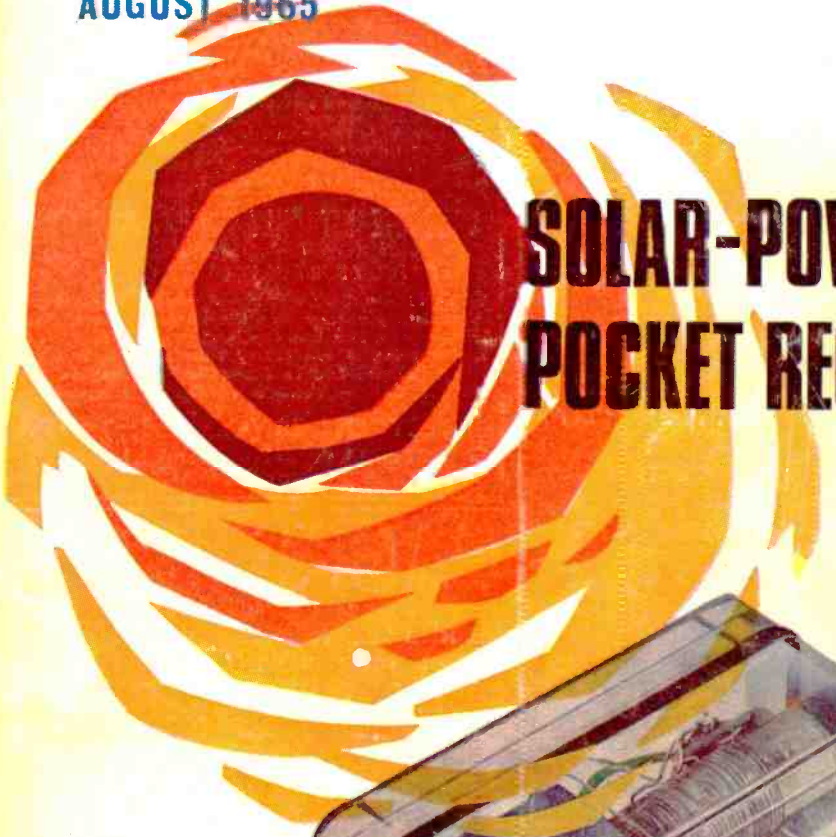


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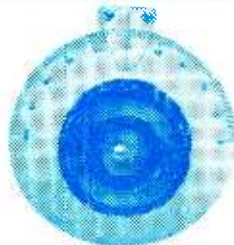
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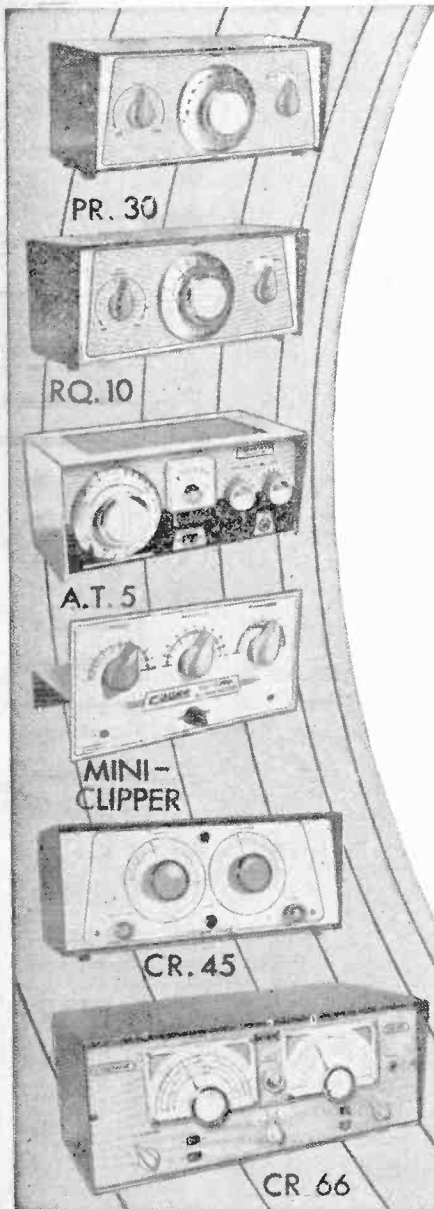
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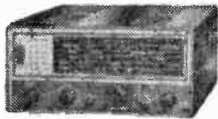
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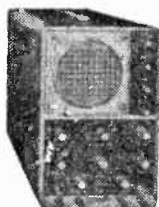
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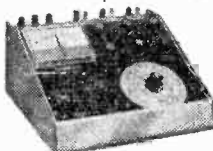


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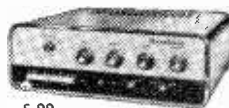
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1L4A	17/6	6F7G	5/-	10F9	9/9	30P14	11/3	CK 12/6	EB67	4/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6	
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99	20/6	M1214	4/6	S141	2/-	U405	13/-	GT16	5/6
1L6A	16/10	6F8	5/-	10F18	9/9	30S1	12/6	CK506	6/6	EL99	20/6	EL99									

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F.M. TUNER UNITS Nos. 15, 16 and 17.....Cash £12.17.6
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GARRARD Model 3000 Stereo Lightweight arm.....Cash £11.11.0
 Or Dep. 47/- and 8 m. pmts. 25/6.....(H.P. Price £12.11.0)
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 Or Dep. 50/- and 8 m. pmts. of 27/6.....(H.P. Price £13.10.0)
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 Or Dep. 52/- and 12 m. pmts. 19/-.....(H.P. Price £14.0.0)
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 Or Dep. 90/- and 12 m. pmts. 33/-.....(H.P. Price £24.6.0)
GARRARD L.A.B. 90 Push button oper., Less cart.....Cash £27.10.0
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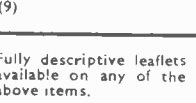
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Items 1, 2 and 14, 3/- each; 6 and 13, 3/8 each; 7, 8, 9, 10, 2/- each; 11, 2/6 each; 12, 5/-. All Post Free.

(1) Mullard "10 Plus 10" Stereo Amplifier

A High-Fidelity design providing up to 10 watts (per channel).

KIT OF PARTS £20.00

Built and tested £24.00 (C. & I. 7/6)

We can also supply the Main Amplifier for operation with our Dual Channel Pre-amplifier.

KIT OF PARTS £27.00

Built and tested £34.00 (C. & I. 10/6)

(2) Mullard Dual Channel Pre-Amplifier

A four-valve design for both Stereo-phonics and Monophonic operation.

KIT OF PARTS £12.10.0

Built and tested £15.0.0 (C. & I. 5/-)

(3) The "Twin Three" Stereo Amplifier

Based on a recent design by Mullard Ltd. it is ideally suited for use in Portable Record Players.

Built and tested £9.0.0 (C. & I. 7/6)

To construct a Stereo Portable Record Player, we offer:

Assembled Amplifier with two 8 x 5in Loudspeakers and Portable Case for £16.10.0 (C. & I. 10/-).

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Self powered VHF/FM long and medium waves. FM 87.5-108.5 Mc/s. AM/MW 522-1,630 Kcs. 1.W 146-270 Kcs. Multiplex output.

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Designed mainly for the Stern/Mullard range of Monophonic Power Amplifiers.

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(8) Mullard "5-10" Main Amplifier

For use with Mullard 2- or 3-valve pre-amplifiers with which an undistorted power output of up to 10 watts is obtained.

KIT OF PARTS £10.0.0

Built and tested £13.10.0 (C. & I. 8/6)

Above incorporates Partridge Output Transformer £1.8.0 extra.

(9) Mullard "5-10RC" Amplifier

The popular "5-10" complete incorporating Passive Control Unit providing up to 10 watts high quality reproduction with an input of 600 mV.

KIT OF PARTS £12.0.0

Built and tested £16.0.0 (C. & I. 7/6)

With Partridge Output Transformer £1.8.0 extra.

(10) Mullard "3-3RC"

A high quality Amplifier developed from the very popular 3-watt Mullard "3-3" design.

KIT OF PARTS £8.8.0

Built and tested £11.10.0 (C. & I. 6/6)

(11) The "Mono-Gram"

A small Amplifier of genuine high quality performance producing up to 3 watts undistorted output.

KIT OF PARTS £4.10.0

Built and tested £6.0.0 (C. & I. 3/6)

(12) Stereo Tape Pre-Amplifier Model STP-1

For use with current Truvox, Brenar or Collaro "Studio" 1- and 1-track Stereo Decks.

KIT OF PARTS £22.0.0

Built and tested £28.0.0 (C. & I. 8/6)

(13) Mullard Type "C" Tape Pre-Amplifier

Suitable for most 1-track Mono Tape Decks.

KIT OF PARTS £14.0.0

Built and tested £19.10.0 (C. & I. 7/6)

(14) Mullard Tape Amplifier Model HF/TR3

Based on Mullard's type "A" design and suitable for most 1-track Mono Tape Decks.

KIT OF PARTS £13.13.0

Built and tested £19.0.0 (C. & I. 7/6)

(16) JLI10 Power Amplifier

Incorporates the latest diode/pentode ECL86 valves in push-pull, Partridge ultra linear output transformer.

Partridge mains transformer and smoothing choke. 10 watts power output, surplus power output, surplus power available for tuner.

Built and tested £12.12.0 (C. & I. 7/6)

(17) Double Feature Pre-Amplifier

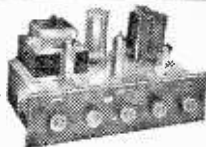
Input for microphone, crystal or magnetic pick-ups, tuner unit, and in addition offers full facilities for tape recording and high fidelity replay.

This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Push-button switching for 3 tape speeds equalised.

Built and tested £18.18.0 (C. & I. 5/-)

Prices if both units purchased together:

Built and tested £30.9.0 (C. & I. 10/-)



(10)



(11)



(12)



(13)



(14)



(16)



(17)

MULLARD 2-VALVE PRE-AMPLIFIER

Employing two EF80 valves and designed to operate with the Mullard AMPLIFIERS but also perfectly suitable for other makes with input up to 250 mV.

★ Equalisation for the latest R.I.A.A. characteristics. ★ Inputs for Cry-star Pickups and variable reactance magnetic types.



COMBINED PRICE REDUCTIONS

Mullard 5-10 Main Amplifier and 2-valve Pre-amplifier.

KIT £16.16.0 (C. & I. 8/6)

BUILT AND TESTED £21.10.0 (C. & I. 8/6)

Mullard 5-10 Main Amplifier and 3-valve Pre-amplifier.

KIT £19.10.0 (C. & I. 8/6)

BUILT AND TESTED £25.10.0 (C. & I. 9/6)

(Above items with PARTRIDGE Transformer £1.8.0 extra.)

★ Input (a) Direct from High imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier. ★ Sensitive Microphone Channel. ★ Wide range BASS and TREBLE Controls. Now with brushed aluminium front panel with contrasting lettering and control knobs.

KIT OF PARTS £66.0 BUILT AND TESTED £9.10.0 (Carr. & Ins. 6/-)

Make an ideal combination with the 2-valve Pre-amp. plus our "5-10" main amplifier.

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 Goodmans Axiom 10 10 watts .. £6.5.11
 Goodmans Axiom 201 15 watts .. £10.17.4
 Wharfedale Super 8/RS/12/DD .. £6.14.2
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 Wharfedale RS/12/DD .. £11.10.0
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 Wharfedale W12EG 15 watts .. £10.10.0
 Wharfedale W15EG 20 watts .. £17.10.0
 Goodmans Axiom 51B 15 watts .. £9.2.3
 Goodmans Axiom 61B 20 watts .. £14.7.8
 Carr. and Ins. extra.

AMERICAN RECORDING TAPE

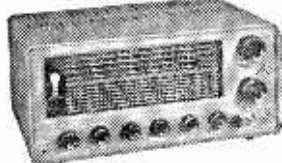
5in. 600ft. Std. Acetate .. 8/6
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★ Push Button Wave Change

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Ready built complete with 7 x 4in.
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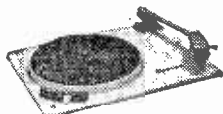
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Starlight 90 Watt Transmitter.

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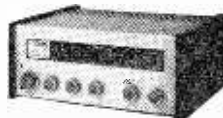
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1 KW ULTRASONIC GENERATOR together with power supply unit for 200-250V. A.C. Complete two chassis with interconnecting cables. Frequency 37 to 43 kc/s adjusted by fine control. Peak output 2kw, average output 500w. Completely new with valves and manual £65. Carriage paid U.K.

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P.C. RADIO LTD

170 GOLDHAWK ROAD, W.12

Shepherd's Bush 4946

Open 9-5.30 p.m. Thursday 9-1 p.m.

STABILISED POWER SUPPLY

UNIT TYPE R.1095 (EDISWAN) with 2 independent outputs.

1. D.C. 120-250V. 50mA metered and regulated.

2. A.C. 6.3V. C.T. 31amps.

Stability 0.02%. Price £18.

STABILISED POWER SUPPLY

UNIT TYPE R.2001 (EDISWAN) with 2 independent outputs.

1. 0-100V. 50mA metered and regulated by coarse and fine adjustments.

2. 250V. Bias as 5mA.

Stability 0.02%. Price £18.

WIDE RANGE MULLARD VALVE

VOLT METER TYPE E 7555/2.

100 mV-500 V, D.C. or A.C. peak from 35c to 5 mc, additional range 500 V. to 15 kc.

D.C. or peak A.C. Frequency response with probe is level from 35c to 100 mc.

Power supply 110/245 V. A.C. Price £25. Carriage £1.

WIRELESS SET No. 52 (CANADIAN)

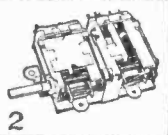
Complete station consisting of Transmitter, Receiver, supply unit for 12 V.

All contained in special carrier. 1.75-16 mc/s in 3 bands. 813 as output valve.

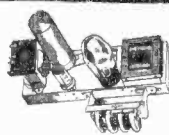
45-75 W. phone and MCW, 70-100 watt CW, M.O. or crystal. Receiver includes crystal calibrator. Tx can be exactly tuned to Rx frequency. Noise limiter. Sidetone. Loudspeaker on receiver with on/off switch. All brand new with accessories. Export. Price on application.

OUTPUT TRANSFORMERS

for push-pull small battery valves (1T4) with output winding for 15 and 600 ohm impedance. 15/- carriage paid.

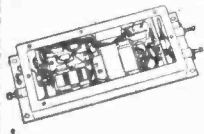


2



Comprising chassis 8 1/2 x 2 1/4 x 1 1/2 in. Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers, etc. Valves 6V6, 6X4 and metal rectifier. Circuit 1/6 free with kit 29/8 plus 4/6 P & P

3



4



6



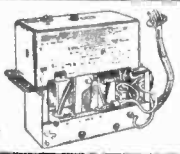
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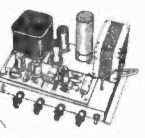
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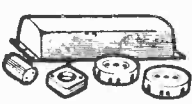
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12



13



14



15



16

1. 6 VALVE 15 WATT PUSH-PULL AMPLIFIER, 15 x 7 x 1 1/2 in. A.C. Mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 8 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies etc. Built and tested. 7 gu. P. & P. 13/6.

2. CYLON A.M.F.M. PERMEABILITY TUNERS FOR ALL TRANSISTOR OPERATION. Size 2 1/2 x 2 1/2 in. approx. By famous manufacturer. A.M. I.F. 470 Kc/s. I.F. 10.7 Mc/s. A.M. coverage from 1630 Kc/s-325 Kc/s. F.M. coverage 108 Mc/s-88 Mc/s. Circuit diagrams 3/6. FREE with Tuner, 1st. 2nd and 3rd A.M. I.F.'s, 1st. 2nd, 3rd and 4th F.M. I.F.'s V.H.F. Osc. choke. A.M. I.F. trap. All the above are the R.F. end of an A.M./F.M. receiver car radio etc. The above items, £2.10.0.

3. AMPLIFIER KIT. 3 to 4 watt Amplifier Kit.

4. TRANSISTOR INVERTOR. 50 v. D.C. Input. Output 240 v. A.C. 40 watts incorporating transformers, choke, condensers and 2 GET373. In solid 16 gauge aluminium case, size 15 x 6 x 2 1/2 in. by famous manufacturer, 19/6, plus 7/- P. & P.

5. FLUORESCENT LIGHT FITTING. Twin 40 watt 200/250 v. less tubes. 39/6. P. & P. 7/-.

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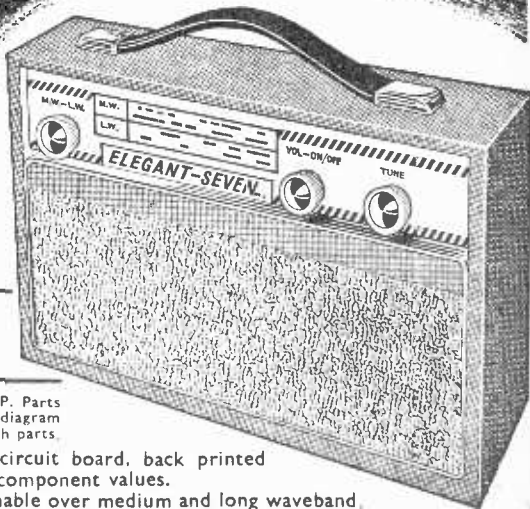
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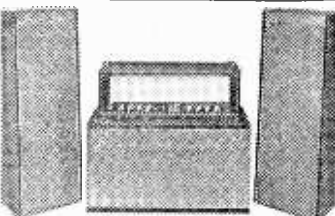
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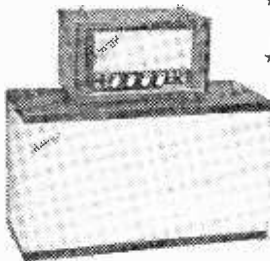
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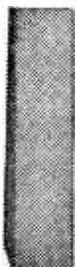
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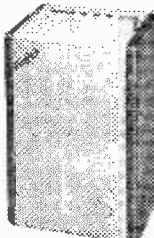
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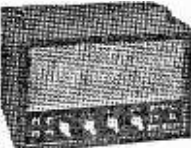
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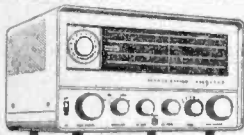
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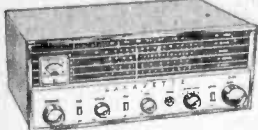
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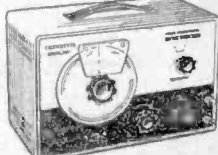
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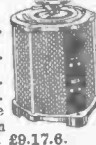
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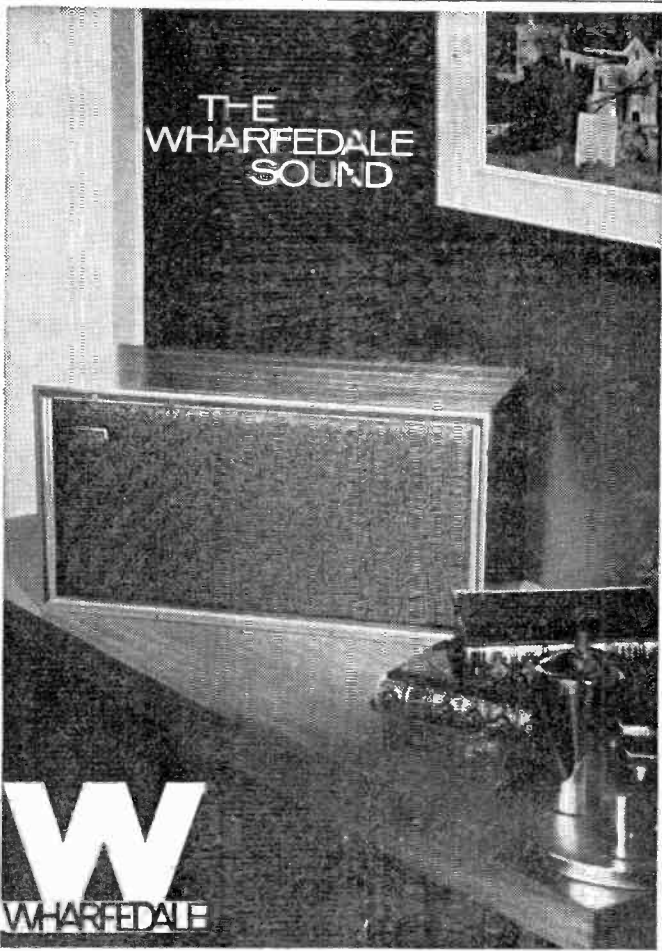
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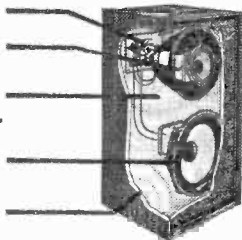
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Free technical folder on the Linton from Dept. P.

PRACTICAL WIRELESS

AUGUST 1965
VOL 41 NO 702

REQUIEM FOR A SHOW

IF we had a flag, it would now be at half mast. For the radio and television industry has stood by and doomed to oblivion the 1965 Radio Show, a venture that was hardly allowed to get off the ground.

Since the 1920's the Radio Show has flourished until in recent years it began to flounder, and both public attendance and stand bookings began to decline. No single factor can be pinpointed for the reasons are several, complex and partly intangible.

However, the snowball effect of company mergers progressively reduced the number of potential exhibitors. The increasing cost of buying stand space and of fitting and manning exhibits, also took its toll, and then the broadcasting authorities made less spectacular provision for entertaining the public.

But the death knell for the old-type Radio Show clearly rang out when major exhibitors began staging their own independent trade-only splinter shows. Now this year with most of the big boys opting out, the 1965 Show had little chance.

Whatever the success of these private ventures, however, we do not think they are in the industry's long-term interest. The public may often prove tiresome and exhausting at exhibitions but these are the people who buy the products and keep the manufacturers in business.

Other major industries manufacturing highly competitive consumer goods continue to run successful exhibitions catering for trade and public. The radio industry is the odd man out—and surely it cannot afford to be so insular. Let it have the foresight to organise something worthwhile for 1966.

The Radio Show is dead! Long live the Radio Show!

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All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 29s. per year to any part of the world. © George Newnes Ltd., 1965. Copyright in all drawings, photographs and articles published in "Practical Wireless" is specifically reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden. THE SEPTEMBER ISSUE WILL BE PUBLISHED ON AUGUST 5TH.

Can Anyone Help

PLEASE can anyone help me? I need a small internal switch for a wireless set issued by R.A.P. Ltd., London, 7634. Apart from this component the set appears to be in good condition. R.A.P. appear to have discontinued this model.

W. M. Stanley.

17 Denton Road,
Wokingham,
Berkshire.

C.W. Standards

As an ex-W.T. operator of 20 years' standing I find after months of listening on the amateur bands that the standard of British operators (c.w.) is fast deteriorating compared with other countries. Many of them seem barely able to work at 10 w.p.m.

At a recent R.A.E. examination centre I met a few of the old ex-Service operators who are all eager to do a spot of operating. These men are excellent operators and quite good mechanics, capable of building their own transmitting and receiving equipment. But these men failed the R.A.E. simply because they were unable to memorise a few formulae. Several lads of about 16, however, passed the test, yet they had not a clue how to operate. Consequently they turn to phone working—too scared to work c.w.

If this state of affairs continues there will be very few British operators working on c.w. in a few years' time.

F. Taylor.

Plymouth,
Devon.

Octal Valves Again!

I DISAGREE with R. A. Packer's comments on I.O. valves (May issue). Manufacturers are all for miniaturisation, as we all know, but need constructors follow blindly along the same path?

While I.O. valves are obtainable I consider that the saving in odd shillings far outweighs the sacrifice of that inch or so of not so valuable space.

J. Hucl.

Canvey Island,
Essex.

NEWS AND..

404 LOUDSPEAKERS IN WEMBLEY P.A. SYSTEM

The largest public address system in Britain is that of the Wembley Stadium where no less than 404 loudspeakers are installed. Sixty of these are mounted on baffle boards and the remainder in 86 column enclosures.

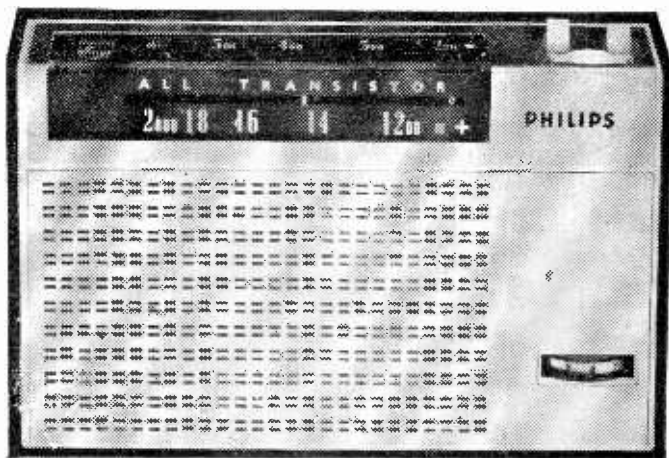
The p.a. system was recently installed by Rediffusion technicians in time for the F.A. Cup Final in May, but only after they had solved the formidable problem of the Stadium's acoustics which, when it is empty are very different from when it is packed to capacity.

NEW COMPUTER FOR THE MIDLANDS

Businessmen in and around Birmingham requiring computer services can now make use of a new Honeywell 200 machine recently installed by Midlands Computing Centre Ltd.

The new British-made computer is expected to find ready acceptance by Midland-based firms too small to buy their own computer, yet large enough to warrant the analysis of production, sales and costs which modern equipment can provide.

LOW-COST PORTABLE MADE IN BRITAIN



This portable receiver is British made and inexpensive. In fact according to the makers, Philips Electrical Limited, it is the lowest-priced British-made portable radio ever.

Known as the "Popmaster", it has been introduced to combat the ever-growing imports of Hong Kong-manufactured portables into the UK and will sell at £7 19s. 6d.

Each set carries a six months guarantee covering spares and labour and also a world-wide service guarantee valid for any service department of Philips companies throughout the world.

The "Popmaster" covers long and medium wavebands and measures just over 5½ in. x 3½ in. x 1½ in. The 6-transistor circuit is powered by four U7 batteries housed in a sealed compartment in the base of the cabinet. Also contained in the base is a fitted earpiece attachment.

.. COMMENT

OXFORD MOBILE RALLY

On July 11th the Oxford and District Radio Society will hold its tenth anniversary mobile rally. The organisation of this event has been in conjunction with the RSGB.

Talk-in stations on 160m, 80m, 4m and 2m will be operating at the venue in the grounds of the College of Technology, Headington, Oxford. Attractions planned for the day include morris dancing, films, demonstrations, competitions, etc.

TRANSCIVERS FOR NEW POLICE SQUAD



Radio communications is playing a big part in London's new 100-strong police patrol group, which began operations recently. The group has been formed to counteract sudden outbreaks of crime by saturating trouble spots with uniformed police.

Contact between the group's vehicles and Scotland Yard and the P.C.s on foot, is by v.h.f. radio' each constable in the group carrying a light-weight transceiver.

There are just two women P.C.s in the group; one of them is seen here using one of the fully-portable transceivers.

THE '65 SHOW CANCELLED

The '65 Show—this year's planned successor to the National Television and Radio Show—is off due to lack of support.

The organisers of the Show—Industrial and Trade Fairs Ltd.—announced the complete cancellation of the venture after many of the largest companies in the British radio industry had decided not to take part. The commercial TV companies also dropped out.

The exhibition was to have taken on a new appearance this year, with all parts of the radio, television and home entertainment industry represented. This year too, overseas participation was expected for the first time.

GPO TO HAVE SEVEN COMPUTERS

The first of seven English-Electric LEO 326 computers ordered by the GPO has been installed at Charles House, Kensington, London, where it succeeds a LEO 3 machine which has been operating for nearly a year. The work of producing six million telephone bills a year, calculating repayments of National Savings Certificates, preparing experimental route schedules for mail vans and analysing stores and equipment, which the old machine handled, will be carried on by the LEO 326 at much faster speeds and still provide extra computer time for further developments.

A second LEO 326 computer will be installed at Charles House later this year and another two will go to the POs Savings Department at Lytham St. Annes, Lancashire.

