of VHF, medium and long wavebands. Stereo and mono inputs for tape record, tape playback, radio and any type of pick-up. Automatic frequency control on FM and, on AM, the ferrite aerial, two IF stages and the very efficient AGC, ensure good Continental reception. Chassis size 14½" x 9" x 5½" high.

**ARMSTRONG STEREO 55 CHASSIS** 32 Gns.
10 watts output is available from two separate amplifiers, each 5 watts. Full coverage of the VHF and medium bands. Stereo and mono inputs for tape record, tape playback, radio and any type of pick-up. Separate full range tone controls and dual volume control for balancing. Chassis size 12⅞" x 8¾" x 5½" high.

# BARGAIN SALE PRICES

**New boxed VALVES 90-day Guarantee**

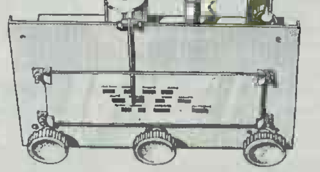
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0Z4 | 5/– | 6K7G | 5/– | EABC80 | 8/– | PCL82 | 10/– |
| 1R5 | 6/– | 6K8G | 5/– | EB91 | 4/– | PCL84 | 10/– |
| 1S5 | 6/– | 6L6G | 8/– | EBC41 | 8/– | PL81 | 10/– |
| 1T4 | 3/– | 6N7M | 6/– | EBC81 | 8/– | PL83 | 8/– |
| 2X2 | 2/– | 6Q7G | 6/– | EBF80 | 9/– | PY80 | 7/– |
| 3S4 | 7/– | 6SN7 | 5/– | ECH42 | 9/– | PY81 | 8/– |
| 3V4 | 7/– | 6V6G | 5/– | ECH81 | 9/– | PY82 | 7/– |
| 3Q5 | 7/– | 66X4 | 5/– | EF85 | 6/– | PY83 | 8/– |
| 5U4 | 6/– | 66X5 | 6/– | EF89 | 8/– | QP25 | 7/– |
| 5Y3 | 6/– | 12AT7 | 5/– | EL32 | 5/– | SP41 | 3/– |
| 5Z4 | 9/– | 12AU7 | 5/– | EL84 | 7/– | SP61 | 3/– |
| 6AC7 | 4/– | 12AX7 | 7/– | EY51 | 9/– | U22 | 7/– |
| 6AM6 | 4/– | 12BH7 | 7/– | EY86 | 9/– | UBC41 | 8/– |
| 6AT6 | 6/– | 12K7 | 5/– | EZ40 | 7/– | UBC81 | 9/– |
| 6BA6 | 7/– | 12K8 | 14/– | EZ80 | 7/– | UBF89 | 9/– |
| 6BE6 | 5/– | 12Q7 | 5/– | EZ81 | 7/– | UCH81 | 9/– |
| 6BW6 | 7/– | 25YSG | 9/– | E1148 | 1/– | UCL82 | 10/– |
| 6C4 | 5/– | 35L6 | 9/– | HABC80 | 10/– | UCL83 | 12/– |
| 6D6 | 5/– | 35Z4 | 5/– | HVR2A | 5/– | UF89 | 9/– |
| 6G6 | 4/– | 807 | 5/– | KT33 | 8/– | UL41 | 9/– |
| 6H6 | 3/– | 954 | 2/– | KT76 | 8/– | UY41 | 7/– |
| 6J5 | 5/– | DAF96 | 8/– | MU14 | 7/– | UY85 | 7/– |
| 6J6 | 5/– | DF96 | 8/– | PCC84 | 8/– | UU9 | 7/– |
| 6J7G | 6/– | DK96 | 8/– | PCF80 | 8/– | VR150 | 7/– |
| 6K6 | 5/– | DL96 | 8/– | PCF82 | 8/– | W81 | 6/– |

## NEW ELECTROLYTICS FAMOUS MAKES

| TUBULAR | | TUBULAR | | CAN TYPES | |
|---|---|---|---|---|---|
| 1/350v. | 2/– | 50/350v. | 5/6 | 16/450v. | 5/– |
| 2/450v. | 2/3 | 100/25v. | 2/– | 32/350v. | 4/– |
| 4/450v. | 2/3 | 250/25v. | 2/6 | 100/270v. | 5/6 |
| 8/450v. | 2/3 | 500/12v. | 3/– | 2,500/3v. | 4/– |
| 16/450v. | 3/– | 8+8/450v. | 3/6 | 5,000/6v. | 5/– |
| 32/450v. | 3/9 | 8+16/450v. | 3/9 | 32+34/450v. | 6/– |
| 25/25v. | 1/9 | 16+16/450v. | 4/3 | 32+32+32/350v. | 7/– |
| 50/50v. | 2/– | 32+32/350v. | 4/6 | 50+50/350v. | 7/– |
| | | | | 64+120/350v. | 11/6 |
| | | | | 100+200/275v. | 12/6 |

## QUALITY 2-STAGE HI-FI AMPLIFIER

A.C. only, 200–250V Valves ECL86 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved front-panel with de-luxe finish. Heavy duty output transformer 3 ohm. Shrouded mains transformer. Stove enamelled chassis size 6" x 5" x 3". **Bargain Price £4.10.0.** Circuit supplied.



## COMPLETE RADIO CHASSIS

4 Mullard valves, 5" speaker. **Superhet Circuit.** Size 9" x 6" x 5½" high. Tested ready for use. 200/250V A.C.–D.C. Mains. **Brand New.** With illuminated dial. Fully tunable over medium wave 200–550 M and long wave 1,000–2,000 M. Guaranteed 12 months. Post free

**Bargain Price £5.19.6**

## MAINS TRANSFORMERS
### 200/250 AC Post 2/- each

**STANDARD** 250–0–250, 80 mA., 6.3 v. 2.5 a. tapped 4 v. 4 a., Rectifier 6.3 v. 1 a. tapped 5 v. or 4 v. 2 a. ... ... ... ... 22/6
Ditto 350–0–350 ... ... ... ... 29/6
**MINIATURE**, 200 v. 20 mA., 6.3 v. 1 a. 10/6
**MIDGET**, 220 v. 45 mA., 6.3 v. 2 a. ... 15/6
**SMALL**, 220–0–220 v. 50 mA., 6.3 v. 2 a. 17/6
**STANDARD**, 250–0–250 65 mA., 6.3 v. 3.5 a. ... ... ... ... 17/6
**HEATER TRANS.**, 6.3 v. 1½ a. ... 7/6
Ditto 6.3 v. 4 a. ... ... ... ... 10/6
**GENERAL PURPOSE LOW VOLTAGE.** Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. ... ... 22/6
**AUTO. TRANS.** 150 w., 0, 10, 120, 200, 230, 250 v. ... ... ... ... 22/6
**AUTO. TRANS.** 500 w., 0, 115, 200, 230, 250 v. ... ... ... ... ... 82/6
**PARMEKO MAINS TRANSFORMER.** Made for special contract, the ratings can safely be doubled. Guaranteed 2 years. Primary 0-110-210-230-250 v. H.T. 300-0-300 v. 50 mA. L.T. 6.3 v. 1.8 a. Weight 6 lb. ... Price 17/6, post 2/6
**MAINS POWER PACK** Size 3¾ x 4½ x 4 in. with mains transformer, metal rectifier and condensers to provide smoothed H.T. output 220 v. 45 mA. D.C., L.T. 6.3 v. 2 a. Centre tapped A.C. All ready built on a strong metal chassis. Brand new. ... ... ... **Bargain 29/6, post 2/6**

**O.P. TRANSFORMERS.** Heavy duty 50 mA, 4/6. Miniature 3V4, etc., 5/9. Small, pentode, 4/6. Multi-ratio push-pull, 7/6. Multi-ratio push-pull 10 w., 15/6. Goodmans heavy duty 10/20 w. 6K push-pull, 30/–; Estone ultra-linear OT/ML 10 w. 45/–.
**L.F. CHOKES** 15/10 H. 60/65 mA, 5/–; 10 H. 85 mA, 10/6; 10 H. 120 mA, 12/6; 10 H. 150 mA, 14/–.
**FULL WAVE BRIDGE CHARGER RECTIFIERS.** 2, 6 or 12 v. 1½a., 8/9; 2 a., 11/3; 4 a., 17/6. Free charger circuit.
**CHARGER TRANSFORMERS.** Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6.
**4 AMP. CAR BATTERY CHARGER** with ampmeter Leads, Fuse Case, etc., for 6 v. or 12 v., 69/6.

## BOOKS (*List S.A.E.*)

| | |
|---|---|
| 40 Circuits for Germanium Diodes | 3/– |
| "W.W." Radio Valve Data | 6/– |
| High Fidelity Speaker Enclosures | 5/– |
| Valve and TV Tube Equivalents | 9/6 |
| TV Fault Finding | 5/– |
| Quality Amplifiers | 4/6 |
| Radio Valve Guide. Books 1, 2, 3 or 4, | 5/– each |
| Transistor Superhet Receivers | 7/6 |
| Practical Radio Inside Out | 3/6 |
| Master Colour Code | 1/6 |

**TINNED COPPER WIRE** 16 to 22 swg. ½ lb. 3/–
**COPPER ENAMEL WIRE** ½ lb. 16 to 22 s.w.g 2/9, 24 to 30 s.w.g. 3/6, 32 to 40 s.w.g. 4/6

**CRYSTAL MIKE INSERT** 6/6
Precision engineered. Miniature size.

**ACOS STICK MIKE 39-1** ... ... 35/–
**T.S.L. DE LUXE STICK MIKE** ... 25/–

## BAKER SELHURST LOUDSPEAKERS

12" Baker 15W Stalwart 3 or 15Ω, 45–13,000 c.p.s. **90/–**

12" Stereo 12W, 35–16,000 c.p.s. Foam suspension **£6.17.6**

12" Baker Ultra Twelve, 20 c.p.s. to 25 kc/s **£17.10.0**

15" Auditorium, Bass Mk II 35W 20 c.p.s. to 12 kc/s. **£18**

Send S.A.E. for leaflet and enclosure details

**LOUDSPEAKERS P.M. 3 OHM.** 2½in. 3in. 4in.-19/6; 5in. Rola, 17/6; 7in. x 4in., 18/6; 4in. Hi-Fi Tweeter, 25/–; 8in. Plessey, 19/6; 6½in. Goodmans, 18/6; 10in. R.A., 30/–; 12in. Plessey, 30/–; 10in. x 6in. E.M.I. 27/6; E.M.I. 13½" x 8" 45/–; Stentorian HF1012 10in., 95/–; HF1016, £8. 12 in. R.A. 15Ω 45/-.
**CRYSTAL DIODES.** G.E.C., 2/–; GEX34, 4/–; OA81, OA70, 3/–. Crystal Coils HAX, 3/–. DRR2, 4/–.
**CRYSTAL SET BOOKLET 1/–.**
**H.R. HEADPHONES**, 4,000 ohms, 15/– pair.
**SWITCH CLEANER FLUID**, squirt spout. 4/6 tin.

## C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions. Mains input.

**TYPE A. LOW LEAKAGE WINDINGS. OPTIONAL 25% and 50% BOOST ON SECONDARY: 2 V. OR 4 V. OR 6.3 V. OR 10.3 V OR 13.3 V. 10/6 ea.** (State voltage reqd.)

**TWIN GANG CONDENSERS.** Transistor 208 pF and 176 pF, with trimmers and screen, 10/6 each; 365 pF, miniature, 1⅞in. x 1½in. x 1¾in., 10/–; 500 pF standard with trimmers, 9/–; midget, 7/6; midget with trimmers, 9/–. 500 pF slow motion drive, standard or midget, 9/–. Small 3 gang, 500 pF., 17/6.
**SHORT WAVE.** Single 10pF, 25pF, 50pF, 75pF, 100 pF, 160 pF, 5/6 each.
**TUNING AND REACTION CONDENSERS.** 100 pF, 300 pF, 500 pF, 3/6 each, solid dielectric.
**CONDENSERS.** 0.001 mfd. 7kV T.C.C., 5/6; ditto 20 kV., 9/6; 0.1 mfd. 7 kV., 9/6; 100 pF to 500 pF Micas, 6d.; Tubular 500 v. 0.001 to 0.05, 9d.; 0.1, 1/–; 0.25, 1/6; 0.1/350 v., 9d.; 0.5/500 v., 1/9; 0.01/2,000 v., 1/9; 0.1/2,000 v., 3/6.
**CERAMIC CONDENSERS.** 500 v. 0.3 pF to 0.01 mfd., 9d. 0.1/30v., 1/3.
**SILVER MICA.** 10% 5 pF to 500 pF, 9d.; 600 pF to 3,000 pF, 1/–; close tolerance (plus or minus 1 pF), 2.2 pF to 47 pF, 1/–; ditto 1% 50 pF to 815 pF, 1/–; 1,000 pF to 5,000 pF, 1/9.

**465 Kc/s. SIGNAL GENERATOR.** Price 15/- Uses R.F.O. Unit ZA 30038 ready made with valve 1C5. **POCKET SIZE** 2½in. x 4½in. x 1in. Only one resistor to change! Full instructions supplied. Battery 8/6 extra 69 v. + 1½ v. Details S.A.E.

**WAVECHANGE SWITCHES**
2 p. 2-way, or 2 p. 6-way, long spindle ... ... 3/6
3 p. 4-way or 1 p. 12-way, long spindle ... ... 3/6
4 p. 2 way or 4 p. 3-way, long spindle ... ... 3/6
8 p. 4-way 2 wafer, long spindle ... ... 6/6
Wavechange **"MAKITS"**. Wafers available: 1 p. 12 wafer, 2 p. 6 wafer, 3 p. 4 wafer, 4 p. 3 wafer, 6 p. 2 wafer. 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/–. Additional wafers up to 12, 3/6 each extra.
**TOGGLE SWITCHES**, s.p., 2/–; d.p., 3/6; d.p.d.t., 4/–. **Rotary Toggles**, s.p., 3/6, d.p., 4/6.
**JACKS.** English open-circuit 2/6, closed-circuit 4/6, Grundig-type 3-pin 1/3
**JACK-PLUGS.** English 3/-, Screened 4/–, Grundig 3-pin 3/6.

**JASON F.M. TUNER COIL SET, 29/–.** H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s., detector transformer and heater choke. Circuit and component book using four 6AM6, 2/6. Complete Jason FMT1 kit, Jason chassis with calibrated dial, components and 4 valves, £6.5.0.

**MORSE KEY—2/6, BUZZER—4/-.**
**VALVEHOLDERS.** Pax. int. oct., 4d. EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, and 7 pin, 1/–. **MOULDED MAZDA** and int. Oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic, EF50, B7G, B9A, Int. Oct., 1/–. B7G, B9A cans, 1/– each.

# RADIO COMPONENT

**Our written guarantee with every purchase.** Buses 133 or 68 pass door. S.R. Stn. Selhu

**VOLUME CONTROLS**

Long spindles. Midget 5K ohms to 2 Meg.

L/S 3/– D.P. 4/6
Stereo L/S 10/6 D.P. 14/6

Linear or Log Tracks.

**80 ohm CABLE Coax**

Semi-air spaced ¼in. Stranded core, 6d. yd. 40 yds. 17/6; 60 yds. 25/-

Fringe Quality, Air Spaced 1/- yd.

**EXTENSION SPKR. CONTROL** 10 Ohm 3/–.
**TELESCOPIC CHROME AERIALS** 13in. extending to 43in. 8/6 each. Coax. Adaptor 1/6.
**RESISTORS.** Preferred values. 10 ohms to 10 meg. ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w. 8d.; 2 w. 1/-.
**HIGH STABILITY.** ½ w. 1%. 2/-. Preferred values. 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg. 9d.

**WIRE-WOUND RESISTORS** 10 ohms- 10,000 ohms
5 watt 1/3
10 watt 1/6
15 watt 2/-
12.5K to 50K 10 w ......3/–

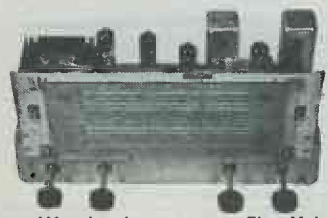
**I.F. TRANSFORMERS 7/6 pair**
**465 kc/s Slug Tuning Miniature Can.** 2in. x ¾in. x ¾in. High Q and good band width. Data sheet supplied.

**WIRE-WOUND Pots. 3 WATT.** Pre-set Min. TV Type. All values 10 ohms to 25K, 3/- ea.; 30K, 50K, 4/–. Carbon 30K to 2 meg., 3/–

**WIRE-WOUND 4 WATT POTS.** Long Spindle, Values, 50 ohms to 50K, 6/6; 100K, 7/6.

**TRIPLEXERS,** Bands I, II, III, ...... 12/6
**COAXIAL PLUGS,** 1/–. **PANEL SOCKETS,** 1/–
**LEAD SOCKET,** 2/–. **OUTLET BOXES,** 4/6
**BALANCED TWIN FEEDER,** 6d. yd., 80 or 300 ohms
**TWIN SCREENED FEEDER,** 1/6 yd. 80 ohms.
**TRIMMERS.** Ceramic 30, 50, 70 pF. 9d.; 100 pF. 150. pF. 1/3; 250 pF. 1/6; 600 pF. 750 pF. 1/9; Philips, 10 pF, 30 pF. 1/– each.

## 1962 RADIOGRAM CHASSIS



Three Wavebands
S.W. 16 m.–50 m.
M.W. 200 m.–500 m.
L.W. 800 m.–2,000 m.

Five Valves
Latest Mullard
ECH81, EF89, EBC81,
EL84, EZ80

12-month Guarantee. A.C. 200-250V, 4-way switch. Short-Medium-Long-Gram. A.C.C. and Negative Feedback, 4.2 watts. Chassis 13½" x 5½" x 2½". Glass dial size 10" x 4½", horizontal or vertical. Two Pilot Lamps. Four Knobs, Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

**BRAND NEW £9.10.0** Carr. 4/6

Matched Speakers 8" 17/6; 10" 25/–; 12" 30/–

**BLACK CRACKLE PAINT.** Air drying, 3/– tin.
**NEON MAINS TESTER SCREWDRIVER,** 5/–
**SOLDER RADIOGRADE,** 4d. yd., ½ lb. 5/–.

**HIGH GAIN TV PRE-AMPLIFIERS**
**BAND I B.B.C.**
Tuneable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred.)
**BAND III I.T.A.**—Same prices
Tuneable channels 8 to 13. Gain 17 dB.

**PAXOLIN PANELS,** 1/16in. x 10in. x 8in., 2/-.
**MINIATURE CONTACT COOLED RECTIFIERS.** 250 v. 50 mA, 7/6; 250 v. 60 mA, 8/6; 250 v. 85 mA. 9/6. 200 mA. 21/–; 300 mA. 27/6. Full Wave Bridge 250v. 75mA. 10/–. 120mA. 15/-.
**SELENIUM RECT.** 300 v. 85 mA. 5/–.
**COILS.** Wearite "P" type, 3/– each. Osmor Midget "Q" type, adj. dust core from 4/– each. All ranges.
**TELETRON D.W.R.** L. & Med. T.R.F. with reaction, 4/–; Med. only DR, 3/6.
**FERRITE ROD AERIALS.** M.W., 8/9; M. & L., 12/6.
**FERRITE ROD AERIALS.** L & M. for transistor circuits, 10/– each. **FERRITE RODS** 8in. x ⅜in., 3/-. 8in x 7/16in. 3/-. 6in. x ⅜in., 3/–.

**ALUMINIUM CHASSIS.** 18 s.w.g. Plain, undrilled. 4 sides, riveted corners, lattice fixing holes, 2½in. sides. 7in. x 4in., 4/6; 9in. x 7in., 5/9; 11in. x 7in., 6/9; 13in. x 9in., 8/6; 14in. x 11in., 10/6; 15in. x 14in., 12/6; 18in. x 16in. x 3in., 16/6.

**ALUMINIUM PANELS.** 18 s.w.g. 12in. 12in. 4/6; 14in. x 9in., 4/–; 12in. x 8in., 3/–; 10in. x 7in., 2/3. 8in. x 6in. 2/–.

**H.F. CHOKES,** 2/6. Osmor QC1 6/9.
**T.R.F. COILS** A/HF, 7/– pair; HAX. 3/–, DRR2, 4/–.
**ALADDIN FORMERS** and cores. ¼in. 8d., ⅜in. 10d.
0.3in. **FORMERS** 5937 or 8 and cans TV1 or 2. ¾in. sq. x 2½in. or ⅝in. sq. x 1½in., 2/– with cores.
**SLOW MOTION DRIVES.** Epicyclic ratio 6-1, 2/3.
**SOLON IRON,** 25 w., 200 v. or 230 v. 24/–.
**PRECISION** Sub-miniature Iron. 200 or 240 v, 29/6:

## 4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER Size 3 x 1¾ x ⅞

A ready built miniature push-pull amplifier with input and output transformers, 4 transistors. Ideal for use with record players, intercoms, etc. Complete with full instructions and circuit.

**PRICE 52/6** 9v Batt. 2/3. 2½" SPEAKER 15/–

**MAINS DROPPERS.** Midget. With adj. sliders, 0.3A, 1,000 ohms 5/–; 0.2A 1,200 ohms, 5/–; 0.15A 1,500 ohms, 5/–; 0.1A, 2,000 ohms, 5/–.

**TELEVISION REPLACEMENTS**
**Line Output Transformers**
from 45/- each, NEW Stock
and other timebase components
Most makes available. S.A.E. with all enquiries

**MIKE TRANSFORMER** 50:1, 3/9.
**P.V.C. CONN. WIRE,** single or stranded, 2d. yd.
**SLEEVING,** 1 or 2 mm, 2d.; 4 mm, 3d.; 6 mm, 5d. yd.

**FERRODYNAMICS AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE**

| | | | Spare Plastic Reels | |
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| Double Play | 7" reel, 2,400 ft. | 60/– | | |
| | 5" reel, 1,200 ft. | 37/6 | | |
| Long Play | 7" reel, 1,800 ft. | 35/– | 3" | 1/6 |
| | 5¾" reel, 1,200 ft. | 23/6 | 4" | 2/– |
| | 5" reel, 900 ft. | 18/6 | 5" | 2/– |
| Standard | 7" reel, 1,200 ft. | 25/– | 5¾" | 2/– |
| | 5" reel, 600 ft. | 16/– | 7" | 2/6 |

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250V A.C. 27/6. Leaflet S.A.E.

**ARDENTE TRANSISTOR TRANSFORMERS**
D3035, 7.3 CT:1 Push Pull to 3 ohms for OC72, 9/6.
D3034, 1.75:1 CT. Push Pull Driver for OC72, 9/6.
D3058, 11.5:1 Output to 3 ohms for OC72, etc., 9/6.
D167, 18.2:1 Output to 3 ohms for OC72 etc., 12/–.
D239, 4.5:1 Driver, ¾in. x ⅝in. x ⅝in., 10/–.
D240, 8.5:1 Driver, ¾in. x ⅝in. x ⅝in., 10/–
**ARDENTE TRANSISTOR VOLUME CONTROLS.** Type VC1545, 5K with switch, dia. .9in., 5/3. Type VC1760, 5K with switch, dia. .7in., 10/6.
**DEAF AID EARPIECE** Xtal or magnetic 7/6.
**SPEAKER FRET.** Gold cloth, 17in. x 25in., 5/–; 25in. x 35in., 10/–. **TYGAN,** various colours, 52in. wide, from 10/– ft.; 26in. wide from 5/– ft. Samples S.A.E. Expanding Metal, Gold, 12in. x 12 in., 6/–

## BARGAIN SINGLE PLAYER KIT

**£8.15.0** post free

WITH 2-STAGE 3-WATT AMPLIFIER.
HIGH-FLUX 5" SPEAKER.
HANDSOME PORTABLE CASE 13" 10½" x 7½".
COLLARO JUNIOR 4-SPEED MOTOR.
CRYSTAL PICK-UP FOR L.P./STANDARD RECORDS, 7"—10"—12".

*Few only 3-speed models with B.S.R. motor.* Complete Kit **£7.15.0** only.

## MONARCH RECORD PLAYER


**BUILD IT YOURSELF using 4-SPEED BSR MONARCH AUTOCHANGER READY BUILT 3W AMPLIFIER, HANDSOME PORTABLE CASE. HIGH FLUX LOUDSPEAKER. FULL INSTRUCTIONS**

Total Price
Carr. and ins. 5/– **£12.10.0**

**De-Luxe Kit with GARRARD Quality Auto-changer £12.19.6** Carr. & Ins. 5/-

## RECORD PLAYER BARGAINS

Complete with LP/STD Xtal Heads.
4 Speed Autochangers: POST 2/– each
BSR, U.A.14 ...... £7.10.0
BSR. U.A.12 Stereo/Monaural ...... £8.5.0
Garrard Autoslim Changer...... £7.19.6
4 Speed Single Players:
EMI with auto. stop ...... £6.5.0

Replacement Sapphire Stylii from 6/–
Replacement Crystal Cartridges from 21/–

**AUTOCHANGER ACCESSORIES**
Amplifier player cabinets with cut boards, 70/–. 2-valve amplifier and 6½ speaker for above, ready mounted on baffle, 12in. x 7in., 3in. deep, *Wired and tested ready for use.* **£4.15.0.**

## QMAX CHASSIS CUTTER

The cutter consists of four parts: a die, a punch, an Allen screw and key.
½" 14/6, ⅝" 14/9, ¾" 15/6, ⅞" 15/9, 1" 17/6, 1⅛" 17/6, 1⅜" 20/–, 1½" 20/6, 1¾" 22/6, 2" 34/3, 2 3/32" 37/9, 2½" 44/3, 1" square 31/6, 1 1/16" square 28/–.

## WEYRAD

**COILS AND TRANSFORMERS FOR A 2-WAVE TRANSISTOR SUPERHET WITH PRINTED CIRCUIT AND FERRITE ROD AERIAL**

Long and Medium Wave Aerial—RA2W. On 6in. rod, 7/16in. diameter, 208 pF. tuning, 12/6.
Oscillator Coil P50/1AC. Medium wave. For 176 pF. tuning, 5/4. Car aerial coil 1/-.
1st and 2nd I.F. Transformer—P50/2CC. 470 kc/s, 11/16in. diameter by ⅞in. high, 5/7.
3rd I.F. Transformer—P50/3CC, to feed diode detector, 6/–. 24-Fixed resistors 10/6.
Driver Transformer—LFDT4, 1 3/16in. x ⅞in. x 1¼ in., 9/6. 16-Fixed condensers 21/–.
Printed Circuit—PCA1. Size 2¾in. x 8¾in. Ready drilled and printed with component positions, 9/6. Jackson 00 gang 10/6.
35 ohm Speakers, 7in. x 4in., 25/–, 3½in., 19/6.
Wavechange Swtch 3/6. Volume Control 4/6.
Set of 6 Mullard Transistors and diode, 42/6.
These components are approved by transistor makers and performance is guaranteed.
Constructor's Booklet with full details, 2/–.

**NEW MULLARD TRANSISTORS**
OC71...6/– OC81D...7/6 OC44...8/9 OC171...10/6
OC72...7/6 OC81...7/6 OC45...8/6 AF117... 9/6
**Sub-miniature Electrolytics** (15 V). 1 mfd. 2 mfd., 4 mfd., 5 mfd., 8 mfd., 16 mfd., 25 mfd., 30 mfd., 50 mfd., 100 mfd., 2/6.
Diodes OA81, 3/–; GEX 34, 4/–.

**B.B.C. 2 Transistor.** M.W. and L.W. Radio Kit, 22/6. Earpiece, 7/6. Battery 2/3.

**6 TRANSISTOR RADIO MED. & LONG WAVE KIT £4.5.0**
First-class components to make a 6-transistor 2-waveband superhet chassis. Ideal for portable or table radio. All parts including BVA transistors ferrite aerial, printed circuit, 8¼in. x 2¾in., but EXCLUDING speaker and cabinet. Simple instructions, 1/6 (Free with kit). 35 ohm Speakers, 3½ in. 19/6, 5 in. 22/6, 7 x 4 in. 25/–.

# SPECIALISTS

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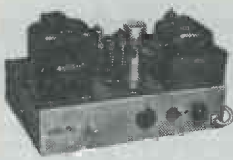
# STERN'S MULLARD DESIGNS

**Designed by MULLARD—presented by STERN'S strictly to specification**

## MULLARD "5-10" MAIN AMPLIFIER



For use with the MULLARD 2-valve pre-amplifier with which undistorted power output of up to 10 watts is obtained. We supply **SPECIFIED COMPONENTS AND NEW MULLARD VALVES**, including **PARMEKO MAINS TRANSFORMER** and choice of the latest Ultra-Linear **PARMEKO** or the **PARTRIDGE** Output Transformer.

COMPLETE KIT OF PARTS (PARMEKO Output Trans) **£10.10.0**

Alternatively we supply **ASSEMBLED** and **TESTED.** **£11.10.0**

**INCORPORATING PARTRIDGE OUTPUT TRANSFORMER, £1.6.0 EXTRA.**

## MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

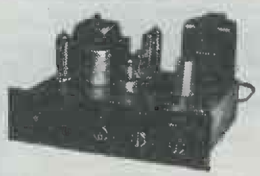
Employing two EF86 valves, and designed to operate with the MULLARD **MAIN AMPLIFIERS**, but also perfectly suitable for other makes.

PRICE COMPLETE KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**

Supplied strictly to **MULLARD'S SPECIFICATION** and incorporating:

- 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.

## THE MULLARD "510/RC" AMPLIFIER



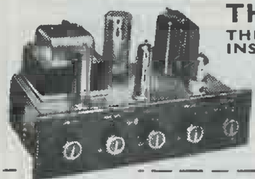
The popular complete "5-10" incorporating Control Unit providing up to 10 watts. Only Specified Components and new **MULLARD VALVES** are supplied including **PARMEKO MAINS TRANSFORMERS** and choice of the latest **PARMEKO** or **PARTRIDGE** ULTRA-Linear Output Transformers.

KIT OF PARTS **£11.10.0** OR ASSEMBLED and TESTED **£13.10.0**

H.P. Dep. £2.6.0 12 months at 17/-. Dep. £2.14.0 12 months at 19/10

ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra

## THE MULLARD "33/RC"



**THE IDEAL AMPLIFIER FOR A SMALL HIGH QUALITY INSTALLATION PROVIDING EXCELLENT REPRODUCTION OF UP TO 3 WATTS OUTPUT**

COMPLETE KIT OF PARTS **£7.10.0** OR ASSEMBLED and TESTED **£8.19.6**

(plus 6/6 carriage and insurance) H.P. Terms: Deposit £2.0.0 and 8 months at £1.0.0. Complete to MULLARD'S SPECIFICATION including Mullard valves and a **PARMEKO OUTPUT TRANSFORMER.**

## Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard.

**KIT OF PARTS £10.0.0**

**ASSEMBLED AND TESTED £14.5.0**

Deposit £2.17.0. 12 months of £1.0.11.

## A BULK PURCHASE ENABLES US TO OFFER

### THE "TUDOR" AM/FM TUNING UNIT

**A SELF POWERED HIGH FIDELITY TUNER PROVIDES FULL COVERAGE of the VHF/FM TRANSMISSIONS and also the LONG and MEDIUM WAVE BANDS.**

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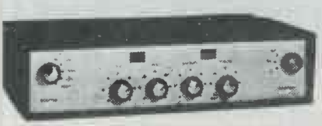
Incorporates Multiplex outlet socket for stereophonic purposes (when adapted) and separate controls for tuning FM and AM bands. Operates perfectly with the STERN-MULLARD AMPLIFIERS and contains matching FRONT PANEL in Black/Gold or White/Black. Also operates equally well with any Amplifier requiring input of 100 to 350 m/Volts.

### THE "TUDOR" STEREO AMPLIFIER



For Only **£18.18.0**

Deposit £3.16.0

12 months £1.7.8

A self contained 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, DESCRIPTIVE LEAFLET IS AVAILABLE.

## PRICE REDUCTIONS

(a) The KIT OF PARTS to build both the "S-10" Main Amplifier and the 2-valve PRE-AMP CONTROL UNIT H.P. Dep. £3.7.0 and 12 months at £1.2.9 .......... **£15.15.0**

(b) The "S-10" and the 2-stage PRE AMP both ASSEMBLED and TESTED H.P. Dep. £3.16.0 and 12 months at £1.7.8.......... **£18.18.0**

With Partridge O/put Transformer £1.6.0 extra.

## RECORD PLAYERS

The Standard **GARRARD "AUTO-SLIM"** 4-speed Autochanger with Crystal Pick-up...... **£8.10.0**

**COLLARO "JUNIOR" 4-SPEED SINGLE RECORD PLAYER** with separate Crystal Pick-up .......... Carriage and Insurance 5/-. **£3.15.0**

Above Pick-up separately for £1.6.6.

**GARRARD "AUTOSLIM DE-LUXE"** 4-speed Autochanger incorporates transcription Pick-up Arm.......... **£12.14.6**

The **COLLARO C60** 4-speed Autochanger unit with Studio "O" Pick-up .......... **£7.19.6**

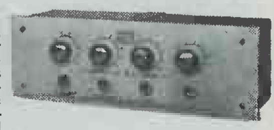
**B.S.R. MODEL UA14.** A 4-speed mixer Autochanger with Crystal Pick-up .......... **£7.19.6**

**GARRARD MODEL TA/Mk.II** 4-speed Player fitted high output Crystal Pick-up.......... **£8.10.0**

**PHILIPS MODEL AG1016** A 4-speed Player which can be operated both manually and automatically. Suitable for Mono or Stereo operation .......... **£13.13.0**

Carriage and Insurance on each above 5/- extra.

## MULLARD FOUR CHANNEL MIXING UNIT



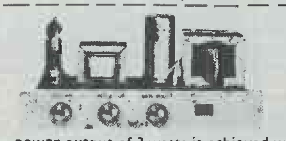
Self powered. Cathode follower output. Incorporates Two inputs for MICROPHONES, One input for CRYSTAL PICK-UP and a fourth for RADIO or TAPE

Kit of Parts **£8.8.0** Assembled and Tested **£10.0.0**

TERMS: Deposit £2 and 12 months at 15/-.

Alternatively **MODEL I.L.** provides for one microphone Input matched for moving coil or Ribbon Mike. £1.17.0 extra.

## THE "MONO-GRAM" AMPLIFIER



A small Amplifier capable of genuine high quality performance. It incorporates the new MULLARD ECL86 Valve, separate BASS and TREBLE CONTROLS and when driven by the standard Crystal Pick-up a power output of 3 watts is achieved without distortion.

The "MONO-GRAM" is ideally suited to incorporate in Portable Record Players. A specially designed case finished in two tone Rexine is available and this will accommodate both the Amplifier and matching 8" x 5" P.M. Loudspeaker.

**PRICE AMPLIFIER ONLY £4.14.6** (Carr. and Ins. 5/- extra.)

**PORTABLE CASE £4.0.0 8" x 5" LOUDSPEAKER £1.0.0**

**COMBINED PRICE** (3 Units) **£9.10.0** also available as a kit of parts, price on application.

## THE "TRUVOX" TOUCH

**With the New "SERIES 60" RECORDERS**

TWO MODELS ARE AVAILABLE

**R62.** Twin Track Recorder with speeds of 1⅞ and 3¾ i.p.s.

**R64.** Four Track Recorder with speeds of 3¾ and 7½ i.p.s.

PRICE FOR EACH MODEL **£40.19.0**

Deposit £8.4.0., 12 months of £3.0.1.

They offer full MIXING, MONITORING and SUPERIMPOSING facilities. There is an AUTOMATIC STOP, a REV COUNTER and a storage compartment for 7 in. spools tape.

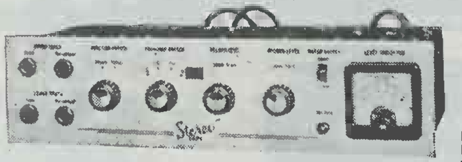
DESCRIPTIVE LEAFLETS READILY AVAILABLE

**STERN RADIO**
**PREMIER RADIO**
**MAIL ORDERS and all POSTAL ENQUIRIES to**

# Stereophonic Sound by Stern's

## THE "STP-1" STEREO TAPE PREAMPLIFIER DESIGNED TO OPERATE WITH

- BRENELL Mk. V TAPE DECK incorporating ¼-TRACK MINI-FLUX TAPE HEADS.
- PUSH-PULL OSCILLATOR
- 4-SPEED EQUALISATION
- FERROXCUBE OSCILLATOR TRANSFORMER
- METER FOR SIGNAL LEVEL
- SEPARATE GAIN CONTROLS
- MULLARD VALVES



COLLARO "STUDIO" TAPE DECK incorporating ¼-TRACK TAPE HEADS.

OVERALL SIZE CASE 13¾ x 3in. FRONT PANEL (Choice of Black or White) 14 x 3¼in.

**PRICES INCLUDE SEPARATE POWER UNITS**

KIT OF PARTS **£22.0.0** Deposit £4.8.0 12 months of £1.12.3

ASSEMBLED and TESTED **£28.0.0** Deposit £5.12.0 12 months of £2.1.1

### COMBINED PRICE SCHEDULE

(a) The **BRENNELL Mk V ¼ TRACK DECK** with complete KIT to build the STP-1 ... ... ... ... ... **£61.0.0**
Deposit £12.4.0. 12 months of £4.9.6.

(b) The **COLLARO "STUDIO" ¼ TRACK DECK** with complete KIT to build the STP-1 ... ... ... ... **£39.0.0**
Deposit £7.16.0. 12 months of £2.17.3.

(a) The **BRENNELL Mk V ¼ TRACK DECK** with the STP-1 assembled and matched to the Deck ... ... ... **£67.0.0**
Deposit £13.8.0. 12 months of £4.18.3.

(b) The **COLLARO "STUDIO" ¼ TRACK DECK** with the STP-1 assembled and matched to the Deck ... ... ... **£45.0.0**
Deposit £9.0.0. 12 months of £3.6.0.

**THE MULLARD "10 plus 10" AMPLIFIER** (described below) with the STP-1 PREAMPLIFIER and one of the TAPE DECKS provide a complete STEREOPHONIC INSTALLATION. Details are readily available.

