15 3P.

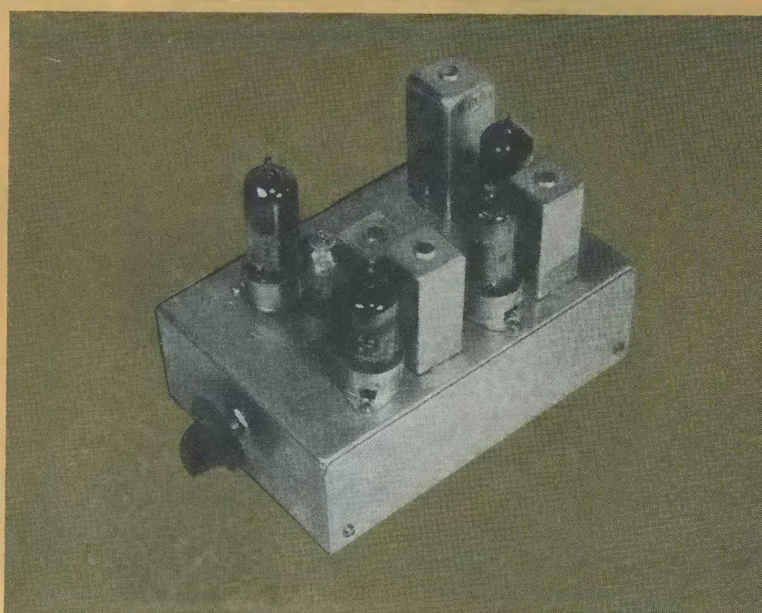
THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 18 NUMBER 7
A DATA PUBLICATION
TWO SHILLINGS & THREEPENCE

February 1965

the "Crystarlet" crystal-controlled F. M. TUNER



"Zephyr" Three S.W. Receiver ★ Economy Capacitance Bridge ★ Sound Operated Switch ★ "A-Pealing" Door Chimes

LASKY'S RADIO

FOR THE FINEST RANGE OF TRANSISTOR RECEIVERS

We consider our construction parcels to be the finest value on the home constructor market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded, less postage.

The SKYROVER Range

GENERAL SPEC.
7 transistor-2 diode superhet portables, covering full Mod. plus 6 S.W. bands.

THE SKYROVER MK II

Now supplied with redesigned cabinet, edgewise controls, new colour tuning scale and cabinet in Sierra Tan. Controls: Waveband Selector, Volume Control with On/Off Switch, Tuning Control. In plastic cabinet, size 10" x 6½" x 3½", with metal trim and carrying handle.

Can now be built for **£8.19.6** **H.P. Terms: 20/- deposit and 11 months at 16/6**
P. & P. 5/- extra

THE SKYROVER DE LUXE

Tone Control circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11½" x 6½" x 3", covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for **£10.19.6** **H.P. Terms: 25/- deposit and 11 months at 20/-**
P. & P. 5/- extra

All components available separately. Four U2 batteries 3/4 extra. Data for each receiver, 2/6 extra, refunded if you purchase the parcel.

LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THESE WELL-KNOWN SETS. A simple additional circuit provides coverage of the 1,100–1,950 metre band (including 1,500 metre Light Programme). This is in addition to all existing medium and short wavebands. All necessary components with construction data. **This conversion is suitable for both models that have already been constructed. Only 10/- extra Post Free.**

VEROBOARD

A really remarkable time saver in setting out complicated circuits. Veroboard is a high grade laminated board with copper strips bonded to it, pierced with a regular matrix of holes. Ideal for producing single items and experimental circuits.

BOARDS

42/1503	2½" x 5"	3/8
43/1504	2½" x 3¾"	3/-
45/1507	3¾" x 5"	5/2
46/1508	3¾" x 3¾"	3/8
44/1505	3¾" x 17"	13/6

ACCESSORIES

Terminal pins—packet of 36	3/3
Spot face cutter tool	9/-
Pin inserting tool	9/9

P. & P. 6d. per item extra

Sub-Miniature Transistorised Amps.

British made, these sub-min. transformerless amplifiers come to you fully built and ready for immediate use. Thousands of uses in all branches of electronics: sound and signal amplification—models—electro medico equipment—pre-amps.—radio tuners—tape head amps., etc. All use NPN–PNP circuit powered by 9V battery.

PC1, input 50mV, output 150mW at 40Ω, size 2" x 1" x ¾". **LASKY'S PRICE** 29/6 P. & P. 1/-
PC2, input 1mV, output 400mW at 15Ω, size 2" x 2½" ¾". **LASKY'S PRICE** 37/6 P. & P. 1/-
PC3, input 5mV, output 400mW at 15Ω, size 2½" x 1½" x ¾". **LASKY'S PRICE** 37/6 P. & P. 1/-
PC4, input 150mV, output 400mW at 15Ω, size 2½" x 1½" x ¾". **LASKY'S PRICE** 37/6 P. & P. 1/-

BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers 2- or 4-track models

COLLARO STUDIO TAPE DECK. Latest model 3 speed, 3 motors. Take 7" reels. Fitted with half-track heads. **LASKY'S PRICE £10.10.0.** New and Unused. *P. & P. 7/6*

COLLARO STUDIO TAPE DECK. As above but fitted with the latest quarter-track heads. **LASKY'S PRICE £13.19.6** *P. & P. 7/6*

MARTIN TAPE RECORDER AMPS. Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3-ohm output, equalising, etc. For 200–250V a.c. mains.

PRICES: ½-track Model **£11.11.0.** ¼-track Model **£12.12.0.** *P. & P. 2/6.*

Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9" x 5" speaker. Price complete with speaker £5.5.0. *P. & P. 5/-*

HI-FI TAPE RECORDER HEADS

High Impedance Record Play. Low impedance erase. Upper or lower track.

LASKY'S PRICE 29/6 Post free per pair. State track required.

MARRIOTT "X" Type ¼ track heads. Record/Play and Erase. **LASKY'S PRICE 4 gns. pair** ½-Track heads Record/Play and Erase 59/6 pair

TAPE DECK MOTORS

Motors for the Collaro Studio Deck — new and unused. 200–250V A.C. Take-up and rewind. Listed at £2 5s. each. **LASKY'S PRICE 14/11 each.** *P. & P. 2/6.*
State motor required when ordering.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size: 4" dia., x 2" high. 1" x ¼" spindle. **LASKY'S PRICE 19/11.** *P. & P. 3/6.*

TAPE POSITION INDICATOR

Open type — as used by most makers. With re-set knob:
3 DIGIT 7/6; 4 DIGIT 10/6. *P. & P. 9d. on each.*

INTERNATIONAL TAPE

Famous American Brand — Fully Guaranteed at record low prices. In sealed cartons.

3in message tape, 150ft	3/6
3in message tape, 225ft	4/11
3in message tape, 300ft	7/6
3in triple play, 450ft. Mylar base	12/6
4in triple play, 900ft. Mylar base	22/6
5in double play, 1,200ft. Mylar base ...	15/-
5in long play, 900ft. Acetate base ...	10/-
5in standard play, 600ft. PVC base ...	8/6
5in triple play, 1,800ft. Mylar base ...	42/6
5¾in long play, 1,200ft. Mylar base ...	15/-
5¾in double play, 1,800ft. Mylar base ...	22/6
5¾in long play, 1,200ft. Acetate base ...	12/6
5¾in standard play, 850ft. PVC base ...	11/6
5¾in triple play, 2,400ft. Mylar base ...	55/-
7in standard play, 1,200ft. Mylar base ...	12/6
7in long play, 1,800ft. Mylar base ...	19/6
7in double play, 2,400ft. Mylar base ...	25/-
7in long play, 1,800ft. Acetate base ...	15/-
7in triple play, 3,600ft. Mylar base. ...	75/-

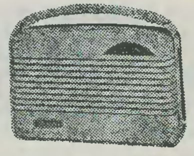
P. & P. 1/- extra per reel; 4 reels and over Post Free.

TRANSISTORS New and Guaranteed

GET.S1, GET.S5, GET.S6—2/6; 873A, 874P—3/6; OC.45, OC.71, OC.81D—4/6; OC.44, OC.70, OC.76, OC.81—5/6 (matched pair 10/6); AF.117, OC.75, OC.200—6/6; OC.42, OC.43, OC.73, OC.82D—7/6; OCP.71—9/6; OC.201, OC.204—15/-; OC.205, OC.206—19/6 OC.28—24/6.

REALISTIC SEVEN

★ 7-transistor Superhet. ★ 350 milliwatt output into 4" high flux speaker. ★ All components mounted on a single printed circuit board, size 5½" x 5½" in one complete assembly. ★ Plastic cabinet with carrying handle, size 7" x 10" x 3½", available in Blue/Grey. Full L. & M. coverage ★ Easy to read Dial. ★ External socket for car aerial. ★ I.F. frequency 470 kc/s. ★ Ferrite rod internal aerial. Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly.



An Outstanding Receiver. **LASKY'S PRICE** for the complete parcel including Transistors, Cabinet, Speaker, etc., and Full Construction Data. Can be built for: **£5.19.6**
P. and P. 4/6

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

REALISTIC 'Seven' De Luxe

With the same specification as standard model —PLUS a superior wood cabinet in contemporary styling. ALSO a full vision circular dial
FOR ONLY **£1** EXTRA
P. & P. as std. model

SINCLAIR SUPER MINIATURES

THE SINCLAIR SLIMLINE

The new 2-transistor pocket radio, size only 2 3/4" x 1 5/8" x 1 5/8". Micro alloy transistors and printed circuit. Easy to assemble.
CAN BE BUILT FOR 49/6

THE SINCLAIR MICRO-6

Self-contained pocket radio. Size only 1 4/5" x 13/10" x ½"—truly amazing performance. Without doubt the most advanced transistor circuit ever offered to home constructors—yet may be built in an evening. Complete with earphone and detailed construction data.
CAN BE BUILT FOR 59/6 Mercury cell 1/11 extra (2 required).

THE SINCLAIR X10

10 watt power amplifier fitted with integrated pre-amp. Requires only 1mV for an output of 10 watts undistorted. Frequency response is flat, ½dB from 5 c/s to 10 kc/s. Size only 6" x 3" x ¾", weight 5 oz., built on printed circuit. Operates from 12V d.c. at 75μA quiescent. Circuit uses 7 MATs and 4 r.f. power transistors.
KIT PRICE £5.19.6 **READY BUILT £6.19.6**
3 pots. for volume, bass & treble, 7/6 the 3 extra.

TRANSFILTERS by BRUSH CRYSTAL CO.

TO-01B 465 kc/s ± 2 kc/s
TO-01D 470 kc/s ± 2 kc/s
TO-02B 465 kc/s ± 1 kc/s
TO-02D 470 kc/s ± 1 kc/s
TF-01B 465 kc/s ± 2 kc/s
TF-01D 470 kc/s ± 2 kc/s

6/6 each
P. & P. 6d.

PICK-UP CARTRIDGES

Crystal P.U. Cartridges complete with stylii—at lowest prices ever!

Mono C.T.I.	4/11
Collaro Type C, stereo, 2 sapphires. ...	15/-
Collel S.C.I. Stereo Diamond LP Sappl. std.	17/6
Sonotone 8T, stereo, 2 sapphires ...	19/11
Sonotone 2TA, mono, 2 sapphires ...	15/-

Postage 1/- each extra.

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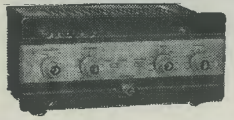
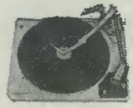
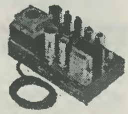
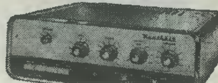
HI-FI AMPLIFIERS — RECORD PLAYERS — RADIO TUNERS

S-33  AT-6  MA-12  S-99 

GOLDRING LENCO TRANSCRIPTION PLAYER. Model GL-58. With G-60 pick-up arm and Ronette 105 cartridge. **£20.1.3** incl. P.T.

