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NOVEMBER 1966

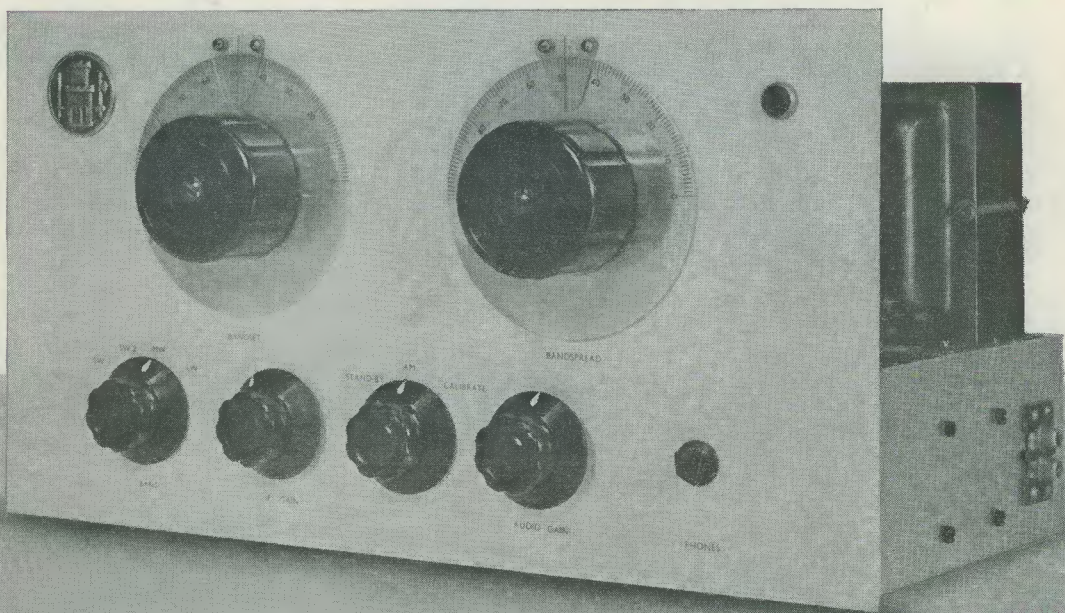
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A DATA PUBLICATION

THE RADIO CONSTRUCTOR

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Basic Q  
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Untuned RF  
Pre-Amplifier

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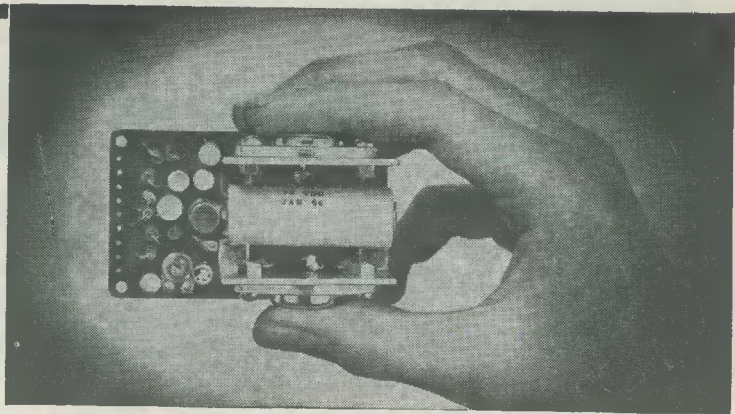
**THE MANAGER**  
**SCOTTISH INSURANCE CORPORATION LTD.,**  
**66-67 CORNHILL, LONDON E.C.3**

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# SINCLAIR Z.12

## INTEGRATED 12 WATT AMPLIFIER AND PRE-AMP

For size alone, the Z.12 marks an important advance in quality design, for its amazing compactness opens up exciting new vistas in amplifier housing and application. Combined with this are fantastic power and superb quality which can provide an effortless output of 12 watts R.M.S. continuous sine wave from the unique eight transistor circuit used. Basically intended as the heart of any good mono or stereo hi-fi system, the size and efficiency of this Sinclair unit make it equally useful for a car radio (with the Micro-6 for example), a high quality radio with the Micro FM, in a guitar, P.A. or intercom system, etc. Other applications are certain to suggest themselves to constructors. The manual included with the Z.12 details mono and stereo tone and volume control circuits by which inputs can be matched (and switched in) to the pre-amp. The size, performance and price of the Z.12 all favour the constructor seeking the finest in transistorised audio reproduction—it is in fact today's finest buy in top grade high fidelity.



**12 WATTS R.M.S. OUTPUT** CONTINUOUS SINE WAVE (24 W. PEAK)  
**15 WATTS R.M.S. MUSIC POWER (30 WATTS PEAK)**

- ★ Ultra-linear class B output and generous neg. feedback.
- ★ Response—15 to 50,000 c/s  $\pm 1$ dB.
- ★ Output suitable for 3, 7.5 and

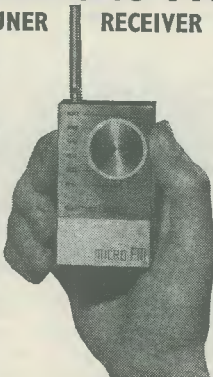
- 15 ohm loads. Two 3 ohm speakers may be used in parallel.
- ★ Input—2mV into 2K ohms.
- ★ Signal to noise ratio—better than 60dB.

Built, tested and guaranteed.

**89/6**

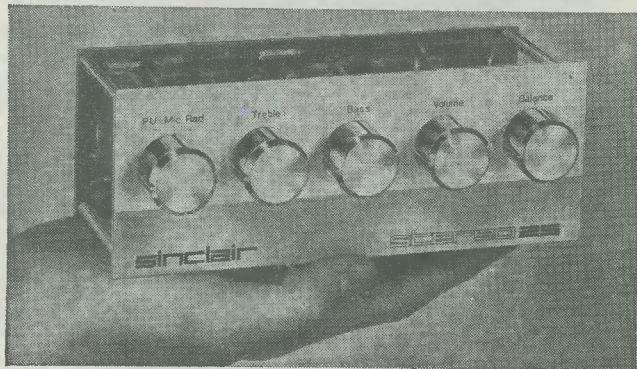
## SINCLAIR MICRO FM COMBINED FM TUNER RECEIVER

Less than 3" x 1½" x ¾" and professional in every way, 7 transistor FM using pulse counting discriminator for superb audio quality. Low I.F. makes alignment unnecessary. Tunes 88-108 Mc/s. The telescopic aerial suffices for good reception in all but poorest areas. Signal to noise ratio—30dB at 30 microvolts. Takes standard 9 v. battery. One outlet feeds to amplifier or recorder, the other allows set to be used as a pocket portable. Brushed and polished aluminium front, spun aluminium dial. A fascinating set to build.



Complete kit inc. aerial, case, earpiece and instructions.

**£5.19.6**



## SINCLAIR STEREO 25

De-Luxe Pre-amp & Control Unit for Z.12 or other good stereo system

Designed specially to obtain the very finest results used with two Sinclair Z.12's for stereo. The best quality components, individually tested before acceptance, are used in its construction, whilst the overall appearance of this compact de-luxe pre-amp and control unit reflects the professional elegance which characterises all Sinclair designs. The front panel is in solid brushed and polished aluminium with beautifully styled solid aluminium knobs. Mounting

is simple, and the PZ.3 will comfortably power the Stereo 25 together with two Z.12's. When fitted, the Sinclair 25 will grace any type of hi-fi furniture. Frequency response 25 c/s to 30 kc/s  $\pm 1$ dB connected to two Z.12's. Sensitivity Mic. 2mV into 50k $\Omega$ : P.U. —3mV into 50k $\Omega$ : Radio —20mV into 4.7k $\Omega$ . Equalisation correct to within  $\pm 1$ dB on R1AA curve from 50 to 20,000 c/s. Size 6½" x 2½" x 2½" plus knobs.

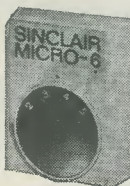
**BUILT, TESTED AND GUARANTEED £9.19.6**

**A HI-FI STEREO ASSEMBLY FOR £22.18.0**  
 All you require is one Stereo 25 Unit (£9.19.6) two Z.12's (£8.19.0) and one PZ.3 (£3.19.6). As an optional extra, you could include the Micro FM (£5.19.6).

## SINCLAIR MICRO-6

The world's smallest radio

Unequaled for power, selectivity and quality. Six stage M.W. receiver, 2 R.F. amplification, double diode detector, 3 stage A.F. amplifier, A.G.C., etc. The Micro-6 is completely self-contained in white, gold and black case, 1¼" x 1¾" x 1½". Plays anywhere. Easy to build. Complete kit of parts with earpiece and instructions.



**59/6**

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■ **SINCLAIR PZ.3**

Transistorised mains power unit specially designed for Z.12. Will power two Z.12's and Stereo 25 with ease. **79/6**



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 Telephone: OCA3-52731

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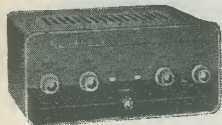
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# HI-FI AMPLIFIERS ~~~~~ TUNERS ~~~~~ RECORD PLAYERS



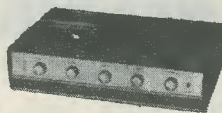
**3+3W  
STEREO  
AMP.  
S-33H**



**10W  
POWER  
AMP.  
MA-12**



**GARRARD  
PLAYER  
AT-60**



**20+20W  
STEREO  
AMP.  
AA-22U**

**10W POWER AMPLIFIER. Model MA-12.** 10W output, wide freq. range, low distortion. For use with control unit. Kit **£12.18.0** Assembled **£16.18.0**

**3 + 3W STEREO AMPLIFIER. Model S-33.** An easy-to-build, low cost unit. 2 inputs per channel. Kit **£13.7.6** Assembled **£18.18.0**

**DE LUXE STEREO AMPLIFIER. Model S-33H.** De luxe version of the S-33 with two-tone grey perspex panel, and higher sensitivity necessary to accept the Decca Deram pick-up. Kit **£15.17.6** Assembled **£21.7.6**

**HI-FI STEREO AMPLIFIER. Model S-99.** 9 + 9W output. Ganged controls. Stereo/Mono gram., radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£28.9.6** Assembled **£38.9.6**

**TRANSISTOR PA/GUITAR AMPLIFIER, PA-2.** 20W amplifier. Four inputs. Variable tremolo. **New Low Price** Kit **£39.19.0** Assembled **£54.10.0**

**50W VALVE PA/GUITAR AMP., PA-1.** Kit **£54.15.0** Assembled **£74.0.0**

**TRANSISTOR MIXER. Model TM-1.** A must for the tape enthusiast. Four channels. Battery operated. Similar styling to Model AA-22U Amplifier. With cabinet. Kit **£11.16.6** Assembled **£16.17.6**

**20+20W TRANSISTOR STEREO AMPLIFIER. Model AA-22U.** Outstanding performance and appearance. Kit **£39.10.0** (less cabinet). Assembled **£57.10.0** Attractive walnut veneered cabinet **£2.5.0** extra.

**GARRARD AUTO/RECORD PLAYER. Model AT-60.** less cartridge **£13.1.7** With Decca Deram pick-up **£17.16.1** incl. P.T. Many other Garrard models available, ask for Lists.

**HI-FI MONO AMPLIFIER. Model MA-5.** A general purpose 5W Amplifier, with inputs for Gram., Radio. Attractive modern styling. Kit **£11.9.6** Assembled **£15.15.0**



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### INSTRUMENTS

**3" LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2.** Compact size 5" x 7 1/4" x 12" deep. Wt. only 9 1/2lb. "Y" bandwidth 2 c/s-3 Mc/s ± 3dB. Sensitivity 100mV/cm. T/B 20 c/s-200 kc/s in four ranges, fitted mu-metal CRT Shield. Modern functional styling. Kit **£23.18.0** Assembled **£31.18.0**

**5" GEN-PURPOSE OSCILLOSCOPE. Model 10-12U.** An outstanding model with professional specification and styling. "Y" bandwidth 3 c/s-4.5 Mc/s ± 3dB. T/B 10 c/s-500 kc/s. Kit **£35.17.6** Assembled **£45.15.0**

**DE LUXE LARGE-SCALE VALVE VOLTMETER. Model IM-13U.** Circuit and specification based on the well-known model V-7A but with many worth-while refinements. 6" Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Kit **£18.18.0** Assembled **£26.18.0**

**AUDIO SIGNAL GENERATOR. Model AG-9U.** 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's. Kit **£23.15.0** Assembled **£31.15.0**

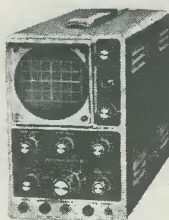
**VALVE VOLTMETER. Model V-7A.** 7 voltage ranges d.c. volts to 1,500. A.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1Ω to 1,000MΩ with internal battery. D.c. input resistance 11MΩ. dB measurement, has centre-zero scale. Complete with test prods, leads and standardising battery. Kit **£13.18.6** Assembled **£19.18.6**

**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. 4 1/2" 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

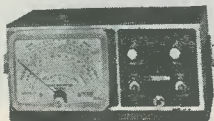
**R.F. SIGNAL GENERATOR. Model RF-1U.** Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100mV output. Kit **£13.18.0** Assembled **£20.8.0**

**SINE/SQUARE GENERATOR. Model IG-82U.** Freq. range 20 c/s-1 Mc/s in 5 bands less than 0.5% sine wave dist. less than 0.15μ sec. sq. wave rise time. Kit **£25.15.0** Assembled **£37.15.0**

**TRANSISTOR POWER SUPPLY. Model IP-20U.** Up to 50V, 1.5A output. Ideal for Laboratory use. Compact size. Kit **£35.8.0** Assembled **£47.8.0**



OS-2



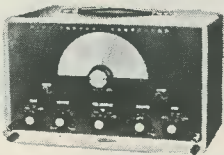
IM-13U



V-7A



RF-1U



IG-82U

Prices and specifications subject to change without notice

### STEREO TRANSISTOR FM TUNER

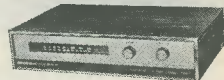
(Mono version also available)

Designed to match the AA-22U Amplifier. Available in separate units comprising Models TFMT-1 RF Tuning Unit **£5.16.0** incl. P.T. and TFA-1M (Mono) IF Amplifier, power supply, etc. **£15.3.0** kit or TFA-1S (Stereo) IF Amplifier, etc. **£19.2.0** kit. TFM-1 14 transistor circuit. Pre-assembled and aligned "front-end". 4 stage IF Amplifier. AFC. Printed circuit construction. Walnut veneered, finished cabinet available as optional extra. Can be built for:

**Total Price kit (Mono) £20.19.0 incl. P.T.**

**Total Price kit (Stereo) £24.18.0 incl. P.T.**

Cabinet **£2.5.0** extra. Send for full details.



### TRANSISTOR RADIOS

**"OXFORD" LUXURY PORTABLE. Model UXR-2.** Specially designed for use as a domestic, car or personal portable receiver. Many features, including solid leather case. Kit **£14.18.0** incl. P.T.

**TRANSISTOR PORTABLE. Model UXR-1.** Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7" x 4" loudspeaker. Real hide case. Kit **£12.11.0** incl. P.T.

**JUNIOR EXPERIMENTAL WORKSHOP. Model EW-1.** More than a toy! Will make over 20 exciting electronic devices, incl: Radios, Burglar Alarms, etc. 72 page Manual. The ideal present! Kit **£7.13.6** incl. P.T.

**High performance CAR RADIO, Model CR-1.** A quality model with many outstanding features. **TOTAL PRICE:** Kit (less speaker) **£12-17-0** incl. P.T. Many accessories available as extras.



UXR-2



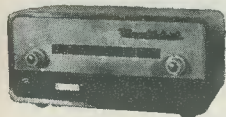
UXR-1

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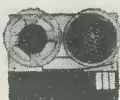
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## TAPE AMPLIFIERS ~~~~~ TAPE DECKS ~~~~~ CONTROL UNITS



**FM  
TUNER  
FM-4U**



**MAGNAVOX  
DECK**

**HI-FI FM TUNER. Model FM-4U.** Available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10.7 Mc/s, and I.F. amplifier unit, with power supply and valves (£13.13.0). May be used free standing or in a cabinet. Total Kit **£16.8.0**

**MAGNAVOX "363" TAPE DECK.** The finest buy in its price range. Operating speeds: 1 7/8", 3 1/4" and 7 1/2" p.s. Two tracks, "wow" and "flutter" not greater than 0.15% at 7 1/2" p.s. **£13.10.0**  
**MAGNAVOX deck with TA-IM Kit** **£31.5.6**

**HI-FI AM/FM TUNER. Model AFM-1.** Available in two units which, for your convenience, are sold separately. Tuning heart (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£22.11.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total Kit **£27.5.0**



**TRUVOX  
DECK**



**AM/FM  
TUNER**

**TRUVOX D-93 TAPE DECKS.** High quality stereo/mono tape decks. D93/2, 1/2 track, **£36.15.0** D93/4, 1/4 track, **£36.15.0**

**MULTIPLEX ADAPTER, SD-1.** Self powered. Ideal for use with Heathkit models FM-4U and AFM-1. Will convert most FM tuners to stereo. Fully transistorised. Kit **£8.10.0** Assembled **£12.5.0**. Send for full details and delivery.

**MONO CONTROL UNIT. Model UMC-1.** Designed to work with the MA-12 or similar amplifier requiring 0.25V or less for full output. 5 inputs. Baxandall type controls. Kit **£9.2.6** Assembled **£14.2.6**

**STEREO CONTROL UNIT. Model USC-1.** Push-button selection, accurately matched ganged controls to ±1dB. Rumble and variable low-pass filters. Printed circuit boards. Kit **£19.19.0** Assembled **£27.5.0**

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**SSU-1**

### SPEAKER SYSTEMS

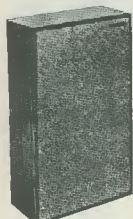
**HI-FI SPEAKER SYSTEM. Model SSU-1.** Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical or horizontal models with legs, Kit **£11.17.6** incl. P.T.

**THE BERKELEY Slim-line SPEAKER SYSTEM,** fully finished walnut veneered cabinet for faster construction. Special 12" bass unit and 4" mid/high frequency unit. Range 30-17,000 c/s. Size 26" x 17" x only 7 3/8" deep. Modern attractive styling. Excellent value.

Kit **£19.10.0** Assembled **£24.0.0**

**COTSWOLD SPEAKER SYSTEMS.** Outstanding performance for price.

MFS: Size 36" x 16 1/2" x 14" deep. Kit **£25.12.0** Assembled **£33.17.0**  
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NOVEMBER 1966

### "AMATEUR" EQUIPMENT

**THE "MOHICAN" GENERAL COVERAGE RECEIVER. Model GC-1U.** With 4 piezo-electric transfilters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised general purpose receiver for Amateur and Short wave listeners. Printed circuits, telescopic aerial, tuning meter and large slide-rule dial. Kit **£37.17.6** Assembled **£45.17.6**

**AMATEUR BANDS RECEIVER. Model RA-1.** To cover all the Amateur Bands from 160-10 metres. Many special features, including: half-lattice crystal filter; 8 valves; signal strength "S" meter; tuned R.F. Amp. stage. Kit **£39.6.6** Assembled **£52.10.0**

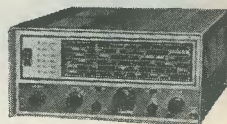
**160-10M TRANSMITTER. Model DX-100U.** Careful design has achieved high performance and stability. Completely self-contained. Kit **£81.10.0** Assembled **£106.15.0**

**COMMUNICATIONS TYPE RECEIVER. Model RG-1.** A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s-1.5 Mc/s and 1.7 Mc/s-32 Mc/s. Kit **£39.16.0** Assembled **£53.0.0**

**REFLECTED POWER METER and SWR BRIDGE. Model HM-11U.** Indicates reliably, but inexpensively, whether the RF power output of your TX is being transferred efficiently to radiating antenna. Kit **£8.10.0** Assembled **£10.15.0**



**GC-1U**



**RG-1**



**HM-11U**

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**Model HW-22 (40M)** **£66. 0.0, Kit.** duty,  
**Model HW-32 (20M)** **£66. 0.0, Kit.** etc.



**80M Transceiver  
HW-12**

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**FULL DETAILS OF MODEL(S)** \_\_\_\_\_

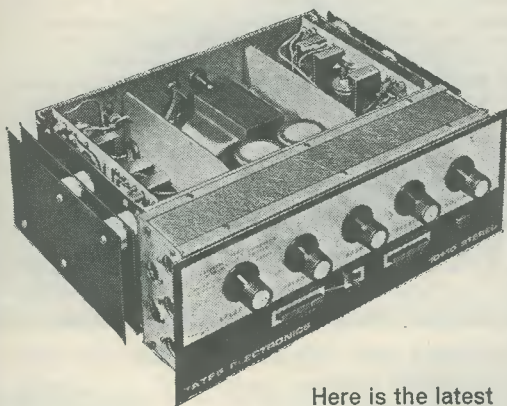
**NAME** \_\_\_\_\_

**ADDRESS** \_\_\_\_\_

**DEPT. RC.11**

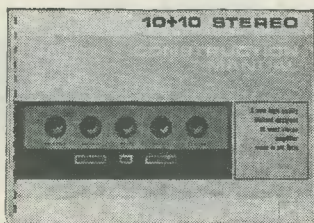
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# 10 + 10 STEREO



Here is the latest  
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This remarkable pi-mode stereo amplifier has been engineered by Tates to very high standards. Gain experience and enjoyment in the thrill of constructing this superb amplifier. Undoubtedly a piece of electronic precision, the Mullard designed 10 + 10 costs no more than ordinary equipment and building can commence for as little as £3 7 6d (Total kit price 38 guineas). Circuits, parts lists and assembly procedure are fully detailed in the 10 + 10 Construction Manual.



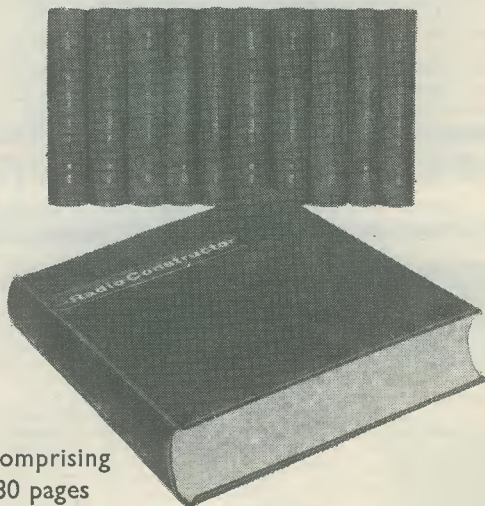
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MICRO-FM7 transistor FM tuner-rcvr. (Kit) £5 19 6  
Z.12 combined 12w. amp and pre-amp, built  
STEREO 25 de luxe pre-amp/control unit (stereo) built .....£9 19 6

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Indispensable for constructors. Enables you to produce "printed circuits" quickly and cleanly. Kit No. 3 inc. baseboard, processed copper strip and sheet as advertised. **15/-**

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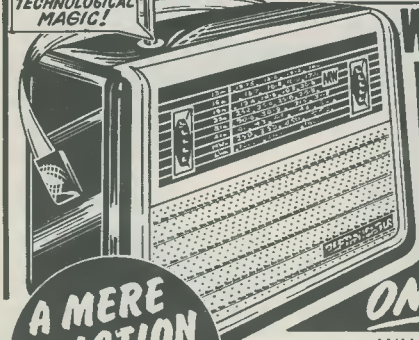
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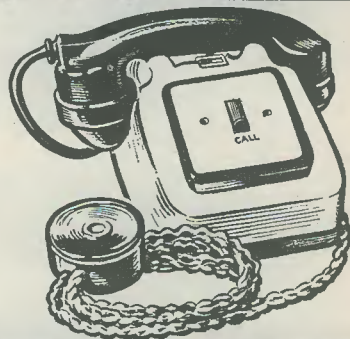
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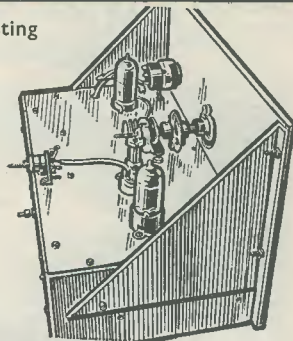
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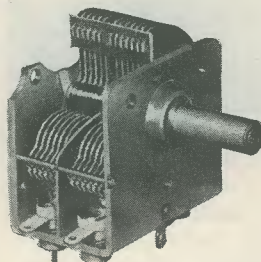
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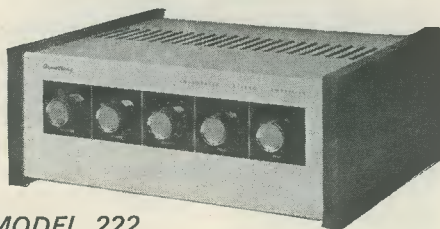
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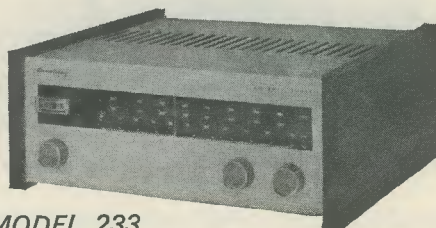
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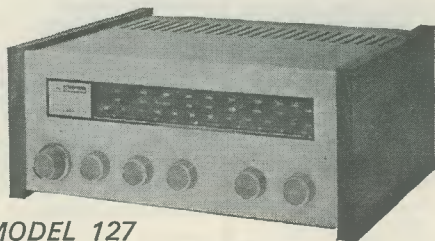
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|                                                                                                         |     |
|---------------------------------------------------------------------------------------------------------|-----|
| Automatic Electronic Switch for Oscilloscopes,<br><i>by W. A. Jones</i>                                 | 202 |
| Low-Cost Reaction Timer,<br>(Suggested Circuit No. 192),<br><i>by G. A. French</i>                      | 208 |
| News and Comment                                                                                        | 212 |
| A Stereo Balancer,<br><i>by L. E. Hyman</i>                                                             | 214 |
| Can Anyone Help?                                                                                        | 215 |
| Electronics and the Electric Guitar,<br><i>by Raymond Liffen</i>                                        | 216 |
| Understanding Radio,<br>(Practical Project—Simple 3-Stage Radio<br>Receiver),<br><i>by W. G. Morley</i> | 218 |
| The Conway 4-Band Superhet Receiver<br>(Cover Feature),<br><i>by James S. Kent</i>                      | 224 |
| Untuned R.F. Pre-Amplifier,<br><i>by N. Fox</i>                                                         | 232 |
| G.S.E. Communication Products                                                                           | 234 |
| In Your Workshop                                                                                        | 235 |
| A.F./R.F. Signal Injector,<br><i>by J. Anderson</i>                                                     | 243 |
| Basic Q Multiplier,<br><i>by Wallace Studley</i>                                                        | 245 |
| Radio Topics,<br><i>by Recorder</i>                                                                     | 249 |

NOVEMBER 1966

201

# *automatic electronic switch for oscilloscopes*

by W. A. Jones

*Oscilloscope trace doubler switches tend to require frequent adjustment, but this shortcoming is obviated in the electronic switch described here by synchronising it with the oscilloscope timebase. The switch may be installed on the oscilloscope chassis or, by using a single-valve sawtooth amplifier, constructed as an external self-contained unit.*

**T**HE purpose of the switch unit described in this article is to enable two independent waveforms to be displayed simultaneously on a simple single beam oscilloscope. The principle is quite well known and will only be briefly described here.

If an amplifier valve is fed with one signal to be displayed, together with a square wave of sufficient amplitude to cut the valve off on the negative part of its cycle, then the output of this amplifier, as observed on an oscilloscope, would be a square wave modulated on its negative part by the original signal (negative because of the phase change in the valve).

If, now, two amplifiers passing two independent signals under observation have their outputs mixed but are fed with mutually out-of-phase square waves, then when one valve is conducting and amplifying, the second valve is cut off.

If the two amplifiers were carefully matched and the two square wave frequencies were of equal amplitude then no square wave component would appear on the screen as the two out-of-phase square waves would cancel out. If however an unbalance exists, cancelling will be incomplete and a square wave component will still exist. On top of the square wave will be one signal and on the bottom will be the second signal.

## **Using Square Wave Switching**

There are basically three ways of employing the principle of square wave switching. Firstly, the square wave generator can be run at a very high speed in comparison with the timebase frequency, whereupon the two traces will be made up of a number of dots which merge into two lines. A second method is to synchronise the square wave generator to half the timebase frequency, in which case the timebase scans first one trace and then the other. A third method, and one which is useful for high timebase frequencies, is similar to the second except that the timebase traces one line more than once before changing to trace the second line.

The simple circuits generally used for applying this principle tend to suffer from the disadvantage that they may require continual adjustment when in use, and it was considered that it would be of interest and value to devise a circuit which required no adjustment at all over the entire timebase range, and yet was still cheap to build.

## **Working Circuit**

As a result of a considerable number of experiments, the circuit of Fig. 1 was devised, this employing a combination of the second and third methods first discussed. It is not, however, synchronised to the timebase but is triggered by the timebase flyback.

The circuit for the square wave generator can be divided into two sections, these being:

- (1) A monostable circuit giving a controlled dead time. This uses  $V_1$ ,  $V_{2(a)}$  and  $V_{2(b)}$ .
- (2) A conventional bistable divide-by-two circuit, using  $V_{3(a)}$ ,  $V_{3(b)}$ ,  $V_{4(a)}$  and  $V_{4(b)}$ .

The preliminary experiments used Section 2 of the circuit on its own to function as a dividing circuit on the timebase frequency. At the higher frequencies, unfortunately, the output waveform became distorted and this led to the development of Section 1 to eliminate this problem.

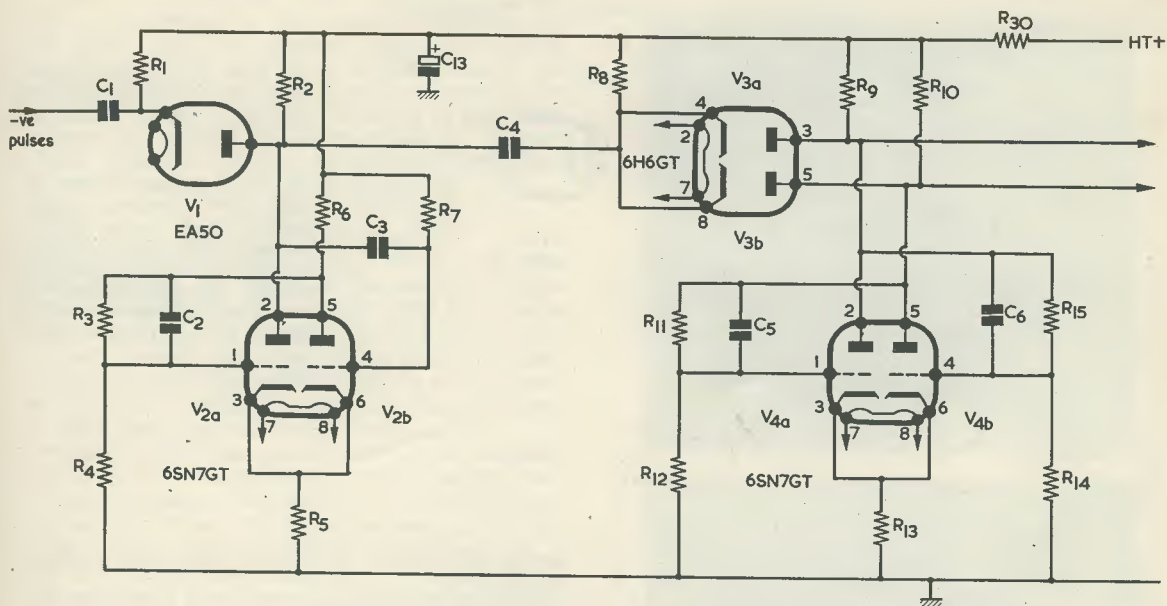


Fig. 1. The switch section. Negative-going pulses from the oscilloscope timebase are applied to  $C_1$

### Operation of the Circuit

The double valve  $V_{4(a)}$ ,  $V_{4(b)}$ , has two stable states, these being  $V_{4(a)}$  conducting with  $V_{4(b)}$  cut off, and vice-versa. To consider circuit operation, let us assume that  $V_{4(a)}$  is conducting.  $V_{4(a)}$  anode potential is then low as also, because of the potentiometer  $R_{15}$ ,  $R_{14}$  is the grid potential of  $V_{4(b)}$ .  $V_{4(b)}$  is therefore cut off and has a high anode potential. As a result of this, and of the action of  $R_{11}$  and  $R_{12}$ , the grid potential of  $V_{4(a)}$  is also high, thus satisfying the stability requirements associated with the initial assumption. Thus, the circuit has two stable states and can act as a switch. To cause a change in state a negative pulse is applied to the grid of the conducting valve, this being controlled by the double-diode  $V_3$ , the cathodes of which are basically at h.t. potential.