## MULLARDS "10 PLUS 10" STEREO AMPLIFIER

**A high fidelity design providing up to 10 watts (per channel) Superb reproduction. Frequency response flat to within 3 db from c/s. to 60 Kc/s at 50Mw. Total Harmonic Distortion at 10 watts 0.1%.**

(a) ASSEMBLED AMPLIFIER, including CONTROL UNIT (as illustrated) ........................................ **£21.0.0**
Deposit £4.4.0, 12 months at £1.10.10

(b) A complete KIT of PARTS........................................ **£18.10.0**
Deposit £3.14.0, 12 months at £1.7.2

We supply the assembled MAIN AMPLIFIER only for operation with our DUAL CHANNEL PREAMPLIFIER, this provides for more versatile installation and would be essential if a low output Pick-Up, such as the Decca, is to be used.

(a) THE ASSEMBLED MAIN AMPLIFIER with the ASSEMBLED DUAL CHANNEL PREAMPLIFIER............... **£30.0.0**
Deposit £6.0.0, 12 months at £2.4.0.

(b) A complete KIT of PARTS for both Units................. **£26.0.0**
Deposit £5.4.0, 12 months at £1.18.2

**Illustrated and Descriptive Brochure available. Please enclose S.A.E.**

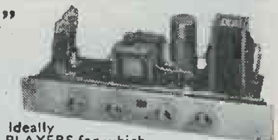
## DUAL CHANNEL AMPLIFIER

A four valve design both **STEREOPHONIC** or **MONAURAL** operation. It is designed primarily to operate with our range of **MULLARD MAIN AMPLIFIERS** but will also operate equally well with any make of Amplifiers requiring an input of 250 m/volts.

KIT OF PARTS **£12.10.0** H.P. £2.10.0 & 12 mths. at 18/4.

ASSEMBLED AND TESTED **£15.0.0** H.P. £3.0.0 & 12 mths. at £1.2.0

## THE "TWIN THREE" STEREO AMPLIFIER



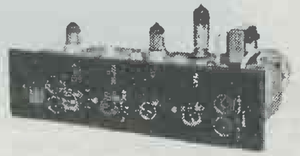
ASSEMBLED AND TESTED for **£7.15.0** (Carr. & Ins. 7/6 extra)

Based on a design by MULLARD LTD. Ideally suited for use in PORTABLE RECORD PLAYERS for which purpose we offer a specially designed Portable Case. Incorporates MULLARD ECL 86 Valves, separate BASS and TREBLE CONTROLS and produces excellent reproduction of up to 3 watts per channel. Frequency response is 40 c/s to 30 Kc/s, size 11½in. x 3in. x 5in.

**To construct a STEREO PORTABLE RECORD PLAYER** we offer:—The assembled AMPLIFIER with two ROLA 8in. x 5in. LOUDSPEAKERS and the PORTABLE CASE for £14 (Carr. and Ins. 10/- extra.) Deposit £2/16/-. 12 months £1.0.6. SUITABLE RECORD PLAYERS FROM £8.14.0

## HF/TR3 TAPE AMPLIFIER

**(Mullard Type "A" design)**



A very high quality Amplifier incorporating 3-speed treble equalisation, by the latest FEROXCUBE POT CORE INDUCTOR FOR COLLARO-TRUVOX-BRENELL WEARITE Tape Decks, has GILSEN Output Transformer. Includes separate Power Supply Unit.

KIT OF PARTS **£13.13.0** Deposit £2.15.0 12 months at £1.0.0

ASSEMBLED and TESTED **£17.0.0** Deposit £3.8.0 12 months at £1.4.[illegible]

### ADD "HI-FI" TAPE RECORDING TO YOUR EXISTING AUDIO INSTALLATION WITH

## STERNS-MULLARD TYPE "C"

**TAPE PREAMPLIFIER—ERASE UNIT**

**INCORPORATING THE NEW FERROXCUBE POT. CORE PUSH-PULL OSCILLATOR and 3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.**

PRICES . . . INCLUDING SEPARATE SMALL POWER UNIT

KIT OF PARTS **£14.0.0** Deposit £2.16.0, 12 months £1.0.6.

ASSEMBLED AND TESTED **£17.0.0** Deposit £3.8.0, 12 months of £1.4.11.

ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11.15.0** and **£14.10.0** respectively. (Carr. and Ins. 5/- extra)

## SPECIAL "COMBINED ORDER" PRICES

For Constructors with their own cabinet—WE OFFER—

(a) KIT to build the HF/TR3 Amplifier together with the COLLARO "STUDIO" DECK **£26.0.0**
Deposit £5.4.0. 12 monthly payments of £1.18.2

(b) As above but with the HF/TR3 supplied ASSEMBLED and TESTED **£29.10.0**
Deposit £5.18.0. 12 monthly payments of £2.3.4

(c) KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK **£42.0.0**
Deposit £8.8.0. 12 monthly payments of £3.1.7

(d) As above but with HF/TR3 supplied ASSEMBLED and TESTED **£45.10.0**
Deposit £9.2.0. 12 monthly payments of £3.6.9

(e) THE ASSEMBLED AND TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer etc. **£60.10.0**
Deposit £12.12.0. 12 monthly payments of £4.8.9.

(a) The COLLARO "Studio" Deck with Model "C" Preamplifier and POWER UNIT ASSEMBLED AND TESTED **£29.10.0**
Deposit £5.18.0. 12 monthly payments of £2.3.3

(b) As above but the TYPE "C" Unit and POWER UNIT supplied as KIT OF PARTS **£26.10.0**
Deposit £5.6.0. 12 monthly payments of £1.18.10

(c) The BRENELL Mk. V Deck with the Model "C" PREAMPLIFIER and POWER UNIT. ASSEMBLED and TESTED **£46.0.0**
Deposit £9.4.0 and 12 months at £3.7.6

(d) As above but Model "C" PREAMPLIFIER and POWER UNIT supplied as a KIT OF PARTS **£43.0.0**
Deposit £8.12.0. 12 monthly payments of £3.3.1

(e) The WEARITE MODEL "4" DECK with ASSEMBLED and TESTED Model "C" PREAMPLIFIER and POWER UNIT incorporating WEARITE HEAD LIFT TRANSFORMER, Etc. **£60.10.0**
Deposit £12.2.0 and 12 months at £4.8.9

(Carriage and Insurance on each above is 10/- extra.)

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# Model 8 Universal AvoMeter

## Designed for Dependability

The Model 8 Universal AvoMeter is a high sensitivity multi-range a.c./d.c. electrical testing intrument providing thirty ranges of readings on a 5-inch hand calibrated scale. Range selection is effected by two rotary switches for a.c. and d.c. respectively.

The instrument has a sensitivity of 20,000 ohms per volt on d.c. voltage ranges and 1,000 ohms per volt on a.c. from the 100-volt range upwards, and meets the accuracy requirements of B.S.S.89/1954 for 5-inch scale length portable industrial instruments. It is robust, compact, and simple to operate, and is protected by an automatic cut-out against damage through inadvertent electrical overload.

| VOLTAGE | | CURRENT | | RESISTANCE |
|---|---|---|---|---|
| D.C. | A.C. | D.C. | A.C. | First indication 0.5Ω<br>Maximum indication 20MΩ |
| 2.5V | 2.5V | 50μA | 100mA | 0—2,000Ω (using internal batteries) |
| 10V | 10V | 250μA | 1A | 0—200,000Ω (using internal batteries) |
| 25V | 25V | 1mA | 2.5A | 0—20mΩ (using internal batteries) |
| 100V | 100V | 10mA | 10A | |
| 250V | 250V | 100mA | — | 0—200MΩ (using external batteries) |
| 500V | — | 1A | — | |
| 1,000V | 1,000V | 10A | — | DECIBELS |
| 2,500V | 2,500V | | | −15 dB to +15 dB |

*Various external accessories are available for extending the above ranges of measurement. Leather carrying cases are also available if required.*

Dimensions: $8\frac{1}{8}'' \times 7\frac{1}{4}'' \times 4\frac{1}{2}''$. Weight: $6\frac{1}{2}$ lb.

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# minitest

## POCKET-SIZED MULTIRANGE TEST SET


Only recently introduced, this instrument is proving an outstanding success. Its high sensitivity makes it ideal for testing and fault location in all types of electrical and electronic circuits. The instrument is well built and economically priced. Each instrument supplied with test leads. (Leather carrying case available as an extra).

**RANGES:**
A.C. Volts. 2.5, 10, 25, 100, 250, 1000.
D.C. Volts. 2.5, 10, 25, 100, 250, 1000.
D.C. Amps. 50 μA, 1mA, 10mA, 100mA, 1A.
Ohms. 2000 200,000 20 MΩ

**ACCURACY:**
D.C. Volts & Amps. ± 3% of full scale deflection
A.C. Volts ± 4% of full scale deflection
Ohms ± 5% at centre scale.

SEI *Send for leaflet MIN 6009/R.C.*

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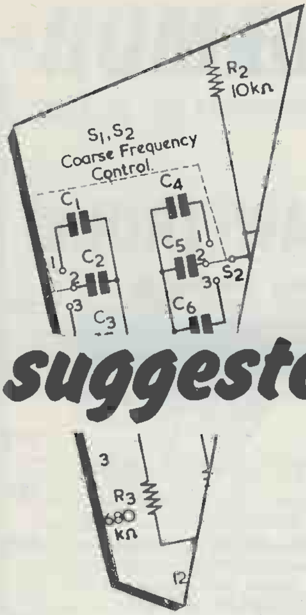


*The circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential data*

# suggested circuits

## No. 144 An Oscillator Checker for Transistor Radios

In some respects, transistor radios can be more difficult to service than valve radios. This is because transistors are, basically, current operated devices, with the result that faults may not be detected as readily by simple voltmeter tests. A circuit in which voltmeter checks can be particularly unhelpful is the oscillator section of medium and long wave transistor superhets. It is frequently desirable to check whether this oscillator is operating but, quite often, the differences in oscillator circuit d.c. voltages between the running and non-running conditions are so small as to be almost negligible. Indeed, one recent transistor receiver service manual states that the most satisfactory method of checking oscillator running is to connect an oscilloscope across the emitter resistor. With the oscillator working correctly, a signal having an amplitude around 250mV peak-to-peak should then be displayed.

Obviously, this state of affairs can prove irksome to the busy service engineer who does not have excess time to spare. What he requires is an instrument which can tell him quickly and reliably whether the receiver oscillator is functioning, such an instrument being capable of quick connection to the receiver under test.

This month's article describes a Suggested Circuit for an oscillator checker. A prototype has been assembled, and this gave good results with a typical medium and long wave transistor receiver. In many instances there should be no necessity for a direct connection to the receiver under test, it merely being necessary to position an insulated probe wire close to the oscillator circuit. Apart from detecting the presence of oscillations, the device may also be used to "follow" the receiver oscillator frequency across either the medium or the long wave band in order to ascertain whether oscillation ceases at any point. Provided care is taken to discriminate against harmonics, the unit may also give a rough indication of oscillator frequency within a band, if a serious fault is suspected in the tracking components. Indications are given by heterodyne beats, these being reproduced via a miniature earphone.

### Principle of Operation

All standard medium and long wave transistor superhets employ an i.f. around 470 kc/s, and in all cases oscillator frequency is higher than signal frequency. A typical receiver medium wave band is 1,500 to 500 kc/s (200 to 600 metres). In this band the oscillator will run at some 470 kc/s higher than signal frequency, and will therefore cover a range of 1,970 to 970 kc/s. A fully tuned long wave band (some receivers have restricted tuning on long waves) would range from 300 to 150 kc/s (1,000 to 2,000 metres), whereupon the corresponding oscillator coverage is 770 to 620 kc/s.

With the checker unit described in this article, a transistor oscillator with a calibrated tuning capacitor functions on two ranges, one covering 1,970 to 970 kc/s and the other 770 to 620 kc/s. The output of the oscillator is coupled to a germanium diode detector as is, also, a lead which is capacitively coupled to the oscillator circuit of the receiver under test. When the two frequencies are sufficiently close together a beat note is formed, this being fed to a transistor a.f. amplifier and thence to the earphone.

In use, the variable capacitor of the checker is set to a calibration corresponding to the dial reading of the receiver under test. By swinging either the checker variable capacitor, or that in the receiver, a beat note should be heard, this indicating that the receiver oscillator is functioning. If desired, positive identification of receiver oscillation may be achieved by switching off the receiver, whereupon the beat note should disappear. For a complete check of the receiver oscillator, the receiver variable capacitor and that in the checker may then be swung in step over the entire band, beat notes occurring as each oscillator passes the other. This indicates that the receiver oscillator is functioning at all tuning positions and that it is running at approximately correct frequency. The process of swinging across either the medium or long wave band is very quick, and can be readily carried out in much less than half a minute after familiarisation with the procedure.

In the checker unit, a standard medium wave r.f. coupling coil, tuned by a 500pF variable capacitor, is employed to provide the 770 to 620 kc/s range just mentioned. The 1,970 to 970 kc/s range is given by an r.f. coupling coil designed for the "shipping" bands. Since the coverage of this second coil with 500pF tuning capacitance does not entirely coincide with the 1,970 to 970 kc/s range it has to be tuned by a 1,000pF variable capacitor, and a suitable component is a 500pF twin gang capacitor having both sections commoned. Both ranges offered by the coils extended, in the prototype, beyond the limits just specified, and this can be an advantage with receivers having extended medium or long wave bands.

The checker may be employed to test the oscillators in medium and long wave valve receivers as well as in transistor receivers.

**The Circuit**

The circuit of the tester appears in Fig. 1. In this diagram the two oscillator coils appear as $L_1$ $L_2$ and $L_3$ $L_4$. The coupling windings, $L_2$ and $L_4$, are connected to the base of oscillator transistor $TR_1$ by way of $S_{1(b)}$, feedback from the collector to the tuned windings, $L_1$ and $L_3$, being effected via $C_4$ and $S_{1(a)}$. When $S_{1(a)}$ and $S_{1(b)}$ are in position 1, coil $L_3$ $L_4$ is selected. This is a medium wave coil, Osmor type QHF8, and it is tuned by the 500pF capacitor $C_2$. When $S_{1(a)}$ and $S_{1(b)}$ are in position 2, $L_1$ $L_2$ is selected, this coil being an Osmor QHF4 designed for the "shipping" bands. At the same time $S_{1(c)}$ connects in parallel with $C_2$, giving a total tuning capacitance of 1,000pF.

An r.f. output is taken from the base of $TR_1$ via $C_6$ to the germanium diode $D_1$. Also applied to the diode, via $C_7$ is the r.f. picked up by the insulated probe wire from the oscillator circuit of the receiver under test. Diode $D_1$ rectifies both these signals, causing a heterodyne to be formed when they are sufficiently close to each other. This heterodyne is applied to the a.f. transistor $TR_2$ and, thence, to the output transistor $TR_3$. The heterodyne may then be heard in the earphone.

**Aspects of Design**

Although this device is very simple in theory, it proved to be somewhat difficult to get into economic working form. The main difficulty was that of the relatively low r.f. voltage at which transistor radio oscillators work. It was considered desirable to avoid direct connections to the oscillator circuits of the receiver under test, and the capacitive pick-up employed allows only a very small r.f. voltage to become available for the diode circuit in the checker. Because of this, a two-transistor a.f. amplifier was required to bring the heterodynes given by the diode to an adequate level.

There is, fortunately, an aspect of the circuit which enables a reduction in components to be achieved. The oscillator in the checker generates r.f. at a reasonably constant level for all settings of $C_2$ (or $C_2$ and $C_3$ in parallel) and this results in a steady d.c. voltage being available across the diode. In Fig. 1 the diode is so connected that the steady rectified voltage is negative of the positive supply line. The rectified voltage is then used to bias $TR_2$. Thus, resistor $R_6$ carries out three functions: it allows the passage of a.f. to $TR_2$; it decouples the transistor base from the diode circuit, thereby reducing the r.f. applied to the base and preventing excessive damping of the diode detector circuit; and it allows a bias current of correct proportions to flow in the base-emitter junction. Thus, by taking advantage of the steady voltage given by the oscillator, a number of coupling and bias components are saved.

Furthermore, by raising the base-emitter voltage of $TR_3$ to a sufficiently high level (through employing a fairly high-value stabilising resistor in the $R_9$ position) it becomes possible to couple the collector of $TR_2$ directly to the base of $TR_3$. In consequence, the two-transistor a.f. amplifier employs a minimum of components and requires only one electrolytic capacitor.

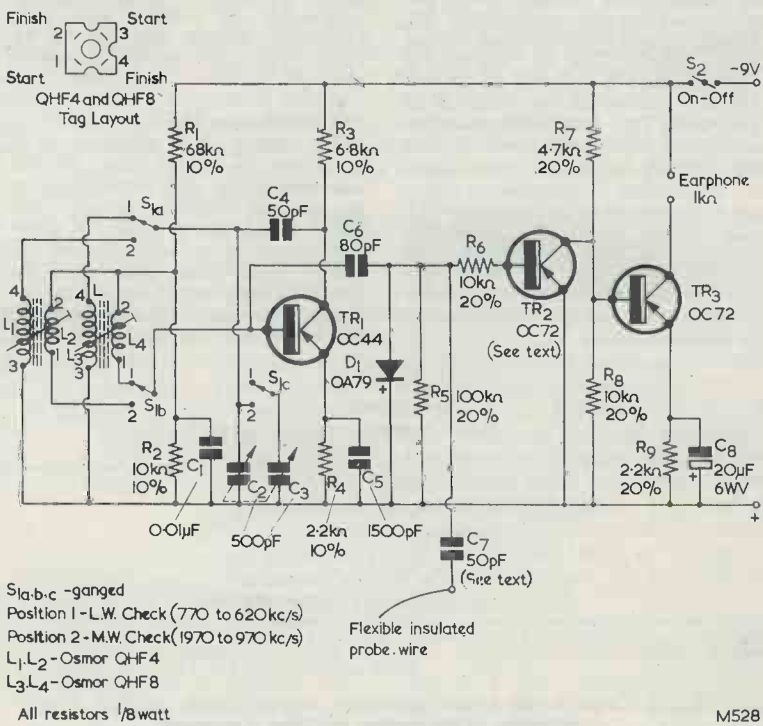


*Fig. 1. The circuit of the oscillator checker*

The detector circuit offers a relatively heavy loading on the oscillator in the checker unit. This is an advantage, because it obviates the idiosyncracies which tend to be present in transistor oscillator circuits when they are required to cover a wide range of frequencies using simple feedback arrangements. Despite the relatively wide coverage, particularly with switch $S_1$ set to position 2, there was no evidence with the prototype of excessive reduction of r.f. energy at the low frequency end of each band, or of squegging at the high frequency end.

An OC72 is specified for the $TR_2$ position, but it should be possible to obtain equivalent results with almost any a.f. transistor here. Equivalents to the OA79 should, similarly, cope in the $D_1$ position. A 1kΩ earphone was employed by the writer with the prototype, but it is probable that any high-impedance magnetic earphone would be equally satisfactory. It should be pointed out that $C_7$ is merely an isolation capacitor, and that it could have any value between 25 and 100pF instead of the 50pF specified in Fig. 1.

**Construction and Calibration**

Little difficulty should be experienced in the construction of the checker, since few components are employed and layout should not be very critical. No r.f. decoupling components are included in the a.f. amplifier circuit as the response of $TR_2$ and $TR_3$ at such frequencies should be low in any case. If it is felt, with a particular layout, that r.f. decoupling is desirable, a capacitor having a value between 0.01 and 0.1μF could be connected between the base of $TR_2$ and the positive supply line. The writer has not checked the effect of adding such a component, and it was not needed in the prototype.

To obtain optimum oscillator efficiency, the cores in $L_1$ $L_2$ and $L_3$ $L_4$ should be set to give maximum coupling between the tuned and coupling windings. This is given approximately when the tops of the cores are level with the tops of the upper windings.

The tuning capacitor $C_2$ $C_3$ should be mounted centrally, so that it may be provided with a large clearly-read dial. It is preferable to give $C_2$ $C_4$ four scales, two of these being calibrated in terms of the frequency at which $TR_1$ oscillates for switch positions 1 and 2, and the remaining two being calibrated in terms of these frequencies less 470 kc/s. The second two scales will then correspond to the tuning dials of receivers employing an i.f. of 470 kc/s, and will be close to those of receivers having i.f.'s which are slightly removed from 470 kc/s.

Calibration may best be effected by applying a signal generator to $C_7$ and marking out the two scales which show the actual frequency at which $TR_1$ oscillates. The remaining two scales may then be marked out by subtracting 470 kc/s. Alternatively, the second two scales may be marked out with the aid of a receiver employing an i.f. of 470 kc/s, the first two scales being calibrated afterwards by adding 470 kc/s. Obviously, greater accuracy will be given with the signal generator method.

**The Checker in Use**

To employ the checker, it is necessary to couple the flexible insulated probe wire capacitively to the receiver oscillator circuit. No direct connection is made. A fairly tight coupling is required, and the writer found that this could be provided very satisfactorily by inserting the insulated wire between the frame and the fixed vane bank of the oscillator gang in the receiver. The wire must not pass between the vanes themselves, because of the possible risk of damage, and it merely lies close to the vane bank. The oscillator gang of the receiver tuning capacitor may be readily recognised, since it usually has fewer vanes than the signal frequency gang.

If it is impossible to position the probe wire sufficiently close to the oscillator circuit elements for reasonable pick-up, a connection to the oscillator circuit via a low-value capacitance may be employed. Fig. 2 shows how a suitable "capacitor" can be made up by twisting two insulated leads together. The crocodile clip may be applied to any circuit element carrying oscillator r.f. energy, typical points being the base or collector of the receiver oscillator, or the fixed vane lug of the tuning capacitor. The small capacitance inserted by the arrangement of Fig. 2 should cause very little detuning of the receiver oscillator.

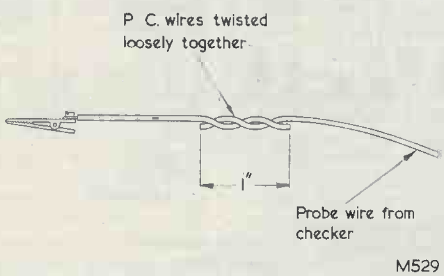


*Fig. 2. How a low value "capacitor" may be made up if a direct connection to the receiver oscillator is necessary*

The flexible probe wire should be p.v.c. covered and may have any convenient length between 1 and 2 ft. Results with the prototype indicated that little increase in pick-up was given by coupling together the positive supply lines of the checker and the receiver under test. Nevertheless, such a connection may be advantageous in some cases and can be readily carried out by applying a crocodile clip to the receiver battery terminal.

After a suitable coupling has been achieved and the presence of oscillations ascertained, the receiver tuning capacitor may be swung across the appropriate band in step with the checker capacitor, as described above. If it is desired to check oscillator frequency coverage due to a suspected tracking fault, the frequency calibration of the checker will give an indication of oscillator frequency. However, care should be taken to avoid working with harmonics of either oscillator, which would give rise to misleading results. With the prototype, harmonic beats were noticeably weaker than fundamental beats, and were only encountered when the checker and receiver tuning capacitors were adjusted to very widely differing settings.

**Results with the Prototype**

The prototype gave reliable results when used with a typical medium and long wave transistor receiver. Capacitive coupling to the oscillator gang of the tuning capacitor was employed, and this caused the a.f. level of the heterodynes in the earphone to be adequate for normal working conditions.

The checker continued to function when the supply was reduced to 3 volts, but it was felt that the increased a.f. level in the earphone at 9 volts justified the use of the higher supply potential. Current consumption at 9 volts varied between 3.3 and 4.2mA according to the frequency of the oscillator.

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**"The Radio Constructor" December Issue**

The December issue of the Magazine will be published on on Saturday, 1st December.

# 27 Mc/s Transistor Transmitter for Radio Control

By M. V. BOND (G3NWF)[1]

UNTIL RECENTLY TRANSISTORS CAPABLE OF GIVING a useful power output at high frequencies have been unobtainable in this country, those being sold having been mostly imported. There are now, however, a range of silicon diffused epitaxial planar transistors available. These transistors are admirably suited to transmitter circuits.

The transistors used in the transmitter described in this article are the lower power types in the range.

**The Transmitter**

The transmitter is intended for use in radio control systems, although the design can also be used for portable transmitters on the 28 Mc/s amateur band.

The power output is limited by G.P.O. regulations to a maximum of 1.5 watts, if used for radio control. This circuit will give up to 2 watts output with transistors having gains at the top of the specified limit. Typical transistors will give an output of about 1.5 watts.

[1] Standard Telephones and Cables Limited.

The transmitter consists of a crystal controlled oscillator driving an amplifier stage which, in turn, drives a push-pull power amplifier. Crystal control has been used, as it was considered necessary to have good frequency stability in order to make full use of the more selective receivers now available for radio control. Using crystal control also has the advantage of eliminating the need for frequency measuring equipment, since the oscillator used cannot oscillate at any frequency but that of the crystal.

The amplifier stage between the oscillator and the power amplifier could possibly be eliminated, but this would necessitate using the crystal at excessive dissipation, resulting in poor frequency stability and possible overheating and destruction of the crystal.

The oscillator is of a type whose operation depends on a negative resistance appearing between base and emitter when the emitter load is capacitive.

The crystal used is of the 3rd overtone type.[2] The circuit operates well over a large frequency range, and has in fact been working between 6 Mc/s and 50 Mc/s using various types of crystal. The adjustment of the circuit is not critical. If intended for use at other frequencies the emitter capacitor and collector tuned circuit need only be changed. The tuned circuit should resonate at, or slightly higher than, the crystal frequency.

[2] The 3rd overtone crystals required for this circuit are available from Standard Telephones and Cables Limited (Quartz Crystal Division), Harlow, Essex.

**Components List**

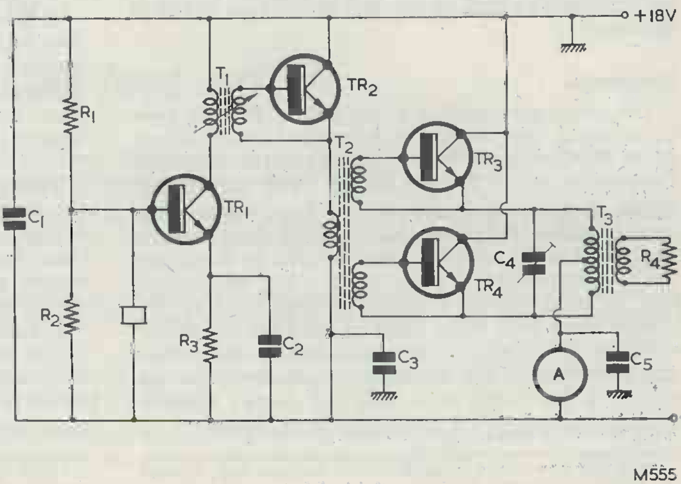
*Resistors*
- $R_1$ 4.7kΩ ¼ watt
- $R_2$ 4.7kΩ ¼ watt
- $R_3$ 470kΩ ¼ watt
- $R_4$ 80Ω (see text)

*Transistors*
- $TR_1$ TK252A S.T.C.
- $TR_2$ TK253A S.T.C.
- $TR_3$ TK253A S.T.C.
- $TR_4$ TK253A S.T.C.

*Capacitors*
- $C_1$ 0.01µF
- $C_2$ 47pF
- $C_3$ 0.1µF
- $C_4$ 30pF
- $C_5$ 0.1µF

*Crystal*
3rd Overtone type (see text)

*Coils*
See Table



The amplifier or driver stage is operated in Class B, this class giving a high collector efficiency whilst still retaining good power gain.

It should be noted that the coils in the amplifier and power amplifier stages have been bifilar-wound on ferrite rings. This has been done to achieve good coupling and power transfer, which are difficult to achieve at the low impedance levels present in this type of circuit.

The output stage is operated in push-pull class B, this configuration giving the highest efficiency. The circuit is designed to work into an 80Ω load. This impedance has been chosen since coaxial cable can then be used between the transmitter and any aerial tuner that may be used. Alternatively the number of turns on the secondary of the output transformer can be changed to suit any aerial impedance.

The best type of aerial for radio control is probably a ground plane, this giving a fairly iniform field strength in all directions over the average terrain.

The above output impedance has also been chosen because it means having an output transformer ratio which gives the maximum transfer efficiency.

**TABLE**

**Coil Winding Details**

| *Transformer* | *Primary* | *Secondary* | *Remarks* |
|---|---|---|---|
| $T_1$ | 7 turns 30 s.w.g. | 2 turns 30 s.w.g. | Slug-tuned on Neosid former type 5000A Primary and secondary interwound |
| $T_2$ | 4 turns 18/47 s.w.g. litz | 2+2 turns 18/47 s.w.g. litz | Bifilar-wound on Stanferite ring type WP3810/SB500 |
| $T_3$ | 4 turns centre-tapped 36/47 s.w.g. litz | 2 turns 36/47 s.w.g. litz | Bifilar-wound on Stanferite ring type WP3809/SB400 |

(NOTE: Stanferite rings are manufactured by Standard Telephones and Cables Ltd.)

### Dissipation

The maximum collector dissipation for the type of transistor used is 600mW at ambient temperatures up to 30°C as rated by the manufacturer, Standard Telephones and Cables Limited. The transmitter design necessitates exceeding this dissipation. This may be done provided that a small heat sink is used, such as the type 5F manufactured by Redpoint Ltd.[3] Alternatively a piece of 16 s.w.g. aluminium may be used having a minimum area of 3 sq. in. One of these heat sinks must be used for the driver transistor and each of the transistors in the power amplifier stage. The oscillator transistor does not require a heat sink as it will not exceed 600mW dissipation, even if its tuned circuit be detuned.

[3] Redpoint heat sinks are available from Redpoint Ltd., Stratton St. Margarets, Swindon, Wilts.

### Construction

Normal constructional practice should be followed, i.e. all leads carrying r.f. must be as short as possible. Also the power amplifier should be as symmetrical as possible when wiring up, since it is inherently a balanced circuit and any unbalance in lead lengths, etc., will result in lower efficiency.

The procedure for aligning the transmitter is very simple and is as follows:

(1) Connect the d.c. supply to the oscillator only, and tune for a dip in collector current.

(2) Detune the collector circuit to a higher frequency (this will lower the drive and prevent the power amplifier from being overdriven).

(3) Connect the d.c. supply to the driver and power amplifier stages, and observe the collector current of the power amplifier. Tune the driver stage[4] for a peak in this reading and then tune the output stage for a dip in the collector current.

(4) Retune the oscillator until the power amplifier collector current reaches 170mA. The transmitter is then ready for use.

N.B.—As these are n.p.n. transistors, the collectors must be connected to the positive end of the supply. All tuning up must be carried out with a dummy load connected to the output. The dummy load can consist of four 330Ω 1 watt carbon resistors in parallel.

The method of keying the transmitter is left to the user. A suggested method is to key the d.c. supply to the oscillator. These transistors pass less than 1μA with no drive, so that the driver and output stages can be considered switched off with no drive applied.

If audio modulation is desired, this can be applied to the base of the driver transistor $TR_2$. Should this method be adopted only a very low modulating power is required, and the modulation is quite linear since the following stages operate in class B.

[4] Although no capacitor is shown across $T_2$, in some forms of mechanical construction this may be necessary.

The power amplifier collector efficiency is about 50%, the total d.c. to r.f. efficiency being about 37%. This is higher than valve transmitters of the same output power.

Another great advantage given by the use of transistors is, of course, the great reduction in the weight and volume of the unit, and of the batteries needed to power it.

# CAN ANYONE HELP?

*Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time*

**APN-1 Radio Altimeter.**—J. C. Hardstone, 192 Streetsbrook Road, Shirley, Solihull, Warks., would like information concerning the circuit, connections and use on 70cm of this 420–460 Mc/s radar set.

* * *

**Slide Synchroniser.**—R. Spencer, 58 Chestnut Avenue, Parks Estate, Belper, Derbyshire, requires information or circuit diagrams of any slide synchroniser, made or bought, which is similar to the Philips type EL3769/60.

* * *

**"Vogue" Tape Recorders.**—G. A. Davies, 1 The Crescent, Mathern, Chepstow, Mon., requires the circuit diagram of the model, serial number STM-13484, or alternatively, the address of the manufacturer.

**Marconi B28 Receiver.**—D. P. Bull, 32 Armstrong Buildings, Armstrong Steps, Gibraltar, urgently needs the handbook or circuit and also any information of modifications and adaptations.

* * *

**Pye TV Receiver, Type 17S.**—R. W. Galley, 43 Alton Road, Fleet, Nr. Aldershot, Hants., wishes to purchase the service sheet for this a.c./d.c. receiver.

* * *

**CR100 Communications Receiver.**—R. Harwood, 32 Moorhey Road, Maghull, Nr. Liverpool, would like to obtain the manual for this receiver.

* * *

**Hallicrafters S38 Receiver.**—E. H. M. Argent, 20 St. Augustines Road, Bedford, is very anxious to obtain the valve line-up of this receiver.

# "LOOK—NO MAINS" TV Camera Operates 30,000 feet up

Thirty thousand feet above the ground, a closed-circuit television camera hurtles through the air at speeds up to 400 m.p.h. in a Royal Air Force Meteor TT20 aircraft, yet transmits clear pictures to a TV receiver in the cockpit.

Purpose of the camera, a Type 8 camera manufactured by E.M.I. Electronics Ltd., is to minimise risk to the pilot's and navigator's lives during evaluation tests of the Del Mar towed target system, at the Ministry of Aviation's experimental establishment at Boscombe Down, Wiltshire.

It is possible for a target to gyrate in the airstream as it leaves and approaches the aircraft during the winching operation. If it were to wrap itself around the tail, the aircraft would tend to go out of control, with consequent danger to the crew.

The camera, which is powered by a 12 volt battery, fits snugly into the fuselage immediately behind the navigator's seat. The lens peeks out through a small aperture facing aft.

A battery-powered television receiver is mounted in front of the navigator and enables him to observe the target's behaviour as he operates the winch. If the target gyrates at a critical moment, he can modify the winching procedure, or, in an emergency, cut the target adrift.

# NEWS and COMMENT . . .

### No National Radio Show in 1963

There will be no National Radio Show at Earls Court in 1963. A trade show, to take place in the late spring or early summer in 1963, is being considered. In addition to set makers, a trade show would be open to aerial, component and valve manufacturers.

According to Mr. S. E. Allchurch, Director of the British Radio Equipment Manufacturers' Association, "Manufacturers believe that it would be better to hold their next public show after the first 625-line UHF television programme has begun and that is the main reason for not holding it in the normal way at the end of August 1963. It is hoped—despite official forecasts to the contrary—that the programme will start before the end of 1963, but it could hardly be started before the autumn."

Plans under consideration for a 1964 public Radio Show include a suggestion that it should be international.

### 1922-1962

It must be difficult for our younger readers to visualise a world without broadcasting but, to our older readers, the knowledge that Wednesday, 14th November will mark the 40th Anniversary of public broadcasting will not only bring back nostalgic memories but will also be a sharp reminder of the passage of time.

What was it like in 1922 with no up-to-the-minute weather forecasts by your fireside, no late news, not even the result of a most important by-election until the paper dropped on your doorstep next morning?

That was until 14th November, when some 30,000 licence-holders, mostly technical enthusiasts and home-constructors, all known in those days as "listeners-in" heard the historic broadcast: "2LO Calling. This is 2LO the London station of the British Broadcasting Company."

Newspapers gave hints to amateurs on how to tune in and get the best results from crystal sets and other types of receiver. They also printed warnings to listeners of the stringent G.P.O. regulations regarding tuners and rectifiers and aerials that must not be allowed to oscillate.

In those days there naturally was not much talk about the infant BBC. Gossip columns were more concerned with the prevailing trouser fashion, "Oxford Bags", then such a craze that the record turn-up width was said to be two feet. Rudolf Valentino's part in *The Sheik* (silent, of course) was a topic of conversation. Mary Pickford was speaking coyly to the Press about her curls. Put-and-Take, a spinning top with numbers on, was the current gambling device. And the hey-day of the Savoy Havana Band was not far off.

Out in the streets of Britain there were still 233,000 licensed horse-drawn vehicles and only 315,000 private motorists!

No Radio Show, and of course, no Radio Times, and for a while no BBC programmes in the Press. Some of the big radio firms, however, began including the programmes in their advertisements. Thus this typical example for 22nd November.

"Tonight's Programmes"
(London Station)

| | |
|---|---|
| 6. | Official Weather Report |
| 6–6.30 | Copyright News Bulletin |
| 8–9.00 | Vocal and instrumental concert by well-known artists. |
| 9. | Latest News Bulletin and Weather Report |
| 9.30–10.30 | Concert, including Dance Music |

Many birthday programmes are planned to celebrate forty years of outstanding achievement. On the eve of the anniversary (Tuesday, 13th November) BBC Television will be presenting a special documentary programme produced by Television's Huw Wheldon, Sound Radio's Douglas Cleverdon and the Film Department's Maurice Harvey. It will look back over the years, during which the microphone has graduated from a delicate temperamental infant, constantly suffering from sore throats, to an almost invisible war-toughened emissary, accompanying man not only to every corner of the earth but into space. In the Home Service, on the birthday itself (Wednesday, 14th November) the pages will be turned of "*Scrapbook for 1922*".

### "International Short Wave Listening Contest 1962"

The above contest is to be held during the month of November, 1962. It has been organised by the I.S.W.L. and World Radio-TV Handbook in conjunction with radio stations throughout the world.

The contest will be open to all short-wave listeners (whether members of I.S.W.L. or not) in all countries of the world. The purpose of the contest is to promote goodwill among peoples.

Four questions have to be answered by each participant. The questions may be heard by listening to various stations during the month of November.

Prizes will include an Eddystone 840C communications receiver, a Hallicrafter communications receiver and a Sony TR-814 portable transistorised receiver.

Readers interested in this contest should write immediately to the International Short Wave League, 12 Gladwell Road, London, N.8.