GARRARD AUTO/RECORD PLAYER. Model AT-6. With R 105 cartridge. **£13.12.1** incl. P.T. Decca Deram pick-up **£14.6.1** incl. P.T.

HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Presentation similar to S-33. Kit **£10.19.6** Assembled **£15.10.0**

HI-FI MONO AMPLIFIER. Model MA-12. 12W output, wide freq. range, low distortion. Kit **£11.18.0** Assembled **£15.18.0**

R.P.M. INDICATOR (Electronic Rev. Counter). A must for the motoring enthusiast. For 4 cylinders, pos. or neg. earth. 12V. Send for details. (Assembled only) **£8.10.9**

HI-FI 6W STEREO AMPLIFIER. Model S-33. 3 watts per channel 0.3% distortion at 2.5W/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram, Stereo or Monaural, ganged controls. Kit **£13.7.6** Assembled **£18.18.0**

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

HI-FI STEREO AMPLIFIER. Model S-99. 18W output. Ganged controls. Stereo/Mono gram., radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£27.19.6** Assembled **£37.19.6**

POWER SUPPLY UNIT. Model MGP-1. Input 100/120V, 200/250V. 40–60 c/s. Output 6.3V, 2.5A A.C. 200, 250, 270V, 120mA max. D.C. Kit **£5.2.6** Assembled **£6.12.6**

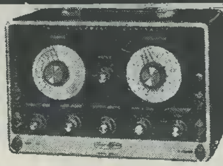
A wide range of American equipment available under direct mail order scheme. Full details and catalogue 1/– post paid.

Heathkit DAYSTROM

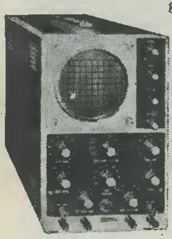
Make the most of the winter evenings...

INSTRUMENTS

T.V. ALIGNMENT GENERATOR. Model HFW-1. Offers max performance at lowest cost. Covers 3.6 to 220 Mc/s fundamentals. Electronic sweep oscillators. Built in marker generators (5 Mc/s crystal) **£34.18.0** Kit **£44.10.0** Assembled



HFW-1



IO-12U

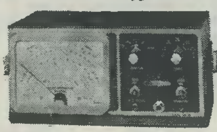
5″ GENERAL-PURPOSE LABORATORY OSCILLOSCOPE. Model IO-12U. This outstanding oscilloscope, with its professional specification and styling, fulfills most laboratory and service requirements. Vertical frequency response 3 c/s to over 4.5Mc/s, sensitivity 10mV r.m.s. per cm. at 1 kc/s. T/B covers 10 c/s–500 kc/s. Kit **£32.12.6** Assembled **£41.10.0**

2¾″ PORTABLE SERVICE 'SCOPE. Model OS-1. This is a light, compact oscilloscope, ideal for servicing, etc. Dimensions 5″ x 8″ x 14½″ long. Wt. 10½lb. Fitted mu-metal CRT shield. Kit **£22.18.0** Assembled **£30.8.0**

S-3U

ELECTRONIC SWITCH. Model S-3U (Oscilloscope Trace Doubler). Enables a single beam oscilloscope to give simultaneous traces of two separate and independent signals. Switching rates approx. 150, 500, 1,500, 5,000 and 15,000 c/s. Sig. freq. response 0–100 kc/s. ±1dB. Separate gain controls and sync. output. Sig. input range 0.1–1.8V r.m.s. Kit **£12.18.0** Assembled **£18.10.0**

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



IM-13U

AUDIO SIGNAL GENERATOR. Model AG-9U. 10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's. Kit **£22.10.0** Assembled **£30.10.0**

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

V-7A

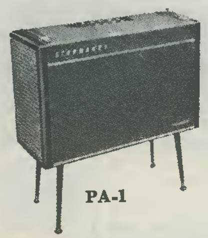
MULTIMETER. Model MM-1U. Ranges 0–1.5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0.2Ω to 20MΩ. 4½″ 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics. Up to 100 mV output. Kit **£13.8.0** Assembled **£19.18.0**

RF-1U

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE. SEND FOR LISTS OF PRICES

FOR THE MUSIC MAKER



PA-1

PA AMPLIFIER PA-1. The ideal compact unit for VOCALISTS, INSTRUMENTALISTS, RECORDS, with 50 Watt output, 2 Heavy Duty Speakers. Variable TREMOLO. Elegant modern cabinet. Kit **£54.15.0** Assembled **£74.0.0**

Legs optional extra **17/6** set of 4

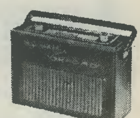
POWER AMPLIFIER MA-50 50W output. Kit **£19.18.0** Assembled **£27.18.0**

ELECTRONIC ORGAN

(Transistorised). Ideal for Soloists, Home use, Groups. FULL 20 WATTS VOLUME. **£187.10.0** Matching bench **£14.10.0** extra.

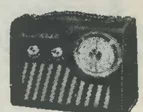
TRANSISTOR RADIOS

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



UXR-2

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



UXR-1

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

UJR-1

JUNIOR TRANSISTOR RADIO. Model UJR-1. Single transistor set. Excellent introduction to radio. Kit **£2.7.6** incl. P.T.

Money-back Guarantee

Daystrom Limited unconditionally guarantees that each Heathkit product assembled in accordance with our easy-to-understand instruction manual must meet our published specifications for performance or the purchase price will be cheerfully refunded.

SINCLAIR

③ SINCLAIR X-10

INTEGRATED 10-WATT HI-FI AMPLIFIER AND PRE-AMP WITH P.W.M.

Cost of all parts together with Instruction Manual

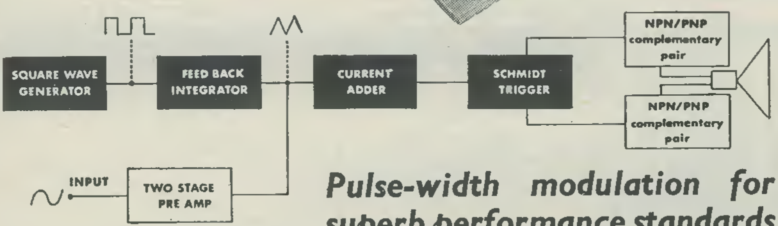
£5.19.6

Ready built and tested together with Instruction Manual **£6.19.6**

Mains power supply unit (A.C. 200-240 volt) to drive one or two X-10 amps. **£2.14.0**

The only design of its kind in the world

THE GREATEST ADVANCE IN AMPLIFIER DESIGN IN YEARS



Pulse-width modulation for superb performance standards

The principle of P.W.M., used in this remarkable amplifier which is complete with its own pre-amp stage and unique output stage, is briefly as follows: A square wave of constant voltage amplitude and with a frequency well above the highest audio-frequency to be reproduced, is applied to the terminals of the load. As the load has a high impedance at this frequency, negligible current flows through the voice coil of the speaker.

When an input signal is applied, the mark-space ratio changes with the result that there is a net current flowing through the voice coil which deflects the cone. When the input signal is at any frequency up to 20 kc/s the net current is an exact replica of the input signal and is independent of the transfer characteristics of the output transistors, making the distortion figures incredibly low. The output transistors act as switches and so dissipate negligible power. This enables us to use 5 Mc/s transistors for this with great savings in space, current consumption and costs. No heat sink is required.

- ★ 11 Transistors and no heat sink
- ★ Unique output stage
- ★ Add your own choice of tone control circuit
- ★ Input sensitivity 1mV into 1kΩ
- ★ Can be used with all types of inputs including low-output pick-ups and microphones
- ★ Total harmonic distortion <0.1%
- ★ Output power up to 10 watts
- ★ Frequency response 5-20,000 c/s ±0.5dB
- ★ Speaker impedance 15Ω
- ★ Damping factor—greater than 100
- ★ Supply voltage 12 volts from batteries or mains supply unit
- ★ Size 6" x 3"

SINCLAIR X-10 MANUAL

Explains how the amplifier functions and how you can add the correct tone and volume control system to suit your precise requirements. A variety of systems is shown, none of which will add more than a few shillings to the original cost of your Sinclair X-10, be it for **MONO** or **STEREO**. *Available separately. Price 1/–.*

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Please send items detailed below £ s d

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BRADFORD 54 Morley Street, Nr. Alhambra Theatre (Half-day Wednesday). New larger premises. Opening Mid Feb. at 10 North Parade.

BRISTOL 14 Lower Castle Street Half-day Wednesday

BIRMINGHAM 30/31 Gt. Western Arcade, opp. Snow Hill Station (No half-day)

DERBY 26 Osmaston Rd., The Spot (Half-day Wednesday)

DARLINGTON 13 Post House Wynd (Half-day Wednesday)

EDINBURGH 133 Leith Street (Half-day Wed.)

GLASGOW 326 Argyle Street (Half-day Tuesday)

HULL 51 Savile Street (Half-day Thursday)

LEICESTER 32 High Street (Half-day Thursday)

LEEDS 5–7 County (Mecca) Arcade (No half-day closing)

LIVERPOOL 73 Dale Street (No half-day closing)

LONDON 238 Edgware Road (Half-day Thursday)

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Callers welcome at our extensive new premises at 60A/60B Oldham Street (No half-day)

MIDDLESBROUGH

106 Newport Road (Half-day Wed.)

SHEFFIELD 13 Exchange Street. Castle Market Bldgs. (Half-day Thursday)

BASS-MAJOR 30 WATT AMPLIFIER

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

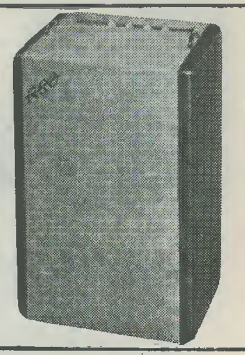
Eminently suitable for bass, lead or rhythm guitar

and all other musical instruments

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

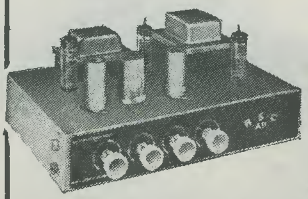
Send S.A.E. for leaflet OR DEPOSIT of £4.3.0 and 12 monthly payments of £3.9.11

39½ Gns. Carr. 17/6. (total £46.2.0).



HIGH FIDELITY 12–14 WATT AMPLIFIER TYPE A11

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



Two input sockets with associated controls allow mixing of "mike" and gram., as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response—3dB 30–30,000 c/s. Six negative feedback loops. Hum level 60dB down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs for **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, LEAD OR RHYTHM GUITARS,** etc.

OUTPUT SOCKET with plug provides 300V 30mA, and 6.3V 1.5A for supply of a **Radio Feeder Unit.** Size approx. 12" x 9" x 7". For A.C. mains 200–250V 50 c.p.s. Output for 3 & 15Ω speaker. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagram supplied. Only **8 Gns.** (Or factory built 51/– extra) Carr. 10/–

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R.S.C. G5 AMPLIFIER. For "mike", gram, lead or rhythm guitar, etc. 5-watt high quality output. Incorporating high flux 12" 10 watt 12,000 line speaker. Sensitivity 50mV. High impedance jack input. Handsome strongly made cabinet (size 14" x 14" x 7" approx.) finished in complementary shades of Rexine/Tygan. 200–250 A.C. mains. **£9.19.6** Or DEPOSIT 22/3 and 9 monthly payments of 22/3 (total £11.2.6). Carr. 7/6.