If  $V_{4(a)}$  is assumed to be on and  $V_{4(b)}$  cut off, then  $V_{4(a)}$  anode and hence  $V_{3(a)}$  anode potential is low, whereas  $V_{4(b)}$  and  $V_{3(b)}$  anode potentials are high. A negative pulse applied to the cathodes of  $V_3$  will only pass through the diode with the high anode potential; in this case,  $V_{3(b)}$ . This negative pulse then passes through  $V_{3(b)}$  and  $C_5$  to the grid of  $V_{4(a)}$ , thus switching the circuit. Because the circuit has switched, a following pulse will then prefer to pass through  $V_{3(a)}$  and  $C_6$  to the grid of  $V_{4(b)}$ , thus changing the switch back to its original condition.

As may be seen, two pulses initiate one cycle in the switch; hence, its dividing by two property. The negative pulses obtainable from the screen grid of a Miller transitron timebase valve in an oscilloscope were found suitable to operate the

COMPONENTS

#### Resistors

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|----------|-----------------------------------------|
| $R_1$    | 100k $\Omega$                           |
| $R_2$    | 47k $\Omega$ 1 watt                     |
| $R_3$    | 220k $\Omega$                           |
| $R_4$    | 450k $\Omega$ –470k $\Omega$ (see text) |
| $R_5$    | 27k $\Omega$                            |
| $R_6$    | 22k $\Omega$ 1 watt                     |
| $R_7$    | 1.5M $\Omega$                           |
| $R_8$    | 220k $\Omega$                           |
| $R_9$    | 39k $\Omega$ 1 watt                     |
| $R_{10}$ | 39k $\Omega$ 1 watt                     |
| $R_{11}$ | 220k $\Omega$                           |
| $R_{12}$ | 330k $\Omega$                           |
| $R_{13}$ | 22k $\Omega$ 1 watt                     |
| $R_{14}$ | 330k $\Omega$                           |
| $R_{15}$ | 220k $\Omega$                           |
| $R_{30}$ | 4.7k $\Omega$ 1 watt                    |

#### Capacitors

|          |                                     |
|----------|-------------------------------------|
| $C_1$    | 75pF                                |
| $C_2$    | 75pF                                |
| $C_3$    | 0.01 $\mu$ F                        |
| $C_4$    | 180pF                               |
| $C_5$    | 100pF                               |
| $C_6$    | 100pF                               |
| $C_{13}$ | 8 $\mu$ F, electrolytic, 350 V wkg. |

#### Valves

|               |        |
|---------------|--------|
| $V_1$         | EA50   |
| $V_{2(a)(b)}$ | 6SN7GT |
| $V_{3(a)(b)}$ | 6H6GT  |
| $V_{4(a)(b)}$ | 6SN7GT |

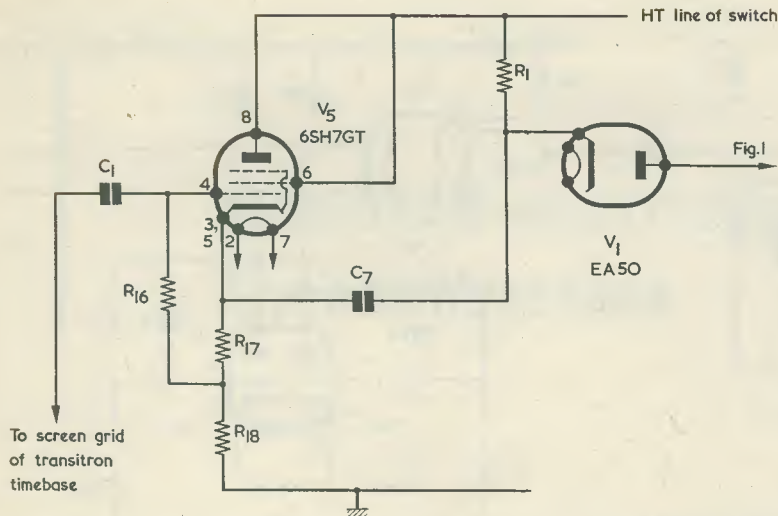


Fig. 2. A cathode follower, for use when timebase valve operation suffers when a direct connection from  $C_1$  is made to its screen grid. An alternative method of synchronising the switch employs the circuit of Fig. 5 instead of that shown here

**COMPONENTS**

(Fig. 2)

*Resistors*

(All  $\frac{1}{2}$  watt 10% unless otherwise stated)

- R<sub>16</sub> 1M $\Omega$
- R<sub>17</sub> 100 $\Omega$
- R<sub>18</sub> 10k $\Omega$  1 watt

*Capacitor*

- C<sub>7</sub> 220pF

*Valve*

- V<sub>5</sub> 6SH7GT

switch and cause it to change during the timebase flyback.

To cope with the higher timebase speeds without distortion, Section 1 was added. This has only one stable state since  $V_{2(b)}$  grid is taken to h.t. positive via  $R_7$ .  $V_{2(b)}$  is thus hard on and has a low anode potential. At the same time,  $V_{2(a)}$  is cut off due to the potentiometer  $R_3, R_4$  and so has a high anode potential. A negative pulse arriving at  $V_1$  cathode can then pass via  $C_3$  to  $V_{2(b)}$  grid, cutting this valve off, bringing  $V_{2(a)}$  on, and preventing further pulses passing through  $V_1$ . This condition is held until  $C_3$  is charged, whereupon the circuit switches back again. During this dead time, negative pulses arriving at the cathode of  $V_1$  cannot

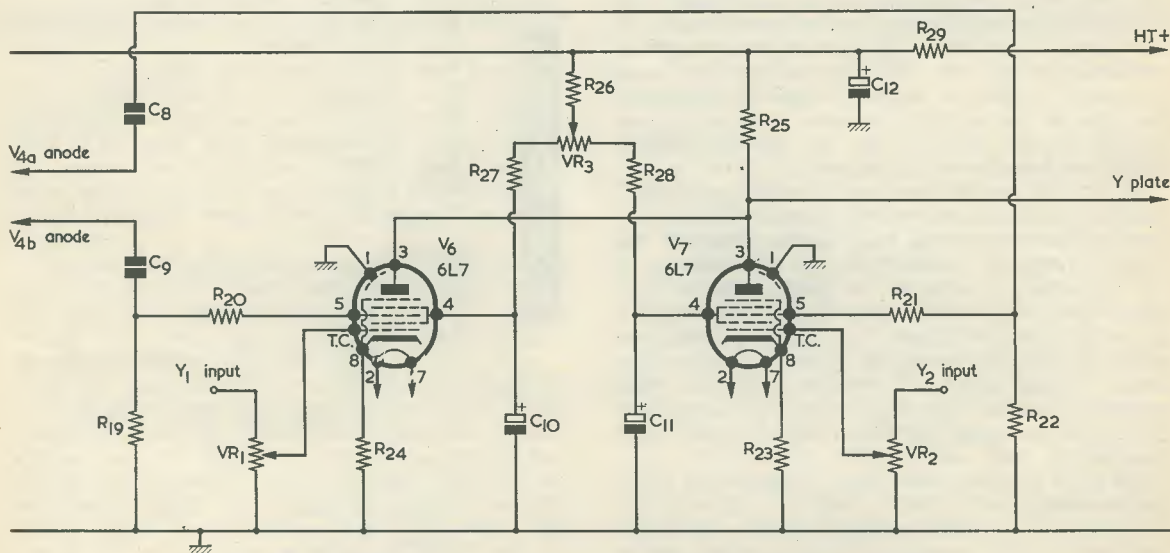


Fig. 3. The amplifiers. Coupling is direct to the Y plate of the oscilloscope c.r.t.

be passed to  $V_3$  and so, above a certain frequency which is dependent on the value of  $C_3$ , pulses are lost in  $V_1$ . In this situation only one of many pulses may get through to the dividing circuit but, even so, the dividing circuit is still triggered by the timebase, though now the switching is according to the third method discussed earlier. The switch is then limited to a range of frequencies in which it is efficient and yet can be used at all timebase speeds.

This circuit has been used successfully with a Miller timebase having a range of 20 c/s to 60 kc/s. This employed an EF50 in the writer's home-constructed oscilloscope. At the lower frequencies there is a problem of flicker, but this is common to all switch circuits. At the upper and middle frequencies the response was perfect, and the circuit could very possibly be made to operate at higher frequencies than those for which it has been tested.

When the unit was checked with other timebase circuits it was found necessary, with some, to insert a cathode follower between the transitron screen grid and  $C_1$ . A suitable circuit is shown in Fig. 2.

The circuit of the amplifiers is shown in Fig. 3. This is conventional, and uses 6L7 mixer valves. The unbalance and, hence, the trace separation is controlled by  $VR_3$  which effectively varies the screen grid potentials of the valves.

## COMPONENTS

(Fig. 3)

### Resistors

(All fixed values  $\frac{1}{2}$  watt 10% unless otherwise stated)

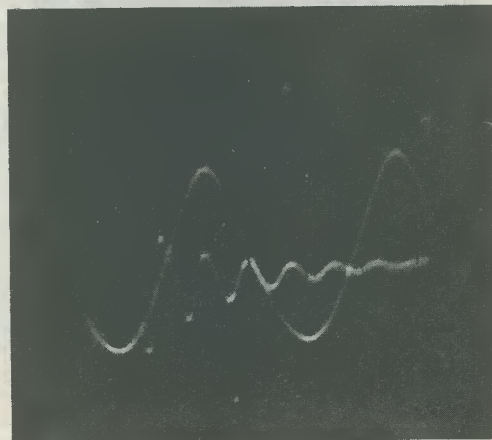
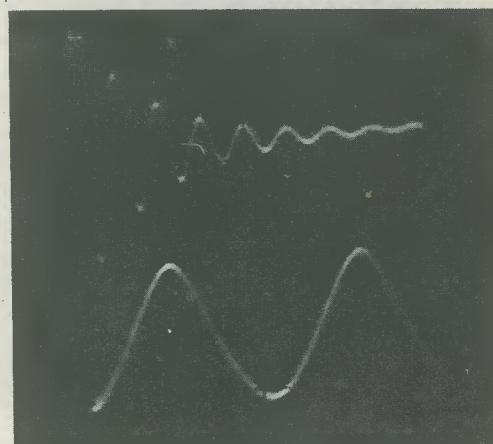
|          |                            |
|----------|----------------------------|
| $R_{19}$ | 1M $\Omega$                |
| $R_{20}$ | 470k $\Omega$              |
| $R_{21}$ | 470k $\Omega$              |
| $R_{22}$ | 1M $\Omega$                |
| $R_{23}$ | 330 $\Omega$               |
| $R_{24}$ | 330 $\Omega$               |
| $R_{25}$ | 47k $\Omega$ 2.watt        |
| $R_{26}$ | 10k $\Omega$               |
| $R_{27}$ | 22k $\Omega$               |
| $R_{28}$ | 22k $\Omega$               |
| $R_{29}$ | 4.7k $\Omega$              |
| $VR_1$   | 1M $\Omega$ potentiometer  |
| $VR_2$   | 1M $\Omega$ potentiometer  |
| $VR_3$   | 50k $\Omega$ potentiometer |

### Capacitors

|            |                                    |
|------------|------------------------------------|
| $C_8$      | 0.25 $\mu$ F                       |
| $C_9$      | 0.25 $\mu$ F                       |
| $C_{10}$   | 16 $\mu$ F, electrolytic, 275V wkg |
| $C_{11}$   | 16 $\mu$ F, electrolytic, 275V wkg |
| $C_{12}^*$ | 8 $\mu$ F, electrolytic, 350V wkg  |

### Valves

|       |             |
|-------|-------------|
| $V_6$ | 6L7 (metal) |
| $V_7$ | 6L7 (metal) |



The top photograph, taken from the oscilloscope screen, shows the two trace lines at a timebase of 1,000 c/s. The centre photograph illustrates a damped waveform together with a 750 c/s sine wave, whilst the bottom photograph shows these superimposed

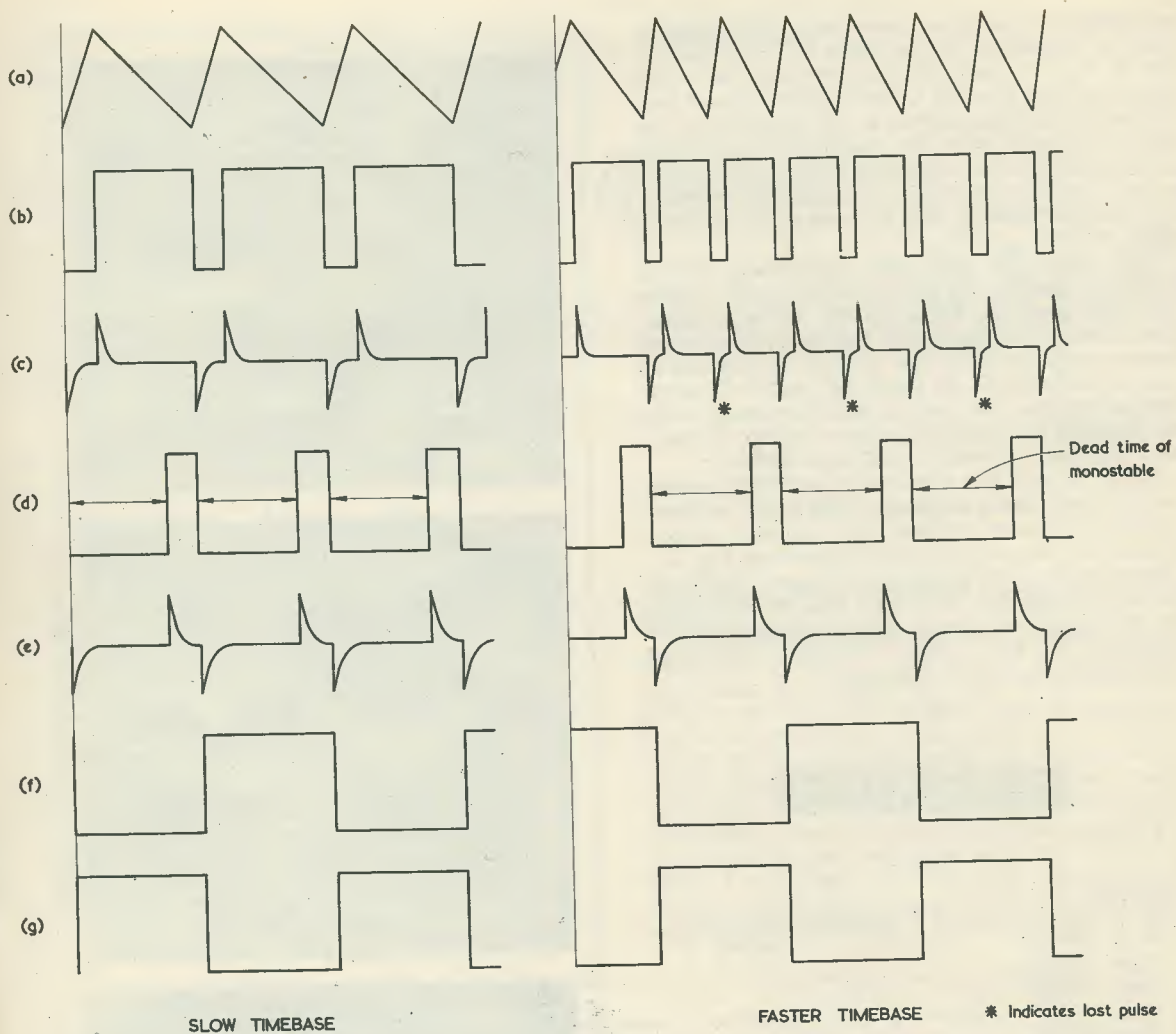


Fig. 4. Waveforms obtained at various points in the switch unit. These are as follows:—(a) timebase sawtooth, (b) screen grid of timebase valve; (c) waveform (b) differentiated ( $V_1$  cathode); (d)  $V_1$  anode, the negative portion length is the monostable dead time; (e) waveform (d) differentiated ( $V_3$  cathodes); (f)  $V_{4(a)}$  anode; (g)  $V_{4(b)}$  anode

### Construction

No layout details have been given as these largely depend on whether the unit is to be incorporated on the oscilloscope chassis as was the case with the prototype, or whether it is to be used as an external unit. (If the latter course is to be adopted, constructors may prefer to employ a modified circuit running from the timebase sawtooth which is described later in this article).

The layout was not found to be very critical, though the usual precautions should be taken. The balancing of the circuit in the switch is perhaps a little more critical, this point applying in particular to the values of the resistors  $R_3$ ,  $R_4$ ,  $R_{11}$ ,  $R_{12}$ ,  $R_{14}$  and  $R_{15}$ . If Section 2 of the switch is constructed first, this can be tested by connecting the screen

grid of the timebase valve via a 75pF capacitor to the cathodes of  $V_3$ . If the circuit fails to trigger, then adjustment of  $R_{12}$  or  $R_{14}$  may be required. Once this has been made to work, Section 1 can be constructed and, should this fail to work, then  $R_4$  may need adjustment.

It must be remembered that this unit requires approximately 20mA at 250 volts (including the cathode follower) and 2.55 amps at 6.3 volts, and if this cannot be provided by the existing oscilloscope power pack then an additional power unit (or heater transformer, if sufficient h.t. current is available) will be required. The h.t. voltage was not found to be very critical.

The valves used in the switch were of the octal type since these were to hand. However modifica-



- Resistors**  
 (All  $\frac{1}{2}$  watt 10%)  
 R<sub>31</sub> 470k $\Omega$   
 R<sub>32</sub> 470k $\Omega$   
 R<sub>33</sub> 470k $\Omega$   
 R<sub>34</sub> 1k $\Omega$   
 R<sub>35</sub> 100k $\Omega$

- Capacitors**  
 C<sub>14</sub> 2,000pF  
 C<sub>15</sub> 0.1 $\mu$ F  
 C<sub>16</sub> 2,000pF

- Valve**  
 V<sub>8</sub> EF50

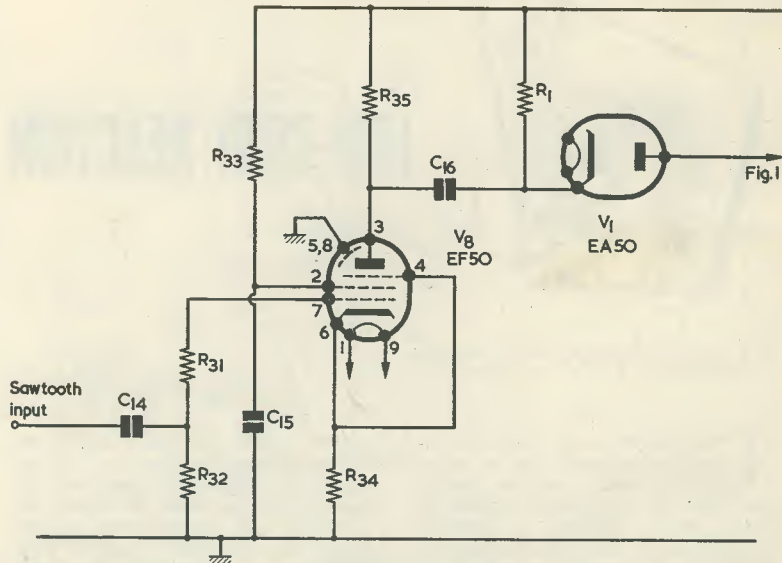


Fig. 5. This amplifier circuit allows the switch to be synchronised from the timebase sawtooth

tions to the values of R<sub>4</sub>, R<sub>12</sub> and R<sub>14</sub> could be made to make the circuit suitable for most types of double-triode, the changes depending on the valve to be used.

Fig. 4 shows the waveform obtained at various parts of the unit for slow timebase speeds and faster timebase speeds. The differentiated spikes marked with an asterisk in waveform (c) are those which are lost due to the action of V<sub>2(a)</sub> and V<sub>2(b)</sub>.

#### Using Sawtooth Control

The circuit described so far requires a special connection into the existing timebase of the oscilloscope so that, if the switch is to be used as an external unit, an extra connection would be required on the oscilloscope. Coupled with the inconvenience of doing this is the fact that a long lead connected to the timebase screen grid can upset the timebase calibration. However, on most oscilloscopes a sawtooth output is available from a socket on the front panel and this could be used for triggering the switch.

After having completed the switch as discussed above and obtained satisfactory results, the author next checked a modification for operation from the sawtooth output from the timebase. The modified circuit would then be preferable for a completely external unit, as opposed to the case

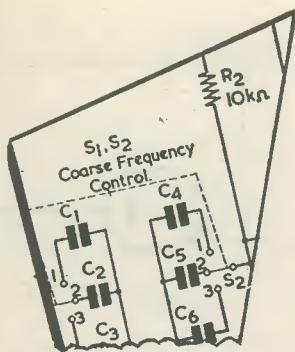
where the switch components are mounted inside the oscilloscope.

All that is required is to employ the circuit of Fig. 5 before R<sub>1</sub> and V<sub>1</sub> of Fig. 1. C<sub>1</sub> is not now required, coupling to the cathode of V<sub>1</sub> being made via the 2,000pF capacitor, C<sub>16</sub>. The circuit of Fig. 5 effectively replaces that of Fig. 2, and uses an EF50 to invert and amplify the sawtooth, and clip off the wave tops. The square wave produced, subsequently differentiated, gives the required triggering pulses.

As an external unit, the only other connection required to the oscilloscope is the signal lead carrying the output of the switch. This signal, obtained from the 6L7 anodes, contains a square wave and because of the difficulty of amplifying such a waveform, it should preferably be applied directly to the Y plate, bypassing the existing oscilloscope amplifier. Should further amplification of signal be required, then this is preferably done before application to the switch. Nevertheless, the square wave in the present circuit is always of lowish frequency, and so reasonable results are feasible if the oscilloscope Y amplifier appears between the switch and the Y plates. The quality of the results depends on the quality of the Y amplifier used and the only way of testing this is by experiment. ★

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# LOW-COST REACTION TIMER

SUGGESTED CIRCUIT No. 192

By G. A. FRENCH

THE WRITER WAS RECENTLY interested to read\* that a "party trick" which can be carried out with a computer consists of using it to measure a person's reaction time. The subject looks at a screen and presses a button as soon as the word "now" appears, whereupon the computer then indicates the time that has elapsed before the button was pressed. It is stated that the average time for most people is about a quarter of a second.

It occurred to the writer that it should be possible to design a simple low-cost instrument which could similarly function as a reaction timer, and the device to be described this month is the result of his investigations. Now that the party season is nearly upon us, this device can provide a useful novelty for the amusement of guests. It can also carry out the more serious function of convincing a car driver that after a few drinks his reactions are not, as he fondly imagines, speeded up but are actually slowed down. The reaction timer could also have applications for the study of reaction times under different conditions of stress, etc., but it must be noted here that the absolute calibration accuracy is not high and that the device should be used, preferably, for comparative measurements between one reaction time and another.

The unit functions by causing a neon lamp to be suddenly illuminated, whereupon the subject presses a button. A meter then directly indicates the time elapsing between the illumination of the neon lamp and the pressing of the button. This

meter reaches full-scale deflection 0.5 seconds after the neon lamp lights up, whereupon the average human reaction time of quarter of a second falls conveniently in the centre of the meter scale. The timing period is started by a second person, but it is also possible for it to be initiated by a relay in a time delay circuit. Costs have been kept to a low level by the omission of stabilising circuits in the power supply. Wide changes in mains voltage can, therefore, result in changes in the readings obtained.

In the interests of simplicity of operation when in use, a small amount of non-linearity has been allowed in the meter circuit. This may, however, be cancelled out on final calibration, if so desired.

### Basic Functioning

The basic operating approach used in the reaction timer is shown in Fig. 1. In this diagram, the act of closing the switch causes a high direct voltage to be applied to the neon lamp and its series resistor, and to a resistor in series with a push-button and a capacitor. The

push-button breaks the circuit when it is depressed. Connected across the capacitor is a voltmeter which consumes negligible current.

The process is started by closing the switch, whereupon the neon lamp becomes illuminated and the capacitor commences to charge via the resistor. The push-button is next pressed by the subject, with the result that the capacitor ceases to charge. The voltage across its plates can then be read at leisure by inspecting the voltmeter, which will thereby indicate the time which has elapsed before the button was pressed. An important feature of the system is that full-scale deflection in the voltmeter is very much lower than the applied direct voltage, whereupon the measurable timing period is limited to a small section at the start of the exponential charging curve for the capacitor. It can be assumed that this small section is sufficiently linear to be considered as a straight line, whereupon the voltmeter calibration may be converted to seconds by applying a simple multiplying factor. The values of the resistor and capacitor

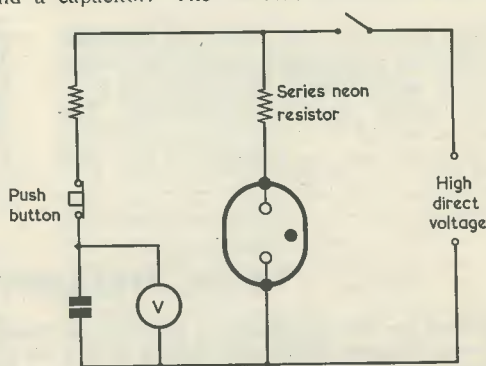


Fig. 1. Circuit showing the basic operation of the reaction timer

\* In *Computers* by K. N. Dodd, Ph.D., published by Pan Books Ltd.

in the charging circuit are such that the voltmeter reaches full-scale deflection in 0.5 seconds.

In the practical circuit, a voltage limiting device is connected across the capacitor to prevent the voltage across this component from rising to an excessively high value if the push-button is not depressed.

### The Practical Circuit

Two main requirements have to be met in converting the basic scheme of Fig. 1 into practical form. The first of these is the provision of a high direct voltage and the second is the provision of a voltmeter which draws a very low current. The necessity for a high voltage argues the use of the mains for supply. If a mains supply is employed the use of a valve in the voltmeter circuit, as opposed to semiconductor devices, then becomes attractive. In the present design power is obtained from the mains and the voltmeter section employs a double-triode.

The practical circuit is given in Fig. 2. When the main on-off switch,  $S_3$ , is closed, the mains supply is applied to heater transformer  $T_1$ , which feeds 6.3 volts to the heater of  $V_1$ . This valve is a double-triode type 12AT7, with both sections strapped together to form a single triode. As soon as the valve cathode has reached operating temperature the circuit is ready for use.

The reaction timing period is initiated by throwing  $S_2$ . Section  $S_{2(b)}$  of this switch closes, allowing the mains supply voltage to be applied to neon lamp  $NE_1$  and its associated series resistor,  $R_5$ , with the result that this lamp becomes illuminated. The mains supply voltage is also fed to silicon rectifier  $D_3$  which allows positive half-cycles to be applied to the valve and to the timing section.

At the same time as  $S_{2(b)}$  was closed,  $S_{2(a)}$  became open, removing an effective short-circuit (via low-value resistor  $R_1$ ) from capacitor  $C_1$ .  $C_1$  now commences to charge, on positive half-cycles from  $D_3$ , via  $R_2$  and the normally-closed push-button  $S_1$ . The upper plate of  $C_1$  is connected to the grids of  $V_1$  with the consequence that, as the capacitor upper plate goes positive, so also do the grids, and cathodes of the valve. The cathode voltage is monitored by meter  $M_1$ , which forms the timing indicator for the instrument. The meter circuit will be considered in greater detail later.

As soon as the subject sees that the neon is illuminated he presses the button, whereupon the capacitor ceases to charge, and an indication of

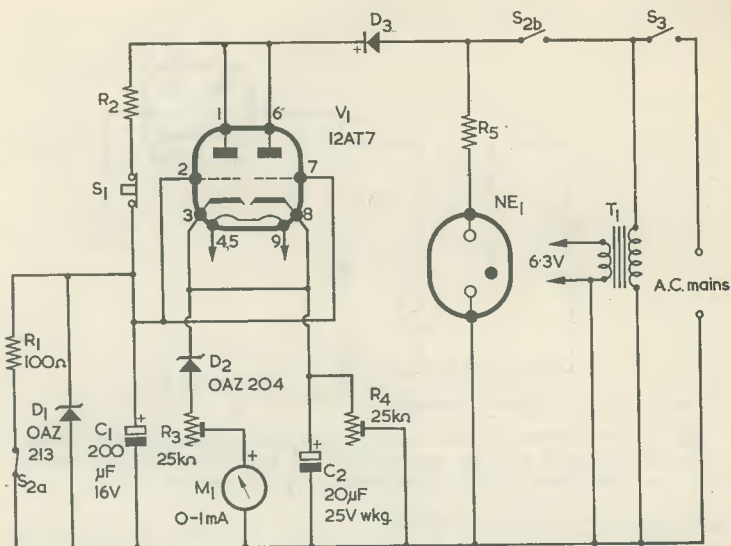


Fig. 2. The practical circuit.  $R_3$  and  $R_4$  are replaced by fixed resistors after setting up

the voltage across it may be read at leisure from the meter. If the press-button is released the capacitor commences to re-charge, allowing the meter to go beyond full-scale deflection. Any further positive excursion is stopped by zener diode  $D_1$ , which becomes conductive when the voltage across  $C_1$  reaches its zener voltage.

To re-set the instrument,  $S_2$  is returned to its previous condition. Contacts  $S_{2(b)}$  open, switching off the supply to the neon lamp and the components supplied via  $D_3$ . At the same time, contacts  $S_{2(a)}$  close, discharging  $C_1$  via  $R_1$ , whereupon the circuit can be set in operation by throwing  $S_2$  once more. Resistor  $R_1$  is inserted in series with  $S_{2(a)}$  to limit discharge current to a safe value.

It will be noted that, although the charging capacitor and valve voltmeter circuits are powered by positive half-cycles only, the potentials at the grids and cathodes of  $V_1$  are of the same "steady" order as would be given if a fully smoothed supply were applied. This is because the large-value timing capacitor  $C_1$  appears between the grids and the lower supply line, and because the  $20\mu\text{F}$  capacitor,  $C_2$ , appears between the cathodes and the lower supply line.

The value required in  $R_2$  is found empirically. The process involved is extremely simple, and is discussed later.

### The Meter Circuit

The meter circuit connected to the

cathodes of  $V_1$  differs from the customary bridge arrangement normally encountered in valve voltmeters. This is because it was desired to have a circuit which could be set up, once and for all, and then left alone without the need for any subsequent adjustments to zero the meter whilst the instrument is in use. Apart from their nuisance value, the existence of such adjustments is liable to give non-technical people the impression that reaction time readings given by the instrument are capable of being "fixed".

The circuit shown in Fig. 2 is intended to give meter readings in  $M_1$  which correspond in linear fashion to  $V_1$  grid voltages (with respect to the lower supply line) ranging from zero to about 9 volts. However, since  $V_1$  cathode current increases as its grids go positive, the potential difference between grids and cathodes changes, and the relationship between grid and cathode voltages varies in consequence. Nevertheless, by suitable adjustments in  $R_3$  and  $R_4$ , it is possible to obtain a very nearly linear relationship for meter readings from about 0.05mA to full-scale deflection, and this is sufficiently accurate for the present purpose. The small discrepancies can, in any case, be taken up in the final calibration, if so desired. It is intended that, when the grids of  $V_1$  are at zero potential, the cathodes are positive of the supply line by the zener voltage of  $D_2$ , with the consequence that minimum deflection is given in the meter. The main

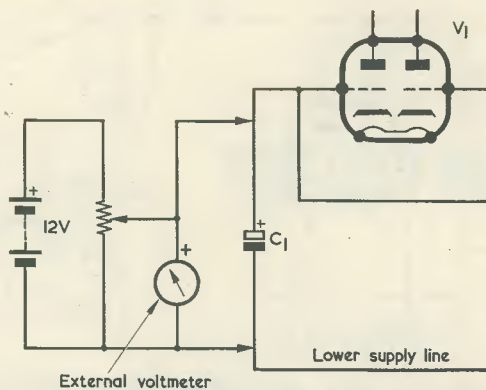


Fig. 3. The external circuit which is connected between the lower supply line and the grids of  $V_1$  for setting up  $R_3$  and  $R_4$ . The potentiometer across the 12 volt battery can have any value between 5 and 50k $\Omega$

functions of  $R_3$  and  $R_4$  are to take up tolerances in zener voltage in  $D_2$ . With the OAZ204 specified for this position, these are  $\pm 5\%$ .