### A.R.M.S. Award

We were very interested to read in the journal of the Amateur Radio Mobile Society that one of our contributors of very long standing, Mr. W. E. Thompson, G3MQT, has presented the Society with a very novel trophy to be known as the "A.R.M.S. Safety Award".

Mr. Thompson, when in Germany recently, had noticed a souvenir consisting of a miner's safety lamp hanging from a hook projecting from an unusually shaped wall plaque, and it occurred to him that the souvenir would make an admirable award to give at the safety inspections at the famous Barford mobile rally.

The Committee of the Society gratefully accepted the award which will be on show at the Society's stand at the International Radio Communications Exhibition.

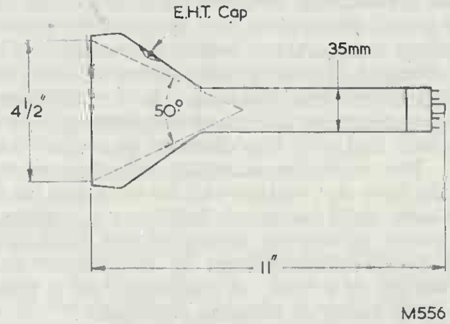
# New TV Monitor Tube for the *EXPERIMENTER*

By B. N. LOVE

FOR SOME YEARS NOW, SERIOUS AMATEUR television experimenters have been looking for a suitable monitor tube of small physical size which is comparatively inexpensive and capable of resolving a faithful television image when operated from standard magnetic receivers. In the past they have had to be content with ex-Government electrostatic radar tubes and in recent years with some magnetic radar tubes coming on to the market. Generally speaking, the screen phosphors of these surplus tubes have been unsuitable for high quality television pictures because of their screen colours or the afterglow characteristics of the phosphors employed.

Where equipment of small physical size has been built or where a bulky tube is inconvenient, many experimenters have turned to the American or Canadian 5FP7 5in flat faced magnetic radar tube. This tube has a 35mm neck and can be scanned by standard domestic television receiver components. Its working potentials and focusing requirements are similar to those required by the early Mullard 12in tubes but it has an International Octal base instead of the duodecal and requires no ion trap magnet. These tubes are readily available on the surplus market and give quite pleasing results on still pictures such as Test Card "C", with slight variations of colour according to the manufacturer. Three typical 5FP7s checked by the writer, one Canadian and two others of different U.S.A. manufacture, showed marked differences in picture tone from identical signal sources.

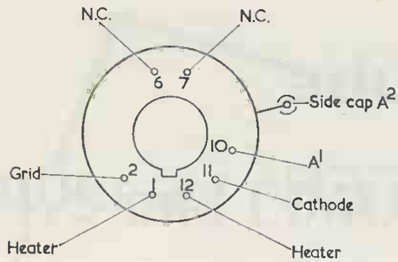
As obtained on the surplus market, the 5FP7 suffers from two distinct disadvantages. In the first case it has a double layer phosphor deposited on the screen, one layer being yellow and the other blue. This results in a blue/yellow picture. The second disadvantage is more serious. The yellow phosphor has a distinct afterglow or long persistence, which means that the illuminated spot on the screen takes several seconds to decay. Where moving objects occur in a televised scene, acute smearing and "ghost" images result. It is possible, with these tubes, to cut off the scanning and beam currents and still retain a "frozen" picture of a televised scene for several seconds, purely on account of afterglow emission.



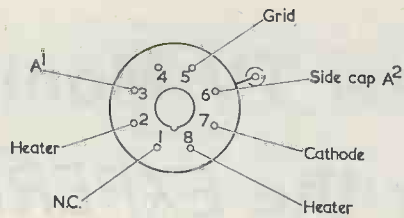

**TABLE**

| RKM6 and RKM12 | 5FP7 |
|---|---|
| Base—Duodecal | Base—International Octal |
| *Voltages* | *Voltages* |
| Heater 12V (RKM12) 300mA | Heater 6.3V |
| 6.3V (RKM6) | |
| A1 250–300V (Focus) | A1 250–350V (Focus) |
| A2 6kV–7kV | A2 6kV–7kV |
| Magnetic focusing* | Magnetic focusing |
| Bent gun ion trap cathode | Straight gun cathode. No trap |
| 35mm neck | 35mm neck |
| Magnetic deflection (angle 50° approx., see text) | Magnetic deflection |
| 5in dia flat faced screen | 5in dia flat faced screen |
| White trace TV tube | Double phosphor radar tube |
| | Blue short persistence and yellow long persistence |

* These tubes are also available with an electro-static focusing gun (see text).




M557




M558

Quite recently a new 5in magnetic monitor tube has been introduced which overcomes these drawbacks and produces a faithful television picture. The tube is based on the shell of a 5FP7 but the original screen phosphors are completely removed and the tube is re-screened with a white trace. The bulb is silvered internally and provided with an external graphite type coating. A complete new cathode gun assembly is fitted incorporating a bent gun ion trap and it is important to fit an ion trap magnet. This must be carefully adjusted on the neck of the tube by rotation and forward and backward motion, until maximum brilliance is obtained on the screen at normal setting of the brightness control. Incorrect adjustment of the magnet can shorten the life of a tube. A duodecal base is fitted and the neck diameter remains at 35mm.

The new tubes are type RKM12 (12 volt) and type RKM6 (6.3 volt) and are manufactured by Diamond Electronics Co.* When properly set up and focused, these tubes produce a very sharp picture of photographic quality. Apart from their obvious use as setting up tubes, they will appeal to constructors favouring miniaturisation. Serious amateur television experimenters will recognise their usefulness as rack monitors, television camera viewfinders and for flying spot scanning experiments. The tubes cost £4 and have a 12 month guarantee.

The accompanying diagram shows a scale drawing for the tube, and it will be noted that a deflection angle of 50% is indicated. This corresponds to a deflection centre positioned well back from the flare and a wider deflection angle would, in consequence, be given with most television scanning yokes. In practice, standard 12in deflector coils and circuits give an ideal scan for these tubes, the usual width and linearity controls requiring very little adjustment if at all.

Details of the RKM and 5FP7 tubes are given in the accompanying table. It should be noted that the new tube is now available with an electro-static focusing gun, thereby allowing the use of either magnetic or electro-static focusing.

* Diamond Electronics Co., Siram Works, 96A Wellington Street, Manchester 18.

# *Britain's New One-Man TV Station will Teach Them*

A new low-cost television station, which can be operated by one man and can transmit programmes up to five miles, has been designed by a British company to help solve the world's teaching problems.

It enables a lecturer to teach a large number of students in his immediate locality by closed-circuit television and, at the same time, to reach more students in outlying schools by means of a low-power television transmitter. Alternatively, since the equipment's output meets full broadcast specifications, it can be fed to a local broadcast station's television transmitter, if that is desired.

The whole of the equipment for this educational television system, now offered by EMI Electronics Ltd., can be carried in a small aircraft and installed in a school classroom. A 50ft tall aerial mast, which is included, is so designed that it can be erected quickly and easily by two people on a suitable site near the classroom, without any site concreting.

A live pick-up television camera and film and slide projection equipment are provided so that film, slide or live pictures can be transmitted. The lecturer can control film starts and slide changes, and point out features of particular interest on films and slides. So two people—an operator and a lecturer—can supply a complete educational programme.

First country to use this new EMI equipment is Northern Nigeria. Several others have already shown considerable interest.

# *A Method of Obtaining Variable Selectivity in Double Superheterodynes*

By J. B. DANCE, M.Sc.

THE NUMBER OF SHORT-WAVE TRANSMITTERS HAS been steadily increasing for many years and at present the ordinary simple superhet is unable to separate most of the weaker signals from the multitude of signals and noise on surrounding frequencies. The short-wave listener who requires a reasonable performance from his receiver must therefore employ a method for obtaining increased selectivity; the two methods most frequently employed are the double superheterodyne and the use of a crystal filter. This article attempts to explain the former method—probably the simplest and cheapest for the home constructor—and gives details of how a very simple but extremely effective variable selectivity intermediate frequency unit can be constructed. The unit can be added to an existing receiver and will give rather more selectivity than can be used with an ordinary amplitude modulated double sideband signal. The method by which the selectivity is altered is a very practical one and no apparatus other than a small meter has been used for the alignment.

Most simple superhet receivers operate by converting any incoming signals (whatever their frequency) into a signal of approximate frequency 465 kc/s; this is called the intermediate frequency or i.f. Almost all of the amplification and selectivity is obtained at this frequency and it is most important that the i.f. should be well away from strong signals or interference will occur. If the i.f. is increased, less selectivity will be obtained for an equal number of tuned circuits and therefore signals on adjacent frequencies will be able to pass through the i.f. section of the receiver and cause interference (called adjacent channel interference). If, however, a low i.f. is used, the receiver will suffer from a type of interference known as second channel interference which cannot be removed by additional i.f. selectivity.

**Double Superhet**

The commonly used i.f. of 465 kc/s has been found to be a fairly satisfactory compromise for ordinary use. Receivers using this i.f. do not suffer very much from second channel interference providing at least one r.f. stage is used, but their selectivity can be very much improved by converting them into double superhet receivers.

The double superhet receiver for use up to about 30 Mc/s operates by converting the incoming signals first to an i.f. which is fairly high (often 1.6 Mc/s) and then converting the frequency again to a very low second i.f. (probably between 30 and 120 kc/s). The rejection of second channel interference is good because of the fairly high first i.f. and the selectivity can be made excellent because of the low second i.f. The double superhet therefore has both of the advantages of a high and a low i.f. in the same receiver. The amplification takes place at two different i.f.'s and therefore the possibility of instability is less than in a single superhet. The only disadvantage of the double superhet is the possibility of whistles being present in the output if signals from the harmonics of the two oscillators find their way into r.f. or i.f. stages. This can be prevented by suitable screening.

**Selectivity**

If a signal in an i.f. amplifier differs slightly in frequency from the i.f., then the ability of the amplifier to reject that signal will depend on the percentage by which that signal is off frequency. For any given frequency difference this percentage is obviously greater in the case of a low i.f. than in the case of a high i.f.; therefore a low i.f. gives the better selectivity. One might expect that ten times as much selectivity would be obtained from an amplifier operating at 46.5 kc/s than would be obtained from a similar 465 kc/s amplifier. Whilst this may be approximately true, other factors (especially the "Q" of the transformers) have to be taken into consideration.

It can be shown theoretically that a receiver which is very selective cannot reproduce high audio frequencies and therefore the quality of sound reproduction from a receiver with high selectivity must inevitably be low. It is therefore highly desirable to be able to alter the selectivity so that a very narrow bandwidth can be used if it is necessary to eliminate interference on a nearby frequency, whilst, if comparatively little interference is present on surrounding frequencies, the bandwidth may be increased in order to render the sound output more natural and easily intelligible. Much greater selectivity can be used when listening to morse transmissions than when listening to speech. If the selectivity of an i.f. amplifier is gradually increased, a point is reached where it is no longer possible to understand speech. If the bandwidth is not too narrow, however, it is possible to make the speech intelligible by introducing bass cut to balance the top cut of the i.f. amplifier. This is most easily done by using a small value for an audio coupling capacitor, but more satisfactory results would probably be obtained if a fairly steep cut high pass filter were used.

**Transformer Construction**

Any frequency between 50 kc/s and 100 kc/s is perfectly satisfactory for the second i.f., but rather more selectivity may be obtained from the lower frequencies. Whilst 85 kc/s i.f. transformers may be purchased or obtained from surplus BC453 units, it is possible to get much satisfaction from making the transformers oneself. In the writer's case, some unwanted permeability tuned transformers were bought for practically nothing from a surplus dealer and the formers and cans were used to make the second i.f. transformers for the unit being described. The formers had an outside diameter of 0.5in and calculations indicated that about one thousand turns of wire would be required in parallel with a capacitor of 680pF to resonate at about 50 kc/s. The wire was wound as tightly as possible and polystyrene cement was used to hold the coil together. Various gauges of wire were tried. It was found that 38 s.w.g. single silk covered enamelled copper wire was the largest which could be used if the transformers were to be placed in the standard 1.4in square i.f. cans. Coils made of wire of a smaller diameter had a much lower Q owing to their greater resistance. Litz wire was not used because of its large diameter and the fact that its use at 50 kc/s is not very advantageous.

Several transformers were constructed, each consisting of two coils of 1,000 turns each of 38 s.w.g. s.c.c. enamelled copper wire spaced 1.1in from each other. Some of the windings were tapped at about 500 turns. These transformers would resonate at about 103 kc/s with a parallel capacitance of 150pF, 85 kc/s with 220pF, 50 kc/s with 680pF and 41 kc/s with 1,000pF. The Q was 70 to 75 at 85 kc/s, dropping to just under 60 at 50 kc/s; these values compare fairly favourably with simple commercial products. It might have been possible to obtain tuned circuits of higher Q by using special magnetic materials or by putting only one tuned circuit in each can and using larger wire. The need for simplicity was, however, kept in mind during the design of the unit.

**Simple Amplifier**

A single superhet receiver can be converted into a double superhet by taking a signal from the i.f. of the receiver and, using a normal frequency changer, converting the first i.f. to that of the second i.f. to be used. This second i.f. is then amplified and detected. A simple amplifier was first built using two of the home made transformers without the variable selectivity switching to be described later. A 6BE6 was used as a converter in the conventional circuit given in Fig. 2. This was followed by a 6BA6 amplifier and finally a 6C4 cathode follower detector. A cathode follower (or infinite impedance) detector is preferred because it does not load the previous tuned circuit appreciably whilst a diode detector would do so. The decoupling capacitors should not be less than 0.1μF. The removal of the 50 kc/s carrier from the audio output is not especially easy; the circuit used by the writer is shown, in Fig. 2, in the cathode circuit of $V_3$.

The oscillator coil was built into an old i.f. transformer can fitted with permeability tuning. The oscillator frequency is not very different from the first i.f. and, if desired, half of a spare transformer of the first i.f. frequency could be modified for use as the oscillator coil and capacitor. The tapping should be adjusted so that the converter oscillator is operating at the r.f. voltage recommended by the valve manufacturers. Rigid con-

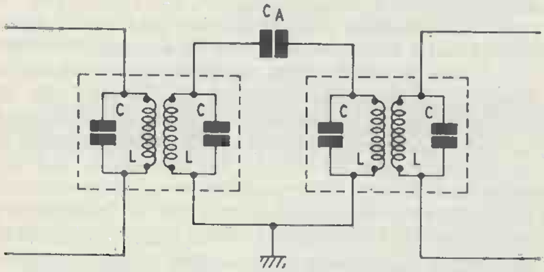



*Fig. 1. A method of coupling two i.f. transformers*

**Components List**

All resistors ¼ watt unless otherwise stated.

*Resistors*

| | |
|---|---|
| $R_1$ | 22kΩ, 1 watt |
| $R_2$, $R_{10}$ | 2kΩ |
| $R_3$ | 22kΩ |
| $R_4$ | 33kΩ, 1 watt |
| $R_5$ | 68Ω |
| $R_6$ | 20kΩ potentiometer (optional) |
| $R_7$, $R_8$, $R_9$ | see text |
| $R_{11}$ | 10kΩ |
| $R_{12}$ | 100kΩ |
| $R_{13}$ | 15kΩ |
| $R_{14}$ | 27kΩ |

*Capacitors*

| | |
|---|---|
| $C_3$, $C_4$, $C_{13}$, $C_{14}$, $C_{17}$ | 0.1μF, paper |
| $C_7$, $C_8$ | 10pF, mica |
| $C_9$ | 1,500pF, mica |
| $C_{10}$ | 100pF, mica |
| $C_{15}$, $C_{21}$ | 82pF, 2% ceramic or mica |
| $C_{16}$ | 33pF 5% ceramic or mica |
| $C_{20}$ | 49pF, 5% ceramic or mica |
| $C_{22}$ | 3,300pF, ceramic or mica |
| $C_{23}$ | 0.25μF, paper |
| $C_{24}$ | 2,200pF, ceramic or mica |
| $C_{25}$ | 1,000pF, ceramic or mica |

*I.F. Transformers*

$L_1C_1$, $L_2C_2$ Final first i.f. transformer
$L_9$ Oscillator coil (see text)
$L_3C_5$, $L_4C_6$, $L_5C_{11}$, $L_6C_{12}$, $L_7C_{18}$, $L_8C_{19}$. Second i.f. transformers (see text)

*Valves*

| | |
|---|---|
| $V_1$ | 6BE6 |
| $V_2$ | 6BA6 |
| $V_3$ | 6C4 |

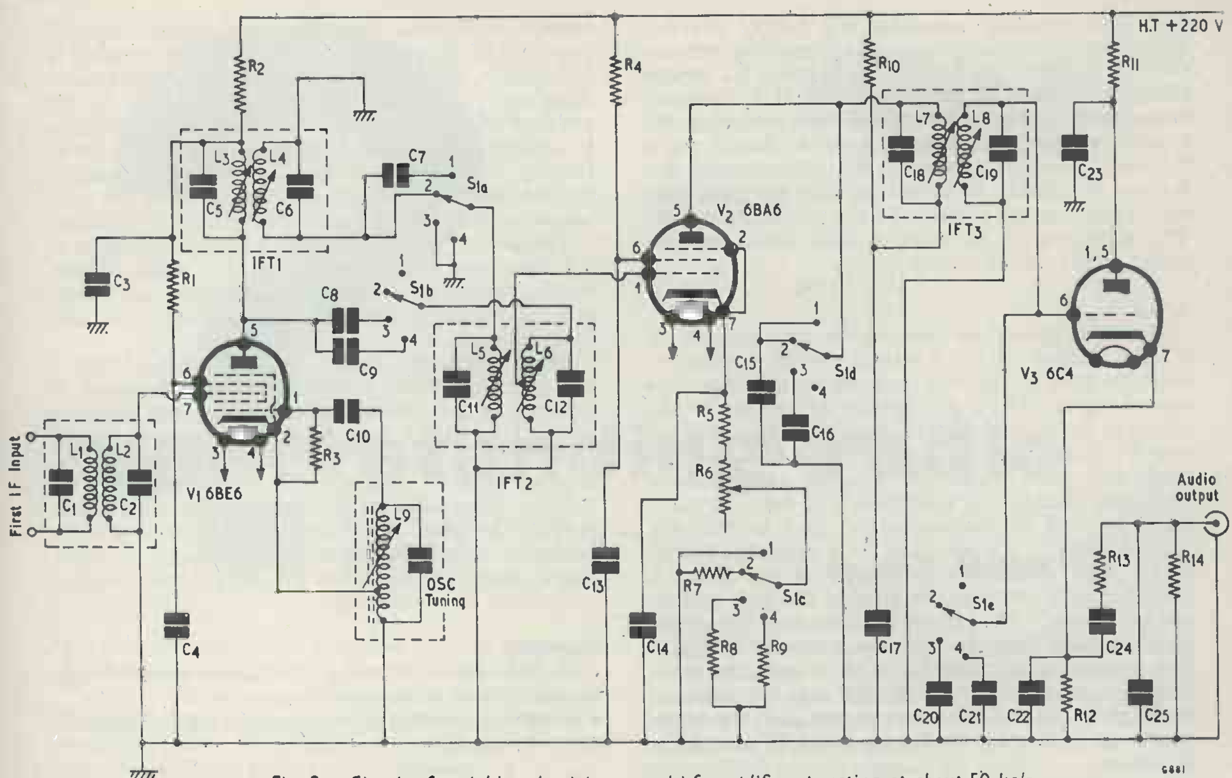



*Fig. 2. Circuit of variable selectivity second i.f. amplifier operating at about 50 kc/s*

struction of the oscillator is most important since, if the oscillator drifts, the unit will be thrown out of alignment and this cannot be corrected by merely altering the main receiver tuning control. A crystal oscillator is very much better for the second frequency changer.

The alignment of the simple amplifier was carried out by first accurately tuning in a local broadcasting station using the first i.f. only, altering the second oscillator frequency until a response was obtained at the end of the second i.f. unit and then adjusting the cores of each of the second i.f. transformers for maximum response at the detector. The response was measured with a 0–500 micro-ammeter in the anode circuit of the cathode follower detector. The final transformer of the first i.f. amplifier should also be realigned. The alignment should be carried out after the receiver has been working for half an hour or so.

**Coupling**

It is possible to obtain greater selectivity by using more i.f. transformers. If the transformers are coupled directly together as shown in Fig. 1 (or by any similar method), it is possible to use more transformers without using additional valves. The greater the value of $C_A$ in Fig. 1, the greater the coupling, and, providing the coupling is at least critical, the less the selectivity. In the extreme case $C_A$ may be replaced by a piece of wire and the two tuned circuits then become one with twice the capacitance (two C's in parallel) and half the inductance (two L's in parallel).

**Variable Selectivity**

The most important requirement of a variable selectivity amplifier is that the frequency of maximum response should remain unchanged as the selectivity is altered. A second requirement is that the gain should remain fairly constant on altering the selectivity. Continuously variable selectivity was not considered necessary, but at least three or four different bandwidths seemed essential. Mechanical methods of altering the selectivity by changing the relative positions of some of the i.f. coils did not seem practical for the home constructor.

The circuit shown in Fig. 2 uses three i.f. transformers. Only one transformer is used between $V_2$ and $V_3$, as otherwise the maximum voltage input to the detector would be severely limited by the attenuating effect of the cascaded transformers. In position 1 of the selectivity switch, all four tuned circuits are used between $V_1$ and $V_2$. In position 2, $C_7$ is replaced by a direct connection so that $L_4C_6$ and $L_5C_{11}$ become one tuned circuit. In position 3 only $L_3C_5$ and $L_6C_{12}$ are used. Finally in position 4, the position of least selectivity, there is virtually only one tuned circuit between $V_1$ and

$V_2$. The coupling capacitor $C_9$ blocks the h.t. voltage but gives a large amount of coupling between the two circuits. Switch wafers $S_{1d}$ and $S_{1e}$ detune the tuned circuits of the transformer $IFT_3$ by equal amounts in opposite directions, thus reducing the selectivity further in positions 3 and 4. Switch wafer $S_{1c}$ alters the bias applied to $V_2$; the resistors $R_7$, $R_8$ and $R_9$ should be chosen so that the gain does not depend on the position of the selectivity switch. This is best done by using a local signal and the meter in the anode circuit of $V_3$.

### A.G.C.

No a.g.c. should be used in the unit because, if it were applied to $V_2$, it would not be possible to keep the gain of the unit constant as the selectivity was changed. The a.g.c. should be applied to the valves in the first i.f. amplifier so that the signal fed into $V_1$ is constant in amplitude; this also helps to avoid any cross modulation troubles at the second frequency changer. It is necessary to take the a.g.c. from the end of the second i.f. unit so that the a.g.c. system is not actuated by a powerful carrier which falls within the passband of the first i.f. amplifier. $R_6$ controls the gain of the unit and its use is optional. The remarks made about the simple amplifier also apply to the circuit shown in Fig. 2. The alignment is carried out in exactly the same way as mentioned previously, but it is important to make sure that the selectivity switch is in the maximum selectivity position (i.e. position 1) during the alignment.

Screening was used beneath the chassis and this also served as a support for the switch. Great care was taken to avoid stray coupling between $V_1$ and $V_2$, as this could lower the selectivity enormously. A good quality ceramic switch was used, as stray coupling might have occurred with a poor quality switch. Instability has never occurred owing to the low operating frequency.

### Results

The unit gives very satisfactory results. It could be used to listen to ordinary amplitude modulated signals which could not even be detected through heavy interference when only a single superhet was used, but all stations, including the most powerful ones, were much more difficult to find. The tuning of high selectivity receivers must be very accurate and a really good slow motion drive without any backlash is absolutely essential. Both the first and second oscillators must be very stable. In the position of minimum selectivity speech quality is reasonable, although the selectivity is much greater than that of a normal broadcast receiver. In the position of maximum selectivity it is barely possible to understand speech, although it is quite satisfactory for morse. If a b.f.o. is used, ordinary double sideband signals can be received on one sideband only in the maximum selectivity position.

The power consumption is only about 1 amp at 6.3 volts and 20mA at 200 to 250 volts. These comparatively small power requirements can normally be obtained from the power supply of the main receiver.

Many variations in the design shown in Fig. 2 are possible. More transformers may be used, if desired, to get still better selectivity, but then an extra i.f. amplifier must be used in order to obtain reasonable gain and avoid cross modulation in $V_1$. It is possible to obtain rather more selectivity by tapping down some of the coils, but this very much reduces the gain. If desired many more selectivity positions could be included, especially if more transformers are used, but this would considerably complicate the switching.

### Appendix

*Calculation of the value of coupling capacitors to be used between two transformers.*

For critical coupling of two tuned circuits of equal Q,

$$k = \frac{1}{Q} \text{ where } k = \text{coupling coefficient.}$$

In the circuit shown in Fig. 1, $C_A$ is the coupling capacitor and C is the capacitance of each tuning capacitor.

$$k = \frac{C_A}{C}$$

where k is the coupling coefficient between the second tuned circuit of the first transformer and the first tuned circuit of the second transformer.

$$\text{Therefore } C_A = \frac{C}{Q}$$

Assuming C=680pF and Q=57, then $C_A$ for critical coupling will be about 12pF.

The 10pF capacitors recommended for $C_7$ and $C_8$ therefore give slightly less than critical coupling. This results in a good compromise between selectivity and gain.

## NEW COMPONENT

Since Eddystone discontinued the manufacture of their Universal Mounting Bracket, Cat. No. 708, there has not been available a commercially made component of this type on the market.

Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey, have now placed on the market their own Universal Mounting Bracket, a sample of which has been sent to us.

The bracket is designed for the mounting of potentiometers, variable capacitors, etc., the central slot allowing for choice of position of these components. The bracket is particularly useful for experimental and prototype work.

Finished in grey stove enamel, the bracket stem is $\frac{3}{8}$in wide by 2in high (approx.), the fixing flange being some $1\frac{1}{2}$in long by $\frac{1}{2}$in wide. The bracket is available to readers at 1s. 6d. each, postage extra.

*The fifteenth in a series of articles which, starting from first principles, describes the basic theory and practice of radio*

*part 15*

# understanding radio

**By W. G. MORLEY**

IN LAST MONTH'S CONTRIBUTION TO THIS SERIES WE introduced alternating current, showing how such a current may be produced from a simple generator comprising a rotating loop of wire in a magnetic field. We shall now continue with this subject, carrying on to a.c. waveforms.

**Waveforms**

As we have seen, an alternating voltage continually changes polarity. Also, as occurred with the a.c. generator of Figs. 81 and 82,[1] the voltage level is itself changing as well. In radio engineering it is desirable to obtain an accurate picture of the manner in which alternating voltages change, and this is done by means of a *waveform*, such as that shown in Fig. 83.

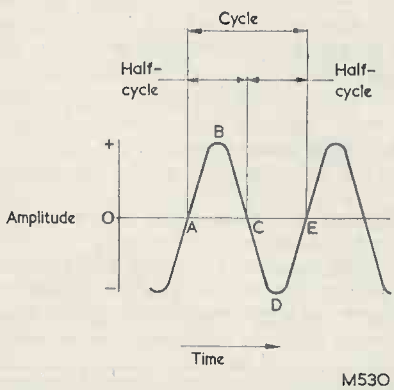



*Fig. 83. The waveform of an alternating current, illustrating the cycle and half-cycle*

In Fig. 83, the amplitude (i.e. the "largeness") of an alternating voltage, as well as its polarity, is indicated by drawing these out with respect to time. Starting at point A the alternating voltage has zero amplitude, after which it rises to a peak at B and drops down to zero again at C. After C the potential reverses and the voltage continues to a maximum, at reversed potential, at point D, returning to zero at E. The portion of the waveform which appears between points A and E is known as a *cycle*, this being that part of the waveform which contains both positive and negative excursions and which ends with the same condition as that with which it started. The section between A and C, or between C and E, is then described as a *half-cycle*.

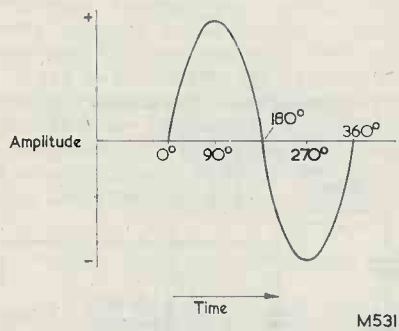



*Fig. 84. An a.c. cycle is divided into 360 degrees, as shown here*

The waveform in Fig. 83 may also be employed to depict an alternating current, in just the same manner as it depicts an alternating voltage.

[1] Published in last month's issue.

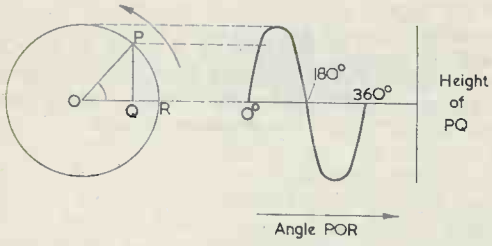



*Fig. 85. In this diagram, OP is a radius in the circle and PQ is a perpendicular to OR. If the height of PQ is plotted against angle POR, the result is a sine wave*

It is necessary to be able to identify and measure sections of a cycle and, for this purpose, the cycle is divided up into degrees. It is assumed that the complete cycle occupies 360°, in the same manner as does a circle. The reason for this choice of unit will become apparent shortly. Fig. 84 illustrates a complete cycle and shows the 0°, 90°, 180°, 270° and 360° points. It will be noted that, with the waveform shown, the 0°, 180° and 360° points are all at zero amplitude and that the 90° and 270° points occur at maximum amplitude.

An important waveform encountered in radio work is that which is given by a *sine wave*. In Fig. 85 we have a circle in which a radius OP revolves around the centre, O. As the radius revolves, the height of PQ, the perpendicular to OR, varies, as also does the angle POR. If we plot the height of PQ (both above and below PR) against angle POR, we get the graph which is shown alongside the circle. This graph is known as a sine wave, because its amplitude varies as the sine of the corresponding angle.[2]

The sine wave represents an a.c. waveform which is constantly employed in radio work, and it is assumed to be the simplest waveform which can be given by an alternating quantity. Unless otherwise described, it may be generally understood that all references in technical texts to alternating voltage or current assume a sine wave, this assumption being similarly followed in calculations. As an example of the manner in which the sine wave appears in things with which we are generally familiar, it

[2] In the circle the sine of angle POR is given by $\frac{PQ}{OP}$. OP, being a radius, is a constant, and so PQ varies as the sine of angle POR.

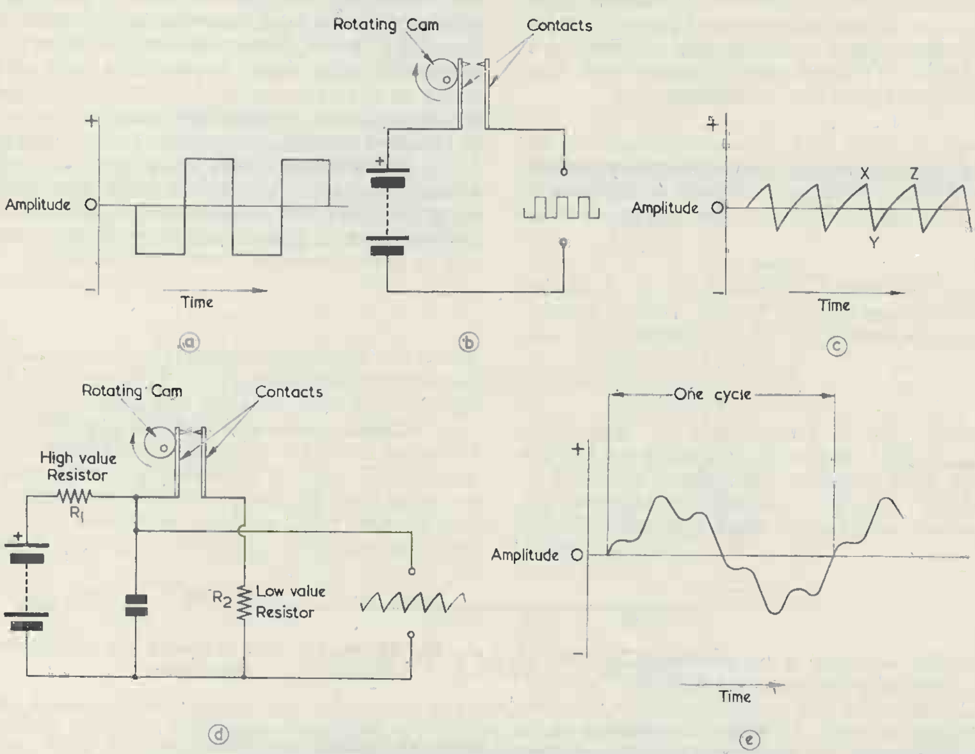



*Fig. 86 (a). A square wave*
*(b). The square wave could be produced in the manner shown here*
*(c). A sawtooth waveform*
*(d). A simple means of forming a sawtooth*
*(e). A complex waveform. This is the combination of two sine waves*

should be noted that the a.c. mains supply fed to our houses is a sine wave. Also, the simple generator shown in Figs. 81 and 82 produces a sine wave.[3]

Many other waveforms may be encountered in radio engineering work, and these can have shapes very far removed from that of the sine wave. A typical example is given by the *square wave* illustrated in Fig. 86 (*a*). Such a waveform could be produced by a pair of contacts such as those shown in Fig. 86 (*b*). If, by some device, such as a motor with a cam, these contacts are made to open and close regularly, they would cause a square wave to be formed. A *sawtooth* waveform is illustrated in Fig. 86 (*c*). A waveform of this type could be produced with the aid of a motor-operated switch, a capacitor and two resistors, as in Fig. 86 (*d*). The contacts close at a time corresponding to point X in Fig. 86 (*c*), whereupon the low-value resistor $R_2$ causes the capacitor to quickly discharge. At point Y of the waveform the contacts open, whereupon the capacitor charges slowly via the high-value resistor $R_1$. At point Z the contacts close again and another cycle commences. The arrangements illustrated in Fig. 86 (*b*) and (*d*) are quite practicable although, in practice, the somewhat clumsy motor-driven contacts would be replaced by alternative devices capable of carrying out the same function.[4]

It is quite possible for an a.c. waveform to be complex, such as that shown in Fig. 86 (*e*). This waveform is a combination of two sine waves, the amplitude and cycle length of one being considerably less than that of the other. It will be noticed that the end of the cycle occurs only when the waveform has reached the same condition as that with which it started.

### Frequency

Since the cycle of an alternating current or voltage occupies a fixed period of time, it becomes possible to use this fact for purposes of measurement. This we do by referring to the *frequency* of the alternating quantity in terms of the number of cycles which occur in one second. Thus, the a.c. mains supplies fed to houses in the United Kingdom and in Europe has a frequency of 50 cycles per second.

The term cycles per second is commonly abbreviated to c/s. Higher frequencies may be expressed in kilocycles per second (kc/s) and megacycles per second (Mc/s). One kilocycle per second equals a thousand cycles per second, and one megacycle per second equals a thousand kilocycles per second.

[3] Actually, the domestic a.c. mains supply may depart slightly from the sine wave form if local devices connected to it draw more current on one half-cycle than the other (as do television receivers, for instance) or if there are shortcomings in the transmission equipment. Also, the generator of Figs. 81 and 82 provides a perfect sine wave only if the lines of force between the magnet pole pieces are parallel and have constant intensity throughout the field in which the loop rotates.

[4] The alternating voltages appearing on the upper terminals in Figs. 86 (*b*) and (*d*) do not go negative of the lower terminals at any time and so they are not *exactly* the same as those shown in Figs. 86 (*a*) and (*c*), which would require the terminals to go alternately positive and negative of each other. Figs. 86 (*b*) and (*d*) are intended to show a practicable means of producing the waveforms concerned, and the latter may be considered as having a direct voltage superimposed on them.

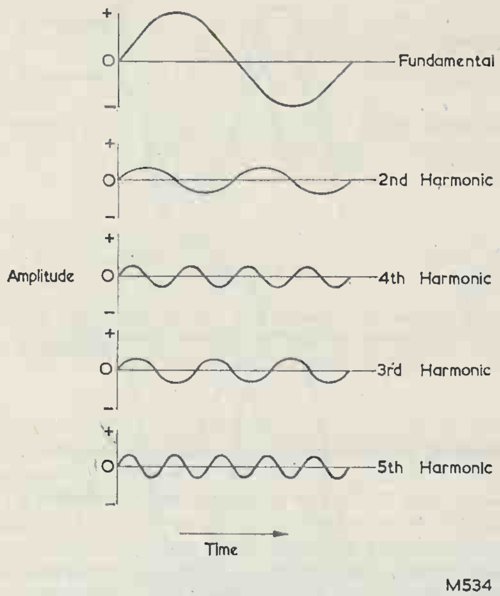



*Fig. 87. A series of harmonics and their fundamental sine wave*

### Harmonics

*Harmonics* (or *overtones*) consist of alternating quantities having a frequency which is an exact multiple of a basic alternating quantity. The latter is then known as the *fundamental*. A number of harmonics are illustrated in Fig. 87, in which diagram we see a fundamental together with second, fourth, third and fifth harmonics. The second harmonic has twice the frequency of the fundamental, and so on.