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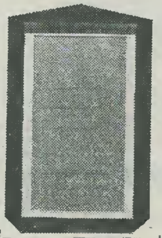

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"A" indicates duel cone type. 30–17,000 c.p.s. Send S.A.E. for leaflets. Terms available.
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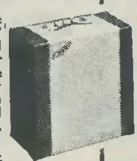

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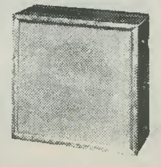

12in. 20-WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18" x 13" x 10" Finish as above. Terms: Deposit 17/9 and 9 monthly payments of 17/9. (total £8.17.6.). Only **£7.19.6** Carriage 8/6.

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The "Zephyr" Three Short Wave Receiver

By **B. W. HOLLINSHEAD**

An efficient and easily constructed design for the short wave listener

SOONER OR LATER MOST RADIO ENTHUSIASTS TURN their attention to the short wave bands to obtain long distance reception of the very interesting transmissions which are available at these frequencies. Those who hope eventually to obtain an Amateur licence find a period as a Short Wave Listener almost essential before attempting the qualifying theoretical and Morse tests. By becoming a S.W.L. much information on operating procedure and transmitting equipment can be gathered by listening to established amateurs "rag-chewing".

Contrary to the beliefs held by some, it is not necessary to have a large, complex and expensive receiver to obtain reasonable results on short waves. The receiver to be described here is well within the capabilities of even comparatively inexperienced constructors and will give extremely good results when coupled to an efficient aerial. Also, the building costs are very reasonable, since relatively cheap and readily obtainable components are specified. Some of the components will, no doubt, be already available in the spares box of many constructors. The writer feels sure that this

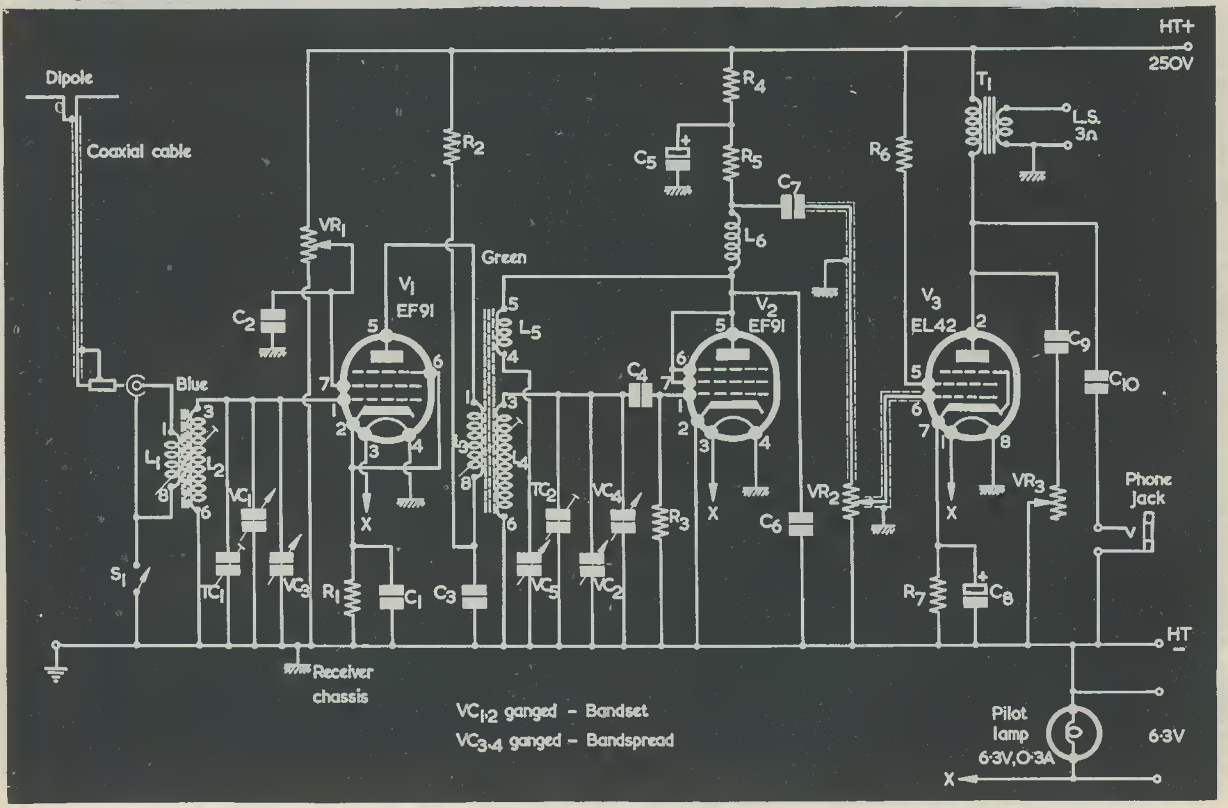


Fig. 1. The circuit of the "Zephyr". If a normal aerial is employed, this is connected to the centre contact of the coaxial socket and S_1 is closed

Components List (Fig. 1)

Resistors

(All fixed resistors 20% ½ watt unless otherwise specified)

R_1	150Ω
R_2	4.7kΩ
R_3	2.2MΩ
R_4	22kΩ
R_5	47kΩ
R_6	1kΩ
R_7	390Ω 1 watt
VR_1	250kΩ potentiometer, log track
VR_2	500kΩ potentiometer, log track
VR_3	50kΩ potentiometer, log track

Capacitors

(All fixed capacitors 350V wkg. unless otherwise specified)

C_1	0.1μF
C_2	0.1μF
C_3	0.1μF
C_4	100pF silver-mica
C_5	8μF electrolytic
C_6	100pF silver-mica
C_7	0.01μF
C_8	25μF electrolytic 25V wkg.
C_9	0.1μF
C_{10}	0.1μF 500V wkg.
$VC_{1,2}$	300+300pF twin-gang (or 500+500pF with 1,000pF 5% silver-mica capacitor in series with each section—see text)
$VC_{3,4}$	25+25pF twin-gang (see text)
VC_5	300pF variable (or 500pF with 1,000pF silver-mica capacitor in series—see text)
$TC_{1,2}$	3–30pF trimmer

Inductors

*$L_{1,2}$	"Maxi-Q" octal-based Blue (Denco)
*$L_{3,4,5}$	"Maxi-Q" octal-based Green (Denco)
L_6	R.F. choke type QC1 (Osmor)
T_1	Speaker transformer, approximate ratio 55:1

Valves

V_1	EF91
V_2	EF91
V_3	EL42

Switch

S_1	s.p.s.t. toggle

Sockets

2 International Octal bases
2 B7G bases with skirts and screening cans
1 B8A base
1 Phone jack
1 Insulated coaxial socket (Belling-Lee Type L.603/B or similar)
1 Pilot lamp holder and glass

Miscellaneous

3 Epicyclic reduction drives
1 6.3 volt 0.3 amp pilot lamp
Knobs, wire, etc., etc.

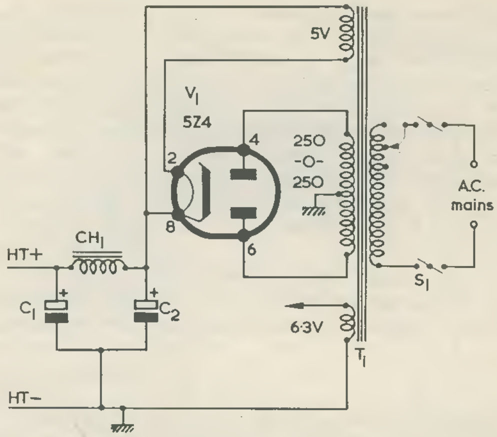


Fig. 2. A suitable power supply for the receiver

Components List (Fig. 2)

V_1	5Z4
$C_{1,2}$	32+32μF electrolytic 350V wkg.
CH_1	Smoothing choke, 50mA. (May be replaced by a 2kΩ 5 watt resistor, if desired)
S_1	d.p.s.t. toggle
T_1	Mains transformer. Secondaries (with minimum currents) 250–0–250 volts 50mA, 6.3 volts 1.1 amps, 5 volts 2 amps

set will appeal both to builders of their first short wave set and to other, more experienced, listeners who might require a standby receiver.

The Circuit

The circuit of the receiver appears in Fig. 1, and it will be seen that this is largely conventional, employing the usual t.r.f. configuration of r.f., detector and output stages. For those who require an even simpler receiver it would be possible to omit the r.f. stage, but this is not recommended because the aerial would then be capable of radiating a considerable amount of interference should the detector oscillate. Without an r.f. stage, and with the aerial coupled directly to L_3, this interference could cause trouble to neighbouring sets. The r.f. stage also aids sensitivity and selectivity. VR_1 controls the gain of this stage by varying the potential on the screen-grid of V_1.

The valves used in both r.f. and detector positions are EF91 high slope r.f. pentodes. Their direct equivalents, Z77, 6AM6, 8D3 or 6F12, could also be used. The reason for choosing these valves, apart from their efficiency and suitability, is that they are cheap and readily available. They were used extensively in many of the earlier TV receivers, and a constructor who obtains one of these may find a supply of these valves together with their associated holders and screens, as well as a speaker transformer and other useful components. Due to the high efficiency of the EF91, it is necessary to provide screens for both V_1 and V_2.

* See Table for frequency coverage

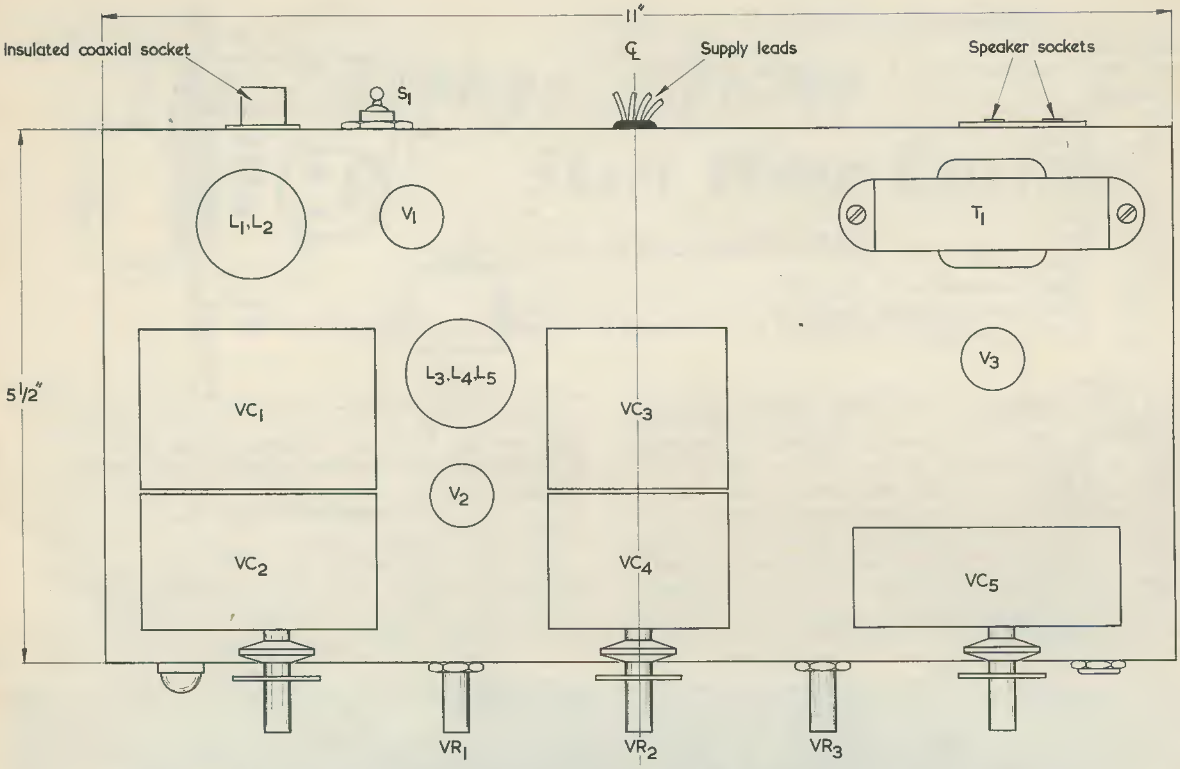


Fig. 3. Outside dimensions and above-chassis layout. The depth of the chassis is 2½in. The aerial and r.f. coils appear, in their screening cans, above the chassis

The EF91 employed in the detector stage (V_2) has its anode, screen-grid and suppressor strapped together to form a triode. To increase the sensitivity, anode reaction is applied via L_5 and VC_5. In the interest of obtaining smooth reaction—which is very desirable if the highest efficiency is to be obtained from the detector—a 100pF silver-mica capacitor, C_6, is connected from the anode of V_2 to chassis.