When all seven are installed and operating, the GPO will be the largest commercial computer use in Europe.

more News and Comment on

Bottling Acid

SURELY Mr. Ian Gregory (News and Comment, June, 1965) is a little antiquated in his choice of containers for hydro-fluoric acid. In this day and age a polythene bottle would probably be cheaper and more easily obtainable than one of wax or gutta-percha and equally effective.

I. M. Hutchings.

Rugby,
Warwickshire.

Correspondents

I AM 27 years of age and studying radio and television servicing with a correspondence school.

I would like to correspond with radio and television servicemen anywhere in the world.

Ernest Tchakanga.

P.O. Box 357,
Mufulira,
Zambia,
Cent. Africa.

I WOULD like to correspond with anyone in South Africa who is interested in radio and motor-yachts. I am 14 years old.

Ian Thornton.

13 Adshead Close,
Poundswick,
Manchester 23,
Lanca.

I AM a regular subscriber to *Practical Wireless*. In addition to being interested in electronics I am a philatelist and would like to correspond with people in England willing to exchange Indian stamps and first-day-covers for miniature electronic components not available here.

G. H. D'Cruz.

Sugar Factory,
Shimoga,
South India.

The Solo Organ

I HAVE located a small error in the transistor solo organ article (April issue, page 1163). The wire from top right-hand tuning resistance tag should go to the lower arm of VR2 and not to the middle arm as shown.

G. W. Hardy.

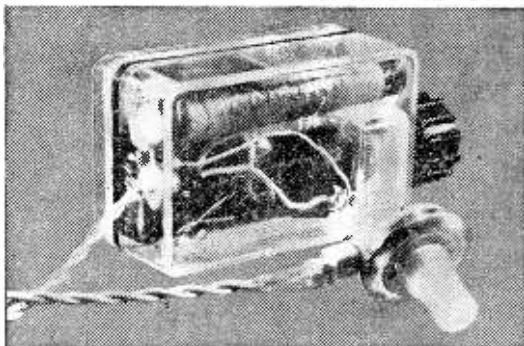
Poole,
Dorset.

page 330

THIS is a receiver circuit using the minimum of components, driving a hearing aid type earpiece, and having as its power supply a solar cell. It requires no external aerial or earth. The final circuit was developed from the somewhat standard receiver circuit of Fig. 1, and it is advisable to build this one up first to test reception conditions in your area. If you have already experimented with one and two transistor circuits of the regenerative and reflex types and you know that you are in a good reception area then the final version may be constructed immediately. Otherwise build up the circuit of Fig. 1 e.g. in a "bread-board" arrangement. This circuit should easily, without external aerial or earth, drive the earpiece on most m.w. stations—the local Home (and possibly Light) should be loud and continentals should be fair. If these conditions are fulfilled then the final Mark 3 version is assured of some success. However, some areas of the country, especially those in deep valleys or below high cliffs, provide very low signal levels (and even a standard six transistor

no single cell had been designed solely as a power supply for an application like this, however it appeared that most could provide sufficient current in average light conditions, all of them appearing to produce a voltage which remained constant at about 0.5V. The type finally chosen was of large (comparatively speaking) surface area: 0.75in. x 0.45in. (1.9cm. x 1.2cm.), designed for both high and low light levels—type MS2A and appears as in Fig. 2.

The current provided by the cell depends on the light intensity, from zero in darkness to about 20mA in bright sunlight on open circuit. Thus the receiver had to be capable of operating from these power conditions. The voltage supply for the design of Fig. 1 was thus reduced to a single dry cell, i.e. 1.5V, and R1 was likewise reduced to approx. 150kΩ in order to keep the same current—of the order of 1mA—flowing in the transistor. Suitable adjustment of TC1 and VR1 then resulted in a fairly similar performance, at slightly reduced volume, to that of the 9V circuit. At this stage the solar cell was substituted for the dry cell, giving



SOLAR-POWERED POCKET RECEIVER

by C. J. Walton

superhet has difficulty in these areas) in which case the circuit of Fig. 1 will receive little if anything and the light powered circuit even less. Thus the disappointment of building something doomed from the start to failure is avoided (and the expense of the solar cell is saved).

Tr1 can be any standard r.f. type for this circuit (in fact a number of accepted "low frequency" transistors will function here, e.g. odd specimens of OC71, XB103, and even an occasional "red spot"—however the recommended r.f. types are necessary for the final circuit) and examples tested were: OC44, XA112, OC171, AF114. Slight variation of R1 may be necessary but the results of this reflexed-regenerative should be good. The coil may need a few turns adding or removing to cover the entire m.w. depending on the characteristics of the components used. It was considered initially that this type of circuit, providing maximum gain at both r.f. and a.f. with separate detection by diodes, would be the most efficient for a light powered receiver.

Then came the choice of a solar cell. Data was obtained from Ferranti Ltd. (Gem Mill, Chadderton, Oldham, Lancs.) and it became obvious that

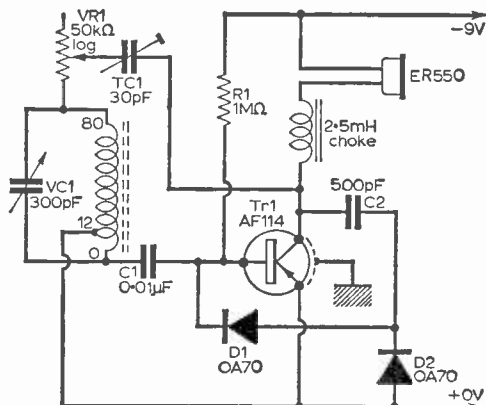


Fig. 1: The circuit of a simple one-transistor reflex receiver which formed the basis of the final design. The coil is wound on a 2in. length of $\frac{3}{16}$ in. diameter ferrite rod using 34s.w.g. d.c.c. wire.

the Mark 1 version of Fig. 3. At this stage it was found that the alloy junction type transistors were not as effective as the alloy diffused types at these low power levels. However the alloy diffused types—OC171, AF114, and a micro alloy type: MAT 121, were all operating quite well. Volume was down from the 1.5V circuit but in my area (Sowerby Bridge near Halifax, in the West Riding of Yorkshire) the Home and Light came through quite well.

With the receiver not tuned to a station as the cell was turned towards a window or other light source, a hissing could be heard in the earpiece signifying that current was flowing in the circuit (and in strong sunlight the hiss was louder than with the 1.5V cell in circuit). Stations became audible just before the hiss commenced, became louder as more light was allowed to fall on the cell, and finally regeneration in the form of whistling was heard. Keeping the light intensity constant and varying R1 the graph of Fig. 4 was obtained. No quantitative measurements were possible, but it can be seen that for regeneration to occur under fairly bright conditions, the optimum value for R1 should be between 10k Ω and 150k Ω approx. A value of 47k Ω was therefore chosen.

Regeneration was, however, difficult to control, occurring either at one end of the band or the

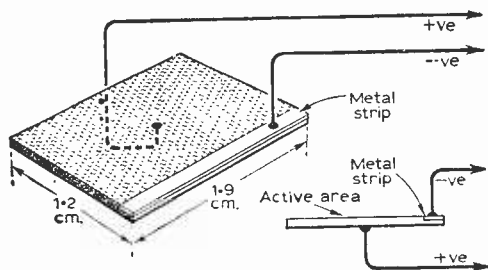


Fig. 2: Physical details of the MS2A solar cell.

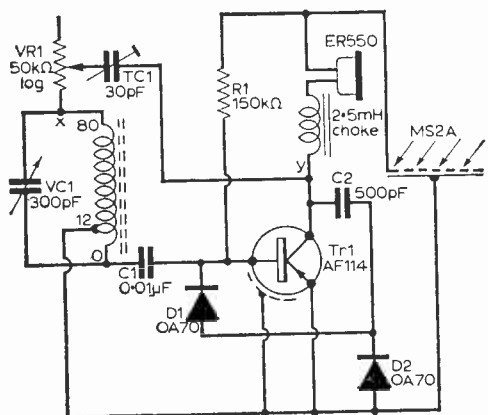


Fig. 3: The basic circuit of Fig. 1 with the solar cell introduced to replace the power supply.

other and was very critical, no matter what adjustment was made to TC1 and VR1 the circuit tended to "plop" in and out of oscillation. To try and alter this unsatisfactory situation and as a further experiment, it was decided to operate the circuit as a regenerative detector, i.e. C2, D1, D2 were removed. The results of this were interesting. Output volume was reduced slightly but regeneration was more easily controllable, far less feedback being required to achieve the same effect. In fact the 30pF trimmer used for TC1 had a too high value even at minimum capacitance (approx. 3pF). VR1 and TC1 were thus removed and a length of insulated (plastic coated) wire was connected to point X and another to point Y (see Fig. 3) and these were twisted together to act as a fine trimmer. This is a very sensitive type of control, the value changing at each twist by only a very small amount.

Finally the effect of removing the r.f. choke (i.e. allowing the earpiece to act as its own choke) was tried. Again there was a reduction in volume but this time regeneration was much easier to control

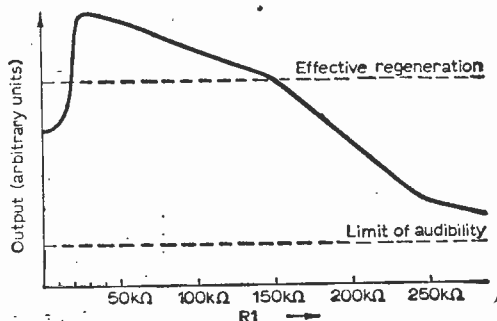


Fig. 4: This graph illustrates the level of sound output with various values of R1, the light intensity kept constant.

and extended more evenly over the entire band with medium light intensity, tailing off at the low frequency end as the light was reduced. This was the final Mark 3 version shown in Fig. 5. Note that it only uses 8 components altogether. Omitting R1 resulted in very weak reception of the Home Service and nothing else.

Details of Components Used in Final Receiver

Transistors tested included OC171, AF114 (this was the actual transistor used when built into a case) and MAT121. VC1, miniature solid dielectric 300pF tuner.

A small, clear plastic case available from dealers (or from T.S.L., Hudson House, 63 Goldhawk Road, W.12) at 1s., size 2.2in. x 1.4in. x 0.9in. The 2in. length of ferrite rod used as aerial would just fit into the case.

The earpiece used in all the versions is an Ardenite ER550. Any good quality magnetic (not crystal) earpiece would be suitable provided its impedance is > 1k Ω . The chassis is a small piece of perforated eyelet board (cut from a 4½in. x 2½in. piece) which is available, including eyelets, from

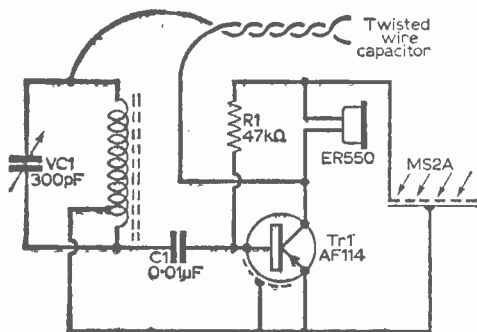


Fig. 5: The final circuit of the receiver.

Right: The finished receiver mounted in its plastic case.

Home Radio (Mitcham), Ltd., 187 London Road, Mitcham, Surrey. The ferrite rod is wound with 32s.w.g. enamelled or silk covered wire. Other details are given in Fig. 6.

The layout of the finished receiver is given in Fig. 6. The cell was stuck with Sellotape to the inside of the case (loss of light through absorption in the plastic is negligible) and its leads sleeved. If an opaque or coloured case is used the cell obviously will have to be stuck on the outside. Feedback was set for dull daylight and if the light intensity should become too high, i.e. a lot of whistling occurring, then the set must be turned away from the light to reduce current rather than changing the feedback.

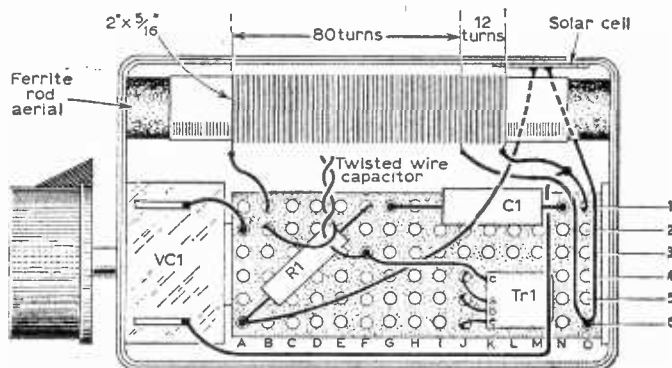
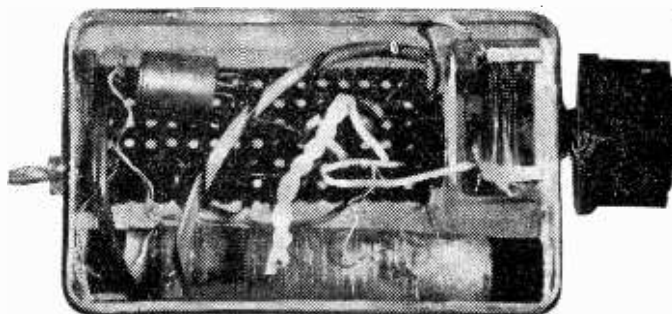


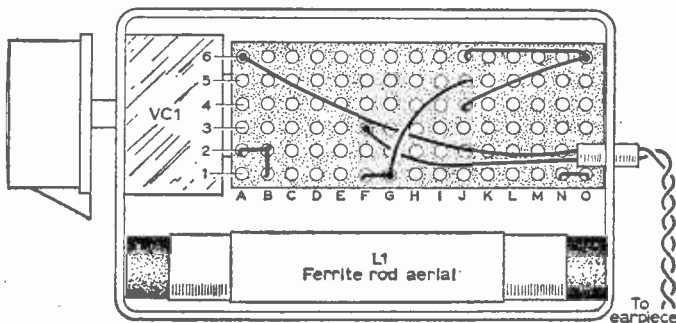
Fig. 6: These two views of the completed receiver show clearly the construction and wiring.

Further Details of Operation

The circuit does cover the entire m.w. band but obviously local conditions will determine exactly what the performance will be. In Leeds the Home, Light and Third are all at reasonable volume and in the evening the heterodyning whistles of most of the Continentals are heard. Careful tuning in quiet surroundings has brought in Luxembourg, A.F.N. and Berlin

as well as Athlone (Eire) and the northern Carline. At night some form of artificial light must be used. Any operated from the mains are found to produce an annoying buzz of "mains hum" either at one end of the band or at various points along it as the cell is moved to and from the light source. An ordinary torch is much better, whilst a fluorescent light is useless, producing a continuous buzz. It was found that the set will operate, if held close enough, from a cigarette lighter or even a match. Note that as with all ferrite rod aerials the set is very directional and sometimes a

—continued on page 338



TAPE TAPE TAPE TERMINOLOGY TAPE PART ONE

by H. W. Hellyer

NOWADAYS every branch of art and science carries around with it an enveloping cloak of jargon. Although this may be understood by the coterie of enthusiasts many of the terms are quite incomprehensible to the outsider.

Not least among the "specialist fields" is the art (or science, if you insist) of tape recording. Most readers of this magazine are quite aware of the general idea of tape recording and can interpret most of the terms in everyday use. But now and again the need arises for a more precise definition.

We want to know what a "drop-out" is and how it is caused, not merely be told it exists. More important, when weighing up a possible bargain we want to know just what those impressive specifications mean.

The following notes are compiled, more or less alphabetically, to clear up a few of these vague definitions. This is not a complete glossary of tape terms—which would insult the average readers' intelligence—but an illustrated description of some of the special aspects of tape recording.

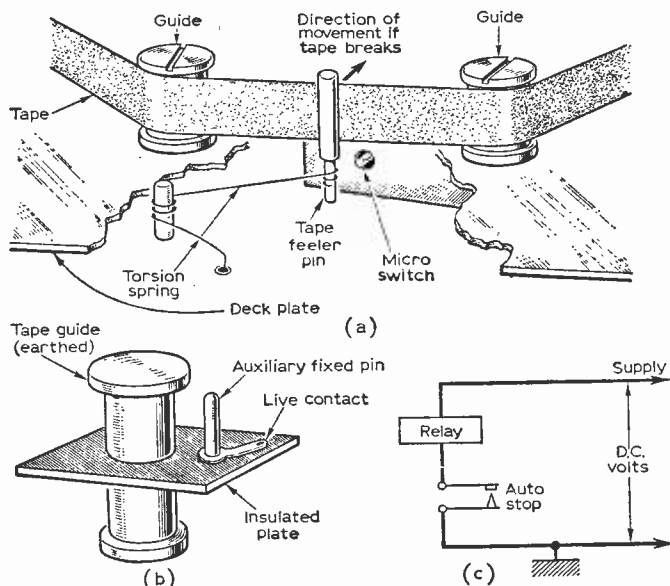


Fig. 1 (a): Micro-switch actuated (open-circuits motor supply) by feeler pin if tape breaks; (b): auto-stop tape guide with separate electrode (alternative may be split-insulated guide); (c): metal foil of tape leader short-circuits contacts to activate relay.

AUTOMATIC RECORDING LEVEL

The principle of automatic gain control for radio and television is well known. In tape recording there are special difficulties and special circuits. A portion of the amplified signal is sampled, amplified and fed back as bias to a controlled stage whose gain varies with the applied voltage.

The difficulty lies in the long time constant needed with audio frequency signals. The sampling circuit must react quickly to a loud sound, apply the bias and then retain a comparative level of sounds for a reasonable period.

It is hoped to devote more space to a detailed description of how this is done in a future number of PRACTICAL WIRELESS.

AUTOMATIC STOP

A method of halting the tape transport system when (a) the tape breaks or (b) metal foil leader tape, usually at the end of the reel, completes a relay circuit.

The actual method of stopping the spools varies from the simple interrupter switch in the motor supply to relay-operated solenoid which disengages the head and capstan pressure system, applies the brakes and neutralises the mechanism. Fig. 1 shows typical systems.

AZIMUTH ADJUSTMENT

Setting of record, playback and erase heads to bring the gap into the right position at 90° to the tape length.

Correct positioning is important to allow tapes to be played on different machines and to ensure maximum gain and frequency response. Incorrect azimuth setting of the record/playback head causes loss of high frequencies (see Fig. 2).

Normal method of azimuth adjustment is to replay a pre-recorded signal of constant level (see Test Tape) and adjust the playback head for maximum response.

BALANCED INPUT AND OUTPUT

Method of connecting items of equipment by transformer coupling with centre-tapped windings which may be earthed.

Hum and noise are cancelled out to a greater extent by this method and longer leads can thus be used. Normally two-cored screened cable is employed and matching is at low impedance.

BANDWIDTH

In hi-fi work this normally refers to the frequency range covered by the amplifying equipment which is between two extremes that occur where the output is 3dB below that of a standard reference frequency. (Usual reference for this purpose is 1kc/s.)

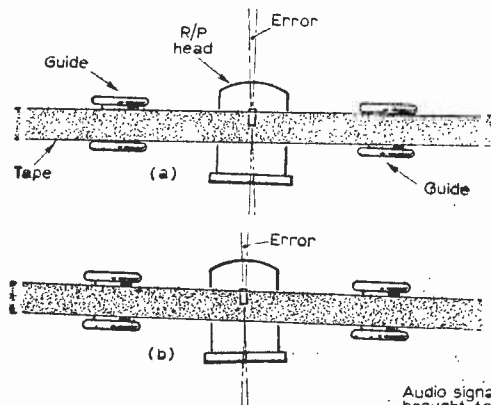
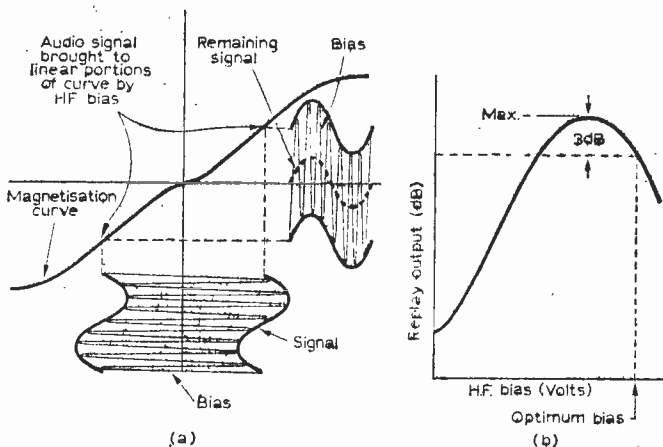


Fig. 2: Off-set guides (a) or head (b) cause h.f. loss.

Fig. 3(a): Signal imposed on bias waveform prevents distortion due to "kink" in magnetisation curve. Optimum bias setting (b) is at value which produces a 3dB drop in output beyond peak.



Where the two limit frequencies only are quoted the above standard is understood. (See also Frequency Response.)

BIAS

The non-linear characteristics of the recording medium are overcome by imposing the audio signal on a high-frequency bias before applying the combined waveform to the recording head (see Fig. 3a).

The frequency of the bias should be as high as possible, allowing for heating losses in the head windings. Normally the bias frequency is about four or five times that of the highest frequency to be recorded; 45 to 70kc/s is the range used in domestic tape recorders.

A bias frequency that is too low will cause shrillness of reproduction of heavily modulated signals.

Bias voltage depends upon the head and tape characteristics and is usually adjustable by a preset control for optimum conditions. Normal adjustment is a little beyond that which produces the maximum output, i.e. over the peak of the curve (see Fig. 3b).

CAPSTAN

Normal method of driving the tape to attain constant speed is by pressing it against a revolving spindle called the capstan. The capstan may be mounted on a flywheel and driven by coupling belts or intermediate wheels from the motor.

The flywheel tends to "iron out" minor speed variations due to its inertia. On some single-motor machines the capstan and flywheel are integral with the motor.

Method of keeping the tape in constant contact with the capstan is by applying a spring-loaded pressure roller or pinch wheel.

CASSETTE

An enclosed spool of tape, usually adapted for automatic loading, either in a complete magazine or as a replacement for a single spool with a free end of tape fed to the take-up spool.

An endless cassette contains a long loop of tape which is wound off the outside and back on the inside of the spool for continuous playing.

C.C.I.R.

See Standards.

CHANNEL

In stereo reproduction, one amplifier chain.

CHANNEL SEPARATION

The degree of interference between channels must be reduced below 30dB for stereo systems. Parallel track systems require more stringent separation, greater than 50dB.

CROSSTALK

The above interference is known as crosstalk and may be specified at certain frequencies. It is more noticeable at higher frequencies. Overall separation at all frequencies for tape recording systems should be better than 40dB.

CROSSTRACK

A method of mixing the output from one track with the input to another by which a composite signal can be built up without the need for "super-imposition". Modern tape recorders may incorporate this under the specified terms *multiply* or *sound-on-sound*.

CUEING

Marking of particular places on the tape, visually or aurally. Special controls for "inching" may be fitted to aid cueing.

Dictation machines may use a method of slow wind when required to assist the finding of particular places on the tape. (See also Tape Position Indicator.)

DEFLUXING OR DEGAUSSING

Heads and ferrous metal parts such as supports and guides tend to build up a residual magnetism during use. This causes noisy reproduction when it affects the modulated tape. Method of removing this residual magnetism is to apply a strong and varying field with a *defluxer* and gradually remove this source so that the normal "random" disposition of magnetic "domains" in the metallic parts is resumed.

The construction of a defluxer is generally based on a solenoid with a projecting pole, shaped to be inserted in the tape path mechanism. Regular defluxing should be carried out to reduce background noise. A pronounced hiss is the usual indication of head magnetisation.

Degaussing of the record/play head can be effected by gradually removing the bias voltage. One method is to switch to "Record" and interrupt the mains supply, allowing oscillations to die away. Repeated several times this can keep a recording head degaussed but will not demagnetise other ferrous parts.

DISTORTION

The difference in waveform between input and output of the amplifier as a whole. This is mainly harmonic distortion and may be expressed as a percentage at a specified frequency at full modulation. (e.g. less than 5% at 1kc/s, third harmonic distortion at full modulation, may be stated as $\leq 5\%$.)

The signal-to-noise figure may also be stated as that obtained for a certain distortion factor (see Signal-to-Noise).

DOUBLE GAP

Method of achieving more complete erasure by applying the erase field at two successive places along the tape path. Dimensions are such that the delay from first to second gap is a few milliseconds.

DROP-OUT

Short-term loss of signal which may be caused by discrepancies in tape coating or uneven tracking of tape.

DUOPLAY

Name given to the system of feeding two outputs from a tape recorder into a single channel amplifying system.

DYNAMIC RANGE

The separation, expressed in decibels, between the smallest and the greatest signals the system can handle with specified minimum distortion. The limits are imposed by the loudest sounds received at the input having to be recorded without over-modulating, while the quietest sounds are still above the noise level and the balance between is in proportion.

For a domestic machine the dynamic range may be between 40 and 60dB. In practical terms this means that a 1kc/s signal has a ratio of 10,000 or 1,000,000 to 1. Although the actual dynamic range of a full orchestra may be as much as 70dB the above range is adequate owing to the non-linear relationship between loudness and sound power.

DYNAMIC MICROPHONE

See Moving Coil Microphone.

DUBBING

A term used, mainly in editing, to denote the combining of two or more sound sources into a single recording. Also, in ciné work, the adding of a soundtrack to the film.

ECHO

A signal delay produced by feeding back a replayed signal into the recording channel. The time of delay is determined by the physical separation of the heads and tape speed and may be doubled on two-channel machines by using the second channel as an intermediate stage.

An echo chamber can be either a device similar to the above, to produce the echo effect, or an acoustic method of achieving the same end. Note that echo alone is not effective without *reverberation* for realistic simulation of original sounds.

EDITING

Altering of the signal by cutting and interposing programme material. This can be done physically (see *Splicing*) or by a form of dubbing, using two machines with the first playing back the original programme, the second recording such parts as are required to be used, and halted meanwhile, or with interposed material recorded during the same operation.

ELECTROSTATIC MICROPHONE OR LOUDSPEAKER

A device which depends on capacitor action for its operation. Fig. 4a shows examples.

Basically a diaphragm is held between perforated plates and charged by an external voltage. Sound signals cause vibration and a change in capacity in the former case and in the latter case set up vibrations of the diaphragm to produce the aural output.

The electrostatic loudspeaker is particularly suited to high-frequency reproduction and is often used as a "tweeter".

EQUALISATION

Compensation for the rising frequency response of the tape system and for high-frequency loss which occurs in the playback head. Circuits in the playback amplifier "shape" the response to a

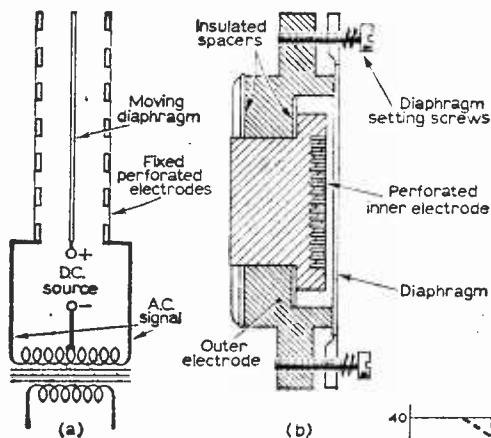


Fig. 4(a): Capacitor loudspeaker and microphone principle; (b): section of capacitor microphone capsule.

recognised standard. For a fuller explanation see *Standards and Pre-emphasis*.

Equalisation is necessary to enable interchange of tapes and tape recorders. It is defined by the time constant of the attenuating section of the circuit. Examples, depending on the speed of the replayed tape are given in Table 1, which also shows the "turnover frequency".

Equalisation standards were revised a year ago and it will be noted that there are three distinct sets of standards, the CCIR, DIN and NARTB. The previous standard, generally accepted, for $3\frac{1}{2}$ in./sec. tape speed was 200 microseconds, now revised to the DIN standard of 140 microseconds, with a turnover frequency at the point where the reactance of the capacitive arm of the attenuator equals the resistance of 1.3kc/s and a low-frequency roll-off of 3.180 microseconds (at 30c/s).

Fig. 5 shows typical equalisation curves. Low-frequency roll-off is generally recognised nowadays as machines in the domestic class rarely reproduce frequencies below this point.