It frequently happens that, when a sine wave alternating quantity is handled in a radio circuit, the waveform becomes *distorted* from its proper shape. It can be shown that the distorted waveform then consists of the fundamental sine wave plus one or more sine wave harmonics. A typical instance of how a distorted waveform may be broken down into its constituent sine waves is shown in Fig. 88, wherein a low amplitude second harmonic is com-

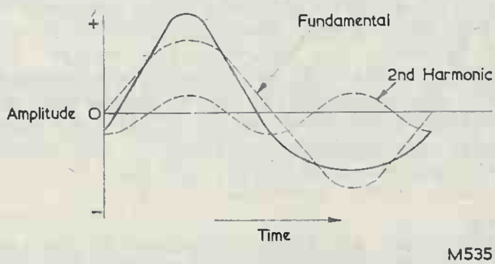



*Fig. 88. The distorted waveform shown in unbroken line is the combination of a fundamental sine wave and its second harmonic*

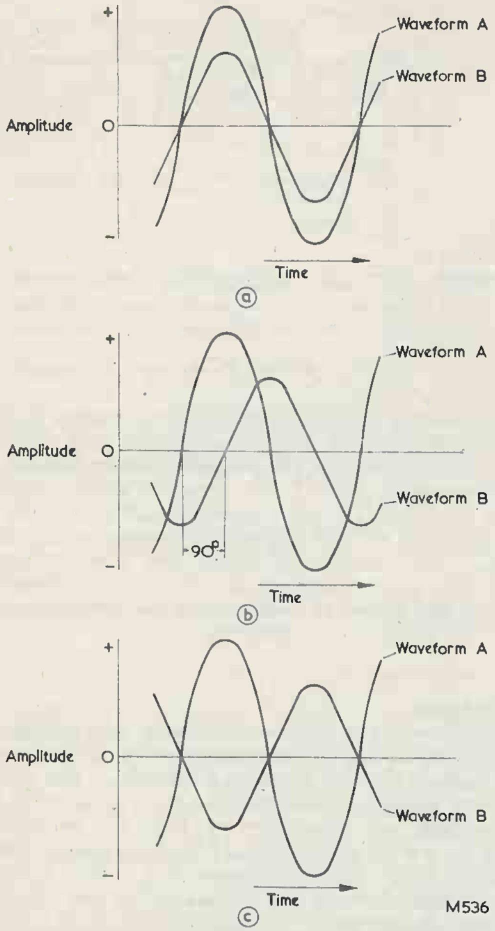



*Fig. 89. Illustrating phase difference. In (a) the two waveforms are in phase, whilst in (b) there is a phase difference of 90°. The waveforms in (c) are completely out of phase*

bined with a high amplitude fundamental. When both these sine waves have the same potential they add, and when they have opposite potential the smaller subtracts from the larger; and the resultant combined waveform is shown in the unbroken line of Fig. 88. Another combination of fundamental and harmonic was shown in Fig. 86 (*e*). This waveform is the result of combining a fundamental and a fifth harmonic. It can be shown that even the square wave of Fig. 86 (*a*) consists of a fundamental with harmonics, although in this instance the number of harmonics is very large.

**Phase**

When two alternating quantities of the same frequency are compared, it is usually necessary to ascertain the difference in time between the commencement of their cycles. This difference is described in terms of *phase*, the amount of difference being expressed in degrees. Fig. 89 (*a*) shows two alternating quantities having the same frequency. Their cycles both commence at the same instant and they are, in consequence, referred to as being *in phase*. In Fig. 89 (*b*) the cycle of waveform B commences 90° after the commencement of the cycle of waveform A, and the two frequencies would then be described as being 90° *out of phase*, or as having a *phase difference* of 90°. Since waveform B starts 90° after waveform A it can be referred to as *lagging* by 90° on A. Alternatively, the same condition may be described by saying that waveform A *leads* by 90° on waveform B.

In Fig. 89 (*c*) the two waveforms are 180° out of phase. In this instance they may also be described as being *completely out of phase*, since each part of one cycle is completely opposed to the corresponding part of the other cycle.

We have used round numbers to illustrate phase differences, but such differences may occur, in

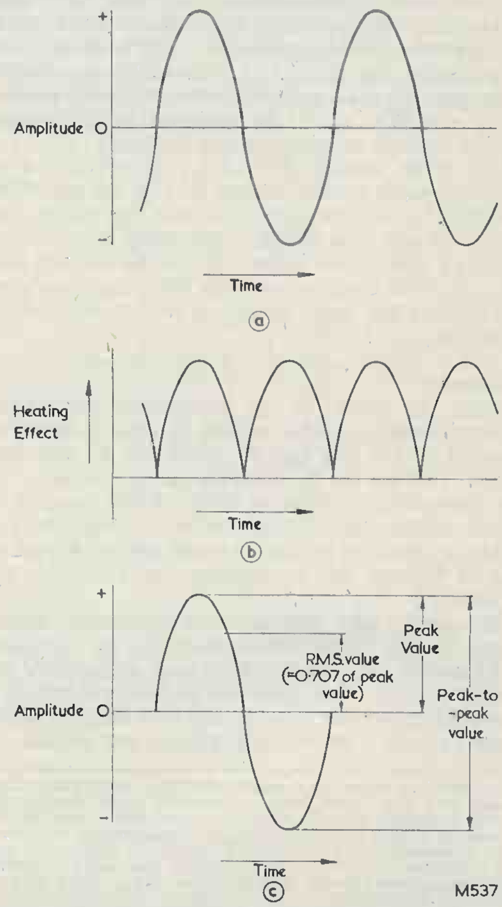



*Fig. 90 (a). A typical sine wave alternating current (b). The heating effect of the current. Since this effect occurs regardless of polarity, both half-cycles contribute towards it (c). Amplitude dimensions, in voltage or current, of a sine wave* practice, for any number of degrees between zero and 360.

**Peak, R.M.S., and Average Values**

We have seen[5] that if a direct current is passed through a moving coil meter in one direction the meter needle moves to the right, and that if the current flows in the other direction the needle moves to the left. What happens if we apply an alternating current to the meter? Since the direction of alternating current is continually reversing, the result will be that the needle of the moving coil meter will be continually forced to right and left. For normally encountered low frequencies, the result may be a perceptible trembling of the meter needle as it attempts to follow the changes in direction of current flow. At higher frequencies the needle will remain stationary at the zero point, since the changes in current direction are too fast to allow it to respond. The moving coil meter on its own does not, therefore, give us any indication of the amplitude of an alternating current or voltage; and we are not able, with its aid, to evaluate a.c. amplitudes in terms with which we have become familiar during our examination of direct current circuits.

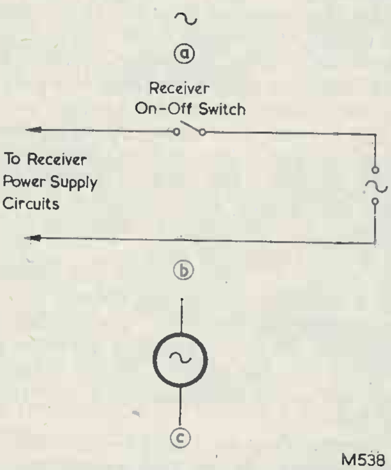



*Fig. 91 (a). The symbol employed to indicate a.c. (b). The a.c. symbol in a typical circuit diagram (c). An a.c. generator*

However, the heating effect of an alternating current, when caused to flow in a resistor, is the same as that given by a direct current, because the heating effect takes place regardless of polarity. This provides us with a connecting link between d.c. and a.c. measurements. In Fig. 90 (*a*) we see a sine wave alternating current which may be caused to flow in a resistor, and in Fig. 90 (*b*) we see the same waveform expressed in terms of heating effect. As may be seen, both half-cycles produce the same heating effect; and they now add, instead of

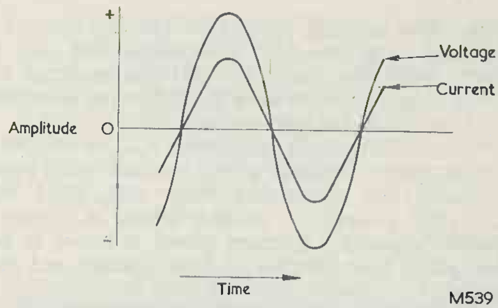



*Fig. 92. The current which flows in a resistor when an alternating voltage is applied across it. The current and voltage are in phase*

cancelling each other out, as occurred with the moving coil meter.

In Fig. 90 (*c*) we return to a cycle of our original waveform but we now add dimensions to indicate amplitude. The first of these is the *peak current* of the waveform, and this defines the current which flows when the half-cycle is at its maximum. Lower down we have the *root mean square*, or *r.m.s. current* for the waveform, this being equal to 0.707 times the peak value. The r.m.s. current is that which has the same heating effect as an equivalent direct current.

The same definitions and relationship hold true if we had considered an alternating voltage instead of an alternating current. We would, this time, have a *peak voltage*, together with an *r.m.s. voltage* which was equal to 0.707 times the peak voltage. The r.m.s. voltage is that which results in the same heating effect as an equivalent direct voltage.

The figure of 0.707 is given by $\frac{1}{\sqrt{2}}$. Since $\frac{\text{r.m.s. value}}{\text{peak value}}$ equals $\frac{1}{\sqrt{2}}$, it follows that the reciprocal ratio is $\sqrt{2}$ (=1.414). This is true, and the peak value of a sine wave is 1.414 times the r.m.s. value.

Referring back to Fig. 90 (*c*) it will be seen that another dimension is shown. This is the *peak-to-peak* value of the waveform and it defines the difference between the positive peak and the negative peak. Since the peak-to-peak value is twice the peak value, it is equal to 2.828 times the r.m.s. value.

It should be noted that the figures for r.m.s. and peak values just given only apply with a sine wave alternating quantity. If the waveform is distorted from the sine wave shape, the relationship between peak value and the value which has the same heating effect as an equivalent direct quantity becomes altered.

In addition to the peak and r.m.s. values of an alternating quantity, it is occasionally necessary to refer to its *average voltage*, or *average current*. The average voltage, or current, is the summation of all the voltages, or currents, which appear in a complete

[5] In "Understanding Radio" part 7, March 1962 issue.

cycle. The average voltage or current appears at the zero axis, one half cycle cancelling out the other. With sine waves the sections on either side of the zero axis are symmetrical, but the same may not apply with distorted waveforms.

Another dimension qualifying a.c. waveforms is *average power*. Average power is equal to the power dissipated due to heating effect and, since both half-cycles provide a heating effect, is always a positive quantity. Average power is equal to half *peak power* (the product of peak voltage and peak current).[6]

Unless otherwise stated, it may always be assumed that any voltage or current figures quoted for an alternating quantity are the r.m.s. values.

### Symbols

In circuit diagrams, alternating current is often indicated by the symbol illustrated in Fig. 91 (*a*). This may be recognised as resembling the waveform for a sine wave cycle. Sometimes, terminal points in circuits (or, indeed, actual terminals on radio equipment) have this symbol printed alongside to indicate that a.c. is present (or should be applied) as opposed to d.c. A frequent instance is given in Fig. 91 (*b*) which shows the input switching section for a mains-operated radio or television receiver circuit diagram. The fact that the two terminals shown should be connected to the mains supply is made obvious by the power supply components following the on-off switch in the full diagram, and the fact that the supply should be a.c. is indicated by the symbol. The symbol is also employed in Fig. 91 (*c*), which shows an a.c. generator. This may be a physical generator, or it may be an imaginary generator employed in a purely theoretical circuit for the purpose of investigating a particular effect.

### A.C. and Resistance

We have already seen, when we discussed r.m.s. values, that we cause an alternating current to flow in a resistor when we apply an alternating voltage across it. It was also inferred that, as the alternating voltage varied throughout the cycle, the current varied likewise.

This effect may be illustrated by the voltage and current waveforms shown in Fig. 92. As will be seen, when voltage is at its peak so also is current, and similar concurrence takes place throughout the cycle. Voltage and current are in phase.

### A.C. and Capacitance

Quite a different state of affairs takes place if we apply an alternating voltage to a capacitor, as we do in Fig. 93 (*a*). In this instance the capacitor must always have the same voltage across its plates as that which is provided by the generator, with the result that the current which flows in the circuit is that resulting from charge and discharge of the capacitor.

Fig. 93 (*b*) illustrates the voltage and current waveforms for the capacitor circuit. At point A in this diagram voltage is changing at its greatest rate, with the result that peak charging current has to flow to maintain the same potential across the capacitor as is provided by the generator. After point A the rate of change of voltage gradually reduces, and so also does the charging current needed to maintain the voltage across the capacitor plates. The current which flows during this period is in the same direction as that which flowed through the resistor in Fig. 92, and so we show this part of the current waveform on the same side of the zero axis as the voltage waveform which produces it.

When we reach peak voltage at B, the rate of change of voltage becomes, for an instant, zero. As a result, no charging current flows. After point B the alternating voltage commences to fall, with the result that the capacitor now has to *discharge* if the voltage across its plates is to be equal to that from the generator. This discharge current is in the opposite direction to the previous charging current, and so the current waveform crosses over to the lower side of the zero axis. At first, the rate of change of voltage is low and so, accordingly, is the discharge current. The rate of change of voltage increases continually until, at point C, it is at a maximum. At this point, therefore, discharge current is at a maximum also.

After point C the voltage waveform passes through a maximum at D and returns to zero at E, thereby completing the cycle. The resultant current is exactly the same as occurred between points A to C except that the polarity of the voltage is now changed and so, in consequence, is the direction of current flow.

The current flow in Fig. 93 (*b*) is not in phase with the voltage. If the two waveforms are compared it will be seen that the current waveform leads the voltage waveform by 90°. The shape of the current waveform is a sine wave, as is that of the voltage waveform.

It is important to note that, although we talk of current flow in the circuit of Fig. 93 (*a*), no current actually flows through the capacitor itself because its plates are separated by an insulator. The current which flows is the charge or discharge current needed to maintain the same voltage on the plates as is produced by the generator. Despite this fact it is quite common practice in technical literature to refer to a capacitor as if it *does* pass an alternating current even though it cannot, in fact, do so. If used carefully, this practice saves much verbiage, and it would be pedantic to condemn it.

The current which flows in the capacitive circuit depends, as we have seen, on the rate of change of

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[6] The relationship between average and peak power may be shown by drawing the power waveform for a sine wave. Then, since

$$P\text{ peak} = E\text{ peak} \times I\text{ peak}$$

$$P\text{ average} = \frac{E\text{ peak} \times I\text{ peak}}{2} = \frac{E\text{ peak}}{\sqrt{2}} \times \frac{I\text{ peak}}{\sqrt{2}}$$

$\frac{E\text{ peak}}{\sqrt{2}}$ is then the r.m.s. voltage and $\frac{I\text{ peak}}{\sqrt{2}}$ the r.m.s. current.

voltage during the cycle. The rate of change of voltage will obviously increase if we raise the frequency of the alternating voltage. As a result, an increase in frequency causes an increase in current. A rise in current will also occur if we increase the capacitance of the capacitor, because more current must flow to charge it and to discharge it. However, it is more convenient to think of the capacitor as a device which, like a resistor, limits current flow; and we describe this ability in terms of the *reactance* of the capacitor. Reactance is similar to resistance and it uses the same unit, the ohm. It must be reiterated, nevertheless, that reactance is not *exactly* the same as resistance, because the current in a circuit having reactance is 90° out of phase with the voltage.

The greater the reactance of a capacitor, the less the current flow, with the result that reactance *decreases* as frequency increases, and *decreases* as capacitance increases. The formula linking the three factors together is:—

$$X_c = \frac{1}{2\pi fc}$$

where $X_c$ is the reactance of the capacitor, f is the frequency in cycles per second, c is capacitance in farads, and $\pi$ is 3.1416.

The term $2\pi f$, which is frequently encountered in radio calculations, is often represented by $\omega$, whereupon the formula becomes

$$X_c = \frac{1}{\omega c}$$

where $\omega$ equals $2\pi f$ in terms of cycles per second.

The farad is a large unit, and it sometimes helps, when using the formula, to express c in terms of microfarads and f in terms of megacycles per second. Since one term in the expression is divided by one million, and the other multiplied by one million, the result is the same as before.

Several examples may assist in familiarising ourselves with the formula, and with the reactance of commonly encountered capacitors. Let us commence by finding the reactance of a 10μF capacitor at a frequency of 50 c/s.

$$X_c = \frac{1}{2\pi fc}$$

$$= \frac{1}{2\pi \times 50 \times 10 \times 10^{-6}}$$

$$= \frac{10^3}{\pi}$$

$$= 318$$

Therefore, the reactance is 318 ohms.

We made this calculation with cycles per second and farads and, in consequence, had to multiply the value in microfarads by $10^{-6}$ to bring it to farads. Readers who are not familiar with indices used in this manner will find that it only takes a little longer to make the calculation without them. Thus:

$$X_c = \frac{1}{2\pi fc}$$

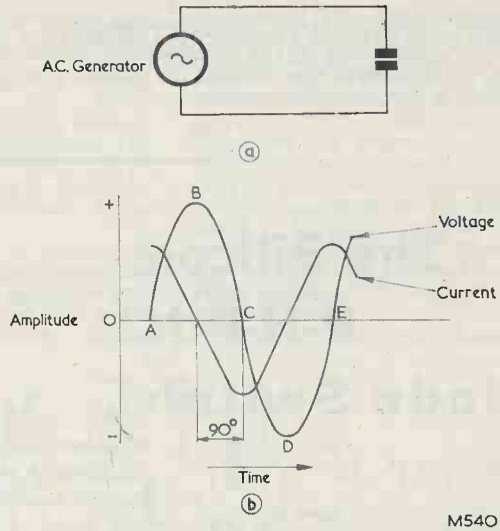



*Fig. 93 (a). Connecting a capacitor to an a.c. generator (b). The current flowing in the circuit of (a) leads the voltage by 90°*

$$= \frac{1}{2\pi \times 50 \times \frac{10}{1{,}000{,}000}}$$

$$= \frac{1{,}000{,}000}{2\pi \times 50 \times 10}$$

$$= \frac{1{,}000{,}000}{1{,}000\pi}$$

$$= \frac{1{,}000}{\pi}$$

$$= 318$$

In this case we divided the number of microfarads by 1,000,000 to bring them to farads.

What is the reactance of a 0.25μF capacitor at 25 Mc/s? In this instance we can use microfarads and megacycles per second, and so we get:

$$X_c = \frac{1}{2\pi fc}$$

$$= \frac{1}{2\pi \times 25 \times 0.25}$$

$$= \frac{1}{12.5\pi}$$

$$= 0.0254$$

Thus, the reactance is 0.0254 ohms.

Before concluding, this month, it should be pointed out that there is another type of reactance, this being that offered by an inductor. The reactance offered by a capacitor is described as *capacitive reactance*, to distinguish it from that offered by an inductor, which is called *inductive reactance*. The letter "X" employed in the formulae just discussed signifies reactance, the small "c" which follows indicating that the reactance is capacitive.

**Next Month**

In next month's issue we shall carry on to inductive reactance, following this with a discussion on impedance.

# The Silicon P-N-P-N Diode Switch

*By M. FARNSWORTH, B.Sc.*

*Our contributor describes the functioning of the p-n-p-n diode switch, illustrating the operation as a two-state device. Also discussed is a simple two-transistor circuit which may be made to operate in the same manner as the p-n-p-n diode*

THIS ARTICLE IS INTENDED TO show the principles of the silicon p-n-p-n diode and to illustrate the manner in which it can be used in a simple circuit to produce an easily variable wide range square or sawtooth pulse generator.

**Operation**

The device, usually referred to as a Shockley Diode, is made up of four layers of alternate p and n type material. Hence p-n-p-n, as opposed to the transistor which has only three layers, p-n-p or n-p-n. Referring to Fig. 1, the two outer layers

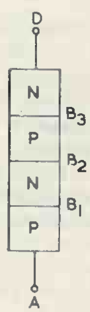
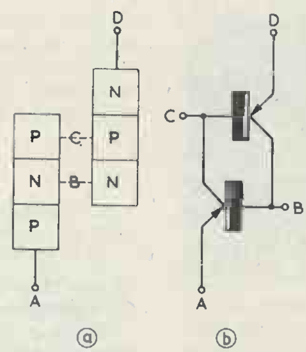



FIG.1

M414

act as emitters, while the centres act both as bases and collectors. To simplify this the diode can be considered to be made up of one p-n-p and one n-p-n transistor interconnected as in Figs. 2 (*a*) and (*b*). Now if a small voltage is applied across AD, A being positive, negligible current will flow, and the device will look like an "off" switch. This is because, whilst junctions B1 and B3 are forward biased, junction B2 is reversed biased. In consequence, only leakage current will flow. If the voltage is steadily increased, the voltage across the device will increase accordingly until a point is reached when avalanche breakdown occurs across the reverse




M415

biased junction $B_2$. At this point AD will now appear as a forward biased diode and will therefore have a resistance of only a few ohms. The characteristic curve is shown in Fig. 3. To keep the device in the "on" state it is now only necessary to apply a holding current $I_h$.

If a negative voltage is applied to A, and increased, the device will have the normal reverse characteristic of a diode.

From the above it can be seen that the p-n-p-n diode is an efficient two-state device, one state having a high resistance of several megohms and the other a low resistance state of a few ohms. To switch from high resistance, "off", to low resistance, "on", the voltage across the diode must reach a voltage $V_b$ at which it breaks down; and then to keep it "on" the current passing through it must be maintained at a value greater than $I_h$. To switch to "off", the current must be reduced below $I_h$ and this can be done either by momentarily reverse biasing the diode or adding series impedance. The diodes are manufactured with breakdown voltages of from 20–100 and holding currents of 1–50mA.

It is interesting to note that the diode can be taken one step further.

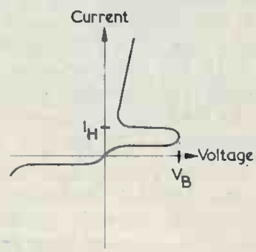



FIG.3

M416

If a lead is attached to the inner p layer between junctions B2 and B3 we have what is known as the silicon controlled rectifier. This point is used as a gate, and if a small current pulse is applied here, the silicon controlled rectifier will switch rapidly from "off" to "on". The action is almost identical with the p-n-p-n diode. However, the silicon controlled rectifier will not be considered further here.

**Square Wave Generator**

Let us now consider the circuit of

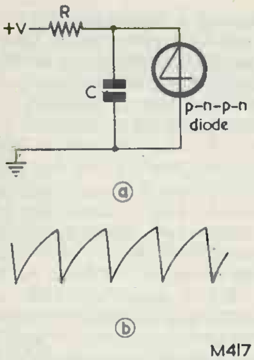
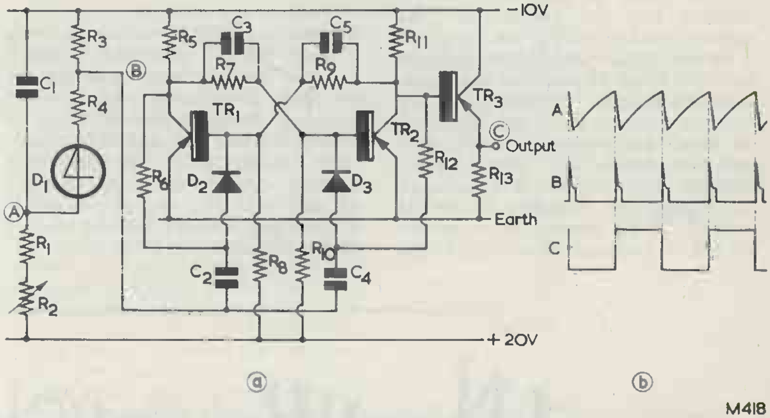



Fig. 4 (*a*), where the turnover voltage of the diode, $V_b$, is less than voltage V. When the voltage V is applied, the capacitor will start to charge up through R until it reaches voltage $V_b$. At this point breakdown will occur in the diode and it will switch to "on" immediately discharging C. Providing R is such that $\frac{V}{R}$ is less than the holding current, the diode will then switch back to "off" and the cycle will repeat. The waveform will be a sawtooth as in Fig. 4 (*b*). By varying R and/or C, the frequency of oscillation can be changed.

As will probably be appreciated the circuit of Fig. 4 (*a*) can now form the basis of a pulse generator with a simple potentiometer adjustment of frequency. To obtain a square wave output, a bistable circuit was triggered from the pulse generator, and the complete circuit and waveform are shown in Figs. 5 (*a*) and (*b*). The p-n-p-n diode used had a breakdown voltage of 20 and a minimum holding current of 15mA, $R_1$ therefore requires a value such that if $R_2$ is short-circuited and $D_1$ is "on", the current though it is less than 15mA; i.e. $R_1 > \frac{30 \times 10^3}{15} = 2k\Omega$. This will ensure, as before, that $D_1$ switches to "off" immediately after discharging $C_1$. The series resistors $R_3$ and $R_4$ are included to stop excessive peak current in $D_1$ at the instant of switching across the capacitor, and by suitable choice of these resistors a positive 7 volt pulse can be obtained at point B to trigger the bistable circuit. The gates of the bistable, consisting of $R_6$, $D_2$, $C_2$ and $R_{12}$, $D_3$, $C_4$ route these pulses to the base of the "on" transistor and switch it "off", and so for every pulse, transistor TR2 switches. An excellent square wave of 1:1 mark-space is produced, and by passing this into the emitter follower $TR_3$, a low impedance output can be obtained. The waveforms at points A, B, and C are shown in Fig. 5 (*b*). The pulse generator is particularly suitable for low frequency operation and by using an electrolytic capacitor for $C_1$, a square wave of less than 1 per second is readily obtainable. On the other hand several tens of kilocycles can be realised by suitable choice of $C_1$. Values are not given for $R_2$ and $C_1$ as almost any will suffice but what was envisaged for




**Components List**
(Fig. 5 (*a*))

*Resistors*
- $R_1$ 2.2kΩ
- $R_2$ See text
- $R_3$ 18Ω
- $R_4$ 33Ω
- $R_5$ 1.2kΩ
- $R_6$ 22kΩ
- $R_7$ 6.8kΩ
- $R_8$ 47kΩ
- $R_9$ 6.8kΩ
- $R_{10}$ 47kΩ
- $R_{11}$ 1.2kΩ
- $R_{12}$ 22kΩ
- $R_{13}$ 1kΩ

*Capacitors*
- $C_1$ See text
- $C_2$, $C_4$ 5,000pF
- $C_3$, $C_5$ 1,000pF

*Semiconductors*
- $TR_1$ $TR_2$ OC44 Mullard
- $TR_3$ OC84 Mullard
- $D_1$ Brush 4E20–28
- $D_2$, $D_3$ OA81 Mullard

**Components List**
(Fig. 6)

*Resistors*
- $R_1$ 500kΩ
- $R_2$ 10kΩ
- $R_3$ 3.3kΩ
- $R_4$ 2.2kΩ
- $R_5$ 5.6kΩ

*Capacitor*
- $C_1$ See text

*Semiconductors*
- $TR_1$ OC71 Mullard
- $TR_2$ OC139 Mullard

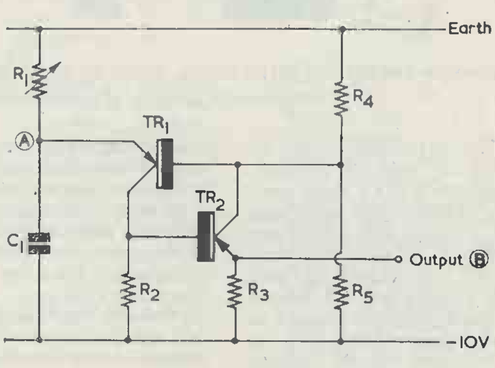
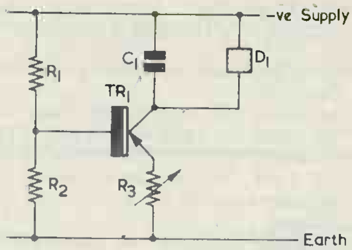



FIG.6 M419

a variable frequency generator was a fixed potentiometer $R_2$ with a switched $C_1$.

**Two Transistors**

As the home experimenter is usually very sceptical about new devices, especially when the price is not very low, it was decided to experiment with a p-n-p and an n-p-n transistor in a circuit similar to the equivalent circuit of the p-n-p-n diode. Fig. 6 was the result, and it gave waveforms at A and B identical to those in Fig. 5 (*b*). Resistors $R_4$ and $R_5$ set the potential on the base of $TR_1$ and, as $C_1$ charges up, the emitter of $TR_1$ approaches this value. At this point a similar action takes place as in the p-n-p-n diode switch and the capacitor discharges. Provided that the current through $R_1$ is not sufficient to hold the transistors "on", they will then switch "off" and the cycle repeats. The output at B is then used to trigger the bistable circuit as before. With the values as shown in Fig. 6 and with $C_1 = 0.25\mu F$, the frequency could be varied between 20 and 500 c/s and with 1,000pF from 10 kc/s. It is obvious that by switching in different capacitors the range of the pulse generator can be widely varied, the only limitations on $R_1$ being that it must provide a current greater than the leakage current into $TR_1$ at one end and a current less than the holding current of the circuit at the other end.




Note: $D_1$ is either of the two switches described.

FIG.7

M420

**Obtaining a Sawtooth**

Nothing has yet been said about the sawtooth which can so easily be obtained from these circuits. If an emitter follower is attached to point A, in Figs. 5 (*a*) and 6 such a waveform may be obtained. However this waveform may be too exponential, therefore a circuit such as that shown in Fig. 7 could be adopted in which $TR_1$ supplies a constant current into $C_1$. As the base potential of $TR_1$ is fixed by $R_1$ and $R_2$, the emitter will be at this potential and a constant current will therefore flow into $C_1$ and give a linear rise to the waveform. The current into $C_1$ is determined by the potential of the base, say $V_1$ and $R_3$. $I = \frac{V}{R_3}$, so by varying either of these the constant current can be varied and, thus, the frequency of operation. In either case the design should be such that at the point of firing $D_1$, the potential of the collector of $TR_1$ is sufficiently negative or "nought" will happen.

# IN YOUR WORKSHOP

*This month Smithy the Serviceman, aided by his able assistant, Dick, turns his attention to a much-neglected branch of radio—mechanical tuning drives.*

TO THE ACCOMPANIMENT OF AN ear-cracking peal of thunder, the Workshop door burst open to admit a sodden and saturated Serviceman. A torrent of water showered through the open doorway, driven in by the blustering gale outside. By putting his full weight against the door Smithy managed to get it closed again, whereupon the sound of the storm became slightly abated. With an expression of intense disgust, Smithy squelched over to the stove, leaving a generous trail of water behind him.

Dick looked up from his bench.

"I see," he remarked brightly, "that it's still raining."

For a moment Smithy stood as one transfixed. Then he turned on his unwitting assistant.

"We are," he fumed, "in the middle of a tempest which threatens to blow off the roof at any moment. Added to that I arrive, darting nimbly between successive thunderbolts, sopping wet and soaked to the skin. And you state that you see it's still raining!"

Smithy's assistant gazed dispassionately at the Serviceman steaming in front of the stove, and listened carefully to the wind and rain raging outside.

"Yes," he remarked eventually, "the storm still seems to be with us."

Smithy snorted and proceeded to divest himself of the outer garments he habitually wore to guard against the rigours of the British winter. These consisted of a large all-enveloping mackintosh, a waterproof hat of indeterminate shape, Wellington boots, and a pair of heavy yellow leggings initially issued in World War II for Gas Decontamination Squads and purchased later by Smithy from a firm specialising in surplus clothing. Like an emergent chrysalis the inner Serviceman examined himself carefully for signs of dampness. Eventually, he gave a grunt which indicated that the rain had not penetrated his defences.

"Well, you seem to have kept dry enough," commented Dick.

"I am quite aware of that," said Smithy in an exasperated tone. "Don't keep telling me things I know already!"

Dick turned back to his bench.

"I suppose you'll be getting down to work now," he remarked dispassionately.

"Of course I'll be getting down to work," replied Smithy furiously. "What do you think I'm going to do: spend the morning riding a unicycle between the benches or something?"

"Dear me," said Dick, "you do seem in a bad temper."

"I've got more than enough to make me that way," said Smithy bitterly. "After a miserable half an hour trying to get my car to function in the midst of a monsoon I eventually arrive to work late. Whereupon I find myself confronted by a host of tomfool remarks which you apparently look upon as intelligent conversation. Where the devil are my Workshop shoes?"

"By the stove," said Dick, "keeping nice and warm for you."

Slightly mollified, Smithy slipped on the worn and comfortable slippers he kept for occasions such as this, and padded over to his bench. Very soon he was immersed in the chassis in front of him, and the Workshop settled down to its usual state of concentrated activity, the quiet being broken only by the sounds of the storm outside, and by occasional grunts and murmurs from the benches as Dick and Smithy bowed diligently over their labours.

**Dial Drives**

As always, however, the silence could not continue uninterrupted for long.

"Dick!"

There was no answer. Dick was completely absorbed in the chassis on his bench.

"*Dick*!"

Smithy's assistant jumped up in surprise and dropped his test prods.

"Are you," he remarked incredulously, "calling *me*?"

"I am," said Smithy gravely. "I need your help."

A broad grin broke across Dick's face.

"I never thought the day would dawn," he commented happily, "when you would actually ask me for assistance. What's the trouble, an awkward snag in a line output stage or something like that?"

"Not quite," replied Smithy. "I just want you to put your thumb on a knot in a tuning drive cord whilst I pull it tight!"

Dick's face dropped, and he walked despondently over to Smithy's bench.

"This is certainly a complicated drive," he remarked, examining Smithy's chassis closely as the Serviceman busied himself with the ends of the cord. "There seems to be string all over the place."

"It's certainly a bit more ambitious than most of the drives you meet these days," conceded Smithy, straightening up and checking the tension of the repaired cord. "Although for real complication you should have seen some of the sets we used to handle before the war. Not only did they have multitudinous drive cords but they also had Bowden cables going all over the place as well. They really *were* shockers!"

"We don't get that sort of thing now," commented Dick, "which is, I suppose, a good thing."

"I'll say it is," agreed Smithy warmly. "Nevertheless, you still get a few tuning drives in sound receivers that can cause you to waste a lot of time if you don't tackle them properly. I must admit, though, that failures are much less frequent now that nylon drive cord is available."

"How do *you* tackle a broken drive cord?"

Smithy pondered.

"Well," he said after a moment. "If I get a broken cord in a drive that looks a little complicated, the first thing I do is to get out the service manual for the receiver."

"Why's that?"

"Because the manual," explained Smithy, "frequently shows you the route taken by the cord, together with the number of times it passes round the drive spindle and so on."

"Couldn't you make a *guess* at the way the cord is laced up in the set?"

"Why waste time with guesses," commented Smithy, "if the manual shows you how to do it right first time?"

"What happens if you haven't got the manual," queried Dick, "or if the manual doesn't show the cord layout?"

"In that case," replied Smithy, "I usually try to work out what the drive layout was before the cord broke. The most important place is at the drive spindle in most instances, and I attempt to discover, by the position of the broken cord, how many times it should pass around this spindle and in what direction. If, for instance, the cord originally passed two and a half times round the drive spindle (Fig. 1 (a)) you may well get slipping if you only pass the replacement cord round one and a half times (Fig. 1 (b)). On the other

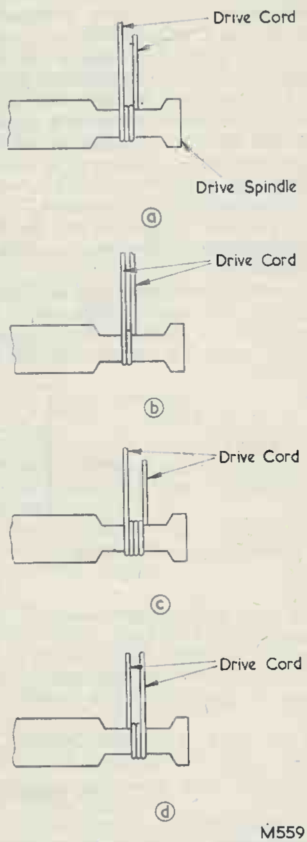



*Fig. 1. When replacing a broken dial cord it is advisable to pass the cord around the drive spindle with the correct number of turns and in the correct direction. In (a) it is assumed that the cord originally passed two and a half times around the spindle. Slipping may occur if it passes round only one and a half times, as in (b), and binding if it passes round three and a half times, as in (c). Binding may also occur if the cord passes round in the wrong direction, (d).*

hand the cord may bind at the ends of the drive spindle groove if you pass it round three and a half times (Fig. 1 (*c*).) The cord may also bind at the ends of the groove if you pass it round the spindle in the wrong direction (Fig. 1 (d).) I know that these seem to be small points, but it's amazing the difference they can make in some receivers."

"What about pulleys?"

"Well," said Smithy. "The cord quite often passes over a system of pulleys, and one of these may get stuck to its spindle. The resultant effect isn't always very noticeable because the cord may still run pretty smoothly over the surface of the stationary pulley. Nevertheless, there will be a tendency towards backlash, because the drive tensioning spring then has to overcome friction at the stationary pulley before the whole system can get moving. Also, wear and tear on the cord increases."

"I suppose a spot of oil on the pulley spindle usually clears matters," offered Dick.

"I would preferably use oil," said Smithy, "on metal pulleys only. In any event, a tuning drive pulley usually seizes up merely because of an accumulation of dirt; and it's quite easy in most cases to get a lot of this dirt out, after which the pulley rotates without any further trouble. I'm not all that happy about using oil on plastic pulley wheels, and it might be better to apply, instead, a little graphite after you've cleaned things up a bit. If you can rub the point of a soft pencil on to the working part of the pulley spindle this will leave enough graphite for most purposes. A touch of molybdenum disulphide lubricant would be ideal, both with metal and plastic pulleys, if you *really* wanted to make a proper job of things."

**The Tensioning Spring**

"Is the tensioning spring of importance?" asked Dick.

"Definitely," remarked Smithy. "Its function is to take up all the residual frictions in the tuning drive system. It may either be mounted on the tuning capacitor drive drum (Fig. 2 (*a*).) or it may be strung into the cord itself (Fig. 2 (*b*).) A disadvantage with having the spring on the drum is that it doesn't always have a great deal of effect if the tuning capacitor is operated at one end for long periods, thereby causing the maximum amount of cord at the spring end to rest on the drum. (Fig. 3 (*a*).) When this occurs, the friction between drum surface and cord sometimes prevents the spring from exerting tension. If the cord gets slack under these conditions you have to turn the tuning capacitor to the other end of its travel in order to let the spring tighten things up again (Fig. 3 (*b*).) Sometimes you can visibly see the spring closing up when you do this, with the result that the drive then becomes quite O.K. for a further period of time. Incidentally, what I've just said points the moral that the cord at the spring end should always pass over the minimum amount of drum surface if the spring is to be of maximum service. This point isn't always observed by home-constructors and others who start stringing up a system from scratch."

"I suppose you don't get this effect when the spring is in the cord itself?"

"That's right," confirmed Smithy. "Having the spring in the cord and off the drum makes quite certain that it can give the correct amount of tension for all settings of the tuning capacitor.