The circuit is set up after the unit has been assembled in the following manner. Disconnect zener diode  $D_1$  but leave capacitor  $C_1$  in circuit. Push-button  $S_1$  can also stay in circuit because, at this stage,  $R_2$  will not be fitted. Connect to the mains supply. Then, temporarily apply a monitored voltage to the grids which is capable of being varied from zero to 12 volts, as shown in Fig. 3. Operate  $S_2$  and  $S_3$ .  $R_3$  and  $R_4$  are then adjusted so that, over the range 0-9 volts, proportionate current readings are given in meter  $M_1$ . With the prototype it was found possible to obtain the correlation between external voltmeter and  $M_1$  readings which is shown in the Table and in Fig. 4. It will be noted that zero grid voltage in this case corresponded to a reading of 0.05mA in  $M_1$ . The process of setting up  $R_3$  and  $R_4$  may appear to be tedious but in practice it is quite simple, and should not take longer than ten minutes or so. It is helpful to position the external voltmeter of Fig. 3 alongside meter  $M_1$  whereupon the correlation between meter readings is more easily observed. If  $D_2$  is on its upper zener voltage tolerance, it may be preferable to work over a grid voltage range from zero to 9.5 and if it is on its lower tolerance, a grid voltage range of zero to 8.5 may give best results. The actual grid voltage corresponding to maximum deflection in  $M_1$  is unimportant, provided that it is of the order of 9 volts.

The result shown in the Table and in Fig. 4 were obtained, in the prototype, with  $R_3$  set to insert

about 7k $\Omega$  and  $R_4$  set to insert about 12k $\Omega$ . These two settings may be used as a starting point for readers' adjustments. Also, in the prototype full-scale deflection in  $M_1$  corresponded to 13 volts on the cathodes.

After the optimum settings in  $R_3$  and  $R_4$  have been found, they may be replaced by fixed resistors having the same value. If the reader wishes to use the results in the final calibration, he can make up a similar Table to that given here.

#### Components

Some points need to be made next concerning the components.

$T_1$  can be any small heater transformer, and its only function is to supply the valve with 6.3 volts at 0.3 amps.

The neon lamp  $NE_1$  may be of any type, but it will obviously be preferable to use a large type which gives a reasonably bright light. Resistor  $R_5$  should have a value suitable for running the particular neon lamp employed from the mains supply voltage. Some neon lamps may already have  $R_5$  incorporated integrally in the base, whereupon the external resistor is not required. A neon lamp is used instead of a filament lamp because it will become illuminated at full brilliance immediately  $S_{2(b)}$  is closed.

Diode  $D_3$  may be any silicon power supply rectifier having a p.i.v. of 400 or more. An OA210 would be suitable. In the prototype, the writer employed a BY100 which happened to be on hand.

The capacitor in the  $C_1$  position is an important component and it must have a very low leakage current so that it does not discharge too

rapidly after  $S_1$  is depressed. The writer used a Mullard miniature electrolytic capacitor here. This gave excellent results, and held its charge for a considerable period after push-button  $S_1$  had been depressed. With the prototype, readings in  $M_1$  up to 0.6mA remained virtually unaltered for 30 seconds or more after  $S_1$  had been depressed. At 0.8mA, readings held steady for some 20 seconds, and at 1mA (f.s.d.) the meter reading remained steady for about 8 seconds, after which it gradually fell. To achieve results of this nature, the insulation of the components to which  $C_1$  connects must be of a high order, and it would be preferable to use a good-quality moulded or ceramic valveholder for  $V_1$ . Excessive grid currents in the valve may have a noticeable effect on the charge in  $C_1$ . If these are suspected another valve should be tried.

It is intended that  $S_2$  be operated by a second person, and it will be necessary for this switch to be thrown unobtrusively and without noise. A simple approach consists of mounting  $S_2$  at the back of the housing in which the unit is fitted whereupon it can be operated without the subject's knowledge. It is, of course, necessary for  $S_2$  to operate silently because the only stimulus received by the subject should be the visual one given by the illumination of the neon bulb. A 2-position Yaxley switch, with its indent ball removed would be a useful choice here. Its contacts should be capable of working at the mains potentials appearing in the  $S_{2(b)}$  section.

The meter  $M_1$  is a moving-coil 0-1mA movement with, preferably, a large scale. It may be mounted on the front of the housing in company with the neon lamp,  $S_1$  and  $S_3$ .

#### Setting Up

The circuit should be assembled without  $R_2$  in circuit, after which  $R_3$  and  $R_4$  should be adjusted as described earlier. The values of  $R_3$  and  $R_4$  should *not* be subsequently altered, this point being automatically satisfied if the potentiometers are replaced by fixed resistors. We may now look upon  $V_1$  and the meter circuit as the voltmeter of Fig. 1, this giving full-scale deflection for a voltage across  $C_1$  of about 9 volts.

Next, temporarily connect a resistor of about 500k $\Omega$ , and whose value is known accurately, in the  $R_2$  position. This will cause the timing circuit to function at a lower rate than that finally obtained, and makes testing easier to carry out

**Voltage and Current Readings  
(Fig. 4).**

| Grid Voltage | M <sub>1</sub> Reading |
|--------------|------------------------|
| 9            | 1.0                    |
| 8            | 0.88                   |
| 7            | 0.76                   |
| 6            | 0.65                   |
| 5            | 0.53                   |
| 4            | 0.4                    |
| 3            | 0.3                    |
| 2            | 0.2                    |
| 1            | 0.11                   |
| 0            | 0.05                   |

Apply an external voltmeter between the lower supply line and the cathodes of V<sub>1</sub>. The voltmeter should be set for readings of 20 volts maximum.

Switch on S<sub>3</sub> and allow the valve to warm up. Throw S<sub>2</sub>, whereupon the voltage on the cathodes of V<sub>1</sub> will rise to the voltage corresponding to minimum deflection in M<sub>1</sub>. C<sub>1</sub> will now commence to charge, causing a continual increase in this cathode voltage. The reading in M<sub>1</sub> will also increase and should eventually go off-scale at maximum. Shortly afterwards, the rise in cathode voltage (as observed in the external voltmeter) should halt abruptly, this indicating that zener diode D<sub>1</sub> has become conductive. If this abrupt halt does not occur, switch off S<sub>2(b)</sub> before too high a voltage is applied to C<sub>1</sub> and C<sub>2</sub> and check D<sub>1</sub> and its connections. The OAZ213 specified has a spread from about 9.3 to 15 volts, and the halt in cathode voltage should occur at some 4 volts above the actual zener voltage.

The external voltmeter connected to the cathodes of V<sub>1</sub> may now be disconnected. Its function is merely to ensure that D<sub>1</sub> is functioning correctly.

Run the circuit several times by operating S<sub>2</sub> to ensure that C<sub>1</sub> becomes fully formed (as may be required if it has been in stock for a considerable period) then check that the reading in M<sub>1</sub> remains reasonably steady whenever S<sub>1</sub> is pressed. Next, measure the time needed to obtain full-scale deflection in M<sub>1</sub>. With the prototype this was found to be 9 seconds. If the time in seconds needed to achieve full-scale deflection in M<sub>1</sub> is called t, then the value needed in R<sub>2</sub> for a 0.5 second timing period is

$$\frac{\text{present value of } R_2}{t} \times 0.5k\Omega.$$

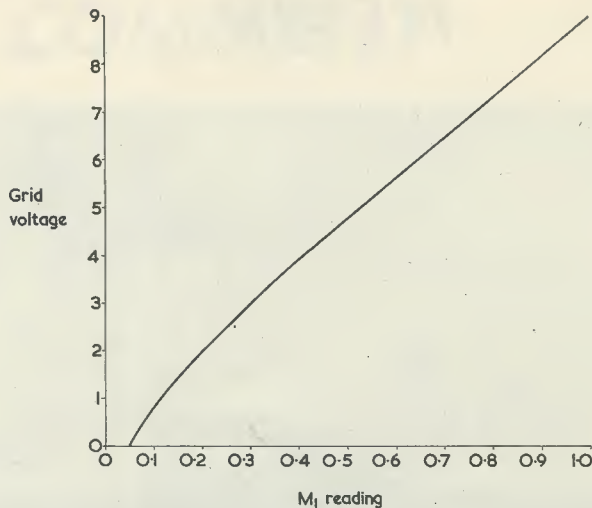


Fig. 4. Graph showing the relationship between V<sub>1</sub> grid voltage and M<sub>1</sub> current obtained with the prototype. Curve points are given in the Table

In the prototype, the writer initially employed a close-tolerance 500kΩ resistor in the R<sub>2</sub> position. Since this gave a timing period of 9 seconds, the final value needed in R<sub>2</sub> for a 0.5 second period was 28kΩ.

It will be noted that this approach involves no mathematics and allows for tolerances on value in C<sub>1</sub>. It also enables the required value in R<sub>2</sub> to be found by the use of a timing period which can be readily measured with any watch having a second hand.

When used in its final form, the timing period is too short to be evaluated in this manner.

The instrument is now complete. If desired, M<sub>1</sub> may be calibrated in units of time from zero to the full-scale deflection of 0.5 seconds. For higher accuracy, the results given in a Table such as the one reproduced with this article could be incorporated into the calibration.

(continued on page 242)

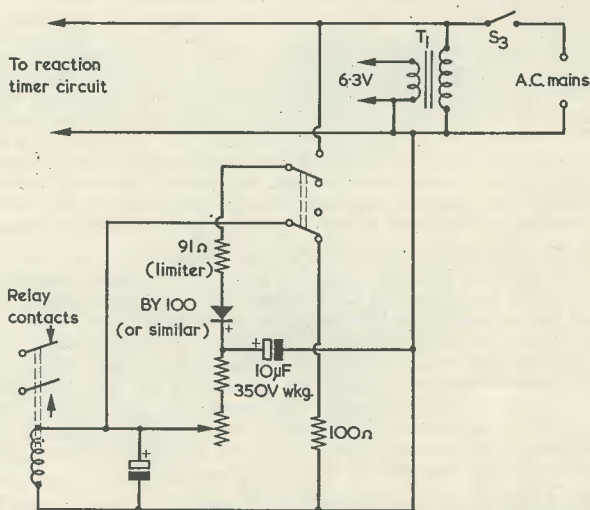
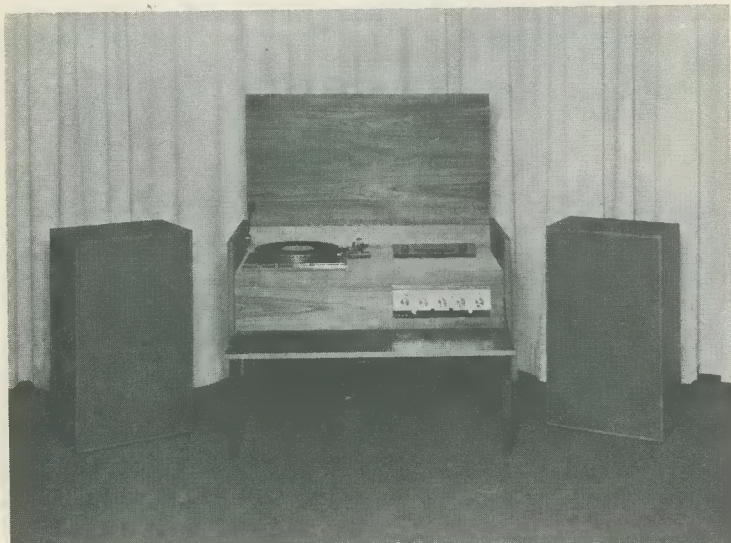


Fig. 5. A suggested circuit to provide delayed initiation of the reaction timing period. Component values not shown are discussed in the text. Two relay contact sets (one normally closed and one normally open) are required, and these replace S<sub>2(a)</sub> and S<sub>2(b)</sub> of Fig. 2



The EQC 18 Equipment Cabinet shown open with the new S 33 speaker enclosures on each side. Equipment installed: Leak stereo 30 amplifier, Leak tuner, Garrard 401 turntable, SME pick-up arm.

## Design Furniture's New Hi-Fi Equipment Cabinet

At the beginning of this year Design Furniture Limited ran a competition for the design of hi-fi equipment cabinets. From the results of that competition their own design team has evolved this new compact cabinet of exceptionally neat appearance—the EQC 18. It will accommodate the majority of popular hi-fi equipment and is particularly suitable for transistorised equipment. This cabinet will satisfy the growing demand for a smaller and compact equipment cabinet as more transistorised equipment becomes available. The motorboard and amplifier top are interchangeable from left hand to right hand, and can be mounted in any position—flat, stepped or sloped.

Most of the designs submitted to the competition were very similar to Design Furniture's existing range, or the cabinets were designed to meet the individual requirements of one particular hi-fi enthusiast. Originality was not much in evidence, and where present, tended to produce extremist designs which, although undeniably attractive to the individual, could command only a very limited market. In the class for the smaller equipment cabinet many entrants reduced (often drastically!) the usual minimum dimensions to which we have adhered—thus restricting the variety of equipment which would be accommodated. Though the EQC 18 is a little larger than the original design submitted, it may still prove too small in some cases, but it will accommodate the majority of popular equipment.

The EQC 18 is soundly made in Design Furniture's own factory at Calthorpe Manor, Banbury, Oxon, and is finished to an exceptionally high standard. It is available in two standard natural wood veneer finishes—walnut with rosewood fall front or natural oiled teak. It is 36½ in wide, stands 27½ in high (including 14½ in legs) and is 18¾ in deep. The approximate retail price is £25—at which price it seems a very acceptable piece of living room furniture.

## Society for Amateur Radio Astronomers

Amateur interest in radio astronomy has shown a marked increase in recent years, and already quite an amount of reliable practical information has been published, enabling the keen amateur to make a start in this fascinating field. This magazine, for instance, as early as 5 years ago published a series of articles which gave much practical information on radio astronomy. The articles were by that well known exponent Frank W. Hyde, F.R.S.A., F.R.A.S.

It was with particular interest therefore that we learned of the formation of "The Society For Amateur Radio Astronomers". The objects of the society are to encourage and help those wishing to build and experiment with their own radio telescopes, to bring together those interested in such projects and to publish information of value to amateur radio astronomers.

The construction and use of an amateur radio telescope is a fairly complex matter, and as the promoters of the society point out, knowledge of electronics and astronomy, and mechanical and radio constructional ability are required to obtain a successful installation. Such projects are therefore very suitable for cooperative effort by students at schools and technical colleges.

The society is to publish a journal, "Radio Sky", which is to contain papers on fundamental principles of radio astronomy, articles of a theoretical and practical nature, and news of the activities of members, etc.

Further details and membership application forms can be obtained from—The Society For Radio Astronomers, 9 Sutherland Road, London, W.13.

## "Speed Hearing" Will Help the Blind

After last month's news of a speech microscope, developed by Standard Telecommunications Laboratories Limited, we now give news of an American device which also removes portions of sound from the spoken word.

# COMMENT

This electronic device allows "speed hearing" of recorded speech at word rates comparable to very fast reading.

Speakers who record for the American Foundation for the Blind speak at an average of 160 to 170 words per minute. But persons with unusual reading skill read at double these rates, from 300 to 400 words a minute.

The device, developed by scientists of the Bell Telephone Laboratories in New York, is called a "harmonic depressor" because it doubles the rate of syllables without doubling the pitch of the speech.

The device divides in half the frequency components in a voice recording while preserving the original time duration. By then doubling the speed of this "half-frequency" recording, the frequency components are restored to normal, resulting in a normal-pitch, double-speed playback.

The engineering division of the American Foundation for the Blind is now developing the device from the Bell Laboratories designs.

## "Silent" Noise Menace

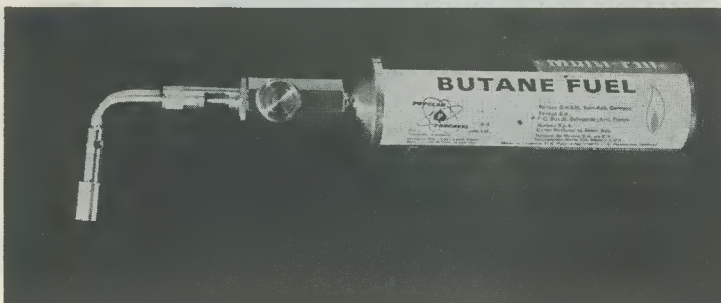
Noise is not always as straightforward as loud music or banging machinery. There is ultrasonic noise which, put simply, is "silent." The best example is the dog whistle which we cannot hear, but which gets through to the animal.

Ultrasonic noise can affect matter. The great tenor, Enrico Caruso could pitch his voice, not only to his audience's pleasure but to shatter a wine glass.

The human ear cannot hear ultrasonic noise. It is pitched above 22,000 vibrations a second—the upper limit of man's hearing. It is employed by machines that can bore holes in glass without shattering it, and which can measure the thickness of steel plates.

In Los Angeles, experts tackled the smog problem over the city with high frequency whistles. The sound collected particles of dust and water together until they were heavy enough to drop to the ground, dispersing the gloom.

The above information appeared in *Safety*, the journal of The British Safety Council; the caption to our cartoon was taken from the same source.



## Modified "Supa-Nova" Blow Torch Can be Used in Any Position

A modification has been made to the "Supa-Nova" miniature blowtorch to enable it to be used with the flame pointing vertically downwards. The nozzle is now bent to a full right-angle, so that the body of the blowtorch need not be tilted below the horizontal.

The "Supa-Nova" was introduced last year as the first blow torch which could be fitted to any standard butane or propane cigarette lighter gas refill. Large numbers have been sold in Britain and on the Continent. The flame develops a temperature of 1600°C and, at full power, is 3in to extreme tip and  $\frac{3}{8}$ in to blue tip. The torch without its gas supply is only  $\frac{1}{2}$ in high, and comprises a burner nozzle, air and gas valves, and controls.

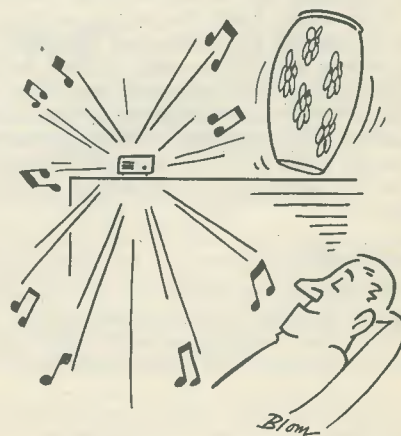
The new model "Supa-Nova" will in future be supplied as standard and the price is unchanged at 45s. Enquiries to Henri Picard & Frère Ltd., 34/35 Fumal Street, London, E.C.4.

## Tanks at the Flower Show

Under the above sub-heading, *The Times* recently, in its feature "As - it Happens", mentions an amusing exchange of messages between an amateur transmitting station operated by members of the Chesterfield and District Radio Society at an open air show in Derbyshire, and a Russian amateur station in Vladivostock.

The Russians asked "How many tanks and rockets are you showing?" The amateurs, a bit taken aback we guess, then had to explain, to the apparently somewhat incredulous Russians, that the show included, floral displays, a dog competition, a rabbit show, amusements for the kiddies and athletics, but no tanks or rockets.

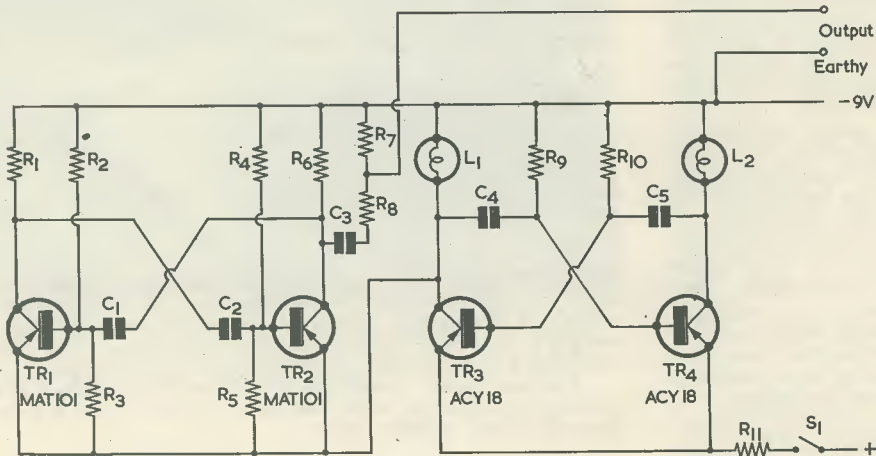
Noise has been defined as "unwanted sound." When one considers pop music, it is obvious straightaway that one man's meat is another's poison. But whatever the personal taste, excess noise is harmful.





# A STEREO BALANCER

L. E. Hyman



This neat little unit enables accurate balance to be obtained in any stereo installation, and has the advantage of compensating for the acoustic characteristics of the listening room.

THE IDEA OF STEREO BALANCING HAS BEEN THE subject of considerable discussion, especially with regard to the many methods which are available and which may be purely electronic or may work from simple theoretical principles. The balancing unit described in this article offers a solution which has been evolved by the writer, and it will provide a balance regardless of possible differences in either amplifier or speaker characteristics on each channel. More important still, it gives an *audio* balance, and consequently compensates for acoustical peculiarities in the listening room.

## The Circuit

The circuit, which appears in the accompanying diagram, is not original, and is in fact a "marriage" of two multivibrator circuits which appeared in previous issues of *The Radio Constructor*.<sup>1</sup> The two

multivibrators are given by TR<sub>1</sub> and TR<sub>2</sub>, and by TR<sub>3</sub> and TR<sub>4</sub>. TR<sub>1</sub> and TR<sub>2</sub> run at around 1 kc/s, whilst TR<sub>3</sub> and TR<sub>4</sub> have a complete cycle of about 0.5 sec. The TR<sub>1</sub>, TR<sub>2</sub> multivibrator receives a supply only when TR<sub>3</sub> is bottomed, thus an audio output is provided for 0.25 sec periods with intervals of the same time.

The two lamps, L<sub>1</sub> and L<sub>2</sub>, function as collector loads for TR<sub>3</sub> and TR<sub>4</sub> and also give a useful indication that the unit is operating. It will be noted that one of the output terminals is common with the negative supply rail. This should be connected to the "earthy" (i.e. chassis) input terminal of the amplifier being balanced.

## Operation

To use the balancer, the two inputs of the stereo amplifier should be commoned and the output of the unit applied. A steady "peep-peep" will then be heard to the left or right of the centre position between the speakers. Operation of the amplifier balance control will centre these pulses

<sup>1</sup> H. T. Slingo, "Simple Transistor Square Wave Oscillator", *The Radio Constructor*, October 1961. M. Farnsworth, "A 'Flashing Man'", *The Radio Constructor*, January 1965.



## COMPONENTS

### Resistors

(All  $\frac{1}{4}$  watt 10% unless otherwise stated)

|                 |                               |
|-----------------|-------------------------------|
| R <sub>1</sub>  | 15k $\Omega$                  |
| R <sub>2</sub>  | 270k $\Omega$                 |
| R <sub>3</sub>  | 47k $\Omega$                  |
| R <sub>4</sub>  | 270k $\Omega$                 |
| R <sub>5</sub>  | 47k $\Omega$                  |
| R <sub>6</sub>  | 15k $\Omega$                  |
| R <sub>7</sub>  | 47k $\Omega$ (see text)       |
| R <sub>8</sub>  | 470k $\Omega$                 |
| R <sub>9</sub>  | 2k $\Omega$                   |
| R <sub>10</sub> | 2k $\Omega$                   |
| R <sub>11</sub> | 30 $\Omega$ 1 watt (see text) |

### Capacitors

|                |                                    |
|----------------|------------------------------------|
| C <sub>1</sub> | 0.005 $\mu$ F                      |
| C <sub>2</sub> | 0.005 $\mu$ F                      |
| C <sub>3</sub> | 0.02 $\mu$ F                       |
| C <sub>4</sub> | 200 $\mu$ F electrolytic, 12V wkg. |
| C <sub>5</sub> | 200 $\mu$ F electrolytic, 12V wkg. |

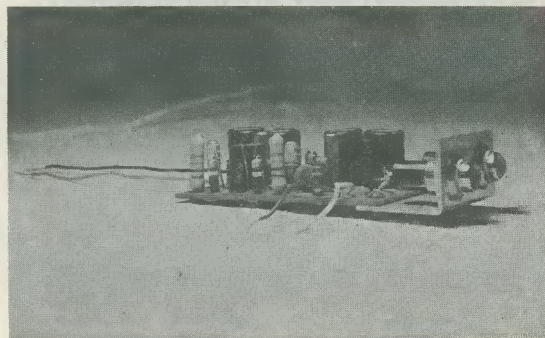
### Transistors

|                 |        |
|-----------------|--------|
| TR <sub>1</sub> | MAT101 |
| TR <sub>2</sub> | MAT101 |
| TR <sub>3</sub> | ACY18  |
| TR <sub>4</sub> | ACY18  |

### Miscellaneous

|                                 |                                   |
|---------------------------------|-----------------------------------|
| L <sub>1</sub> , L <sub>2</sub> | 6.5V, 150mA, m.e.s., with holders |
| S <sub>1</sub>                  | on/off switch                     |
|                                 | 9-volt battery                    |

If it is found that the output amplitude of the unit is too great for the particular amplifier input with which it is intended to be used, a reduction may be made by fitting a lower value in the R<sub>7</sub> position.



The neat and compact version of the balance unit constructed by the author. The components are fitted to an insulated board measuring 3 x 1 $\frac{3}{4}$  ins. The on/off switch is not mounted on the board

exactly, and the amplifier channels will then be acoustically balanced.

The unit should flash steadily as soon as it has been assembled and a 9-volt supply applied. Also, a clear "peep-peep" should be heard when it is connected to the amplifier. If the audio tone is uneven, or rises sharply at the end of the pulse, adjust R<sub>11</sub> slightly, either way.<sup>2</sup>

As may be seen from the illustration, which shows the author's version, the whole unit may be made up in neat and compact form. As assembled by the author, the components were fitted to an insulated board measuring 3 x 1 $\frac{3}{4}$  in, the two lamps being mounted in suitable holders on an aluminium bracket bolted to the board. This particular unit used two pairs of 100 $\mu$ F electrolytic capacitors in parallel for C<sub>4</sub> and C<sub>5</sub>, as 200 $\mu$ F components were not to hand. Also, the on/off switch was fitted externally.

<sup>2</sup> This will, of course, affect the brightness of the lamps. A high level of brightness will be given if R<sub>11</sub> is 20 $\Omega$ .—Editor.



## 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

**Tape Recorder.**—A. Roberts, 1 Blackburn Row, Mirfield, Yorks.—made by "Granvox School Equipment", maker's address or circuit diagram.

**1154 Transmitter and Power Unit.**—P. Madden, 75 Franks Avenue, New Malden, Surrey—loan or purchase handbook, circuit, etc.

**R107 Receiver.**—H. Stokes, 37 Baldock Road, Royston, Herts.—purchase (preferably) circuit or manual.

**Transistor Radio.**—C. Tomlinson, 73 Wellington Street, Matlock, Derbyshire—loan or purchase circuit of model

GEC9812 (McMichael M112/Sobell S312BT).

**Service C.R.T.**—T. J. Kill, 81 Ashby Avenue, Chessington, Surrey—information (connections and supplies) for this tube—No. CV2292/KB/K.

**Minimitter Top Band Receiver.**—A. Corker, 5 West Crescent, Sunnyside, Nr. Rotherham, Yorks.—loan or purchase of circuit diagram for transistor receiver TR7.

**Valve Equivalents.**—A. L. Dodd, c/o Mrs. Firth, 5 Langshot Street, Glasgow, S.W.1—borrow or purchase commercial equivalent tables for CV and VT numbers.

# Electronics and the Electric Guitar

by Raymond Liffen

*Modifications to a simple electric guitar can result in a considerable increase in the range of sound it produces*

THE GUITAR MUST SURELY BE rated as one of the most adaptable of musical instruments. From the same six strings that produce the quiet beauty of Early English music or the wild excitement of Flamenco comes today's sound—amplified, strongly rhythmic and with a vast range of tone colours. It is with these tone colours that this article deals.

There are two main types of electric guitar: solids and semi-acoustics. The semi-acoustic retains at least some of the sound box that was the "amplifier" for the early guitars. Both types are usually fitted with two or more electro-magnetic pick-ups, since combination tones (resulting from mixing pick-up outputs together) are usually more harmonically interesting than the tone from a single pick-up. A 2-pick-up model has one pick-up mounted near the bridge, giving a sound rich in harmonics. Rather more of the fundamental comes from the other pick-up, which is mounted near the fingerboard. A third pick-up may be mounted between these two.

## Normal Circuitry

The usual circuitry fitted by guitar manufacturers is fairly elementary with perhaps just a volume control, tone control, and a pick-up change-over switch. The electronics enthusiast can easily improve such a guitar by juggling a little with the circuitry.

A warning must be given, though. Only solid guitars can be modified in

this manner. The semi-acoustic has its potentiometers and switches built-in when the instrument is made and they cannot, normally, be worked on without taking it to pieces. With most solid guitars one has the electronics mounted on a "chassis" which forms part of the top of the guitar and is usually made of plastic or Perspex. By slackening the strings and lifting out the bridge the "chassis" can be unscrewed and removed.

The next step is to work out the circuit diagram. The author's guitar is an early 3-pick-up solid, but the internal circuitry of current guitars is very similar. Fig. 1 shows the

circuit of the author's instrument before modification.  $S_1$  was the pick-up selector. In position 1 it selected the bridge pick-up, in position 2 it selected all three pick-ups, and in position 3 it selected the fingerboard pick-up. Each pick-up had its own volume and top cut control and  $S_2$  cut down the output for rhythm, i.e. chord, playing.

Fig. 2 is the circuit as modified by the writer. The place of  $S_1$  has been taken by three separate d.p.d.t. toggle switches (though rotary Yaxleys could be fitted, if preferred). These give the facility that makes all the difference—phase reversal. Normally, two pick-ups are connected in phase so that their fundamentals add together; this gives good bass but there is often a slightly "woolly" effect. A lead guitarist does not want a lot of bass, which is supplied by the bass guitar. The lead instrument should "stand out". By paralleling two pick-ups out of phase the fundamentals cancel out completely, leaving a tone lacking in bass but having an undeniable crispness. When the third pick-up is added, in or out of phase, the effect is even more marked and the number of possible pick-up selections rises very considerably. If toggle switches with a centre-off position are obtained and fitted, so much the better; easier selection is achieved.

In the modified circuit the volume control is retained for each pick-up, but most of the tone controls have changed. Top cut is left on the fingerboard pick-up but the bridge pick-up has variable bass cut instead, these controls emphasising the important elements in the respective pick-ups. (Paradoxically,

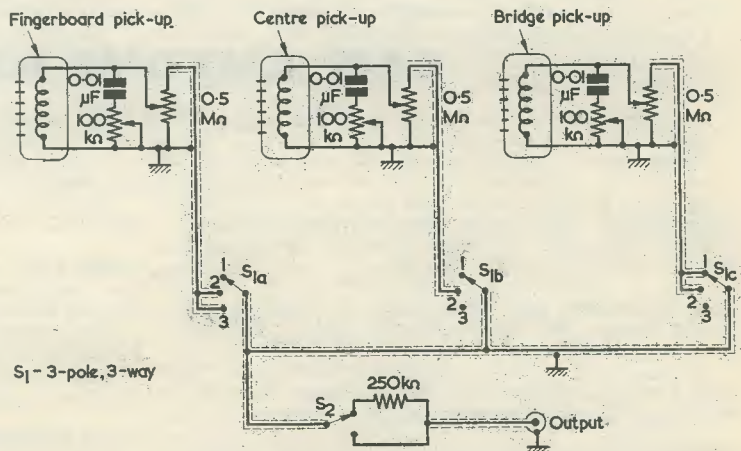


Fig. 1. The circuit originally employed in the author's guitar

the bass cut control will increase bass with phase reversal!)

Quick changes in output level can be made by  $S_7$ , which is one section of the old  $S_1$ . The resistor chain gives three useful volume levels which could be categorised as soft rhythm, pounding rhythm and lead.

The tone control has been removed from the centre pick-up, and a 6-position 2-pole Yaxley switch now controls the output. This provides three degrees of bass cut and two degrees of treble cut, and is especially useful for correcting undesirable amplifier characteristics.