The detected a.f. signal from V_2 is fed to V_3 via a 500kΩ potentiometer, VR_2, functioning as a volume control. The valve used in the output stage is an EL42, which is capable of producing 2.5 watts for the modest power requirements of 0.2 amps at 6.3 volts, and approximately 30mA at 225 volts. The anode load impedance should be 9kΩ, which for a 3Ω speaker, means an output transformer having a ratio close to 55:1. Resistor R_6 is included to ensure that the screen-grid voltage does not rise above that at the anode. A simple top-cut tone control circuit, C_9 and VR_3, is included, and is advantageous in the elimination of certain types of background noise.

Power Supply

The power supply can be quite straightforward and conventional. Approximately 50mA at 250 volts h.t. and 1.1 amps at 6.3 volts for the heaters are all that is required. As the writer obtains power for all his apparatus from a large separate power pack, it was not thought necessary to include a power supply on the receiver chassis. However, for those constructors who require a complete receiver independent of other units, slight alterations to the component placing should enable a mains transformer and rectifier to be accommodated. If there is not sufficient room, a slightly larger chassis than that specified should overcome this difficulty. Alternatively, the power supply could be mounted on a separate chassis. A suitable circuit is shown in Fig. 2.

Tuning Arrangements

The tuning capacitors can usually be obtained quite cheaply from various sources. The twin-gang bandset capacitor, VC_1, VC_2, should have a maximum capacitance of 300pF for use with the coils specified, but as twin-gang capacitors with this value may not be immediately available it is quite in order to use one of 500pF maximum with 1,000pF silver-mica capacitors of 5% tolerance connected in series with each set of fixed vanes to reduce the maximum capacitance to that required. The variable capacitor should be smooth in action and free from sloppiness in movement. If a small component is available so much the better, although there is room on the chassis to fit one of standard size. The bandspread capacitor is a twin-gang component with a 25pF capacitance for each section, although the actual maximum capacitance here is not critical. New components are available from several manufacturers, as they are used in the construction of many f.m. tuners, but the one used in the prototype was a surplus Air Ministry component.*

The reaction capacitor should also have value of 300pF, and again it would be quite in order to use a 500pF capacitor with a 1,000pF silver-mica fixed capacitor in series. Either an air-spaced or solid dielectric component would serve here, although solid dielectric components are not generally as easy to set up when making critical adjustments as are the air-spaced types.

Since bandspread tuning is employed, an elaborate slow motion drive is not required, and this brings about an appreciable saving in costs. Simple epicyclic reduction drives of ratios of 6:1 are fitted to all three variable capacitors. It is not strictly necessary to fit one to the reaction capacitor, but the slight extra cost is more than repaid in the ease of reaction control.

Coils

The home constructor has two choices open to him as regards coils. He can either wind his own or buy ready-made commercial types. The latter are generally smaller in size and more efficient, and for this reason commercial coils are used in the "Zephyr".

If reception on more than one band is required, provision has to be made for coil changing. This can either be done by using band-switching or, alternatively, plug-in coils. To simplify construction and also eliminate the losses that can arise from over-long switch wiring, plug-in coils are used in this receiver. Those specified have their own screening cans and plug into standard International Octal bases. They are manufactured by Denco (Clacton), Ltd., and are available in 5 ranges to cover all bands.

The phone jack provides an output for high resistance phones. The isolating capacitor, C_{10}, should be a reliable component having a rating of at least 500 volts d.c.

Aerial

The receiver has been operated with a number of different types of aerial, these ranging from a simple vertical rod to a tuned dipole, and including inverted-L aerials of the normal type. Best working was obtained with the dipole using a coaxial down-lead, and an insulated coaxial socket accepts the lead from the dipole centre to the aerial coupling winding. A switch, S_1, is inserted to connect the earthy end of the coupling winding to chassis or

* A suitable choice for the bandset component, VC_1, VC_2, is the 2-gang capacitor Type E, Cat. No. 4507, with capacitance swing of 310 pF, manufactured by Jackson Bros. Ltd. The bandspread capacitor, VC_3, VC_4, could be a Type U.101/S-S, Cat. No. 5095, gang capacitor with capacitance of 3.8 to 27pF in each half. This component is also manufactured by Jackson Bros. Ltd.—Editor.

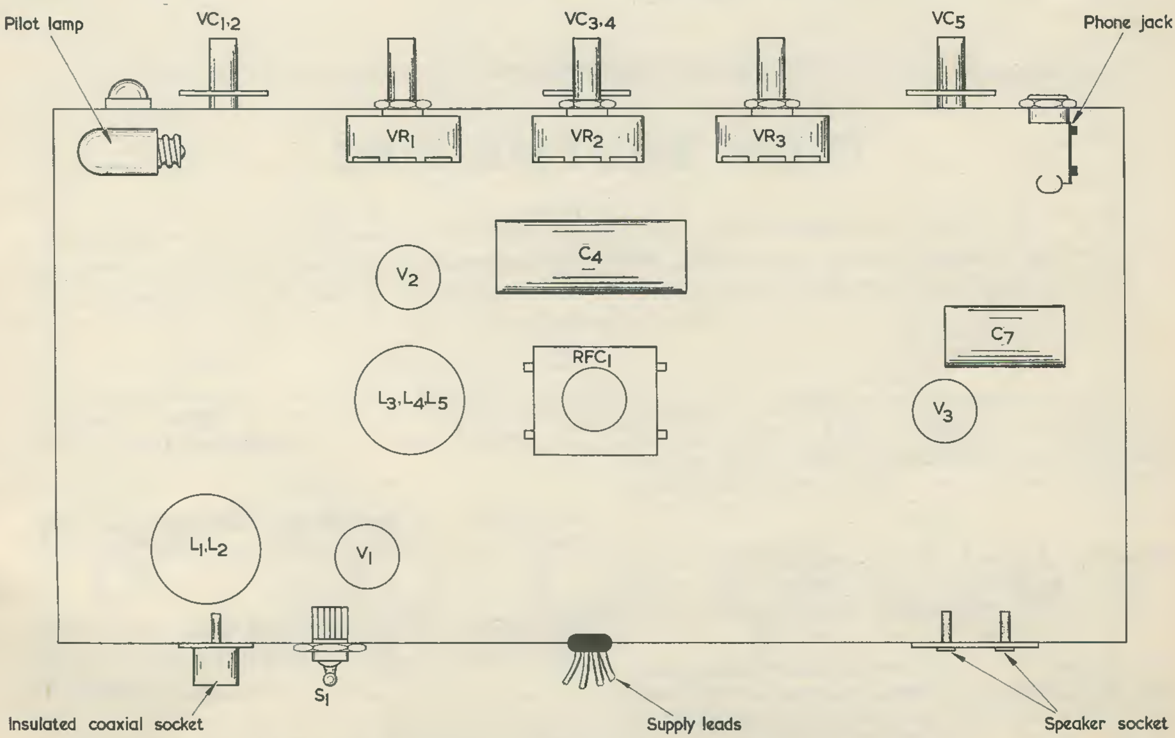


Fig. 4. The positions taken up by the principal components below the chassis

TABLE
Coverage of "Maxi-Q" Blue and Green coils.

Range	Mc/s	Metres
1	0.175—0.525	1700—570
2	0.515—1.545	580—194
3	1.67—5.3	180—57
4	5—15	60—20
5	10.5—31.5	28—9.5

leave it isolated as desired, and the writer found that this facility helped in reducing some kinds of background noise. The switch is mounted near the aerial socket to avoid the long wiring which would be necessary for a panel switch. If a vertical rod aerial is employed, the switch should be closed to connect the earthy end of the coupling coil to chassis.

Construction

The receiver is built on a chassis of either 18 or 16 s.w.g. aluminium sheet cut and bent to the dimensions shown in Fig. 3. The panel can be either of wood or aluminium, as there will be no hand-capacitance effects due to the metal construction of the variable capacitors. The layout of the various controls is shown in the views of Figs. 3, 4 and 5, and it will be seen that a pleasing symmetrical layout can be achieved.

The chassis layout is not unduly critical, and small adjustments of component positioning can be made without affecting the performance of the receiver. When all holes have been cut the various components can be mounted. The bases for the coil screening cans are cut and mounted according to the instructions contained in the cans and sent with each coil. The coils appear above the chassis and their screens are fitted after they have been plugged in. One point requires mention and that is in connection with the three variable capacitors. Clearance holes must be drilled in the front panel to allow the epicyclic drives to protrude. When mounting these it is important that the plates on which the pointers are fixed to the drives clear the front panel sufficiently to allow the pointers freedom of movement.

Wiring is perfectly straightforward and deserves no special mention other than that all wires connected with the r.f. and detector circuits should be routed by the shortest possible way. Screened lead is used for the grid circuit of V_3.

Controls

When the front panel has been fixed in position, the cursors, or pointers, for the three variable capacitors can be made and mounted. In the writer's receiver these are cut from celluloid or Perspex approximately $\frac{1}{16}$in thick. Before mounting,

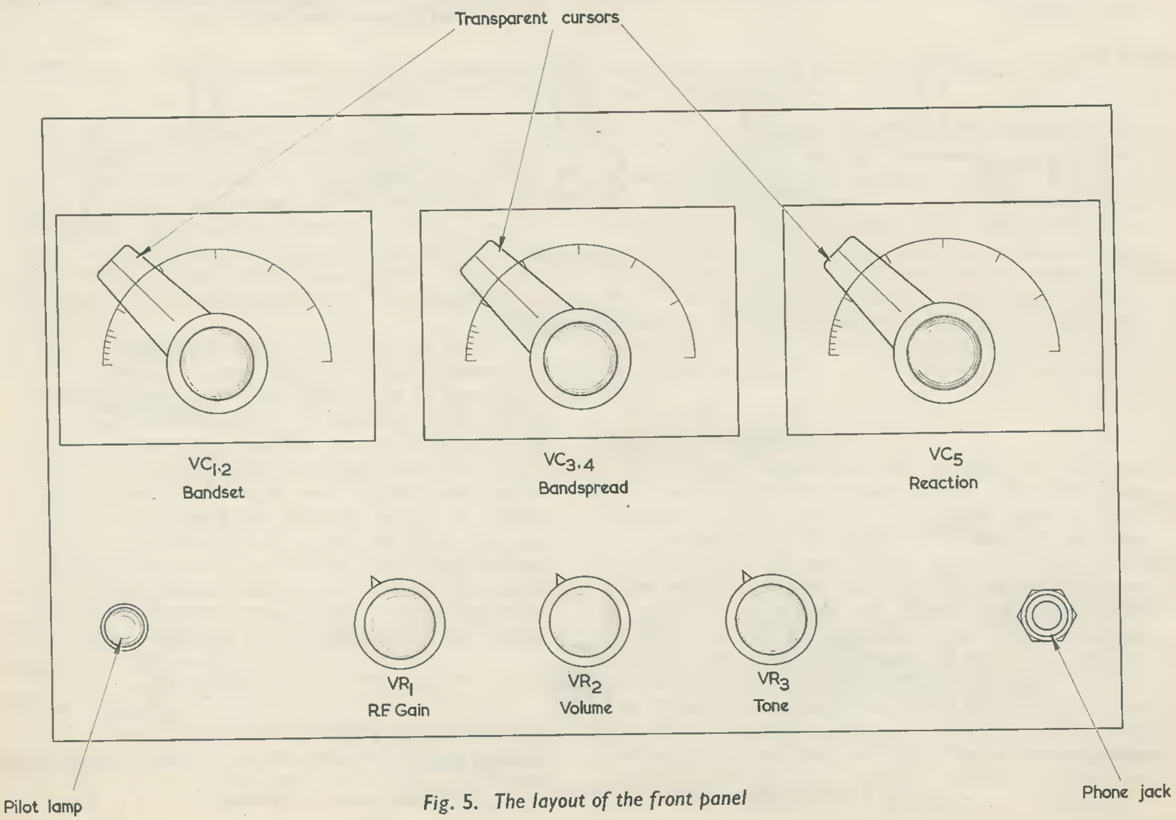


Fig. 5. The layout of the front panel

a line is scored along the centre of each with a needle or compass point. Coloured ink is then run into this groove and the surplus wiped quickly away, leaving a neat hair-line. Scales can be marked on stiff white paper in any suitable units and mounted behind the cursors. (A particularly attractive appearance is given by using scales taken from the Panel-Signs Set No. 6, available from Data Publications Ltd.—EDITOR.) Two chromium plated handles, as are used on professional communications equipment, were finally added to the writer's set, giving the receiver a "finished" look.