"An important point to remember when re-stringing a cord system," Smithy continued, "is to make certain that you get the spring at just the correct tension. If it's too loose you will, obviously, get backlash. If it's too tight you may find that things start getting pulled out of position! Frequently, some of the pulleys in the system are mounted on flimsy brackets which also support the tuning scale. These may tend to bend quite noticeably with the increased strain if the tensioning is too great. Also, the tuning capacitor can be pulled hard against any anti-microphonic mountings it may have, and the set may become microphonic in consequence. Another snag is that, whereas a normally tensioned spring allows the cord to slip on the drive spindle if you continue to turn this at the end of the range, too tight a spring can cause it to grip excessively. The result is that anyone who is sufficiently ham-handed can strain the system to a considerable extent if he turns the control knob too far."

"There seem," said Dick, "to be quite a few more things in this drive cord business than I'd guessed about"'

"There always are," grinned Smithy, "when you start digging into things! Anyway, whenever I've completed mending a cord drive I

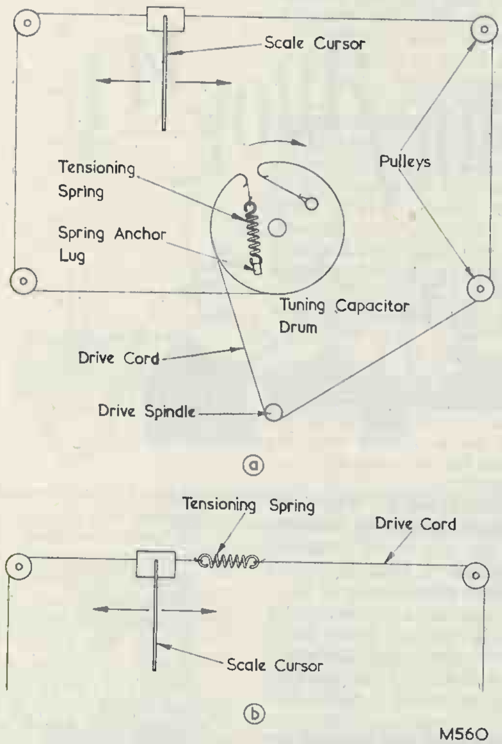



*Fig. 2 (a). A typical cord drive, including the scale cursor. The tensioning spring is fitted at the tuning capacitor drum.*
*(b). Occasionally, the tensioning spring may be inserted in the cord itself instead of on the drum.*

always check it for backlash, after which I swing over the whole range and continue turning at the ends to see that everything goes nicely."

"What about positioning the pointer?"

"That's no trouble normally," said Smithy. "You usually have either a carriage which slides along a metal strip or a bit of wire which couples into two sections of the system. (Fig. 4). In both instances, the pointer can be positioned at any point along the cord, and you just set it up for correct calibration on the tuning scale. Sometimes the manufacturer puts a little marker on the tuning scale which corresponds to the tuning capacitor being fully open or closed, and this can help quite a lot. When the cursor is mounted on a carriage it is also worthwhile seeing that this moves along freely."

Smithy returned to his chassis with an air of finality.

"And that," he remarked, "is all that there is to tell you about cord dial drives."

**Cog Wheel Drives**

"Many thanks for the gen," said Dick. "I suppose that, now you've repaired that drive, you're going to test it out."

"Naturally," said Smithy.

"Then you'll put the chassis back into its cabinet?"

Smithy looked suspiciously at his assistant.

"Of course," he remarked.

"Whereupon you'll take the set over to the rack?"

"Where else should I take it?"

"And leave it there?" persisted Dick.

"What on earth do you expect me to do with it?" fumed Smithy. "Stuff the tarnation thing into the stove or something?"

"Ah," said Dick equably, "I see you're getting quite red in the face now."

"It's a wonder I haven't blown a gasket," exploded Smithy. "I've never heard such an inane conversation in all my life."

Dick grinned.

"Sorry about that, Smithy," he remarked. "Actually, I'm just getting in a bit of practice with a new game my gang and I have dreamed up. We call it 'Obvious Remarks'."

" 'Obvious Remarks'?"

"That's right," said Dick. "We've suddenly noticed how many obvious remarks there are in ordinary conversation. Like, for instance, when you've been coughing and sneezing all over the place and someone says: 'Ah, you've caught a cold'."

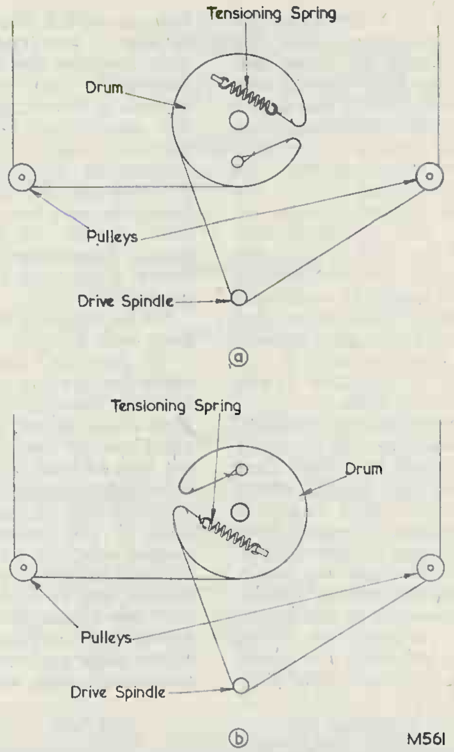



*Fig. 3 (a). If the tuning capacitor is positioned continually at one end of its range, as shown here, a relatively long section of the drive cord rests on the drum surface. The subsequent friction may occasionally be too great for the tensioning spring to overcome.*

*(b). Rotating the tuning capacitor to the other end of its range reduces the length of cord on the drum and allows the tensioning spring to have full effect.*

Smithy looked interested.

"I've met people like that," he commented thoughtfully.

"Our idea," continued Dick enthusiastically, "is to hold conversations which consists *entirely* of obvious remarks. You can keep it up for ages if you try hard enough!"

Despite himself, Smithy grinned.

"Well, don't try it on me," he chuckled. "I've got enough to do this morning as it is."

"I was hoping you'd pass on a bit more gen about tuning drives," continued Dick hopefully. "Mechanical ones, for instance."

"Sorry Dick," said Smithy. "I've got too much work to do."

"I was looking at a communications receiver the other evening," continued Dick artlessly, "which had a cog wheel arrangement between the tuning drive spindle and the capacitor."

"Oh yes?" replied Smithy noncommitally.

Dick, experienced in these matters, saw that Smithy was rising to the bait.

"Shocking backlash it had, too," said Dick. "There was about a quarter of a turn of the knob before the tuning capacitor started moving."

"That *was* shocking," agreed Smithy.

"Still," continued Dick, relentlessly, "I suppose you must accept this sort of thing with cog wheel reduction gears."

"Nonsense," snorted Smithy. "Cog wheel reduction drives give excellent results."

"I don't see how they can," said Dick, "if they haven't got a tensioning spring like you have with cord drives."

"If you look closely at a conventional cog wheel drive," said Smithy, completely hooked by now, "you'll see that the large cog in each reduction pair has springs which either exert pressure or tension. The more usual arrangement is the pressure type. (Fig. 5 (*a*) and (*b*).) In actual fact, the large driven cog consists of two separate cogs, one fixed to the driven spindle and one free to rotate about it. These two cogs have slots to accomodate the springs, and the latter cause the teeth to bear firmly on either side of the teeth in the small driving cog. As you rotate the driving cog in one direction its teeth exert torque on the large cog which is directly coupled to the driven spindle. As you rotate the driving cog in the other direction it exerts torque on the free cog. The torque is then transmitted to the fixed cog via the springs. Provided that the springs are powerful enough to overcome any friction which exists on or after the driven spindle you get a perfect, backlash-free, reduction drive."

"We didn't in the case I was talking about," said Dick.

"When these drives give trouble," Smithy commented, "it's either because the springs have lost their strength or because there's excess friction after the driven cogs. If you've got a simple two-gear train the servicing process is fairly simple. You first of all uncouple any mechanism following the driven spindle, this usually consisting of the tuning capacitor and, perhaps, the tuning scale indicator, and clear any excess friction this may have. After this, you can check the strength of the springs on the driven cogs by carefully inserting the blade of a small screwdriver into two adjacent teeth indents in these cogs. The blade of the screwdriver effectively bridges the two cogs. If you turn the screwdriver in the direction needed to bring the two sets of teeth into line with each other you're exerting force against the springs, and the torque needed to turn the screwdriver gives you an idea of their strength."

"What happens if the springs have gone weak?"

"If possible," said Smithy, "you move the free cog round one or two teeth in relation to that which is fixed to the driven spindle. I should point out, by the way, that this is a job best tackled by people with the requisite mechanical aptitude because it's quite easy to completely wreck a drive of this nature if you're not careful how you set about fixing it. The first thing to do is to release the driving cog in such a manner that you can re-couple it back to the driven cogs very quickly. The two driven cogs are now free to rotate relative to each other. You next put the blade of a screwdriver into a suitably positioned indent of one cog and the blade of a second screwdriver into a similarly placed indent of the second cog. Hold the screwdrivers well down, close to the teeth of the cogs, because they tend to slip off very easily. Rotate the two cogs against the springs until the latter are exerting what you feel to be a reasonable amount of pressure or tension, as the case may be. Then, when you have two indents in line, smartly move one of the screwdrivers over so that it lies in an indent on both cogs and thereby maintains them in position. With your free hand you then quickly return the small driving cog to its proper position, whereupon the two driven cogs are locked in place with their springs exerting the force you have selected. After that you can relax, and you should have a nice drive which is completely free from backlash."

"Phew!" said Dick. "That's a bit of a performance, isn't it?"

"Not really," remarked Smithy. "After a little practice you should only need to take a few minutes over the job. You must be very careful, incidentally, not to apply too much force when you apply a screwdriver to the cog wheel indents. These cogs are often made of quite soft metal and they may be easily damaged by the screwdriver blade. If you were *really* careless you might even break off a tooth from one of the cogs. So you have to be very careful when doing a job of this nature."

"Some cog wheel drives," volunteered Dick, "have more than just one pair of cogs. The first driven spindle carried a second driving cog, which then couples to a further driven cog on the tuning capacitor spindle."

"If you get backlash in a double set of gears like that," said Smithy, "your first job is to find in which set the springs are too weak. Usually it's the second set—that which is coupled to the tuning capacitor spindle—since this has the greater amount or work to do. To locate weak springs you need to look carefully at the teeth on one pair of driven cogs, and rotate the tuning knob first one way and then the other. If the teeth of one cog move in relation to those of its partner in the driven cog assembly, then the springs aren't doing their job, or there's too much friction further down the line. It's possible to discern extremely tiny degrees of relative movement between the teeth in a pair of driven cogs if you look carefully enough. A snag with

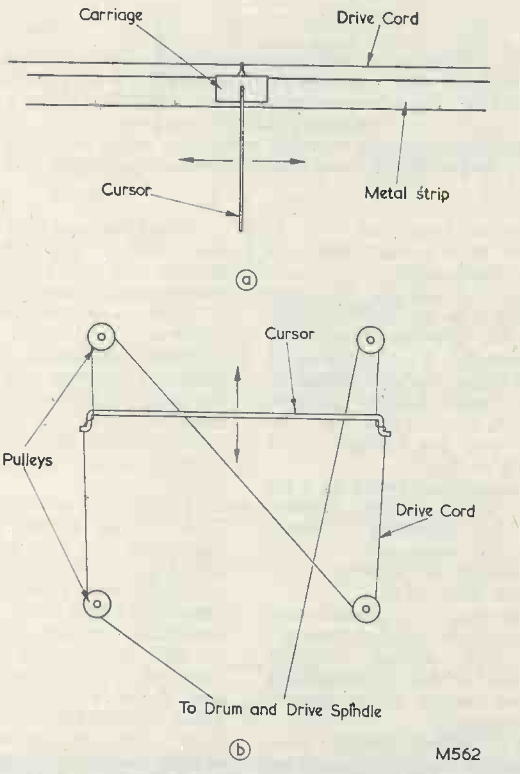



*Fig. 4. Two typical cursor mountings. In (a) the cursor is mounted on a carriage which slides horizontally on a metal strip. The cursor in (b) moves vertically, and is coupled directly to the drive cord at two points.*

multiple gear trains of this type is that the spindles of all the cogs are sometimes mounted between two end plates in the same manner as a clock. Take one of the end plates off and the whole assembly comes to pieces!"

"What's the procedure then?"

"If you feel up to it," said Smithy, "you can still, in many cases, reassemble the drive with the driven cogs nicely sprung by the screwdriver method I've just described. But it's rather a ticklish operation. Alternatively you can fashion some sort of jig or clip which will hold the driven cogs correctly sprung until you've got the end plates back on again. After which you remove the jigs or clips. It's quite a delicate task and should be carried out only by those who have the ability and confidence to tackle it."

**R1155 Drives**

Smithy stopped and lit a cigarette.

"And that," he remarked, "is pretty well the lot concerning cog-wheel tuning drives."

"I see," remarked Dick, "that you've started smoking again."

"I'm afraid so," replied Smithy unsuspectingly. "Still, I'm only getting through five a day, so I'm not as bad as I was."

"A packet of twenty," commented Dick, "must last you out just nicely for four days, then."

"That's right," agreed Smithy.

Dick looked at the Workshop windows. The storm had now abated, and a pale November sun shone fitfully through grey clouds.

"It's stopped raining now," said Dick.

"So it has," replied Smithy.

"If," continued Dick inexorably, "you'd put off coming in until now, you wouldn't have got wet, would you?"

"Of course I wouldn't," said Smithy shortly. "But I didn't, did I?"

"No you didn't," replied Dick. "And you got quite wet as a result."

"I *know* I got wet," snorted Smithy.

Suddenly light broke in.

"Dash it all!" said the Serviceman wrathfully, "are you off on this 'Obvious Remark' business again?"

"Well, I thought I'd try to keep my hand in," admitted Dick. "It's easy to get rusty, you know."

But Smithy had suddenly discovered a new train of thought, and was not listening to his assistant.

"Talking about obvious things," he remarked musingly, "one of the most obvious tuning drives that ever appeared in this country was also one of the least understood and,

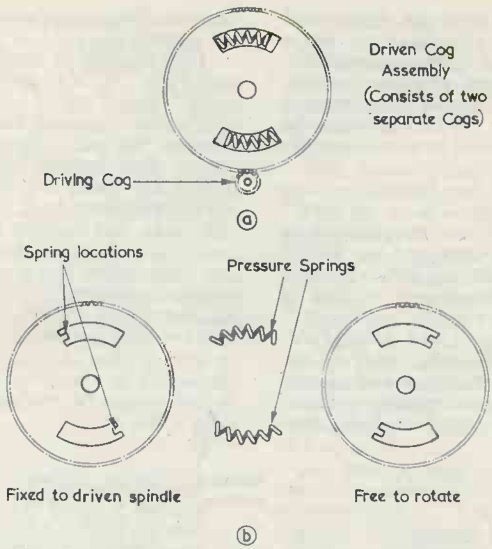



*Fig. 5 (a). A typical cog wheel tuning drive employing pressure springs in the driven cog assembly.*
*(b). The sections of the driven cog assembly.*

perhaps, the least appreciated."

Dick looked puzzled.

"I'm afraid I'm not quite with you," he remarked.

"I'm referring," said Smithy, "to the tuning drive on early R1155 receivers. This was one of the simplest and most efficient drives I've ever encountered."

"Do you mean," asked Dick, "those versions of the R1155 in which the outside tuning knob was fitted directly onto the end of the tuning capacitor spindle, and the inside knob gave the slow-motion?"

"That's right."

together again but the drive was just as bad as when I started."

"That's exactly what I mean," commented Smithy. "It's an extremely simple drive and yet it isn't properly understood or appreciated."

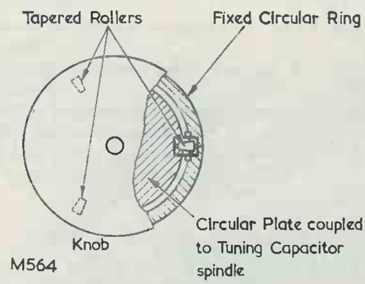
"How does it work, then?"

"By reason of the tapered rollers," replied Smithy. "However, let's start at the beginning. If you remove the outside tuning knob on an R1155 of this type, you find a simple spring causing the inside knob to press against the panel. Right?"

"Correct."

"Fair enough," said Smithy. "Now fitted into depressions under

*Fig. 6. The reduction gear employed in early versions of the R1155 receiver. The three tapered rollers, fitted in depressions in the underside of the knob, bear against the fixed ring and circular plate.*




"Well, I've bumped into several of those sets in the form of surplus," remarked Dick, "and their slow-motion drives used to slip like anything. I tried to repair one once, but I couldn't even discover how it worked. All I could find were three tapered rollers held under the knob, and nothing else. I put it all back

the inside knob are three tapered rollers (Fig. 6). The wide ends of the rollers bear against a circular ring fixed to the panel itself, whilst the narrow ends of the rollers bear against a circular plate coupled to the tuning capacitor spindle. O.K.?"

"Everything," commented Dick, "is fine up to now."

"Well, there you are then," said Smithy. "All you have to do is turn the knob. This causes the rollers to rotate and the circular plate to move round at a reduced rate of knots. What slow-motion drive do you know of that is simpler than that?"

Dick drew a deep breath.

"What you've said up to now," he remarked, "is true enough because I've *seen* the works of an R1155 tuning drive for myself. What I still don't understand is how it works."

"It's obvious," said Smithy impatiently. "The thick ends of the rollers run on the fixed surface, and the thin ends on the rotating surface."

"The effect may," replied Dick, "be obvious to a superior brain such as yours, but I'm afraid that I'm bogged down even before I begin! I just *cannot* understand why tapered rollers should give you a reduction drive."

Smithy seized a pencil and a pad of paper.

"O.K. then," he said. "Let's look at the thing from first principles. Let's assume we have a tapered roller and we lay it down on a flat surface. What happens if we give it a push?"

"Like the egg of the ouzel bird," said Dick, "it will go round in a circle." (Fig. 7 (*a*).)

"Exactly," replied Smithy, scribbling on his pad. "Now let's next mount our tapered roller on a spindle and cause it to run over two straight-edged surfaces. (Fig. 7 (*b*).) The wide end of the roller bears down on a fixed surface, whilst the thin end bears down on a surface which, in my sketch, is free to move up and down. We next move the roller up and down also, taking care to ensure that the spindle passing through it is always at right angles to the edges of the surfaces. All right so far?"

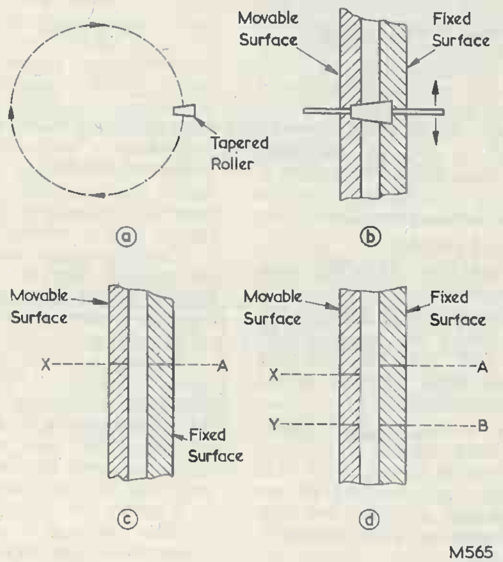



*Fig. 7 (a). If a tapered roller is set in motion on a flat surface it describes a circle.*

*(b). A tapered roller bearing against two surfaces, one fixed and one movable.*

*(c). Before the commencement of a revolution in the roller, points X and A on the surfaces are alongside each other.*

*(d). After one revolution, points Y and B are alongside, point X having been shifted in the direction of motion of the roller.*

"I think so," said Dick, frowning.

"Well," said Smithy, "what happens when we move the roller?"

Dick's face took on an appearance indicative of heavy thought.

"What the roller wants to do," he said thoughtfully, "is to go round in a circle like it did previously. But it can't do this, because we're keeping its spindle at right angles to the surface edges. It must, therefore, revolve at the rate dictated by the fixed surface at the thick end."

Suddenly his face cleared.

"I'm with it now!" he exclaimed suddenly. "The thin end would normally cover less distance than the thick end and it tries to do this on the surface which is free to move. As a consequence it drags that surface along with it!"

Smithy beamed.

"That's my boy!" he said. "The result is that the surface which is free to move is caused to travel in the same direction as the roller, but it covers a smaller distance. This being dependent, of course, on the taper in the roller. Another way of looking at the process is to consider what happens after a complete revolution of the roller. At the start, the roller may rest on points A and X of the fixed and moving surfaces respectively. (Fig. 7 (*c*).) At the end of the revolution, the roller will be bearing against point B of the fixed surface and point Y of the moving surface. Since the circumference of the roller is greater over the fixed surface, AB will be longer than XY." (Fig. 7 (*d*).)

"But," chimed in Dick, "since the roller is maintained at right angles to the surface edges, point Y must be opposite point B. And this can only be achieved if the movable surface has shifted in the same direction as the roller."

"I couldn't," pronouced Smithy, "have put it better myself. Now, to return to our R1155, all we have to do is to change our straight fixed surface to a circular fixed surface, and our straight movable surface to a circular movable surface, and our slow-motion drive is set up. There's one important point outstanding, however."

"What's that?"

"We are now," explained Smithy, "dealing with circular surfaces. We know that a tapered roller travels in a circle if it is pushed, and that it would be possible to make a roller whose taper was such that it travelled in a circle having exactly the same diameter as that traced out by the rollers in the R1155 system. In consequence, the rollers we use in such a system must have a greater taper than this for the slow-motion drive effect to take place."

"I can fully understand that," said Dick. "And I must admit, now that you've explained things, that the R1155 type of tuning drive is definitely the simplest I've ever encountered. But there's one thing that still bothers me."

"What's that?"

"The trouble I had with the R1155 drives I encountered myself. As I told you, they slipped quite a bit as the slow-motion knob was turned."

"Provided," remarked Smithy, "that there isn't excessive friction in the tuning capacitor itself, there is a basic common snag in nearly all those early R1155 drives which will give you that trouble. If you take the control knob off you'll find that the inner circular metal plate coupling to the tuning capacitor spindle has a disc of thin cork behind it. Over the years this cork disc tends to spread, whereupon it projects outside the edge of the circular metal plate (Fig. 8 (*a*).) This prevents the rollers from bearing down on the metal plate and causes the slipping you've just mentioned. The cure is to get a razor blade and very carefully cut away the cork protruding outside the edge of the metal plate, thereby leaving the two edges flush. (Fig. 8 (*b*).) The rollers then get a good grip on the plate and the drive should work as good as new."

"Well, I'm dashed!" said Dick. "Is that all there is to it?"

"That's all," confirmed Smithy cheerfully. "just a ten-minute job!"

**How Obvious Can You Get?**

The Serviceman glanced at the Workshop clock.

"Goodness me," he remarked. "I see we've wasted half the morning again!"

Dick looked at the clock, walked automatically over to the sink and picked up the battered Workshop kettle.

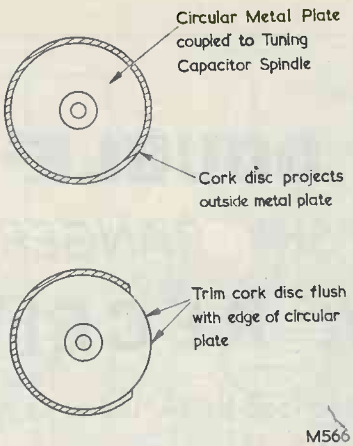



*Fig. 8 (a). A common fault with R1155 tuning drives of the type discussed here is that the cork disc under the circular metal plate spreads, projecting outside the circular plate edge.*
*(b). The excess cork may be carefully trimmed with a razor blade. This diagram shows the cork partly cut away.*

"I see you're filling the kettle," commented Smithy gravely.

"That's right," replied Dick over his shoulder.

"From the tap,"

A sudden suspicion crossed Dick's mind.

"Where else?" he remarked.

"Very convenient sources of water," stated Smithy.

"What are?"

"Taps."

Dick decided that his suspicions were confirmed.

"Except," he said, "when they get frozen up."

"Ah yes," replied the Serviceman promptly. "Which happens during the winter, of course."

There was silence for a moment.

"Darn it," complained Dick. "I can't think of any further obvious comments to make!"

"Keep trying," said Smithy encouragingly, "you'll think of one in a moment."

As Smithy watched him, Dick assumed an expression of agonised concentration. The Serviceman noticed with interest that the kettle was now overflowing and that the surplus water was falling neatly down his assistant's right leg.

Suddenly, Dick looked down and gazed with horror at the wet patch spreading over his trousers.

"I observe," remarked Smithy gently, "that the kettle's full."

For some reason, however, Dick was disinclined to continue the conversation. And, indeed, Smithy found that, from that moment on, he was able to carry on with his work entirely free from any further "Obvious Remarks".

# TRADE REVIEW . . .

## "Pensource"—The New Pocket Signal Generator

For engineers, radio and TV servicemen who require a small and convenient form of input for testing or fault finding, Electronic Machine Control Ltd. have produced the "Pensource" range of pocket signal sources.

These instruments as the illustration shows, look like conventional pen torches but are in fact pocket signal generators, giving approximately 0.5V output.

They are made in several ranges, 500 c/s square wave audio and 465 kc/s modulated i.f. being two of the various combinations available. Basically each "Pensource" is a transistor oscillator potted in a robust chromium plated case. The supply to the oscillator is provided by a 1½V penlight cell and under normal conditions of use should last approximately four to six months.

The "Pensource" is invaluable for signal tracing, calibration and alignment, in fact it can be used at any time when a portable pulse, i.f. or r.f. signal is required.

It sells at £4 10s. and a leatherette felt lined case is also available at an extra cost of 10s. 6d. Further details may be obtained from the makers: Electronic Machine control Ltd., Mayday Road, Thornton Heath, Surrey, England. (Thornton Heath 3601.)

*The "Pensource" pocket signal generator that has been produced by Electronic Machine Control Ltd. to provide engineers, radio and TV servicemen with a small and convenient form of input for testing and fault finding*

Cover Feature

# THE DOUBLE-TWO "SKY RANGER" S.W. RECEIVER

Described by JAMES S. KENT

*In which our contributor describes, step by step, the construction of the "Globe-King" a.c. operated short wave receiver. The design is ideally suited for construction by the beginner and the subsequent operation of this receiver should provide many hours of enjoyment and pleasure on the populous and popular short wave frequencies*

THE DOUBLE-TWO "SKY RANGER" 2-VALVE SHORT wave receiver is the latest design to emerge from the long established and well-known "Globe-King" range of receivers. Although designed specifically for the beginner, it should also prove eminently suitable for use as a standby set by the more advanced constructor or short wave listener. The design is sound and very stable in operation, the completed receiver presenting a very attractive appearance as may be seen from the cover illustration.

To the beginner, looking for a design which he can build fairly easily at a comparatively inexpensive outlay, the "Sky-Ranger" should prove to be an admirable undertaking.

The tools required for constructing this receiver are few in number and, once built, no complicated lining-up techniques are required. A pencil-bit soldering iron, a small pair of sidecutting pliers, a penknife and a small screwdriver are all that is required to complete the construction.

**Soldering**

Before the beginner commences construction, the writer would like to point out that the art of soldering should be mastered before using the soldering iron on the receiver. Only good and sound soldered joints are to be made in a set of this nature (or indeed any other radio equipment). A poorly soldered joint will cause endless trouble at a later stage: crackles, poor results, indifferent and erratic performances—or even failure to work altogether. These are the results of a joint which, through bad soldering, sets up an additional resistance and ruins the performance of an otherwise perfect receiver.

Using the blade tip of the penknife, scrape clean and brighten all wire ends of components, soldering tags, etc, carefully preparing and cleaning each joint before the actual soldering is carried out. Apply to the joint, at the same time, both the iron (once it has attained a working temperature) and the solder. Allow the solder to flow freely *all over* the joint and then remove the iron. At this stage *do not cause any movement to be made in the joint*; hold the joint perfectly steady until the solder has solidified, when a perfect joint will result. Moving the joint whilst the solder is still hot and flowing will result in a badly soldered connection (dry joint).

Never carry the solder to the joint on the bit of the iron or "dwell" on the joint too long.

Soldering is an acquired knack, quite easy to achieve, but one which requires a little practice. In the writer's experience, bad soldering is the beginner's greatest fault and pitfall, the second one being that of impatience together with the burning desire to "get it finished and start listening" inherent in all beginners. Curbing this natural shortcoming and making sound joints as previously described, the beginner should aim at a "job well done" with all the resultant satisfaction that this will bring in the long run.

**Circuit**

This is shown in Fig. 1 from which it will be seen that the design centres around two Mullard duo-type valves, the ECC81 and the ECL80, resulting, in effect, in a four valve receiver.

The primary winding of the coil ($L_1$) connects to the aerial via $C_1$ which isolates the detector stage ($V_{1(a)}$) from aerial capacity effects and prevents dead spots in reaction operation. The winding is tuned over the desired range of frequencies by the variable capacitor $C_2$ (Bandset), in parallel with the Bandspread capacitor $C_3$. The reaction grid components are capacitor $C_5$ and grid leak $R_2$, the values of these, together with the other reaction components, ensuring positive feedback free from backlash. $L_2$ is the reaction winding and $C_4$ the reaction control.

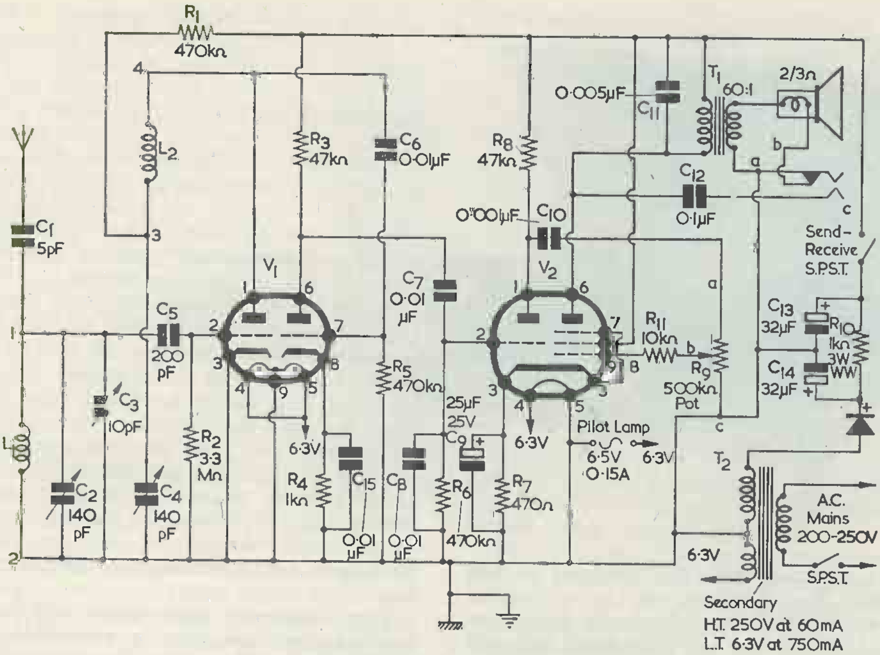


Fig. 1. Circuit of the Double-Two "Sky Ranger"

M548

## Components List

*Resistors*

| | |
|---|---|
| $R_1$ | 470kΩ Hi-Stab |
| $R_2$ | 3.3MΩ ½ watt |
| $R_3$ | 47kΩ |
| $R_4$ | 1kΩ ½ watt |
| $R_5$ | 470kΩ ½ watt |
| $R_6$ | 470kΩ ½ watt |
| $R_7$ | 470Ω ½ watt |
| $R_8$ | 47kΩ ½ watt |
| $R_9$ | 500kΩ potentiometer |
| $R_{10}$ | 1kΩ 3 watt wirewound |
| $R_{11}$ | 10kΩ ½ watt |

*Capacitors*

| | |
|---|---|
| $C_1$ | 5pF silver mica |
| $C_2$ | 140pF variable |
| $C_3$ | 10pF variable |
| $C_4$ | 140pF variable |
| $C_5$ | 200pF mica |
| $C_6$ | 0.01μF ceramic |
| $C_7$ | 0.01μF ceramic |
| $C_8$ | 0.01μF ceramic |
| $C_9$ | 25μF, 25V wkg electrolytic |
| $C_{10}$ | 0.001μF ceramic |
| $C_{11}$ | 0.005μF ceramic |
| $C_{12}$ | 0.1μF paper tubular |
| $C_{13}$ | 32μF 350V wkg electrolytic |
| $C_{14}$ | 32μF 350V wkg electrolytic |
| $C_{15}$ | 0.01μF ceramic |

*Valves*

| | |
|---|---|
| $V_1$ | ECC81 |
| $V_2$ | ECL80 |

*Coils & Holder*
Messrs Johnsons (Radio)

*Cabinet, Chassis & Panel*
Messrs Johnsons (Radio)

*Output Transformer*
5kΩ impedance, 60:1
Messrs Johnsons (Radio)

*Dial Light Assembly*
Messrs Johnsons (Radio)

*Valveholders*
B9A (2)

*Speaker*
7 x 4in elliptical

*Mains Transformer*
250V, 60mA; 6.3V, 750mA

*Miscellaneous*
Switches, Knobs, grommets, wire, Tagboard, etc.
Messrs Johnsons (Radio)

*Dials*
Messrs Johnsons (Radio)

*Above-chassis view of the completed receiver*

The anode h.t. positive supply is via $R_1$ and $L_2$, and the output from $V_{1(a)}$ is taken, via $C_6$, to the grid of the first audio amplifying stage, $R_5$ being the grid resistor. Cathode bias for this stage is supplied via the cathode components $R_4$ and $C_{15}$. The anode supply is applied via $R_3$ and the output from this stage is then fed to the grid of $V_{2(a)}$ via $C_7$. $R_6$ and $C_8$ are the grid components for this stage.

The triode portion of $V_{2(a)}$ is the next audio amplifier, $R_7$ and $C_9$ providing cathode bias both for this stage and $V_{2(b)}$. The resultant audio output from $V_{2(a)}$ is taken, via $C_{10}$, to the top of the volume control $R_9$, the required audio output being tapped off through the slider and applied, via $R_{11}$, to the grid of $V_{2(b)}$. The screen grid h.t. positive supply is taken direct from the h.t. rail and that for the anode via the primary winding of the output transformer $T_1$. $C_{11}$ is included in the anode circuit for tone correction purposes. The output to the phone jack is via $C_{12}$, insertion of the phone plug into the jack automatically muting the speaker by breaking the connection from the secondary of $T_1$ to the speaker itself.

The power supplies are obtained from the mains transformer $T_2$, this having a primary rated at 200–250V a.c. and secondaries at 6.3V, 750mA, and 250V at 60mA. Rectification is carried out by the metal rectifier, and the supply is adequately smoothed by $R_{10}$, a 3-watt wirewound component, and $C_{13}$, $C_{14}$.

Two single-pole single-throw switches are incorporated, one acting as a mains on/off and the other as a standby or send/receive control.

The communications style metal cabinet has a silver-grey cellulose finish and a hinged lid is fitted for easy coil changing purposes. A precision micro-drive dial is fitted to the Bandspread capacitor for easy and smooth rotation, the dial itself being large and easily read. Looking at the heading illustration the controls are, from left to right, Standby switch, Headphone jack, Mains On/Off switch, Audio Gain, Reaction, and Bandset, the large dial above being Bandspread.

**Construction**

Construction should commence by bolting to the chassis all the main components. Dealing with the valveholders first, it should be noted that the first stage valveholder (ECC81) is that nearer the front panel (see illustration). Both these holders should be so positioned that the location gaps between pins 1 and 9 (see Fig. 2) point approximately towards the speaker aperture. The coil holder should be secured in such a manner that the three tags numbered 1, 2 and 3 in Fig. 3 are facing towards the valveholders.

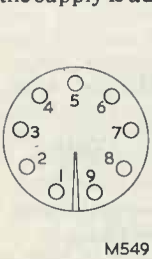



*Fig. 2. Valveholder connections, underside view*

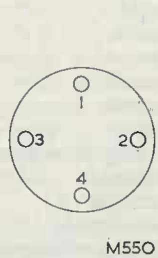



*Fig. 3. Coil holder, underside view*

Secure the smoothing capacitors ($C_{13}$ and $C_{14}$ are both contained within the single metal can) to the chassis by means of the two self-tapping screws and the metal strip provided. Fasten the metal rectifier to the chassis by means of the central hole and a nut and bolt.

The mains and output transformers should next be fitted, the former being that situated nearer the rear edge of the chassis.

The front panel should now be fitted to the chassis by means of the four self-tapping screws provided. Fit to the front panel the two switches and headphone jack, the latter being so mounted and secured that the three tags are uppermost and the switches so that the two tags of each are nearest the chassis deck. Before finally securing the switches into position, note that these are set back from the panel in such a manner the threaded bush is flush with the front panel securing nut. (See illustration.)

Fix the volume control to the panel so that the three tags are nearest the chassis deck, bending these so that no contact is possible with the chassis.

Next, fit the reaction and bandset capacitors to the panel in the positions previously described, and the bandspread capacitor above these latter two components. The bandspread capacitor is the smaller of the three capacitors, the remaining two being of the same physical size and electrical value.

Secure the on/off red indicator light holder to the panel and follow this by fitting the speaker mesh and the speaker. Note here that the bolts should be pushed through the panel, through the metal mesh and through the speaker elongated holes themselves, being secured by means of washers and nuts. As shown in the illustration, the speaker tags should be positioned towards the nearest panel edge.

This completes the assembly of the main components.

**Wiring the Receiver**

Note here that, in the prototype, earthed returns are effected by soldering direct to the metal chassis and that this will entail the use of an iron having a large bit. For those using a pencil bit type iron, the use of soldering tags mounted under the nearest nut and bolt would be required.