A further possible modification (not shown in Fig. 2) consists of fitting a switch which causes all three pick-ups to be applied direct to the output socket. The idea behind having "all pick-ups full" is the production of distortion. If the guitar output is fed to a small transistor pre-amplifier before the main guitar amplifier, overloading of the first, high-sensitivity, stage of the main amplifier takes place with the full pick-up output, and the clean sound of the pick-ups with phase reversal and bass cut can be changed to a deep muddy roar as a special effect in some tunes. Owing to differences in amplifier and pick-up performance, this represents a change in the experimental category.

#### Practical Points

Making the holes for the new switches can be somewhat troublesome because the plastic panel to which they will be mounted may be brittle. With Perspex and similar materials an ordinary drill, which has a positive rake on

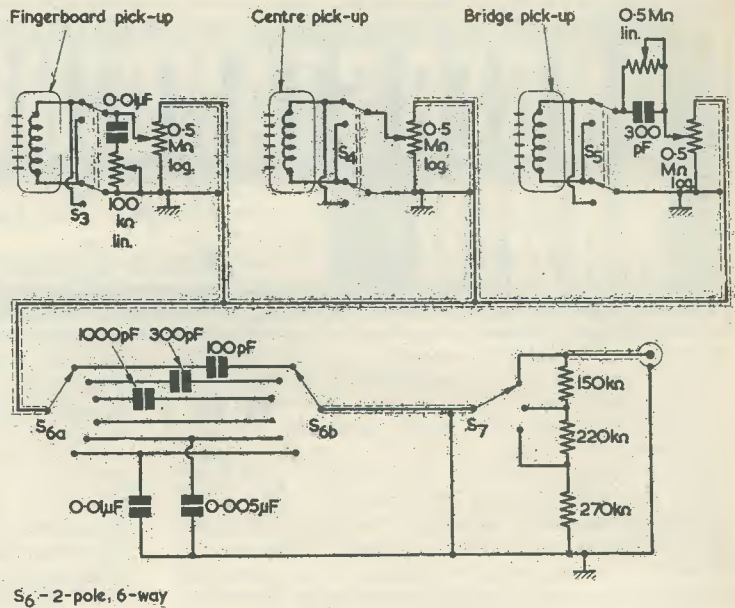


Fig. 2. The circuit after modification

its cutting edge, will tend to dig in and cause fracture. The plan employed by the author is, whilst using a drop of oil as lubricant, to drill a small hole (which will not fracture a large area of the material) then enlarge this with a tapered tool of square cross-section or by twisting a pair of tapered scissors.

The writer's guitar was fairly lavishly supplied with controls before modification, and space was no problem. But, on some guitars, little space may be available. In

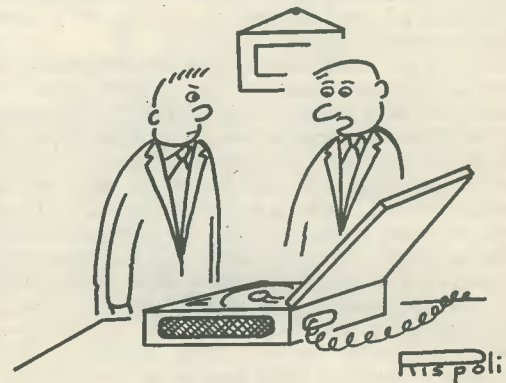
such a case it might be worth scrapping all the tone controls and replacing them with the phase reversal switches. Treble boost and bass cut control circuits may then be added to the guitar amplifier itself to achieve that crisp twangy sound so much sought after by lead guitarists.

Pick-ups differ, and it may be found that the best sound comes from a different set of component values. Remember, however, that a guitar sounds only as good as the amplifier it feeds. \*

## dca ELECTRONICS LTD CATALOGUE

dca Electronics Ltd. have pleasure in announcing their 1967 Electronics Catalogue, which is now available. This catalogue will comprise a wide range of component parts, kits, hi-fi equipment, valves, transistors and special services, etc., and is aimed at providing a time saving shopping medium, at highly competitive and in some cases much reduced prices. The catalogue will be available price 1s. from dca Electronics Ltd., 28 Uxbridge Road, Ealing, W.5.

## cartoonsmile

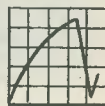


"Is he supposed to hum on that record, or is it the mains?"

# UNDERSTANDING RADIO

## Simple 3-Stage Radio Receiver

$$f = \frac{1}{2\pi\sqrt{LC}}$$



by W. G. Morley

IN LAST MONTH'S ARTICLE WE COMPLETED OUR description of the first constructional project which is intended to illustrate, in practice, the theoretical points which have been discussed previously in this series. This project was a general purpose power supply unit with a heater output at 6.3 volts and an h.t. output with a niminal voltage of 250.

In this month's issue we introduce a simple three-stage receiver which may be powered by the supply unit and which offers loudspeaker reception of signals on long waves, medium waves and on a short wave band ranging from some 5 to 15 Mc/s (60 to 20 metres). The description of the receiver's construction will be completed next month, after which the "Understanding Radio" articles will revert to technical matters for several issues in order to deal with r.f. (radio frequency) amplification. We will then recommence the constructional projects, the first of these being the addition of an r.f. amplifying stage to the receiver which is now to be described.

### The Receiver—General Points

Before commencing a detailed examination of the circuit of the receiver, a number of general points need to be raised.

As with the power supply unit which formed the previous constructional project, this receiver is constructed on a chassis made up from prefabricated Lektrokit chassis construction parts. This approach means that the metal-working required in construction is negligible, and that the major part of the work is devoted to wiring and soldering only. There is no necessity to bend panels, cut out valvholder holes or carry out any other of the somewhat tedious tasks which are involved in the preparation of a normal chassis. The use of Lektrokit chassis parts will be of particular advantage also to those who have limited metal-working facilities. With the present design a price has to be paid for this convenience, and the completed receiver is somewhat larger in size than would be given if it were

assembled on a chassis specifically designed for it. The only basic tools that are required are screw-driver, pliers, side-cutters, soldering iron and a small hacksaw to cut the potentiometer spindles to correct length. With the prototype, the author ran into a slight difficulty which involved the use of another tool. It was found that the tapped grub screw holes in the knobs specified had proud edges on the internal surface of the knob bush, whereupon these proud edges had to be taken off with a file before the knobs could be fitted on the control spindles. If the reader encounters the same difficulty he will also require a small round file capable of entering the knob bushes.

Other points applicable to Lektrokit chassis parts, and to general construction and wiring practice, were given in the preceding two articles, and need not be repeated here.

The receiver which forms the present constructional project is capable of providing good quality loudspeaker reproduction of local medium and long wave transmitters, together with entertainment value reproduction of the more powerful short wave transmitters. But it must be emphasised that station selection is achieved with the aid of a *single* tuned circuit only, and that, even though reaction is employed, the selectivity offered cannot possibly be as good as is given by the conventional superhet circuit employed in commercially made domestic receivers (and which, typically, has some five tuned circuits—some with critical coupling—to select the signal required). So far as the question of selectivity is concerned, it must be remembered that one reason for setting up the f.m. chain of stations in the U.K. was the difficulty of obtaining complete medium wave coverage over the country (with superhet receivers) due to interference from Continental transmitters. The sensitivity given with the present receiver depends mainly upon the aerial employed. In most localities acceptable results with local stations should be given with about eight yards of lighting flex "strung around the room" to act as an aerial, whilst longer and

more favourably-placed aerials will in some cases give improved results. With the prototype, the local medium wave and 1500 metre Light programme transmissions were received well and gave adequate volume at a pleasant quality level.

### The Circuit

The circuit of the receiver appears in Fig. 1, and it will be helpful to examine this by proceeding from right to left in the diagram.

The power supply connections are obtained by way of the octal plug. In the practical version this is fitted at the end of a 4-core flexible lead, and it plugs into the output octal socket in the power supply unit which formed the preceding constructional project. All the remaining components in Fig. 1 are mounted on the receiver chassis. The 6.3 volt heater consumption in the receiver is 0.75 amps (0.3 amps for  $V_1$  and 0.45 amps for  $V_2$ ) and the heater supply may be obtained from single pins in the octal plug. It will be recalled that the octal plug pins are rated at 1 amp maximum and that it is necessary to use two or more in parallel for currents above this figure. The actual octal plug pins employed here are 1 and 8.

In the power supply unit, pin 5 corresponds to h.t. negative and chassis, and it will be seen that, in Fig. 1, pin 5 connects to the chassis of the receiver. Thus, inserting the plug into the power supply socket enables an h.t. negative connection to be obtained and ensures that both chassis are connected together. Pin 4 connects to the h.t. positive output of the power supply unit. There is no smoothing capacitor in the power unit, and this

function is carried out by  $C_{11}$  in the receiver. Since  $C_{11}$  is also required to offer a low source impedance to the receiver circuits, it is fitted on the receiver chassis to enable short wiring to be provided to these circuits.

The a.f. output valve is  $V_2$  and this feeds into the loudspeaker via output transformer  $T_1$ .  $V_2$  is a beam tetrode and is a valve type which we have not yet considered in this series. For the present, we may say that it is a valve specifically designed to operate a loudspeaker when an a.f. signal from a voltage amplifier is applied to its grid. It was considered worthwhile incorporating this type of valve in the design, despite the fact that its operation has not yet been explained, because it enables good loudspeaker reproduction to be obtained despite the relative simplicity of the remainder of the circuit. We shall discuss the output transformer when we come to consider the components employed. The valve employed for  $V_2$  introduces some distortion, which results in the appearance in its anode circuit of spurious harmonics of the signal applied to its grid. These harmonics are largely second harmonic with an appreciable amount of third harmonic and, unless suitable precautions are taken, will result in an apparent "shrillness" of the reproduced sound. Reduction of this "shrillness" is achieved by connecting  $C_9$  and  $R_9$  in series across the primary of  $T_1$ . The reactance offered by  $C_9$ , and hence the impedance offered by  $C_9$  and  $R_9$  in series, reduces as frequency increases, with the result that the higher audio frequency currents tend to be partly bypassed by these two components. In consequence, the higher a.f.

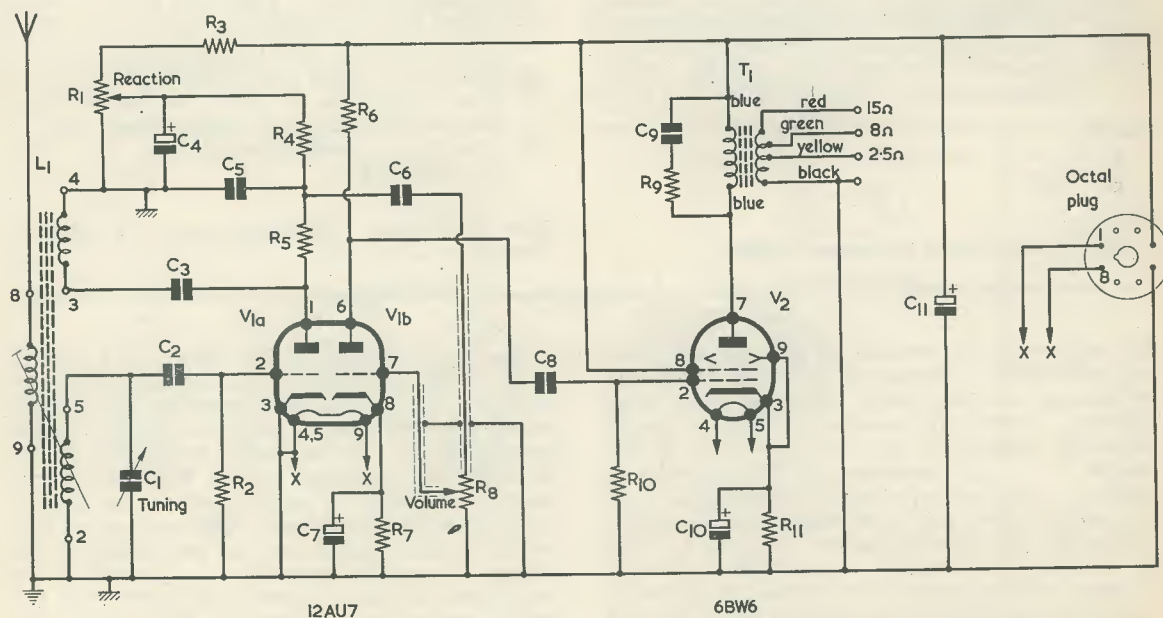


Fig. 1. The circuit diagram of the receiver. The three stages are given by a grid leak detector, an a.f. voltage amplifier and an a.f. output valve

## COMPONENTS

### Resistors

(All fixed values  $\frac{1}{4}$  watt 10% unless otherwise stated)

- R<sub>1</sub> 25k $\Omega$  potentiometer, carbon track, linear
- R<sub>2</sub> 1M $\Omega$
- R<sub>3</sub> 75k $\Omega$  1 watt
- R<sub>4</sub> 180k $\Omega$
- R<sub>5</sub> 10k $\Omega$
- R<sub>6</sub> 100k $\Omega$
- R<sub>7</sub> 3k $\Omega$
- R<sub>8</sub> 250k $\Omega$  potentiometer, carbon track, log
- R<sub>9</sub> 10k $\Omega$
- R<sub>10</sub> 470k $\Omega$
- R<sub>11</sub> 240 $\Omega$  1 watt

### Capacitors

(All fixed values 350V wkg. unless otherwise stated)

- C<sub>1</sub> 310pF, single or two-gang (see text)  
E. Gang variable capacitor, Cat. No. 4507  
(Jackson Bros. Ltd.)
- C<sub>2</sub> 100pF silver mica
- C<sub>3</sub> 50pF silver mica
- C<sub>4</sub> 2 $\mu$ F electrolytic, 150V wkg.
- C<sub>5</sub> 200pF silver mica or ceramic
- C<sub>6</sub> 0.01 $\mu$ F paper or plastic foil, 150V wkg.
- C<sub>7</sub> 12 $\mu$ F, 6V wkg.
- C<sub>8</sub> 0.01 $\mu$ F paper or plastic foil
- C<sub>9</sub> 0.005 $\mu$ F paper or plastic foil
- C<sub>10</sub> 25 $\mu$ F electrolytic, 25V wkg.
- C<sub>11</sub> 32 $\mu$ F electrolytic, wire-ended

### Inductors

- L<sub>1</sub> Miniature Dual Purpose Coil, Green, Ranges 1, 2 and 4, as required (Denco)
- T<sub>1</sub> Output transformer to match 5,000 $\Omega$  to speaker. Cat. No. T05 (Home Radio (Mitcham) Ltd.)

### Valves

- V<sub>1</sub> 12AU7 or ECC82
- V<sub>2</sub> 6BW6

### Sockets

- 3 B9A valveholders with centre spigots

### Screws, Nuts

- 42 6BA cheese- or binder-head screws,  $\frac{1}{4}$ in.
- 3 6BA cheese- or binder-head screws,  $\frac{3}{8}$ in.
- 3 6BA cheese- or binder-head screws,  $1\frac{1}{4}$ in.
- 48 6BA nuts
- 6 6BA washers

### Miscellaneous

- 1 Knob type K403, black (Bulgin). Cat. No. KN71 (Home Radio (Mitcham) Ltd.)
- 2 Knobs type K402, black (Bulgin). Cat. No. KN77 (Home Radio (Mitcham) Ltd.)
- 1 Tuning drive and scale. Tuning drive type 2154 fitted with "C" scale, Cat. No. 2154/C (Jackson Bros. Ltd.)
- 1 Barrier (Terminal) strip, 12-way 5 amp (Radiospares)
- 4 6BA solder tags
- 1  $\frac{1}{2}$ in. grommet
- 2ft. thin flexible screened lead
- 4-core flexible power cable
- Connecting wire, solder, etc.

### Lektrokit Chassis Parts

All Lektrokit parts are available from Home Radio (Mitcham) Ltd. Those marked with an asterisk (\*) are available in quantities of 10 or 12.

- 2 Side Plates No. 1. Part No. LK-301
- 2 Chassis Plates No. 1. Part No. LK-111
- 2 Chassis Plates No. 2. Part No. LK-121
- 2 Chassis Rails. Part No. LK-201
- \*4 Tagstrips 5-way. Part No. LK-2231
- \*6 Spacers No. 2.  $\frac{3}{8}$ in. Part No. LK-2521
- \*1 Plastic Clip No. 3. Part No. LK-2831 (or suitable alternative for securing power lead)
- \*5 Insulators, Lead-Through, No. 1. Part No. LK-2021

Note Radiospares components may be obtained through retailers only.

harmonics become attenuated and the subjective impression to the listener is that the "shrillness" is cleared and the overall response made more pleasing. Despite the somewhat rough-and-ready approach involved in the use of a filter of this nature, this circuit approach is very common in domestic reproducing equipment employing a single a.f. output valve, and it provides quite acceptable results for this class of service. R<sub>9</sub> and C<sub>9</sub> may be described as forming a *top-cut filter*, the term "top-cut" inferring that the higher (top) audio frequencies are attenuated. Top-cut filters working on a similar principle may be fitted at other points in an a.f. amplifier or in the a.f. amplifying stages of a receiver, if so desired.

The signal applied to the control grid (pin 2) of V<sub>2</sub> is obtained, via C<sub>8</sub>, from the anode of voltage amplifier V<sub>1(b)</sub>. Standard resistance-capacitance coupling is used here, as was described in "Understanding Radio" in the August 1965 issue. It will be noted that the anode load of V<sub>1(b)</sub>, R<sub>6</sub>, is connected to the same h.t. positive point as the primary of the speaker transformer. This method of connection is quite satisfactory in equipment of this nature. Smoothing capacitor C<sub>11</sub> presents a low impedance to audio frequencies across the h.t. supply connection common to both the valves, and reduces to a negligible level any unwanted coupling via this common connection. In domestic equipment which employs a single output valve

preceded by a triode voltage amplifier, it is very common practice to return both anode loads to the h.t. positive supply which is given immediately after the smoothing capacitor.

It may be added that if a further voltage amplifier were added, before  $V_{1(b)}$ , it would become desirable to incorporate an h.t. decoupling circuit as shown, in generalised form, in Fig. 2. In this diagram the output valve and the voltage amplifier which immediately precedes it are run from the same h.t. supply connection as before, whilst the added voltage amplifier has an h.t. supply which is decoupled from the smoothed h.t. supply by the decoupling components shown, these consisting of a resistor and capacitor. The capacitor has a relatively large value (of the order, usually, of 2 to  $12\mu\text{F}$ ) and offers a low impedance at a.f. The result is that any small changes at a.f. which may appear on the smoothed h.t. positive line, and which will be due to the output valve, are dropped across the resistor in the decoupling circuit and are not passed to the anode circuit of the added voltage amplifier.

$V_{1(b)}$ , in Fig. 1, is one half of a double-triode type 12AU7. This valve is also manufactured under the European coding ECC82, and either type may be employed in the receiver. A 12AU7 is chosen because it provides a triode, for the  $V_{1(a)}$  position, which functions satisfactorily in a grid leak detector circuit employing reaction.  $V_{1(b)}$  then become conveniently available as a voltage amplifier.

The signal to  $V_{1(b)}$  grid is taken from volume control  $R_8$ , which regulates the level of the a.f. signal provided by  $V_{1(a)}$ .  $R_8$  is a component having a log track<sup>1</sup>. It is necessary to employ a

potentiometer having a log track for the volume control because human perception of sound intensity judges changes in intensity along a geometric progression as being changes along an arithmetic progression. Thus, relative sound intensities in the progression 1: 2: 4: 8 are perceived, in terms of aural sensation, as changes in the progression 1: 2: 3: 4: The use of a volume control with a log track gives the subjective impression of smooth and gradual change in sound intensity as it is rotated, and it is standard practice to use volume controls of this type in a.f. amplifier circuits.

Fig. 1 shows that the wiring to the upper end of the track of  $R_8$ , and to its slider, is screened. The reason for this is that, in the practical version of the receiver, layout considerations require that fairly long leads are run to  $R_8$ . There is sufficient a.f. amplification after the grid of  $V_{1(b)}$  for any 50 c/s hum picked up by these leads (due to such possibilities as stray capacitive coupling to the heater wiring) to be reproduced at audible level by the loudspeaker. This capacitive coupling is prevented by the screening. Had the volume control been positioned close to the components to which it connects, and well away from heater wiring, the leads to its terminals need not have been screened.

### The Detector

$V_{1(a)}$  functions as a leaky-grid detector with reaction. The detected signal, in company with an amplified version of the r.f. signal applied to its grid, appears at  $V_{1(a)}$  anode, whereupon the filter given by  $C_3$ ,  $R_5$  and  $C_5$  ensures that negligible r.f. voltage appears at the junction of  $C_5$  and  $R_5$ . The a.f. signal appears across  $R_5$  and  $R_4$  in series, the component values being such that a high proportion of the a.f. appears across  $R_4$ . This a.f. signal is then applied, via  $C_6$ , to the volume control,  $R_8$ , and thence to the grid of  $V_{1(b)}$ .

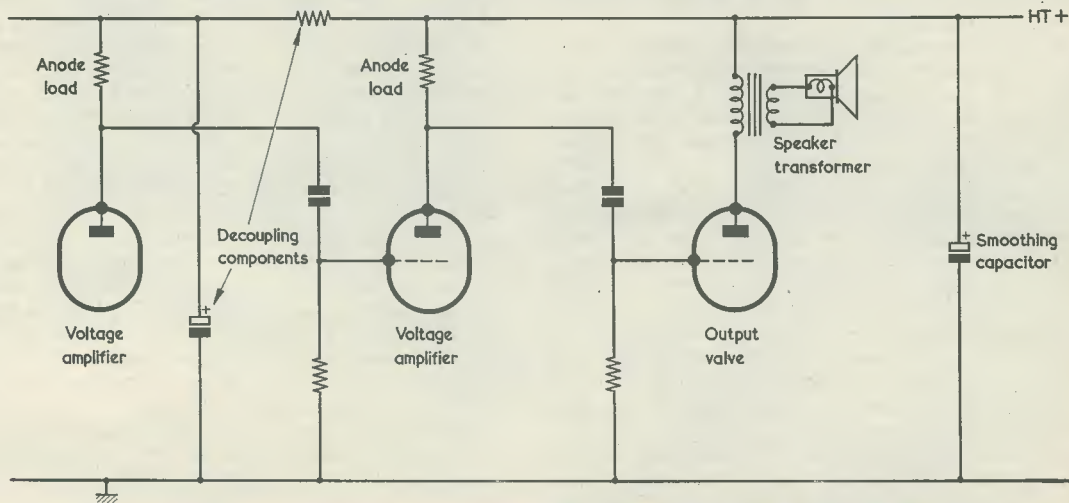


Fig. 2. In a simple a.f. amplifier it is possible for the speaker transformer primary and the anode load of the voltage amplifier which immediately precedes the output valve to be returned to the same section of the h.t. line. If a further voltage amplifier precedes the two valves just mentioned, decoupling components should be interposed in the h.t. supply to its anode load. In this simplified diagram, only anodes and control grids are shown in the valve envelopes

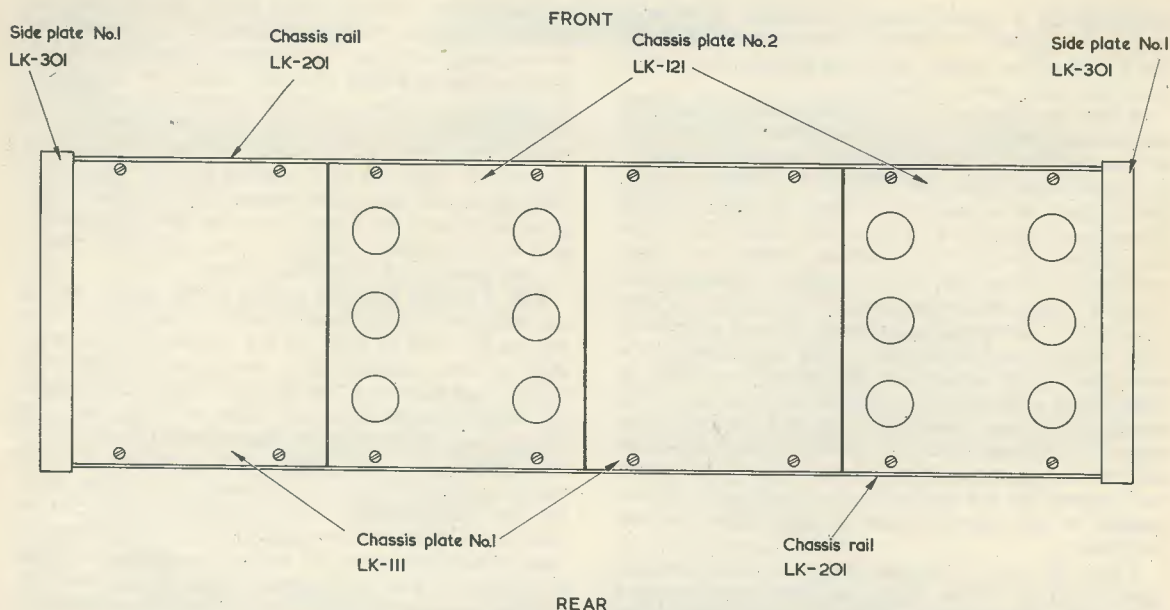


Fig. 3. The first step in construction. The chassis is assembled, using prefabricated Lektrokit components, in the manner shown in this view of the top

A control of reaction is provided by means of  $R_1$ , to whose slider the upper end of  $R_4$  is connected. If the circuit is examined it will be seen that the winding of  $L_1$  between terminals 2 and 5, together with  $C_1$  forms the tuned circuit, whilst the winding between terminals 3 and 4 provides a feedback winding which couples to the anode of  $V_{1(a)}$  via  $C_3$ . We thus have the circuit for a tuned grid oscillator.  $R_1$  may then be adjusted to provide the anode of  $V_{1(a)}$  with a voltage which is just below that needed to cause oscillation to occur, and  $R_1$  thereby functions as a reaction control.<sup>2</sup>

It will be noted that the reaction control circuit also provides decoupling for the anode load of  $V_{1(a)}$  along the lines illustrated in Fig. 2.  $R_3$  and the section of  $R_1$  track above the slider provides the series resistance, whilst  $C_4$  provides the bypass capacitance to chassis.

The reaction circuit of Fig. 1 was chosen, in preference to a circuit employing a variable reactance capacitor, because it offered the most consistent control over the fairly wide range of frequencies at which the receiver works and the various aeri-als with which it will be used. It suffers from the slight disadvantage that, at frequencies where only a low setting in  $R_1$  is required,  $V_{1(a)}$  offers a reduced level of a.f. amplification. However, it was felt that the provision of reliable reaction outweighed this disadvantage.

The aerial coupling coil is provided by the winding of  $L_1$  between terminals 8 and 9. An earth connection, to the receiver chassis, is also shown. However an earth connection is by no means essential in

practice, and the receiver may be operated with an aerial only.

#### Components

We have just referred to the various windings in coil  $L_1$ .  $L_1$  is a Denco Miniature Dual Purpose Coil, of the type which may either be wired permanently into a circuit or plugged into a B9A valveholder. In the present receiver the plug-in facility is employed, and the number references in Fig. 1 then apply to the valveholder pins into which the coil is inserted. Three coils may be used, the appropriate coil being plugged in for the tuning range required. The coils are intended for use with a tuning capacitor having a nominal value of 300pF<sup>3</sup>, whereupon a Range 1 coil is designed to cover the range of 150 to 500 kc/s (2,000 to 750 metres), a Range 2 coil to cover 515 to 1,545 kc/s (580 to 194 metres) and a Range 4 coil to cover 5 to 12 Mc/s (60 to 20 metres). It will be found, with the present receiver, that the high frequency end of each range extends slightly higher than the figures just quoted; this is due to the fact that these figures assume the presence of a trimming capacitor across the tuning capacitor, and a trimming capacitor is not included in the present design. Such a capacitor will, however be added when the r.f. stage, to be described in a later article in this series, is fitted.

Tuning capacitor  $C_1$  may be either a single-gang component or one section of a two-gang capacitor, as specified in the Components List. Readers who

<sup>3</sup> The actual tuning capacitance specified by Denco (including stray wiring capacitances, self-capacitance in the coil, and trimming capacitance) should vary from 39 to 352pF to provide the ranges quoted here.

<sup>2</sup> See "Understanding Radio" in the August 1966 issue.



do not intend adding the r.f. stage may fit the single gang capacitor. If the two-gang component is fitted, its unused section will be brought into circuit when the r.f. stage is added.

As may be seen from the accompanying photograph, a fairly large dial and drive assembly is used, the scale being calibrated from zero to 100, with space for further calibration by the constructor. Any other suitable slow motion drive and scale may be employed if the constructor so desires, but the one specified is particularly useful for tuning on the short wave band. It should be mentioned that it is supplied with a glass window and escutcheon which may not be employed in the present instance unless the constructor intends to house the receiver in a cabinet. It is also possible, of course, to use alternative knobs to those specified.

Output transformer  $T_1$  is a robust high-grade component which provides outputs at impedances of 2.5, 8 and 15 $\Omega$ . A 3 $\Omega$  speaker may be connected to the 2.5 $\Omega$  output. If it is desired to use an alternative speaker transformer, this should have a primary capable of passing 50mA and a turns ratio which allows a primary impedance of 5k $\Omega$  to be stepped down to the impedance of the speaker employed. The most usual speaker impedance likely to be employed is 3 $\Omega$ , whereupon the required turns ratio is equal to the square root of the impedance ratio,

viz.  $\sqrt{\frac{5000}{3}} = 40$  approx. A 40 : 1 transformer will therefore be adequate with a 3 $\Omega$  speaker<sup>4</sup>. The

<sup>4</sup> Impedance transformation and the required turns ratio was discussed in "Understanding Radio" in the July 1963 issue.

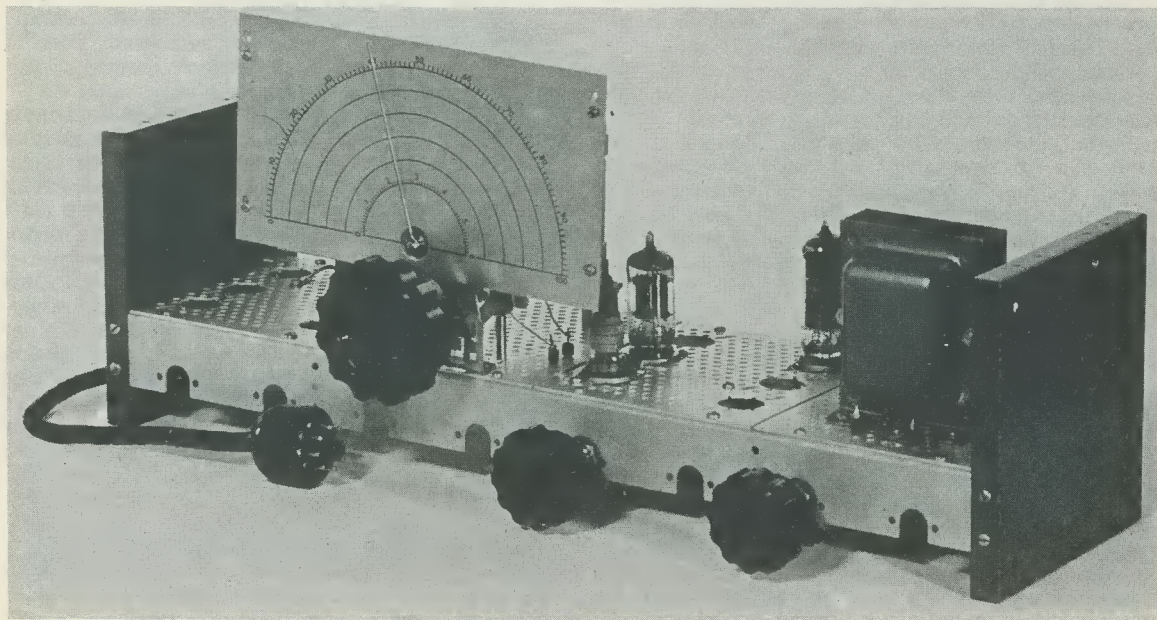
6BW6 employed in the  $V_2$  position is a B9A equivalent to the octal-based 6V6, and a transformer described as being suitable for use with a *single* 6V6<sub>5</sub> will also be suitable with the 6BW6.

Any speaker of the requisite impedance may be employed, but best results will be given by a fairly large speaker, say 6in. cone diameter or more, fitted in a cabinet of reasonable size to give good reproduction of bass frequencies.