Replaying tapes recorded to one standard on a machine equalised to another will require some modification to the amplifier response to achieve a "level" output. Thus American tapes, recorded to NARTB standards, replayed on European machines, equalised to CCIR standards, will tend to sound over-brilliant and with some bass accentuation.

Conversely CCIR recorded tapes replayed on machines with NARTB standards, having bass and treble cut to compensate for the recording pre-emphasis, will tend to sound weak in both treble and bass.

		Speeds (in./sec.)				
		15	$7\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{8}$	
Time Constant (micro-secs.)	CCIR	35	70	200 (old)		
	NAB	50	50			
	DIN	35	70	140	280	
Turnover Frequency (kc/s)	CCIR	4.5	2.6	0.8 (old)		
	NAB	3.2	3.2			
	DIN	4.5	2.6	1.3	0.68	

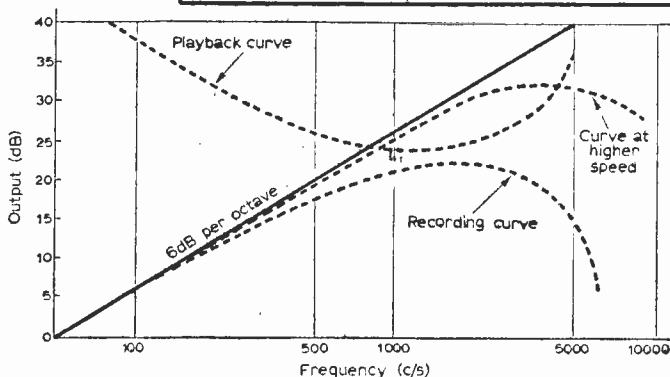


Fig. 5: Recording and playback curves, showing effect of h.f. loss in recording which must be compensated by a boost during playback. At higher speed the loss is less. 6dB octave curve is ideal response.

ERASE

One virtue of the tape recording medium is the possibility of "cleaning off" a tape for re-use. This is termed "erasure" and consists of destroying the pattern of magnetism on the tape and reverting to the normal random disposition of magnetic domains.

Erasure is effected by the application of a strong and varying field as the tape passes a point prior to the recording head.

The method of applying erasure may be by passing the tape across a permanent magnet, or magnets, or by applying the field from the gap of a d.c. or a.c. energised head. The last-mentioned is preferable, as d.c. or permanent magnet erasure tends to build up a unidirectional magnetism, resulting in a hiss.

The waveform should be symmetrical, and is often derived from the common oscillator used to provide the bias waveform.

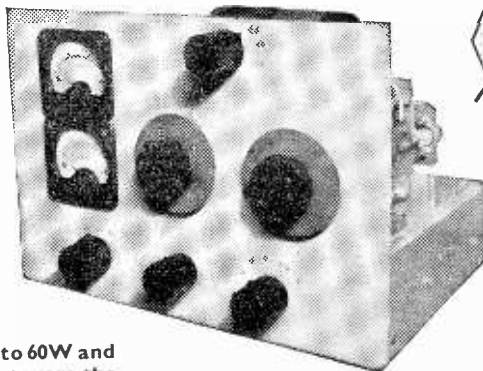
Bulk erasure is a method of removing the modulation from a tape in one action by inserting the complete spool in a strong field. Special apparatus for this purpose has been developed and is widely used. The applied a.c. field is made to diminish regularly, to prevent residual magnetism leaving a high background level.

PART TWO NEXT MONTH



3 BAND TRANSMITTER

by G30GR



THE 6146 will take an input of up to 60W and the transmitter described here covers the 80, 40 and 20m bands. The building cost is not very great and can be further reduced by simplifications described later if required. The transmitter itself is crystal controlled but it can readily be used with a v.f.o.

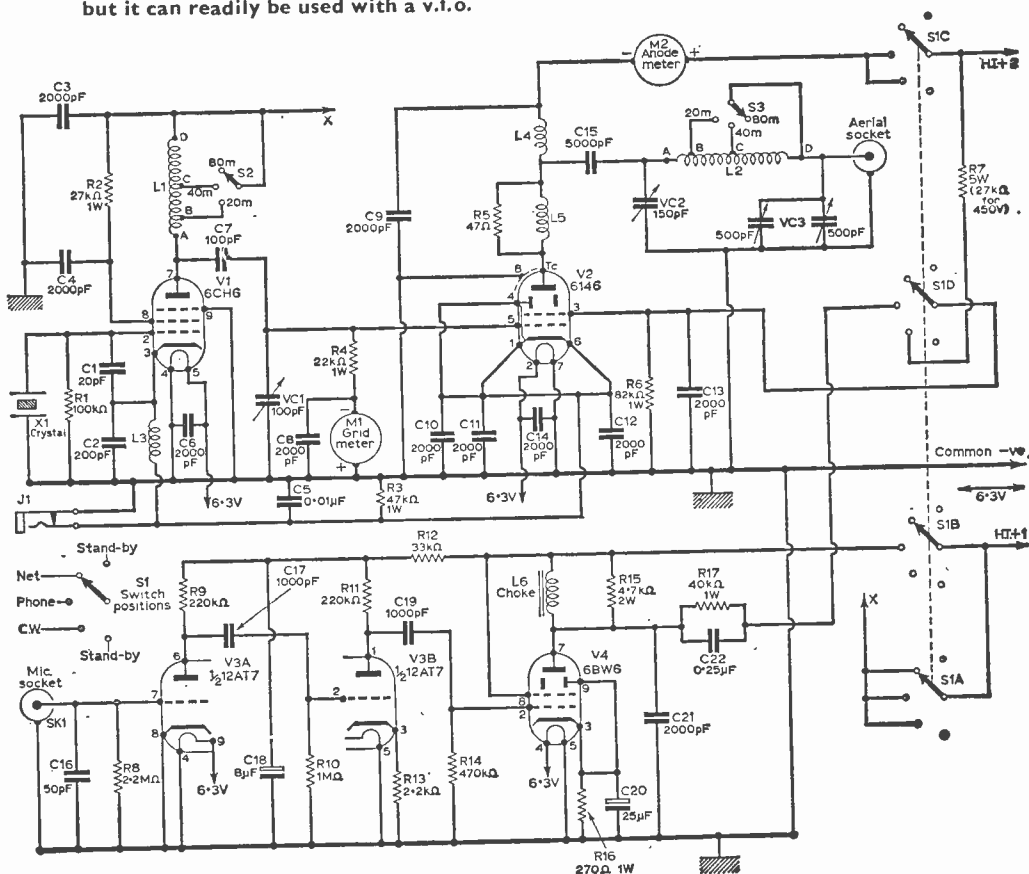


Fig. 1. The transmitter circuit complete except for the power supply.

Fig. 1 shows the transmitter circuit. A 6CH6 is used as an oscillator (V1) which gives high harmonic output when wanted, so that 3.5Mc/s crystals may be used for the 80, 40 and 20m bands. Some 160m band crystals are also satisfactory, especially for 80m.

L1 is the oscillator anode coil switched to cover the 80, 40 and 20m bands and tuned by the 100pF variable capacitor VC1, which also allows grid drive to be adjusted to obtain suitable grid current. It was found that more than sufficient grid current was available on all bands, so this capacitor is normally tuned somewhat off the resonant point. This has no effect on oscillator frequency.

The 6146 (V2) runs with about 2mA to 2.5mA grid current, providing about 40-50V bias developed across the 22k Ω grid resistor R4. This valve has three cathode and beam plate pins each grounded for r.f. by a 2000pF capacitor to chassis (C10-12). For c.w. operation the key plug is inserted in closed-circuit jack J1, the cathodes of both stages being keyed. For 'phone transmission the plug is withdrawn or the key shorted.

L2 is the pi tank coil for three-band coverage and this can work directly into many aerials. L5 is an anti-parasitic choke. Anode current is checked with the anode meter M2. For a 600V h.t. supply the anode current of the 6146 is listed as 112mA, providing an input of 67W. It is, however, probably as well to restrict the anode current to 100mA. This would give an input of 60W at 600V or 50W at 500V and so on. Good results have been obtained with a 275V h.t. supply or input of 27.5W.

In order to avoid the necessity of providing a large modulator, screen grid modulation is used. A single 6BW6 (V4 in the circuit diagram) will easily supply enough audio power for this type of modulation, excess being dissipated in the 4.7k Ω resistor R15.

When using 'phone it is necessary to reduce the power amplifier (6146) input to about one-half that which can be run on c.w. This is a general rule with screen grid modulated systems. The transmitter thus has an input of up to about 30W on 'phone for average work and 60W on c.w., which is adequate for much DX working.

The modulator section is very straightforward and has enough gain for a crystal microphone of reasonable output. Component values have been chosen to give some treble and bass cut.

Full control switching is furnished by a four-pole, five-way switch S1, the positions of which are shown in Fig. 1. Each "standby" position switches off all circuits but leaves the heaters running. These positions are used while receiving. The second standby position is merely to allow the operator to switch from C.W. to Standby without passing through the 'phone and net positions.

With the switch at "net" h.t. is applied to the oscillator only, allowing tuning up for grid current and netting the receiver on the transmitter frequency. (With a v.f.o. this allows the v.f.o. to be tuned to the receiver frequency also.)

With the switch set for "phone" the modulator is brought into use and h.t. applied to the p.a. anode. Choke modulation of the screen grid is by

the 6BW6, with the d.c. potential derived from the modulator high-tension supply.

When the switch is in the "c.w." position the V2 screen grid is supplied from the high-voltage supply through a dropping resistor chosen to allow full input. This resistor can usually be 27k Ω but is selected as described later.

Metering

As grid and anode currents are very important in setting up, two meters are included. A single meter with grid/anode switching is sometimes employed but the use of separate meters avoids the need for repeated switching from grid to anode circuits and avoids errors such as looking for anode current while the single meter is switched to read grid current.

Two "surplus" meters were used and suitable thermo-couple meters can be purchased at very low cost. When the thermo-couple is removed these instruments usually have a full-scale reading of about 2mA to 5mA. They are thus readily shunted to allow suitable scales to be drawn. The latter can be on thin card cemented to the old dial.

For grid current a 5mA meter is suitable. The one used was 2mA full scale, shunted for 4mA full scale. For anode a 100mA, 150mA or 200mA instrument is suitable or a smaller meter shunted to 150mA or 200mA full scale.

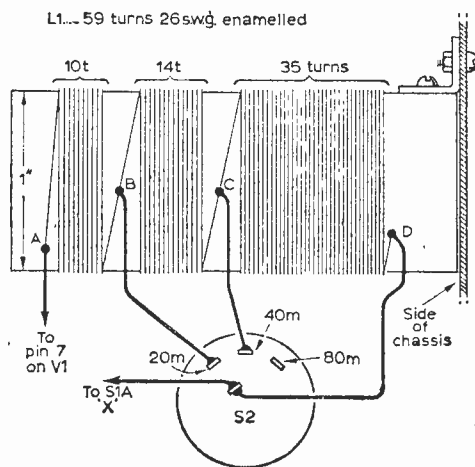


Fig. 2: Winding details of the oscillator anode coil, L1.

Oscillator Stage V1

The oscillator anode coil L1 is shown in Fig. 2 and is wound with 26s.w.g. enamelled wire on a paxolin or similar former 1in. in diameter and 2½in. long. A space of about ⅛in. is left between each section. All turns are in the same direction.

Ends A and D are anchored by passing them through holes. Taps B and C are made by baring and twisting the wire and soldering the loop. Switching is so arranged that ten turns are in circuit for 20m, 24 turns for 40m and the whole 59 turns for 80m.

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7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5 v. torch batteries. The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-94 M. and also 4 separate switched band-spread ranges, 13M, 16M, 19M and 25M, with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow stage by stage instructions.



NEW—The SKYROVER Mk III

Now supplied with redesigned cabinet, edge-wise controls, black and chrome plastic cabinet. Size 10 x 6 1/2 x 3 1/2 in. with carrying handle.

Can now be built for **£8.19.6** Post 5/-.

H.P. Terms: 20/- dep. and 11 months at 16/8. Total H.P. Price **£12.1.6**.

The SKYROVER DE LUXE

Tone Control Circuit is incorporated with separate Control. In a wood cabinet, size 11 1/2 x 6 1/2 x 3 1/2 in. covered with a washable material with plastic trim and carrying handle. Car aerial socket fitted.

Can now be built for **£10.19.6** H.P. Terms: 25/- dep. and 11 mths at 20/-.

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A simple additional circuit provides coverage of the 1100/1560M. band (including 1500 M. Licht programme). All components and detailed construction data.

Only 10/- extra Free

This conversion is suitable for both models that have already been constructed.

Data for Receiver 2/6 extra. Refunded if you purchase the parcel. Four C2 batteries 3/4 extra. All Components Available Separately.

We are pleased to announce the opening of our premises at **42 TOTTENHAM COURT ROAD, LONDON, W.1.**

This branch will be devoted exclusively to quality High Fidelity equipment—Tape Recorders, Record Reproducers, Radios, Tuners, etc. Custom built installations will provide balanced comparisons of the best in Hi-Fi in ideal surroundings. Open all day Thursday, early closing Saturday. Tel. LAN 2573.

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High quality 4-track Stereophonic Tape Recorder with unique "solid state" transistor circuit. Brief spec: 4-track recording, mono or stereo, 4 or 2 track replay; 3 speeds—7 1/2, 3 1/2, 1 1/2 ips; fast forward and rewind; auto tape stop; output 2 watts per channel to two 7in. x 4 in. speakers in detachable enclosures; frequency response 60/14,000 cps; input for 2 mikes and 2 radio/pick-ups. Takes 7in. spools. For 200/250 v. mains use. Overall size 22 x 15 x 7 1/2 in. Brand new and guaranteed. List Price **49 Gns.**

LASKY'S PRICE 33 Gns. Incl. 2 crystal mics, tape and spool. Carriage & Packing 15/- extra.

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Type P.E. 220. Transistorised device which enables any 50 microamp D.C. Multimeter to be used in place of a valve volt meter. On the IV range an impedance of 1 megohm is offered which increases on the 1000 V. range to 100 megohms. 7 ranges immediate connection to Avo 8 but suitable for use with any other 50 microamp meter. Size 6 x 6 x 3 1/2 in. New and boxed. List Price **7 Gns.**

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Supplied in sub-assemblies for easy building. Covers range from 540 Kc/s to 20 Mc/s. Ham Band is provided with a scale for direct reading and can also be band spread. Facilities: A.N.L., A.V.C. and M.A.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity. Valve line up 2x6B6, 2x6B6, 2x6AV6, 1x6Q6 and 5Y3. 2 Aerial sockets. Standby position for use with a transmitter. 8 meter fitted, 200-250V. A.C. mains. Steel cabinet, grey crackle finish. Size 15 x 8 x 10 in. Dual 12 x 4 in. All parts new and fully guaranteed. Complete with full construction data and operating manual.

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5 in. Standard play, 600ft., PVC base,	8	6	7 in. Long play, 1,800ft., Acetate base,	15	0
5 in. Triple play, 1,800ft., Mylar base,	35	0	7 in. Triple play, 3,600ft., Mylar base,	58	6
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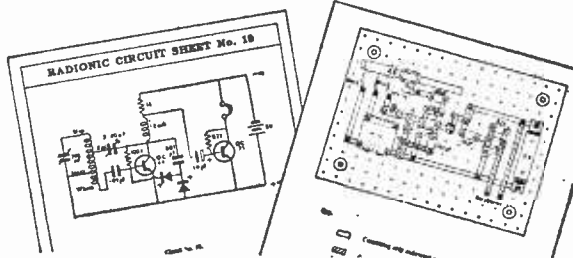
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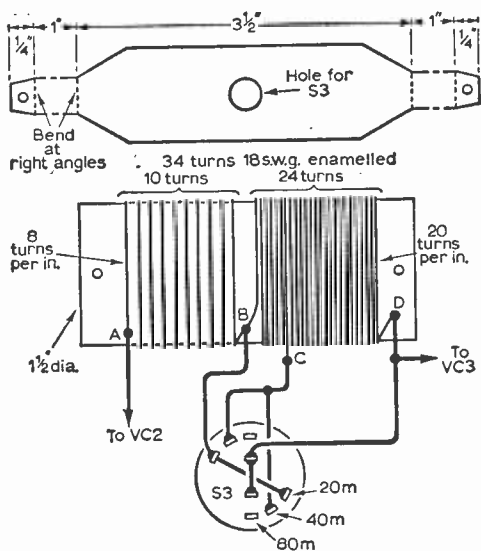


Fig. 3: Winding details of L2, the p.a. tank coil, and dimensions of a bracket to mount it in association with S3.

The maximum effective capacitance across the coil is 50pF and tuning should be correct with the 100pF capacitor nearly open for 20m and 40m and about one-half closed for 80m. If 3.5Mc/s and 7Mc/s crystals are used it is not possible to tune this circuit to unwanted harmonics. L3 is a 2.5mH 60mA r.f. choke.

P.A. Tank Coil L2

This is wound on an insulated tube 3 1/2 in. long and 1 1/2 in. diameter as shown in Fig. 3. Beginning about 1/4 in. from one end, the 18 s.w.g. wire is anchored in hole A and ten turns are wound at eight turns per inch. The wire is secured at B. A further ten turns are then wound and a small loop made at C. After 14 more turns the wire is fixed at D.

The aluminium bracket shown in Fig. 3 holds the coil to the switch. It is cut and bent as shown and fitted to the coil with 6BA bolts, S3 already being in the central hole. Stout connections are then soldered to S3. They are as short as possible. S3 has two three-way sets of contacts and they are used in parallel.

The completed tank coil assembly can be attached to the panel by the securing nut of S3 and short connections taken from A to VC1 and D to VC3.

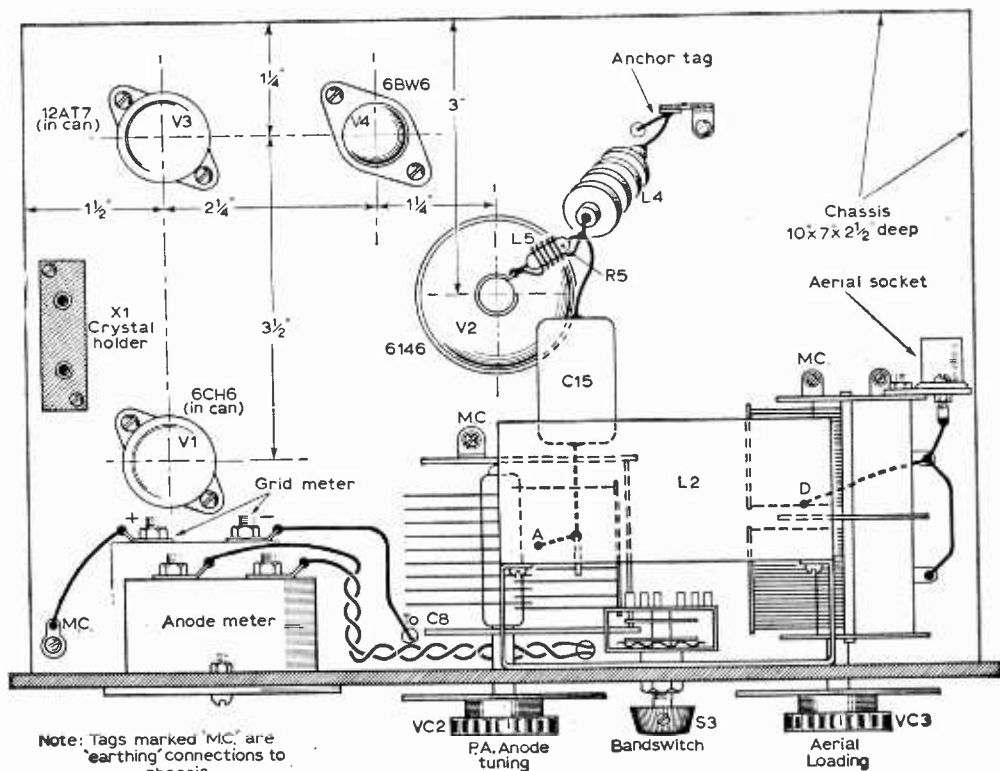


Fig. 4: Above chassis layout where most of the larger components are mounted.

Above Chassis

The chassis measures about 10 x 7 x 2½ in. and the layout is shown in Fig. 4. The crystal holder can be for ½ in. or ¾ in. spacing crystals or both. Valveholders can be located from the dimensions given.

VC2 must have wide spacing to avoid sparking over; a spacing of 0.05 in. between plates is more than adequate for 600V. For 40 and 20m 100pF will suffice but 150pF is required for 80m and 200pF would be better.

VC3 is a receiver type capacitor and should have a total of at least 1,000pF (two-gang 500pF with sections in parallel). For low impedance aerials on 80m 1,500pF is better (three-gang capacitor) but 1,000pF is easily sufficient for the 20 and 40m bands.

Both capacitors are bolted to the chassis and short earth returns provided for their rotor contacts. A small plate carrying a coaxial socket is bolted to the frame of VC3 and allows a coaxial feeder from an aerial to be plugged in. The socket outer sleeve is common to the chassis. This socket is not placed on the rear of the chassis as complete segregation of the p.a. anode and aerial circuit from other wiring would then be difficult.

The front panel measures 10½ x 7½ in. It can be of hardboard or aluminium. Holes are required for the meters, capacitors and S3. S1, S2 and VC1

hold the panel to the chassis. L4 and C15 are wired together and to VC2 (Fig. 4). The assembled tank coil unit can then be fixed by S3 and a short lead taken from A on the coil to VC2 fixed plates. D on the coil is connected to the fixed plates of VC3. L4 is a 2.5mH r.f. choke rated at 150mA d.c.

The anti-parasitic choke L5 consists of five turns of 20 s.w.g. wire with an outside diameter of ½ in. and a total length of ½ in. When the choke is made R5 is placed inside it and connected to choke and anode cap with the shortest possible leads.

Twin twisted leads from the anode current meter pass through a hole nearly under S3 to C9 and the switch. The grid meter is connected from chassis to C8 as in Fig. 4. The lead from L4 goes through the chassis to C9, which is immediately below.

S3 control knob should have band positions marked. It is convenient to use 0-100 or similar dials for p.a. anode tuning and aerial loading (VC2 and VC3) but control knobs without dials are also perfectly satisfactory. Screening cans should be provided for the 12AT7 and 6CH6.

Underside of Chassis

Positions of components and leads are shown in Fig. 5 and the transmitter may conveniently be

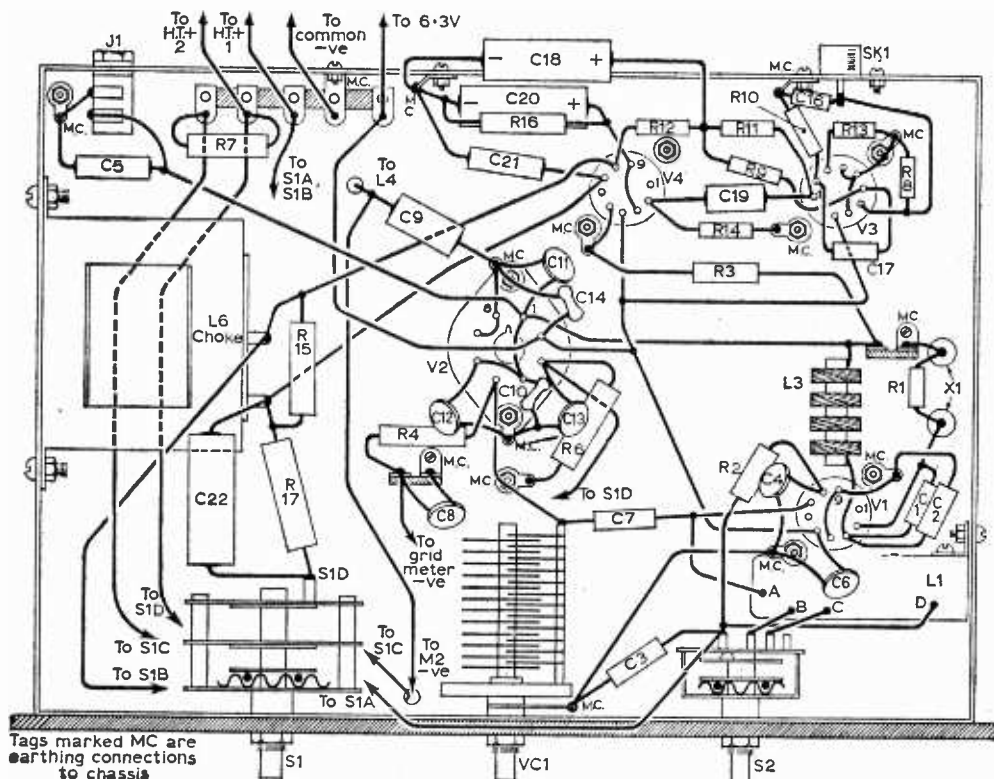


Fig. 5: Complete underchassis wiring, except for the switch, S1.

wired in stages. For r.f. circuits 18 or 20 s.w.g. wire is used. Heater and h.t. wiring should run against the chassis and be adequately insulated. It will be helpful to use sleeving or insulated wire of several colours, especially to identify meter, h.t. and switch circuits.

6CH6 Oscillator

Coil L1 is left until wiring is otherwise finished here. C4 and C6 are disc ceramic capacitors. L3 and R3 are anchored to an insulated tag near the crystal holder. Points MC are tags bolted to the chassis in the usual way.

Connections to C7 and C3 should be as short as possible. L1 is held with a bracket bolted about 1in. from the lower edge of the chassis and 2½in. from the panel.

The oscillator may be tested, if desired, by applying 6.3V a.c. to the heaters and about 250V d.c. to point X (see Fig. 1). With valve and crystal in, current should drop to about 20mA as

for r.f. by C10, C11 and C12, as shown, is necessary to avoid unwanted oscillation.

Double Triode

C17 and C19 should be mica or of equal quality as any slight leakage will upset bias on the second triode section (V3B) or on the 6BW6 (V4). C18 is displaced in Fig. 5 to show connections but lies over R16.

The microphone has the usual screened lead terminating in a coaxial plug. The inexpensive type of general purpose crystal mike should be satisfactory. It may be necessary to keep the microphone and its lead reasonably clear of the aerial.

6BW6 Output

The 6BW6 audio output stage or modulator V4 is very straightforward. For the anode choke L6 a speaker output transformer is most suitable. The type intended for a mains pentode, rated at 60mA or more and probably with a ratio of about 40:1, is ideal. The secondary is not used.

The optimum load of the 6BW6 is about 5kΩ, but the modulating impedance of the screen grid is much higher and not uniform throughout the audio cycle. As more power is available than required a 4.7kΩ resistor R15 is thus added to supply a stable load. The 6BW6 anode connection runs near the back of chassis and tag strip, clear of r.f. circuits, as in Fig. 5.

The modulator may be tested, if required, by temporarily connecting a loudspeaker to the transformer secondary. R15 may be disconnected. Speech should be clear and distinct. The microphone must be well away from the loudspeaker to avoid feedback howling.

Function Switch S1

This is four-pole, five-way, but no circuits have to be completed at either extreme position. Two two-pole, four-way wafers were actually used, assembled on a cut-down spindle from an old switch, and with a stop removed so that a second "off" position was obtained.

Fig. 6 shows the wiring for a new switch, consisting of two wafers, each having two-poles with five-ways. Lengths of coloured flex or other insulated wire can be soldered on before mounting the switch in the chassis.

Switching can be checked without supplies and valves. High tension should reach the 6CH6 anode (pin 7) in all but "standby" positions. With the switch at "phone" h.t.+1 should be connected to pin 8 of the 6BW6 holder and through R17 to pin 3 of the 6146 holder. H.T.+2 also goes to 6146 anode. When the switch is at "c.w." h.t.+2 remains connected to the 6146 anode but pin 3 is now fed through R7 from h.t.+2. In no circumstances must switching be such that screen grid voltage is present on the 6146 when the anode voltage is absent.

Power Supplies

The heaters require 3.2A at 6.3V, so a 3½A or 4A secondary will do well. For h.t.+1 a 250V receiver type power pack is ideal. A supply of about 220V to 270V at 60mA is sufficient.