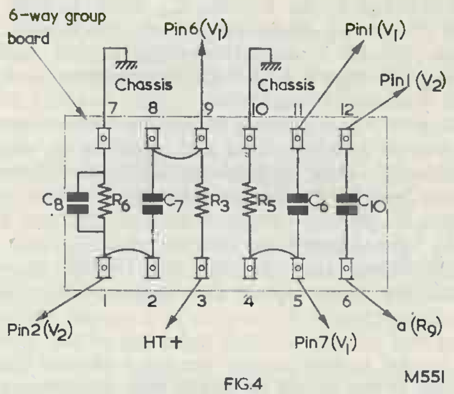


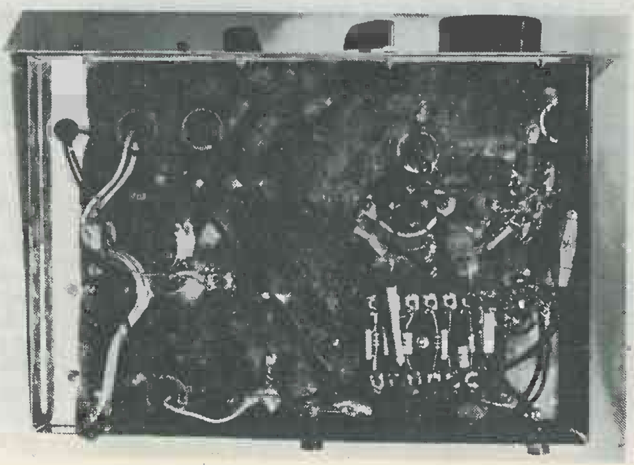

*Fig. 4. 6-way group board and component wiring*

Before wiring commences, the rubber grommets should be fitted into the appropriate seven holes on the chassis, and a further grommet fitted to the a.c. mains input aperture on the rear chassis wall. To this latter wall should also be fitted the red aerial input socket and the black earth socket. The latter socket should be connected direct to the chassis by means of a small length of bare wire. The aerial input socket is, of course, insulated from the chassis.

The groupboard should next be wired as shown in Fig. 4 before it is mounted on the chassis. Commence wiring by soldering into position $R_6$ (470k$\Omega$) together with $C_8$ (0.01$\mu$F) across tags 1 and 7 of the groupboard. Note here that the colour code for 470k$\Omega$ is yellow, mauve, yellow, and that for 0.01$\mu$F (assuming a colour coded capacitor) it is brown, black, orange.

Across tags 2, and 8, mount $C_7$ (0.01$\mu$F, brown, black, orange), and across tags 3 and 9 solder $R_3$ (47k$\Omega$, yellow, mauve, orange) into position.

Tags 4 and 10 should next be fitted with $R_5$



*Below-chassis view showing the 6-way group board and remaining components*

(470kΩ), tags 5 and 11 with $C_6$ (0.01μF) and tag 6 and 12 with $C_{10}$ (0.001μF, brown, black, red).

Tags 1 and 2 should now be joined together (see Fig. 4), tags 4 and 5 joined together, and tags 8 and 9 similarly treated.

Mount the groupboard to the chassis by means of the nut and bolt provided and continue to wire the groupboard into circuit as follows. Cover a suitable length of wire with sleeving and join tag 1 of the groupboard to pin 2 of $V_2$. Connect tag 3 of the groupboard to HT+, routing the wire (suitably insulated) through the rubber grommet nearest the front panel and edge of the chassis (see above-chassis illustration). Connect the other end of this wire to the left-hand tag of the Standby switch (the switch nearer the edge of the chassis) looking at the switch from the rear of the chassis.

From tag 5 of the tagboard connect a suitably covered wire to pin 7 of $V_1$. From tag 6 solder a length of wire to tag a of the volume control $R_9$, routing this lead up through the right hand grommet of the three situated just behind the switches.

Tag 7 and tag 10 should now be soldered either to the chassis direct, or to a suitably placed solder tag.

Tag 9 should next be connected to pin 6 of $V_1$ and tag 11 to pin 1 of $V_1$.

Tag 12 should be connected to pin 1 of $V_2$.

The 470kΩ resistor $R_1$ should be soldered at one end to tag 3 of the groupboard and at the other end to pin 3 of the coilholder (see Fig. 3). The lead-out connecting to tag 3 of the groupboard will have to be lengthened by soldering an additional length of wire to it. The whole length of wire at both ends of the resistor must be covered with sleeving to ensure adequate insulation.

Also connected to tag 3 of the groupboard is $R_8$ (47kΩ), its other end connecting to tag 12 of the groupboard. A further connection is again made to tag 3 of the groupboard, this coupling the tag to pin 8 of $V_2$.

This completes the wiring of the groupboard.

Dealing next with the coil holder, pin 2 should be connected direct to chassis or to a suitably positioned earth tag. Pin 4 should be connected to pin 1 of $V_1$ by means of a sleeving-covered length of wire. To pin 3 of the coil holder (that to which $R_1$ is already connected) connect a further length of covered wire, this now being fed through the adjacent rubber grommet and soldered to the reaction capacitor $C_4$ (stator plates connection).

To pin 1 of the coil holder solder one end of $C_1$, the other end of this capacitor being connected to the red aerial input socket on the rear of the chassis. Also to pin 1 solder one end of $C_5$, the other end of which should be connected to pin 2 of $V_1$. Again to pin 1 of the coil holder solder a further length of insulated wire, feeding this through the adjacent rubber grommet for connection to the tag of $C_2$ (stator plates connection). This completes the coil holder wiring.

The next stage in the wiring procedure is to complete the valveholder wiring, that for $V_1$ being dealt with in the first instance.

To pin 2 (to which $C_5$ has already been connected) solder one end of $R_2$ (3.3MΩ, orange, orange, green), the other end of this resistor being connected direct to the chassis or a suitable earthed tag. Pin 3 should be joined, by means of a bare length of wire, to the central metal spigot of the valveholder and also to pin 9, being connected from this latter point to chassis. Pin 8 of $V_1$ should now have one end of both $R_4$ and $C_{15}$ connected to it, the other ends of these components being soldered direct to chassis or to a suitably placed earth tag. Note that $R_4$ has a value of 1kΩ (brown, black, red) and that $C_{15}$ is an 0.01μF component (brown, black, orange).

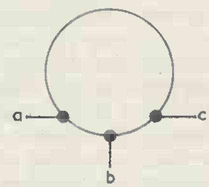



*Fig. 5. Volume control, rear view*

Pins 4 and 5 of $V_1$ should now be joined by means of a small bare end of wire, the remainder of the wire being covered by sleeving and soldered, at the far end, to pin 4 of $V_2$. From this latter point a further connection is required to one of the yellow wires connected to the mains transformer (it does not matter which yellow wire is used here). Thread the yellow wire through the adjacent grommet and join the length of wire to it, suitably covering with with sleeving so that neither the wire or the soldered joint can possibly make contact with the chassis.

Return to pins 4 and 5 of $V_1$ and solder a short length of covered wire to them, route this wire through the nearest rubber grommet and solder the other end to one tag of the on/off light assembly (it does not matter to which tag this wire is connected).

Dealing next with the remaining connections to the valveholder of $V_2$, join pins 3 and 7 with a short length of insulated wire. Solder to pin 3 one end of both $R_7$ (470Ω, yellow, mauve, brown) and $C_9$ (25μF, 25V working). Ensure that the positive end of $C_9$ connects to pin 3. Connect the other ends of these two components direct to chassis or a suitable earthed tag. Pin 5 and the central metal spigot should now be connected direct to the chassis. Pin 6 of $V_2$ should be connected to one end of a length of covered wire the other end of which is soldered to tag 3 of the output transformer (see Fig. 6). To pin 9 of $V_2$ solder one end of $R_{11}$ (10kΩ, brown, black, orange) and to the other end of this resistor join a length of covered wire, adding sleeving to cover the joint and lead-out. Route this wire through the rubber grommet nearest the volume control and connect this wire to tag b of this control (see Fig. 5).

**Power Supply**

The next items to wire into circuit are the mains input wiring and the mains transformer. The mains input wiring should first of all be fed through the rubber grommet fitted to the rear wall of the chassis. The clear plastic double wire should be parted into two leads and one fed through the centre of the three front rubber grommets and soldered to the mains on/off switch left hand tag looking at the switch from the rear of the chassis. The mains on/off switch is that nearer the volume control. A suitably covered wire should now be soldered to the other tag of this switch and passed back under the chassis through the same rubber

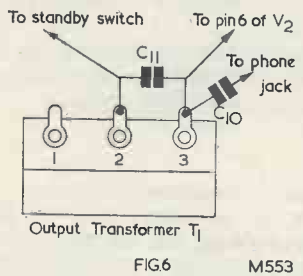



*Fig. 6. Output transformer $T_1$ and component wiring*

grommet and soldered to one of the purple wires (it does not matter which of the two purple wires are used) from the mains transformer, these transformer wires being fed through the appropriate grommets and positioned under the chassis. Ensure that the soldered joint is completely covered with insulating material so that no accidental contact with the chassis can be made. The other lead of the mains input wire should now be cut to length and soldered to the remaining purple wire from the mains transformer. Cover the soldered joint as previously described. The mains lead should now be withdrawn through the rubber grommet and a knot tied in it in order to provide an anti-strain device. The lead should now be threaded back through the grommet.

One red and one yellow lead from the mains transformer should now be connected direct to chassis, the enamel covering of the yellow lead wire being removed before soldering.

The remaining red lead from the mains transformer should next be soldered to the negative tag of the contact cooled rectifier. One end of a lead, suitably covered, should now be connected to the positive (+) tag of the rectifier and connected at the other end to the red tag of the capacitor $C_{14}$. To the red tag of this capacitor connect one end of $R_{10}$, the other end of this resistor being soldered to the yellow tag of $C_{13}$. (Both $C_{13}$ and $C_{14}$ are contained within the single metal can.) The plain tag of this combined capacitor should now be connected to the under-side of the chassis by passing a bare length of wire through the adjacent hole in the chassis deck. A length of sleeving-covered wire should next be connected to the yellow tag of of $C_{13}$, fed through the chassis via the nearby rubber grommet and thence to the standby switch at the extreme right hand edge of the front panel looking at the panel from the rear. The wire should be fed up through the right hand grommet and soldered to the right hand tag of the switch, looking at the switch from the rear. From the left hand tag of this switch connect a short length of covered wire to tag 2 of the output transformer. (See Fig. 6).

$C_{11}$ (0.005μF, green, black, red) should now be fitted, as shown in Fig. 6, to the output transformer $T_1$.

**Panel Controls**

To complete the wiring of the receiver we must now continue with the wiring into circuit of the panel controls.

Dealing with the phone jack in the first instance, tag b should be connected to the uppermost tag of the speaker. Tag a should be soldered to one of the wires from the underside of the output transformer (it does not matter which of these two wires are connected to tag a) and the other wire from the underside of the transformer should be connected to the lower tag of the speaker. From tag a of the phone jack solder a short length of covered wire and connect the other end to tag c of the volume control. To tag c of the phone jack connect one end of $C_{12}$, suitably covered with sleeving, and solder the other wire of this component to tag 3 of the output transformer (see Fig. 6).

From tag c of the volume control solder a length of bare wire (having a length sufficient to reach the pilot light assembly) and, at convenient points along its length, solder to the earthed tags of both $C_2$ and $C_4$ (bandset and reaction) these tags being those connected to the rotor plates of the capacitors. The end of this length of wire should now be connected to the blank tag of the pilot light assembly. From this latter point a further length of wire should be connected to the earthed tag of $C_3$ (bandspread).

One of the tags (stator) of this latter capacitor should now be connected to one of the tags (stator) of the bandset capacitor via a length of covered wire.

At a point midway between $C_2$ and $C_4$, a short length of wire should be soldered to the bare wire connected to both rotor tags of these capacitors, the other end of this short length is then fed through the chassis via the adjacent rubber grommet and soldered to the chassis or an earth tag.

This completes the wiring of the receiver.

**Operating Instructions**

Plug the two valves into their respective holders, $V_2$ (ECL80) being that nearer the rear edge of the chassis, and place over each valve its black screening can.

Connect to the a.c. mains (200 to 250 volts) by means of the twin flex from the receiver and a suitable plug. Connect an earth to the black socket and an aerial to the red socket.

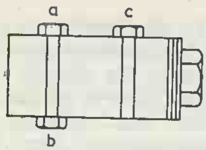



*Fig. 7. Phone socket connections*

Set the three variable capacitor dials to zero and the gain control to the mid-way position. Insert coil No. 2.

Assuming that the switches are in the "Off" (up) position, switch both of these to the "on" position whereupon the panel lamp should become illuminated. The set is ready to operate after a brief time to allow the valve heaters to warm up.

Rotate the bandset control to read 4 degrees for the approximate 31 metre band. Rotate, very slowly, the reaction control until a click is heard and remain at this point for the present. Now search for signals by carefully rotating the large micro control of the bandspread control through 0 to 100 degrees. If a squeal or howl is heard together with any signal then the receiver is oscillating, in which case carefully back-off the reaction control until the oscillation ceases. This is the method used when searching for distant signals. Set the bandset in progressive stages from 0 to 10 degrees to complete the range of the coil. See Table for calibration details. Complete rotation of the bandspread from 0 to 100 degrees is equal to one section of the bandset, i.e., 0 to 1, 1 to 2, and so on. Throughout the searching operation the reaction control should be so adjusted that it is "following" the tuning, in step, just below the point of actual oscillation.

During fair conditions on the short waves, a great number of signals will be heard, some weak, others very strong—the latter requiring use of the gain control in order to reduce audio strength to a comfortable listening level.

After a little practice, the knack of extracting the maximum efficiency from a grid detection circuit will soon be acquired and the finer points of operating can be carried out.

Where two or more signals can be heard at once, first reduce the audio gain until the signals can just be heard. Boost back the signals by careful reaction adjustment, thus attaining the position of maximum selectivity.

**TABLE**

**Calibration Chart — Approximate Dial Readings**

| Bandset Scale | | Metres |
|---|---|---|
| *Coil No. 1* | | |
| 0–0.5 degrees | Amateur .. .. .. | 10 |
| 2 ,, | Broadcast .. .. .. | 11 |
| 3.5 ,, | Broadcast .. .. .. | 13 |
| 4.5 ,, | Amateur .. .. .. | 15 |
| 5.5 ,, | Broadcast .. .. .. | 16 |
| 8–8.5 ,, | Broadcast .. .. .. | 19 |
| 9 ,, | Amateur .. .. .. | 20 |
| *Coil No. 2* | | |
| 1–1.5 degrees | Broadcast .. .. .. | 25 |
| 3 ,, | Broadcast .. .. .. | 31 |
| 7 ,, | Amateur & Broadcast .. | 40 |
| *Coil No. 3* | | |
| 0–1 degrees | Broadcast .. .. .. | 49 |
| 2 ,, | Broadcast .. .. .. | 60 |
| 6.5 ,, | Amateur .. .. .. | 80 |
| *Coil No. 4* | | |
| 7–7.5 degrees | Amateur .. .. .. | 160 |

Continuous coverage: 28.700 Mc/s to 1.600 Mc/s

The above mode of operating is that for the reception of the spoken word and music (modulated signals). Where reception of Morse is desired (c.w. or continuous wave) the same search procedure applies with the exception that the reaction control should be so adjusted that the receiver is just in the oscillating condition. The beat or pitch of the c.w. note may be changed to suit individual requirements by rotating the bandspread control either side of the signal.

Single sideband (SSB) transmissions can be converted into intelligible signals by carefully adjusting the receiver as follows: operate as for c.w., carefully tuning across the signal until the "scrambled" effect becomes intelligible. Tune very slowly with the receiver just in the oscillating state.

**Reception Conditions**

On occasions, sun-spot activity results in a complete black-out of short wave signals, the few signals that may be heard invariably suffering from acute fading, distortion or being so weak that they cannot be identified. This will probably puzzle the newcomer to short wave operating but very soon, with a little experience, he will become acquainted with such phenomena and upon switching on for a listening session, sense whether conditions are good or bad after a short run over the various bands.

## THE DOUBLE-TWO "SKY RANGER"

**Further Notes**

Since the above article was prepared, the following modifications and additions to this receiver have been made:

(a) $R_1$ is a high-stability type resistor.

(b) An improved index is now being supplied with the slow motion dial assembly together with a hair cursor.

(c) A further coil is now available covering the Trawler Bands. Coil No. 5 (180 to 300 metres).

# A TRANSISTORISED ELECTRONIC ORGAN

**Part 4**

By **S. ASTLEY**

*This is the concluding article in our popular series describing a transistorised electronic organ, and it covers the vibrato unit, the $C^1$ generator, and the reverberation unit. The process of tuning is also discussed, together with suggestions for further improvements*

### Vibrato

THE VIBRATO UNIT EMPLOYS A PHASE-SHIFT oscillator, as shown in Fig. 35, together with an amplifier and an amplitude control. The vibrato frequency is controlled by the "Fast-Slow" switch which, in the "Slow" position, connects a further 1μF capacitor across $C_1$. The "Fast-Slow" switch is brought out to the front panel as, also, are the "Vibrato On-Off" switch and the "Vibrato Amplitude" potentiometer.

The output of the vibrato amplifier feeds the twelve 47kΩ resistors connected to the base of each master oscillator. See Fig. 8 (published in Part 2 of this series).

If any difficulty is experienced in making the vibrato circuit oscillate, it should be noted that a transistor with a high current gain (100 or over) is required in the $TR_1$ position and that several types may need to be tried. Having obtained the correct transistor, the writer has found that the circuit needs no further attention whatsoever, and that it oscillates reliably every time it is switched on.

To illustrate the effect of the vibrato unit, Fig. 36 shows a 1 kc/s waveform, both with and without vibrato.

### The Low C Generator

The circuit for the low C ($C^1$) generator appears in Fig. 37. This is basically the same as the vibrato unit, and the same remarks concerning transistor gain apply.

The oscillator is tuned by beating with $C^2$ and rotating the tuning control, $R_7$. If, due to component tolerances, the desired frequency cannot be

**Components List (Fig. 35)**

| | |
|---|---|
| $R_{1,2,3}$ | 8.2kΩ ¼W |
| $R_4$ | 10kΩ ¼W |
| $R_5$ | 2.2kΩ ¼W |
| $R_6$ | 47kΩ ¼W |
| $R_7$ | 2.2kΩ ¼W |
| $R_8$ | 33kΩ ¼W |
| $R_9$ | 68kΩ ¼W |
| $R_{10}$ | 10kΩ ¼W |
| $R_{11}$ | 1kΩ ¼W |
| $R_{12}$ | 3kΩ potentiometer |
| $C_{1,2,3}$ | 1μF |
| $C_4$ | 2μF 12 w.v. electrolytic |
| $C_5$ | 8μF 12 w.v. electrolytic |
| $C_6$ | 50μF 6 w.v. electrolytic |
| $C_7$ | 1μF |
| $C_8$ | 100μF 12 w.v. electrolytic |
| $C_9$ | 1μF |
| $TR_1$ | OC72, OC78 or OC81 |
| $TR_2$ | OC71 |

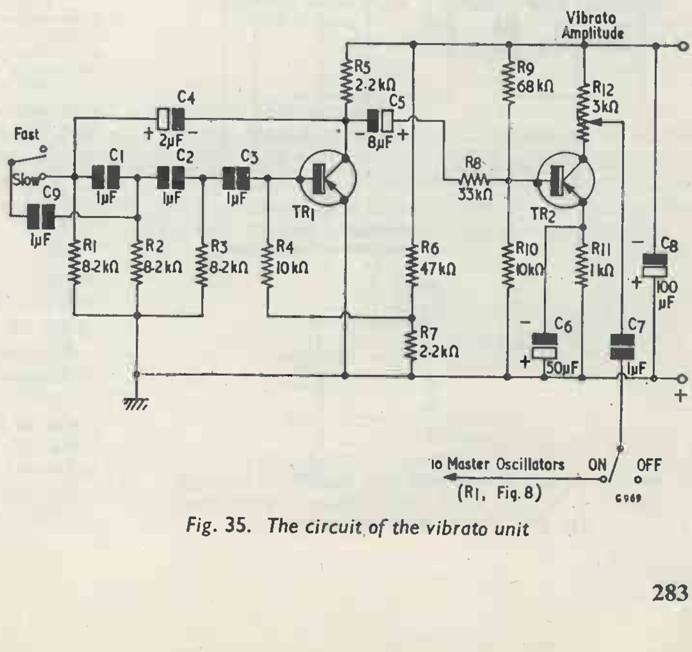



*Fig. 35. The circuit of the vibrato unit*

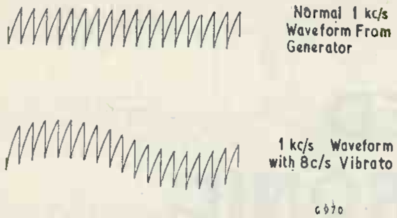



*Fig. 36. The effect of vibrato on a 1 kc/s waveform*

obtained, any of the 0.5μF base capacitors can have their values adjusted accordingly.

**Reverberation**

Although frowned on by the purists, reverberation offers a very worthwhile addition to the organ. There are several methods of obtaining reverberation, these including magnetic tape (using an endless belt and multiple heads), delay lines, and electro-mechanical methods.

The last-named was found by the writer to be the simplest method, especially for the amateur, and it can be put into practice in the form of a transmitter and receiver separated by a length of spring, as shown in Fig. 38. The transmitter consists of a moving coil unit fed by the main speaker system. Energy is transmitted down the spring, whose diameter, length and expansion determine the delay. Along the spring is a crystal cartridge whose output

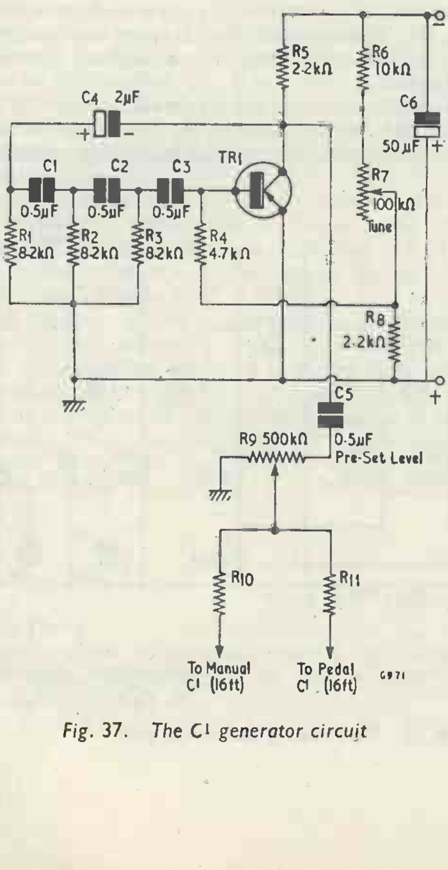



*Fig. 37. The C¹ generator circuit*

is fed into a second amplifier and loudspeaker. For reasons of economy it may be found desirable to dispense with the separate amplifier and speaker, and feed the receiver output back into the main organ system at the input to Pre-Amplifier No. 2 (See Fig. 3, published in Part 1 of this series.) In this case an attenuator is necessary to prevent oscillation due to the feedback loop consequently set up. A suitable attenuator is shown in Fig. 39. The use of a separate amplifier and loudspeaker is much more preferable, however, as it gives greater flexibility of operation without the risk of feedback.

The transducer, i.e. transmitter unit, employed by the writer was taken from an ex-Government radio Altimeter.[1] This unit is connected in series with the main 15Ω loudspeaker (it being borne in mind that one side of the moving coil is common to the magnet frame).[2] The ceramic capacitor plate is removed and an eyelet is affixed to the diaphragm centre with Araldite. It is possible that a small 3in moving coil loudspeaker could be employed as a transducer, in which case a suitable web and eyelet could be fitted to the cone.

The spring should be lightly suspended, and slight sagging is quite permissible. That used by the writer was $\frac{1}{4}$in in diameter, the spring wire being approximately 26 s.w.g. and, in fact, consisted of a number of individual springs (each 1$\frac{3}{4}$in long) looped together in a chain. The tensioner allows some control of reverberation. It was found that satisfactory results were given with approximately 16in. of spring between the transmitter and the receiver.

The receiver is a crystal cartridge of the high output type such as the Acos Hi-G or the Garrard GC2. The stylus is removed and a small loop of copper substituted, to which a miniature crocodile clip is fixed.

The reverberation components are mounted in a rectangular sealed box, preferably screened to prevent external influences on the spring.

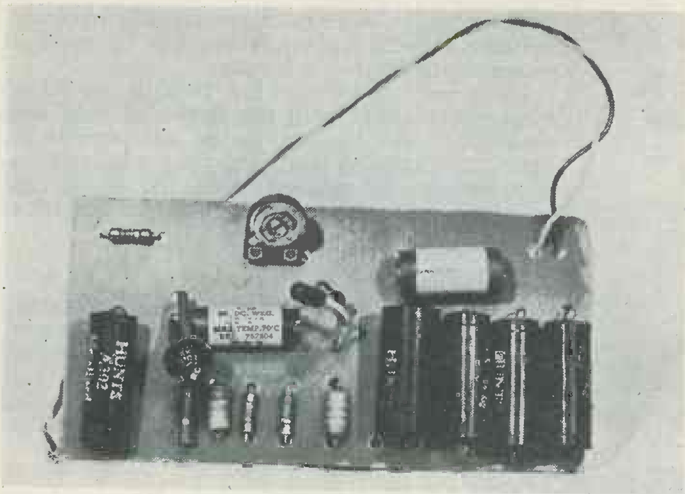
When the separate amplifier and speaker are

[1] The original function of the transducer was to frequency-modulate an r.f. oscillator. This it did by offering a tuning capacitance between the moving coil diaphragm and a fixed plate, the capacitance varying in sympathy with the a.c. applied to the moving coil.—EDITOR.

[2] Suppliers for the Radio Altimeter, and for the transducer unit on its own, are listed at the end of this article.

**Components List (Fig. 37)**

| | |
|---|---|
| $R_{1, 2, 3}$ | 8.2kΩ $\frac{1}{4}$W |
| $R_4$ | 4.7kΩ $\frac{1}{4}$W |
| $R_5$ | 2.2kΩ $\frac{1}{4}$W |
| $R_6$ | 10kΩ $\frac{1}{4}$W |
| $R_7$ | 100kΩ potentiometer |
| $R_8$ | 2.2kΩ |
| $R_9$ | 500kΩ potentiometer |
| $R_{10, 11}$ | 100kΩ $\frac{1}{8}$W |
| $C_{1, 2, 3}$ | 0.5μF |
| $C_4$ | 2μF 12 w.v. electrolytic |
| $C_5$ | 0.5μF |
| $C_6$ | 50μF 12 w.v. electrolytic |
| $TR_1$ | OC72, OC78 or OC81 |



*A transistor pre-amplifier and vibrato oscillator mounted on a single Paxolin sheet. The oscillator is to the right*

used, as is advised, a single ECL82—or, better, the new ECL86—is quite sufficient. A suitable circuit is given in Fig. 40.

The addition of reverberation takes away the "deadness" associated with electronic instruments, and the unit described here could probably find other applications, e.g. with electric guitars, etc. More than one spring may be used if desired; but the writer is of the opinion that one suffices, otherwise the organ sounds as if it is being played in an ice-rink.

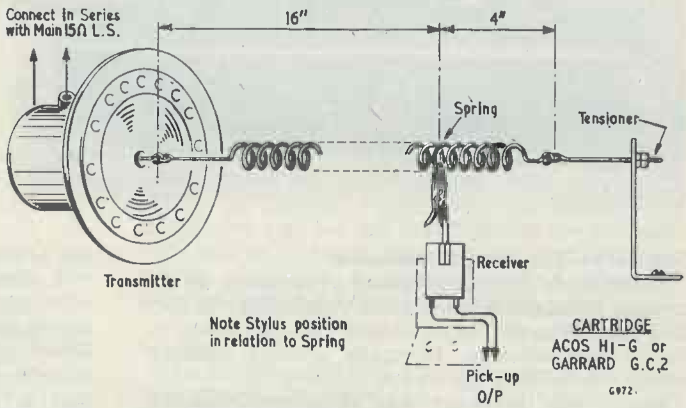



*Fig. 38. Reverberation may be obtained by a moving coil transducer and crystal pick-up as shown here, the delay element being a spring*

**Tuning**

Tuning should be carried out in fifths. An A tuning fork should be struck and an A on the keyboard depressed. No vibrato should be used, and a stop such as Diapason 8ft should be drawn.

Listen carefully, as the A tuning potentiometer is rotated. Beats will be heard, slow or fast. Correct tuning is achieved when these are resolved to zero.

Next, E should be played with A and the beat made approximately 1 c/s fast. To obviate too involved a description here, Table 3 shows the complete tuning cycle. The letters "F" or "S" in the table denote slightly fast or slow on beats. If these are approximated to 1 to 2 c/s as indicated, the resultant tuning should be sufficiently accurate for amateur usage.

As was explained in Part 2 of this series, the organ may also be tuned against a piano or accordion.

**Specimen Combination**

Table 4 gives a specimen combination of stops, couplers and controls for the complete organ. A combination such as this offers quite a comprehensive instrument, and it is possible to add still further facilities, as has been mentioned in these articles.

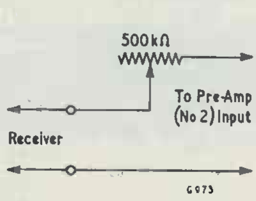
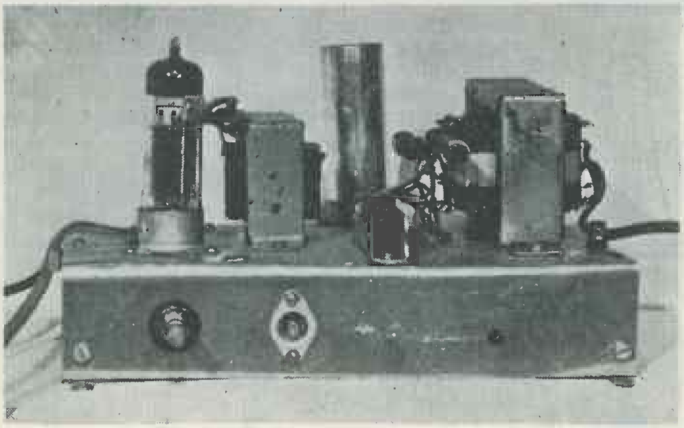



*Fig. 39. The crystal pick-up of Fig. 38 may be coupled back to pre-amplifier No. 2 by way of a simple attenuator, as illustrated here*

**TABLE 3**
*Tuning—Note Relationships*

| | | |
|---|---|---|
| A | — | Zero |
| A–E | — | F |
| E–B | — | S |
| B–F♯ | — | F |
| F♯–C♯ | — | S |
| C♯–G♯ | — | F |
| G♯–D♯ | — | F |
| D♯–A♯ | — | S |
| A♯–F | — | S |
| F–C | — | F |
| C–G | — | S |
| G–D | — | S |
| D–A | — | F |

F denotes fast (or higher frequency) approx. 1–2 c/s.
S denotes slow (or lower frequency) approx. 1 c/s.



*The reverberation unit amplifier. An ECL82 appears at the left, followed by the output transformer, electrolytic smoothing capacitor and metal rectifier. The two large resistors connected to the mains transformer are 47Ω units in series across the heater supply, their junction connecting to chassis*

**Summary—The Present Instrument**

Little needs to be emphasised in summing up the present instrument apart from reiterating the fact that heat from the valves should not be allowed to rise to the transistors. Normally, a simple deflector screen will achieve this result.

Since little literature has been published on transistor organ circuits, the writer has had to design virtually from scratch. So far as he knows at the time of writing, there is only one commercial transistorised organ in existence.

The present instrument has been in use for a number of months with the failure of only one transistor. And this was a 3s. 6d. component which was just being tried out! Once a suitable set of transistors is installed, their life should be practically endless because of the generous operating conditions under which they work.

**Improvements**

It is always possible to improve on an electronic organ and the following text describes some additions which the writer would suggest and which he hopes to try out with his own instrument.

Probably the first extra would be an additional octave of generators to carry the 4ft tone up to the top of the keyboard.

A second set of generators, one for each manual, with separate amplifiers would certainly enhance the the chorus effect. The writer is considering another set of generators which would give a rectangular waveform. This waveform has a hollow wood tone that is absent on the instrument as it stands, although it can be approximated. The generators

**TABLE 4**

| *Accompaniment* | *Solo* | *Pedal* |
|---|---|---|
| Open Diapason (or Tibia) 8ft | 16ft Tibia | Open Diapason 16ft |
| Stopped Diapason 8ft | 8ft String Diapason | Bourdon 16ft |
| Dulciana 8ft | 8ft Harmonic Flute | Dulciana 16ft |
| Violina 4ft | 8ft Salcional | Flute 8ft |
| Octave 4ft | 8ft Oboe | |
| Flautina 2ft | 8ft Horn | |
| Nazard 2⅔ft | 8ft Vox Humana | Accompaniment to Solo 8ft |
| Trumpet 8ft | 8ft Trumpet | Accompaniment to Pedal 8ft |
| Clarion 4ft | 4ft Flute | {Full to Expression Pedal |
| | 4ft Salicet | {Solo to Expression Pedal |
| | 4ft Clarion | Tremulant (Vibrato) Fast–Slow speed |
| | 2ft Fifteenth | |
| | 2⅔ft Twelth | |

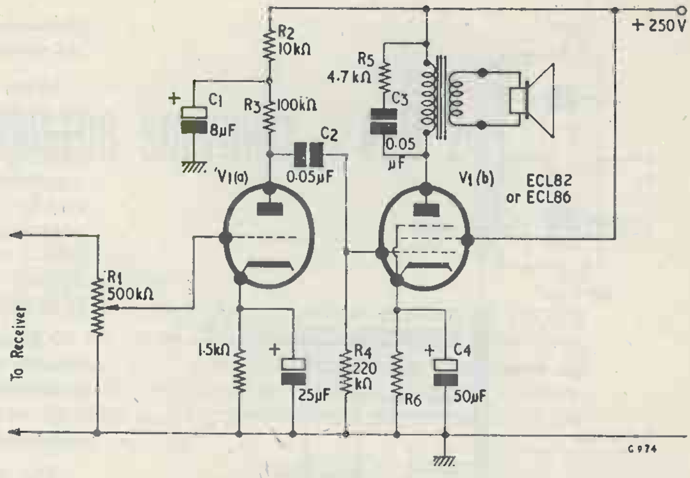



*Fig. 40. A separate amplifier system for use with the reverberation unit*

**Components List (Fig. 40)**

| | |
|---|---|
| $R_1$ | 500kΩ potentiometer, log track |
| $R_2$ | 10kΩ ¼W |
| $R_3$ | 56kΩ ¼W |
| $R_4$ | 220kΩ ¼W |
| $R_5$ | 4.7kΩ ¼W |
| $R_6$ | 680Ω 1W (ECL82) / 270Ω ½W (ECL86) |
| $C_1$ | 8µF 350 w.v. electrolytic |
| $C_2$ | 0.05µF paper |
| $C_3$ | 0.05µF paper |
| $C_4$ | 50µF 50 w.v. (ECL82) / 50µF 25 w.v. (ECL86) |
| $V_1$ | ECL82 or ECL86 |

Speaker transformer; primary impedance 9–10kΩ
Speaker

will consist of flip-flop circuits, (using two transistors) each generator serving two notes, and maybe three in the bass, for reasons of economy. This arrangement will still enable chords up to the 7th to be obtained, and except for discords (adjacent notes) the semi-polyphonic working will not be obvious.

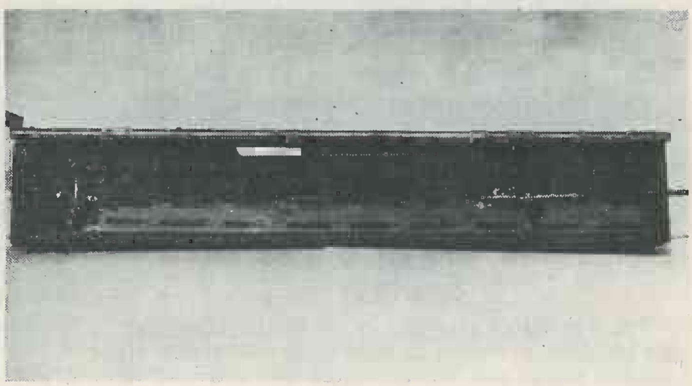
Another improvement would consist of having a foot button or press button under the manuals to select individual stops, and thereby act as a "blind" combination piston. The stops could all be solenoid operated, each button having its own "setter board" to choose or change a stop combination at any time. A simple way of obtaining full organ is to have an "On" button control a solenoid which closes a switch and brings in a simple bypass filter as shown in Fig. 41. Cancellation would be by a second "Cancel" button coupled to an opposing solenoid.

For those readers who are interested in such projects a suitable solenoid, similar to that shown in Fig. 41, is provided by a Triang Points Motor type X156. This is designed for 12 volts but will function from a 9 volt supply, as would be given across $C_1$ of the power supply (Fig. 7—Part 2). The 0.1 µF capacitors across the push-buttons stop clicks caused by the self inductance of the solenoid.

As may be gathered, the construction of electronic organs constitutes a hobby in which ideas for improvements can never be exhausted.

**Suppliers**

The ex-Government Radio Altimeter is available from Proops Brothers Ltd., 52 Tottenham Court Road, London, W.1.



*The reverberation unit employed by the writer. The transducer is to the left and the individual lengths of spring are clearly visible. The tensioner is on the right*

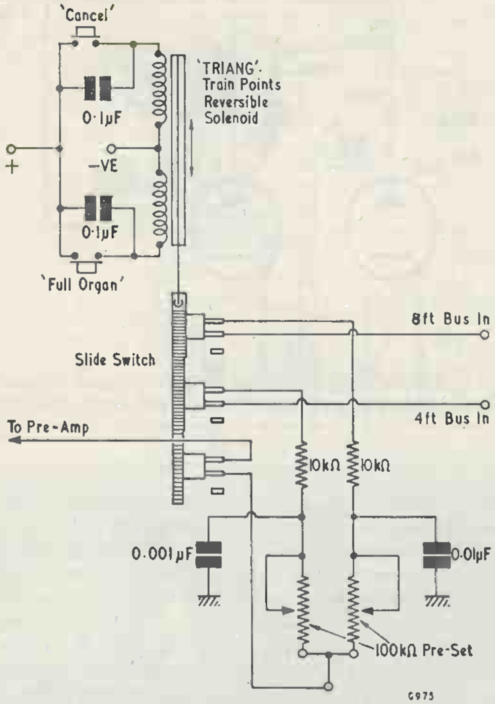



*Fig. 41. A suggested method of obtaining a "blind" combination piston*

An A.P.N.I. transducer (at lower cost than the Altimeter) may also be available from Proops Brothers Ltd., or from Testgear Components (London) Ltd., 2/4 Earlham Street, London, W.C.2.