Testing

When the receiver is completed and the wiring has been carefully checked, a speaker or a pair of high resistance phones should be plugged into the appropriate sockets. (The set should not be switched on without either one or the other connected). A resistance reading is taken to ensure that there are no h.t. short-circuits, and a suitable power supply is connected and switched on. The r.f. and a.f. gain controls are next set to maximum and the reaction capacitor for minimum capacitance. A suitable aerial is connected and the reaction control advanced slowly until the detector oscillates. This will be heard as a "rushing" noise in the speaker or phones. The control is backed off slightly until this noise just ceases, whereupon the detector will be at its most sensitive. Stations should be tuned in quite easily by adjusting the bandset and bandspread capacitors, slight re-adjustments of reaction being made as necessary for maximum sensitivity. The setting of the reaction control tends to be fairly critical on the higher frequency bands, but less so at lower frequencies. The cores and trimmers can then be adjusted for maximum performance, adjusting the trimmers at the high frequency end and the cores at the low frequency end of each band covered.

For very strong signals, the r.f. gain control can be "backed off" to avoid overloading the detector stage. As mentioned previously, the top-cut control will help to eliminate certain kinds of background noise, and it also assists in the reception of c.w. signals. The latter are, of course, received with the detector just oscillating.

The writer hopes that the "Zephyr" will give as much pleasure to intending constructors as it has to him. When conditions are right and a good aerial is used, Dx reception is easily obtained. Broadcast and amateur stations have been heard from many countries, often at excellent loudspeaker strength. When the building cost is compared with that of a superhet, a very favourable comparison can be made on the side of the "Zephyr".

CAN ANYONE HELP?

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

Eddystone S640.—D. Watts, 52 Edgell Road, Staines, Middx—manual or any information.

* * *

Test Set Type 74A Oscilloscope.—P. Moat, 30 Prospect Place, Newcastle-on-Tyne, 4—any information.

* * *

Hallicrafters S38B Receivers.—B. G. Jackson, 73 Park Avenue, Chadderton, Oldham, Lancs—loan of circuit.

* * *

BC312M Receiver.—R. Wilson, 11 Sulgrave Close, Liverpool, 16—manual, circuit or modifications.

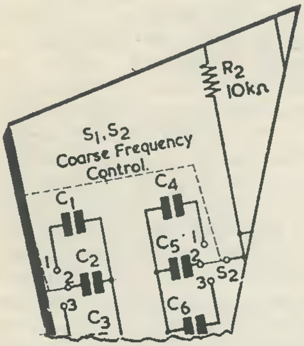
Wanted.—R. K. Lloyd, P.O. Box 1164, Lusaka, Zambia, Central Africa—circuit for transistorised burglar alarm, extra capacity type (relay operated when person approaches). Also manual for T1154N transmitter.

* * *

R1392 VHF Receiver.—F. H. Ladd, 4 Wellington Close, Melbourne Park, Chelmsford, Essex—circuit diagram or any information.

* * *

Transistorised Transmitter.—D. R. Coppen, 45 Vine Street, Romford, Essex, is interested in constructing such a unit for phone and c.w. operation on the 160 metre amateur band, can any reader suppy a circuit?



An "ECONOMY" Capacitance Bridge

SUGGESTED CIRCUIT No. 171

By **G. A. FRENCH**

One of the more useful tools in the amateur workshop is a capacitance bridge. Unfortunately, however, such a bridge is normally required at infrequent intervals only, with the result that the constructor faces a dilemma having two conflicting solutions. For best results a capacitance bridge requires a relatively large number of components, and these may entail a heavy expenditure of cash on their purchase. At the same time, the fact that such a bridge is only used occasionally makes it desirable to keep cost to a minimum.

This month's circuit offers a solution to both these requirements, and it does this by obviating the balance indicator circuit and its components altogether. The instrument then comprises only an oscillator, a buffer stage, and the bridge itself. The balance indicating device with which the instrument works may be any medium wave superhet radio receiver having a tuning indicator. As judged by results with a prototype, an overall range of less than 3pF up to 0.01μF is quite feasible, and this should meet almost all situations likely to be encountered by the amateur. An incidental advantage is that one of the best terminals is at chassis potential, whereupon it becomes possible to measure capacitors and stray capacitances *in situ* (provided, of course, that any parallel impedances which may exist are disconnected).

Design Approach

In the writer's experience, the capacitance values which require measurement very much more frequently than any others lie in the range below 0.01μF. This covers practically all the silver-mica and ceramic components which are likely to be suspect, or whose markings are ambiguous or have become rubbed off. Capacitance measurements above 0.01μF are very rarely required, as capacitors having such values are usually reliably marked and, when faulty, display such obvious symptoms as leakiness, short-circuit or open-circuit. In consequence, the writer felt that a safe approach for the present design would be to aim at an instrument offering readings from some 3pF to 0.01μF.

If a bridge is to measure capacitance values around 3pF, the bridge energising frequency becomes important. The 50 c/s mains supply does not represent an attractive choice here, because the reactance of a 3pF capacitor at this frequency is greater than 1,000MΩ. It would be unwise, to say the least, to expect a low-cost instrument to measure reactances as high as this. A much higher energising frequency is required, and this entails the use of an oscillator.

Once again, the question of cost takes over, and it would obviously be preferable to employ a transistorised oscillator running from a 9-volt battery than a valve oscillator with all its attendant encumbrances of mains transformer, h.t. rectifier and smoothing circuit. The only disadvantage with a transistor oscillator is that, with simple circuitry, its voltage output will be markedly lower than that given by a valve oscillator, with the result that a higher sensitivity is required of the null indicating device.

In the circuit described here, the instrument has no null indicating device at all! Instead, the output from the bridge is applied, at any frequency in the medium wave band, to any medium wave superhet receiver fitted with a tuning indicator. Balance settings are then obtained by observing the tuning indicator display. Since the receiver will offer a considerable degree of gain, the bridge can then function at low energising voltages and there is no necessity to obtain a high output voltage from the oscillator. The writer considers that this approach offers a very good compromise between cost and performance, since almost every amateur workshop will possess a medium wave superhet receiver which can be pressed into service for occasional capacitance measurements. Even if the receiver is not fitted with a tuning indicator, such an indicator can usually be added without too much trouble. A tuning indicator is, of course, merely a device which offers a measure of signal strength. With valve receivers, all that would be needed is a meter in series with, say, the anode of an a.g.c. controlled valve, or even a voltmeter temporarily clipped between chassis and the screen-grid or cathode of such a valve. The addition of a signal strength meter to a transistor radio may usually be accomplished by connecting a voltmeter between the positive supply rail and the emitter of an a.g.c.-controlled transistor, or between the positive supply rail and the a.g.c. line itself. Most transistor receivers have a car aerial input socket, to which the output from the bridge may be connected.

The writer had hoped initially to employ a medium wave receiver to give *audible* results, the oscillator frequency being made to beat with that of a local station and the bridge being adjusted for minimum beat note from the loudspeaker. Unfortunately, the masking effects of a.g.c. in the receiver made the null point considerably less obvious than occurred with a visual tuning indicator and the idea was abandoned.

Since the oscillator is intended to feed a bridge circuit which will offer varying capacitive impedances, it is necessary to insert a buffer stage between the two. Otherwise, adjustmets in the bridge may affect the frequency of oscillation and give misleading results. A simple emitter-follower stage functions adequately here.

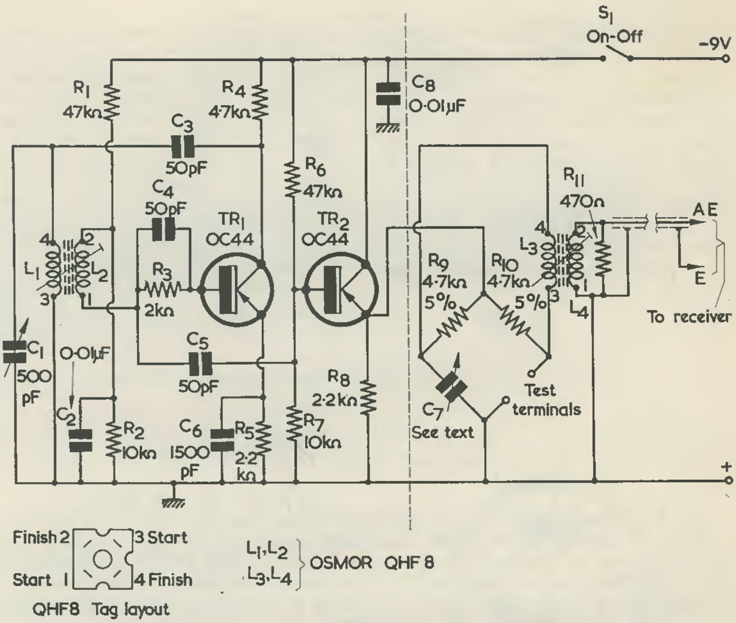


Fig. 1. The circuit of the capacitance measuring instrument. The bridge circuit proper (R_9, R_{10}, C_7 and the "test terminals") is that initially employed in the prototype

The Circuit

The circuit of the capacitance bridge unit appears in Fig. 1. In this diagram TR_1 is the oscillator, the tuned circuit being given by C_1 and L_1. L_1 is the tuned winding of an Osmor medium wave coil type QHF8, and it couples to TR_1 collector via C_3. The coupling winding of the coil, L_2, connects to the emitter of TR_1 via C_4 and R_3, thereby providing the necessary feedback for oscillation to take place. The components C_4 and R_3 assist in maintaining oscillator amplitude at a reasonably constant level over the tuning range, as also does C_6 which, it will be noted, has the somewhat low value of 1,500pF. C_1 is a variable capacitor having a maximum value around 500pF, and it tunes the oscillator circuit over the medium wave band.

Oscillator output is taken, via C_5, from the coupling winding L_2, and is applied to the base of TR_2. TR_2 functions as an emitter-follower buffer stage, whose function is to prevent oscillator detuning due to varying capacitances in the bridge, and the r.f. voltage appears across its emitter resistor, R_8. This voltage is fed to the bridge.