The voltage applied at h.t.+2 depends on the

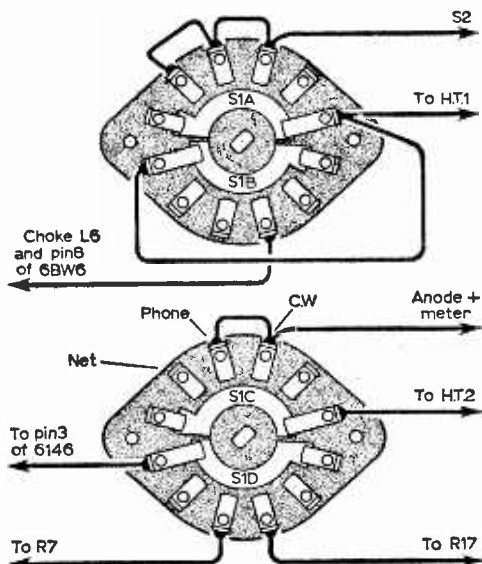


Fig. 6: Connections to the four poles of the function switch, S1.

oscillation commences. The carrier may be detected with a receiver or a tuned wavemeter with bulb indicator will glow if near L1, with S2 and VC1 adjusted for each band.

Power Amplifier

C10, C11, C12 and C13 are disc capacitors connected with very short leads. R4 is clear of the chassis and anchored at a tag providing the grid meter negative connecting point. C8 is a disc capacitor. The meter leads run against the chassis and anode meter leads are clear of the grid meter connections and pass through a separate hole near the function switch S1.

When no plug is inserted in the key jack, L3 and the p.a. cathode circuit are returned to chassis by closing of the jack contacts. Efficient grounding

power supplies which may be available and the input wanted. It is a good plan to make an initial test or tuning up with reduced voltage, such as can be obtained from a 250V supply, or by joining h.t.+2 to h.t.+1.

About 100mA at 450V to 600V falls easily within the rating of a transformer of moderate size and a suitable power supply is shown in Fig. 7. R7 controls the screen grid voltage when working on c.w. and it may be reduced to 10k Ω or less for a 300V supply. The screen voltage of V2 should not exceed 250V or 400V with key open. A screen voltage of about 150V is generally suitable for c.w. current, being about 10mA. Screen dissipation (volts x current) should not exceed 3W.

If there is any doubt the best solution is to begin with a high-value screen grid resistor and reduce this after checking the screen grid voltage and current with a meter. For 'phone the screen voltage is much lower as this is necessary for correct modulation.

Tuning Up

First tests should be made with the switch at "Net". A 3.5Mc/s band crystal can be inserted and adequate grid current should be found on each band by adjusting VC1. Grid current should not be allowed to exceed 3.5mA and should generally be between 2mA and 2.5mA. S2 is always switched to the band upon which output is wanted, so that the final amplifier is not used as a doubler.

A 7Mc/s band crystal is useful to check 14Mc/s tuning to make sure the third harmonic of 3.5Mc/s (10.5Mc/s) is not selected by VC1 in error. Or a bulb indicator meter or receiver can be used. The 14Mc/s band should peak up with VC1 nearly open.

An initial test can be made with power delivered into a 60W household lamp connected to the aerial socket and chassis by a few feet of twin flex. With S2 and S3 at 80 close VC2 and VC3 and tune for grid current at "Net". The function switch is then turned to "Phone" and VC2 is immediately adjusted to find the dip in anode current as shown by the anode meter. The current is increased by opening VC3 and retuning with VC2. VC2 is always tuned for minimum anode current, corresponding to maximum r.f. output.

Grid current is readjusted if necessary by VC1. When the p.a. has been tuned to resonance the switch can be turned to "c.w." if wanted (key closed). As loading progresses in the way described the lamp will light with increasing brilliance. For c.w. the anode current may run up to 100mA.

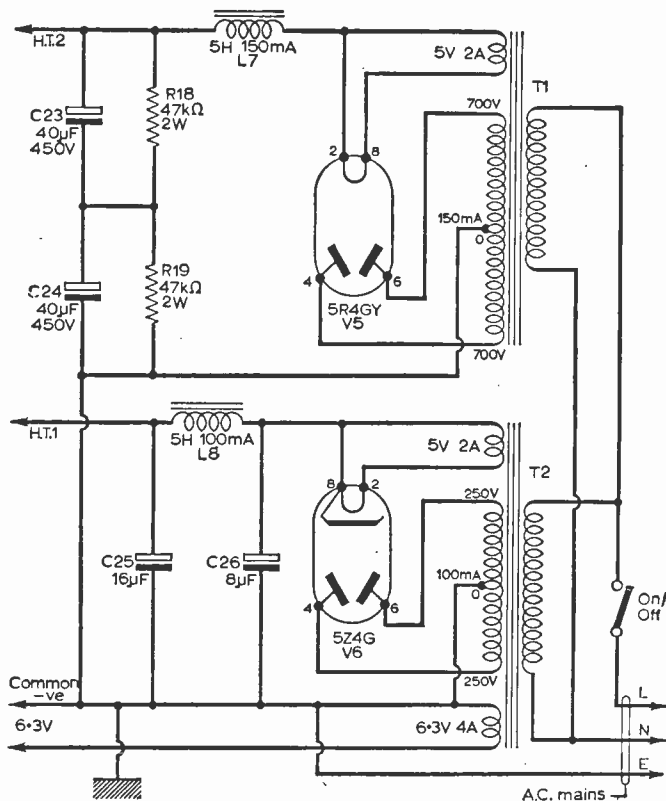


Fig. 7: Circuit of a suitable power supply for the transmitter.

Loading the transmitter into an aerial follows the same method. A coaxial-fed dipole can be fed directly from the transmitter. Various end-fed aersals can also be used in this way with a good earth to transmitter chassis. For resonant end-fed aersals some type of aerial tuner placed between aerial and transmitter will be almost essential.

Crystal Frequencies

Crystals with fundamental and harmonics falling within the band limits may be used on all three bands but some crystal frequencies will not supply harmonics within the bands. For 7Mc/s and 14Mc/s, 7Mc/s crystals may be used, while 3.5Mc/s crystals will do for 3.5, 7 and 14Mc/s. Any 1.75 to 1.9Mc/s crystals will do for 3.5-3.8Mc/s also.

'Phone Loading

For best speech quality with screen grid modulation the p.a. must be heavily loaded. To accomplish this the screen voltage of V2 is kept low by R17 and loading with the pi-tank is continued until the dip in anode current on rotating VC2 has become small. An input of about

—continued on page 321

on the Short Waves

MONTHLY NEWS FOR DX LISTENERS

All times are in G.M.T.

All frequencies are in kc/s.

The Broadcast Bands—by John Guttridge

ONE station getting its schedule out well in advance is Radio Moscow. Until the end of August English for Europe is aired at 0700—0730 on 11,830/9,710/9,600/9,480/7,240; 1200—1300 on 15,490/11,930/11,830/11,700/9,780; 1900—1930 on 9,710/9,480/7,340/6,050/1,320; 2000—2030 on 9,710/9,480/7,160/7,340/6,050/1,380; 2100—2200 on 9,710/7,340/7,260/6,050/1,490; 2200—2230 on 9,710/7,340/6,050/1,490/1,380/1,320. In September/October the following changes are made: 0700—0730, 11,830 dropped; 1900—1930, 2000—2030, 7,280/6,170 replace 9,710/9,480; 2100—2230, 7,280 replaces 9,710.

Frequencies used for several English transmissions were changed by *Radio Prague* for its summer schedule. Changes are: 0100—0155, 0330—0425 on 5,930/7,120/7,345/9,795/11,990; 0300—0355 on 15,285/15,448/17,825; 0800—0855 on 6,055/9,503/15,235/15,285/21,450. On its QSL, says D. Hill, date, time and metre band are given.

T. Robinson, Liverpool, reports that *Radio Nederland* (P.O.B. 222, Hilversum) has a DX programme at 1600 on Fridays and a request programme on Saturdays. In London 15,425 gives better reception than 11,730 for the 2100—2150 English transmission but suffers from severe interference from A.F.R.T.S. New York on 15,430.

A. Waddelow, Norwich, has heard the Bonaire relay with Dutch at 2100 on 15,290 giving SINPO 33433. He reports full verification details from *Radio Denmark* (Radio House, Copenhagen V), *Radio Andorra* (Roc des Anelletes, Andorra-la-Vielle, Andorra—return postage required), *Radio Berlin International* (Berlin-Oberschöne-weide, Nalepastrasse 18-50, German Democratic Republic), and *Radio Belgrade*.

The 1315—1400 English transmission to South-East Asia from *Emissao Nacional de Radiodifusao* (Rua Sao Marcal, IA, Lisbon) is now on 21,495/17,895. The BBC now has an English transmission to East Africa from 1800—1830 on 15,420.

D. Hill mentions two English transmissions from *Radio Bucharest* (P.O.B. 111, Bucharest) from 1930—2030 on 9,570/9,510/7,225 and 2230—2300 on 7,195/6,190.

Middle Eastern stations reported this month are *Radio Ankara*, *Kol Israel* (Broadcasting House, Jerusalem, Israel), *Radio Baghdad* (Salihiya, Baghdad), *Radio Iran* (Ministry of Information, Meydan Ark, Teheran), and Saudi Arabian Broad-

casting (Ministry of Information, Airport Road, Jeddah). Paul Harris, Elgin, says that English from *Kol Israel* is now from 2045—2115 on 9,009/9,625/9,725. Ankara now has French at 1930—1945 and German at 1800—1815 on 15,160. A. Waddelow reports English on this frequency at 2200—2230 (SINPO 44441).

E. Conduit, Wolverhampton, has had a QSL with date and frequency only from Saudi Arabia and with frequency only from Baghdad, although W. Smith had a yellow card giving date and frequency from Baghdad. Alex Bushby, Glasgow, reports a letter giving no details from Iran.

Two African stations, *Radiodiffusion de la Republique Democratique du Congo* (B.P. 3171, Leopoldville) and the Nigerian Broadcasting Corporation (Broadcasting House, Lagos) are reported by R. Howard, Stockport. The former he has heard between 2030—2200 on 11,795. Nigeria was logged in English between 2130—2205 on 11,900/15,255.

Cairo Radio (U.A.R. Broadcasting and TV, Maspero) has changed the language segments for its transmissions on 17,920 to East and Central Africa. They are now Nianga 1545, Shona 1615, Somali 1645 and English 1745—2030.

According to Paul Harris, *Radiodiffusion Television, Ivoirienne* (B.P. 2261, Abidjan, Ivory Coast), has replaced its International Network frequency of 11,820 by 6,015. He has heard this frequency at 2200—2400 and presumes it carries the 1830—1900 English transmissions on weekdays.

A. Wildsmith, Manchester, advises those who have written to *Radio Ghana* (Broadcasting House, P.O. Box 1633, Accra) and have not received a reply not to despair. He has just received a verification after five months.

Conflicting reports on the QSL of *All India Radio* (P.O. Box 500, New Delhi) from E. Conduit and D. Hill. The former's card had the date only, whilst the latter's had all details.

Finally three reports on *Radio Pyongyang* (Pyongyang, North Korea). Paul Harris has heard English at 1800—1900 on 10,380 and 1900—2000 on 6,540/7,379 with 7,580 being announced as well. According to announcements, he says, other transmissions are 1000—1100, 7,580; 1100—1200, 9,750; 2400—0100, 17,520; 0300—0400, 9,570. M. Clark, Cheltenham, has heard the station on 6,500 at 1900 when it says it is using 7,389/7,595/8,333/10,381. A transmission from 1000—1200 on 6,061/7,353 was also announced.

The Amateur Bands—by David Gibson G3JDG

ONCE more unto the h.f. bands, dear friends, and verily DX shall be thine. Unbelievers should listen on 20m, where thousands of stations from almost everywhere are battling it out.

It is fair to reckon that all those not on 20 are on 15 and this band seems more consistent these days. It stays open for longer and although there is often some QSB it's on the up and up, certainly as regards reliability.

Poor old 10? Not any more—half Europe gets on at the weekends and the African continent shows itself, too. Those with directional antennas on this band should have very full logs.

TWENTY

Let's start with a bang. Here is the pick of the log from **BRS26813**, of Cheltenham, who uses an S640 and HRO5T with a 90ft longwire. All c.w.: AC4H (Tibet), CN8MH, CR4AE, 4BC, EL2AE, 2AM, ET3GO, 3USA, DU1OR (Philippines), FG7XS (Guadeloupe), FM7WH (Martinique), HI4ARM, HK3RQ, HP1BR, HZ3TYQ (Saudi Arabia), JA1BZR, 1FHK, 1DU, 1ZZ, 7AB, 7ARZ, JTIAG, KH6DSW, FLK, JJ, TD, WU, KM6DJ, KP4ARS, LA4EJ/P (Jan Meyen Island), LU2DAW, 8EE, OA4EM, OY7ML (Faroes), PY1BTX, 2ON, PJ2CZ, SU11M, UL7PY, UN1BR, VE8CO, VK2EO, 2OO, VO2NA, VP5BH/MM, 9EP, VU2GW, 2LI, W5IUW/VP9, 6JNX, XE1OE, YV1AD, 4MC, 5AAQ, 5ACP, 5BH, ZD8BC, ZE8TT, ZP5LS, ZS6AJQ, 4U1ITU, 4X4HK, MZ, QA, 5A3TT, 5Z4DW, 6Y5MJ, XG, 7X2ARA, 7X3CT, 9J2GJ.

Which goes to show that if it emits r.f. then it can be found on 14Mc/s and BRS26813 will hear it! Well done, Bob—when do you sleep?

Norman Ponsford (Devon) found these on his t.r.f. CR45 with 60ft longwire, all on a.m.: HB9VW, K3NHL, K2YLM, OE3CL, PY7GV, SV0WBB, WA410, 4X4FA, 5Z4AQ, 5Z4ERR. **W. Langham** (Somerset) got these on a domestic receiver and 75ft longwire: I1BUG, LZ1KBD, PA0PAN, UA9KCF, UO5KBR, YU6BC, 4X4OS, all a.m.

Messrs. **McWhirter** and **Weare** are the ops at Derby School Signals Platoon and pulled in these on an R107 with 200ft longwire: K2ZRK/P, SP4AUQ, UA2KBD, VE4SA, W2RKY, W8HCP (all on a.m.), ET3USA, UA1KIB, UA9MX, UN1BR, UW3FV(?) on c.w.

FIFTEEN

Stephen Beale (London), using the P.W. t.r.f. (May, 1964) and a 66ft. longwire, got these on a.m.: CR6BY, EA8ER, LA4EI, SV1DL, ZC4MO, 4X4QR, 5A1TK, 5A5TE, 5R2KOB, 9G1MR, 9J2DT, 9L1WN, 9Q5DL, 9X5RZ.

D. F. Carrington (Derby) pulled in on his HE30 and 68ft longwire with 14ft vertical whip at far end: CT3AQ (Madeira), EL5CG, EA6GL, PY1NBA, PY1AGP, SV0WO, W9ACU, ZC4KW, 4X4QR, 5A1TK, 9X5WTB and 9Q5's DL, US, AWB, RB, AQ and AD.

Mike Silverstein (London), CR100 and 132ft longwire, hooked. CR6BY, CR7FR, HI8BGA,

JA1GTN, KZ5BE, OA4OS, PY1BYS, VP4LE, VS9ANR, ZE7JR, 9X5RZ.

TEN

Back in circulation! Why, we have even been getting logs!

George Owen (Bristol), using a five-valve t.r.f. and vertical joystick, leads the field with CE4FB, CR4AO, BC, CT1CN, MZ, ILX, IOF, LIM, EA3PA, EL2L, F2SI, HB9FMA, 1ISO, BIW, IYJ, MTO, PAI, WRR, KC4KC, OK1ABN, ZD8JC, ZE1JJ, 5A4HR, 5Z4AA, 9Q5AA.

THE L.F. BANDS

Only the real stalwarts stick at it. On 7Mc/s **Bob Garvy** (Gloucester) had these on his HRO and 90ft longwire, all on c.w.: DJ3ZXA, E19TF, OK4ADX, PY7AOD, SM7ACR, UA1KAL, VP2LZ, ZS6DF.

On 3.5Mc/s **A. Rolfe** (Halstead) got DJ8RS, DL2UZ, DL6VU, F2WW, F3ZK, PA0PAL, SM3YF/MM using an R109 and 12ft whip. And an unsigned log from Preston mentions DJ6QT, DL6ME, EI4R, GC2AZ, OZ3IH, SM7WW, VE1IE.

Top band almost abandoned and the only letter we had was from **W. Smith** (Staffs) with a large list of G stations heard.

IN GENERAL

The coat-hanger and cuff-link gang are still at it! **BRS26325** (Dundee) used a fireguard on 21Mc/s for 5A1TK, CT1LJ, 9M4LP, EA8EH. **M. Carter** (North Wales) used a ground-floor window frame into an HRO for 14Mc/s s.s.b.: EP2DS, KH6BK, KR6AAC, MP4BCC, OD5BZ, HV1CN, HB0AFM, HL9PK, KP4CL, VE6TP, W6VPY, W7MKI, ZS6XB, 5N2AAC, 9M2SR. Anybody thought of the little strip of metal foil around cellophane wrapped cigarettes? (Watch it, they resonate at 947Mc/s!)

ZB1 (Malta) is now 9H1 for sure. The Western Carolines and Kure Islands are on and the calls to listen for KC6 and KH6 respectively. 4U1ITU is the headquarters station of the International A.R.C. located in Geneva. Others rumoured to be squirting r.f. about are South Georgia VP8, Christmas Island and Cocos Keeling both VK9, ZD8 on Ascension Island, Crete SV0WGG high end of 20 on s.s.b., Willis Island VK4 and Samoa KS6. For Top-band addicts there is a beacon on 1.801Mc/s in South Africa signing ZE1AZD, reports very much appreciated.

What a lot of field days, British, American and now Korean. The Korean effort will be July 3rd-4th on 80, 40, 20 and 15m. Callsigns to listen for are HM and HL. Other activities on in July are: 4th, 144Mc/s portable contests; 11th, three mobile rallies, tenth anniversary rally, South Shields rally and Torbay mobile rally; 17th-18th, 1.296Mc/s tests (you've just got time to wind a set of coils); 25th, 70Mc/s portable contest and Cornish mobile rally. August 1st, SLADE D/F qualifying event. Good hunting and don't forget to drop me a line on what's coming in at your QTH.



Practical Substitutes

by M. L. Michaelis, M.A.

RESISTOR AND CAPACITOR VALUES

A frequent type of enquiry concerns apparently strange component values, such as "a capacitor of 0.056 μ F". Whilst the familiar sequence of preferred values is quite commonplace for resistors, it is less familiar in Britain for capacitors. However, our example of a 0.056 μ F capacitor simply bears the same relation to a more familiar 0.05 μ F capacitor as does a 56k Ω resistor to an older-type 50k Ω resistor. Such values are mutually interchangeable unless very critical conditions are involved and which the author of an article would point out. Unless otherwise stated, the constructor may assume that a $\pm 20\%$ tolerance is implied for resistor and capacitor component values. This obviously permits mutual interchange of a 0.05 μ F capacitor with a 0.047 μ F or 0.056 μ F preferred-value capacitor. (The 0.05 μ F $\pm 20\%$ could, of course, be anything between 0.04–0.06 μ F.)

If a preferred-value component is outside the tolerance of a near old-type component, one should select a parallel combination of two standard value capacitors to get closer to the specified value. Thus, given $\pm 20\%$ tolerance, the correct substitute for a 0.68 μ F capacitor is a parallel combination of a 0.5 μ F and a 0.2 μ F.

Similarly a 50k Ω resistor can generally replace a 47k Ω or 56k Ω resistor, but a 68k Ω resistor requires either a 75k Ω resistor as substitute, or

THE lists of parts for constructional articles are those found satisfactory in the prototypes and available at the time of publication. Many queries which the editor receives show that many beginners regard a published list of parts as being strictly binding down to the last detail.

Whilst this may be true for special projects a considerable latitude normally exists and the informed constructor can use his discretion regarding substitution of components already in his possession or more readily available.

It is the aim of this article to help readers in making on-the-spot substitute decisions if a dealer does not happen to have the exact item desired in stock. The information given will also serve many other useful practical purposes, such as the selection of modern replacements for defective components in obsolete equipment, or just to make better use of items available in the junkbox instead of making new purchases.

various combinations of two resistors, such as a 50k Ω and a 20k Ω component in series, or two 150k Ω resistors in parallel. Note that the individual wattage ratings of series or parallel combinations of two resistors can be halved only if the individual values are equal or very nearly equal.

In cases where resistor or capacitor substitutions of the kind discussed above lead to a residual discrepancy close to the tolerance limit, e.g. when substituting a 10k Ω resistor for a 12k Ω resistor, it is advisable to measure the actual values. Judicious selection can often lead to a closer approach to the specified value and will avoid additive tolerance errors greater than the tolerance limit. However, a large number of experimental circuits remain uncritical even under the latter circumstances.

The important thing to remember is that, generally speaking, any value within the tolerance of the specified value will be acceptable.

CRITICAL CAPACITOR AND RESISTOR VALUES

Resistor values are frequently more critical when they constitute parts of bleeder networks which determine the operating point of a valve or transistor, or when they are parts of calibrated shunts, multipliers, attenuators or other measuring circuits.

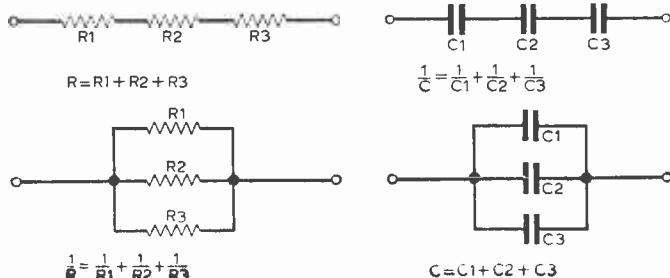


Fig. 1: Series and parallel combinations of resistors and capacitors

Capacitor values are critical in tuned r.f. and i.f. circuits and in oscillator padding positions. Even then, substitutions of combinations of two or even more components in series or parallel to make up the exact specified value are generally permissible.

Note that capacitors in parallel and resistors in series are added whereas capacitors in series and resistors in parallel are equal to the reciprocal of the sum of the individual reciprocals, see Fig. 1.

ELECTROLYTICS

It is normally permissible to substitute non-electrolytic capacitors of the same value for specified electrolytics, if space permits, but electrolytic capacitors cannot be substituted for paper or foil capacitors when insulation and capacitance stability are important factors.

Thus it is usually unsatisfactory to substitute an electrolytic for a paper or metallised foil component in an anode-grid coupling circuit since leakage of the electrolytic would lead to an intolerable displacement of the operating point of the subsequent stage. Very large metallised foil capacitors in long-period high-impedance timing circuits (minutes or hours) cannot be replaced by electrolytics. However, low-impedance transistorised timing equipment does often use low-voltage electrolytics. The accuracy of such circuits, or at least their long-term stability, nevertheless tends to be inferior.

Electrolytic capacitors are relatively coarse, inaccurate components whose capacitance and insulation may vary greatly during the useful lifetime and according to the length of resting time without applied voltage. Thus even if an electrolytic capacitor is found to function satisfactorily in a critical circuit position at some particular time, that circuit cannot in general be relied upon to function satisfactorily with it at all subsequent times. In valve circuitry, electrolytics should normally be confined to smoothing and decoupling functions.

Electrolytics are more widely usable in transistorised circuitry because impedances are generally lower, so that insulation deficiencies are less important. Therefore any slight leakage of electrolytic coupling capacitors leads to much smaller relative displacements of the transistor operating points than in the case of valve circuits.

RF CAPACITORS

It may be unsatisfactory to substitute paper capacitors for ceramic or mica capacitors in r.f. circuits when the operating frequencies are high, although this may not matter so much in long- and medium-wave circuits. On the other hand, ceramic or mica capacitors of adequate voltage rating may be substituted for specified paper ones.

In most r.f. applications it is immaterial whether ceramic or mica types are used. Modern ceramic materials have a greater capacitance in a smaller space, but their voltage ratings are often more limited. Paper capacitors generally have a lower capacitance stability, so that even if they work in local oscillator circuits they should nevertheless be avoided in these stages, otherwise trouble is

likely to be encountered with drift. Mica or ceramic components of good basic stability are most desirable, especially for v.h.f. circuits.

Where an author specifies strange combinations of odd-value capacitors with exact details of manufacturer and type number, and with two or more such capacitors connected in parallel at each position, the intention is to achieve mutual cancellation of the individual temperature coefficients. In such cases it is not possible to make straightforward substitutions of other capacitors without impairing the frequency stability of the circuit.

Forbidden resistor substitutions can arise in circuits where the stray inductance of the resistors plays a significant role. This often means that wirewound resistors cannot be used in place of specified carbon resistors in such circuits as the signal amplifiers of oscilloscopes and wideband a.c. valve voltmeters, or in the video stages of television equipment. However, in these same types of equipment wirewound resistors with a definite inductance used as frequency-correcting peaking inductance may sometimes be found.

If such resistors fail and have to be replaced, simple substitution of a carbon resistor or an arbitrary-inductance wirewound resistor of the same wattage and resistance value may lead to unsatisfactory performance of the equipment (generally reduced bandwidth at the high-frequency end).

POWER SUPPLIES

Due to the lack of standardisation in mains transformers, difficulty in obtaining the exact one specified in an article is a common problem.

Other power supply problems concern rectifier substitutions, in particular the conditions under which valve, metal and silicon rectifiers may or may not be mutually substituted. Finally, readers often query possible interchanges of halfwave, fullwave and bridge rectifier circuits if a specified rectifier arrangement is not available.

There are standard rules of substitution which can be applied to most power supply problems.

MAINS TRANSFORMER SUBSTITUTION

Space permitting, it is always possible to use separate heater transformers, either to cater for all heater requirements independently, or to augment the heater supplies available on the transformer which also carries the h.t. winding. If more than one transformer is used, all primaries should be connected in parallel, but *never* connect secondaries of physically or electrically different transformers in parallel. Series connections of secondaries are always permissible for any combination of transformers, within the insulation ratings, e.g. to obtain higher heater voltages.

If it is possible to obtain a transformer with all the required windings as far as voltages are concerned, but the current ratings are too low, then it is always permissible to wire two such *identical* transformers in parallel.

All primary and secondary connections should be respectively connected in parallel. The current

rating of each composite winding is then twice that of a single transformer. It must be stressed that such connections are possible only for *truly identical* transformers.

If, for example, an h.t. current rating of 150mA is specified, there is no objection to using a transformer with a somewhat higher rating, e.g. a 200mA or even 250mA. However, overloading of h.t. windings in the other direction should be avoided, since it leads to severe overheating. Thus if 150mA h.t. rating is required but only a 100mA transformer type is available, two such identical transformers will have to be connected in parallel.

Fig. 2 shows such a transformer substitution. In the example, a 250-0-250V 200mA transformer with two separate 6.3V 2.5A heater windings has

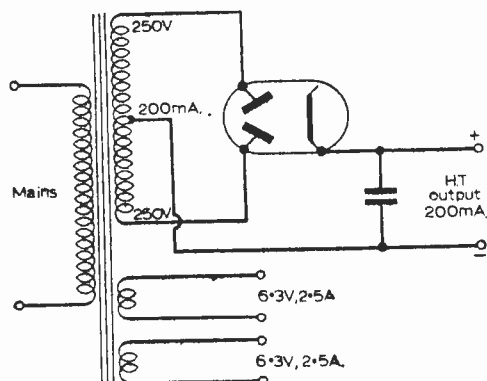


Fig. 2a: Normal full-wave rectifier circuit.

been specified (Fig. 2a). This may be replaced by two smaller transformers, each having a simple 250V 100mA winding for halfwave rectification and a single 6.3V 2.5A heater winding.

Provided that the two transformers are fully identical, there is no objection to feeding the two sections of a full-wave rectifier circuit from separate transformers in the manner shown, and the current rating of each transformer need only be one half of the required rectified h.t. current.

But there is one rather important reservation. The two separate transformers must be of a type specifically intended for halfwave rectification at their full rated current output. Halfwave rectification always passes a d.c. current component through the secondary winding of a transformer, which magnetises the core and lowers the primary inductance. The primary inductive current therefore increases and the transformer gets much hotter than it would otherwise do.