(*Conclusion*)

**Corrections**

We have been requested by the Electronic Organ Constructors Society to state that Mr. Boutillier, although still actively connected with the Society, has relinquished the position of Hon. Secretary. The Hon. Secretary, D. J. Tanner, 56 Leadale Avenue, Chingford, London, E.4, states that the Society would be very pleased to hear from all constructors, or would-be constructors, of electronic organs.

The circuit of the frequency divider (Fig. 11, page 121, September issue) should have a connection from the secondary winding of $T_1$ to the negative rail.

# Electronic Organ Constructors Society

The number of amateurs in the British Isles who are building, or intend to build electronic organs is steadily rising, and it is estimated that well over a thousand organs are actually under construction or are completed.

Many of the amateur builders are not very well up in the study of electronics, and one object of the Society is to give assistance to these amateurs by offering technical advice from more experienced members, sending them books and articles on loan, and by making it possible for them to contact other amateurs through the medium of a Newsletter, in which will be published the names and addresses of Society Members (with their permission), the types of organs they are building, and the state of progress.

Already there have been several cases where the Society has been able to put amateur organ-builders in touch with one another, and they have "teamed up" in groups of three or four, to everybody's advantage.

The Society holds meetings where both amateur and professional organs are demonstrated, lectures are given and general discussion takes place. Question time invariably finds a place in the programme.

When the forming of the Society was under discussion, it was thought desirable to invite members of the Organ Building and Electronics Industry to take an active interest in its affairs, and now that the Society is in being, it is felt that without their help, the Society might never have been formed.

The aims and objects of the Society are:

1. To provide a Technical Advice Bureau.

2. To provide a library of technical books to be sent out to members, on a short term loan.

3. To provide tape recordings of meetings, lectures, and other matters of technical interest.

4. To arrange demonstrations of organs, both amateur-built and commercial instruments.

5. To provide a Newsletter service, and possibly a periodical journal.

6. To publish in the Newsletter the names and addresses of Members (with their permission) stating the type of organ they are building, with a view to their contacting other amateurs in their district who are building organs similar to their own.

The subscription is £1 per annum. In the case of Old Age Pensioners, no subscription is required.

It is not the intention of the Society to recommend any particular type of organ or kit, but it will do everything in its power to provide opportunities for the amateur to inspect and try out the various types, so that he will be in a position to decide for himself which is the type most suited to his requirements.

# THE "PROGRESSIVE" TRANSISTOR SUPERHET – Part 2

**By A. A. BAINES**

*This series of two articles describes what are, in effect, four superhet receivers of varying performance, all of which may be assembled on the same circuit board and with the same basic layout. The term "progressive" arises from the fact that it is possible to commence by constructing the simplest version first, and to modify this later to the more advanced circuits. Alternatively, any model out of the four described can be built without passing through the intermediate versions*

## Construction

IT MUST BE STRESSED THAT THIS RECEIVER IS NOT for the pick and shovel brigade—ultra-miniature components have not been used but there is, nevertheless, little elbow room. A hot instrument soldering iron and a modicum of manual dexterity is required to achieve a neat and efficient outcome. Given these two points there is nothing to deter a beginner from making a successful job of any of the versions.

Fig. 4 (published last month) gives the layout and drilling instructions for the circuit board; in the writer's case this was of Formica having a light coloured finish on one side which took the pencil marking-out admirably, but any insulated material of $\frac{1}{16}$in thickness, such as paxolin, would be suitable. All pencil marks must be removed after drilling is complete.

Two methods of obtaining solder anchor points have been employed. (See Fig. 4.) The first uses lengths of 16 s.w.g. brass wire held by a force fit into holes in the circuit board and the second, and neatest, utilises hollow plated brass rivets (eyelets). These rivets are obtainable from leathercraft shops and are normally used for the repair of handbag hinges and similar articles. Fortunately, they take solder well and being a few "thou" over $\frac{1}{16}$in diameter they are held rigid when forced through a hole of that diameter. When inserting these rivets into the circuit board, use a block of very soft wood as an anvil to prevent cracking of the board.

The holes for $T_1$, $T_2$, $T_3$ and $T_4$ are best made $\frac{3}{32}$in diameter to accommodate any slight inaccuracies in marking out or drilling which may occur. Any tightness of the pins of these coils in the circuit board can be rectified by careful use of a rat-tailed file, *but on no account must any undue pressure be placed on the cans.* The cans are held in place initially by kinking the can lugs and, subsequently, by means of the circuit wiring.

Two light alloy or aluminium brackets are required for the volume control and tuning capacitor, and details are given in Fig. 5. Note that the feet

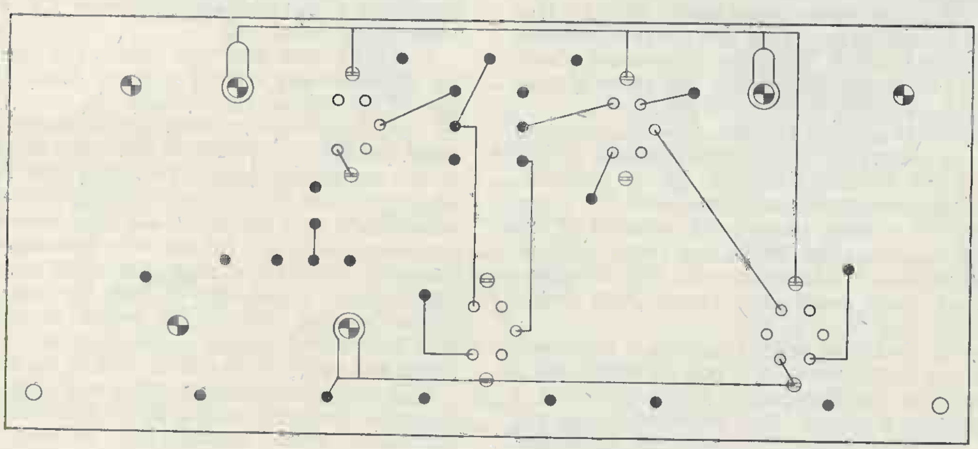


*Fig. 7. Underside view, circuit B, stage 1*

M541

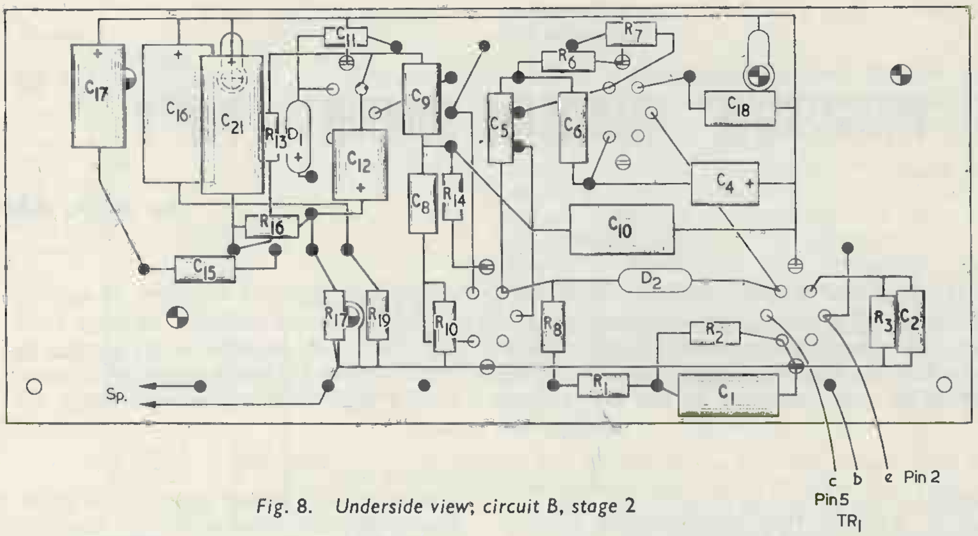



*Fig. 8. Underside view; circuit B, stage 2*

of the brackets are of opposite "hands", and that they must be made to drawing.

Fix the solder anchor rivets or rods to the baseboard at the $\frac{1}{16}$in holes, bolt on the transformer(s), brackets and solder tags as shown in Figs. 7 and 9, and add the oscillator and i.f. cans by "kinking" the lugs, making certain that these are in the correct position and orientation for the oscillator coil. Pin positioning and colour identifications for these items are shown in Fig. 6, and the upper layout (for Circuit B) in Fig. 9.

Figs. 7 and 8 give the wiring diagrams for Circuit B. If Circuit A is intended to be built then those components of Circuit B which are additional to Circuit A will have to be ignored; for these components refer to the Component List. If Circuit C or D is to be built the modifications given later should be observed.

Fig. 7 shows the initial under-board wiring. This should be completed first using thin gauge connecting wire, insulated where necessary to prevent short-circuits. This stage completed, the second stage can then be added as indicated in Fig. 8.

The board is turned over and, without mounting the volume control or tuning capacitor, the above-board wiring is completed as far as possible. Components immediately associated with the tuning capacitor and volume control are soldered to the respective tags on these items and these, in turn, are assembled to the brackets and the remaining connections made good. The above-board details are given in Fig. 9.

The writer lacks the skill of holding a transistor, a heat shunt in the form of a pair of pliers and a soldering iron simultaneously whilst soldering a transistor into a circuit, and therefore makes use of the following dodge. Lengths of insulation, about $\frac{3}{4}$in long are slipped over the transistor leads and, using round nosed pliers, closed loops of around $\frac{1}{8}$in diameter are made in the free ends of the leads, leaving about $\frac{1}{4}$in of protruding straight wire. The loop is gripped by a crocodile clip that has been modified by having strips of $\frac{1}{16}$in thick brass soldered to the jaws, the transistor is held in the fingers and the soldering iron in the other hand, making soldering into circuit a simplified procedure. The loop enables the crocodile clip, acting as a heat shunt, to have an improved grip on the wire and also stops the insulation slipping down the transistor lead when the shunt is removed.

Leads to the wavechange switch, which can be of the slide, toggle or rotary wafer type can then be connected, as indicated in Fig. 9. Capacitor $C_{19}$ can be conveniently mounted across the "Ae Yellow" and "earth" tags of the switch. The writer prefers to use a toggle switch as these have proved to be more durable and reliable in his experience. $C_{20}$ appears between $C_3$ and the appropriate switch tag.

The aerial rod assembly, which (in the case of the manufactured article) is finally attached to the roof of the cabinet by means of the strap provided by the manufacturers with the assembly and an angle bracket, is available in two types varying only in coil connection detail. With one type the flying leads from both the medium and long wave windings are brought to a central six-tag ring whereas, with the other, each coil has its own four-tag ring. If the latter assembly is used, the white and yellow colour coded solder tags of each tag ring must be joined together with a 5in length of connecting wire before making the connections to the circuit board and switch from the tag ring of the aerial rod.

It is recommended that the connecting wires to the aerial assembly, and also the transformers, use the same colour identification as used by the manufacturers of these articles to avoid confusion.

The speaker leads are taken to the speaker, and battery clips, suitable to the type of battery in use, are soldered to the ends of the battery leads, thus completing the wiring up of the receiver.

### Modifications for Circuits C and D

To construct either Circuit C or D from the one just described, remove transistor $TR_4$, transformer $T_5$, resistor $R_{19}$ and reposition $C_{15}$ as shown in the under view of Fig. 10.

Mount the new driver and output transformers $T_5$ and $T_6$, the actual types being dependent on the output transistors to be used (see Component List). Solder in the circuit links using insulated connecting wire and add the new-value $R_{19}$ and the other resistors, $R_{21}$, $R_{22}$ and $R_{23}$. Make the connections from the transformers to the circuit board as shown in Fig. 10 and solder in the new $TR_4$ transistor in the same position as was previously occupied by the OC72.

Output transistors $TR_5$ and $TR_6$ are finally added to the circuit, whereupon the necessary modifications are complete.

### Alignment

As it is difficult to fully align the receiver in the cabinet, the leads to the aerial can be left about 12in long and only lightly soldered to the tag ring. Then, after alignment of the receiver outside the cabinet, these leads can be cut to a more convenient length on final assembly. Alternatively, a more satisfactory method would be to use a test jig for alignment.

The latter needs only to be a piece of wood, 9 x 4in, and any suitable thickness, with strips of 1in square wood nailed across the ends to support the ends of the circuit board. A length of threaded rod with one end screwed into the wooden base will hold the aerial rod in its correct relationship to the circuit board and, similarly, a scrap of hardboard can hold the wavechange switch. This method will ensure correct run of the leads, and no further adjustments for lining up the receiver will be required after installation into the cabinet.

Before switching on the receiver for the first time, the circuit must be checked against the circuit diagram and assembly diagrams. This is important, so do not skimp this procedure.

The receiver can be aligned by either using a signal generator or by broadcast stations and, as it is presumed that those having a signal generator or access to one will be familiar with its use for alignment purposes, emphasis here will be given on lining up the set by use of broadcast stations.

The first job is to align the i.f. transformers and this is simple as the manufacturers of the transformers specified pre-align them; so it is mainly a question of giving them the "final touches". To do this requires a trimming tool which can be made from a tough piece of plastic, shaped to that it can slip inside the rather fragile cores of the transformers; a knitting needle often provides suitable material.[1]

Position the medium and long wave windings on the aerial rod so that the free ends of the formers are at the ends of the ferrite rod (assuming the manufactured assembly is used) select medium waves, switch on and increase the volume control to maximum. A satisfying "plop" should be heard

[1] See Note at end of article.

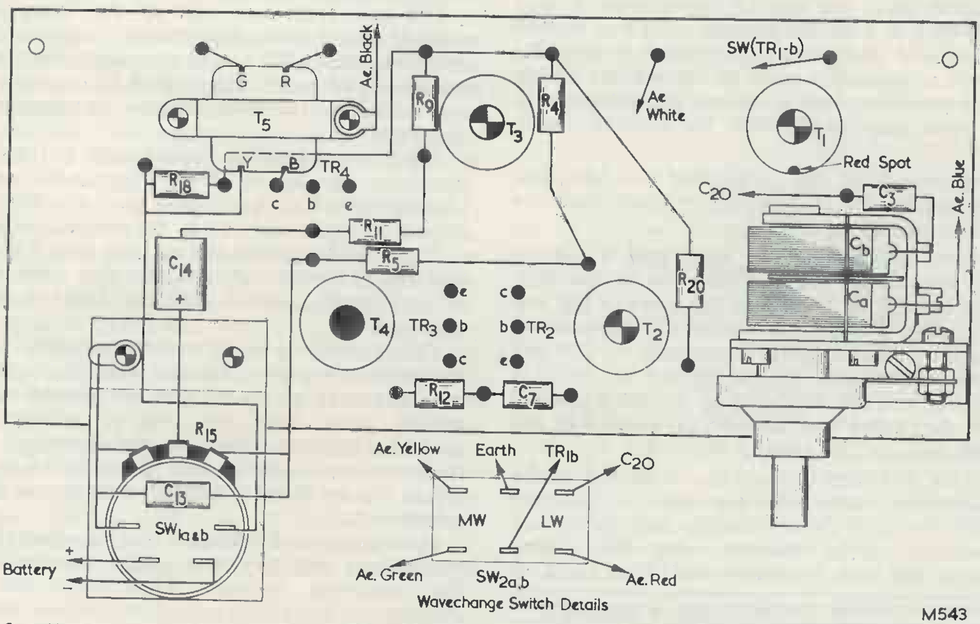



*Fig. 9. Above view of circuit B. Care should be taken to ensure that the on/off switch offers a supply of correct polarity to the receiver circuits*

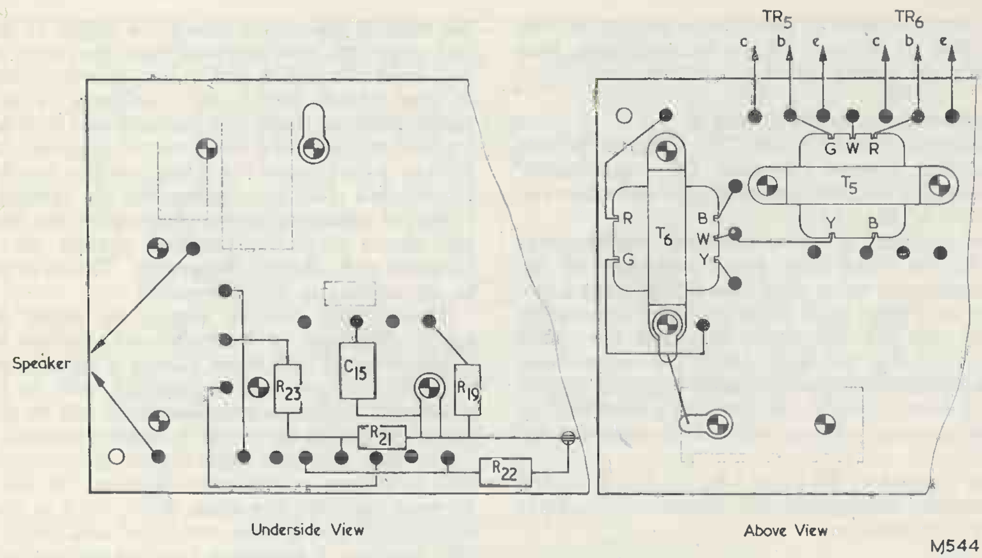



*Fig. 10. Circuit C and D—modifications to circuit B*

from the speaker on switching-on; if not, switch off and check the circuit.

Slowly tune over the medium wave band, whereupon several stations should be heard; if not, try adjusting the oscillator coil core one turn and try again. Choose a weak station or rotate the aerial rod to get minimum signal pick-up so as to render nugatory the effects of the a.g.c. circuits, and very carefully adjust the core of the third i.f. transformer $T_4$ to obtain maximum volume.

This done, go to the next i.f. transformer $T_3$ and adjust its core in a similar manner until it is peaked for volume and then repeat the procedure with $T_2$. These core adjustments must be carried out slowly as it is possible to lose a station completely in a quarter turn, particularly with the first i.f. transformer.

Having completed this procedure and obtained optimum results, the i.f. transformer cores must not be touched again.

Alignment of the medium waveband is carried out with the aid of two stations, one at the high frequency end of the band and the other at the low frequency end. For the purpose of this explanation the West (Home) and Third Programme on 206 and 464 metres respectively will be referred to, but it is stressed that it is not necessary to use these specific stations. Any other two stations, provided they are well separated, will be equally effective.[2]

Adjust the trimmers $C_{a1}$ and $C_{b1}$, mounted on the tuning capacitor, so that they are open one complete turn from the fully closed position and switch on with medium waves selected. Set the tuning capacitor at the high frequency end of the band so that its vanes are enmeshed about 10° only and make coinciding pencil marks on both the low speed and high speed spindles of the reduction drive. These marks will facilitate resetting the tuning to the same point after adjustment. Alternatively, a pointer can be fixed to the drive with a cardboard scale behind it and the pointer position marked on the scale.

Having selected the "dial" position, the core of the oscillator coil $T_1$ is carefully adjusted until the West programme is received at maximum strength.

The low frequency end of the band is now selected and with the tuning capacitor vanes enmeshed about 70°, marks are made on the spindles as before and, again, the core of $T_1$ is screwed in or out until the Third Programme is received satisfactorily.

The tuning capacitor is then reset to the original markings, *not* to the West programme, and this time trimmer $C_{b1}$ is adjusted until the West transmission is again received at the original setting.

The low frequency setting, *not* the Third Programme, is now re-selected and this time the core of $T_1$ is gently altered until the Third programme is received.

This procedure is then repeated until the best compromise between the two stations is obtained, but note that at no time is the tuning capacitor moved away from the original settings whilst moving either the core or the trimmer. If the trimmer runs to one end or the other of its travel, adjust the oscillator core one way or the other to compensate.

Having attained optimum results, select the West programme and this time adjust trimmer $C_{a1}$ for the maximum volume. Then select the Third Programme and slowly adjust the medium waveband aerial winding on the ferrite rod for maximum volume.

[2] Allowance for differing wavelengths must, however, be made when setting up the tuning capacitor at the high and low frequency positions. A glance at the tuning scale of a conventional receiver should give a good idea of the angular displacement involved. —EDITOR.

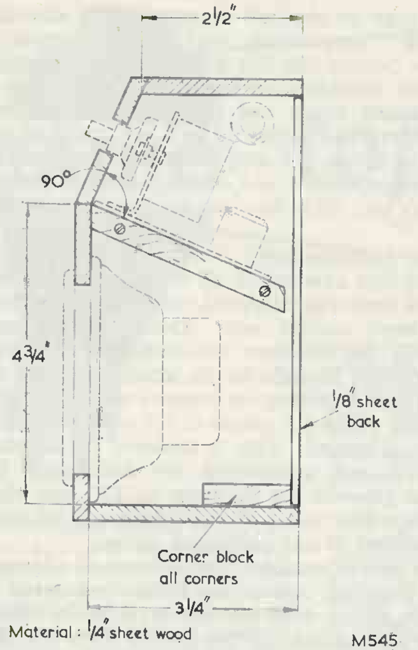



*Fig. 11. Cabinet side view. All dimensions are internal*

Revert again to the West when it will probably be found that volume has diminished, so again adjust $C_{a1}$ to achieve the maximum volume. A slight adjustment to the aerial winding may even be necessary.

Tune in the Third Programme again and repeat the procedure just outlined, to be followed by the same procedure at the other end of the waveband until satisfactory results with both stations have been achieved. The medium wave aerial coil is then fixed to the ferrite rod by means of strips of Sellotape or wax.

Alignment of the long waveband is considerably simpler as, normally, the Light programme is the only station of interest. Switch to long waves and slowly tune over this band until the Light programme is received and then adjust the position of the long wave aerial coil on the ferrite rod whilst slightly "rocking" the tuning capacitor until maximum volume is achieved. The position of the coil on the rod is then fixed as for the medium wave coil.

If a signal generator is to be used for alignment, note that no direct connection to the receiver should be employed, and that there should be only a loose coupling with the rod aerial. Standard procedure should be followed, the i.f. being 470 kc/s, and the m.w. tracking points 1,400 kc/s and 600 kc/s.

**Cabinet**

This is detailed in Figs. 11 and 12 except for the speaker aperture, the latter being cut to suit the actual speaker to be used. The minimum thickness of wood recommended is ¼in and all joints, in addition to being glued, should be pinned or screwed for security in the event of that harder-than-average knock that a cabinet always gets on some occasion.

Possibly the least difficult method of making the cabinet is to prepare the sides, base and speaker board first. To the insides of the cabinet sides, glue and screw the circuit board supports at the angle shown; the circuit board is subsequently held to these by ⅜in roundhead screws. Assemble the sides to the base and the speaker board to the sides. Use a 2½in wide piece of wood for the top of the cabinet and when secured, chamfer the front edge to match the end slope of the sides. A chamfer is then planed on one edge of a further 2½in wide strip of wood so that it mates with the upper edge of the speaker board. This front board is lightly held in place and the receiver itself is used to mark the positions for drilling clearance holes for the spindles of the volume control and tuning capacitor. A further clearance hole for the wavechange switch is required between the other two. The front board is then firmly secured and the cabinet can then be cleaned up.

A cloth or plastic grille is fitted to the speaker aperture and a back piece is made from hardboard or ⅛in plywood. The back is held to the cabinet by means of wood screws fitting into wood block inserts glued into the corners of the cabinet.

There is sufficient room between the speaker and back to accommodate a 9V grid bias battery and this can be held by means of two aluminium clips to either the base or the cabinet back. There is also

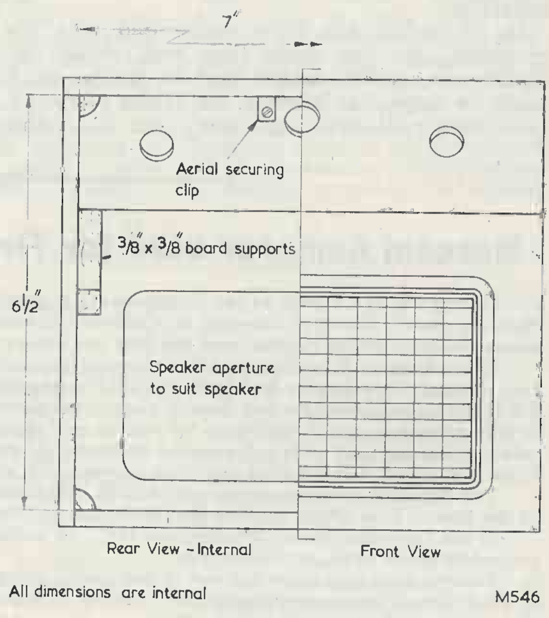



*Fig. 12. Front and rear views*

room on either side of the speaker for batteries up to Ever-Ready PP7 size. Two similar batteries connected in parallel and held in position with suitable clips can be used, one on either side of the speaker. Possibly the simplest method of battery retention seen by the writer consists of a ⅜in wide rubber band with the ends held to the cabinet base with the aid of stout drawing pins.

The cabinets made by the writer were from ¼in sheet mahogany using half-lap joints and were finally french polished. However, a cabinet made from a good plywood with nailed joints and subsequently covered with a plastic cloth such as Fablon would be just as attractive.

An attache case type handle could be affixed to the top of the cabinet if it is intended to transport the complete receiver around from place to place.

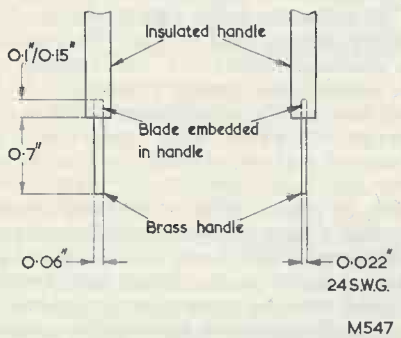



*Fig. 13. A suitable trimming tool*

**Instability**

No instability has been experienced with the prototype, but the writer feels that, should instability occur with models built to the design, it might be helpful to increase the values of the i.f. decoupling capacitors $C_4$, $C_5$, $C_6$ and $C_{10}$. This point may be checked by temporarily shunting the existing components with further capacitance. Higher values for $C_8$ and $C_9$ might reduce any possible instability, although this also would result in reduced audio top response. It may pay to experiment and values up to 0.1μF could be tried.

These points are only mentioned to assist in the event of instability and, as has just been mentioned, no such instability has occurred in the prototype.

**Further Modifications**

Since this description of the receiver was written and the drawings prepared, two minor modifications have been carried out. These changes are not essential for receiver functioning but they are, nevertheless, brought to the attention of the reader.

The first modification consists of adding negative feedback to the a.f. stages of the versions employing push-pull output. This is achieved by deleting $C_{15}$ (0.01μF) and connecting an additional 1.5MΩ resistor between the collector of $TR_5$ and the base of $TR_4$. The value of the additional resistor can be modified to suit individual tastes.

The second modification consists of adding a car aerial coupling coil to the ferrite rod aerial. This has not, as yet, been connected up in the cabinet.

The photographs of the chassis show the receiver with these two modifications added.

**Note**

The i.f. transformers specified for this receiver are supplied pre-aligned, in that they are tested on standard equipment at the factory which calls for their alignment at 470 kc/s. Stray capacitances in the circuit layout may necessitate some slight re-adjustment and these should be kept to a minimum.

A suitable trimming tool for the cores may be home-constructed, and it is essential that this fits the full length of the adjustment slot. A suitable tool, recommended by Weymouth Radio Mfg. Co., is illustrated in Fig. 13.—EDITOR.

*(Conclusion)*

## Marconi Cameras used for First Live Colour TV sent via Telstar

During the 587th orbit of the Telstar satellite, another milestone in the history of telecommunications was passed. Marconi colour television cameras at Culdrose, almost within shouting distance of the birthplace of transatlantic telecommunications at Poldhu, sent the first live colour television signals across the Atlantic to America.

This transmission was more than a technical experiment, forming a highlight of the American Medical Association's 12th Annual Congress on Dermatology, held at the Shoreham Hotel in Washington, D.C. Shortly after 3.45 p.m. B.S.T. on 12th September, five leading experts on dermatology in this country demonstrated chronic skin conditions in four patients at the Royal Naval Air Station at Culdrose in Cornwall. The demonstration was televised by a mobile colour television unit built and supplied by Marconi's Wireless Telegraph Co. Ltd. to the pharmaceutical firm of Smith Kline and French Laboratories Ltd., and operated for them under contract by Marconi engineers.

Two Marconi colour cameras, type BD848, were used and the signals were passed after processing and monitoring to the British Post Office satellite ground station at Goonhilly Down, by a BBC microwave link.

In the Shoreham Hotel, Washington, D.C., an audience of 3,000 doctors from 50 countries saw the demonstration projected on to a 9ft by 12ft screen.

Reports from the American end of the space link at Andover state that an excellent colour picture was received. In Washington, the demonstration was received with acclaim and although the colour saturation deteriorated at times the picture definition was good. One eyewitness stated that the general colour standard seen in Washington approached that of a medical atlas.

# RADIO topics

**By RECORDER**

NOW THAT THE PILKINGTON Committee Report and the subsequent Government White Paper have passed into history, we are in a position to take stock of what is happening at the present, and what is planned for the future, so far as British 625 line television is concerned.

**The Future**

Let us commence by examining future prospects.

As we all know, 625 line transmissions are scheduled to commence in u.h.f. on Bands IV and V. Following the Stockholm Plan, Band IV will contain Channels 21 and 34 and Band V Channels 39 to 68. Table I gives details of the upper and lower channels in each Band together with those in which we are most likely to be interested in the next few years. As may be seen, each channel has a width of 8 Mc/s; and it is possible to readily calculate the upper and lower frequencies of intermediate channels not given in the table by working in 8 Mc/s steps from those shown. Thus, Channel 24 occupies 494 to 502 Mc/s, and Channel 25 occupies 502 to 510 Mc/s. Although the highest frequency in Band V is 960 Mc/s there are no plans to use frequencies above 854 Mc/s for television in the U.K. The Pilkington Report stated that the allocation in this country of services for the 790 to 960 Mc/s sector has not yet been decided, but that we have tabled, at the 1961 Stockholm Conference, full television usage for 614 to 822 Mc/s and minimum usage for 822 to 854 Mc/s. Band V also includes 606 to 614 Mc/s, but this sector may now be reserved for radio astronomy. The Band limits shown in Table I are those on which all future British television on u.h.f. is being planned.

The channels to be used by the main stations in the U.K. are laid down in the Stockholm Plan, although changes may be made as detailed planning proceeds. Assuming that there are to be four programmes on u.h.f., most of the stations will use channels spaced according to the scheme n, n+3, n+6, n+10, or n, n+4, n+7 and n+10, n being the lowest channel at the station concerned. In London, however, the spacing will be n, n+3, n+7, and n+10, the actual channels being 23, 26, 30 and 33. In most cases, the channels used at a particular station will be either all in Band IV or all in Band V. It will be seen that there is a spacing of ten channels between the highest and the lowest channels at these stations. At a few stations, however, the channels will cover a much greater frequency range.

It is anticipated that the first u.h.f. programmes will commence in 1964 in the London area, and that six high power u.h.f. stations, each with an e.r.p. up to 1,000 kW, will be built in other parts of the country by about the beginning of 1966. These will probably serve about 60% of the population. The transmitter network will then be extended to give substantially national coverage, this process taking some years to complete because about sixty high and medium power transmitters will be required as well as some hundreds of low power relay stations.

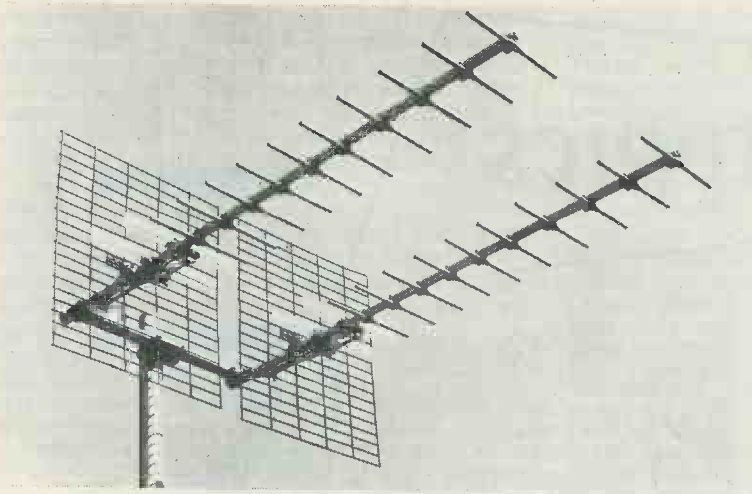
Since most u.h.f. stations will work on channels ranging between n and n+10, there is an 88 Mc/s spacing between the highest and lowest frequencies in the channels transmitted. It is, in consequence, important that receiving aerials should be able to cover the requisite frequency range. The B.B.C. states that most viewers whose aerials are virtually within sight of the transmitting aerial will find an aerial of 8 to 10 elements suitable (this gives a gain of 8 to 10dB and a front-to-back ratio of 20 to 30dB). Less favourably situated viewers will require bigger aerials, with up to perhaps 20 elements and a gain of 14dB. Since some stations will transmit channels covering a much larger range than 88 Mc/s, specially designed aerials will be required to operate over these wide bandwidths. In some difficult locations it may be more satisfactory to use two separate aerials connected to the same down-lead via a diplexer.

**TABLE I**

U.K. Band IV—V Channels

| *Channel* | *Frequency (Mc/s)* | *Remarks* |
|---|---|---|
| Band IV | | |
| 21 | 470–478 | Lowest channel in Band IV |
| 23 | 486–494 | Allocated for London area |
| 26 | 510–518 | Allocated for London area |
| 30 | 542–550 | Allocated for London area |
| 33 | 566–574 | Allocated for London area |
| 34 | 574–582 | U.H.F. field trial channel<br>Highest channel in Band IV |
| Band V | | |
| 39 | 614–622 | Lowest channel in Band V* |
| 44 | 654–662 | U.H.F. field trial channel |
| 68 | 846–854 | Highest channel in Band V* |

* As tabled at Stockholm European Broadcasting Conference 1961.



*U.H.F. television receiving aerial for Channels 34 to 44 in Bands IV and V. (Belling-Lee, Ltd.)*

Another important point arising from the 10-channel spacing to be adopted at most transmitters is that this necessitates good second channel rejection at the receiver. This is because the upper and lower channel frequency difference will be close to twice the intermediate frequencies employed in the receiver.

**The Present**

Before the future plans can be brought into operation a number of current problems have to be tackled, these including research into reception difficulties and the final parameters to be adopted for the British 625 line signal. The B.B.C. is currently carrying out test transmissions on 625 lines in order to provide experience and to pave the way for more permanent future standards.

These test transmissions are being undertaken by the B.B.C. in co-operation with the Post Office, the I.T.A., the radio industry and the trade. Transmissions on Channel 44 are at present in progress from Crystal Palace, with an average vision e.r.p. of 160kW, and it is expected that further simultaneous transmissions will commence on Channel 34 by early 1963. At a later stage, probably in 1963, the frequencies will be changed to two of the permanent channels allocated to the London area (see Table I) and power will be increased.

The choice of Channels 34 and 44 for the test transmissions results in the 88 Mc/s overall frequency range liable to be offered by most permanent future transmitters. The accompanying illustration shows an aerial manufactured by Belling-Lee for reception of these channels. This type is from a small pre-production batch which has been manufactured purely for the tests, and which has been made available to the trade and industry. The aerial is manufactured to "ruggedised" standards and is in process of being engineered by Belling-Lee for mass production and subsequent sale to the public at a considerably reduced cost. It is also the subject of various patents and applications.

Basically, the aerial is a 13-element array comprising two folded dipoles coupled by a transmission line, with ten directors in front and an aperiodic reflector at the rear. The arrangement of two coupled dipoles has been used to obtain the required bandwidth, which covers 11 channels each 8 Mc/s wide, and the dipoles are rectangular in shape because they are punched from sheet metal instead of having the more usual tubular construction. What may appear at first sight to be a further element (behind the two dipoles) is the mounting for the grid reflector.

It should be fully understood that this particular aerial is a "professional" model intended only for the tests, and that the permanent London transmissions will, as has just been stated, cover a different range of frequencies than that for which it has been designed.

Table II gives the main parameters for the 625 line test transmissions, and it will be seen that these follow the recommendations of the Television Advisory Committee 1960, in that sound and vision carrier spacing is 6 Mc/s, video bandwidth is 5.5 Mc/s and the vestigial sideband is 1.25 Mc/s wide. No information is given on sound and vision carrier frequencies within the channel but, if these follow Western and Eastern European 625 line practice, the sound carrier should be 0.25 Mc/s below the channel edge. This would make the sound and vision carriers in Channel 34 581.75 and 575.75 Mc/s, and in Channel 44 661.75 and 655.75 Mc/s respectively.

Tests will also be carried out on 625 line colour transmissions using both a modified N.T.S.C. system and the SECAM system, and a choice between these two systems should be made around the end of this year.

Finally, emphasis must be given to the fact that the current series of transmissions are purely for trial purposes and that it must not be assumed that the results obtained will be the same as with the permanent broadcasts on u.h.f. Also, the parameters quoted in Table II are tentative only and are subject to change as the trials proceed.*

**The Council Of Industrial Design**

Readers may recall that in the August issue I referred to the Council of Industrial Design, stating that, if a product is considered satisfactory for appearance, it is entered in the Council's Design Index. I then said that the fact that the efficiency of a product is of secondary importance makes the Design Index of rather doubtful value, and referred to reports in the Consumer Association publication *Which?* concerning a mains-driven photographic slide projector in which a live point could be touched but which was, nevertheless, listed in the Index. (The manufacturer of the projector has since added a protective covering.)