The particular bridge circuit shown in Fig. 1 has two equal-value resistors, R_9 and R_{10}, in the upper arms. Balance then occurs when C_7 is equal to the capacitance connected to the test terminals. If C_7 is a two-gang 500+500pF capacitor with both sections in parallel, the bridge becomes capable of measuring up to 1,000pF maximum. Variations to the bridge circuit are dealt with later.

It will be noted that a small direct voltage, due to the voltage dropped across R_8, appears across the test terminals. This voltage does not affect the performance of the bridge at r.f., and no damage can result if the test terminals are accidentally short-circuited.

Neither output terminal of the bridge is at chassis potential and these are, in consequence, coupled to an r.f. isolating transformer, L_3, L_4. This transformer is a second Osmor QHF8 coil, the bridge connecting to what, in normal service, would be the tuned winding. The coupling winding then couples the bridge output to the aerial and earth terminals of the associated medium wave receiver via screened coaxial cable. Heavy damping is provided by R_{11} to prevent the possibility of undesirable resonances in L_4 in conjunction with the receiver aerial input circuit, and one side of L_4 is at chassis potential.

To take a capacitance measurement, the unit is coupled to the medium wave receiver and the latter tuned to any convenient point on the medium waveband where there are no powerful transmitted signals. Tuning capacitor C_1 is then adjusted so that TR_1 oscillates at the same frequency, the adjustment being made for maximum deflection in the tuning indicator. The unknown capacitor is connected across the test terminals and C_7 adjusted for *minimum* deflection of the tuning indicator (i.e. minimum signal input). This is the null or balance point, and the value of the unknown capacitor may then be read from a scale fitted to C_7.

If the measurement is made during the evening or at night it will probably be helpful to turn down the receiver volume level and work with the tuning indicator on its own. This is because it will be difficult at such times to find a point on the receiver dial which is entirely free of received signals and, if these break through, their heterodynes with the bridge signal may prove distracting. It may even be found that heterodynes with weak signals *increase* as the null point is approached, this being due to the reduction of a.g.c. voltage as the output from the bridge decreases.

Components

A few details need to be given with regard to the components employed.

C_1 can be any inexpensive single-gang variable capacitor having a maximum value around 500pF. A solid dielectric component should be quite adequate here. It does not require a slow motion drive as any final fine tuning that is needed may be carried out by the receiver tuning control.

The value of C_6 is rather critical. If this value is too high, the oscillator may squeg over part of the band (evident as a loud hissing noise

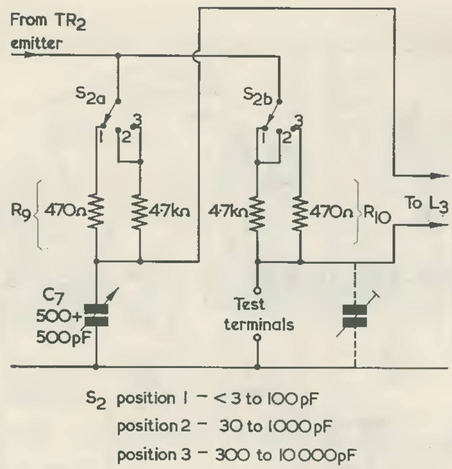


Fig. 2. A suggested bridge circuit which enables measurements to be made from less than 3pF to 10,000pF. The resistors should be 5% types or better, according to the degree of agreement required between the ranges covered by C_7. The trimmer shown in dotted line may be helpful if there is a wide unbalance in stray capacitances to chassis at the output terminals of the bridge

from the receiver) and if the value is too low oscillator output may drop at the low frequency end of the band. Should either of these eventualities occur, the value of C_6 should be adjusted accordingly.

The resistors in the oscillator circuit, R_1 to R_5, should, preferably, have a tolerance of 10% or better. R_6, R_7, R_8 and R_{11} may be 20% types.

The coils employed have adjustable dust cores. For the present application, these cores may be set so that their upper edges are level with the upper ends of the coil formers.

The Bridge Circuit

The bridge circuit shown in Fig. 1 was that employed initially by the writer to check that the unit was capable of functioning adequately in practice. As was just stated, balance is obtained when C_7 is equal to the test (i.e. the "unknown") capacitance. The prototype employed a 500+500pF two-gang tuning capacitor for C_7 with both sections in parallel, giving a total maximum capacitance of 1,000pF. The use of a tuning capacitor has the advantage that, due to its capacitance/rotation "law", the lower capacitance end of the range is expanded.

Using the Fig. 1 circuit it was found that the amount of capacitor rotation needed in C_7 for balance between test capacitances of zero and 5pF was very small, although the shift in C_7 position was still quite definite. R_9 was then replaced by a 470Ω resistor, which would result in the maximum test capacitance capable of measurement being 100pF. This change resulted in a considerable expansion at the lower capacitance end of the scale, the rotation required in C_7 for zero to 3pF test capacitance being about 5 degrees. A 10pF test capacitance corresponded to a rotation in C_7 of some 12 degrees. Even a test capacitance value as low as 1.5pF resulted in a discernable rotation in C_7 of several degrees.

To check that the bridge could read up to 0.01μF, R_9 was restored to 4.7kΩ and R_{10} replaced by a 470Ω resistor. Test capacitance readings up to 0.01μF were then found to be possible.

The two output terminals of the bridge have stray capacitances to chassis, these consisting mainly of the stray capacitances between L_3 and L_4. It was found that, by connecting the bridge output terminals to coil tags 3 and 4 in the manner shown in Fig. 1, it was possible for C_7 to just "pass through" a position corresponding to zero capacitance across the test terminals; whereas, if the connections to L_3 were reversed, C_7 could only approach, but not reach, a position corresponding to zero test capacitance. Obviously, tag 3 of the particular coil employed by the writer offered a higher stray capacitance to chassis than did tag 4. If, in units made up to this circuit, C_7 cannot "pass through" a position corresponding to zero test capacitance, the effect of reversing the connections to the tags of L_3 should be tried.

Because of the unbalance of stray capacitances across the output terminals of the bridge, the setting of C_7 corresponding to zero test capacitance shifts when the value of R_9 or R_{10} is changed. This effect can be a little irritating if the shift is large because part of the useful scale on a low capacitance range becomes "lost". The effect could be nullified by connecting a small trimmer across the test terminals and setting this up so that, on a low capacitance range, the setting of C_7 which corresponds to zero test capacitance is very near its own minimum capacitance.

All these points are taken up in the suggested bridge circuit shown in Fig. 2. In this diagram the range switch connects a 470Ω resistor in the R_9 position when set to Range 1, giving a total range of less than 3pF up to 100pF. When set to Range 2, both R_9 and R_{10} are 4.7kΩ, giving a range from 30 to 1,000pF. On Range 3 a 470Ω resistor appears in the R_{10} position, giving a range of 300 to 10,000pF. Fig. 2 also shows, in dotted line, the trimmer connected across the test terminal. If fitted, this is set up, as just described, on Range 1.

The calibration of C_7 will be non-linear and will need to be carried out by measuring known values of test capacitances. Ideally, a single scale should cope for all three ranges, as the range switch in Fig. 2 causes multiplication by ten. In practice, however, a single scale will necessitate very careful attention to resistor tolerance, wiring layout and stray capacitances, and it may well prove easier to calibrate three separate scales.

It should be pointed out that many constructors may prefer alternative bridge networks to that shown in Fig. 2, these having a variable resistance arm instead of a variable capacitance arm. A wide field of experiment is open here, and there is, of course, no reason why such alternative circuits should not be employed.

The stray capacitances to chassis resulting from the use of the r.f. transformer, L_3, L_4, have already been referred to. It is feasible that unbalanced stray inductive reactances to chassis may also be offered by this coil, whereupon these could cause different settings in C_7 at different operating frequencies. Such an effect was not noticeable in the prototype, and it could, in any case, be guarded against by using roughly the same operating frequency for all tests, choosing a frequency which is most convenient under local reception conditions.

To obtain optimum sharpness of balance there should be a minimum of random r.f. coupling between the components on the left hand side of the vertical dashed line in Fig. 1 and those on the right. For best results, the components to the left of the dashed line should be fitted in a screened compartment. If this is not done, great care should be taken to keep random couplings (especially between the two QHF8 coils) to a minimum by means of a suitable layout; also, the receiver should be at least three feet away from the oscillator section.

The wiring in the bridge circuit proper should be well-spaced and clear of chassis. The circuit used by the writer has the slight advantage that the moving vanes of C_7 are at chassis potential and so there are no problems of excessive stray capacitance to chassis with this component.

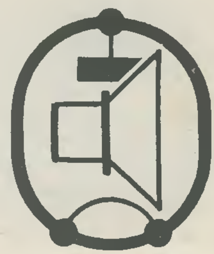
Results With The Prototype

The prototype circuit was checked out with a conventional medium wave valve superhet receiver at various points on the medium wave range. Final checks were made at around 360 metres, which suited local conditions adequately. The results obtained were those which have been already described.

The current drawn by the prototype bridge unit was 1.8mA at 9 volts.

Unusual Loudspeaker Enclosure

By F. WALKER



Much of the work done with high fidelity reproducing systems has, in the end, to be evaluated by subjunctive reactions in the listener. In consequence, it is not impossible to obtain surprisingly good results by using entirely empirical methods of design. This is the approach employed by the writer of the present article, who describes an enclosure based on "infinite baffle" principles but having a semi-flexible rear wall. The design is presented here as a project for the experimenter, and it has the advantages that the materials needed for its construction are readily available at low cost

THE LOUDSPEAKER ENCLOSURE TO BE DESCRIBED uses to beneficial ends the inherent defect in most low-cost enclosures, i.e. resonance or "boom". Indeed, one might say that in this enclosure the resonator acts as a second radiator of sound, quite apart from the main bass speaker itself.

The enclosure started life four years ago as a simple bass reflex type in which a slot or vent was utilised to increase efficiency at bass frequencies. Unfortunately it was found that, unless the enclosure was big enough, resonance tended to occur at about 100 c/s or so.

Improving Matters

The author set about to improve matters. First of all the cabinet back was removed and the port blocked with a piece of hardboard; the back was then replaced and the quality of reproduction noted. With the port blocked, the thumpiness in the reproduction had gone. So had most of the bass.

The back was then removed altogether to see if some of the missing bass could be retrieved. This was achieved but only, however, to a limited extent. Actually, the enclosure now was working as a simple baffle, there being no restriction of sound from the rear of the speaker.

It was at this point that the great idea was hit upon. The author at that time was using a 10in common-or-garden 3Ω loudspeaker mounted in an old cardboard box for testing purposes in the workshop, and it was noted with surprise that the quality of bass reproduction was alarmingly good with quite ordinary domestic radio sets. Apparently, this unexpected manifestation had something to do with the cardboard in which the speaker was mounted.

After a great deal of thought and consideration, it was decided that the enclosure at home should have a piece of cardboard attached to it, and the best position seemed to be in place of the missing back.