There is no net d.c. magnetisation of the core when the type of full-wave rectification shown in Fig. 2a is employed, with both rectifiers fed from the conventional centre-tapped h.t. winding on a single transformer.

If the two transformers of Fig. 2b are not designed for halfwave rectification, it is better to

change the rectifier arrangement too, using a single transformer with a simple h.t. winding (now rated for the full required h.t. current) feeding a bridge rectifier as shown in Fig. 3.

Provided that the transformer voltages are the same and the rectifier classes of Fig. 2a and Fig. 3 are the same (e.g. in both cases contact-cooled selenium rectifiers, or all silicon diodes), the respective circuits are generally completely interchangeable, whichever one an author should happen to specify.

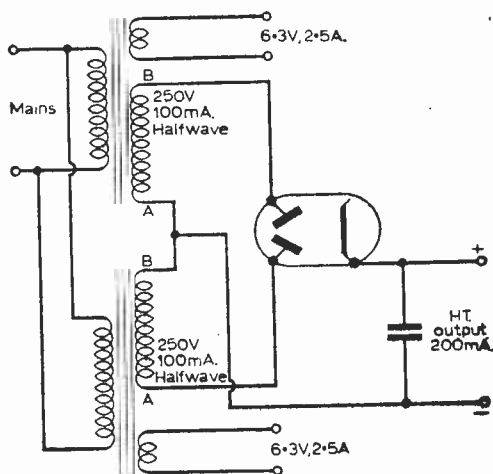


Fig. 2b: Full-wave rectifier circuit with two half-wave transformers.

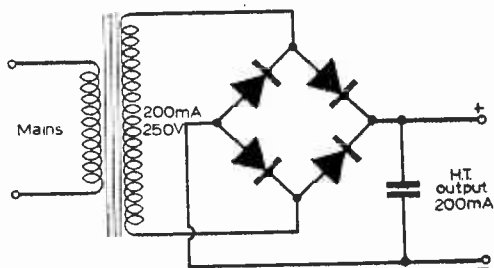


Fig. 3: Bridge h.t. rectifier circuit with simple transformer winding.

PROBLEMS WITH HEATER WINDINGS

Unless two or more transformers are absolutely identical, heater windings should not be connected in parallel, but any form of series connection for obtaining higher voltages is permissible. It is inadvisable to connect two heater windings on the same transformer in parallel, even if the current ratings are identical.

If two or more heater windings are required to meet the demands of all valves in a piece of equipment, it is generally best to "common" one side of each winding to chassis and to connect

ratings are then required for C1 and C2.

If the valve rectifier is directly heated (e.g., type 5Y3G), it will deliver h.t. voltage before many of the other valves in the equipment have fully warmed up and are able to draw full h.t. current. The initial h.t. voltage excess will then be less than in the case of semiconductor rectifier circuits, and certainly of shorter duration, but it will often still be significant. Thus beware even of substituting a directly heated rectifier valve for a specified indirectly heated one.

Note that some indirectly heated rectifier valves, e.g. the EZ80, will tolerate the full h.t. output voltage between cathode and heater, so that the rectifier heater may be connected in parallel with the heaters of the other valves, with one side connected to chassis. Other rectifier valves, and of course all directly heated types, will not tolerate this and require a separate rectifier heater winding floating at h.t. voltage on the mains transformer.

If the transformer h.t. winding delivers 250V a.c. or less to the rectifier, a common figure for small amplifiers and receivers, standard 350/380V electrolytics will always be satisfactory for any type of rectifier, whether valve or semiconductor, since this voltage rating withstands the maximum peak voltage which could arise under such conditions. In such equipment there is generally no objection to straightforward substitution of a metal rectifier for a specified valve rectifier.

The same applies for equipment which derives h.t. voltage by direct rectification of the mains input without a transformer, since the a.c. input voltage is then also below 250V.

Whenever transformer voltages higher than 250V are employed (as in high-power amplifiers and oscilloscopes) care must be exercised if it is desired to replace a specified indirectly heated valve rectifier by a metal rectifier or silicon diode combination.

If any such changes are undertaken, the reservoir (C1) and smoothing (C2) electrolytics, as well as all decoupling electrolytics for individual stages, must be replaced by components of higher voltage rating equal to 1.5 times the a.c. input voltage applied to the rectifier.

The operating voltage across C3 is much lower than that across C1 and C2, because of the large voltage drop across R2 due to anode current of V2a. But until V2 is warm, there is no anode current, so that even C3 charges to the full peak voltage. This will also require replacement.

Apart from such replacements of electrolytics where necessary, a careful check of the complete circuit diagram should be made to see if any other components could be damaged by the higher surge voltages which arise when a metal rectifier is substituted.

PART TWO NEXT MONTH

3 BAND TRANSMITTER

—continued from page 314

50mA should be suitable. If loading is too small speech quality will deteriorate. Excessive loading will reduce r.f. output.

When working with the full anode voltage the p.a. should always be tuned up initially on 'phone, even when c.w. is required, as this helps keep off-tune anode current down. The p.a. stage must not be left operating off tune or without grid current.

V.F.O.

The voltage stabilised v.f.o. originally described for the 160/80m 'phone transmitter is satisfactory*. This v.f.o. operates on 1.75Mc/s. The 160m anode coil is replaced by a slug-tuned coil broadly resonant in the 80m band. Tuning may

be done by observing grid current, then leaving the coil alone.

It is necessary to short L3 and C1 may be disconnected. Drive to the 6CH6 is on 3.5Mc/s. for all bands. Any other ordinary v.f.o. is likely to be satisfactory.

Simplifications

If 'phone working only is wanted, R3, C5, C10, C11 and C12 may be omitted, the cathode circuit going directly to chassis. R7 is not wanted, nor the "c.w." switch position. For c.w. only the whole modulator and associated circuits can be omitted. It is also possible to use an 807 as the p.a. with useful results and this type of valve is very inexpensive.

* PRACTICAL WIRELESS, March, 1965.

All this

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TWO-BAND DIPOLES

CONFIGURATED COAX-FED AERIALS

by F. G. Rayer

A HALF-WAVE dipole, centre fed with a coaxial or twin line, is one of the simplest aerials which can be used successfully without trouble. Most ready-made, kit and home-built transmitters have a pi-output circuit which allows the transmitter to be loaded directly into a 75 Ω or similar coaxial line. This method of working is accordingly very convenient.

An ordinary dipole of this type has two disadvantages which sometimes prevent its use. First it needs to be of particular length and enough space may not be available. Secondly the aerial is generally suitable for one band only, which rather limits operating unless another aerial is also available. Both these difficulties can be overcome to a useful extent.

Dipole Length

Requirements for a single band dipole can best be noted first. An aerial of this kind is shown in Fig. 1. The total length is a half-wave at the operating frequency. This can be found from:

$$\text{Length in feet} = \frac{468}{\text{Mc/s.}}$$

It is usual to cut the aerial for about the middle of the band so that actual coverage includes most of the band. On this basis typical lengths are:

80 metre band	...	128ft.
40 "	"	66ft. 4in.
20 "	"	33ft.
15 "	"	22ft.
10 "	"	16ft. 3in.

If particular interest lies at the c.w. end of a band, or any other frequency, length can be adjusted to suit.

A 75 Ω coaxial feeder is generally used and can be of any length. It may run against roof, walls or elsewhere and is thus easily brought back to the transmitter.

Practical Construction

A suitable method of making the aerial is shown in Fig. 2. A ceramic dipole "T" piece is most convenient at the middle and the overall length is measured as indicated. Hard-drawn 14s.w.g. wire is most suitable but 7/26 aerial wire is lighter and cheaper. The 14s.w.g. wire can be tightly twisted at insulators but the 7/26 needs knotting, soldering or binding.

The coaxial cable outer braiding is separated with a pointed tool and twisted into a pigtail. This is soldered to one aerial wire. The inner lead is soldered to the other wire. Tape holds the feeder to the "T" piece. If moisture enters the coaxial cable this will upset working. Some spacing material can be melted with the soldering iron to seal the end. Or a sealing compound can be used. Ribbed insulators are generally used. For supporting, polythene line is excellent.

If the aerial is not too long, and supports are rigid, the wire can be drawn taut from the ends. But if the aerial is long (say for 80m) an additional pole or other support at or near the centre is useful to help take the weight of the coaxial cable. The latter should run away at right-angles from the aerial.

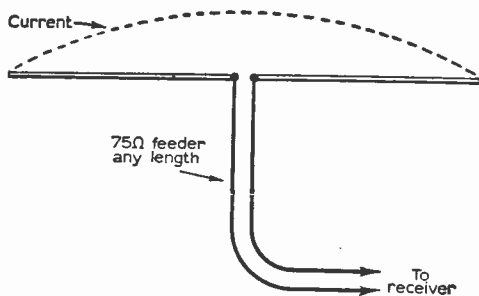


Fig. 1: The usual form for a half-wave dipole.

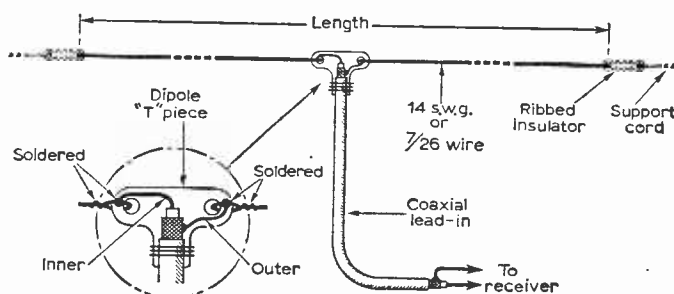


Fig. 2: A practical arrangement for a dipole complete with coaxial feeder.

Two-band Aerial

Distribution of current in the aerial is as shown in Fig. 1 and current is large and impedance low at the centre. This is why the 75Ω feeder is satisfactory.

On any even multiple a high-impedance point will be found near the centre, so the 75Ω feeder is then unsuitable. But on odd harmonics an uneven number of half-waves exist on the aerial, so that the centre is again low impedance. This is shown for three half-waves in Fig. 3.

As a result a 7Mc/s dipole can be used on 21Mc/s. The actual calculated length for three half-waves is:

$$\text{Length in feet} = \frac{492 \times 2.95}{\text{Mc/s.}}$$

It will be found that three half-waves for the 21Mc/s band result in an aerial of about 68ft. Despite this quite good results can be obtained. No other two amateur bands can be covered with a single wire in this way.

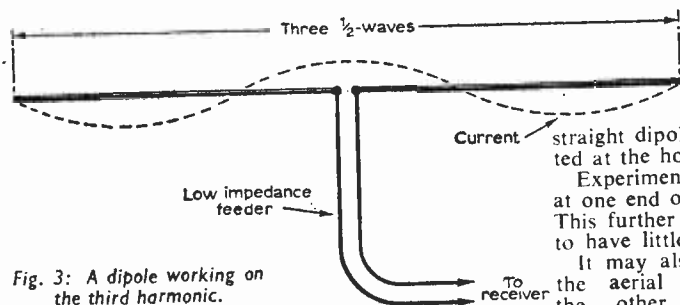


Fig. 3: A dipole working on the third harmonic.

Double Dipole

A dipole for any two chosen bands can be made as in Fig. 4. Length L1 is for the lower frequency band and L2 is for the chosen higher band. One half of L1 is high impedance at even harmonics, so has little effect on the band covered by L2.

In an aerial of this kind made for 3.5Mc/s (80m) and 14Mc/s (20m) bands it was found convenient to suspend the smaller dipole by 6in. ceramic spreaders as used for open-wire lines. L1 was 120ft and L2 33ft. Three spreaders were used each side the centre "T" piece.

On the first day of testing this two-band dipole the best signal report received was strength 8 to 9 from K4QVK, using 120W a.m. Subsequent results in general seemed about the same as those from a single band dipole cut for 20m. On 80m no change in signal strength compared with an 80m dipole could be found.

From these results it appears that the system is

completely practical, though it is clear that the aerial is not one offering any gain in signal strength but merely allowing immediate operating on either of two bands.

It is apparent that if L1 or L2 is operated in the way described for Fig. 3 three-band working is possible. That is, coverage is given for 7Mc/s, 21Mc/s and one other band.

Bent Dipoles

Since the aerial has to be a half-wave this may require a clear span greater than available. This can often be overcome by using some other configuration for the dipole.

Tests show that the conventional arrangement of elements in line can be varied considerably, without much loss of efficiency. A dipole with its two wires at about right angles has almost no directivity. Lengthy tests with such an aerial showed no obvious loss at all, compared with the

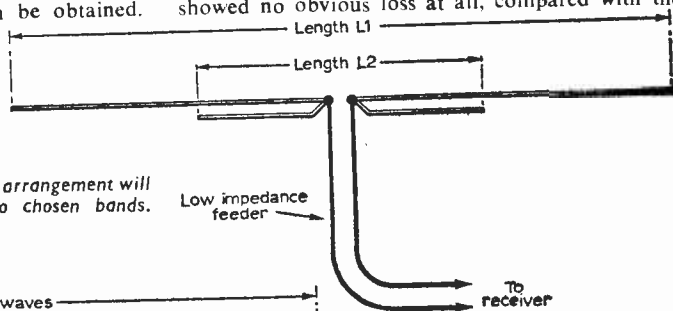


Fig. 4: This dipole arrangement will work for any two chosen bands.

straight dipole. The apex and feeder were supported at the house.

Experiments were made by letting several feet at one end of the horizontal wires drop vertically. This further reduces the space needed, and seems to have little effect on radiation.

It may also be possible to have one half of the aerial in a roof or attic space, with the other half suspended over a short garden. Sloping dipoles were also tried, the angle being from about 30° from vertical to 45° so that 15m and 20m band aerials could run from a single pole down to an anchor point a few feet from the ground. These all gave good results.

Length Adjustment

When making tests with practical dipoles which were in part near earth or walls, etc., it became apparent that the theoretical length as calculated in the way described was not always best. As a result, it was found that some aerials would load the transmitter in a satisfactory manner near the low-frequency end of the band, but not near the HF end.

This is cured, if necessary, by pruning the outer ends of the aerial. With a 80m aerial, there will probably be no harm in cutting off 2ft. at each end to begin. But with the higher frequency bands, pruning should be correspondingly less, say about 2 per cent of the total, at a time.

circuits for PHOTOCELLS

FOUR circuits are described, starting with a simple design using the photocell in series with a relay and supply and concluding with a more advanced device using two cells and a transistor logic circuit.

There are several different types of device which are called collectively "photocells". This article is concerned only with one type: the photoconductive cell, which is compact, fairly cheap and suitable for most switching applications. The photoconductive cell is essentially a resistance which changes its value according to the intensity of the light falling on it. Cells are available which give a very large change of resistance with light intensity; a typical change might be from $10M\Omega$ to 300Ω when the cell is exposed to bright, unfocused daylight after being in complete darkness. From this it can be seen that a simple switching circuit need be no more complicated than that shown in Fig. 1.

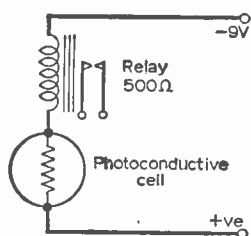


Fig. 1: A simple switching circuit employing a photocell.

With the values given the current in the relay when the cell is illuminated will be a little more than 10mA and this should be sufficient to operate many surplus relays.

The values are given simply as an example and are not critical. For instance, the supply voltage could easily be increased to 12V if required. The range over which the supply voltage and relay resistance can be changed is limited by three considerations:

(1) The current required in the relay for it to operate. This is determined by the mechanical construction of the relay and will fix an upper limit to the relay resistance for any given supply voltage.

(2) The maximum voltage which the cell can sustain across it. If the voltage across the cell

exceeds a certain value it will "break down" and become permanently damaged. This maximum permissible voltage is usually about 100V or above.

(3) The power dissipated in the cell. This is measured in the normal way by the product of the voltage dropped across the cell and the current flowing through it. Photoconductive cells are not usually capable of dissipating much power and this places an upper limit to supply voltages and a lower limit to relay resistance. The maximum power which a cell can dissipate varies according to the type. For the Mullard ORP12 (which is the cell for which Fig. 1 was designed) the value is 200mW. The circuit must be designed so that this value is not exceeded for any intensity of illumination. The cell is not necessarily dissipating the most power when it is fully illuminated and the current is at a maximum, nor when it is in the dark and the voltage across it is at a maximum. The most power is dissipated when the current flowing is half the value it would have if the cell were short-circuited and the relay placed straight across the supply.

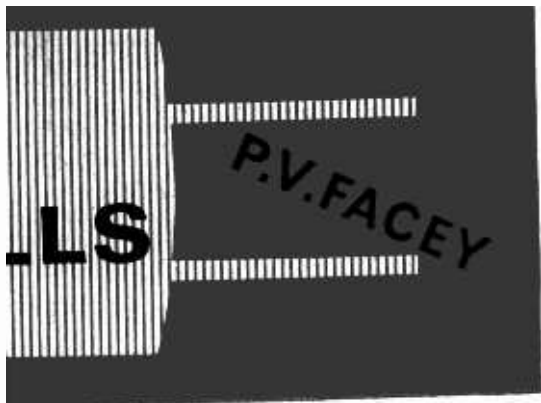
Suppose a circuit is required to operate a 1,000Ω relay which needs 20mA to actuate it. Assuming a maximum cell resistance when illuminated of 200Ω then:

Supply voltage = $20 \times (1,000 + 200) = 24V$.

Dissipation in cell = 80mW at 20mA current and = 144mW at 12mA (with relay alone $I = 24mA$). Since these values are within the maximum ratings for the cell (ORP12) the circuit will be satisfactory.

The photoconductive cell is not sensitive to the polarity of any voltage across it. Consequently in the simple circuit of Fig. 1 it is not necessary to use a d.c. supply; a.c. is equally satisfactory. It should, however, be remembered that the values given for a.c. voltages are usually r.m.s.; it is important to consider whether the peak supply voltage ($r.m.s. \times \sqrt{2}$) is going to cause the cell to exceed its maximum voltage rating.

If it is desired to make the sensitivity of the circuit adjustable a variable resistance can be put in series with the other components. As the relay is held on when the cell is illuminated it is best to use a relay with changeover contacts, so that the circuit is suitable for such applications as automatic garage door opening by the headlights as well as detecting intruders or counting people passing through doorways.



The circuit of Fig. 1, whilst it has the merit of being extremely simple and compact, nevertheless has some disadvantages. If the cell is used so that it is normally illuminated the relay will be held on all the time and battery drain will be high. Also the power limitations of the cell mean that relays requiring currents above 30mA or so cannot be used.

CIRCUIT ONE

Fig. 2 shows a circuit which overcomes these disadvantages and uses an OC83 transistor as a current switch operated by the cell. In this circuit the photocell forms part of a potential divider to which the base of the transistor is tapped. When the cell is illuminated the transistor will be cut off and the total battery drain will be substantially equal to the current flowing in the potential

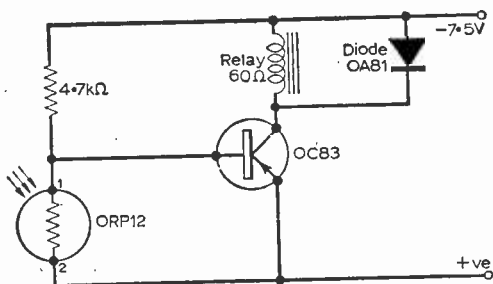


Fig. 2: In this switching circuit the photocell operates the transistor as a current switch.

divider. This is less than 2mA and so photocells with a low power rating can be used provided they give a suitable change in resistance.

The magnitude of the collector current is determined by the supply voltage, the relay resistance, the current gain of the transistor (α) and the base current. With the values given in the figure and assuming $\alpha=90$ we have:

$$I_c = \alpha \times I_b, I_b = 1.5\text{mA approximately.}$$

$$\therefore I_c = 90 \times 1.5 = 135\text{mA.}$$

However, since the maximum voltage across the relay is 7.5V and it has a resistance of 60Ω the current is limited to $7.5/60=125\text{mA}$. Any relay

that will operate at this current or below will do and the coil resistance need not be exactly 60Ω. If a relay with a different coil resistance is used the 4.7kΩ resistor should be changed accordingly to give a suitable base current. The OC83 can carry a maximum collector current of 500mA but for power dissipation reasons it is necessary to limit the current to a maximum value of considerably less. Currents up to about 200mA should be O.K. The OA81 diode is placed across the relay to short-circuit any induced e.m.f. set up across the relay windings when the transistor switches off. If the diode were not present any induced e.m.f. due to the relay inductance would give rise to a large voltage across the transistor at a time when it is still conducting quite heavily. In other words, the transistor would be called upon to dissipate too much power.

CIRCUIT TWO

Fig. 3 shows a circuit with variable sensitivity using a 100Ω 20mA relay. The circuit can be adjusted to respond to any desired intensity of light above a certain minimum. It will work equally well with a bright focused beam and with the light from a 60mA pea bulb underrun at 40mA from a supply chopped at 10c/s. The

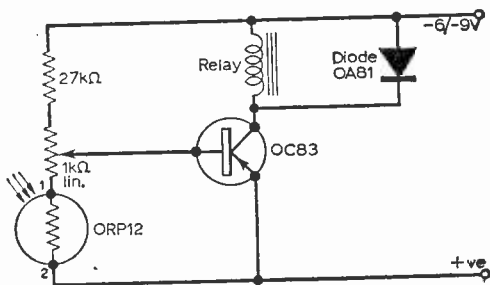


Fig. 3: This circuit, which incorporates a sensitivity control, was found to work well even with an underrun 60mA bulb as the light source.

circuit has been run under these latter conditions for five hours in daylight with the cell unshielded and placed a few centimetres from the flashing bulb. The relay oscillated in sympathy with the light for the whole period in spite of the changing ambient light level. Since the transistor was continually being switched on and off during this time this trial serves as a good test of power stability. The transistor did not heat up at all.

There is much scope for experiment in the circuits of Figs. 2 and 3. Almost any relay to hand may be tried (with due attention to the power handling capacity of the OC83) and the potential divider adjusted to suit any special requirement. Additional sensitivity to dim light may be achieved by connecting point A to a third supply line, positive with respect to the OV line. (+1.5V, OV and -7.5V supplies can readily be obtained from a 9V grid bias battery). Different types of screening, lattice windows and coloured filters can also be tried. Photoconductive cells will respond to most of the visible spectrum and

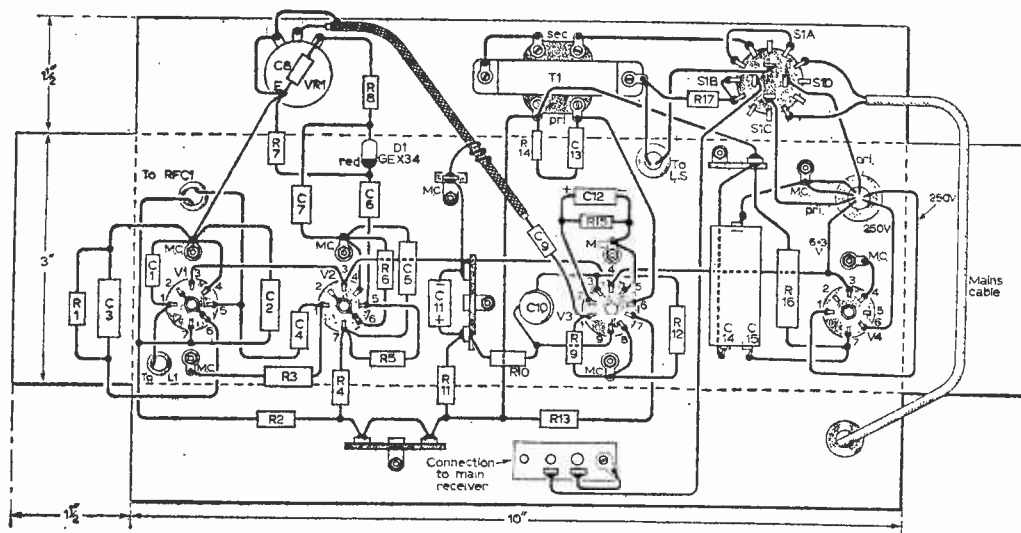


Fig 2: The underchassis wiring of the unit.

mains transformer and a 6X4 valve rectifier. Any other arrangement which provides these currents and voltages will be quite suitable, however, if half-wave rectification is used, it will be necessary to double the value of the reservoir capacitor C15. Smoothing is provided by resistor R16 and capacitor C14. Depending on whether there are one or two r.f. stages and upon the transformer-rectifier combination employed, the value of R16 may need alteration to bring the h.t. line voltage within the range 230–250V. A 6.3V 0.3A pilot light is fitted in any convenient position on the front of the speaker cabinet.

Connection to Main Receiver

Switches S1 a, b, c and d, are the poles of a 4-pole, 3-way switch. This is arranged so that, from a central OFF position, rotation in one direction connects the speaker to the main receiver and in the other, to the internal receiver, at the same time switching the power supply as necessary. Switch S1b introduces a dummy resistive load at the positions where the speaker is not connected to the main receiver, so that the loading of the main output stage will not be upset by operations at the extension. If the extension speaker is of 15Ω impedance, the value of R17 should be increased to

COMPONENTS LIST

Resistors:

R1	150Ω	R10	220kΩ
*R2	1kΩ	R11	22kΩ
*R3	47kΩ	R12	470kΩ
*R4	1kΩ	R13	2.2kΩ
*R5	4.7kΩ	R14	4.7kΩ
*R6	150Ω	R15	680Ω
R7	47kΩ	R16	1kΩ, 5W
R8	47kΩ	R17	4.7Ω
R9	10MΩ		

All 10% 1/4W carbon, unless otherwise stated
VR1 470kΩ potentiometer

Valves:

V1	EF91	V3	ECL82
*V2	EF91	V4	6X4

Inductors:

L1	Dual-wave ferrite rod aerial (Denco FRA2)
RFC1	R.F. choke (Denco RFC7A)
T1	Output transformer. 55:1 ratio for 3Ω speaker; 25:1 ratio for 15Ω speaker
T2	Mains transformer. Secondaries: 250-0-250V, 60mA; 6.3V, 2A

Capacitors:

C1	330pF silver mica 350V
*C2	0.01μF paper 350V
C3	0.01μF paper 350V
C4	330pF silver mica or ceramic 350V
*C5	0.01μF paper 350V
*C6	330pF ceramic 350V
C7	330pF ceramic 350V
C8	330pF ceramic 350V
C9	0.01μF paper 350V
C10	0.01μF ceramic 350V
C11	8μF electrolytic 350V
C12	25μF electrolytic 25V
C13	0.01μF paper 350V
C14	32μF electrolytic 350V
C15	8μF electrolytic 350V

Miscellaneous:

S1	4-pole, 3-way rotary switch
D1	GEX-34 or similar diode
LPI	6.3V, 0.3A pilot lamp
	Three B7G and one B9A valveholders.
	Lampholder. Tinned copper wire, sleeving, grommets, etc.

*These components are not required if there is to be only one r.f. stage.

about 22Ω. The connection to the extension line is made by way of a non-reversible plug and socket as shown in Fig. 2, the "earthy" side of the line being taken to the larger of the plug pins.

Construction

This is not at all critical and the size and shape of the chassis can be varied to suit the cabinet into which it is to be fitted. For the prototype, an 8in. speaker in a cabinet 12 x 12in. offered a narrow space at the bottom and a chassis 10 x 3 x 1½in. of 18s.w.g. sheet aluminium was used. Because of the proximity of the aerial, V1 and V2 must be screened and RFC1 must also be enclosed in a screening can. A satisfactory mounting for the aerial can be made from sheet aluminium, cut to shape shown in Fig. 3 and bolted to the rear chassis runner. Fit rubber grommets into the two ¼in. holes and pass the aerial rod through them as shown in the illustration.

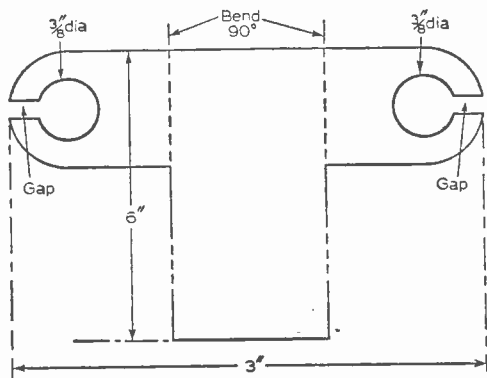


Fig. 2: A suggested addition to the chassis for mounting the ferrite rod aerial.