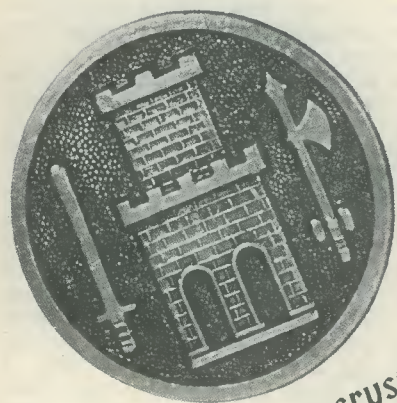
All the fixed resistors are  $\frac{1}{4}$  watt, with the exception of  $R_{11}$  and  $R_3$ .  $R_{11}$  has a value of 240 $\Omega$  and passes about 50mA with the consequence that, from  $P=I^2R$ , the power it dissipates is 0.6 watts. The 1 watt resistor specified gives a reasonable safety margin. The 75k $\Omega$  resistor,  $R_3$ , appears in series with the 25k $\Omega$  potentiometer,  $R_1$ , across the h.t. supply, which has a nominal value of 250. A current of 2.5mA flows through the total 100k $\Omega$  provided by those two resistors in series, whereupon dissipation in  $R_3$  becomes approximately 0.5 watt and dissipation in  $R_1$  becomes approximately 0.15 watt. In practice, dissipation in  $R_1$  will be a little higher than 0.5 watts due to the small anode current flowing in  $V_{1(a)}$  (which is limited by the high value of  $R_4$ ) and a 1 watt resistor is specified here. The dissipation in  $R_1$  is sufficiently low to enable a carbon track potentiometer of standard dimensions to be employed. A carbon track potentiometer will also give smoother control of voltage, and hence reaction, than some wirewound types.

<sup>5</sup> As opposed to two 6V6's in a push-pull circuit.

(continued on page 232)



A front view of the completed receiver. The section to the left of the tuning capacitor will, later, be used for an r.f. amplifying stage.



★ 100kc/s crystal oscillator

**ECH81**

**EF183**

**OA79**



## The Conway 4-Band Superhet

THE "CONWAY" superhet receiver is presented here for those readers who are emerging, as it were, from the t.r.f. stage of receiver construction and who wish to undertake a more advanced design. The ability to read, and correctly interpret, a circuit diagram is assumed, no point-to-point diagrams being given.

The design incorporates 5 valves of the B9A based type and a diode detector. The 100 kc/s crystal oscillator is, of course, optional but the writer considered its inclusion a worthwhile addition to the circuit, in that its use allows accurate alignment of the various band edges, etc.

The double-tuned i.f. stage (in  $V_2$  anode circuit) provides additional selectivity over that obtained from a single i.f. transformer. Nevertheless, IFT<sub>3</sub> could be dispensed with by those who do not consider the extra expense involved worthwhile, even though this is small. The complete design can therefore incorporate several alternatives according to the available cash or requirements of the intending constructor.

The "Conway" design is for a semi-communications type receiver covering the long, medium and two short wave bands. The specified wavelength coverage, when tuned by a variable capacitor having a 500pF "swing", is from 16 to 2,000 metres, but this coverage is altered slightly by the inclusion of bandsread capacitors. The individual ranges are: long wave, 800 to 2,000 metres (375 to 150 kc/s); medium wave, 194 to 550 metres (1.546 to 545 kc/s); short wave 1, 50 to 160 metres (6 to 1.85 Mc/s); and short wave 2, 16 to 50 metres (18.75 to 6 Mc/s). In practice, the actual frequency ranges obtained will be, as just mentioned, slightly lower in frequency than those quoted, this being due to the additional bandsread capacitors and the stray capacitances

introduced by their inclusion in the circuit. The loss of frequency coverage mainly occurs at the 18.75 Mc/s end of the highest frequency range and is not, in itself, of any great consequence. With a receiver of this type, and even if an extended range is provided, the use of a converter is generally preferable for best results at frequencies above 18 Mc/s or so.

All the components used in this receiver are modern types of the best quality and are currently obtainable on the market. It is not advisable to incorporate surplus items into a design of this nature.

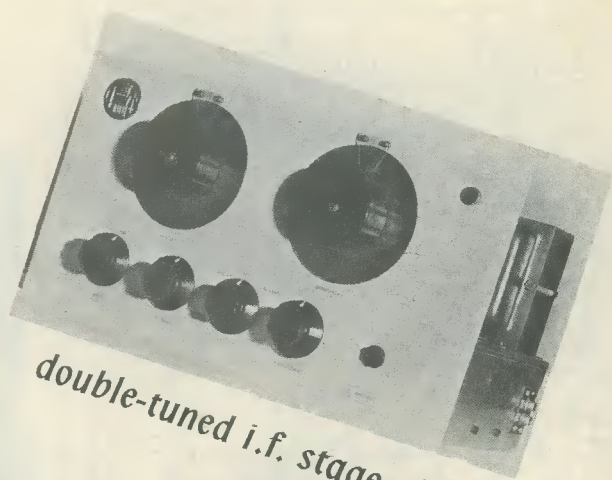
On the rear chassis apron, a power outlet supply socket has been included in order to provide supplies for a converter, where required, or for other ancillary equipment such as a pre-selector, etc. With the h.t. tap between R<sub>21</sub> and R<sub>22</sub> connected to pin 4 of the power outlet socket, as shown in the circuit diagram, a current of approximately 25mA at a voltage of 250 is available with the crystal oscillator switched out of circuit. The total power consumption of the receiver, under no-signal conditions (with the aerial disconnected and the function switch at a.m.) is 48mA at approximately 200V, the latter being the main h.t. line voltage. For those therefore who require a lower h.t. tap at the power outlet socket, this merely entails removing the outlet socket tap to the junction of R<sub>21</sub> and C<sub>22</sub>. The total rated output of the power supply is 75mA.

### Circuit

From the circuit diagram shown in Fig. 1, it will be seen that the receiver comprises an ECH81 frequency changer, EF183 i.f. amplifier, OA79 detector, ECL83 audio amplifier and power output EZ81 full-wave rectifier and an EF80 crystal oscillator.

## Cover Feature

### et Receiver 16-2,000 Metres



**ECL83**

**EZ81**

**EF80**



The colours of the various leads shown around  $V_1$  are those of the coilpack connections, yellow representing the coilpack chassis connection (see Fig. 5). Switch  $S_{1(a)}$ , (b), (c), (d) is fitted integrally with the coilpack, and only one coil is shown in the aerial and oscillator positions for reasons of clarity. There are, in fact, four coils in each position, these being selected by  $S_1$ .

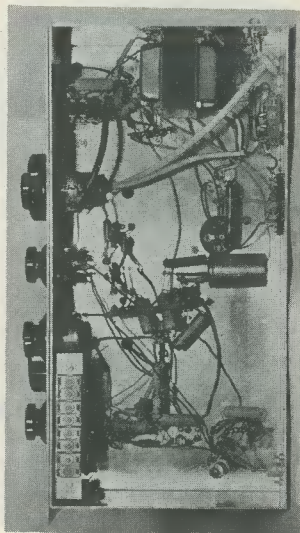
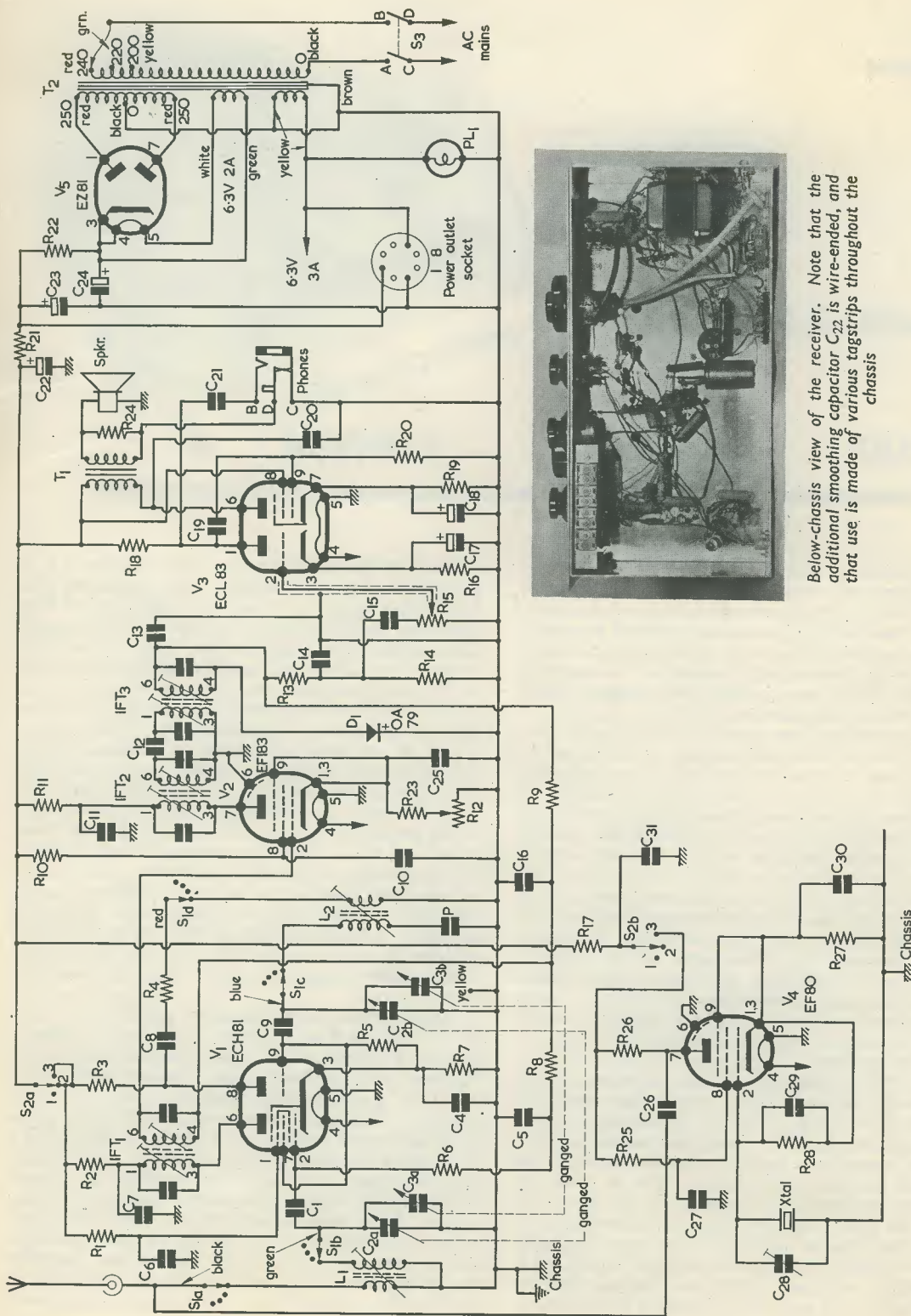
The signal from the aerial input socket is fed, via  $S_{1(a)}$ , to the selected primary winding of  $L_1$  and is then coupled to its secondary winding. This latter winding is tuned by the parallel band-set and bandspread capacitors ( $C_{2(a)}$  and  $C_{3(a)}$ ) the selected signal being passed to the control grid of  $V_1$  via the a.g.c. blocking capacitor  $C_1$ . Automatic gain control voltage is fed to this stage via the resistor  $R_6$  from the a.g.c. line. Grids 2 and 4 (pin 1) receive a positive potential via the resistor  $R_1$ , these grids being bypassed to chassis via the capacitor  $C_6$ . The anode of the heptode (pin 6) receives h.t. via the decoupling resistor  $R_2$  and the primary winding of  $IFT_1$ ,  $C_7$  being the bypass component to chassis. Grid 3 (pin 7) of the heptode is connected externally direct to the triode grid (pin 9).

The triode anode (pin 8) is connected to the h.t. line via the resistor  $R_3$ , and to the oscillator feedback coil via  $C_8$ ,  $R_4$  and switch  $S_{1(d)}$ . The triode grid obtains leaky-grid bias via the resistor  $R_5$ , this component being connected between the grid and the cathode (pin 3). Cathode bias for the heptode section is supplied by  $C_4$  and  $R_7$ . The triode grid tuned circuit is tuned by the band-set and bandspread variable capacitors  $C_{2(b)}$  and  $C_{3(b)}$  respectively, and the padder capacitor  $P$  (this latter component being an integral part of the coilpack), the grid being coupled to the tuned

circuit via the capacitor  $C_9$ . The resistor  $R_4$ , in the triode anode feedback circuit, ensures that optimum conversion conductance takes place over the entire frequency coverage without "squegging". The resultant i.f. signal is now passed, via  $IFT_1$ , to grid 1 (pin 2) of  $V_2$ . An a.g.c. voltage is supplied to  $V_2$  via the secondary winding of  $IFT_1$ .

The circuit of  $V_2$  incorporates an EF183 frame-grid variable-mu r.f. pentode, the high gain of which is taken advantage of to offset the slight insertion loss caused by the inclusion of  $IFT_3$ . This latter component is wired "back-to-back" with the more normally connected i.f. transformer  $IFT_2$ , top coupling being effected by the low-value capacitor  $C_{12}$ . With the method adopted here, a considerable degree of improvement with regard to selectivity is achieved at the least possible cost. Bias is provided via the components  $R_{23}$ ,  $R_{12}$  and  $C_{25}$ , this being made variable by the inclusion of the variable resistor  $R_{12}$ . With the circuit values shown,  $R_{12}$  effectively controls the gain of this stage.

An h.t. potential is applied to grid 2 of  $V_2$  (pin 8) by way of  $R_{10}$ , this being bypassed to chassis via the capacitor  $C_{10}$ . The anode supply is via the decoupling resistor  $R_{11}$  and the primary winding of  $IFT_2$ , their junction being bypassed to chassis via  $C_{11}$ . The internal screen of the EF183 (pin 6) is connected to chassis. The secondary of  $IFT_2$  is coupled into the primary of  $IFT_3$  via the top-coupling capacitor  $C_{12}$ . The amplified i.f. signal is next fed, via the secondary winding of  $IFT_3$ , to the diode detector and the r.f. filter comprised of the components  $R_{13}$ ,  $C_{13}$  and  $C_{14}$ , any residual r.f. present being bypassed to chassis. Resistor  $R_{14}$  is the diode load, the a.g.c. line being decoupled by  $R_8$ ,  $R_9$ ,  $C_5$  and  $C_{16}$ . The detected a.f. signal



Below-chassis view of the receiver. Note that the additional smoothing capacitor C<sub>22</sub> is wire-ended, and that use is made of various tagstrips throughout the chassis

Fig. 1. Circuit of the "Conway" receiver. Trimmer capacitors integral with the coilpack are not shown for reasons of clarity. Similarly, only one coil is shown in both the aerial and oscillator circuits

**COMPONENTS**

**Resistors**  
 (All  $\frac{1}{2}$  watt 10% unless otherwise stated)

R1 33k $\Omega$   
 R2 10k $\Omega$   
 R3 33k $\Omega$   
 R4 150 $\Omega$   
 R5 47k $\Omega$   
 R6 1M $\Omega$   
 R7 220 $\Omega$   
 R8 220k $\Omega$   
 R9 2.2M $\Omega$   
 R10 100k $\Omega$   
 R11 10k $\Omega$   
 R12 5k $\Omega$  pot. linear track  
 R13 22k $\Omega$   
 R14 270k $\Omega$   
 R15 1M $\Omega$  pot. log track (with S<sub>3</sub>)  
 R16 1.8k $\Omega$   
 R17 10k $\Omega$   
 R18 100k $\Omega$   
 R19 470 $\Omega$   
 R20 220k $\Omega$   
 R21 1.5k $\Omega$  5 watt  
 R22 1.5k $\Omega$  5 watt  
 R23 100 $\Omega$   
 R24 10 $\Omega$   
 R25 100k $\Omega$   
 R26 27k $\Omega$   
 R27 10k $\Omega$   
 R28 470k $\Omega$

**Capacitors**  
 (All fixed values 350V wkg. unless otherwise stated)

C<sub>1</sub> 100pF silver mica  
 C<sub>2a-b</sub> 500pF variable, 2-gang, (type ME Jackson Bros Ltd.)  
 C<sub>3a-b</sub> 27pF variable, 2-gang, (type U102 Jackson Bros Ltd.)  
 C<sub>4</sub> 0.01 $\mu$ F tubular (Mullard)  
 C<sub>5</sub> 0.01 $\mu$ F tubular (Mullard)  
 C<sub>6</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>7</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>8</sub> 200pF silver mica  
 C<sub>9</sub> 50pF silver mica  
 C<sub>10</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>11</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>12</sub> 5pF ceramic

C<sub>13</sub> 100pF silver mica  
 C<sub>14</sub> 100pF silver mica  
 C<sub>15</sub> 0.01 $\mu$ F, tubular (Mullard)  
 C<sub>16</sub> 0.01 $\mu$ F, tubular (Mullard)  
 C<sub>17</sub> 10 $\mu$ F, electrolytic, 12V wkg  
 C<sub>18</sub> 25 $\mu$ F, electrolytic, 25V wkg  
 C<sub>19</sub> 0.01 $\mu$ F, tubular (Mullard)  
 C<sub>20</sub> 0.01 $\mu$ F, tubular (Mullard)  
 C<sub>21</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>22</sub> 24 $\mu$ F, electrolytic, 450V wkg  
 C<sub>23</sub> 32 $\mu$ F, electrolytic, 450V wkg  
 C<sub>24</sub> 16 $\mu$ F, electrolytic, 450V wkg  
 C<sub>25</sub> 0.01 $\mu$ F, tubular  
 C<sub>26</sub> 2pF ceramic  
 C<sub>27</sub> 0.1 $\mu$ F, tubular (Mullard)  
 C<sub>28</sub> 3-30pF concentric trimmer  
 C<sub>29</sub> 100pF ceramic  
 C<sub>30</sub> 1,000pF ceramic  
 C<sub>31</sub> 0.01 $\mu$ F, tubular (Mullard)

\* 8+16pF contained in single can and "strapped".  
 † Contained in single can, complete with clip.

**Valves**  
 V<sub>1</sub> ECH81 (Mullard)  
 V<sub>2</sub> EF183 (Mullard)  
 V<sub>3</sub> ECL83 (Mullard)  
 V<sub>4</sub> EF80 (Mullard)  
 V<sub>5</sub> EZ81 (Mullard)

**Diode**  
 D<sub>1</sub> OA79 (Mullard)

**Valveholders**  
 5 B9A with centre spigots  
 (2 with skirt  
 and screening can)  
 1 B7G (for Xtal)  
 1 International Octal

**Inductors**

IFT<sub>1</sub> 465 kc/s (Denco type IFT11/465)  
 LFT<sub>2</sub> 465 kc/s (Denco type IFT11/465)  
 IFT<sub>3</sub> 465 kc/s (Denco type IFT11/465)  
 L<sub>1</sub>L<sub>2</sub> Coilpack type CP3F (Denco)

**Transformers**

T<sub>1</sub> Type 117E (H. L. Smith & Co, Ltd.)  
 T<sub>2</sub> Pri: 0-200-220-240V; Secs: 250-0-250V,  
 75mA; 6.3V (centre-tapped) 3A; 0-5-6.3V,  
 2A. Type 3104A (H. L. Smith & Co, Ltd.)

**Switches**

S<sub>1(a)</sub>, (b), (c), (d) Integral with coilpack  
 S<sub>2(a)</sub>, (b) 2-pole, 3-way  
 S<sub>3</sub> Integral with R<sub>15</sub>

**Speaker**

3 $\Omega$  impedance

**Phone Jack and Plug**

Igranic

**PL<sub>1</sub> Assembly**

6.3V, 0.3A (red) (H. L. Smith & Co., Ltd.)

**Chassis and Panel etc**

(H. L. Smith & Co., Ltd.)

**Dials**

2 Scale Ball Drive, type 4489 (Jackson Bros. Ltd.)

**Crystal**

100 kc/s vacuum mounted (Brookes Crystals Ltd.)

**Knobs**

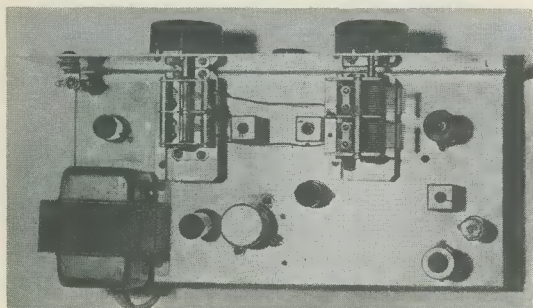
(H. L. Smith & Co., Ltd.)

**Tagstrips**

As required

**Miscellaneous**

Coaxial socket, speaker output socket strip, grommets, wire, nuts and bolts, wire etc.



The above-chassis view of the "Conway" receiver. At bottom, from left to right, are  $V_1$ , bandset capacitor,  $IFT_2$ ,  $IFT_3$ , bandspread capacitor,  $V_3$  and pilot light assembly. Left to right, above,  $IFT_1$ ,  $V_2$ , main smoothing capacitors  $C_{23}$ ,  $C_{24}$ ,  $V_5$  and mains transformer  $T_2$ . At the top left-hand corner are the vacuum mounted 100 kc/s crystal and  $V_4$

is now passed to the volume control  $R_{15}$ , via the d.c. blocking capacitor  $C_{15}$ .

The following stage,  $V_3$ , is constructed around the ECL83 triode pentode which functions firstly as an audio amplifier, given by the triode section, and secondly as a power amplifier, given by the pentode section. Cathode bias for the first section is supplied by way of the components  $R_{16}$  and  $C_{17}$  and for the pentode section by  $R_{19}$  and  $C_{18}$ .

Capacitor  $C_{21}$  connects the output of the triode anode to the headphone jack, this method being preferable to taking the headphone output direct from the anode of the pentode section. With the latter method, heavy bursts of audio may become painfully loud when operating the receiver at high gain across some of the broadcast bands. Capacitor  $C_{21}$  must be rated at 350V at least, in order to allow a margin of safety when the phones are in circuit. The insertion of the headphone plug into the jack automatically mutes the loudspeaker.

The amplified audio signal from the triode section is taken, via capacitor  $C_{19}$ , to the grid (pin 9) of the pentode section of the valve,  $R_{20}$  being the grid leak. Tone correction is obtained by including the capacitor  $C_{20}$  between the pentode anode and chassis. The resistor  $R_{24}$ , connected across the speaker transformer secondary winding, has been included in order to prevent high a.f. voltages appearing across the primary winding when the speaker is disconnected by inserting the phones into their socket.

The power supply stage, ( $V_5$ ), is built around an EZ81 full-wave rectifier having a double resistance/capacitance filter,  $R_{22}$ ,  $C_{23}$ ,  $C_{24}$  and  $R_{21}$ ,  $C_{22}$ . A pilot on/off indicator light,  $PL_1$ , is inserted between the 6.3V 3A line and chassis, the pilot lamp assembly being mounted on the front panel. The a.c. mains on/off switch is an integral part of the volume control  $R_{15}$ .

The 100 kc/s crystal filter stage,  $V_4$ , includes an EF80 in a Colpitts oscillator circuit and provision

is made for slight adjustment of the operating frequency by means of the pre-set capacitor  $C_{28}$ . The output from the oscillator stage is fed direct to the aerial input socket via the coupling capacitor  $C_{26}$ .

The function switch  $S_{2(a)}$ , (b) operates in the following manner. At position 1, (standby), no h.t. is applied either to the crystal oscillator or to the frequency changer  $V_1$ . At position 2, (a.m.), the crystal oscillator is inoperative whilst  $V_1$  is connected to the h.t. line. On position 3, (calibrate), the crystal oscillator is also switched on by connecting the h.t. potential to the anode circuit of  $V_4$  via  $S_{2(b)}$ .

The coilpack and i.f. transformers specified for this circuit are supplied pre-aligned and only small adjustments, to allow for the various stray capacitances, are required.

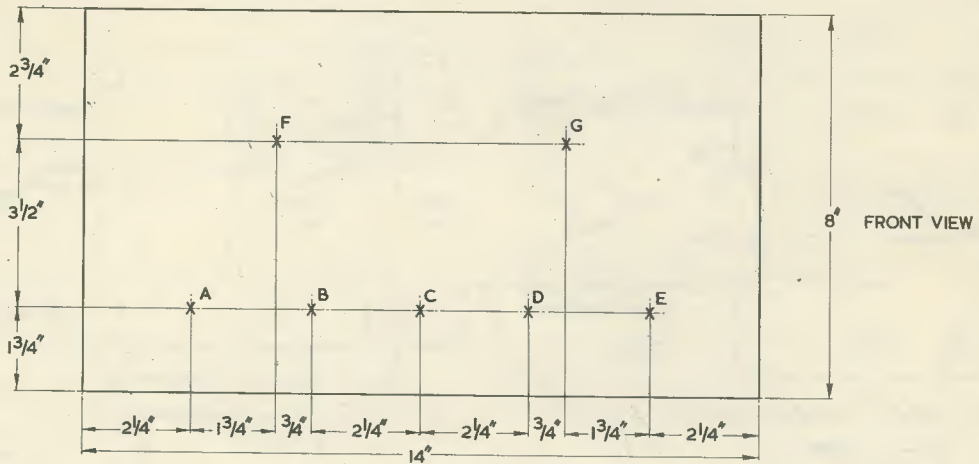
The front cover illustration shows the panel layout of the "Conway" receiver. The controls bottom left to right, are bandswitch, i.f. gain, function switch, audio gain and on/off, and phones. The left hand dial is that of the bandset and the right hand dial that of the bandspread capacitors. Top right is the pilot light on/off indicator assembly whilst to the top left is the "Conway" motif, the latter being obtainable at any Woolworth store button counter!

### Construction

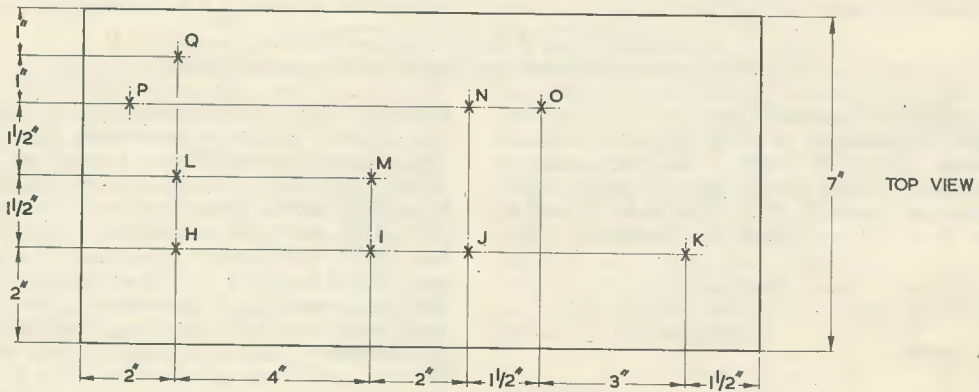
The front panel measurements are shown in Fig. 2 (a), the panel having an overall measurement of  $14 \times 8$  in. The holes marked A, B, C, D and E are all  $\frac{7}{16}$  in diameter. The first hole, A, is for the bandswitch, B is for the i.f. gain control, C is for the function switch, D is for the audio gain control and on/off switch, and E is for the phone jack. Holes F and G are for the bandset and bandspread spindles respectively and these should also be of  $\frac{7}{16}$  in diameter. Reference should be made to Fig. 2 (d) for the remainder of the drilling details required for these last two holes, so that the two dials may be fitted correctly at a later stage.

The pilot lamp assembly and the "Conway" motif drilling measurements are not given here, such details depending upon the actual types of fitment obtained. In the prototype, the pilot light assembly hole is positioned 1 in from the right hand edge of the panel and  $1\frac{1}{4}$  in down from the top of the panel, the hole being of a size to fit the assembly. The motif can, of course, be secured to the panel after it has been painted (or cellulosed) by means of one of the contact adhesives.

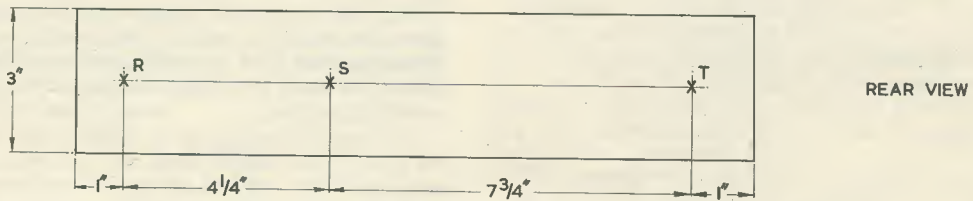
Having proceeded this far, the next step is to place the front panel against the chassis and clamp these two together in exactly their final positions. The two edges and bottom of both panel and chassis must be square and level. A centre-punch should now be used and a mark made in the centre of holes A to E. Remove the panel from the chassis and drill holes of the same diameter. The holes in the chassis should now coincide with those on



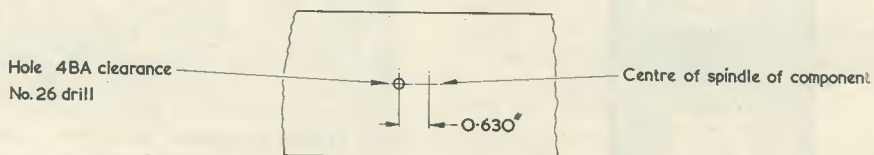
(a)



(b)



(c)



(d)

Fig. 2 (a). Panel drilling details. (See text)

(b). Chassis drilling details. (See text)

(c) Hole positions on the rear apron

(d). Drilling details for fitting the bandset and bandspread dials, together with their associated slow motion drives

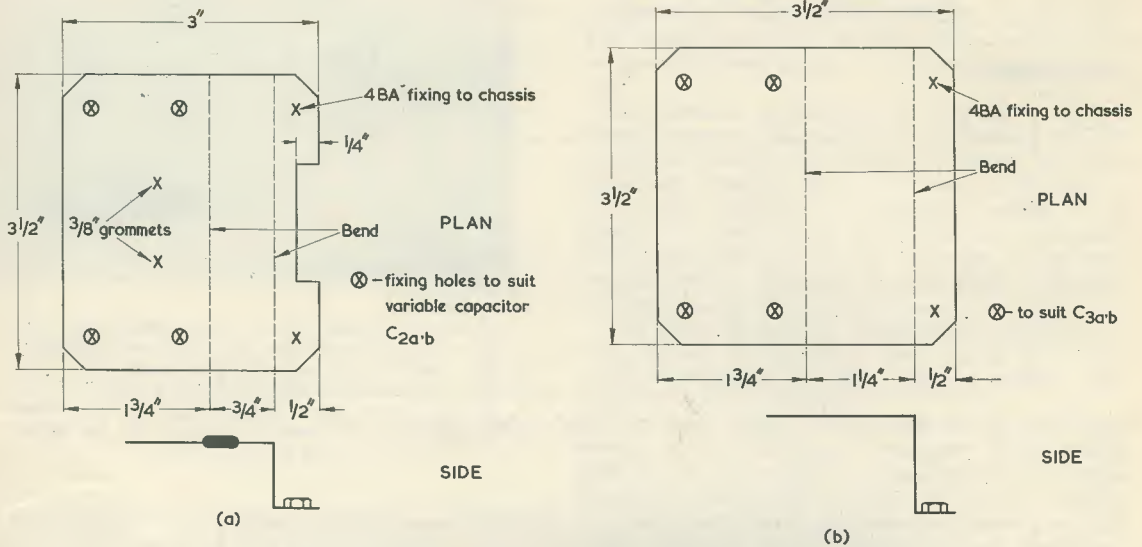


Fig. 3. Side and plan views of the aluminium platforms required for the (a) bandset two-gang capacitor and (b) bandspread two-gang capacitor

the panel, although a small amount of filing may probably be necessary in order to finally line up the chassis holes with those of the front panel.

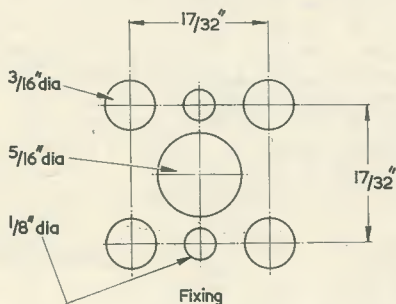
The main drilling details for the chassis deck are shown in Fig. 2(b). Holes H, K, M, O and Q are for  $V_1$ ,  $V_3$ ,  $V_2$ ,  $V_5$  and  $V_4$  respectively. The

holes for these valveholders have a diameter of  $\frac{3}{8}$  in. Hole N is for the smoothing dual-capacitor,  $C_{23}$ ,  $C_{24}$ , and should have a diameter of  $1\frac{1}{2}$  in. Holes I, J and L should next be marked, these being the centre holes for the i.f. transformers IFT<sub>2</sub>, IFT<sub>3</sub> and IFT<sub>1</sub> respectively. Drilling details for the i.f. transformers are shown in Fig. 4 and care should be taken by the constructor to ensure that the orientation of these transformers is correct with respect to pin numbers, bearing in mind the shortest possible routing of the connecting wires to anode and grid circuits. Hole P is for the crystal socket and should have a diameter of  $\frac{5}{8}$  in.