Various cardboard backs were tried, and it was found that a thin piece, comprising a corrugated section sandwiched between two almost paper-thin sheets, the whole being ⅛in thick, gave the best really low-frequency bass reproduction. It should be mentioned here that it is important that no air

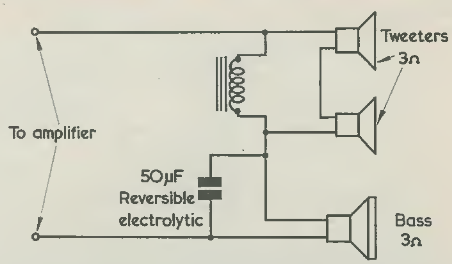


Fig. 1. The crossover network employed by the author. The inductor is the 3Ω secondary of a small output transformer, whilst the capacitor is a 50μF reversible (i.e. non-polarised) electrolytic component

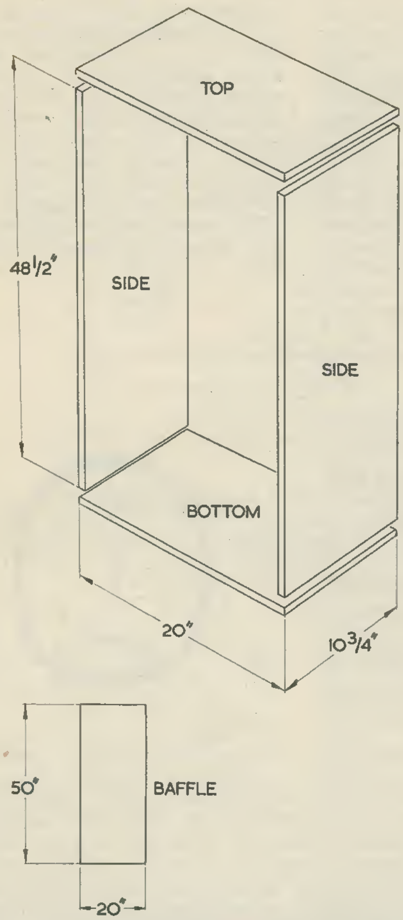


Fig. 2. Dimensions of the front, top, sides and bottom of the enclosure. The back, which is discussed in the text, has the same dimensions as the front baffle

leaks are allowed to interfere with the operation of this type of enclosure, since the cardboard back is "damped" by the air contained within the cabinet.

The enclosure seems to be directional both at high and low frequencies, but strangely enough more bass is audible when the listener stands in *front* of the enclosure than behind it. This effect is most certainly beneficial; also the bass reproduction is better when the enclosure is used in a large room, and it is at its best when used "free-standing" in a large hall. Readers who play electronic guitars, especially bass guitars, may do well to remember this point.

High Frequency Reproduction

The bass side of the sound reproduction has been dealt with, and it is now the turn of the high notes. In the author's enclosure two tweeters are employed to give a spread to the radiated sound, since all high-note speakers are inherently directional.

Proper 4in solid-back tweeters must be used; small speakers as employed in domestic portable radio sets will not do, because high bass pressures are developed inside the enclosure. These make ordinary small speakers rattle, competely spoiling the quality. The author used Richard Allan tweeters type 410T.

Crossover Network

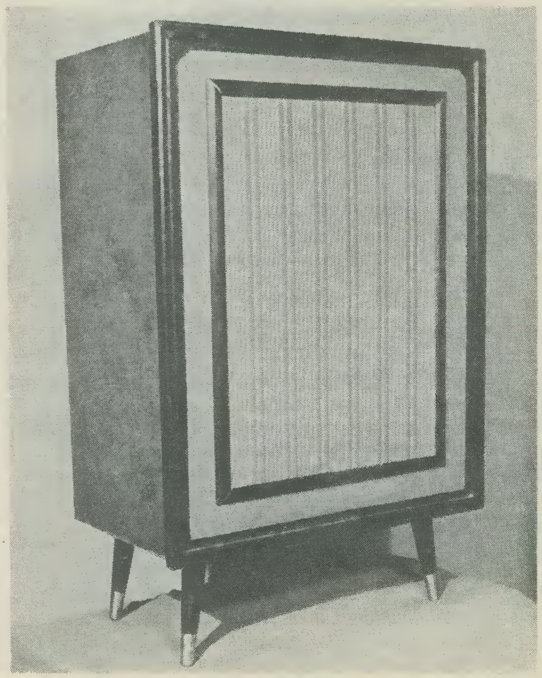
A suitable crossover network which has been devised by the author is shown in Fig. 1. In this diagram the two tweeters are connected in series across a choke which consists, in practice, of the 3Ω secondary of a small output transformer. The capacitor is a 50μF reversible electrolytic component having a working voltage of 12. It has been found that this circuit gives very good results in practice, with a smooth response at and about the crossover frequency.

The wiring should be such that all loudspeakers are in phase.

Loudspeakers

The impedance presented by the complete loudspeaker system raises a question, but it has to be remembered that the impedance of an ordinary loudspeaker, free-standing without baffle, varies considerably from its nominal figure over the audio frequency range.

With the present design it has been found that good results are given by employing 3Ω speakers, and coupling the assembly to the 3Ω output of the amplifier. It is felt that the impedance variation over the range of frequencies handled is no better



The attractive appearance of the enclosure constructed by the author or worse than a number of commercial designs.

The loudspeakers incorporated are not critical as to manufacture provided that units of reasonable quality are used. The author has checked this point with a number of alternative types. So far as the bass speaker is concerned, a 10 or 12in unit of good quality should suffice. The tweeters may be the Richard Allan type mentioned above, or similar units.

Construction

Chipboard or "Weyrock" $\frac{3}{4}$in thick is used to make the main part of the enclosure, the outside dimensions being 50 by 20 by 11$\frac{1}{2}$in. So the pieces required are:

1-off 50 by 20in
2-off 48$\frac{1}{2}$ by 10$\frac{3}{4}$in
2-off 20 by 10$\frac{3}{4}$in.

An exploded diagram can be seen in Fig. 2.

Having obtained the pieces, cut out the speaker holes, remembering to leave at least $\frac{3}{4}$in from the sides where the tweeters fit. The actual position of the speakers is not critical; the bass speaker can be mounted right in the centre of the baffle and the tweeters right at the top of the enclosure and almost up against the sides.

The whole box is fastened together with 2in panel pins (use plenty, spaced about 1in apart) so no fancy woodworking techniques are required. When the job has been put together, including speakers and cardboard back, test it by connecting it to an amplifier handling a suitable programme.

Once tested, any "frills" that are desired can be added to the enclosure. The author's version is shown in the photograph. This is covered in dark blue rexine with an expanded gold speaker fret covering almost all the front, and with four black and gold contemporary legs 6in long. Three-quarter round beading is fastened all round the front. If the constructor uses expanded fret, cover all the baffle with thin felt first (cutting out the speaker holes, of course) or rattles will be evident in operation.

The enclosure lends scope to amateur cabinet makers who may want to make a really attractive item of furniture, but for less well equipped and less knowldgeable builders the rexine is probably the best for giving a reasonable appearance. When using rexine, all dents and small holes must be filled in, otherwise they will show through the covering. Any putty-like material can be used for filling such as plastic wood or cellulose filler.

The cardboard back, which has already been discussed, is affixed to the cabinet with a large number of $\frac{3}{4}$in tacks (spacing 2in). This large number must be used to give an effective air seal, and also to ensure that no looseness gives sympathetic vibration. Be very careful during construction to see that everything is firmly fixed, that no loose pieces of glue or nails are left inside, and that no wires can touch the back.

Hammarlund HQ145AX OFFERS CONTINUOUS VFO 540 kc/s to 30.0 Mc/s PLUS 11 CRYSTAL CONTROLLED CHANNELS

Amateurs or SWLs desiring the precision of crystal controlled reception in a moderately priced communications receiver will welcome Hammarlund's newest modification to the HQ145A . . . the HQ145AX. In addition to the superlative performance characteristics of the A model, the HQ145AX offers a choice of 11 crystal controlled channels selectable from the front panel for any frequency in the receiver's tuning range of 540 kc/s to 30.0 Mc/s.

General specifications of the new HQ145AX are: 540 kc/s to 30 Mc/s tuning in four bands; calibrated electrical bandspread on 80, 40, 20, 15, and 10 metre amateur bands; dual conversion above 10.0 Mc/s; six position crystal filter plus adjustable slot filter with up to 60dB attenuation; adjustable, high stability b.f.o. for s.s.b. and c.w.: 1 microvolt sensitivity gives 10:1 signal to noise ratio.

For complete details and specifications on the HQ145AX write to Hammarlund Manufacturing Company, A. Gianinni Scientific Co., 73–88 Hammarlund Drive, Mars Hill, North Carolina.

NEWS AND COMMENT

How wrong can you be?

Often, at this time of the year, we have quoted from the Annual Forecast sent out by Hugo Gernsback, the well-known American scientific publisher. In the foreword to his booklet for 1965, under the same title as our heading, he uses a radio example which may not be known to some of our readers.

"It seems that when the great inventor William Marconi first thought of transmitting a radio signal from England to America in 1901 he felt he should ask first the greatest authority and scientist of his day, the illustrious Heinrich Hertz, what his ideas were.

"Remember, Marconi was not a theoretical scientist, but only an experimenter and technician.

"Now what do you think Hertz counselled? Said he: 'The scheme is not practical; it would require huge mirrors the size of a continent.'

"In other words, the discoverer of the Hertzian waves had no confidence whatsoever that electro-magnetic waves could be projected over the horizon; he gave Marconi a totally erroneous picture of what is today a routine experience all over the world.

"Fortunately, Marconi did not believe Hertz and went ahead with his own hunch, which proved correct.

"Nowadays, radio amateurs can send messages to the Antipodes with only a few dry cells and a small aerial; *in other words, microscopic radio energy easily travels around the world.*

"Experts, you will note, cannot always be trusted. Usually, and all too often, they are proved wrong by history. The theoretical expert is all too frequently immersed in tradition. When it comes to something that is revolutionary and new he is apt to be wrong."

New Edition

We feel that a few comments on the latest edition, the ninth, of our Data Book *The Radio Amateur Operator's Handbook*, will be of interest.

This new edition has been enlarged by including, with the permission of the Postmaster General, the Post Office regulations concerning Amateur Licences. The types of licence and how to qualify for them, together with the numerous conditions under which a licensed amateur is allowed to operate his own radio station are set out. The conditions include, of course, the regulations on such matters as frequency tolerances, frequency bands, classes of emission and the powers of the Post Office in a National Emergency. Details of the morse test and the full syllabus for Parts 1 & 2 of the City and Guilds Radio Amateur Examination, are also given.

All the other essential information for radio amateurs included in previous editions, such as Amateur Prefixes, has been revised and brought up to date. There can be few books of 64 pages priced at only 5s., which are so packed with relevant essential information, and there is no doubt that this standard reference book will be more popular than ever.

Death of Radio Pioneer

Older readers, in particular, will have been saddened by the news of the death, in December, of C. S. Franklin, often referred to as "The Father of modern radio telecommunications" and one of the greatest pioneers after Marconi himself.

His quiet persistence and stubborn refusal to accept face values led to the largest single contribution to modern telecommunications that this country has ever known.

In 1899 he joined Marconi's and almost immediately left for South Africa and the Boer War to help introduce wireless to the battlefield. His first close contact with Marconi himself came in 1902 when the two of them sailed across the Atlantic in the *Philadelphia*, successfully receiving transmissions from Poldhu in Cornwall, at ranges of up to 1,550 miles. Then followed two years of demonstrating radio equipment in Russia. On return to this country he began a long personal association with Marconi, the two of them often working late into the night on experimental ideas. During the eight years from 1908–16 much of their work was done in the isolation of the wireless stations dotted around our coasts and it was in this period that Franklin was at his happiest.

In 1916 Franklin and Marconi started their first experiments into short-wave communications, Franklin designing a special spark transmitter operating in compressed air. Some highly promising results were obtained from these initial experiments and they eventually led to the first beamed short wave system in the world. This was the greatest breakthrough in radio communications since the spanning of the Atlantic in 1901 and the forerunner of all today's complex communications facilities. In fact, some of Franklin's designs are still in use providing h.f. communications to this day.

Sixty-five patents stand to Franklin's credit including the variable capacitor, the ganged capacitor, the reaction circuit and the concentric feeder. This last invention is widely used today in practically every household possessing a television set.

He was known and respected by all the early followers of wireless and his death is a great loss to all those who were concerned with the early development of the radio industry.