Fig. 3 shows all the wiring and the approximate positions of the components on the chassis. Tinned copper wire of 22s.w.g. covered with sleeving, is suitable for all the wiring. Work can proceed in any desired order, but it is convenient to deal with the power, output and a.f. stages first and to fit the aerial last, one lead from L1 being earthed at a convenient point above chassis. The ratings for resistors and capacitors are given in the components list. No special components are required but it is convenient to use a disc ceramic for C10.

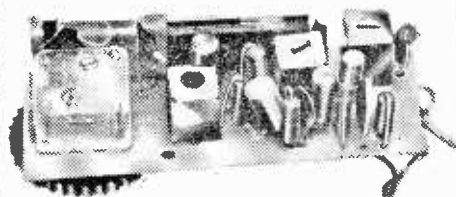
Testing and Alignment

When all the wiring is complete, check with a meter between C15 and chassis to see that there are no shorts in the h.t. circuits. Now connect the power supply and after allowing a minute or so for warming up, advance the volume control and slide L1 along the ferrite rod until the programme is heard. Accurate tuning is obtained by connecting a high resistance voltmeter, positive to chassis, across VR1 and adjusting the position of L1 carefully for maximum indication. Alternatively, the adjustment can be done by ear at very low volume. When the best position for L1 has been found, fix it in position with a little beeswax. ■

NEXT MONTH IN PRACTICAL WIRELESS

THE 'RECORDIO' RADIO TUNER

Designed to be built into a tape recorder for straight-through radio via the recorder amplifier, or the recording of radio programmes.



BAND EDGE MARKER

Crystal controlled unit, using a single transistor, giving band edge markers for 80, 40, 20, 15 and 10 metre bands.

THE VERSATILE EF50

Still available for a shilling or two on the surplus market, this valve can be used for a wide number of applications.

TRANSISTOR TWO

Constructional details for a 2-transistor, four-stage reflex receiver for beginners.

SEPTEMBER NUMBER
on sale August 5th

ORDER YOUR COPY NOW!

Wonderful Response

You will, I am sure, be pleased to know that my letter, printed in the May issue of *Practical Wireless*, has more than served its purpose.

I have received a complete set of transformers from a student in Bridlington and a set of slugs from a Londoner. I also received a rather bald request for "the h.f. coil" with no mention of slugs at all! Even then I would have replied, of course, if he had had the goodness to include a s.a.e.

Perhaps the most pleasant result of your publication was a brief note asking me if I was a person the writer knew years ago in . . . I am indeed, so you have found an old friend for me!

Again many thanks and my best wishes for the continued success of P.W.

G. H. Scholey, G3CDR.

Dartford,
Kent.

Like Practical Television

I AM a keen reader of *Practical Wireless* and *Practical Television*. I think that they are both excellent magazines but I would like to see a Test Case relating to radio in *Practical Wireless*. I would also like to see a monthly section on Servicing Radio Receivers set on similar lines to Servicing Television Receivers as in *Practical Television*.

Wm. G. Hall.

Billingham,
Co. Durham.

I would be interested to hear what other readers may have to say on the above subject.—
Editor.

Competent Constructors

WITH reference to Mr. R. A. Packer's letter (News and Comment, May issue). In my view, a competent constructor is one who makes the best possible use of components he *already has in stock*. Or to put it another way, no sensible person would go and buy a new Mini if there was a perfectly good and reliable large car of somewhat older vintage already in the garage.

H. T. Kitchen.

Nuneaton,
Warwicks.

NEWS AND.

SEMICONDUCTOR SUPERMARKET

For the first time in the UK, semiconductor components will soon be available on a self-service basis in a number of centres throughout the country.

Pre-packaged components complete with technical data and information booklets will be displayed in selected retail shops where constructors will be able to help themselves to a range of solar cells, transistors, rectifier diodes, zener diodes, silicon controlled rectifiers, selenium photocells, etc.

The manufacturers of all the products are International Rectifier of Oxted, Surrey, and the first semi-conductor centre opened at Stern-Clyne Ltd. in Holloway Road, London, during May.

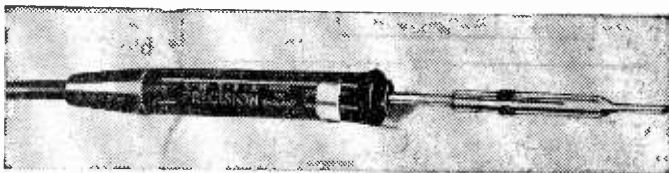
All these components have guaranteed performance figures and in the case of such items as transistors, hundreds of American and European equivalents are listed in accompanying literature.

HONG KONG IMPORTS BRITISH RESISTORS

A British electronics firm—Morganite Resistors—is exporting a quarter of a million resistors to Hong Kong every week. According to a recent announcement this is because Japan—a major component supplier to the Hong Kong radio industry—cannot make resistors of the same accuracy within the price range, with a tolerance of better than 10%.

The resistors are mainly used in low-cost transistor receivers.

MINIATURE 18W SOLDERING IRON



This new 18W miniature soldering iron—model "G"—was announced recently by Antex Limited of Grosvenor House, Croydon.

As in all Antex irons, the heat-source of this model is placed inside the actual bit, which is split to prevent "freezing" to the iron. Extra heat storage capacity is achieved with this particular iron in the heavy shank of all the bits designed to fit it. In fact there is a range of four bits (from $\frac{3}{8}$ in. to $\frac{1}{4}$ in.) available for the model "G".

Complete with bit the iron weighs between two and three ounces (according to the bit used) and costs 32s. 6d.

RADIOTELEPHONES FOR TANKER FLEET

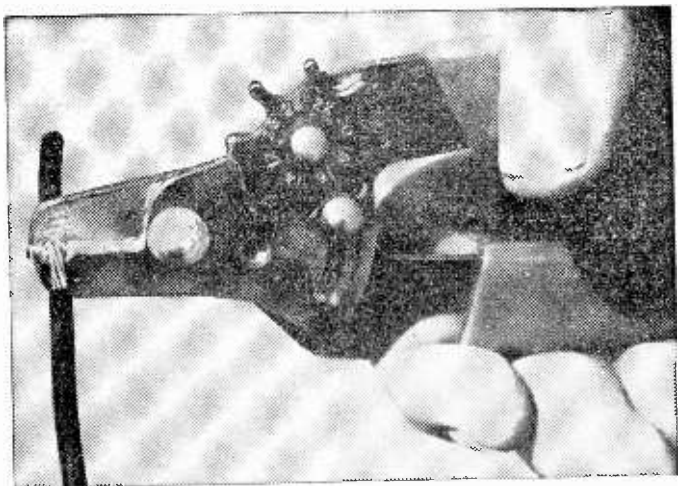
The installation of a v.h.f. a.m./f.m. radiotelephone in the S.S. *British Holly* this year brings the number of Redifon v.h.f. equipments now in use aboard B.P.'s fleet of tankers up to one hundred. A similar installation was also made in the 100,000 ton *British Admiral*—the largest tanker ever built in Europe.

Redifon supply two types of v.h.f. radiotelephone—the GR.286 Mk.2 and the GR.289 Mk.2—for use in vessels of all classes. The GR.286 Mk.2 provides complete coverage of all allocated f.m. channels in the International Maritime band of 156–162Mc/s.

The GR.289 Mk.2 radiotelephone provides 11 f.m. channels and covers international distress and safety, inter-ship, port control and radar advice services while also providing public correspondence and private band ship-to-shore channels.

..COMMENT

IMPROVED WIRE STRIPPERS



A wire stripper and cutter, more sophisticated than previous models, has been introduced by Multicore Solders Limited (Maylands Avenue, Hemel Hempstead, Herts.).

The tool is in the form of a pair of pliers and is shown in the photograph above. A rotating gauge on the side selects the depth to which the stripper blades cut for any Standard Wire Gauge between 12 and 26, while the blades will also cut through any wire or flex if required. The price is 7s. 6d.

ELECTRICAL ENGINEERS EXHIBITION 1966

Over 30,000 sq. ft. of extra floor space will be available to exhibitors at next year's Electrical Engineers Exhibition.

Already the dates for the Exhibition, to be held once again at Earls Court, London, have been fixed as 23rd to 30th March. Increased overseas participation is expected at the larger show.

RADIO/TV LICENCES TOP 13½ MILLION

The total number of combined sound and television receiving licences in the UK now stands at over 13½ million. The actual figures for April just issued, show an increase during the month of 42,722 to 13,295,767.

The number of sound only licences continues to decrease, the April total being 2,788,405, including 630,191 for sets in cars.

TELEGRAMS VIA EARLY BIRD

During June American telegraph companies and selected customers in Great Britain exchanged pictures and data, telex calls and public telegraph messages via the Early Bird satellite. (Before this Early Bird had been used to relay trans-Atlantic television exchanges).

The telegraph messages transmitted, were ones selected at random from normal "traffic", and were transmitted both by trans-Atlantic cable and by the satellite. Recipients of these received two copies of the telegrams, one clearly marked "Via Early Bird".

BECAUSE OF THE LARGE NUMBER OF OUTSTANDING "SELL OR LOAN" REQUESTS NOW HELD BY US, WE REGRET THAT FOR THE NEXT FEW MONTHS WE WILL NOT BE ABLE TO ACCEPT ANY LETTERS FOR THIS COLUMN.

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

... circuit diagram and/or any information regarding the Holland-made radio Type KY5841E "Nr 3731". I do not know the brand but there is a symbol showing an orchestra conductor on the cabinet.—Lee Soon Eng, 147 Sungai Korok, Alor Star, Kedah, Malaysia.

... any details for making a bass guitar. The main points I wish to know are: the space measurements between the fret wires and the distance from the junction of head and stem to bridge.—G. Braddock, 36 Hardy's Road, Cleethorpes, Lincs.

... modification details (2m) for 19 "b" set.—J. H. Dresner, Paul's Hill, Leigh, Nr. Tonbridge, Kent.

... manual or any information about Gecoso G209 Receiver.—C. R. Dcherty, 5, Bedford Street North, Liverpool 7.

... a circuit diagram and/or information about the valves used in the "Packard" A00914 four valve superhet m.w. receiver.—E. Jones, 13 Curie Way, Meadowbridge, Cape, South Africa.

... information on the connections to, or any other data on, the c.r.t. type CV1526.—A. F. Young, 56 Church Road Kearsley, Bolton, Lancashire.

... the details for a s.s.b. adaptor and a circuit diagram and data of a 60W v.f.o. type transmitter and modulator.

Also, could the reader who very kindly lent me the manual for SX28 please let me have his address.—S. L. Anand, 207 I.I.T. Quarters, Kallanipour, Kanpur U.P.

... any information on the G.P. receiver R1116A, rel. 100/1322, serial No. 3888.—P. Hogarth, 16 Blackett Ave., Norton, Stockton-on-Tees, Co. Durham.

... any information on the crystal controlled oscillator section of the Elco v.h.f. receiver unit AP61357—62H, No. 1597, including the type and frequency of crystal required.—P. Neeson, 34 Bangor Road, Holywood, Co. Down, N. Ireland.

... circuit diagram and information re Hallicrafter Communications Receiver model 540; frequency range .55Mc/s to 44Mc/s.—Nimal Ratnayake, Royal Ceylon Air Force, China Bay, Ceylon.

... any information at all on unit R-3/ARR-2X and/or indicator unit type Z6.—D. Bartle, Runnymede, 35 Oakland Avenue, West Hartlepool.

... the handbook or circuit diagram for the wireless set (Canadian) 58 Mk.1.—M. Brereton, 38 Burma Road, Stoke Newington, London, N.16.

... a circuit of an o.cilloscope using the "Etel 4EP7" tube.—James P. F. Windle, 57 Victoria Rise, London, S.W.4.

... the handbook for the R220.—J. Freer, 83 West End, Kirbymoorside, York.

... the handbook for the Globe Scout model 65, by World Radio. Also information as to where a stockist for this company exists in Britain.—Denis McCann, 23 Ochilview, Cowie, Stirlingshire, Scotland.

... a service sheet or circuit diagram for Smith's Radiomobile model 4100 or 4200 car radio.—J. Carpenter, 7 Hawkdene, Chingford, London, E.4.

... the circuit and servicing manual of the Walter Metropolitan tape recorder.—13 Grange Avenue, Leicester Forest East, Leicester.

... any information on the army ser No. 19.—B. Kitcher, 11 Scarborough Road, Blackburn, Lancashire.

PREPARING R.A.E. FOR THE

BRIAN ROBINSON.

10. CRYSTAL OSCILLATORS; FREQUENCY MULTIPLIERS; POWER AMPLIFIERS; TRANSMITTER KEYING; AMPLITUDE MODULATING A TRANSMITTER

10.1 R.F. Oscillator Stability

VARIOUS oscillator circuits were dealt with in a previous article (R.A.E., May, 1965, P.W.) and in each case the frequency of oscillation was determined by an inductance and capacitance combination forming a tuned circuit. (Types of oscillators mentioned included the Tuned Anode-tuned Grid (T.A.T.G.), Colpitts and Hartley.)

In any of these circuits a change in the value of any component in the tuned circuit will result in a change in frequency of the oscillator. For example, if the oscillator valve generates sufficient heat to slightly alter the size of the inductance a gradual frequency drift will occur. Changes in voltages applied to the valve electrodes may also cause frequency changes as different voltages will cause different amounts of heat to be generated. Mechanical vibrations in an oscillator may also cause frequency changes—and can even modulate the oscillator frequency.

An extremely stable oscillator can, however, be constructed which does not use the familiar inductance/capacitance in the grid circuit but instead uses a quartz crystal.

10.2 Crystal Controlled Oscillators

The frequency of an oscillator can be maintained at a constant level by using a quartz crystal as the tuned circuit. The crystal is resonant at a particular fixed frequency and this is determined almost completely by the dimensions of the crystal. In fact the thickness of the crystal is the

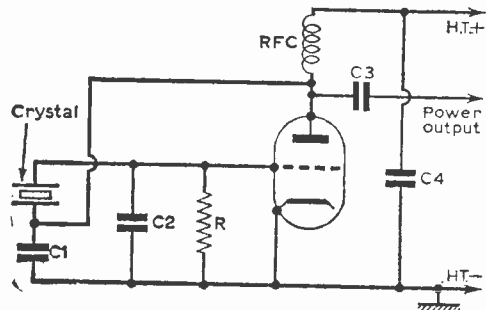


Fig. 88: The Pierce crystal controlled oscillator.

main controlling factor. In order to make a quartz crystal oscillate, however, feedback from the anode to the grid must be facilitated in much the same way as in other types of oscillator mentioned.

When a crystal oscillator is operating, a small current passes through the crystal, this being determined primarily by the amount of feedback applied. If this current becomes too large, heating of the crystal will occur and slight frequency changes will result. It is important to use as low a crystal current as possible—consistent with easily maintained oscillation.

It can be seen that the power output of a crystal controlled oscillator should preferably be kept low and in this respect it is inferior to the inductance/capacitance controlled oscillator.

10.3 Typical Crystal Controlled Oscillator Circuits

In Fig. 88 is shown a very simple crystal controlled oscillator circuit—this is, in fact, a Pierce oscillator.

In Fig. 88 the amount of feedback is controlled by the ratio of the values of $C1$ and $C2$. If the circuit is studied carefully it can be seen that $C1$ is in parallel with the anode/cathode interelectrode capacitance of the valve and that $C2$ is in parallel with the grid/cathode interelectrode capacitance of the valve. In order to obtain feedback the interelectrode capacitances of the valve are effectively increased. R is a grid leak and may have a value of 20-100,000Ω. R.F.C. is a radio frequency choke and this prevents r.f. power from the oscillator being dissipated in the power supply or from being passed to another circuit through the power supply circuits.

Shown in Fig. 89 is an oscillator circuit which is basically the same as the tuned anode-tuned grid oscillator dealt with previously. In this case the inductance/capacitance in the grid circuit has simply been replaced by a quartz crystal.

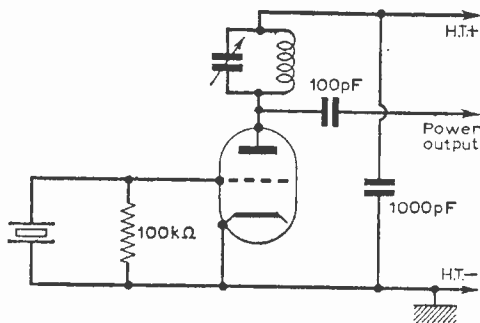


Fig. 89: A grid plate crystal controlled oscillator.

10.4 Frequency Multiplier Circuits

Up to quite recently crystals were only reliable up to a frequency of about 20-30Mc/s, crystals for higher frequencies being very thin and able to operate at very low powers only. Therefore it was found to be comparatively easy to multiply the frequency of operation of a crystal. Frequency

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The British National Radio School has had 25 years' experience of HOME STUDY coaching for students wishing to master the fascinating subjects of Electronics—whether the object be career or as a hobby or new interest. The School is entirely independent and specialises ONLY in the teaching of electronic subjects. It employs only fully qualified staff to conduct and supervise each individual course taken by a student and it is this close and personal contact between Tutor and Student which we believe makes possible the successful completion of a course of study.

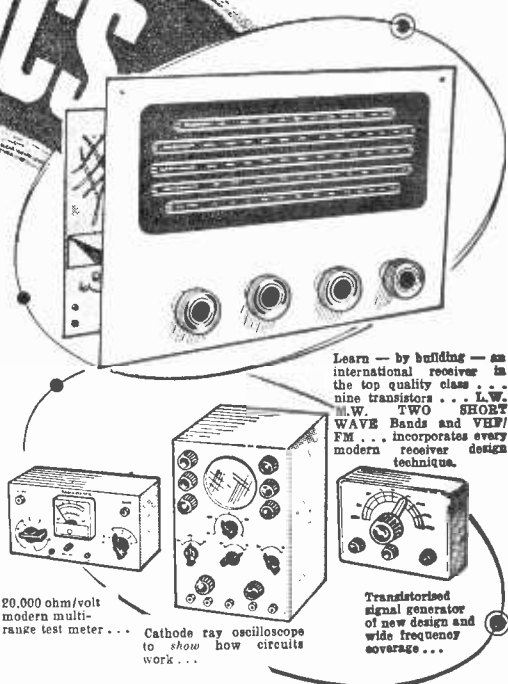
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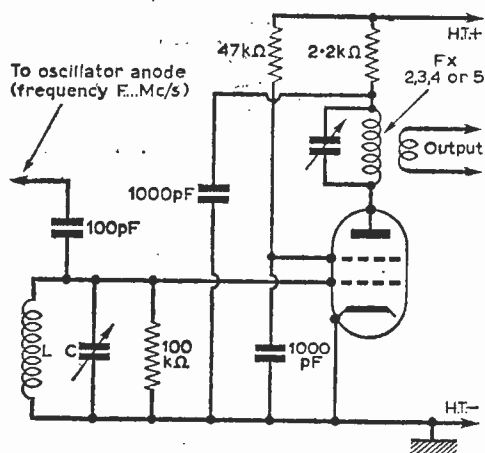


Fig. 90: A frequency multiplier circuit.

multipliers are also of use to enable a single crystal of, say, 3.5Mc/s to be used to obtain output frequencies of 3.5, 7 and 14Mc/s, etc.

In a simple form a frequency multiplier could be as represented in Fig. 90. The tuned circuit in the grid of the valve is resonant at the same frequency as the crystal oscillator and the tuned circuit in the anode may be resonant at two, three, four or five times this frequency. The power output from a frequency multiplier can never be as great as when the stage is used as a straight amplifier. Consequently the greater the number of times the frequency is multiplied the less the power output from the multiplier. Bearing this in mind it is not general to use frequency multipliers which multiply the frequency more than five times.

A simpler frequency multiplier does not use a tuned circuit in the grid but is connected directly to the oscillator anode. This circuit is shown in Fig. 91.

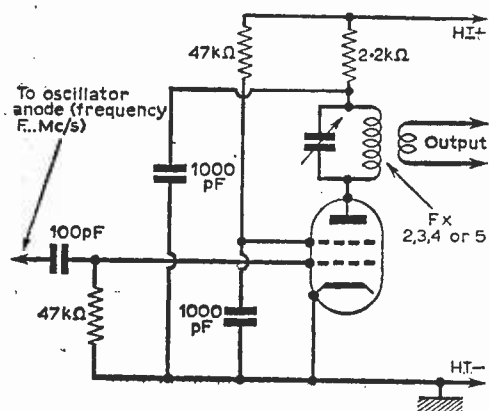


Fig. 91: A simpler frequency multiplier in which the tuned circuit in the grid of Fig. 90 is eliminated.

10.5 R.F. Power Amplifier Circuits

In order to radiate considerable power from a transmitter the signal generated by the oscillator has to be amplified to a very great extent. The function of a power amplifier is, as mentioned, to generate high r.f. powers, but it must also be efficient in respect that harmonic radiation is low. In order to minimise harmonic radiation the Q of the tuned circuits used in a Power Amplifier (p.a.) is made very high.

A simple p.a. is shown in Fig. 92 and L2 may be connected to the aerial or to the next amplifier stage. The load resistance at which the valve operates must be matched to the transmission cable which carries the power to the aerial. For example, the transmission line or feeder may be of, say, 300Ω impedance and, as the p.a. load resistance is usually much higher, L1—L2 constitute a step-down matching transformer.

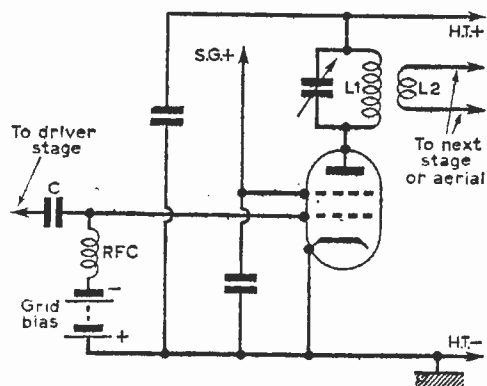


Fig. 92: The circuit of a simple r.f. power amplifier.

In Fig. 92 the r.f.c. is to prevent the power from the driver stage being dissipated in the low impedance bias supply. R.F. power amplifiers are generally operated under Class C or AB conditions. Output circuits will be dealt with further when aerials are discussed.

10.6 Keying a Transmitter

In order to radiate carrier wave (c.w.) signals, using the Morse Code, the output of the transmitter must be reduced to zero after each "dot" and "dash". This is simply a way of saying that in fact the transmitter must be switched on and off in order to radiate the desired signal. This is usually accomplished by using a key. In the interests of safety it is desirable to key the transmitter at a point where high voltages are not present. The key is often placed in the cathode circuit of a crystal controlled oscillator or in the cathode circuit of a buffer amplifier (a buffer amplifier is an amplifier which is used to isolate an oscillator from any higher power amplifier which may follow and it usually operates at the same frequency as the oscillator). In a v.f.o. (variable frequency oscillator) it would be

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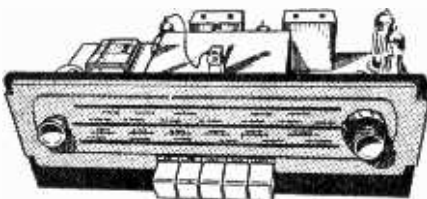
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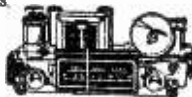
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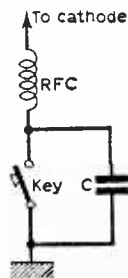
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preferable to key the buffer amplifier rather than the oscillator in order to ensure that the signal does not become "chirpy". A chirpy note results when the keying of the transmitter either directly or indirectly alters the frequency of the oscillator.

When the transmitter key is closed a spark may result; this will generate an r.f. signal but this will only be heard in the immediate vicinity of the transmitter.

When key clicks can be detected on a receiver many miles away they are formed in a different way. When the transmitter is keyed and the carrier wave is interrupted almost instantaneously a key click will result. In order to eliminate the key click the components in the keying circuit must be arranged so that the carrier wave is not interrupted instantaneously but fairly gradually. (The time taken for the signal to reach its peak value is, of course, only measurable in microseconds— μ S.)

Fig. 93: A typical keying circuit. The r.f. choke and capacitor eliminates key clicks.



A simple keying circuit which could be used in the cathode circuit of a buffer amplifier is shown in Fig. 93. The radio frequency choke and the capacitor act as a filter to eliminate r.f. clicks.

10.6 Amplitude Modulating Transmitter

Modulation is the superimposing of one type of signal on to another, in fact in the cases to be discussed it is the superimposing of an a.f. signal on an r.f. signal.

In Fig. 94a an r.f. signal is represented and in Fig. 94b an a.f. signal is represented. (Scales are not, of course, correct.) If 94a is modulated by 94b the modulated wave will be of the type shown in Fig. 95. The line AB on Fig. 95 represents the mean value of the modulating signal and the ratio of x to y enables the percentage modulation to be calculated, i.e. percentage modulation

$$= \frac{x}{y} \times 100\%.$$

Obviously if x equals y the modulation must be 100%. A carrier modulated to 100% is shown in Fig. 96.

If modulation exceeds 100%, distortion will occur as the signal envelope is no longer the same shape as the modulating signal.

When a carrier is modulated the signal which is transmitted does in fact consist of three components, a carrier, an upper sideband and a lower sideband. If a carrier of 100kc/s is modulated by an a.f. signal of 10kc/s the transmitted signal would consist of three components—100kc/s (the carrier), 100kc/s+10kc/s (the upper

sideband) and 100kc/s-10kc/s (the lower sideband). The modulating signal is carried by the sidebands.

10.7 Anode Modulating a Transmitter

A very common method of amplitude modulating a transmitter is anode modulation. The output from an audio amplifier (class A or B and generally push-pull) is passed, via a modulation transformer, to the anode voltage supply of the r.f. power amplifier valve. The modulation of the r.f. amplifier will be 100% when the output of the audio amplifier is such that the voltage appearing at the r.f. amplifier anode varies between 0 and 200% of its d.c. operating voltage.

In order to obtain 100% modulation the sine wave audio power output from the modulator

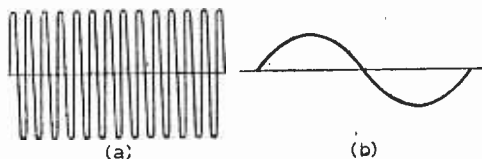


Fig. 94(a): The r.f. signal; (b): the a.f. signal.

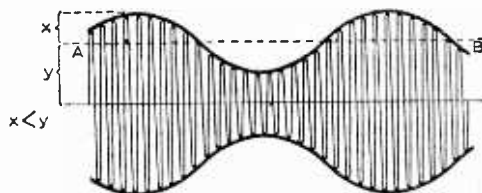


Fig. 95: Here the r.f. signal has been modulated by the a.f.

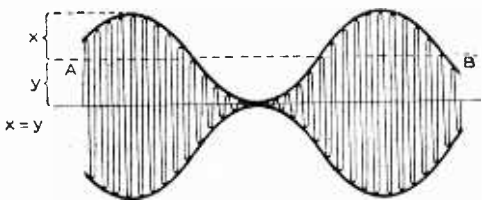


Fig. 96: 100% modulation.

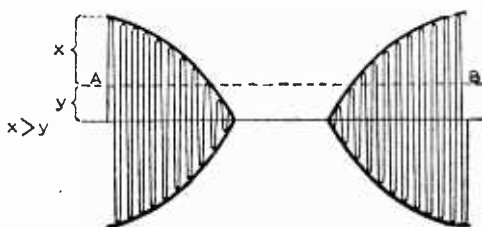


Fig. 97: Modulation in excess of 100%.