We have now received the following letter from the Council of Industrial Design, which is reproduced herewith.

Dear Sir,

An article in your August issue refers to the Council of Industrial Design's selection policy for products which are accepted into its Design Index.

It is perfectly true that the Council considers the appearance

*Acknowledgments are due to the Engineering Information Department of the B.B.C., and to Belling-Lee, Ltd., for generous assistance in preparing the information given here.

**TABLE II**

625 Line U.H.F. Field Trials, 1962–1963. Tentative Parameters

| | |
|---|---|
| Channel bandwidth | 8 Mc/s |
| Spacing between unmodulated sound and vision carriers | 6 Mc/s |
| Polarisation | Horizontal |
| Upper video sideband | 5.5 Mc/s |
| Lower video sideband | 1.25 Mc/s |
| Blanking level | 72.5 to 77.5% |
| Difference between black level and blanking level | 0% |
| Peak white level | 10 to 12.5% |
| Sound modulation | F.M. (peak deviation 50 kc/s, pre-emphasis 50μs.) |
| Lines per picture | 625 |
| Interlace | 2:1 |
| Field frequency | 50 c/s |
| Line frequency | 15, 625±15 c/s |
| Aspect ratio | 4:3 |
| Synchronising and blanking waveforms | To conform with current C.C.I.R. requirements |

of products as an important part of assessing their suitability for inclusion in the Index but this is not to say that the importance of functional efficiency is ignored; indeed it is obviously of prime importance.

The Council has no testing facilities of its own but in reaching conclusions on functional efficiency it has to be satisfied that the product conforms to the relevant British Standards and other established tests.

In the particular case to which your article referred, the slide projector did conform to British Standard 1915 and British Standard 816. The latter Standard deals with safety requirements including inaccessibility of live parts. It would not have been accepted into the Index unless it had met these requirements, but the new and even safer version has, of course, now replaced the original one in the Index.

Yours faithfully,
Paul Reilly, Director.

**Compatible Stereo Transmissions**

Is is pleasant to be able to chalk up a "first" occasionally. So far as I know, I was the first contributor in a British monthly journal to give technical details of the Zenith-G.E. stereophonic broadcasting system which was approved last year by the American Federal Communications Commission. This information appeared in "Radio Topics" for October, 1961.

I am considerably interested to note, therefore, that the B.B.C. has been carrying out a series of experimental stereo transmissions from Wrotham using this system. Details of these tests were given last month in our Radio Show Report.

The results of these experiments, and of similar tests carried out in other countries, will be studied at a meeting of the European Broadcasting Union in December, and at the next Plenary Assembly of the C.C.I.R., which is to be held at New Delhi in January.

Obviously, a lot of spade work has to be done before the B.B.C. can go permanently on the air with compatible stereo, but things seem to be rumbling along at a fairly comfortable rate, nevertheless. Let's hope, after all the technical considerations have been satisfactorily cleared up and the requisite Government decision to proceed is called for, that the whole question of stereo f.m. is not pushed away, as seems to happen so often these days, into the misty oblivion of Cloud-Committee Land.

## *Electronic Organ Constructors Society*

The dates of some future meetings, at which visitors are welcome, are listed herewith for those who may be interested in attending.

**15th November, 1962,** at Arsenal Tavern, Blackstock Road, Finsbury Park, N.4, 7 p.m.—Exhibits, transistor organs by Harmonics (Bromley) Ltd.

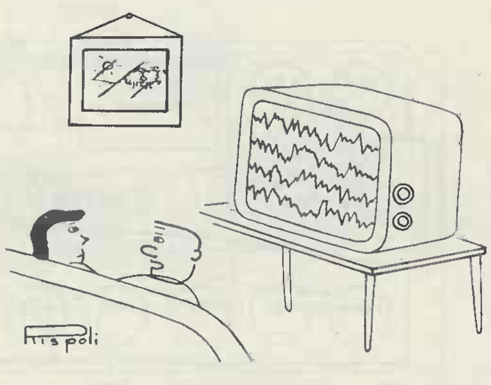
**8th December, 1962,** at Northern Polytechnic, Holloway Road, N.7, 3 p.m.—Organ by Clyne Radio Ltd.

**14th February, 1963,** 7 p.m.—Venue to be arranged (probably Arsenal Tavern).

**16th March, 1963,** at Northern Polytechnic, Holloway Road, N.7, 3 p.m.—Organ by Society member T. R. Culyer.

## HEATHKIT DEMONSTRATION

Daystrom announce that they are holding a special demonstration of Heathkit Hi-Fi Equipment at the Russell Hotel on 3rd–7th November from 11 a.m. to 8 p.m.




*"Of course it will look much better in colour!"*

# An Economic Oscilloscope

## By J. BURGESS

*This article describes a reliable oscilloscope incorporating variable flyback suppression and an internal square wave generator. The oscilloscope is built around a surplus BC929A unit and the cost of the unit constructed by the writer was approximately £5. Our contributor states that the cost to a constructor with no access to a spares box would be slightly more, at around £6 10s.*

THE UNIT TO BE DESCRIBED IS designed to meet the needs of the experimenter who wants a versatile oscilloscope at low cost and with the minimum of trouble in construction. Its actual specification need not be stated here, as the uses and limitations of each part of the circuit are discussed as the construction is dealt with.

The oscilloscope is built on the chassis of the BC929A unit, which is readily obtainable from dealers. The line-up of the 'scope is 6X5, 6SN7, 6K7, SP61, SP61, whilst that of the BC929A unit is 6X5, 2–6SN7, 2–6H6, 2X2, 6G6. This means that, if the unit is purchased complete with valves, the constructor will be left with several not very useful valves on his hands. Accordingly, he is advised to do as the author, and buy the unit less valves, at a price of about £1. In any case, the valves are by no means critical, and several alternatives for each will be suggested below. When the unit arrives the first thing to do is to remove all interior components except the tube and the valveholders marked 6H6GT (2 of) and 6SN7G (see Fig. 1). If the tagboard is still with the unit, remove it with care and unsolder the components as several of these can be used in the 'scope. Also take out all the potentiometers, the topmost input socket, and the celluloid template in front of the screen. After a preliminary dusting, the chassis is now ready to take the 'scope. Firstly, let us deal with the power supplies and tube circuits.

**Construction**

Begin by replacing the appropriate potentiometers in their new positions as in Fig. 2. Next, insert a mains switch in the space left by the removed input socket, and position the mains transformer as near to the back of the chassis as possible. This positioning is complicated by the very large hole which originally held a 500 c/s transformer. The most satisfactory way of overcoming this problem is to bolt a piece of aluminium over the hole and fix the mains transformer to this. The circuit of Fig. 3 can now be wired up, and little comment is necessary on this subject. Note, however, that the shift network of 2.2MΩ resistors is supported on part of the original tagboard. A general layout diagram of the whole 'scope is given in Fig. 4. The e.h.t. rectifier, a K3–45, could be replaced by the original 2X2 if the unit were purchased with valves, but this is not to be recommended, since it would involve either moving one of the Y-amplifier valves, or cutting a hole in the steel chassis to accommodate the 2X2 base, both of which are to be avoided. As regards components it must be noted that the 0.1μF 1,000V working capacitor and the 1W 100kΩ smoothing resistor and also the choke, are all present in the unit originally. The 6X5 is rated at 70mA and so the external power socket can provide about 20mA h.t., the l.t. rating depending on the transformer used. Although the c.r.t. heater is drawn as working from a separate winding from the valve heaters, this is not essential with the tube supplied (3BP1). This concludes all there is of importance to say about the power pack and we can now go ahead, assuming all is well, with the timebase unit.

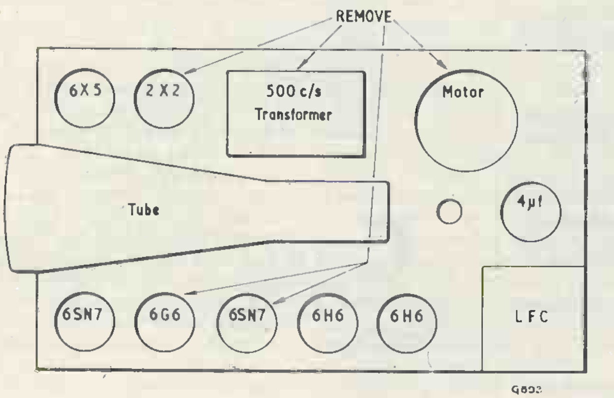


Fig. 1. Initial above-chassis layout

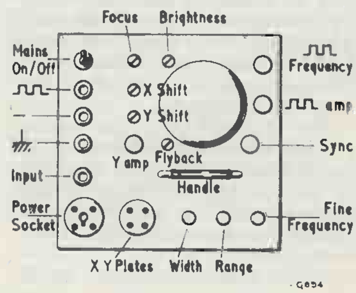


Fig. 2. New front panel

The timebase is built around a 6K7 pentode, though almost any similar valve will do. The circuit of the timebase is given in Fig. 5 and will be seen to be of the simplest possible type consistent with good results. The frequency ranges are approximately 20–200 c/s, 60–600 c/s, 300 c/s–3 kc/s, 2–20 kc/s and 10–100 kc/s. The last figure really only represents an order of magnitude, since the stray capaci-

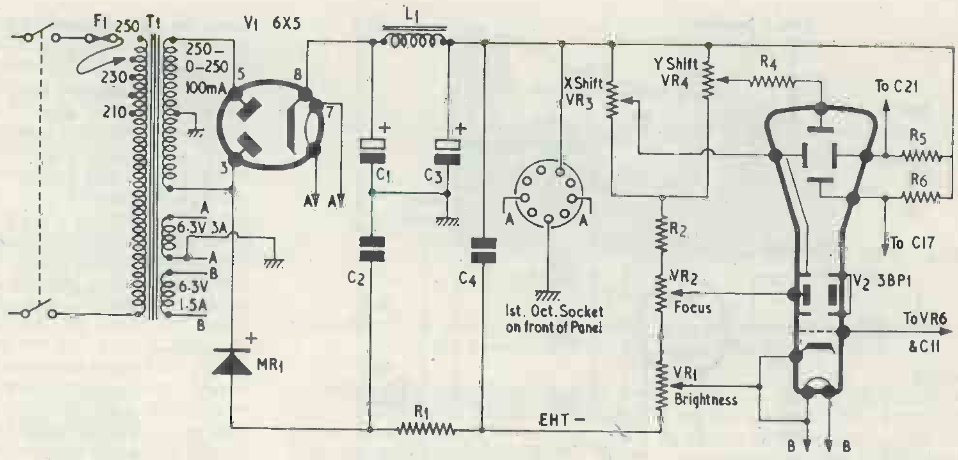
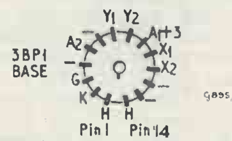



Fig. 3. Circuit of the power supply and c.r.t.




### Components List
(Fig. 3)

*Resistors*

| | |
|---|---|
| *$R_1$ | 100kΩ 1 watt |
| *$R_2$ | 1MΩ ½ watt |
| $R_3$ | 2.2MΩ ¼ watt |
| $R_4$ | 2.2MΩ ¼ watt |
| $R_5$ | 2.2MΩ ¼ watt |
| $R_6$ | 2.2MΩ ¼ watt |
| *$VR_1$ | 1MΩ preset |
| *VR2 | 1MΩ preset |
| *$VR_3$ | 1MΩ preset |
| *$VR_4$ | 1MΩ preset |

*Capacitors*

| | |
|---|---|
| *$C_1$ | 4μF 400V |
| *$C_2$ | 0.1μF 1,000V |
| $C_3$ | 8μF 500V |
| *$C_4$ | 0.1μF 2,000V |

*Valves*

| | |
|---|---|
| *$V_1$ | 6X5 |
| *$V_2$ | 3BP1 |

*Miscellaneous*

| | |
|---|---|
| $MR_1$ | K3-45 (S.T.C.) |
| $F_1$ | 1A fuse |
| $T_1$ | Primary 210, 230, 250V Secondary 250–0–250V 100mA, 6.3V 1.5A, 6.3V 3A |
| $L_1$ | L.F. Choke |

*Available in original equipment.

tance will vary greatly according to the particular layout. The 50kΩ amplitude control, $VR_5$, was provided so that the timebase could be dispensed with without the need for using a contact on the range switch which would limit the versatility of the timebase. The length of the trace at full output easily exceeds the width of the tube and a study of traces obtained using the timebase shows the waveform to be of good linearity. Unless one is contemplating higher frequency ranges there is, again, no need to go to great lengths about the layout although it is essential, during later wiring, to avoid running any connections to early parts of the Y-amplifier near the timebase since "cross-talk" will occur and give rise to doodle-like traces on the screen. On the whole, however, provided reasonable care is taken it will be found that the chassis provides an effective screen on its own and no trouble should be experienced. One snag which was encountered with the original model was a lateral sway of the trace, which was a nuisance when it interfered with serious work with the 'scope. This led the author to insert the 2μF decoupling capacitor $C_{10}$, which righted the matter completely. The system for flyback suppression calls for some comment. It is important that the capacitor used to isolate the grid of the c.r.t. shall not break down, as this would strain the tube severly and probably destroy it altogether. The best way to ensure that this will not happen is to connect two or even three capacitors in series in the $C_{11}$ position. If each is rated at say 500V, the risk of a break down is negligible.

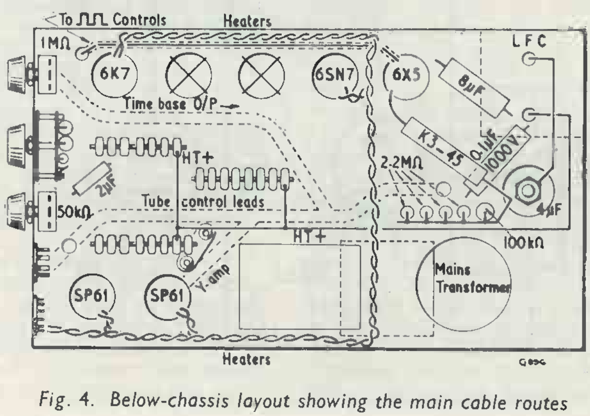



Fig. 4. Below-chassis layout showing the main cable routes

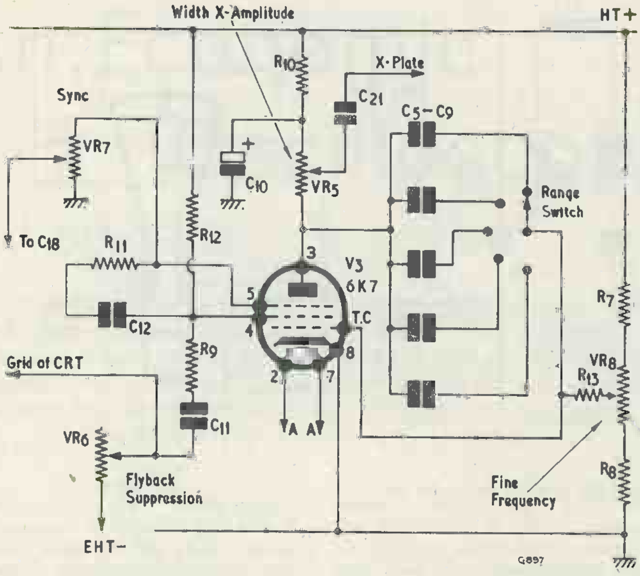



*Fig. 5. Circuit of the timebase, showing sync and flyback suppression*

**Components List**
**(Fig. 5)**

| *Resistors* | |
|---|---|
| $R_7$ | 100kΩ ¼ watt |
| $R_8$ | 68kΩ watt |
| $*R_9$ | 220kΩ ¼ watt |
| $*R_{10}$ | 10kΩ ½ watt |
| $*R_{11}$ | 47kΩ ¼ watt |
| $R_{12}$ | 27kΩ ½ watt |
| $R_{13}$ | 220kΩ ¼ watt |
| $VR_5$ | 50kΩ potentiometer |
| $*VR_6$ | 100kΩ preset |
| $VR_7$ | 50kΩ potentiometer |
| $*VR_8$ | 1MΩ potentiometer |
| *Capacitors* | |
| $C_5$ | 0.02µF 350V |
| $*C_6$ | 0.005µF 350V |
| $*C_7$ | 0.001µF 350V |
| $*C_8$ | 150µF 350V |
| $C_9$ | 47pF 350V |
| $C_{10}$ | 2µF 350V electrolytic |
| $C_{11}$ | 2 x 0.1µF 500V (in series) |
| $C_{12}$ | 0.01µF 350V |
| $C_{21}$ | 0.1µF 350V |
| *Valve* | |
| $V_3$ | 6K7 |

*Available in original equipment.

**Testing the Timebase**

At this stage it is a good plan to try out the circuit to make sure all is well. This is done as follows: Plug the unit into the mains and switch on. Turn the X-amp control into the lowest position and allow the valves and tube time to warm up. If no bright patch appears on the screen rotate the Brightness control, whereupon a green patch should become apparent, either on the screen or just off it. Get the patch roughly in the centre of the screen by means of the shift potentiometers and focus it down to a small spot, reducing the brightness at the same time in order to avoid burning the screen. Now slowly turn up the X-amp control, whereupon a straight line should appear. If it does not, the timebase is at fault and should be checked. If a line does appear and its brightness can be altered by means of the range-switch (due to different sweep speeds) all is well and work can go ahead on the rest of the circuit.

**The Y-Amplifier**

The next, the most critical, part of the construction is the Y-amplifier. This consists of the two SP61's connected in a straight-forward R-C circuit, as in Fig. 6. The construction of this part of the instrument should be carried out with some care as the amplifier is quite sensitive and any spurious signals getting in will be quite a substantial nuisance by the time they have reached the tube. As a general rule, make all leads as short as possible, and use screened cable for the input connections to the first valve. The SP61 has a

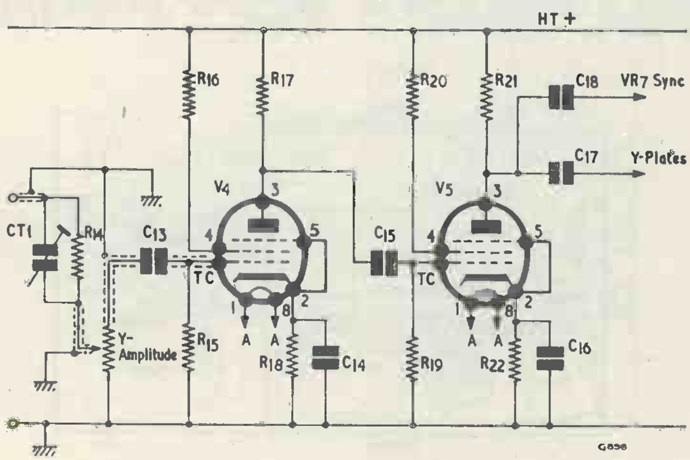
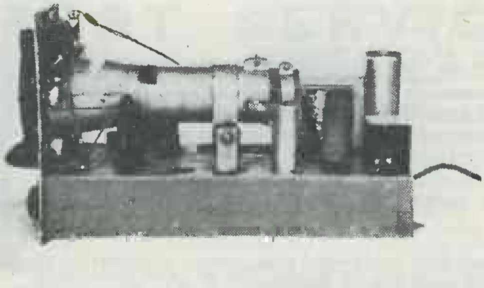



*Fig. 6. Circuit of the Y amplifier with connections to sync*

**Components List**
**(Fig. 6)**

| *Resistors* | |
|---|---|
| $*R_{14}$ | 100kΩ ¼ watt |
| $R_{15}$ | 2MΩ ¼ watt |
| $R_{16}$ | 1kΩ ½ watt |
| $*R_{17}$ | 20kΩ ½ watt |
| $R_{18}$ | 220Ω ½ watt |
| $*R_{19}$ | 1MΩ ¼ watt |
| $R_{20}$ | 220Ω ½ watt |
| $*R_{21}$ | 10kΩ 1 watt |
| $R_{22}$ | 220Ω ½ watt |
| $VR_9$ | 100kΩ potentiometer |
| *Capacitors* | |
| $C_{13}$ | 0.25µF 350V |
| $C_{14}$ | 0.001µF 350V |
| $C_{15}$ | 0.25µF 350V |
| $C_{16}$ | 0.001µF 350V |
| $C_{17}$ | 0.1µF 350V |
| $C_{18}$ | 0.1µF 350V |
| $CT_1$ | 3–30pF (see text) |
| *Valves* | |
| $V_4$ | SP61 |
| $V_5$ | SP61 |

*Available in original equipment.



*Side view of the oscilloscope. This illustration, taken during early experiments with the prototype, shows a 12AT7 in the 6SN7 position*

large base which facilitates an open grouping of components, so that no serious trouble should arise when the constructor is aware of the dangers of careless layout. One part of the circuit requiring special attention is the sync control. This has to be mounted on the right of the tube and so the connections to it must pass the timebase generator. Although sync is applied via the final stage of the Y-amplifier, there is still a strong chance of interference between X and Y circuits unless screened connecting leads are used. The section of the circuit between the input socket and the grid of the first valve is the most susceptible to stray pick-up and this should be wired especially carefully. The best way of doing this is to use the lowest of the four remaining sockets as the "live" side of the input, earthing the second one up. In this way the

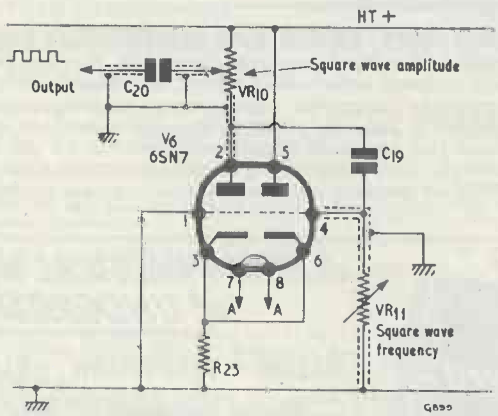



*Fig. 7. Circuit of the square wave generator*

connections to potentiometer $VR_9$ are kept to an absolute minimum. (Of course, there is little point in going to a lot of trouble inside the unit if the external leads to the equipment under test are long and straggly. Connection to external circuits should always be made via screened cable or, at the worst, by two leads tightly twisted together.)

The value of the amplitude control is kept low in order to minimise losses leading to distortion at high frequencies. This HF distortion is quite simply tested by means of the internal squarewave generator which is described below.

When the Y-amplifier is finished, it should be roughly tested by applying the heater voltage to the input and observing the effect on the screen. If there is no effect then the signal is being stopped at some stage. To ascertain where this is, apply the same voltage to the grid of the second valve. If there is still no trace, the trouble lies in the second stage of the amplifier. If a trace appears, and is roughly in the shape of a sinewave, all is correct in the second stage and the fault lies in the first. If a trace appears when the voltage is applied at the correct input socket and its height can be varied by means of the Y-amp control, then all is well enough to continue with the next phase in the construction. A sinewave with no input indicates that the heater supply is interfering with the grid of one or both valves. To find which one, short-circuit the grid of each to earth in turn—the one at which the trace disappears is the offender. If the "waviness" refuses to go with both grids earthed, the trouble is probably magnetic coupling and can only be dealt with by a repositioning of the mains transformer.

**The Square-Wave Generator**

If, despite the long list of possibilities, there is nothing apparently wrong with the amplifier, then one can proceed with the final unit, the square-wave generator. The circuit Fig. 7, is a fairly standard one, using a 6SN7. As the generator is placed at the back of the 'scope, the only chance of interaction with the rest of the circuit occurs in the leads going to the frequency and amplitude controls, and so these should be screened. The output of the generator is taken to the top socket on the front panel. When this has been wired up the generator should be

**Components List**
(Fig. 7)

*Resistors*

| | |
|---|---|
| $R_{23}$ | 1kΩ ½ watt (see text) |
| $VR_{10}$ | 10kΩ potentiometer |
| $VR_{11}$ | 1MΩ potentiometer |

*Capacitors*

| | |
|---|---|
| $C_{19}$ | 0.005µF 350V |
| $C_{20}$ | 0.1µF 350V |

*Valve*

| | |
|---|---|
| $V_6$ | 6SN7 |

checked for good waveform connecting its output to the Y-plates of the tube by means of the 4-pin valve base at the front of the unit. Insert a variable resistor in series with the cathode of the 6SN7 and alter its value until the output is at its most square. Having done this it becomes possible to check the Y-amplifier for trueness of reproduction. Squarewaves are perhaps the best means one has of checking the performance of any amplifier and the Y-amplifier is no exception! The most common fault in the amplifier is that the waves appear on the screen as pips. This will usually disappear at higher frequencies, but the only way to eliminate it at all frequencies is to adjust the component values in the coupling circuits. If the amplifier is built according to Fig. 6 little or no trouble should be experienced in this way, since component values have been adjusted on the prototype to give the best all-round performance. HF losses are seen as a rounding of the corners of the square wave and are compensated for by shunting the input resistor with a 3-30pF trimmer and adjusting this for the best all-round waveform. On the prototype this compensation was not necessary, but it will nevertheless depend on individual layouts. Excessive compensation is shown by overshoot corners of the waveform, and is allowed for in the opposite way to that first described.

*Underside view of the completed oscilloscope*

**Conclusion**

It is hoped that what has been said will allow even quite a beginner to construct this oscilloscope. Only a few incidentals are left to be cleared up. The mains lead is led into the 'scope by means of the holes at the back of the case which originally housed the mounting spikes. If the chassis is not earthed and the mains cable is two-core, as on the author's unit, hum trouble may result, and can be eliminated by connecting a 0.1μF 250V a.c. capacitor between the earthy side of the mains and the chassis.* The oscilloscope is very reliable in use, and can be employed on a wide range of problems from checking Hi-Fi amplifiers for fidelity to monitoring the waveform of oscillators and the like.

* It should be borne in mind that connecting a 0·1μF capacitor in this manner may allow an appreciable a.c. current to flow from the mains to the oscilloscope case and may result in shock.—EDITOR.

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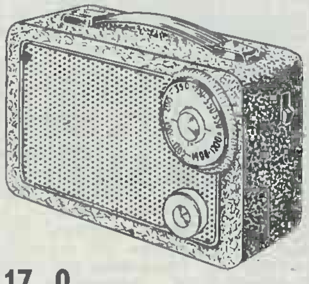

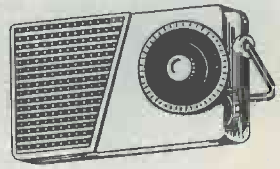

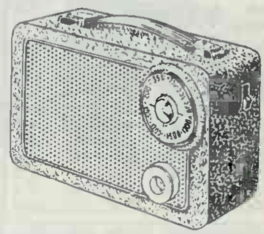

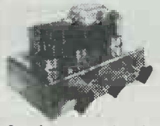

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*continued on page 309*

## SMALL ADVERTISEMENTS

*continued from page 307*

**PRIVATE**—*continued*

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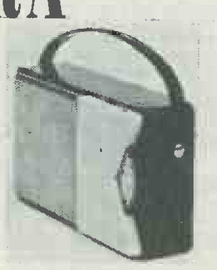





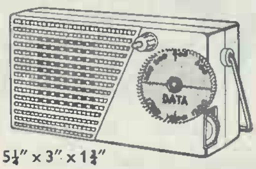



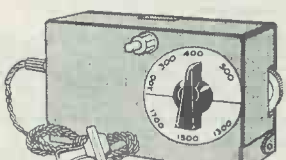

# SMALL ADVERTISEMENTS

*continued from page 309*

TRADE—*continued*

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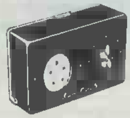

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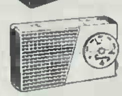

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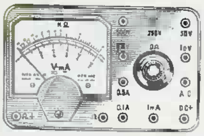

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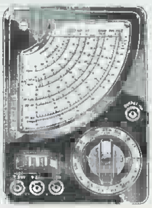

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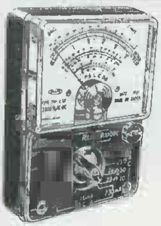

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2. For PP4, PP7, PP9, PP10, 9 volt Portable Radio Batteries up to 300mA. **45/-.** P.P. 2/-.
3. De Luxe version of No. 1, also charges PP3 type batteries. **29/6.** P.P. 1/-.
4. Rechargeable PP3 Battery. Runs as long as 100 batteries. Complete with charger unit. **35/-.** P.P. 1/-.

## TYPE 38, TRANSMITTER RECEIVER

Complete with 5 valves. In new condition. These sets are sold without guarantee but are serviceable. 7.4 to 9 Mc/s. **22/6** P.P. 2/6

| | | | |
|---|---|---|---|
| Headphones pair | 7/6 | Juction Box ... | 2/6 |
| Throat Mike ... | 4/6 | Aerial Rod ... | 2/6 |

## MARCONI 19 SET CRYSTAL CONTROLLED CALIBRATOR

Crystal controlled oscillators giving either 10 kc/s, 100 kc/s or 1 Mc/s pips. Features neon modula or, supplied with spare valves and full handbook. **79/6** P.P. 2/-

Ideal standard frequency check.

## TRANSISTOR PORTABLE TAPE RECORDER

★ **New 4-Transistor Version** ★

★ Play/record up to 30 min.
★ Built-in speaker, volume control, batteries and play/record/rewind.
★ Quality reproduction.
★ Sturdy case 6" x $8\frac{1}{4}$" x $2\frac{3}{4}$".

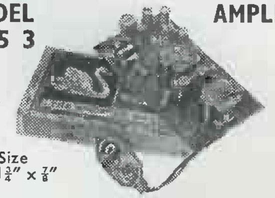
**£9.19.6**
P.P. 5/-.

**Fully Guaranteed**

Supplied complete with microphone, tape, batteries and personal phone (for monitoring), and full instructions. New 4-transistor version with push-pull output, better quality, more attractive case, etc.

The Above are FULLY ASSEMBLED TESTED and GUARANTEED.

## 4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER MODEL PK-5 3



Size 3" x $1\frac{3}{4}$" x $\frac{7}{8}$"

A ready-built, miniature 250mW push-pull amplifier incorporating input and output transformers, 4 transistors, 9 volt battery snap cord, speaker and volume connection leads. Ideal for use with record players, intercoms, hearing aids, tape recorders, etc. Complete with full instructions and circuit diagram.

**PRICE 52/6** P.P. 1/6.
SUITABLE $2\frac{1}{2}$" SPEAKER, 16/6

## BATTERY RECORD PLAYER

★ 6-$7\frac{1}{2}$ volt Garrard turntable with crystal pick-up. Plays 45 r.p.m. Ideal for above amplifier.

**55/-** P.P. 1/6.

★ Suitable cabinet for amplifier and player, **17/6** P.P. 2/-.

## LIGHTWEIGHT HEADPHONES

★ 2,000 ohms, **12/6**
★ 4,000 ohms, **14/6**
P.P. 1/-.

*HIGH EFFICIENCY*

## MINIATURE CLEAR FACED BRAND NEW PANEL METERS

| | | |
|---|---|---|
| 0-50 microamp | D.C. ... | 39/6 |
| 0-500 ,, | D.C. ... | 32/6 |
| 0-1 milliamp | D.C. ... | 27/6 |
| 0-5 ,, | D.C. ... | 27/6 |
| 0-300 volts | D.C. ... | 27/6 |
| "S" meter 1mA | ... | 35/- |
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## CRYSTAL MICROPHONES

**ACOS 39-1.** Stick Microphone with screened cable and stand (list 5 gns.), **32/6.** P.P. 1/6.

**ACOS 40.** Desk Microphone with screened cable and built-in stand (list 50/-), **15/-.** P.P. 1/6.

**ACOS 45.** Hand Microphone with screened lead, very sensitive, **25/-.** P.P. 1/6.

**100 C.** Stick Microphone with muting switch and screened cable, detachable desk stand, cord and neck, **39/6.** P.P. 1/6.

**MC 24.** Stick Microphone with muting switch and cable. **25/-.** P.P. 1/6.

**LAPEL.** Miniature Mic. With clip. Ideal for recording, **15/-.** P.P. 1/-.

**BM 3.** De Luxe Stick Mic., with muting switch cable, neckcord and detachable stand. Complete **52/6.** P.P. 2/-.

# Henry's Radio Ltd

*PADdington 1008/9*
**5 HARROW ROAD LONDON W2**
*Open Mon. to Sat. 6-9, Thurs. 1 o'clock*
**TRADE SUPPLIED**

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★ combined portable and car radio ★

**NOW** WITH 600mW **MELLOWTONE** OUTPUT ON MEDIUM AND LONG WAVES

**NOW** FITTED HORIZONTAL TUNING SCALE WITH ALL STATIONS CLEARLY MARKED

**NOW** SUPPLIED WITH SIX MULLARD TRANSISTORS AND TWO DIODES

**NOW** FITTED RECORDING SOCKET AND CAR AERIAL SOCKET

**NOW** SUPPLIED WITH TWO-TONE BEIGE OR TWO-TONE BLUE CABINET WITH GOLD FITTINGS

**GUARANTEED THE VERY BEST OBTAINABLE**

● **All parts sold separately** ●

**TOTAL COST £10.19.6** P.P. 3/6

**OVERALL SIZE** 10¼" x 7¼" x 3⅝"

● **Detailed Leaflet on Request** ●

The New "CONTESSA" 6-Transistor Portable Superhet Radio. Features simple printed circuit construction and fully illustrated building instructions, with all parts clearly marked and identified. Fitted with 8" Ferrite aerial. Double IFTs and the latest in components and design. Full tuning of both Medium and Long Wave bands with unbeatable selectivity and sensitivity. Clearly marked station dial and room-filling "MELLOWTONE" push-pull output are standard features. FULL AFTER-SALES SERVICE AND GUARANTEE

★ ALL THESE EXTRA FEATURES AT NO EXTRA COST ★

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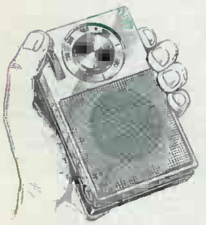
★ **NEW HUGE PURCHASE REDUCES TOTAL COST** ★

### "CAPRI" POCKET-6

**6-TRANSISTOR SUPERHET**



Size only 4½" x 2¾" x 1¼"

**REALLY POCKET SIZE!**

The most compact 6-transistor and diode radio with speaker available to the home constructor. Features the latest in miniature components and circuitry. Supplied with Mullard transistors and two-tone moulded cabinets in red/white or blue/white with gold fittings. All components are supplied in packets and clearly identified. A printed circuit is used with fully illustrated building instructions. Push-pull output coupled with a sensitive and selective circuit make the "CAPRI" hard to beat. Fitted Earphone/Record socket. Full tuning on medium waves with long wave Light.

TOTAL COST **£5.19.6** P.P. 2/-

★ **Detailed Leaflet on Request** ★

**After Sales Service and Guarantee**

### PHOTO-TRANSISTOR

★ Type PT1 suitable for light operated circuits as per this magazine, **8/6.**

★ ORP12 LDR cell, **12/6.**

*NEW 40 PAGE ILLUSTRATED CATALOGUE FULL OF COMPONENTS AND UNITS. 1/- POST FREE*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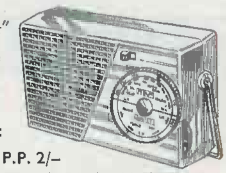
### "QUINTET" MEDIUM AND LONG WAVE POCKET RADIO

PUSH-PULL SPEAKER OUTPUT



Size 5¼" x 3" x 1¾"

Red or Blue with Gold trim

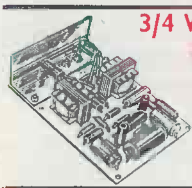
**Total Cost 99/6** P.P. 2/-

A 5-Transistor and Diode Medium and Long Wave Printed Circuit Loudspeaker Radio. Features Mullard transistors and plainly marked printed circuit with carded components. Excellent results with full station separation guaranteed. Including Radio Luxembourg. Push-pull output up to 200mW. Fitted phone/record socket and car aerial socket.

*Leaflet on request.*

**Full after-sales service and guarantee.**

### 3/4 WATT TRANSISTOR AMPLIFIER



★ 1 watt peak output.

± 3dB 70 c/s to 12 kc/s.

Output to 3 ohm speaker.

9 volt operated.

**Details on request.**

| Built and Tested | Kit of Parts |
|---|---|
| **59/6** OR | **52/6** |
| P.P. 1/6 | P.P. 1/6 |

A printed circuit high gain amplifier size 4" x 2¾" x ¾" using Mullard OC71/OC81D and 2-OC81 Transistors. Ideal for Inter-comm., Record Player, Tuner Amplifier or any application requiring a quality and reliable amplifier.

### SUB-MINIATURE 3-TRANSISTOR AMPLIFIER

Size only 1.9" x 1" x 12"! 125mW push-pull output. Uses PP3 type battery. 45/-. P.P.1/-. Suitable 2¼" speaker, 15/-.

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### IT'S TINY BUT POWERFUL "MINIRANGER"

PERSONAL M.W. RADIO 3-TRANSISTOR, 2-DIODE

Size 3" x 2" x ¾"

The smallest printed circuit transistor radio available for home construction. Full coverage of Medium waves and top band without any aerial or earth. Fitted calibrated dial, volume control and 9 volt battery. All stations including Radio Luxembourg are received with amazing clarity. Pre-tinned printed circuit clearly marked with component details.

● **Simple to Build** ●

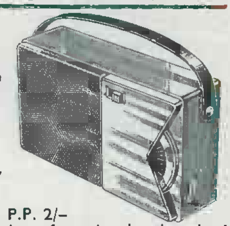
*Guaranteed Amazing Results*

**TOTAL COST OF ALL PARTS 59/6** P.P. 1/6

● **Designed for your top jacket pocket** ●

*Circuit Diagram Free on Request*

**Medium and Long Wave Superhet Radio**



Size 5¾" x 3⅜" x 2"

**£7.19.6** P.P. 2/-

Modified version of previously advertised "PW" Superhet. Now with new style Two Tone Cabinet. First grade components and transistors. Printed circuit. Features matched set of 6 Transistors. New 2½" quality speaker and new illustrated building instructions.