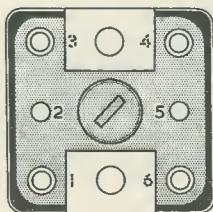
Fig. 2(c) shows the details for the chassis rear apron, holes R, S and T being for the a.c. mains inlet grommet ( $\frac{1}{2}$  in diameter), power outlet socket ( $1\frac{1}{2}$  in diameter) and aerial input socket ( $\frac{1}{2}$  in diameter) respectively.

The mains transformer  $T_2$  should next be placed on top of the chassis deck at rear right, and the required holes marked using the component itself as a template. Rubber grommets ( $\frac{1}{2}$  in diameter) will be required for the leads to be fed below the chassis deck. Similarly, the output transformer  $T_1$  should be used as a template on the chassis side apron. See illustrations for the positions of these latter two components. The speaker output Paxolin socket strip is also positioned on the chassis side apron, alongside the output transformer.

In order that both the bandset and bandspread capacitor spindles line up with the appropriate holes drilled in the front panel, these two components must be mounted on small platforms, details of which are given in Fig. 3 (a) and (b). The components themselves should be used as templates for marking the fixing holes, 4BA nuts,



(a)



Underside view

(b)

Fig. 4 (a). The i.f. transformer drilling details (b). Underside view of the i.f. transformers



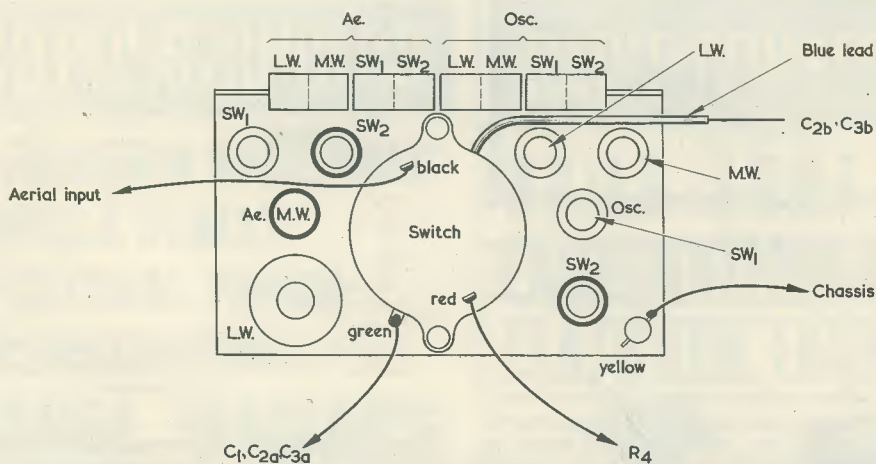


Fig. 5. Coilpack rear view showing the various connection points. Yellow is the coilpack earth, (connect to chassis); blue is the oscillator coil tuned circuit lead, via  $S_{1(c)}$ , (connect to  $C_{2(b)}$ ,  $C_{3(b)}$ , and  $C_9$ ); red is the oscillator coil feedback lead, via  $S_{1(d)}$ , (connect to  $R_4$ ); green is the lead from  $S_{1(b)}$ , (connect to  $C_1$ ,  $C_{2(a)}$  and  $C_{3(a)}$ ), and black is the lead from  $S_{1(a)}$ , (connect to aerial input socket and  $C_{2e}$ )

bolts and shakeproof washers being used for fixing purposes. Fig. 3 (a) shows that two small rubber grommets are required in the platform deck for  $C_{1(a)}$  (b) to take the two leads through to the underside of the chassis. Similarly positioned holes, with grommets, are needed in the main chassis also. On the right hand side of the metalwork shown in Fig. 3(a) there is a small cut-out section to allow for the mounting of the IFT<sub>2</sub> transformer and this cut-out should be  $\frac{1}{4}$  in deep. Once the drilling of these platforms has been completed, bend along the lines as shown so that the final form is as in the side elevation shown below each plan view.

With the drilling details now completed, it only remains for the main components to be mounted in position, the panel being secured to the chassis by means of the control bushes and nuts common to both items of metalwork. It should be noted that the valveholders for  $V_1$  and  $V_4$  are fitted with skirts and screening cans.

#### Wiring-up

The usual precautions with respect to wiring-up a design of this nature should be taken, and all wiring should be as short and direct as possible. Each valveholder centre spigot should be connected to an adjacent earthed solder tag and the valveholder for  $V_2$  should have a small metal

screen soldered across the holder in such a manner that the grid is effectively isolated from the anode, the screen itself being earthed to chassis. The screen may be cut from thin tinplate, being soldered to the centre spigot.

In the prototype, as may be seen from the illustration of the underside of the chassis, various sized tagstrips were used to accommodate most of the resistors and capacitors. The fixed vanes of the two variable capacitors are wired in parallel, with the wires passing direct from one to the other above the chassis deck.

#### Conclusion

Once the wiring, testing and alignment has been completed, the latter following standard procedure, the only remaining task is to finish the front panel by (a) cleaning with petrol, (b) applying two coats of quick drying enamel or cellulose in the preferred colour (c) fitting the dials and knobs and (d) applying the appropriate Panel Sign transfers—see front cover illustration.

The receiver will be found to perform very well over the entire frequency coverage and the later addition of a pre-selector as an external unit, together with the possibility of a b.f.o. stage included as a modification to the existing design, will provide the enthusiast with a basis for a listening station capable of giving endless hours of enjoyment and pleasure. \*

### DECODER UNIT FOR STEREOPHONIC BROADCASTS

Following the extension of stereophonic radio broadcasting by the B.B.C., Mullard is making available to set manufacturers a compact stereophonic decoder unit for incorporation in transistor receiver designs.

The unit, LP1167, the latest in the range of Mullard circuit modules, is fully-screened and requires only to be fed by a 14V power supply to give the necessary separation of the left and right channel information contained in the stereophonic signal. It is suitable for use with most types of ratio detector or similar circuits. The module has negligible insertion loss, very low noise and distortion; and may be left in circuit during normal monophonic reception.



## untuned r.f. pre-amplifier

by N. Fox

Our contributor, who lives in South Africa, gives details of an r.f. pre-amplifier which provides enhanced reception conditions on the short wave and broadcast bands

THE UNTUNED R.F. PRE-AMPLIFIER DESCRIBED here, and whose circuit is given in the accompanying diagram, took exactly fifteen minutes to assemble and about the same time to insert in the radio, which is a mains operated valve model with medium and short wave bands. The components are mounted on a 5-way tagboard which is bolted to the tuning capacitor near the frequency-changer.

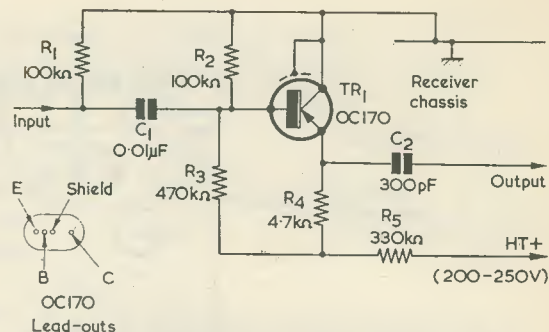
The input lead connects to the aerial socket, whilst the output lead connects to the aerial lug on the wavechange switch.

The writer has an indoor aerial slung across a room and, where he lives, is lucky if he can receive the three local stations with, possibly, a fourth at night. When the pre-amplifier was added, however, the entire 200 to 550 metre band came alive as, also, did the 40 to 120 metre band.

As will be seen, there are no tuning components in the circuit at all, and the transistor obtains its power from the h.t. supply in the receiver. None of the leads are screened.

### Editor's Note

When checked by ourselves on a receiver operating from a short aerial, the circuit caused a significant and useful increase in signal strength to be achieved. However, the amount of signal strength increase is liable to vary according to receiver aerial input couplings. If the receiver has a "bottom-end" aerial input



The circuit of the untuned r.f. pre-amplifier. This is inserted between the aerial and the receiver aerial input terminal

coupling circuit, it may prove helpful to increase  $C_2$  to around 5,000pF.

The voltage across the transistor is kept at a low level by the emitter current flowing through  $R_5$  and, in our circuit, with 225 volts applied, the voltage at the junction of  $R_4$  and  $R_5$  was 4 volts positive of chassis. To obviate the risk of accidentally damaging the transistor, due to incorrect wiring, etc., it is advisable to initially couple  $R_5$  to a positive voltage considerably lower than that of the receiver h.t. supply and check the voltage at the junction of  $R_4$  and  $R_5$ . This voltage should be read with a meter having a resistance of  $1M\Omega$  or more.

A practical difficulty which may not, at first sight, be apparent, is that if mains a.c. voltages of sufficient amplitude appear at the base of the transistor, these could cause emitter current to reduce on positive half-cycles and an excessive voltage to appear across the transistor. Such an eventuality could occur (in the worst case) if, with an a.c./d.c. receiver, the receiver chassis was at live mains potential and the aerial had a low leakage resistance to earth. This risk could be obviated by replacing  $R_1$  with an r.f. choke. The risk will not occur if the receiver chassis is reliably earthed. With long aerials,  $C_1$  should be reduced to around 1,000 or 500pF.



### UNDERSTANDING RADIO (continued from page 223)

The octal plug shown in Fig. 1 is, of course, part of the power supply unit with which the receiver is to be used.

It will be noted that six Lektrokrit Spacers No. 2 are specified in the Components List, and these may be spacers left over from the package required for the power supply unit. The same applies to the four tagstrips.

A final point concerning components has to do with the barrier (terminal) strip specified in the Components List. This is a moulded flexible polythene terminal block which may be cut into sections, as required, with a knife or small hacksaw. In the present design, 2-way and 4-way sections are employed for aerial and earth, and for speaker connections respectively, these being cut from the

12-way section. The 5 amp strip has fixing centres at 0.37in., which enable the 4-way section to be secured at two points to a Lektrokrit Chassis Plate. Incidentally, terminal strips of the same general type are readily available at quite low cost on the electrical counters of the popular stores.

### Chassis Assembly

The first step in assembling the receiver is to make the chassis. Fig. 3 gives a top view of the assembled chassis, and it will be seen that this consists of standard Lektrokrit parts. All fixing is by means of 6BA  $\frac{1}{4}$ in. screws and bolts. It should be mentioned that the Chassis Plate No. 2 at the right hand side in the diagram does not, with the present design, take any valveholders or major components. These will be fitted later when the r.f. stage is added.

### Next Month

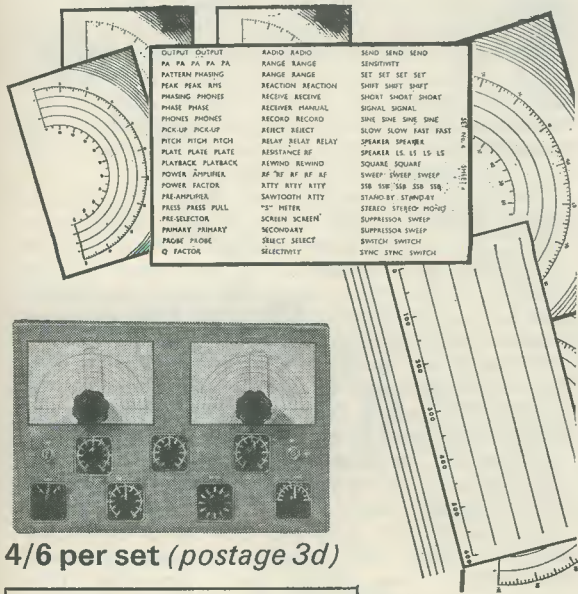
In next month's issue, we shall give full details of construction and wiring for the receiver.



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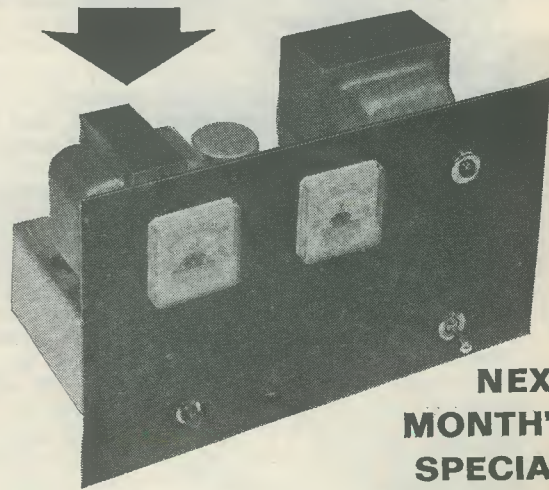
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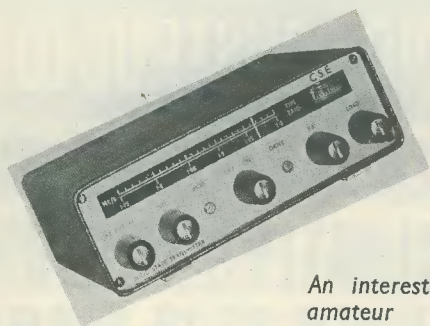
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## G.S.E. Communication Products



An interesting new series of fully transistorised amateur radio transmitting and receiving equipment.

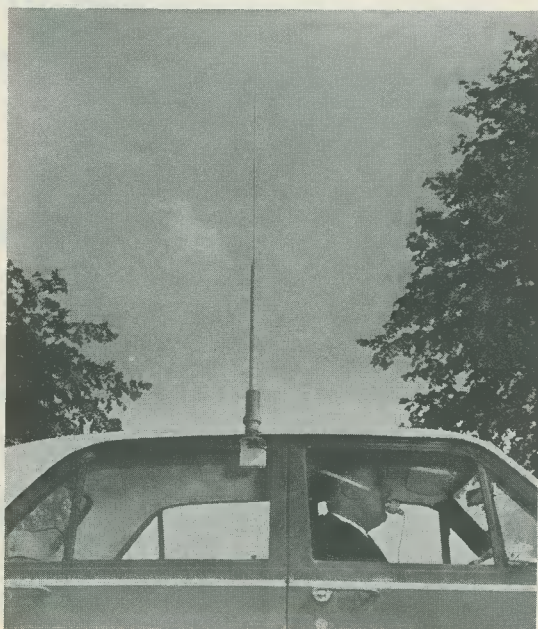
MUCH INTEREST HAS BEEN AROUSED AMONGST radio amateurs by the appearance on the market of a solid state transmitter suitable for mobile or fixed station use and the announcement of a matching receiver, both designed for use from a 12 volt source of direct current, and for operation in the "Top Band" channel of amateur radio transmission frequencies.

Produced by Contactor Switchgear (Electronics) Ltd; the C.S.E. 2A10 as it is designated, has a whole list of interesting features. As is natural with transistorised equipment, diminutive size is the first feature to catch the eye and as can be seen from our illustration, this is a really small, but well constructed unit, making it ideal for mobile and portable use. Despite its small size, it will easily produce the 10 watts input permitted on Top Band. The total drain of the C.S.E. 2A10 at 11 to 14 volts d.c. is just over 1 amp on a.m. and just under 1 amp on c.w. This is in very pleasing contrast to the many amps usually taken by similarly powered equipment

using valves, the low current consumption opening up a wide field of possibilities of new locations to be explored for portable use, which have hitherto been inaccessible because of heavy battery loads. Two very useful accessories are available; one being the MM2 microphone, specially designed to exclude extraneous noise and leave the hands free; the other being an integrally tuned, instant mounting mobile aerial, which provides an extremely efficient, r.f. radiator for the transmitter. There is to be a companion receiver released in the near future, the C.S.E. 2AR, and the two units will then complete a truly ideal installation for use in home, car, caravan, boat or rucksack—in the latter case operation being possible from two 6 volt lantern type batteries or the new Ever-Ready TV1 12 volt pack.

On test, the transmitter has proved to be sufficiently stable to work other stations using s.s.b. gear. C.W. contacts have been made from the centre of England with Scotland and the Channel Islands from a stationary car using the aerial mentioned, and a.m. contacts have been made from the same location with stations on the South Coast regularly. An interesting feature is that the design is such that overmodulation is impossible and when displayed on a c.r.t., the r.f., a.f. and modulation envelopes are seen to be strictly sinusoidal.

Contactor Switchgear Electronics are to be congratulated on having persevered in developing this equipment, which sets a new fashion in amateur radio transmitting gear and puts at a reasonable price, the latest techniques in transmitting within the reach of any amateur radio operator. Our regular readers will know that we have been to the fore in this magazine in describing transistorised gear both for the home constructor and of a commercial nature, and also we are keen advocates of the full use of the Top Band amateur frequencies. We are therefore very pleased to have the opportunity of describing this equipment to our readers, which we can thoroughly recommend to any who wish to equip themselves, either for home use or for portable or mobile operation, with the most modern equipment in the field of amateur radio transmitting. Further details and prices can be obtained from Contactor Switchgear (Electronics) Ltd., Moorfield Road, Wolverhampton, Staffs, mentioning this magazine. ★



# In Your Workshop

As we are reminded from time to time there is, despite the present preoccupation with transistor receivers, a lively interest in bringing the earlier a.m. valve mains radios up to full working order. These receivers are capable of very good results and, this month, Smithy discusses some simple modifications which can often result in an even better performance

"DID YOU HEAR," ASKED DICK, about the chap who couldn't tell putty from margarine?"

"No I didn't," answered Smithy.

"What happened to him?"

"His windows fell out!"

"I do not," commented Smithy, "wish to know that. Kindly leave the Workshop."

A contemplative silence fell on the pair.

"I only wish I could," said Dick after some moments.

"Could what?"

"Leave the Workshop," replied Dick irritably. "Dash it all, Smithy, we've been sitting here twiddling our thumbs and doing nothing for over quarter of an hour now."

"That's the way it goes in this game, my boy," said Smithy. "Sometimes it's all rush and sometimes it's dead quiet. Before you know what's happening, the van will be round with another load of sets and you'll then be grumbling because you've got too much to do."

## Valve Radios

"Perhaps you're right," conceded Dick. "Anyway, it looks as though I'll be doing more work at home this evening than I've been doing here during the day."

"How come?"

"One of my aunts has presented me with an old long, medium and short wave mains radio," replied Dick, "and I'm going to do it up a bit. She says it's worn-out, but I should think there'll be plenty of life left in it if I give it a good old going-over."

"Very probably," agreed Smithy. "Incidentally, it's funny that you should raise the subject because I get quite a lot of queries on these

older valve a.m. radios. The non-technical types seem to think that, because they use valves instead of transistors, they can't give as good a performance. In practice, a well-designed four-plus-one superhet can give a performance which is better than quite a few of the transistor a.m. radios that are knocking about these days."

"Four-plus-one?"

"Four-plus-one," repeated Smithy. "The design of valve a.m. radios stabilised after the war into a line-up which consisted of four valves plus the rectifier, and the sets acquired the name 'four-plus-one' as a result. The general line-up in these receivers is frequency changer, i.f. amplifier, double-diode-triode and output pentode. Plus the rectifier. (Fig. 1 (a)). The frequency-changer is usually a triode-heptode of the ECH81 type, whilst the i.f. amplifier is a straightforward variably-mu r.f. pentode. The diodes of the double-diode-triode give signal and a.g.c. detection whilst the triode section acts as a.f. voltage amplifier feeding the output pentode. A dead simple line-up, and one that works jolly well, too."

"Didn't some of the later sets," queried Dick, "have a triode-pentode for a.f. amplification?"

"That's right," agreed Smithy.

"When triode-pentodes like the ECL82 appeared on the scene, largely as a result of their introduction for TV sets, they were also employed in a.m. radios. The usual line-up then has three valves plus the rectifier, instead of the earlier four valves. There's a frequency-changer, as before, this being followed by a double-diode-pentode of the EBF89 class. A variable-mu r.f. pentode provides the pentode section, and the two diodes give signal and a.g.c. detection. The third valve is the triode-pentode, the triode of which acts as a.f. voltage amplifier, whilst the pentode functions as output valve." (Fig. 1 (b)).

"Whenever I think of these triode-pentodes," said Dick, "I always seem to identify them with the vertical timebase and output circuits of TV sets."

"That's because those are the circuits," replied Smithy, "in which they require most frequent replacement. The pentode section loses emission and you get insufficient vertical scan. A triode-pentode which doesn't give sufficient vertical scan will still give quite good results in an a.f. amplifier circuit, though, because the operating conditions are not so stringent."

"Fair enough," commented Dick.



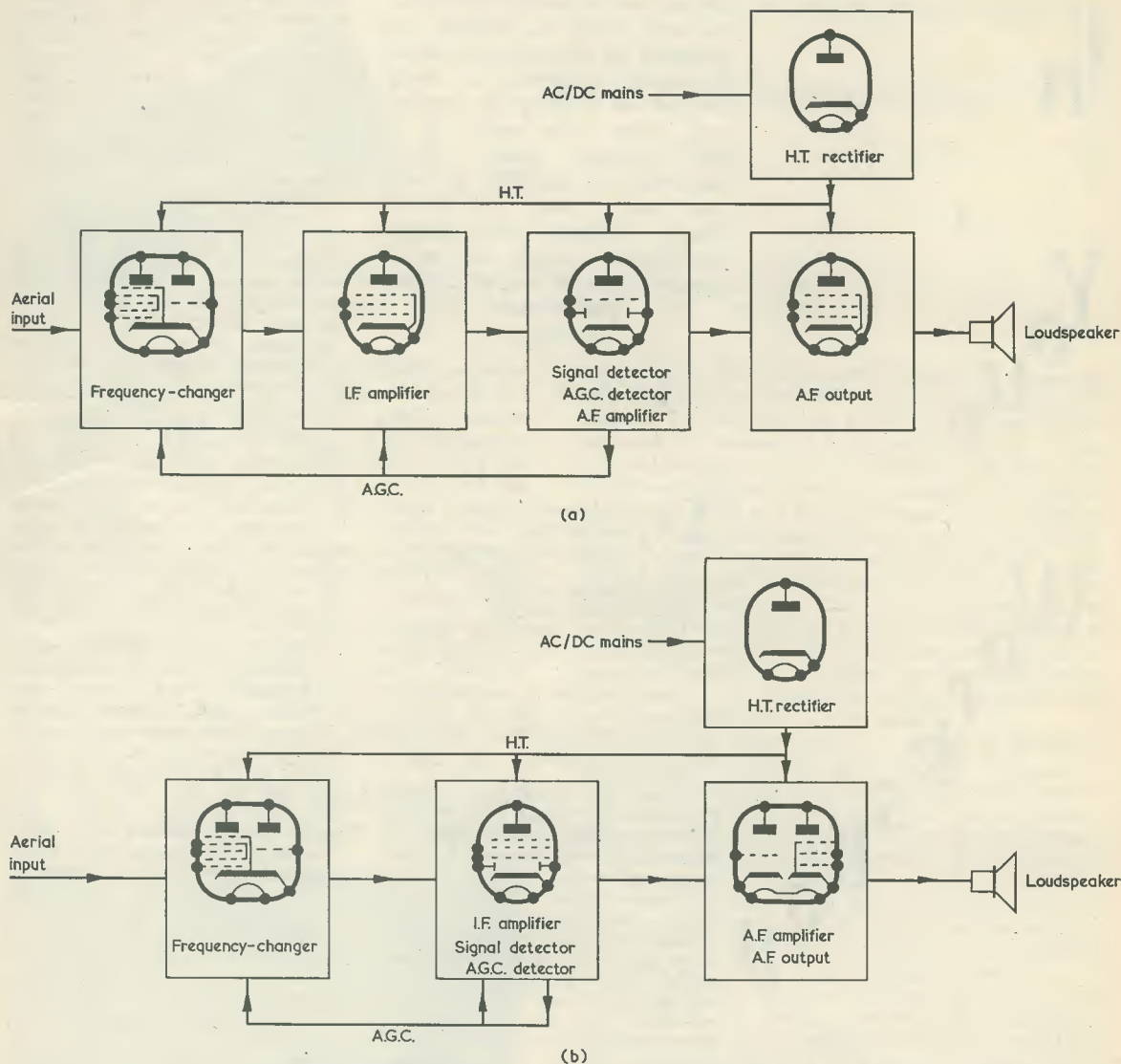


Fig. 1 (a). The general line-up of a conventional "four-plus-one" radio receiver  
 (b). The use of a triode-pentode in the a.f. stages allows a line-up of the type shown here to be employed. The a.g.c. voltage developed at the a.g.c. detector is applied to the i.f. pentode in the same "block"

"Well, it looks as though I'll have a pretty easy job getting this old set of my aunt's working properly."

"You shouldn't have too much trouble," agreed Smithy. "Nearly all the post-war a.m. mains radios had quite simple circuits whereupon, if you're going to give them an overhaul, the obvious things to look for are dried-out electrolytics, leaky grid coupling capacitors in the a.f. section, scratchy volume controls, and things like that.

What will probably be of more interest to you is that you can quite often improve their performance by carrying out a few mods here and there. Such mods are mainly applicable to sets made before printed circuits were introduced because wiring changes are involved, and I must hasten to add that you want to get the set in full working order before you start carrying them out. There's no point in making changes to a set which isn't working

properly."

#### Modifications

"I see your point," commented Dick. "What sort of mods do you have in mind?"

"To start off with," said Smithy, "one of the weaknesses of these sets is that the anode circuits of the frequency-changer heptode, i.f. amplifier and triode voltage amplifier are all bypassed to chassis by a single electrolytic capacitor, which

also functions as smoothing capacitor. The output valve screen-grid will also be returned to this capacitor and, sometimes, the output valve anode as well. (Fig. 2 (a)). More frequently, the output anode will be returned to a point in the smoothing circuit which is closer to the rectifier cathode, whereupon an output transformer with a tapped primary is often used. (Fig. 2 (b)). This tapped primary ensures that any ripple current present flows to the output anode in one direction and

to the remainder of the receiver in the other direction, whereupon two opposing fields are set up in the output transformer and largely cancel out the ripple applied to the speaker. However, I don't want to deal with the a.f. side for the moment, as the first modification I want to talk about is in the i.f. section."

Smithy settled himself more comfortably on his stool.

"To get really good results from an a.m. radio," he continued, "you

want an i.f. response that is nice and symmetrical on either side of the centre frequency. Now, the single bypass capacitor across the h.t. lines is bound to offer some impedance at i.f., especially when you remember that it's an electrolytic capacitor. There will also be some impedance offered by the wiring in the h.t. circuit between the i.f. transformers and this capacitor. All this means is that there's a common impedance in both i.f. transformer primary circuits, where-

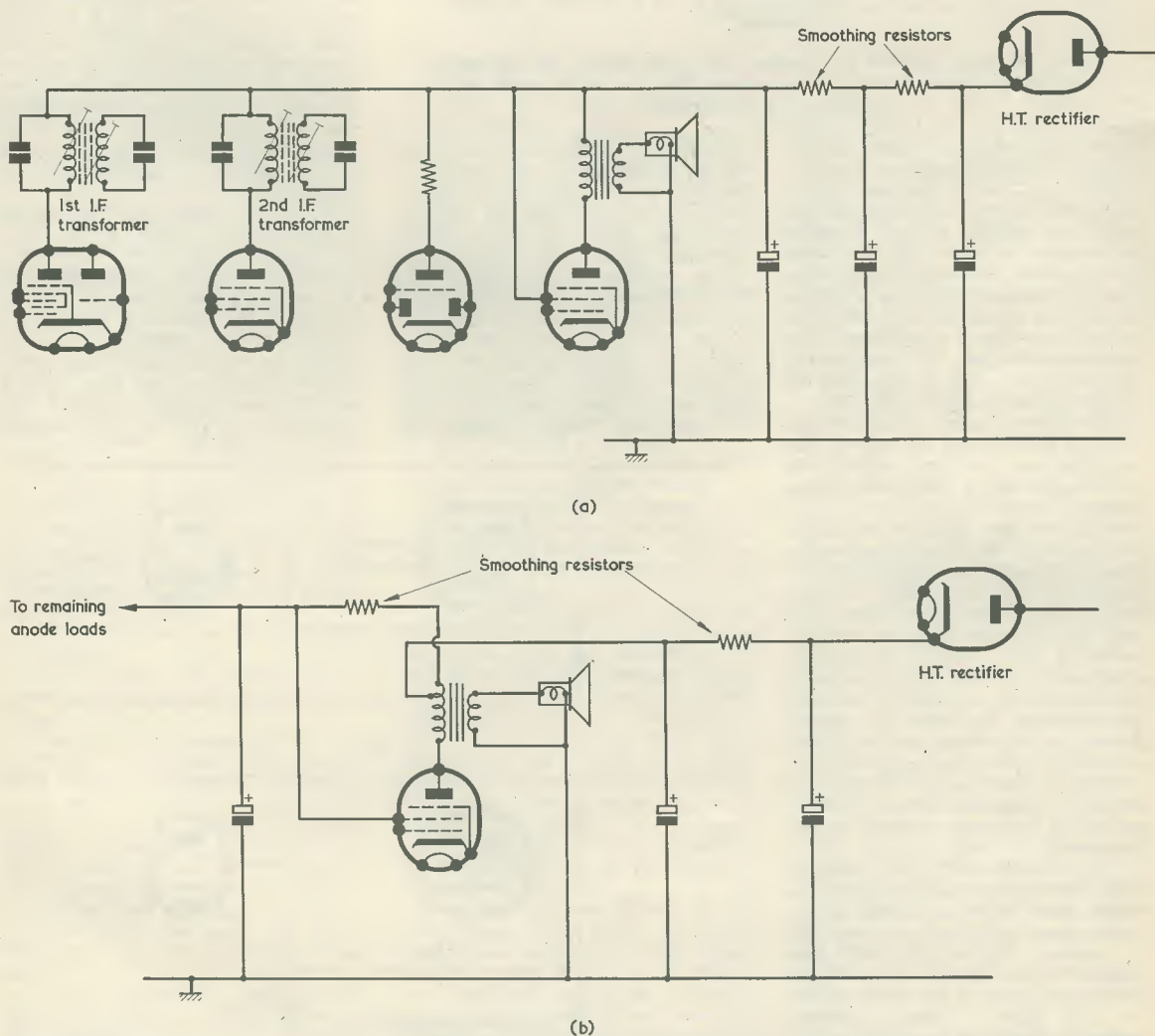


Fig. 2 (a). In a valve a.m. superhet it is conventional practice to return the first and second i.f. transformer primaries, the a.f. voltage amplifier anode load resistor, the output valve screen-grid and the speaker transformer primary to a common bypass capacitor. This is the left-hand smoothing capacitor shown here. A single resistor and two electrolytic capacitors may also be encountered

(b). Very frequently, the anode of the output valve is coupled to a point in the h.t. filter closer to the rectifier than the remaining anode loads. If a single smoothing resistor is used, as in Fig. 7 (a), the output anode may connect directly to the rectifier cathode

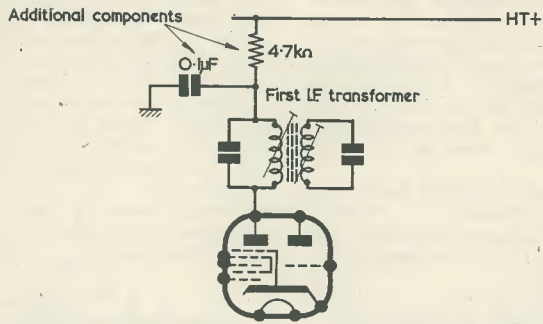


Fig. 3. In some receivers an improved i.f. response may be obtained by inserting additional decoupling components in the anode circuit of the frequency-changer heptode

upon some feedback must occur. If the common impedance is sufficiently high, this feedback could affect the overall i.f. response and make it difficult to get a really symmetrical curve. The first mod obviates the common impedance, and it consists of putting a simple decoupling circuit in series with the h.t. feed to the heptode section of the frequency-changer. A resistor of around  $4.7k\Omega$  and a capacitor of  $0.1\mu F$  will do the trick." (Fig. 3.)

"In other words," said Dick, "you're adding just the sort of decoupling that you'd get, say, in the i.f. stages of a communications receiver."

"That's the idea," confirmed Smithy. "I can't guarantee any significant improvement in i.f. response by the addition of this decoupling circuit, because the original performance depends on the value of the common impedance presented by the electrolytic smoothing capacitor and the h.t. wiring. Nevertheless, the mod can do no harm and, in some sets, it may result in a noticeable improvement."