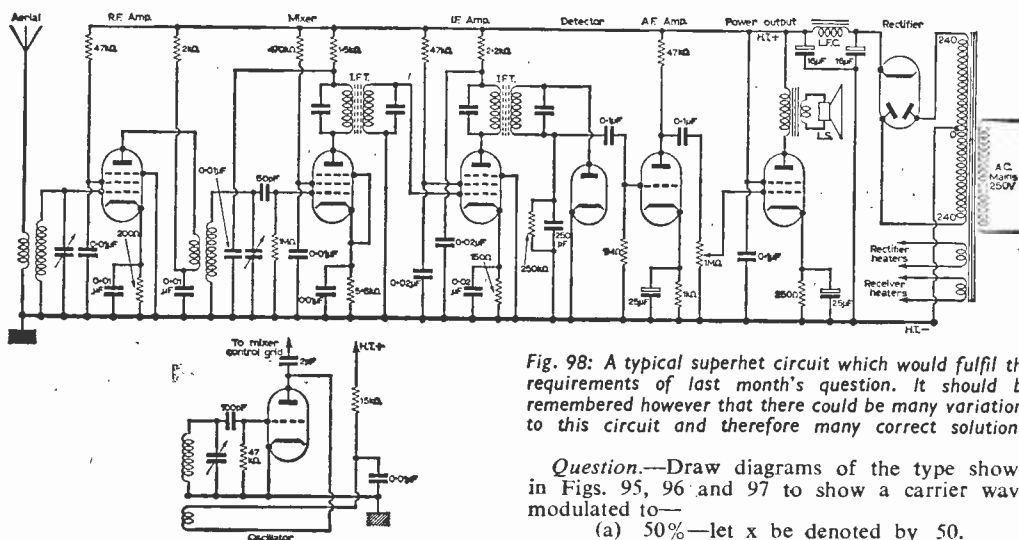


Fig. 98: A typical superhet circuit which would fulfil the requirements of last month's question. It should be remembered however that there could be many variations to this circuit and therefore many correct solutions.

Question.—Draw diagrams of the type shown in Figs. 95, 96 and 97 to show a carrier wave modulated to—

- (a) 50%—let x be denoted by 50.
- (b) 75%— " " " " " 75.
- (c) 150%— " " " " " 150.

Last Month's Question.—A typical answer to this question is as shown in Fig. 98.

PART II NEXT MONTH

must be at least half of the d.c. power input to the r.f. amplifier.

Readers are advised to study also control grid modulation, screen grid modulation and cathode modulation.

SOLAR-POWERED POCKET RECEIVER

—continued from page 302

compromise between the signal direction and the light direction has to be made.

The total cost of the final receiver was about £3, but this may be reduced considerably by using an International Rectifier B2M solar cell, price 15s.

The effect of adding a second transistor was negligible but further experiments may prove

fruitful. The final circuit appears so simple that to many it would appear inconceivable that it works, yet it does. Surely in this circuit the transistor is operating to its capabilities (as they should in all circuits). The field of light operated transistor circuits appears to be almost untouched by experimenters, both amateur and professional (what about Sinclair Radionics Ltd. and others?). The writer would be very interested in receiving details of similar experiments carried out by readers.

PHOTOCELL CIRCUITS

—continued from page 326

by the device has a definite ending (e.g. garage door opening, gate opening, etc.) the output from the gate can be made to set a bistable which controls the opening motor. A limit switch can then be used to reset the bistable when the doors have opened.

No particular transistor is specified for the bulk of the circuit as almost any type will do except surface barrier types.

Fig. 6 shows a suitable relay drive circuit which may be tacked on to any bistable or monostable designed for these supply voltages and with a collector resistance of around 1.5kΩ.

For simple on/off applications the photocell should be mounted in a lightproof box painted matt black inside. A simple lens system using two converging lenses with the cell and lamp filament at the foci will do. The cell lens should be shielded by a tube painted matt black inside so

that light can only enter from sources along the axis of the tube.

The constructor who has some old glass encapsulated transistors which are lightproofed with black paint might like to try making his own photocell by scraping off the paint. The paint can easily be scraped off with a penknife and should be removed from the rounded top end and for about 2mm down the side. The capsule will be filled with blue, white, greyish or transparent grease. Obviously the transparent grease types are best and the blue and white types are no good at all; it is best to repaint them for future use. The scraped transistor will function as a photoconductive cell (emitter +ve) with the base open circuit, but for best results try a resistance between base and emitter. The value will be between 5 and 100kΩ and can be found experimentally. Photocells made in this way will not be as sensitive as proper ones but can be made to work perfectly well by the use of a suitable transistor amplifier stage.

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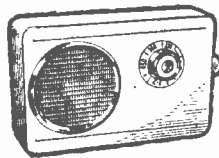
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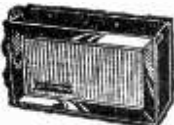
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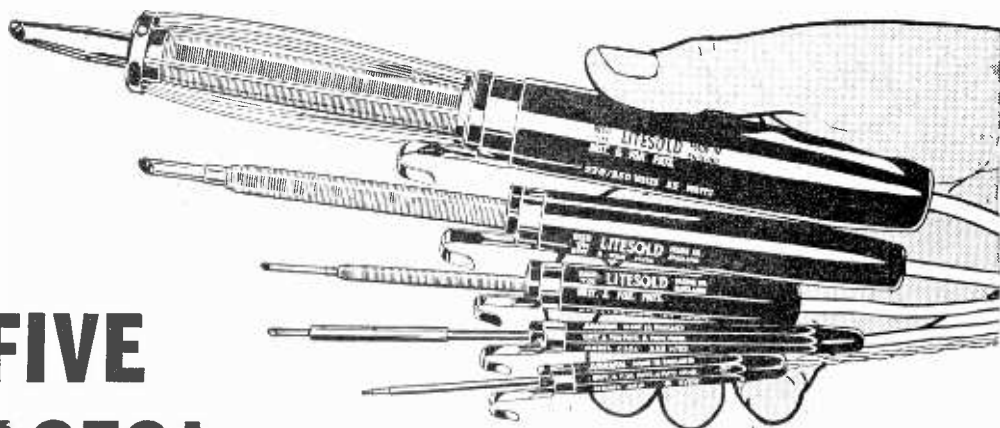
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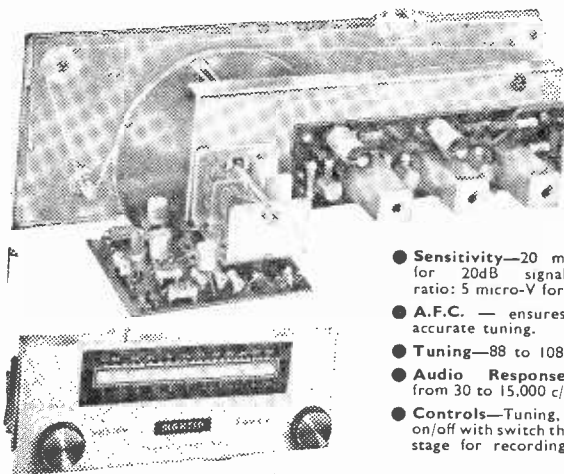
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A COMMENTARY BY HENRY

PRACTICALLY WIRELESS

No. 12

Little Bittery

THE Radio and Electronic Component Show was held at Olympia from May 18th to 21st.

The old joke about disposable sets—you know, throw it away when the battery runs out—is coming uncomfortably close to reality.

Of the 300 firms exhibiting, more than twenty were making a thing of micro-miniaturisation. Despite the off-hand attitude of one demonstrator, "Needn't bother us, old boy. Thing of the future, what?" I was impressed by the strides recently made by some of the firms we have always regarded as stick-in-the-mud reactionaries. Tiny switches, banks of printed-foil circuits, combination components, and everywhere that with-it word Integration. If a circuit is not integrated nowadays, nobody wants to know.

The ultimate seems to be achieved when our old friends Mullard come up with a three-stage amplifier about the size of a soldered joint. As one critic said: "What's the point if the piece of equipment is smaller than the knob which is being used to control it?"

Whatever the PRO boys may tell you, quoting reliability, efficiency, weight-cost factor, serviceability, etc., it boils down to one essential: is the tiny fellow going to be cheaper to

produce, in quantity than the hand-assembled juggernaut it transplaces? And the answer appears to be Yes. Modern methods have found ways of whittling down capacitors and reducing resistors to strips of etching.

So far, the problem of reducing inductors physically has proved difficult, but the bright lads at Manchester University have been playing about with that one. They have already used computer control on a thin film micro-circuit to prove what can be packed into its 1 square millimetre area and come up with the amazing answer of 100 passive elements. That is equivalent, to save you reaching for the slide rule, to 70,000 per square inch. So, in the space taken up by that coil you can make up practically any R-C combination you wish to supersede it.

Certainly, the modules shown by Eric had quite a few identifiable bits packed into them, and the sub-miniature switches by Elcom and Arrow made one want to hide one's clumsy fingers.

Who makes these things? we wanted to know. How the dickens are they assembled? And the answer, as we might have expected, is that magic word "automation". Cassandra Henry has already commented on the machine that is more reliable than the circuit designer. Here, at Olympia, we saw machines ten times more reliable at fault tracing than any engineer.

Elliott-Automation had an automatic circuit tester that monitors up to 1,000 contact points for continuity and insulation at a rate of ten tests a second. Faster than our apprentice as clocking-off time approaches.

More threatening still, from Solartron we hear of a machine which is programmed to allow



The machine prevents him

the operator to carry out a sequence of tests, or make connections. But if he makes a wrong connection in the sequence, the machine prevents him from making the next move. I was afraid to ask how!

Flexible printed circuits—no, not those from certain portable radios which the makers really intended to be rigid—but genuinely flappable boards, copper-clad laminate that could be bent and shaped without cracks in the foil appearing. That's another thing on the way—as Formica and Electropoints Ltd. showed us. This seems to promise much fun in the workshop.

Yet another aspect of the modern trend is the increasing use of "precious metals". There are firms specialising in the plating of switch contacts with not only silver and platinum, but gold, rhodium and palladium.

With memories of the old days, when circuits were laboriously screwed together by hand, when scraping off a resistor was the accepted method of modification, when the nearest approach to integration were those horrible "blocks" of components covered with shiny black pitch, Henry is not at all sure whether he will be able to bring himself to throw away his radio each time the sun goes in and his solar cell runs down.



Who makes these things?

A DIRECTION FINDER for Small Craft by F. C. Judd PART TWO

FULL constructional details of this receiver were given in Part 1, together with calibration procedure and notes on the Radio Information Charts which are essential when using the long wave marine radiobeacons. This part deals with a suitable mounting for the receiver and gives further notes on calibration and testing, etc.

Receiver Mounting

The receiver is much easier to handle if it can be rotated through 360° by mounting it on a heavy base as shown in Fig. 8. The base could be made of wood, preferably loaded with brass or lead or, better still, made entirely of brass. A cast-iron

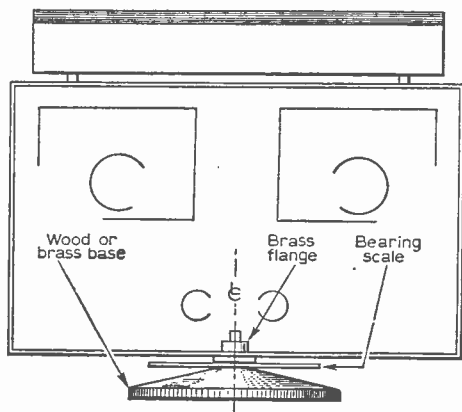


Fig. 8: A suitable mounting arrangement for rotating the receiver on a heavy base.

base could also be used, in fact the one shown in the photograph in Part 1 is cast-iron. In this case, however, careful checks must be carried out to ensure that it does not interfere with the compass. A 360° protractor, obtainable from most large stationers, should be screwed to the top of the base, for this is most useful when working against the heading of a vessel or when there is no alteration in position, i.e. when the vessel is at anchor. A small pointer is attached to the bottom of the receiver case for use with the bearing scale.

The receiver could, of course, be permanently mounted in a vessel providing it (the receiver) can be rotated through 360° . In this case a compass need not be fixed to the receiver but the bearing scale would have to be used in conjunction with the compass on the vessel.

Calibration of the Tuning Dials

The tuning dials, which are small Data Panel Signs (100° type), require pointers which can be attached to the flanges of the Jackson epicyclic ball drives. These pointers can be cut from thin perspex or stout celluloid and shaped and drilled as in Fig. 9. The tuning control knobs can be left to the discretion of the constructor.

The actual calibration of the tuning dials has already been dealt with but as a further guide the diagram in Fig. 10 may prove useful. It is, however, very important that the exact tuning point of each radiobeacon group frequency is known. As it is difficult to mark the actual spot frequencies on the r.f./oscillator dial it is suggested that a separate calibration chart is compiled, this being mounted on stiff card and protected by a celluloid cover.

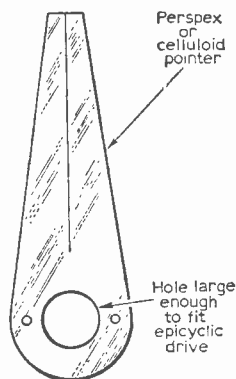


Fig. 9: Two of these perspex tuning dial pointers are required.

Testing the Receiver

Preliminary tests and approximate tuning, etc., can be carried out with a long aerial loosely coupled to the ferrite aerial coil via a small series capacitor. This will allow the radiobeacons to come in quite strongly, but as soon as initial alignment has been completed, close calibration, etc., should be carried out with the band switch in position 3 (d.f.) and any other aerial disconnected. Remember, you may not hear a particular radiobeacon if the ferrite aerial happens to be *end on* (in the null position) to that particular station. When listening for different stations in different

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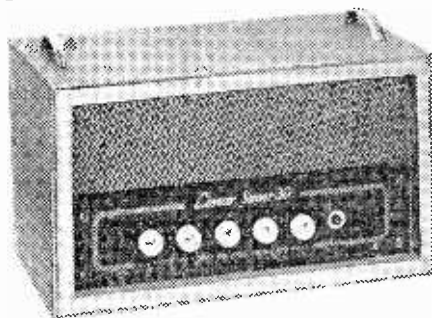
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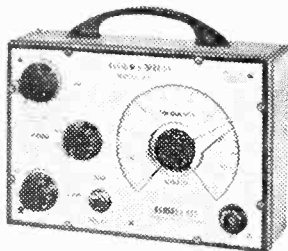
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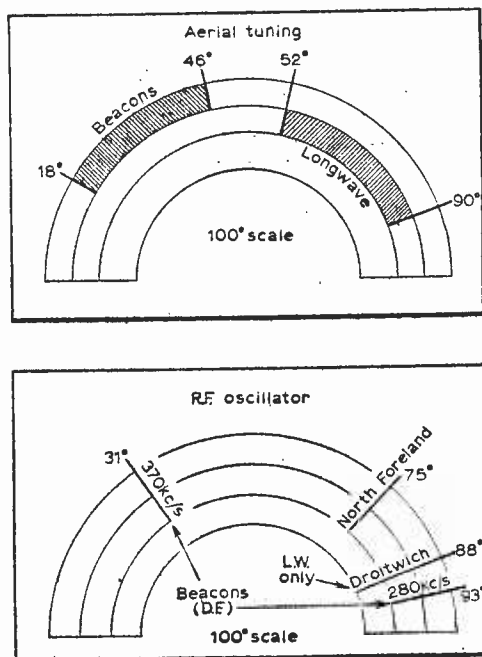


Fig. 10: The aerial and r.f. oscillator tuning dials after calibration.

groups, etc., it is essential to work with the Radio Information Charts, a compass and a protractor, so that whilst calibration is being carried out maximum signals can be maintained with the ferrite aerial *broadside* to the station.

Use of the telescopic aerial will alter the tuning of the ferrite aerial slightly, but remember, *this aerial is only an aid to finding weaker signals and must not be used when direction finding.*

The final calibration of the dials or the making of a calibration chart requires infinite patience, since it may be necessary to wait for each particular group to operate. It is, of course, only necessary to identify one station in a group working on a particular frequency and it does not follow that all the stations in a group will be heard. These stations use quite low power (10 to 20W) and a good deal depends on propagation conditions as to whether they will be received inland.

D.F. and Compass Checks

On no account should d.f. checks be carried out at night as errors may occur through so-called "night conditions" which cause the signals to arrive by different paths. When, and only when, you are satisfied with the calibration, d.f. and compass checks should the receiver be used under

working conditions. **On no account should one blindly rely on a radiobeacon d.f. receiver whether made commercially or home constructed. Radio direction finding is a navigation aid, not a method of navigation.** Like other navigation aids a d.f. receiver is used mainly to confirm position as otherwise plotted by compass and charts.

It is interesting to note that whilst we were carrying out d.f. checks with this receiver in the North Sea and in thick fog at that (see last month's cover), two other small cruisers hailed us to enquire as to where they were. They also requested direction to a particular position on the mainland. This information, confirmed also by our own d.f. fixes, depth finder readings and compass and chart navigation, we were able to give. To our great surprise, however, both cruiser skippers then admitted that *neither had even a compass!* We pointed into the fog and they went thataway! !

The Radio Information Charts

Details of these charts were given earlier, and it must be emphasised that they are not suitable for navigation of any kind. The charts merely show the positions of the radiobeacons on a large scale. The exact position in latitude and longitude of all the radiobeacons is, however, given in the tables printed on the charts. These should be used in conjunction with standard navigation charts. The Radio Information charts also give precise details of frequencies, groups and sequences as well as radiotelephone, British Coastal radio stations and Aircraft beacons. The latter can be received with the d.f. receiver but should be used with caution as most of them are inland which may result in serious bearing errors.

Finally, when using a d.f. receiver, it is necessary to be aware of the various reasons for bearing errors. These can be due to (a) night effects when signals arrive at the receiving aerial by two different propagation paths, (b) reflection from high land, such as cliff faces, (c) reflection from other aerials or stay wires or even from metal structures on the vessel.

Errors in plotting can also occur, especially when converting magnetic to true bearing or vice versa and in taking into account the heading of the vessel which is usually from magnetic compass. Remember the d.f. aerial will indicate a true bearing and the difference between this and a magnetic compass reading is approximately seven degrees. Up to date navigation charts will show the exact deviation.

Radio on Yachts and Cruisers

The ordinary broadcast receiving licence authorises the reception of programmes sent only from authorised broadcasting stations for general reception. It does *not* permit the reception of messages from coast stations, ship stations, special service stations and radio navigation stations. If reception of messages etc., from these stations is desired (this includes marine radiobeacons) a special "ship" receiving licence is required. This does, however, cover broadcast station reception as well and can be obtained from the Radio Services Department, W.T.S. G.P.O., London, E.C.1. The licence costs £1 per year.

Useful References to Radio Navigation etc.

Admiralty list of Radio Signals and R.D.F. Stations and Beacons
Vol. 2 27s. 6d.
Motor Boat and Yachting Manual 17th Edition 21s.
Temple Press Books

BOOKS REVIEWED

AMATEUR RADIO CIRCUITS BOOK, compiled by G. R. Jessop, A.M.I.E.R.E., G6JP.
Published by the Radio Society of Great Britain.
96 pages. Size 9½ in. x 7¼ in. Price 8s. 6d. post paid.

IF you were asked to find the circuits of a 3.5Mc/s transistor transmitter, a Q-multiplier, a cathode modulator and an electronic T/R switch, it is highly probable that you would have to search through a number of books and sort issues of magazines in order to find them.

Amateur Radio Circuits Book is a collection of some 150 circuits liable to prove useful to the average ham. Transmitters, front ends, oscillators, power supplies, noise limiters, and a host of other items. There are circuit diagrams only, for the person who needs just this and values.

At first sight this appears a most excellent book, but a second more detailed reading brings disappointments. For although the drawings score full marks many details are omitted.

The first page depicts an A.T.U. We are shown how the coils are mounted, informed that the diameter should be 2½ and 3 inches and that 14s.w.g. is suitable. But not told how many turns, or even the inductance.

It is this lack of odd bits of information which spoils the ship. A 15W transistor transmitter has all the information except the transistor types. A d.c. amplifier has no transistor type or voltages specified for the two batteries. And so on.

The idea of having all those useful circuits together in one volume is excellent, but it is to be hoped that when second edition time comes around the editor will have filled in the few remaining details.—F.H.S.

THE OSCILLOSCOPE, by George Zwick.
Published by Gernsback Library Inc., New York, N.Y.
224 pp. 8½ in. x 5½ in., paper back. Price 28s.

MANY books have been written about the uses and applications of the oscilloscope. It is a great pity that these are studied only by the committed reader, the experimenter, would-be constructor, student, etc. The man with his cobwebbed 'scope, past its first intriguing fascination, hidden in a corner of his den, seldom finds the book to suit him. And the technician who brings his workshop instrument into occasional use often has no idea of its potentialities.

This book does much to remedy the defect. It first appeared in February, 1963, and has already in March, 1964, come out with a healthy reprint. Its virtue is the method of presentation, rather like an amplified operating manual. As such it should appeal both to the inquiring experimenter and the man at the service bench.

The first four chapters are descriptive. Chapter 1 discusses waveforms, laying the ground for later works. Chapters 2 and 3 cover the theory of the cathode ray tube and the principle of sweep

systems. In Chapter 4 a more practical approach is introduced. Detailed descriptions of both general purpose and laboratory type oscilloscopes are given with 21 diagrams of the vital portions of circuitry.

From this point we enter the field of application. Chapter 5 is a long one, dealing with alignment. Although it is obvious that precise instructions cannot be given because of variations of circuit design a valiant attempt has been made to cover the many possibilities. Chapter 6, on Oscilloscope Techniques, underlines this practice and could profitably have been juxtaposed. There is much useful information in these 24 pages.

More applications are to be found in the next chapter, dealing with tests and measurements. Audio experimenters and students of electronics would find several points of interest; the "hooking-up" details, so often ignored in more technical works, are meticulously outlined. Values of network components, too, are not ignored.

In the final chapter this is carried a step farther by the explicit instruction in 16 useful experiments. We should like to have seen the "hook-up" diagram continued in this chapter but by the time this stage is reached the student should be able to cope.

Both as general reading and as a bench-side reference this book is to be recommended.—H.W.H.

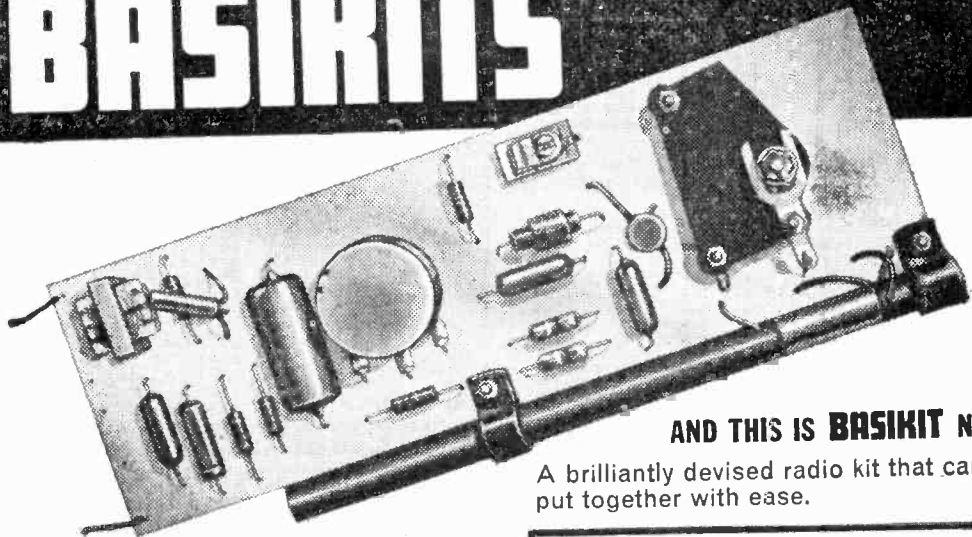
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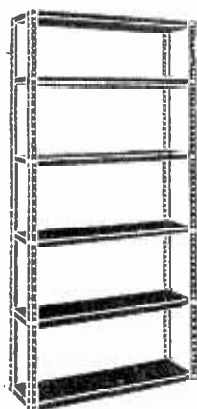
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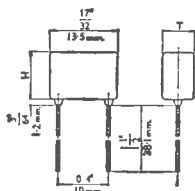
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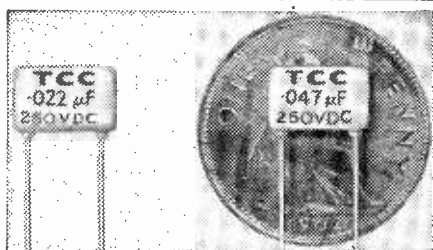
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6U4G	4/6	12K7GT	4/3	DK96	6/6	EF89	4/3	PCL82	6/11	UAF42	7/9
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6AL5	2/-	20L1	12/3	DL34	5/6	EF193	7/6	PEN4A	6/6	UBF89	6/9
6AM6	2/6	20P4	13/6	DL96	6/-	EL33	6/6	PEN383	9/6	UCC84	8/-
6AQ5	6/-	20P5	11/9	DM70	4/11	EL38	11/9	PEN4VA	10/9	UCC85	6/9
6AT6	4/-	25L6GT	4/9	DY86	6/9	EL41	7/3		12/6	UCC80	8/6
6BA6	4/9	25L7GT	10/9	DY87	1/-	EL84	3/6	PEN3815	10/9	UCL42	7/6
6BE6	4/9	30C15	9/6	EAF40	8/-	EL95	5/6	PL36	3/9	UCL81	7/-
6BG6G	12/6	30F5	8/6	EAF42	8/-	EM34	6/3	PL81	7/-	UCL82	7/6
6BH6	5/-	30FL1	9/6	EB41	4/-	FM80	6/3	PL82	5/6	UCL83	9/9
6BJ6	5/6	30L15	10/3	EB91	2/-	FM81	7/3	PL83	6/-	UF41	7/3
6BW6	7/9	30P4	13/6	EB33	5/-	EM84	6/3	PL84	6/3	UF42	4/6
6F13	3/6	30P19	13/6	EB41	7/3	EM87	7/-	PX23	7/9	UF85	6/6
6F14	9/-	30P13	9/6	EBF80	6/-	EY51	6/-	PY32	9/-	UF96	6/6
6K7G	1/6	30PL13	10/9	EBF83	7/6	EY86	5/6	PY33	9/-	UL41	7/6
6K8G	4/3	30PL14	11/9	EBF89	6/6	EZ40	6/9	PY80	5/3	UL44	15/-
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6Q7GT	7/9	53K10	8/6	ECC82	4/9	PW4500	6/3	PY88	7/3	UY85	5/6
6SL7GT	4/9	AC/VP2128	6/3	ECC83	7/-	GZ33	14/6	PY800	6/9	VP48	12/6
6SN7GT	4/9	136	4/6	ECV84	6/3	GZ37	8/6	TH81C	9/6	W75	3/6
6V90	3/9	CL33	9/6	ECC85	5/9	K781	6/6	TH333	7/6	W77	2/6
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by G. H.
Meeten

for r.f. resonance indication

THE instrument to be described was intended for use as an indicator of resonance while making r.f. measurements. Its range is 0.1 to 1V peak, approximately, with a high input impedance. It was felt advantageous to use a circuit giving a known scale law so that no calibration of the movement would be necessary, also making the instrument generally more useful. To fulfil these conditions the Moullin or anode-bend circuit was chosen. In this simple, well-known circuit a triode is biased almost to cut-off, and if the V_g-I_a characteristic of the valve is non-linear in this region, partial rectification takes place as shown in Fig. 1.

In particular, if the characteristic can be represented by the relation $I_a = aV_g^2 + bV_g + c$, where a, b, c are constant for a particular value of the anode potential, then analysis shows that when the input e.m.f. to the grid is of the form $v = V_{pk} \sin \omega t$, the mean value of

the increase in anode current is $\frac{a}{2} V_{pk}^2$, where V_{pk} is

the peak e.m.f. Hence a square-law scale can be produced. This means that true r.m.s. values can be read, independent of the input waveform.

CHOOSING A VALVE

The following valves were measured (all pentodes and tetrodes being connected as triodes) to determine the form of the V_g-I_a curve when using 9 volts anode potential. 1T4, EF91, 12AT7, 3S4, CK503AX. The 3S4 and CK503AX gave the most promising

results when plotting $\frac{dI_a}{dV_g}$ against V_g , which should

be a straight line if the V_g-I_a curve is of the required form. The CK503AX is a miniature wire-ended output tetrode. It was decided to use the 3S4 (a battery powered output tetrode) since it is more readily obtainable. The 3S4 filament is tapped and, except where stated, half the filament is unused, the valve taking 50mA at 1.4V.

WORKING POINTS

The basic circuit, shown in Fig. 2, is self-explanatory. The potentiometer across the filament ensures that V_b is the true bias on the grid.

It was stated above that the change of anode current, which will be called ΔI_a , was equal to $\frac{a}{2} V_{pk}^2$, assuming parabolic V_g-I_a characteristics.

In practice there is a best value of V_b for a maximum ΔI_a as the graph of Fig. 3 shows. It was drawn using

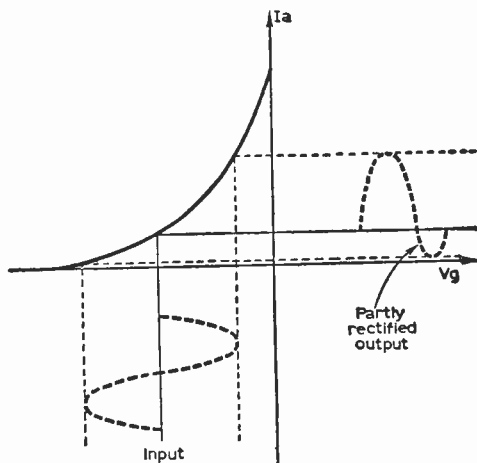


Fig. 1: Partial rectification occurring in the non-linear section of a triode characteristic.

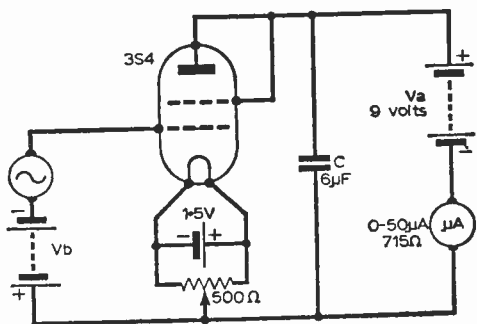


Fig. 2: The basic circuit. A conducting source of e.m.f. is assumed.

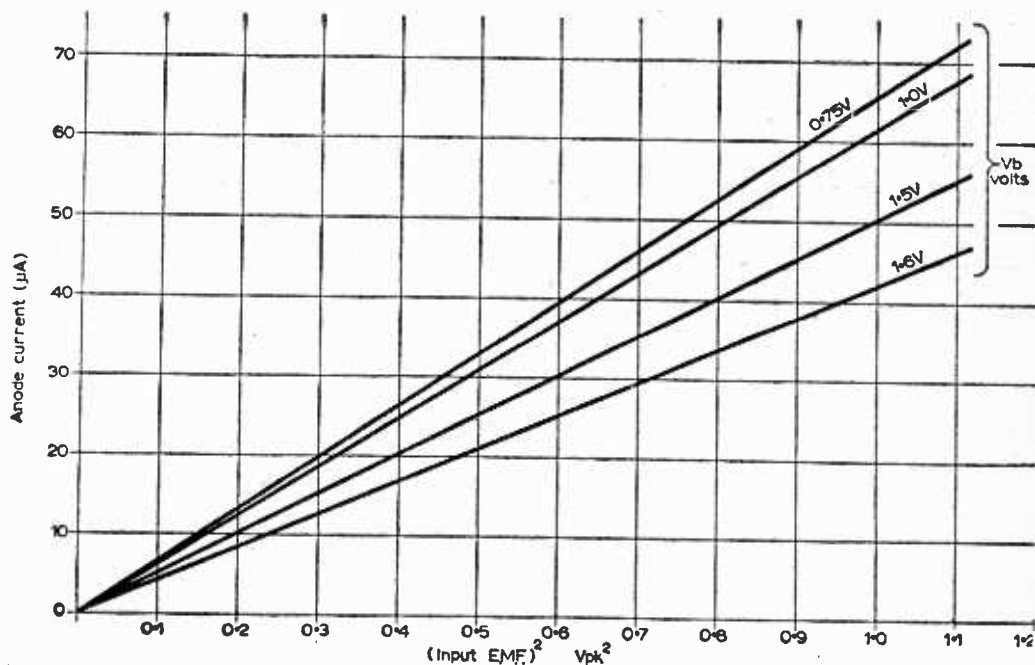


Fig. 3: Illustrating variation of sensitivity and linearity with bias (V_b).

Fig. 4 (right): The complete circuit. Backing-off current is taken from the heater supply cell.

the circuit of Fig. 2 with V_b variable and a source frequency of 50 c/s.

It can be seen from Fig. 3 that although the square-law is true approximately for a range of V_b , it is best when $V_b = 1.5V$ or greater, but the sensitivity falls as V_b increases. A bias of $-1.5V$ is a good compromise between sensitivity and linearity and is also the e.m.f. of a single dry cell. A mercury cell could be used with a little loss of linearity and negligible current is drawn.

It was found that if all the filament of the 3S4 was used i.e. $0.1A$ at $1.4V$, then ΔI_a for any given V_b was approximately doubled, but a greater non-square linearity was also incurred. Since the use of dry cells was contemplated the $50mA$ consumption will be used henceforth.

The complete circuit is shown in Fig. 4. The meter movement is backed off with an equal and opposite current to the standing anode current with no signal which was approximately $80\mu A$. The values of the resistors and capacitors are not at all critical. The following are the components used in the original:

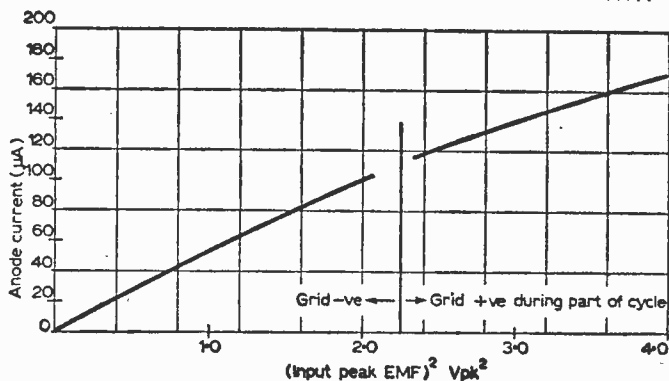
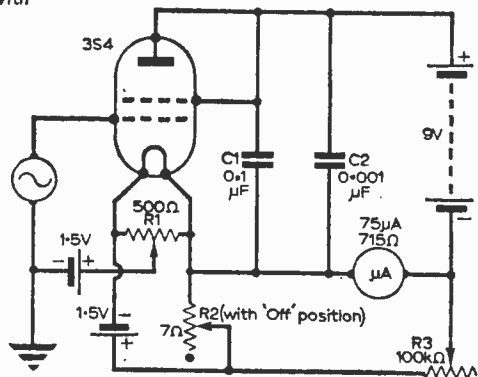


Fig. 5: Large signal characteristics showing the effect of driving the grid positive.

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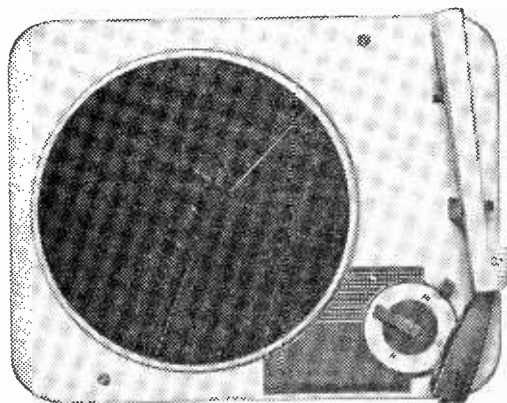
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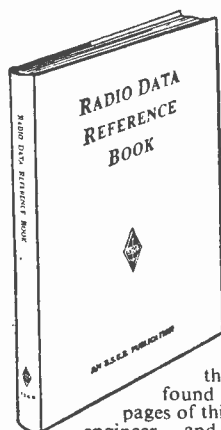
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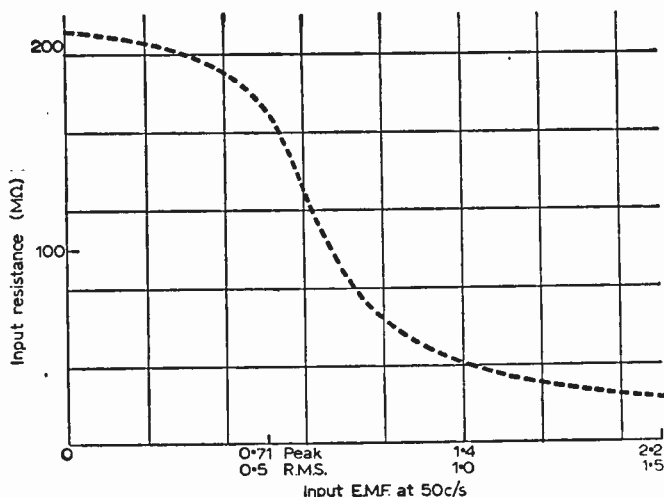


Fig. 6 (left): Illustrating the variation of input resistance with input e.m.f.

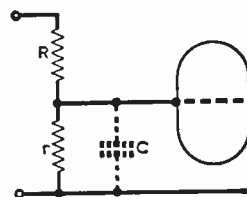


Fig. 7: The input capacitance (dotted) in parallel with the potential divider arm.

R1	500 Ω	wire-wound
R2	7 Ω	wire-wound with filament on/off switch.
R3	100k Ω	carbon
C1	0.1 μF	paper
C2	0.001 μF	ceramic
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If a multi-range instrument is used for the detector it should be of roughly constant input resistance from one range to the next or the sensitivity, i.e. the slope of the $V_{pk}^2 - \Delta I_a$ graph will vary.

connected to the same source by a high resistance R_1 ohms, then it can be shown that:

$$R = \frac{R_1}{\sqrt{[(n-1)^2 + \omega^2 R_1^2 C^2]}}$$

where R and C are defined above, ω is the angular

$$\text{source frequency and } n^2 = \frac{\Delta I_{a1}}{\Delta I_{a2}}$$

C includes the capacitance of the wiring in the grid circuit and between the grid and other electrodes. An average value is about 15pF. A graph of input resistance R with input e.m.f. is shown in Fig. 6, in which $C=15\text{pF}$ is assumed. The decrease of input resistance is due to the increasing number of electrons reaching the grid as it becomes more positive. The input resistance is however still greater than 30M Ω when the grid is being driven positive during part of the input cycle.

SQUARE-LAW LINEARITY

The degree of square-law linearity and the effect of bias upon it is shown in Fig. 3. The effect of driving the grid positive is shown in Fig. 5. The grid is made positive when the peak input signal exceeds the standing bias. When the grid is positive, grid current flows, which is equivalent to saying that not all the electrons from the cathode reach the anode. Hence a lowering of anode current change and sensitivity as Fig. 5 shows. The over-all increase in anode current can be explained by the positive grid now attracting more electrons from the cathode than were formerly emitted. It can be seen that the square-law is not quite true for large input e.m.f. even when the grid is negative.

CALIBRATION

It should be stressed that permanent calibration of the instrument is not readily obtainable without voltage stabilisation of the supply power. The square law however is valid over a fairly wide range of battery ageing and for many purposes only the ratio of two e.m.f.'s need be known.

INPUT IMPEDANCE

If the input of the voltmeter can be assumed to consist of an input resistance R in parallel with an input capacitance C then simple measurements can be made, to arrive at an estimate of R if C is known (or vice-versa). If ΔI_{a1} is the current change when the voltmeter is fed from a low impedance source, and ΔI_{a2} is the reading when the voltmeter grid is con-

FREQUENCY RANGE

The original instrument was used at all frequencies between 25c/s and 25Mc/s; beyond these limits it was not tested. The Moullin instrument of the 'twenties was stated to be useful up to about 30Mc/s.

—continued on page 354

**BRADFORD RADIO SOCIETY**

Hon. Sec.: J. D. Midgley, G3SAQ, 77 Brantwood Road, Bradford 9, Yorkshire.

Meetings are now held in the Bradford Technical College, and the call sign G3NN has been issued for the Club station, G3TO.

There was an "Inquest" on the N.F.D. on 22nd June.

COVENTRY AMATEUR RADIO SOCIETY

Hon. Sec.: A. J. Wilkes, G3PQQ, 141 Overslade Crescent, Coundon, Coventry.

The Society will be taking part in the N.F.D. event again after an absence of many years.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

Raymond F. Street gave a lecture entitled "Introduction to Colour Television" on 23rd June, and on the 30th G. D. Kelsey, B.Sc., discussed the problems of Effluent and its Treatment.

On 3rd-4th July, the 144 Mc/s (portable event) was held, and on 17th July there will be a Garden Party and Exhibition at Heanor Alcester Secondary School.

HALIFAX AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec.: J. Ingham, G3RMQ, Lambert House, Greetland, Halifax, Yorkshire.

On 27th July, G. Drake, G3SJG, will give a talk on Transmitters, and on 24th August, there will be a lecture by F. Nicholls, G3MAX and a visit from the Huddersfield Radio Society.

HUDDERSFIELD AMATEUR RADIO SOCIETY

Hon. Sec.: R. Highton, 5 Brian Avenue, Dalton, Huddersfield, Yorkshire.

Recently the Society held a lecture and demonstration on Oscilloscopes. The Society operating QTH has proved very good with GDX in mind, using a 250ft. dipole.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY

Hon. Sec.: H. C. Loxley, 5 Guy Street, Warwick.

There will be an open meeting on 12th July, when members will be able to discuss a range of subjects.

Meetings are now held on the top floor of 7 Regent Grove, Leamington Spa. These premises are well situated in the centre of the town, close to main bus routes and with ample car-parking accommodation.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY

Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.

Recent activities of the Club have been a recorded lecture by the late G2SU who was a founder-member; and the first of this year's demonstrations when the Club call sign was first used.

A novel innovation this year was a mobile car in the Warley Gala procession which was able to report back to the fixed station on the progress of the parade.

Some future events will include, on 21st July a Ragchew and on 4th August, a lecture on D.F. Equipment by G3LGN.

READING AMATEUR RADIO CLUB

Hon. Sec.: N. C. Taylor, G3TOQ, 83 Stoneham Close, Tilehurst, Reading, Berkshire.

The first Mobile Picnic of the season was held on 20th June, and a good time was had by all. Talk-in stations were operated by G3TOQ on 2 metres and G3EJA on 160 metres.

SALTASH AND DISTRICT AMATEUR RADIO CLUB

Hon. Sec.: D. Bowers, BR5 26760, 95 Grenfell Avenue, Saltash, Cornwall.

A "Mobile Rally" was held at Calstock on Whit Monday, 7th June, and on the 18th, there was a tape and slide lecture which was kindly loaned by Northern Heights A.R.S.

An R.S.G.B. Tape Lecture on Receivers was heard on 2nd July. There will be a Treasure Hunt on 16th July.

SOUTH BIRMINGHAM RADIO SOCIETY

Hon. Sec.: J. Rowley, G3TQO, 195 Castle Lane, Solihull.

On 17th June there was a demonstration and display of Heathkit Products and transmitters, receivers and test gear were on show for members to see.

SOUTHGATE, FINCHLEY AND DISTRICT GROUP OF THE R.S.G.B.

Hon. Sec.: R. Wilkinson, G3TXA, 23 Ashridge Gardens, Palmers Green, London, N.13.

The May lecture was given by G3OLE, who spoke about his "hybrid" mobile transmitter. The next meeting will be on 8th July.

SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB

Hon. Sec.: D. Forster, G3KZZ, 41 Marlborough Street, South Shields.

The Club is making preparations for its 6th Mobile Rally which is to be held on Sunday, 11th July at the Bents Park Recreation Ground, Coast Road, South Shields.

Meetings are held weekly on Friday evenings at 7.30 p.m., in Trinity House Social Centre, Laygate Lane, South Shields.

SPEN VALLEY AMATEUR RADIO SOCIETY

Hon. Sec.: N. Pride, 100 Raikes Lane, Birstall, Nr. Leeds.

On 24th June there was an Open and Final Meeting of the season. The A.G.M. of the New Session will be held on 8th July.

Meetings are held at 7.30 p.m. at Heckmondwike Grammar School.

WEST KENT AMATEUR RADIO SOCIETY

Hon. Sec.: H. F. Richards, 17 Reynolds Lane, Tunbridge Wells, Kent.

On 9th July, John Gould will give a talk entitled "Seventy C.M.S.", which is aimed at getting all the Club members on 430 Mc/s.

WIRRAL AMATEUR RADIO SOCIETY

Hon. Sec.: A. Seed, G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

A Tape Lecture was given on 7th July. Meetings are held at Scout H.Q., Harding House, Park Road West, Cloughton, Birkenhead, at 7.45 p.m. on the first and third Wednesdays in each month.

A BASIC MOULLIN VOLTMETER

—continued from previous page

CONSTRUCTION

No special construction is needed and the constructor may adopt any layout. The only wire that is at all critical is the grid lead. It should be short and well spaced from any other wires to minimise the input capacitance, and very well insulated. The input terminals should be well apart on a panel of insulating material and a ceramic valve-holder should be used. A high input resistance will not be obtained if the above is disregarded although of course the instrument will still work.

RANGE EXTENSION

Although a range of 0.1 to 1V peak is ample for radio-frequency measurements, i.e. measuring Q or self-capacitance of coils, an extension of range would make the instrument more versatile. It is however very difficult to do at high frequencies due to input capacitance. At low frequencies, when the reactance of the input capacitance is considerably less than the resistance of the potential divider in parallel with it, (see Fig. 7) it can be done.

The e.m.f. at the grid is then $\frac{r}{R+r}$ of the applied

e.m.f. If a non-contributory source of e.m.f. is being used then the grid must be given a d.c. path to earth. This can be done with a high resistance, 5MΩ being a suitable value. The input resistance then drops to slightly below 5MΩ, but which is high enough for most purposes.



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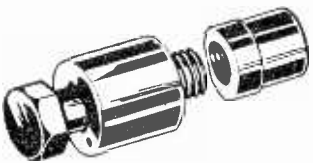
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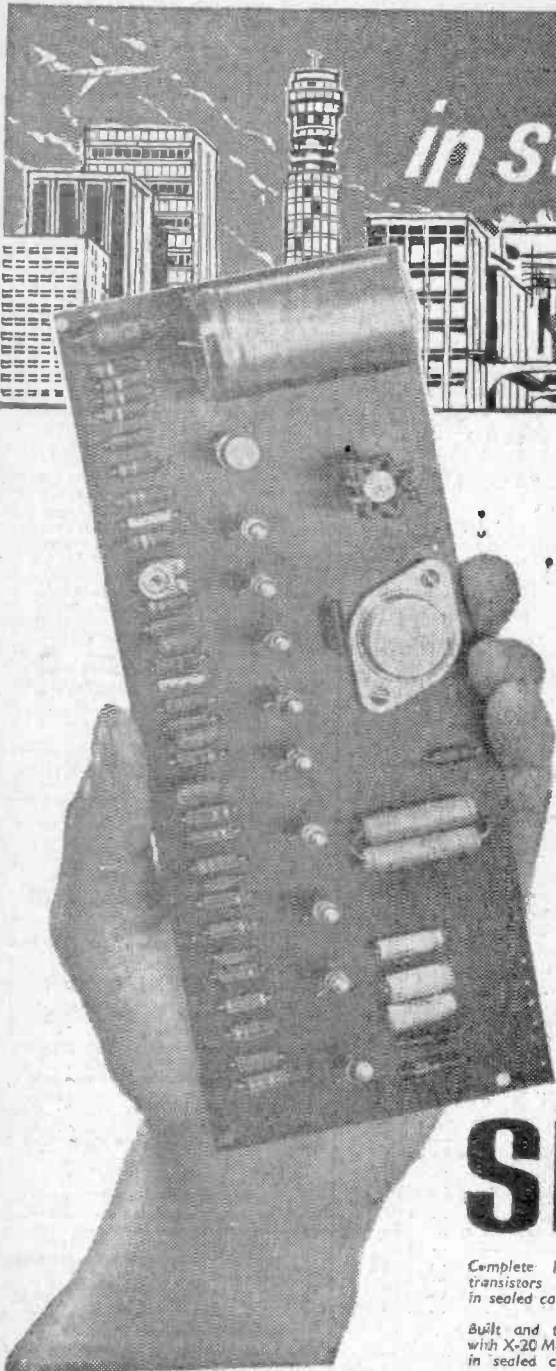
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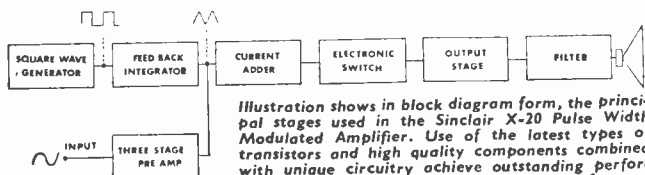


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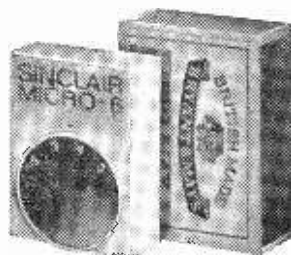
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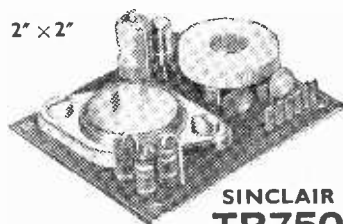
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6L57	4/6	20P48	6/6
6L58	4/6	20P49	6/6
6L59	4/6	20P50	6/6
6L60	4/6	20P51	6/6
6L61	4/6	20P52	6/6
6L62	4/6	20P53	6/6
6L63	4/6	20P54	6/6
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6L91	4/6	20P82	6/6
6L92	4/6	20P83	6/6
6L93	4/6	20P84	6/6
6L94	4/6	20P85	6/6
6L95	4/6	20P86	6/6
6L96	4/6	20P87	6/6
6L97	4/6	20P88	6/6
6L98	4/6	20P89	6/6
6L99	4/6	20P90	6/6
6L100	4/6	20P91	6/6
6L101	4/6	20P92	6/6
6L102	4/6	20P93	6/6
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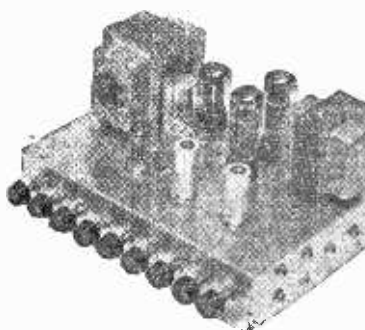
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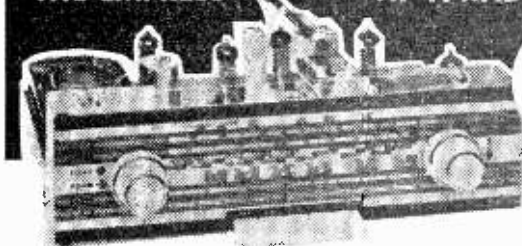
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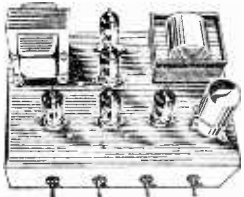
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● Peak output in excess of 1 1/2 watts. ● All standard British components. ● Built on printed circuit panel size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114) or 81 Mullard OC81D and matched pair of OC51 o/p 9 volt operation. ● Everything supplied with battery clips solder etc. ● Comprehensive easy to follow instruction and circuit diagram 1/6. (Free with Kit). All parts sold separately.

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● F.M. tuning head by famous maker.

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By famous maker. Brand new and unused. Complete with POC84 and PCF80 valves 34-35 Mc/s I.F. Bandwidth for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. **ONLY 25/-** each. P. & P. 3/9.

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E.M.I. 4-SPEED SINGLE RECORD PLAYER DECKS

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A top-quality record player amplifier. Size 7in. w. x 2 1/2in. d. x 6 1/2in. h. This amplifier (which is used in a 29 gm record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Ready built and tested

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7in. metal turntable

Low flutter performance

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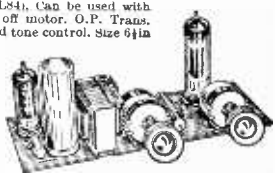
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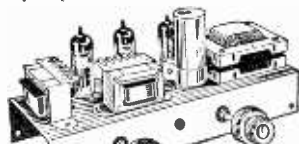
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Suitable for use with above. 2in. Goodman. Ideal replacement for most pocket portables 8/6. 3 1/2in. 12/8; 5in. 17/8; 7 x 4in. 21/- P. & P. 2/- per speaker.

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3 I.F. transformers one oscillator coil one driver transformer and wound Ferrite aerial (med. long and car aerial coupling) 32/6 complete post 2/- 6 transistor printed circuit board to match 8/6. Post 1/6. Circuit diagram 1/6 extra.

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5in., 12/6; 6in., 15/-; 8in., 21/-; 10in., 25/-; 12in., 27/6; (12in. 15 ohm, 30/-) 10in. x 6in., 26/-; E.M.I. 1 1/2 x 8in. with high flux ceramic magnet, 42/-; 10 ohm, 45/-.

4in. HIGH FLUX TWEETER. 3 ohm or 15 ohm imp. Famous British make, 12/- P. & P. 4 and 6in. 2/-, 6in. and 8in. 3/6; 10 and 12in. 3/6 per speaker.

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MATCHED PAIR OF 2 1/2 WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1 1/2 x 1 1/2 x 1 1/2 in. Output trans. tapped for 3 and 15 ohm output, 10/- pair. P. & P. 2/6. BRAND NEW PLESSEY 12V. 4 pin. non-synch. vibrators. Type 12 1.48D. ONLY 8/6 P. & P. 1/6 each.

1 1/2 IN. TELESCOPIC AERIAL. Comprising two 3-section heavily chromed rods. Closed 12in. each extending to 32in. each. Completely adjustable from vertical to horizontal. Supplied complete with universal mounting bracket, coax lead and plug. Suitable for F.M. or T.V. 12/6 P. & P. 3/6.

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Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any parcel insured against damage in transit 6d. extra.

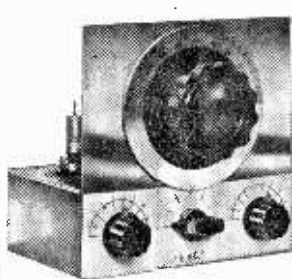
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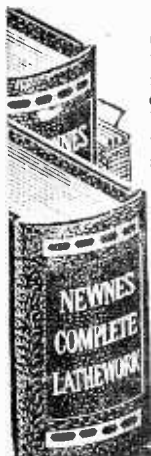
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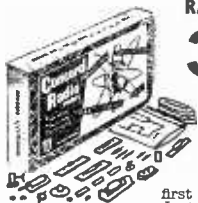
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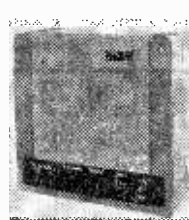
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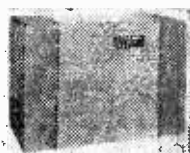
Suitable for guitars, gramms and radios. The 5 watt output amplifier incorporates separate volume, treble and bass controls.

Two jack socket inputs are fitted. Twin speakers give exceptionally realistic reproduction and are

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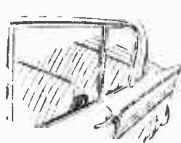
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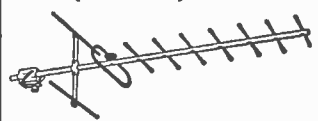
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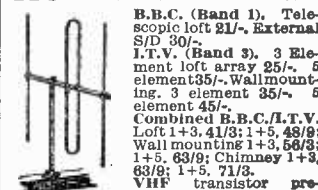
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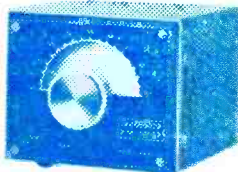
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- ★ Push-pull speaker output.
- ★ Easy printed circuit.
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(Mains units Mono 59/6 Stereo 69/6)

★ PREAMPLIFIERS—MONO AND STEREO VERSIONS.

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30 c/s to 20 kc/s.

Complete range of

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Size 9½ x 2½ x 2 in.

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Enables complete Mono or Stereo equipment to be assembled

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4 WATT AND 1½ WATT PACKAGE AMPLIFIERS

★ 6-transistor push-pull printed

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★ Peak output 8 watt and 3 watt.

★ Size only 2½ x 2 x 1½ in.

★ 4 watt, 12/18 volt; 1½ watt, 9/12 volt.

★ Output for 3 to 5 ohm speakers.

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