"Won't the added decoupling resistor," objected Dick, "cause a reduction in anode voltage to the heptode?"

"It's bound to," said Smithy. "But the heptode anode only passes about 3mA under no-signal conditions when minimum a.g.c. voltage is present. So you'll only lose some 15 volts from an h.t. line which will normally be of the order of 200 to 250 volts. There's another dodge of the same type, too, which you can try out in sets where the screen-grids of the i.f. pentode and the frequency-changer are connected together." (Fig. 4 (a)).

"Hey?" interposed Dick. "This is a new one on me!"

"It shouldn't be," chuckled Smithy. "It's a very common circuit

technique. The screen-grids share a single dropping resistor from h.t. positive and a single bypass capacitor. It's worth trying the effect of inserting a second decoupling circuit between these two screen-grids, using another  $4.7k\Omega$  resistor and  $0.1\mu F$  capacitor. (Fig. 4 (b)). The common dropping resistor still goes direct to the heptode screen-grid, and the  $4.7k\Omega$  resistor is then inserted between this screen-grid and that of the i.f. pentode. There are now two bypass capacitors and

these should connect to their respective screen-grids and to chassis by short wiring. Incidentally, the additional  $4.7k\Omega$  is inserted in series with the screen-grid of the i.f. valve because that is the screen-grid which draws less current."

"I'll definitely have to try out these mods," said Dick. "It looks as though I'm going to have quite a busy evening."

"I think," warned Smithy, "that I'd better repeat what I said earlier on. Don't try any mods before you've got the set in normal working order. And don't forget that the two decoupling mods I've just mentioned aren't guaranteed to effect an improvement in i.f. response. Nevertheless, they do make the i.f. decoupling a little more respectable, whereupon there is a better chance of getting a good response."

"Can I," asked Dick, "borrow the signal genny tonight?"

"What for?"

"To line up the i.f. transformers in this set I'm going to fix."

"You can take it if you like," replied Smithy carelessly. "But it's pretty easy to do the i.f. alignment, after the mods have been carried out, with received signals. This assumes that the i.f. transformers

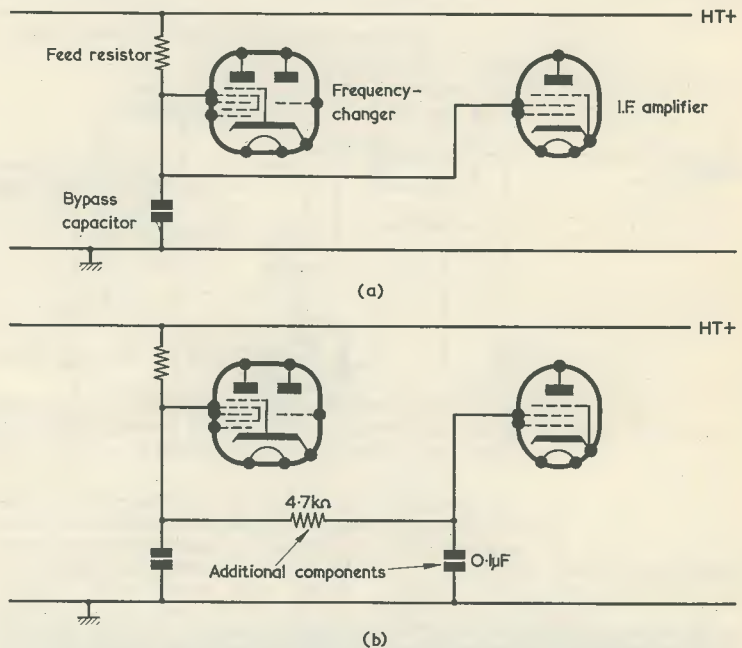


Fig. 4 (a). A common technique consists of supplying the screen-grids of the frequency-changer heptode and i.f. pentode by way of a single feed resistor and bypass capacitor. A typical value for the common feed resistor is  $22k\Omega$ , and  $0.1\mu F$  for the bypass capacitor

(b). Adding a decoupling circuit between the two screen-grids



are already on, or very near to, their correct frequency. What you do initially is to turn the volume up to full, find a station on medium or long waves that's just barely audible and tune it in accurately. You should then be putting a signal into the i.f. transformers which is either on, or close to, their correct frequency. All that remains is to give a final little trim-up by adjusting the transformers for maximum level of the weak signal. You can get an idea of the response curve which results from this process by next tuning in the Light Programme on 1500 metres and rocking the tuning capacitor on either side of the signal. Any serious asymmetry in the i.f. response will stick out a mile."

### Reduced Warm-Up Time

"I can't help but get the impression," offered Dick artlessly, "that you must have had some slight experience of lining up a.m. radios in the past. And particularly without a signal genny."

"Slight experience?" snorted Smythy, outraged. "Slight experience? Blimey, Dick, I've lined up more a.m. radios without benefit of a signal generator than you've had hot dinners!"

A sudden thought diverted Smythy's mind from the affront.

"Talking of hot dinners," he continued, "has just reminded me of something. How is it that you're staying in this evening working on that old radio, instead of going down to Joe's Caff with your mates, as you usually do?"

Dick's face took on an expression of disgust.

"Joe's Caff?" he replied. "Oh, we've given that place up for good now."

"Why, what's happened?"

"Well," said Dick, "you know he's always changing it round, don't you?"

"Is he still doing that?" queried Smythy. "The last I heard was that he'd converted it to a Chinese Restaurant and was calling it 'The Mandarin's Noshers.'"

"That was ages ago. It's gone through three more changes since then."

"This," remarked Smythy, "is quite fascinating. 'What was the first change?'"

"Well, that," admitted Dick grudgingly, "wasn't too bad. He dreamed up the idea of making it into a discothèque and so he got in an old wind-up gramophone and a pile of records of Carol Gibbons and the Savoy Orpheans, and he called it 'The Swinging Stylus.'"

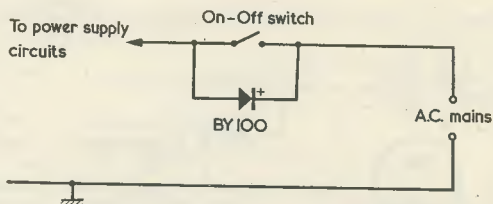


Fig. 5. Reduced warm-up time may be achieved by connecting a BY100, or similar silicon diode, across the on-off switch contacts in series with the receiver rectifier, as shown here. If the receiver has a double-pole on-off switch, the contacts in series with the chassis connection have to be short-circuited

"To my mind," commented Smythy, "that seems to be quite a good idea."

"It had its lighter moments," agreed Dick. "But I'm afraid that some of the rougher element objected. Things came to a head one night when someone emptied a saucepan of hot baked beans over the turntable."

Dick paused for a moment as he savoured the recollection.

"Do you know, Smythy," he said, "before that evening I'd simply had no idea of the immense velocity that can be acquired by a baked bean merely by causing it to rotate at 78 revolutions a minute."

"It must," said Smythy, impressed, "have been a stirring spectacle."

"It was, indeed," confirmed Dick.

"Anyway, the next evening somebody sabotaged his sound-box, and so he decided to make another change."

"What happened then?"

"He persuaded the cleaning woman to come in in the evenings wearing a fluffy tail and a bow-tie and two long ears, and he called it 'The Bunny Warren'. Dead repulsive it was, too. You couldn't fancy a meat pie with your chips because of the thought that there might be myxomatosis in it. In any case, the rougher element stopped that, too."

"This rougher element," remarked Smythy, "seems to be causing him a lot of trouble."

"It's because he's trying to get rid of them," said Dick, "that he's carried out his latest change. He's made it all posh, like those shops the debs and models are opening out in Chelsea, and he's got wrought ironwork all round the steam generator with nobody serving you when you walk in. He calls it 'The Adelphi Boutique And Salt-Beef Counter.'"

"Dear me," remarked Smythy, "that's very swish."

"Too swish for us," replied Dick morosely. "The result is that none

of the gang goes there at all, now."

"Oh well," said Smythy sympathetically, "seeing that the delights of the town have lost their relish for you, I'd better get down to talking about some further modifications on these a.m. sound radios. There's a very simple mod which can be fitted to a.c./d.c. radios having a series heater chain, and it causes the warm-up time to be considerably reduced. As a matter of fact, the basic idea appeared in a recent article in the 'Suggested Circuit' series."

"G. A. French rides again," commented Dick approvingly. "Now, there's someone who's really on the ball!"

"I do wish," reproved Smythy, "that you'd use a little more decorum in your reference to your betters. At any event, the idea can be easily incorporated into an a.m. sound radio. What you do is to solder a silicon diode such as the BY100 across the on-off tags of the switch in the radio. (Fig. 5). The BY100 is connected with opposite polarity to the h.t. rectifier in the set so that, when the switch is open, no h.t. is provided. At the same time the heaters run at half-power by way of the BY100. The result is that, when you close the switch, the warm-up time for the heaters is much shorter than if they were switched on from cold."

"Blow me," commented Dick enthusiastically. "That is neat. What do you do if you want to switch the set off altogether?"

"You turn it off at the socket into which it's plugged," replied Smythy.

"Isn't there something," asked Dick, "about running valves for long periods without h.t.?"

"If," replied Smythy, "you run a valve for a very long period with its heater alight but with no h.t. there is a risk of cathode poisoning. With the present idea, however, the risk should be pretty slight if,

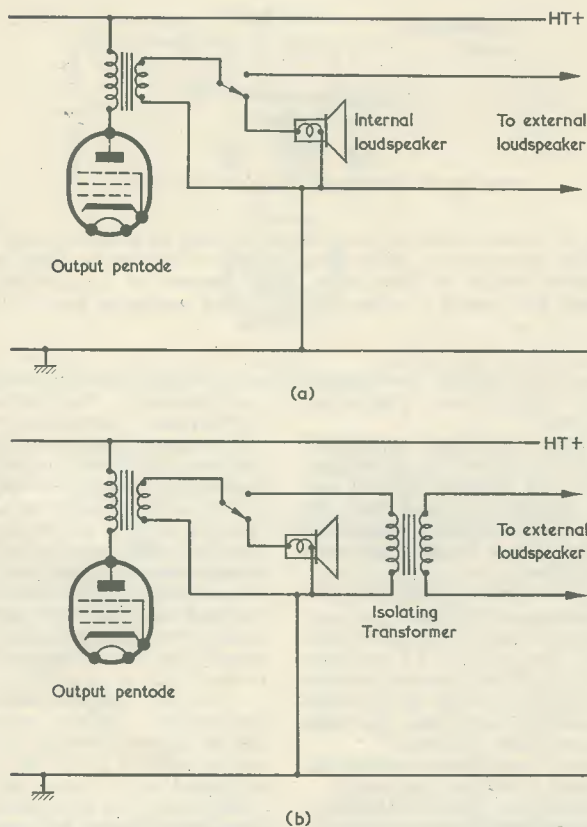


Fig. 6 (a). A simple switching circuit which enables a larger external speaker to be employed with a receiver of the semi-midget class. With a.c./d.c. receivers, the leads to the external loud-speaker will be at mains potential and full precautions against shock must be observed. The leads should not be run to an external loudspeaker in another room  
 (b). Full isolation can be given by employing an isolation transformer, which should be fitted in the receiver cabinet. Suitable transformers are available from Radiospares Ltd. It should be noted that these may only be obtained through retailers

say, you switch the receiver on in the half-power position at the start of an evening and turn it off at the socket switch before you go to bed. Another approach consists of connecting a resistor across the BY100 which allows a low h.t. voltage to appear in the set, but since this was all dealt with fully in the 'Suggested Circuit' article, there's no point in my repeating it now."

#### External Speaker

"Okey-doke," said Dick. "Any other mods?"

"If the set is one of the smaller semi-midget types," replied Smithy, "you can obtain better reproduction by hooking its output to a larger external speaker fitted in a decent size cabinet. The bigger cabinet

acts as a baffle so that there's less cancellation of the bass notes."

"I know what you mean," said Dick. "With a small cabinet, most of the lower frequency notes come round to the front where-upon, since they're out of phase with those given by the front of the cone, they tend to cancel them out."

"That's the idea," confirmed Smithy. "All that the baffle does is to provide physical separation between the back and the front of the speaker cone. Also, the bigger the baffle the lower the frequency at which the cancellation effect begins to become noticeable. I must emphasise that running the set in this manner doesn't, of course,

represent true high fidelity practice. Nevertheless, it's worth remembering that these small mains radio sets have quite powerful output bottles in them and, whilst coupling them to a larger speaker in a larger cabinet cannot give proper hi-fi reproduction, it can still give you quite a pleasant sound at very low cost."

"How," asked Dick, "would you couple up the external speaker?"

"I would add a little change-over switch to the set," replied Smithy. "This could switch from one speaker to the other. (Fig. 6 (a)). A very stern word of warning is needed here, though, because the leads to the external speaker will be at chassis potential. Should, as is most likely, the receiver be an a.c./d.c. type type, the leads will be at mains potential as well. Ideally, you should fit an isolating transformer between the set and the speaker (Fig. 6 (b)), and there's a special 1:1 transformer in the Radiospares range which is especially designed for this job. This is the Radiospares 'Midget' speaker isolating transformer, and it matches a 3Ω output to a 3Ω speaker. It works at power up to 2 watts and has full mains insulation between primary and secondary. There's also a larger job, the Radiospares 'Universal' speaker isolating transformer, which will go up to 5 watts and which has 3Ω, 7Ω and 15Ω taps on both primary and secondary. If you don't use an isolating transformer, make *absolutely* certain that all wiring and connections are completely covered up so that no-one can touch them. Also, the wiring to the external speaker must not go into another room. If there are any plugs and sockets, these could be of the type normally used for mains connections."

"If the external speaker offers improved reproduction of the lower frequencies," asked Dick, "won't it cause the hum level to become louder as well?"

"That is possible," replied Smithy. "And the amount of hum you get will depend on the set itself, of course. Some of these small radios may have quite a high hum level on the signal which is passed to the internal speaker but, since this is a small unit in a small cabinet, the audible level of the hum is quite low. But it will become much more noticeable if you hitch the set up to a larger speaker in a larger cabinet. If you do get trouble with hum, the obvious thing to do first is to check the h.t. electrolytics and replace them if they've lost part of their capacitance. Should

this not clear the hum, another mod may be required. Most of these small receivers have simple resistance-capacitance h.t. smoothing with just one smoothing resistor. (Fig. 7 (a)). You can often knock the hum level down quite a bit by popping in an extra resistance-capacitor section immediately after the reservoir capacitor. Fig. 7 (b)). A 330Ω series resistor and a 40μF 350V wkg. electrolytic would give quite a useful bit of extra smoothing."

"But," protested Dick, "won't this cause you to lose a lot of h.t. voltage in the extra resistor?"

"Not really," replied Smithy. "The h.t. current drawn in these sets is usually of the order of 60mA, so a 330Ω resistor will only drop about 20 volts. By the way, 20 volts time 60mA comes to—let me see, now—1.2 watts, so the 330Ω resistor should preferably be rated at 2 watts."

"I do wish," objected Dick, "you wouldn't keep doing these lightning calculations of yours. They're a bit too speedy for my untutored brain!"

"Nonsense," said Smithy. "If you remember that 1mA through 1kΩ is 1 volt, these little Ohm's Law sums are dead easy to work out. In the present case the current is 60mA, whereupon 60mA through 1kΩ is 60 volts. But the actual resistance is 330Ω, which is a third of 1kΩ and so the answer must be 20 volts!"

"I'll take your word for it!"

However, Smithy now had the bit firmly between his teeth, and he ignored his assistant's comment.

"Another useful little numerical fact to keep in the old memory store," he went on, "is that 10μF at 100 c/s represents a reactance of approximately 160Ω. This is a useful thing to remember if you're making quick assessments of smoothing circuit operation. The 40μF capacitor I suggested just now for the additional smoothing filter will, therefore, have a reactance of 40Ω at 100 c/s and 80Ω at 50 c/s, whereupon it will take a really fair-sized bite out of the 50 c/s ripple coming from a half-wave rectifier, and will take twice as big a bite out of the 100 c/s harmonic on that ripple which will actually be the more audible!"

"W. G. Morely," murmured Dick, "could not have been more explicit."

"And," continued Smithy, "if you want to get the h.t. ripple down to really small proportions, you could even pop in a little choke instead of the 330Ω resistor. (Fig. 7 (c)). The primary of a small

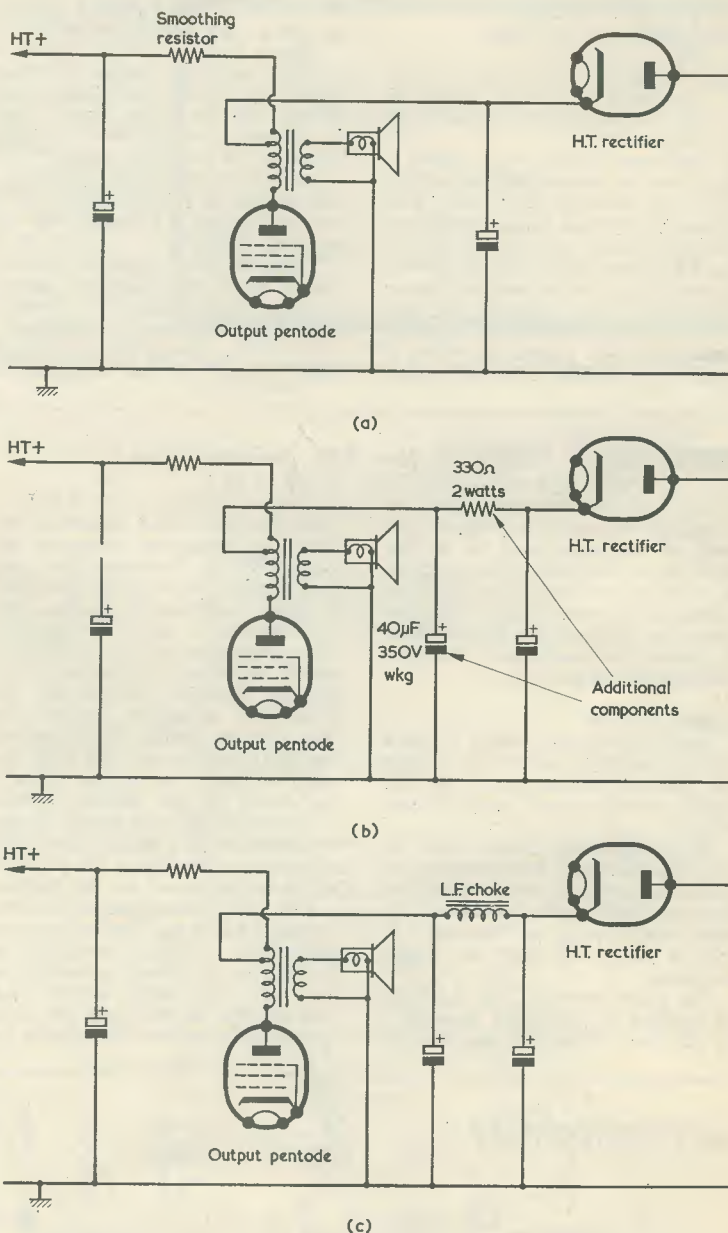


Fig. 7 (a). Many of the smaller receivers have a single smoothing resistor, as illustrated here

(b). Hum level may be reduced by inserting an additional filter. This brings the smoothing circuit to the same form as was shown in Figs. 2 (a) and (b)

(c). A considerably greater reduction in hum level may be provided by fitting a small l.f. choke in place of the added 330Ω resistor of (b). The primary of a small speaker will frequently be an economic proposition here

speaker transformer would be an economic proposition here provided it could pass the current required.

As a point of interest, the primaries of the speaker transformers which appear in small mains radios nor-

mally have a resistance of around 300 to 400Ω in any case."

#### Final Points

"Are there any other places in the set," asked Dick, "where hum may be caused?"

"The only other place where a high level of hum could be picked up," said Smithy, "is in the grid circuit of the triode voltage amplifier. This will include the volume control and its wiring and it may be necessary to add a little judicious screening and adjust lead dressing in this circuit if hum becomes troublesome when you couple the set to a larger loudspeaker. It is, of course,

very easy to tell if you're picking up hum in that part of the set."

"How's that?"  
"You simply," replied Smithy, "short the triode grid down to chassis. If the hum stops, then it's obvious that the hum is being picked up in that grid circuit."

As Smithy concluded, there was a loud squeal of brakes from outside the Workshop, followed by a sonorous clatter.

"Darn it all," snorted Smithy, "there goes the dust-bin again. Do you know, Dick, I'm certain that van-driver does it on purpose."

But Dick, having now extracted from Smithy all the information

on mains a.m. radio sets that he required for his immediate purpose, was already preparing his bench for the first faulty receiver from the van.

Indeed, the Workshop was now returning to its normal state after having passed through one of its standard work-discussion-work cycles

A cycle, it might be added, to which even the good Dr. Heinrich Hertz himself would have hesitated to append his name.

**Editor's Note.** The "Suggested Circuit" referred to by Smithy appeared in the July 1966 issue.



## SUGGESTED CIRCUIT No. 192 (continued from p. 211)

The performance given with the prototype was quite impressive. As soon as the neon lamp lit up the meter needle started travelling across its scale, being "frozen" in position whenever  $S_1$  was pressed. It was found that it wasn't too easy to press  $S_1$  before the needle had advanced half-way across the scale!

#### Relay Operation

Some readers may prefer to use a delayed switching system to initiate the reaction timing period, as this would obviate direct manipulation of  $S_2$ .

Any time delay circuit could be adapted for this function and a simple suggested approach which has been used by the writer in the past for other applications is illustrated in Fig. 5 and will now be briefly discussed.

The relay shown in Fig. 5 should be capable of energising at some 5 to 10 mA. When the double-pole

switch is operated the rise in voltage across the relay coil is delayed by the electrolytic capacitor connected across it. When, eventually, the relay does energise, its contacts carry out the same functions as do  $S_{2(a)}$  and  $S_{2(b)}$  of Fig. 2. After the reaction timing period is over, the double-pole switch of Fig. 5 is returned to its original position, whereupon the electrolytic capacitor across the relay coil is rapidly discharged via the 100Ω resistor and the relay de-energises again. A random factor is introduced by the variable resistor in the relay energising circuit. If this is provided with a plain knob it may be set up to provide a delay period which is unknown to the subject.

The basic requirements of the circuit of Fig. 5 are that, without the electrolytic capacitor connected in circuit, the maximum resistance in the coil energising circuit (i.e. between the BY100 and the relay coil) is still sufficient to enable the

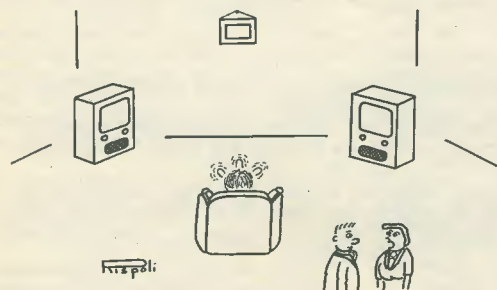
relay to operate, and that the minimum resistance in the coil energising circuit is not so low that an excessively high current flows or an excessively high voltage appears across the relay coil. The electrolytic capacitor may have a value around 1,000 to 2,000μF and a working voltage equal to the highest voltage which can appear across the coil. The relay contacts should be capable of switching mains voltages.

#### Mains Operation

A final point, which applies to the circuit of Fig. 2 with or without a time delay circuit as in Fig. 5, is that the components in the reaction timer connect directly to the mains supply without an isolating transformer. In consequence the unit should be housed in an insulated case which ensures that no components or wiring may be touched. All other normal precautions with respect to accidental shock must also be observed.



## cartoonsmile



"I understand its some stereo TV experiment"

## First TV Service in the Holy Land

An order for television equipment for two transmitting stations and a production studio has been placed with The Marconi Company by the Ministry of Information of the Hashemite Kingdom of Jordan. The stations will be on the air next year, and will provide the first television service in the Holy Land.

One transmitting station, broadcasting in Band III, will be located in Jerusalem, to give coverage of the Holy City and the surrounding area. The other will be on the outskirts of Amman, and will broadcast in Band I. The Jordan Television Corporation studios will be in the city of Amman itself, and programmes will be fed to Jerusalem by a microwave link.

MANY CONSTRUCTORS REPAIR SETS FOR FRIENDS in their spare time, and for many others there is often a "moment of truth" when, having built a piece of equipment, the components from the spares box decide to be unco-operative. In both these cases, a signal injector can be of great value in localising or pinpointing a fault.

The signal injector about to be described was made as two distinct sections. The first, called for the sake of simplicity the r.f. section, generates a fundamental and harmonics in the range 3 kc/s to some 2 Mc/s, although a little more expense will raise this upper limit to some 12 Mc/s. The output is approximately a square wave.

## AF/RF Signal Injector

by J. Anderson

A neat little unit which offers both r.f. and a.f. outputs

### COMPONENTS

#### Resistors

(All fixed values  $\frac{1}{4}$  watt 10%)

- R<sub>1</sub> 1.8k $\Omega$
- R<sub>2</sub> 47k $\Omega$
- R<sub>3</sub> 47 $\Omega$
- R<sub>4</sub> 47k $\Omega$
- R<sub>5</sub> 1.8k $\Omega$
- R<sub>6</sub> 47 $\Omega$
- R<sub>7</sub> 100k $\Omega$  potentiometer, linear track
- R<sub>8</sub> 200k $\Omega$
- R<sub>9</sub> 1.5k $\Omega$
- R<sub>10</sub> 2k $\Omega$  (see text)

#### Capacitors

- C<sub>1</sub> 0.005 $\mu$ F paper
- C<sub>2</sub> 0.005 $\mu$ F paper
- C<sub>3</sub> 1,000pF ceramic, 350V wkg.
- C<sub>4</sub> 0.25 $\mu$ F paper
- C<sub>5</sub> 0.02 $\mu$ F paper, 350V wkg.

#### Transformer

T<sub>1</sub> See text

#### Transistors

TR<sub>1,2</sub> OC70, OC71, OC45 or Red Spot  
TR<sub>3</sub> OC70, OC71 or Red Spot

#### Switches

S<sub>1</sub> Press switch, on-off  
S<sub>2</sub> Slide switch, on-off  
S<sub>3</sub> Slide switch, s.p.d.t.

#### Battery

9-volt battery

#### Meter

Moving-coil, 0-10mA

#### Miscellaneous

2 coaxial sockets  
Screened test lead with coaxial plug, prod and clip  
Case, tagboard, etc.

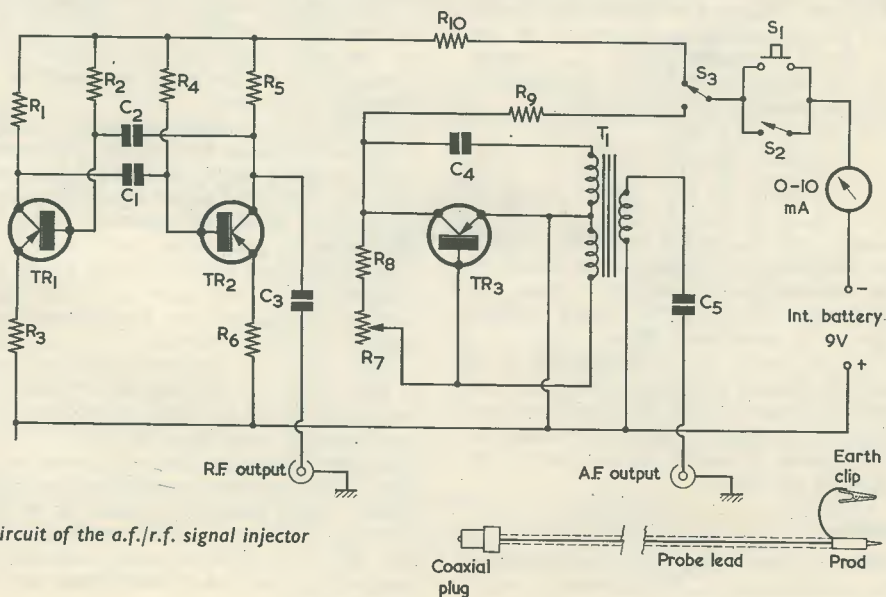


Fig. 1. The circuit of the a.f./r.f. signal injector

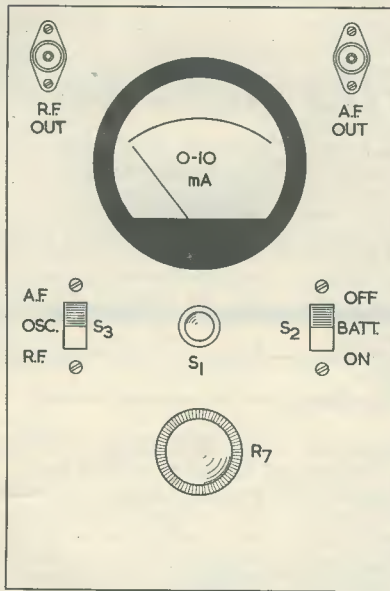


Fig. 2. Front panel layout adopted in the author's version

The second section is an a.f. oscillator, providing a reasonably pure note in the range 800 c/s to 1,200 c/s; this note is continuously variable in frequency, to discriminate between the injected signal and internal oscillations in faulty a.f. equipment.

#### The R.F. Section

The r.f. section, as will be seen from Fig. 1, consists of TR<sub>1</sub> and TR<sub>2</sub> in a multivibrator circuit. The frequency of oscillation is dependent on the values of C<sub>1</sub>, C<sub>2</sub>, R<sub>4</sub> and R<sub>2</sub>. When C<sub>1</sub> is equal to C<sub>2</sub> and R<sub>4</sub> is equal to R<sub>2</sub>, the fundamental frequency may be found from the formula

$$f = \frac{1}{1.4 R_4 C_1}$$

where f is in c/s, R<sub>4</sub> is in MΩ and C<sub>1</sub> is in μF.

The resistors R<sub>3</sub> and R<sub>6</sub>, which would not appear in the normal multivibrator circuit, were found by the author to increase the r.f. output. Taking the emitters of TR<sub>1</sub> and TR<sub>2</sub> direct to chassis resulted in a reduction in r.f. output.

Since the output from the multivibrator is of square wave form, it has a strong harmonic content. With Red Spot transistors or OC70's, the maximum frequency provided is about 2 Mc/s. This may be considerably extended, however, by the use of r.f. transistors such as the OC44.

#### The A.F. Section

The a.f. section is given by the components around TR<sub>3</sub>. In the oscillator circuit, R<sub>7</sub> provides a panel control of oscillator frequency.

Changes in the oscillator frequency range may, if desired, be effected by altering the values of R<sub>9</sub> and C<sub>4</sub>, but it should be remembered that too low a value in R<sub>9</sub> may result in excessive battery drain.

The oscillator transformer, T<sub>1</sub>, is a transistor push-pull output component, and the writer employed a Repanco type TT5 here. Types QXO2 (Osmor) and D.3035 (Ardente) will also function reliably. Since the transformer is employed in a circuit for which it was not originally intended, it is possible that some specimens may result in an output frequency range differing from that obtained by the author. In this case the required range may be obtained by adjusting the value of C<sub>4</sub>.

#### Other Points

Resistor R<sub>10</sub> is included to keep the r.f. output at a fairly low level consistent with good operation, as the writer feels that the output of some square wave injectors tends to be excessive and may even cause interference with neighbouring receivers. The value employed in the prototype for R<sub>10</sub> was 2kΩ. If a higher r.f. output is required, this resistor may be reduced in value.

A press-button switch was incorporated in parallel with the on-off switch S<sub>2</sub>, so that the injected signal may either be "pulsed" in order to distinguish it from other oscillations or received signals or alternatively, by closing S<sub>2</sub>, it may be left on continuously whilst servicing is in progress, the application being made simply with the test probe.

The meter was included in the circuit largely as a means of indicating efficient operation and the state of the battery.

#### Construction

The components were arranged on a small tagboard, measuring 4 x 1in, the a.f. section being at one end, and the multivibrator at the other. Connections to the panel components and battery were by flying leads.

An aluminium case measuring 6 x 2½ x 4in was employed to house the injector, this being connected to the positive supply rail and, hence, providing the chassis. The front panel layout is shown in Fig. 2. Three Ever Ready D22 batteries were used for the supply in the prototype, but it would probably be more convenient to use a single 9 volt battery. The dimensions of the case and tagboard are not, however, of importance, and alternative dimensions may be employed instead.

Fig. 1 shows a screened probe lead terminated in a prod and an earthing crocodile clip, which is connected to the braiding of the screened lead. The earthing clip may be secured to the chassis of the equipment being checked. It should be remembered that, if the equipment under test has a power supply circuit which causes its chassis to be connected to one side of the mains, the metal case of the injector will be similarly connected, and the appropriate precautions against shock must be observed in consequence.



# Basic Q Multiplier

by wallace studley

This Q Multiplier circuit is intended for use at an i.f. of 1620 kc/s, as is encountered in many short wave communications receivers. The basic circuit may also be adapted, by the constructor who understands the simple principles involved, to work with other intermediate frequencies as well.

duces no insertion loss. The test model made by the writer causes no signal loss and may therefore be left permanently connected to the receiver; when its use is not required its function switch is set to "Out". There seems no reason why similar results should not be obtained in other installations.

The receiver referred to employs an intermediate frequency of 1620 kc/s. The Q multiplier unit could doubtless be used with other receivers, but if these employ a different intermediate frequency, such as 470 kc/s, an alternative feedback transformer will be required to that specified here. Other changes may also be needed. When correctly adjusted, the Q multiplier functions immediately it is switched to "In",

## COMPONENTS

(Fig. 1)

### Resistors

(All fixed values  $\frac{1}{2}$  watt 10%)

- R<sub>1</sub> 1M $\Omega$
- R<sub>2</sub> 47k $\Omega$
- R<sub>3</sub> 15k $\Omega$
- VR<sub>1</sub> 50k $\Omega$  potentiometer, linear track

### Capacitors

- C<sub>1</sub> 1,000pF ceramic
- C<sub>2</sub> 100pF silver mica (see text)
- C<sub>3</sub> 1,000pF ceramic
- C<sub>4</sub> 100pF silver mica
- C<sub>5</sub> 5,000pF ceramic
- C<sub>6</sub> 10,000pF ceramic
- C<sub>7</sub> 10,000pF ceramic
- VC<sub>1</sub> 100pF variable, type C804 (Jackson Bros.)

### Inductors

- L<sub>1</sub> See text
- L<sub>2</sub> I.F. transformer type IFT16 (Denco)

### Valve

- V<sub>1</sub> EF92

### Switch

- S<sub>1(a)(b)</sub> d.p.d.t., toggle

### Plugs, Sockets

- 2 B7G sockets
- 1 B7G plug
- 1 coaxial socket (plus 1 at receiver)
- 1 coaxial plug (plus 1 at receiver)
- 1 pilot lamp holder and lens

### Miscellaneous

- 1 pilot lamp, m.e.s., 6.3V 0.15A
- 2 knobs
- Material for housing
- Panel-Sign transfers
- Coaxial cable, connecting wire, etc.

THIS EASILY DUPLICATED DEVICE has been used by the writer for some time in combination with the Heathkit RA-1 Amateur bands communications receiver to provide a very high degree of selectivity and sensitivity. The writer spends a good deal of time in reading c.w. transmissions, whereupon any device capable of effectively reducing bandwidth is worth consideration and especially if it intro-

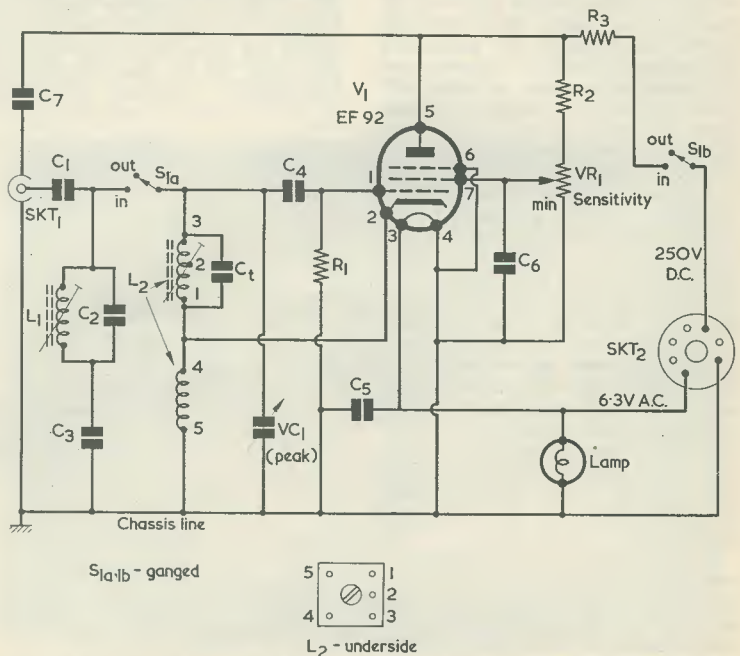


Fig. 1. The circuit of the Q multiplier

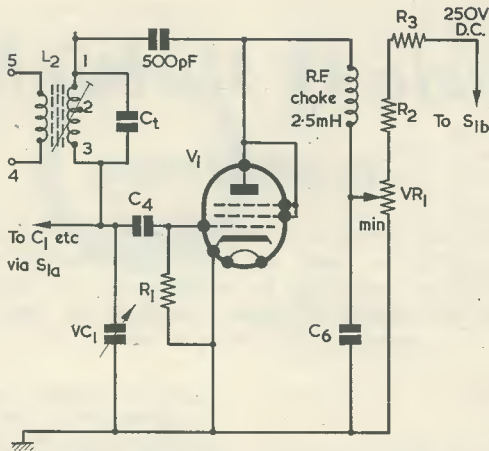


Fig. 2. An alternative method of connecting the components around  $V_1$ . No connections are made to tags 4 and 5 of  $L_2$

whereupon sensitivity is dramatically improved and the receiver tuning increases significantly in sharpness. The noise level also tends to increase, as might be expected. It is interesting to note here that many phone transmissions that were completely inaudible otherwise have been read successfully on the 21 Mc/s (15 metres) Amateur band with the unit in circuit.

#### The Circuit

The simple circuit of the Q multiplier is shown in Fig. 1, in which  $V_1$ ,  $L_2$  and the associated components form a regenerative configuration capable of being adjusted to the very verge of oscillation. Variable capacitor  $VC_1$  permits the device to be tuned manually across the receiver i.f. passband—in this case on either side of 1620 kc/s—and if a screened lead from socket  $SKT_1$  is connected to the primary of the first intermediate frequency transformer and the correct operating conditions exist, the effective Q is increased enormously, with an improvement in gain as well as in selectivity. Constructors who have experimented with simple t.r.f. receivers employing a regeneration (reaction) circuit know well how dramatically both gain and sensitivity increase due to judicious use of the feedback control; similar results are obtainable here.

It is desirable for operating convenience to make both  $VC_1$  and  $VR_1$  panel controls, so that the unit may be kept "on the nose" at all times. Switch  $S_1$  is also fitted to the panel, together with a red warning light which gives visual

indication that power is applied.

In the test model, coil  $L_2$  consists of a sub-miniature transistor i.f. transformer by Denco, designated IFT16. The can is removed from the transformer and the windings are connected to enable  $V_1$  to function in the Hartley as encountered in electron coupled oscillators. The value of capacitor  $C_1$  is not specified since it is integral with the transformer when purchased. This transformer plays an important part in the circuit; it should have a good Q factor and it should be capable of being tuned across the associated receiver's i.f. passband. In the case of 470 kc/s intermediate frequency amplifiers, the use of a Denco transformer type

IFT14 might be feasible and connections thereto would be identical to those shown in Fig. 1; but it must be emphasised that no tests have been made using this particular item or with any 470 kc/s i.f. strip and that the suggestion is meant for the experimenter only, who is prepared to alter other parts of the circuit should this be necessary.

Positive feedback results due to the cathode of  $V_1$  being tapped into the tuned winding, but an actual oscillating condition is not required here. By adjusting  $VR_1$  the valve may be brought gently and smoothly to the verge of oscillation—its most sensitive operating point—where it is there normally left. It will be seen from Fig. 1 that one winding of coil  $L_2$  must carry the cathode current of the valve. If this is objected to on the grounds of safety for the winding, the alternative circuit shown in Fig. 2 may be used instead. In Fig. 2  $L_2$  carries no direct current whatever. Component designations and values are exactly as specified for Fig. 1, but an additional 500pF silver mica capacitor is required as, also, is an r.f. choke of 2.5mH; resistors  $R_2$  and  $R_3$  could, in practice, be a single component of 75k $\Omega$ . It should be added that the risk of damage to  $L_2$  due to cathode current is extremely slight, and that no trouble whatsoever has been experienced with the prototype, which uses the circuit of Fig. 1, on this score. The circuit of Fig. 2 has the secondary advantage that only two connections are made to the coil in the regenerative circuit, and this may assist in obtaining a

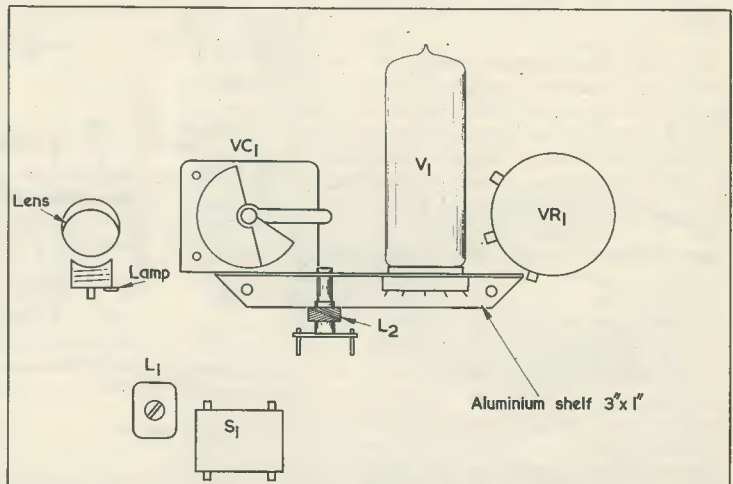


Fig. 3. The components are fitted to the rear of the front panel, and have the layout shown here



suitable coil for intermediate frequencies other than 1620 kc/s.

A short length of coaxial cable is necessary to interconnect the receiver and Q multiplier, and this will cause serious detuning of the receiver i.f. transformer if precautions are not taken. Referring again to Fig. 1, the detuning effect is counteracted by  $L_1$ ,  $C_2$  and  $C_3$ . When these items have been suitably set up no further adjustments to them need normally be made. For  $L_1$ , a conventional dust-cored coil of about 60 to  $90\mu\text{H}$  has been found ideal in the case of 1620 kc/s, and a medium wave oscillator coil should be quite suitable. Capacitor  $C_2$  may require adjustment in value, although it is only necessary to find a value that will enable coil  $L_1$  to be peaked by means of core adjustment. This is done at the setting up stage. For intermediate frequencies other than 1620 kc/s it will be necessary to find an alternative inductor for the  $L_1$  position.

The power required by the Q multiplier is some 250 volts h.t. at 10mA, together with 6.3 volts a.c. at 0.35A. This will usually be available from the receiver, but a separate power supply unit can be made up if necessary. The power supply is applied to the pins of  $\text{SKT}_2$  in the following manner: pin 1, 6.3 volts; pin 5, h.t. positive; pin 7, h.t. negative and 6.3 volts. It is assumed that one side of the available 6.3 volt supply is at chassis potential, and this point should be checked before making the connection.

#### Construction and Testing

A simple fabricated casing of paxolin and hardboard houses the unit, the components being mounted directly on the inside of the panel. Dimensions and layout of casing and components may be seen in Figs. 3 and 4 respectively. As may be observed, the valveholder and  $L_2$  are mounted on a small shelf of aluminium.  $L_2$  is held with adequate firmness merely by drilling a small hole barely large enough to take the stem of its former, further rigidity being imparted by the wiring.

The panel face is surrounded by a frame of  $\frac{1}{2}$  in mitred quadrant, the whole casing being lacquered. Legends and suitable scales are applied by using standard panel-sign transfers available from Data Publications Sets No. 4 (Wording—Black) and No. 6 (Dials) being chosen. These legends, etc., are "fixed" when dry with clear nail varnish purloined from either the YL or XYL as

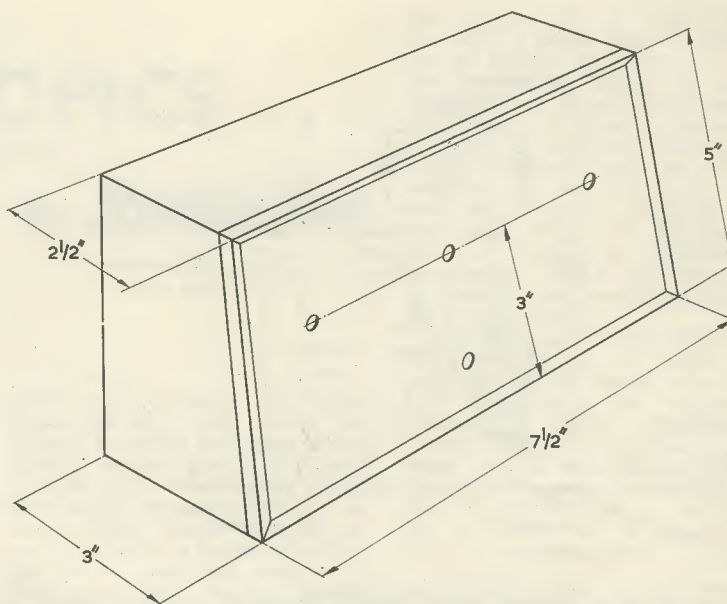
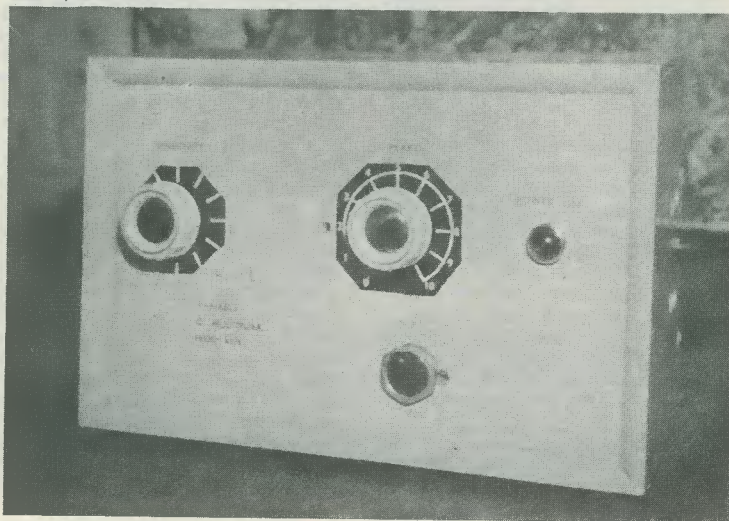


Fig. 4. The dimensions of the cabinet for the unit

applicable! Sockets  $\text{SKT}_1$  and  $\text{SKT}_2$  are most conveniently fitted to the rear of the casing.

Before affixing any back or base to the case, however, tests should be made, firstly without power applied to ensure that no h.t. short-circuits exists, and later with power to check that the device can be made to oscillate correctly. The first tests consist of the normal practice of checking for h.t. short-circuits with an ohmmeter. To check the oscillating condition a multimeter set to read 0-50mA is

inserted in the lead from  $R_3$  to  $S_{1(b)}$ .  $\text{VR}_1$  is then rotated to the "Min" position,  $S_1$  closed and the current reading noted. This will probably be of the order of 4 to 6mA.  $\text{VR}_1$  is then slowly advanced, and the steady upward excursion of the meter pointer carefully observed until, at a certain point, a slight unsteadiness or downward kick will be seen.  $\text{VR}_1$  is now left alone and either pin 1, pin 3 or pin 4 of  $L_2$  is momentarily short-circuited to the chassis line, whereupon a sudden current swing should be



Panel view of the completed unit—note the use of Panel-Signs Transfers

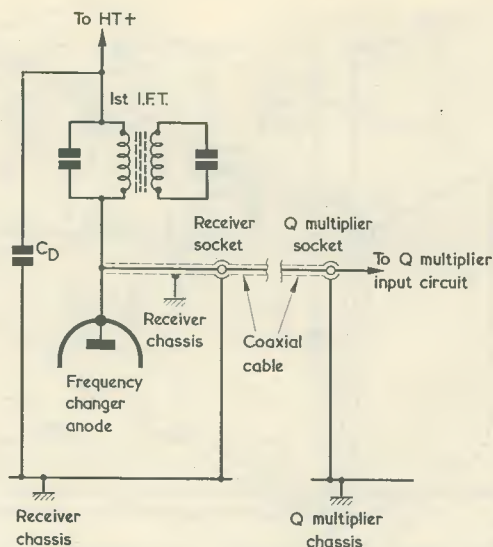


Fig. 5. Due to the presence of decoupling capacitor  $C_D$  which will already be fitted in the receiver, the Q multiplier is effectively applied across the primary of the first i.f. transformer

seen on the meter. This indicates that the circuit is functioning correctly, but it must be noted that the experimental short-circuit must not be maintained longer than is necessary to make the check, otherwise damage to components might result. The unit may now be switched off and the back and base of the cabinet secured, after drilling a hole in each through which a trimming tool may be passed to engage with the cores of  $L_1$  and  $L_2$ .

#### Setting up

On the receiver a coaxial socket is affixed to the rear chassis apron to accept a coaxial lead from socket SKT<sub>1</sub> on the Q multiplier.\* The central terminal of the receiver socket is wired directly to the anode pin of the frequency changer valve. This anode pin is already connected to one side of the first i.f. transformer

\* The coaxial socket on the receiver should be coupled to the frequency changer anode inside the receiver via coaxial cable, the braiding of which is earthed both at the socket end and (at any convenient chassis point) at the i.f. transformer end. According to its length, the cable in the receiver will cause some detuning of the i.f. transformer primary when no plug is inserted, and the constructor may prefer to retrim the primary to take this up. If the Q multiplier is connected permanently, detuning due to the cable in the receiver is of no consequence because it will be corrected by  $L_1$  and  $C_2$ .—EDITOR.

primary winding, the other side of which is at h.t. potential. Referring to Fig. 5 it is clear that, although the Q multiplier input is taken from the frequency changer anode and chassis, it is effectively across the primary of the i.f. transformer because of the decoupling capacitor  $C_D$ , which has a low reactance at intermediate frequency. The d.c. potential present at the anode of the frequency changer is not short-circuited to chassis in the Q multiplier, since it is blocked by capacitor  $C_1$ .

Prior to connecting SKT<sub>1</sub> to the receiver a moderately strong signal should be tuned in. Also the Q multiplier sensitivity control, VR<sub>1</sub>, should be set to "Min", VC<sub>1</sub> adjusted to mid-travel (i.e. vanes about 50% enmeshed) and S<sub>1</sub> set to "Out". The coaxial cable is now connected to the receiver to bring the two units together, whereupon a sudden serious fall in received signal strength will probably be noted. Leaving the receiver tuning as set, the core of  $L_1$  on the multiplier unit is carefully adjusted in an attempt to return the level of the signal to its former value. It may be found that it is not possible to peak the coil correctly, and should signal strength still be on the increase when the core commences to come out of the former completely it is apparent that the value of  $C_2$  is

too great. If, on the other hand, signal strength seems to be on the increase even when the core of  $L_1$  is fully engaging the winding then either a larger value of capacitance must be assigned to  $C_2$  or a coil of greater inductance is needed. It will soon be evident what exactly is required in this connection and when, after making any necessary component changes, peaking is in fact possible, a more definite final indication can be visually obtained by utilising the receiver "S" meter. When no improvement in received signal strength can be obtained, S<sub>1</sub> may be closed and attention devoted to  $L_2$  core, leaving VC<sub>1</sub> as already set.

If at this stage VR<sub>1</sub> is carefully advanced as the core of  $L_2$  is adjusted, a point will be found where received signal strength tends to increase. The core of  $L_2$  will possibly be seen to be slightly disengaged from its former, and will now require only a little final adjustment. Keeping  $L_2$  peaked and advancing VR<sub>1</sub> slowly, a point will be reached where the Q multiplier bursts into oscillation. The trimming tool is now removed and VR<sub>1</sub> backed off a shade to reinstate stability. Receiver sensitivity should now be very high and its tuning much sharpened, whilst slight adjustment to VC<sub>1</sub> will enable optimum results to be maintained on the various bands. The effectiveness of the unit may then be assessed by opening and closing S<sub>1</sub>.

The Q multiplier may now be considered complete, and its usefulness will depend on various factors not the least of which is that of noise normally inherent in the associated receiver. As was mentioned earlier it offers particular benefit in c.w. reception, and it has now become a very welcome accessory in the writer's shack.



## ELECTRICITY EARTHING

The Minister of Power has approved the new 14th Edition of the Regulations for the Electrical Equipment of Buildings drawn up by the Institution of Electrical Engineers.

One of the main changes is that ordinary domestic water systems can no longer be recognised as a means of earthing new electrical installations. This is because the use of plastic water piping is becoming more common and it does not provide an earth.

If electrical installations are not properly earthed accidents can happen and though the new regulations do not affect existing buildings unless new electrical work is done, it is just as important that the earthing arrangements in existing buildings should be effective.

# RADIO TOPICS . . .

by *Recorder*

**D**O YOU EVER KNOCK UP EXPERIMENTAL circuits to prove a little point of theory? Or get to the "awkward" bits of a circuit sorted out before making it up in final form?

I should imagine that we all do this from time to time, if only to check component values and things of that order. Naturally, one doesn't want to take too much time with the experimental circuit set-up, and so any scheme which enables quick connections to be made and altered is the one which is likely to save most time and to offer the maximum convenience.

## Tagstrips Are Easiest

My own approach to this problem is to use tagstrips and a set of special chassis. I have half a dozen small chassis in the spares box which I keep entirely for experimental work, these having holes for B7G, B9A and octal valveholders already cut out in them. It is then a simple matter to quickly knock up a 1 to 3 valve circuit on them, provided that the experimental circuit doesn't operate at frequencies which require extra-careful layout and positioning of the valves. There are also a number of 4BA clear holes which take the tagstrips I mentioned just now. The chassis are, in fact, salvaged from old radios, Band III converters (do you remember *those* days?), and the like, with a few added extra holes for the experimental rigs. Lektrokit components weren't available in the days when I acquired these chassis, and the Lektrokit System represents a more polished approach (*much* more polished!) to the knock-about chassis idea that I've been using over the years.

The tagstrips themselves are simply 5-way types with the centre tag earthed, and they represent the most convenient method I have found of providing anchor points for experimental rigs. They can be

bolted to the chassis at any desired point and offer what seems, on average, to be the best compromise between anchor points at chassis potential and anchor points which have supply or signal voltages on them. Some twelve years or so ago I had quite a few experimental projects to work out, and so I went mad and bought several hundred of these tagstrips. These are also used on permanent construction jobs, and I'm just getting down to the bottom of the box now!

More recently, the valveholder holes in the experimental chassis have tended to be vacant, and the chassis have just become mounting plates for semiconductor circuits which I've been playing around with. But these chassis have still served their purpose well, even if they nowadays get coupled up only to a PP9 battery instead of to the bench 6.3 volt heater and h.t. supply.

An important requirement of the 5-way tagstrips is that they should be fairly large in size with single tags projecting vertically, and the ones I use have a Paxolin strip which is  $1\frac{1}{2}$ in long. This allows plenty of room for the soldering iron when connections are changed from one tag to the other. It's surprising how much time and trouble this single factor saves.

Most experimental circuits are concerned with, firstly, finding the exact circuit connections which provide best results and, secondly, finding the best component values. So far as the latter is concerned, resistor values are those which appear, in practice, to be most frequently in question. In consequence, I usually fit a variable resistor of appropriate value at any point where it is possible that resistance values may need checking. Small skeleton potentiometers are particularly useful here, provided that only a small dissipation is required. After a potentiometer

has been set up for best results, the value it inserts into the experimental circuit is measured. In the permanent circuit, a fixed resistor of that value is then fitted.

When an experimental project is complete, its circuit and component values are noted and the whole lot is stripped down. The circuit is then set up in final form on the permanent chassis, or Veroboard, etc., on which it is intended to be employed. And all the component go back into their own boxes ready for the next time.

The doyen of workers on experimental circuits is of course my colleague G. A. French, who has been contributing his "Suggested Circuits" for 16 years ("Suggested Circuit" No. 192 appears in this issue) and who must hold the world record for technical journalism in this class. I am happy to state that G. A. French is, in general, a 5-way tagstrip man, too!

## A Silly Change

It would appear that the use of the Continental term Hertz, for cycle per second, is going to become accepted practice in this country. It has been adopted officially in the United States and has already become common usage in American journals which are now reaching me. I should add that the term has been employed in Europe for many years, and that adoption by Britain and the U.S. does, admittedly, represent the recognition and use of a common technical term. The abbreviation for Hertz is Hz, whereupon kc/s becomes kHz, Mc/s becomes MHz, and so on.

I honestly don't think I'm being too reactionary when I say that I consider that the change has gone in the wrong direction. The term cycle per second, with its obvious abbreviation, c/s, states exactly what the quantity is in the clearest possible manner. The term Hertz is one step removed from this transparently clear expression, and represents an artificially introduced complication for the student, the beginner and the layman. I appreciate that all honour is due to Hertz, but I still feel that it would have been far better if, instead, the countries concerned had agreed to drop the term Hertz and had adopted cycles per second as the universal expression.

So far as *The Radio Constructor* is concerned, I should imagine that we shall continue to refer to cycles per second for quite a little while yet in our articles. Fortunately, the matter is not one of earth-shattering importance and so there is no

hurry to make the changeover to the new term.

But it does seem a pity that the change should have to be made at all.

#### Electronic Shooting Range

Whilst talking of overseas journals, a recent issue of the Soviet technical publication *Radio* is to hand, and I'm interested to note that it carries, with full acknowledgements to ourselves, a potted version of one of our articles.

The article in question is "Electronic Shooting Range" by J. Daich, which appeared in our last December issue. In the shooting range described in the article a toy "space pistol" shines a narrow beam of light at a target. Behind the target bull's eye is an ORP12 photoconductive cell which triggers a monostable circuit when illuminated, thereby causing a relay to flash a lamp or ring a bell.

It's nice to know that our party gadgets have an appreciative audience in Russia!

#### The Critesistor

Most readers will be familiar with the thermistor, a device which has different values of resistance at

different temperatures, but the critesistor is not nearly so well known. This latter device has a resistance which changes very rapidly at a temperature of  $68 \pm 1^\circ\text{C}$  to one half or one quarter of its previous value. It is used in fire detectors and certain temperature control circuits where a much sharper change in resistance with temperature is required than can be obtained with a normal thermistor.

Three types of critesistor are being made at the present time. Type CB46 has a resistance within the range 9.7 to  $31\text{k}\Omega$  at  $25^\circ\text{C}$ , type CB56 within the range 29 to  $103\text{k}\Omega$  at  $25^\circ\text{C}$  and type CB66 within the range 97 to  $310\text{k}\Omega$  at  $25^\circ\text{C}$ .

Further details of these devices can be obtained from the manufacturers, Hitachi Ltd., 4, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan.

#### Symmetrical Transistors

In the last April issue I discussed the inherent symmetry of a transistor and pointed out that, when connected in the earthed emitter mode, it will still amplify if the emitter and collector leads are transposed. I

also described some simple tests I had carried out on six common transistors. Of these, two OC44's gave gains of 15 and 8.5 with their emitters and collectors changed over, causing me to comment that "these OC44's are jolly good for amplifying wrong way round".

Several letters subsequently reached me on the reverse gain characteristics of transistors, one (which I referred to in the July issue) pointing out that the OC139, OC140 and OC141 have been specifically introduced with symmetrical working in view. Another letter on the subject, from Mr. J. R. Davies of Rayleigh, Essex, has now arrived. Mr. Davies says:

"Whilst servicing a kit-built transistor radio for a friend I was applying voltage checks to the transistors. Imagine my surprise at finding TR<sub>1</sub>, an OC44, had its emitter several volts negative of base. The set had been working perfectly for over a year with emitter/collector connections reversed! When connected correctly little difference in performance was noted. The OC44 is certainly a 'jolly good transistor'!"



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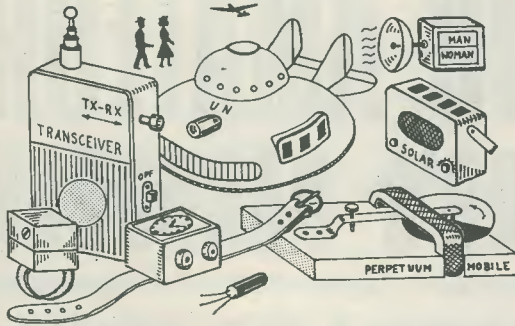
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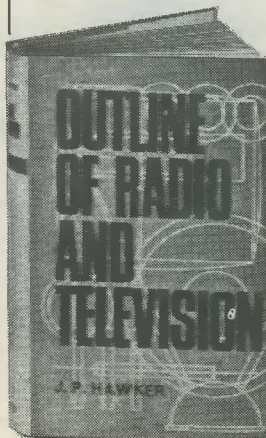
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continued on page 255



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continued from page 254

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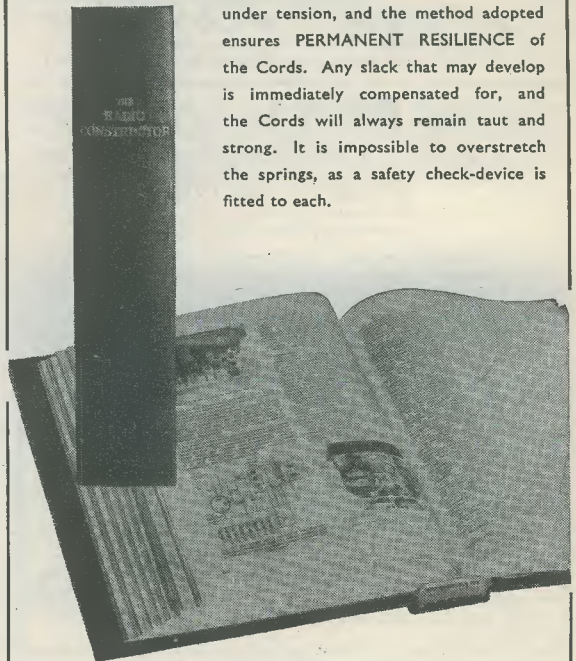
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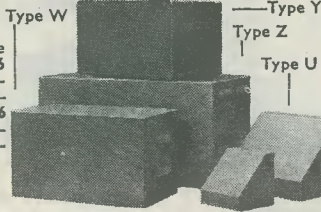
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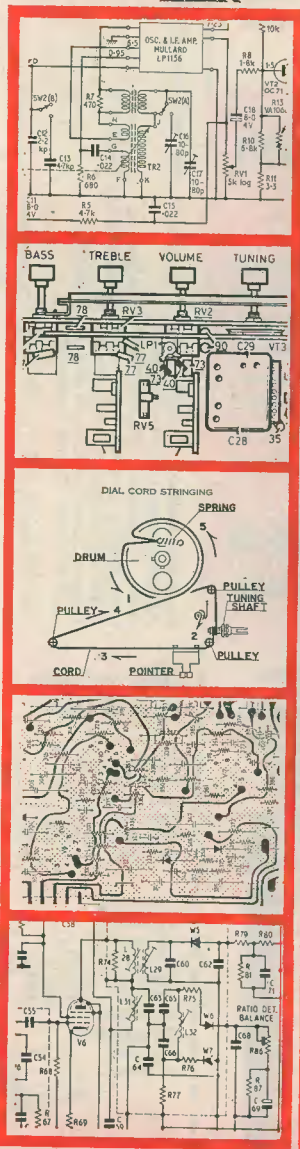
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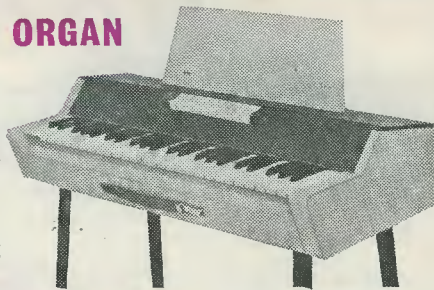
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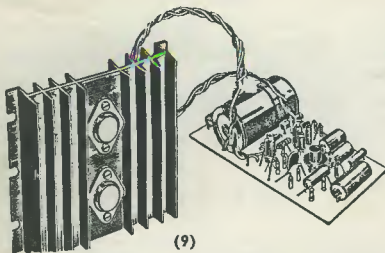


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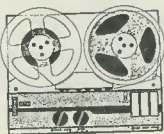


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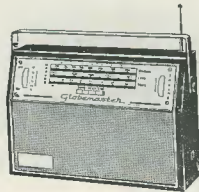
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