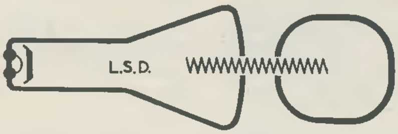
Political Broadcasts

Following our comments in the November issue, we were intrigued to learn that during the hearing of the action by the Communist candidate in the constituency of Sir Alec Douglas-Home, to unseat Sir Douglas, the Presiding Judge, Lord Migdale, laughed loudly after hearing that the reason for the high ratings of party political broadcasts on television was that they were shown simultaneously on both networks, thus giving the audiences no choice.

Tailpiece

Two astronauts who landed on the moon were busy fixing up their radio equipment when one commented—"Say, old man, where do we fix this wire marked 'earth'?". From *Radial*, the monthly journal of the Radio Amateur Invalid Bedfast Club.

Making Service



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By JOHN T. BENSON, F.T.S.

Our contributor, who has had more than thirty years' experience of radio and television servicing, passes on some common-sense advice which will be of value in any radio repair workshop

THE OPERATING THEATRE OF THE service engineer is his workshop, and if he is going to turn out profitable work it must be adequately equipped. For those with properly laid out workshops this article will have no interest, but for others it may supply useful ideas for improving their present conditions and so increase their efficiency.

Lighting

Wherever possible, daylight is still best and a north light best of all. If this is not possible, then each bench or cubicle should be equipped with good overhead lighting and at least one lamp of the angle-poise type. Fluorescent lighting is not advisable as the writer has found that the stroboscopic effect on both tools and work in hand is exceedingly annoying, and that it often produces severe eyestrain followed by headaches. This effect can be overcome where a 3-phase supply is available and 3-phase fluorescent lamps are employed. A focusing type torch should be available for working in very difficult corners.

Heating

There is nothing worse than trying to locate a particularly sticky fault when one is frozen stiff, so no matter what type of heating is used—gas, electricity, coal or oil—see that the workshop temperature is kept up to a comfortable level. This is also necessary from a receiver working point of view, as there are a number of faults which do not occur until a certain temperature is reached.

Floor Covering

General cleanliness is a *must* in a workshop and I have found that good plain lino takes a lot of beating from all points of view, a fairly light colour facilitating the finding of dropped screws. In my workshops it has been the daily job of the most junior apprentice to keep the floor swept clean.

Interior Decoration

In these days of washable papers and plastic paints there is infinite choice for interior decoration. The main requirement is that walls and ceiling should reflect as much light as possible without being "cold". If an engineer feels "at home" in his workshop, he will work all the better. The large valve wall-charts displayed in advantageous positions save a lot of time looking up pin connections in manuals. (Pin-ups will also appear from time to time . . . they help to keep the co-efficient of humour adjusted!)*

Benches and Seating

Television receivers can be of considerable weight. The early receivers (1936–1949) were very heavy, the average table model weighing 100lb or more. Although modern receivers are only half this weight, or less, a bench made from a converted kitchen table with rickety legs is still of little use. Benches should be of solid construction and free from shakes. The top should be plain and covered with lino or similar material, fixed with a suitable adhesive. Tin-tacks or nails of any description should not be used as they constitute danger points for flash-over from the high voltages encountered in television receivers. A drawer provided in each bench is essential for the engineer to store his own personal kit. The front of the bench should be free from obtrusions. The back can accommodate a tool rack surmounted by a shelf, on which instruments can be placed whilst being used with a receiver on the bench. In my workshops I provide large rubber mats on the bench tops, and they save many scratches on receivers which are repaired whilst still in the cabinet.

At one end of the bench a small square of asbestos board provides a good resting place for the odd job requiring an application of heat or the occasional heavy duty soldering iron. Each bench should be provided with a distribution board panel fitted with each type of outlet socket common to the district (and these vary enormously!). A variable voltage a.c. supply is a great time saver, but is not an essential. Also on the bench, in the most accessible place, should be positioned sockets which provide a high and low impedence coupling to a baffle-mounted p.m. speaker. Benches constructed in this manner become plug-in units and can be moved very easily for cleaning purposes.

Aerial connections have not been forgotten, but I prefer these to be near the bench, and not part of it. The reason for this is that it has been found that unwanted coupling effects can occur when permanent signal sources are too close to tool racks, etc. In my workshops the coaxial outlets from the aerial systems are placed on the wall near the bench, double-ended coaxial leads being used for connection to them.

Most of the engineer's bench work can be carried out in a sitting position. Comfort at work is essential for efficiency. High wooden topped stools are ideal, although I favoured an organ-type stool as it permitted more movement. The height of the benches should be adjusted so that when a person of average height (5ft 8in) is seated, the bench top should come below his elbow when his arm is bent. This facilitates the placing of a receiver on the bench with the least amount of effort.

* Smithy, please note! EDITOR

Soak-Test Bench

The soak-test bench can be of the single or double deck type, and it should be placed so that the engineer can keep an eye on his completed (he hopes) jobs. A time test after completion is most necessary and eliminates many expensive return journeys and disappointed clients.

Vacuum Cleaner System

I judge a vacuum cleaning system to be another of the *musts* in servicing. The accumulation of dust and dirt in the average television receiver after twelve months' use has to be seen to be believed. If breathed in in any quantities, it produces first-rate colds and catarrh. Each bench should be supplied with a flexible hose connected to a vacuum source. The latter can be a domestic cleaner with extended hose, but the type is of no great importance so long as it is available.

Tools for the Journeyman

A television receiver is a mixture of mechanical, electrical and electronic devices, all bonded together on a metal chassis or on several sub-chassis linked together. To work on this type of structure a fairly comprehensive range of tools is required.

The engineer's tool kit should contain a variety of pliers, screwdrivers long and short, BA spanners, a polarity indicator and a number of trimmers (non-metallic knitting needles are ideal). Also required are a rubber "hammer" (a large grommet on a piece of dowelling is excellent), a light hammer, a six-inch hacksaw (Eclipse), a heavy-duty screwdriver and a soldering iron of the quick-heating type in which a piece of 16 s.w.g. wire is used as a bit. This type of soldering instrument saves endless time and burnt patches in carpets! Some small tins containing assorted staples, screws, bolts, etc., are more than useful.

These I would suggest are a serviceman's basic "mechanical" kit. and each engineer will add his own particular favourite odds and ends.

So far as electrical test gear for outside work is concerned, a good multi-range a.c./d.c. meter (not less than 1,000 ohms per volt) is essential. For long life and reliability, this should be carried in a sorbo-lined case. The meter should be constantly checked against a workshop standard, as I have known very large errors creep into test gear which has been transported around in vans and cars, etc. Unless the repair is a special one, there is no necessity to carry any more test gear away from the workshop. Test gear is expensive and should not be knocked about by transport. A case capable of carrying all the tools mentioned should be provided. It does not indicate efficiency if an engineer enters a house shedding bits and pieces from overloaded arms!

Mechanical Aids

In my workshops I have always kept one section for the mechanical side of television. This includes drilling, sawing, chassis punching, heavy soldering and the odd bits of woodwork which crop up from time to time. If efficiency is to be maintained, the following are necessary for a satisfactory mechanical section. A full range of high speed twist drills; drilling machines, hand and bench; a tool grinder; a light lathe (not an absolute necessity); a full range of spanners, box and open-ended; chisels, wood and steel; heavy duty hacksaws; a selection of wood bits; and chassis punches. These are all kept permanently in the workshop and are only taken outside for exceptional cases. Only basic requirements have been mentioned —each workshop will acquire its own collection of extras with time.

Workshop Test Gear

Electrical measuring instruments are expensive and frequently incorporate delicate mechanisms. They should be treated with care if they are to maintain their original accuracy. The number and types available are legion, and the following are what I consider to be absolutely necessary. First in the list are multi-range test meters of 20,000 ohms per volt, together with a number of d.c. milliammeters with large scales (4in) covering 1 to 50mA. On each bench, also, *permanently* connected a.c. moving-iron voltmeter, with an accuracy of 1%. This is used for checking a.c./d.c. multi-range instruments, as it has been my experience that instrument rectifiers vary over comparatively short times and need constant checking. Also required are a reliable CR bridge, 10pF to 100μF, and a valve voltmeter (high impedance input).

Signal generators should be chosen with care, and only those working on *fundamentals*, especially in the v.h.f. ranges, should be considered. A television waveform generator, such as is available from Telequipment Ltd., is excellent for use in areas where the received signal is liable to suffer from periods of fading. An oscilloscope for locating the many faults which appear in timebases and their associated circuits is the best time-saver of the lot. I have always favoured the 3in instrument for service work, as it is compact and does not take up too much room on the bench. If a 5in oscilloscope is used, then it should be mounted on a trolley. Last, but by no means least of the essential instruments for servicing, is a means of measuring e.h.t. voltages. There are many types of instruments available, but the best choice for d.c. is the electrostatic meter.

A 500 volt "megger" can be useful for testing suspected leakages, and could be added to the list also.

The fact that a wobbulator is not included as an essential item will probably cause many eyebrows to be raised. Every engineer should know how to use a wobbulator for alignment purposes, but for general service work it is very, very seldom used. In my own case I have used wobbulator gear mostly for experimental work and instructional purposes only.

So far as valve testers are concerned, I prefer the substitute *known* valve to the valve tester. The setting up of many valve testers is a lengthy job, and I have always favoured the procedure which saves time, for time is the most costly component used in service work!

If this list of test gear seems extravagant I ask the reader to remember that my experience has all been gained in a difficult "fringe" area where a clean signal is seldom received. Under these conditions it is necessary to have a source of signal which is free from man-made impulsive types of interference, particularly when tracing timebase faults.

It has been my practice also to allow apprentices to build various items of test gear. The experience gained is a worthwhile investment.

Service Data

Perhaps the most useful adjunct to any successful servicing business is its library of service data. Some engineers state that service sheets or manuals are unnecessary. I personally prefer to work to manufacturers' specifications and guides than to rely wholly on memory, which can be very fickle at times. Service sheets are invaluable not only for circuitry but also for the locating of components which, in old and discoloured chassis, can cause a considerable waste of time. My own service sheets and data, of which I have some thousands, are indexed numerically and alphabetically and are stored in hundreds, each hundred having a shelf of its own in a steel wall cabinet. It is the job of the most junior member of the staff to collect service sheets when finished with and file them each morning. I also keep in the workshop a number of standard textbooks for reference, together with all the latest facts and figures regarding valves, etc. Easy access to information can save a lot of time.

Test Leads

Every workshop should have a large selection of leads made up ready for instant use. These consist of mains leads, short-circuiting leads with a crocodile clip at each end, and leads for connecting instruments to receivers, etc. They are an invaluable aid to quick service.

Time is Money

The items listed in this article may seem to represent a formidable array of equipment. However, more than thirty years of radio and television repair work has taught me that, although we have to extemporise on many occasions, and especially on work done away from the workshop, this is a procedure which inevitably takes up time. At the risk of repeating myself I would again point out that *time* is the most costly component in the service world. A properly equipped workshop is the only answer to making service work pay.

Three Low Voltage Series Regulated Power Supplies

By A. FOORD

Three circuits for the constructor who needs only the relevant information. All semiconductors are operated well within their ratings

For most general applications involving transistorised equipment it is necessary to supply a constant voltage to a variable load. For low load currents (say up to 100mA) this can be achieved using the normal full-wave rectifier circuit. If the load current varies over a large range (say 0 to 1A), then it is possible for the output voltage of a simple power supply to vary by several volts.

In order to maintain a constant output voltage under these circumstances a series regulator is normally used. The majority of regulators contain five functional elements, as shown in Fig. 1.

The regulator circuit is normally designed so that the voltage across the series control transistor is about 6 volts when the load current is zero. If the load current increases V_{in} drops, whereupon the voltage across the control transistor drops and V_L is held constant. This process is achieved by comparing the output voltage V_L with a reference voltage, and adjusting the control transistor to maintain V_L at a constant value. Naturally it is not possible to exactly compensate for the drop in V_{in}; but its effect can be greatly reduced.

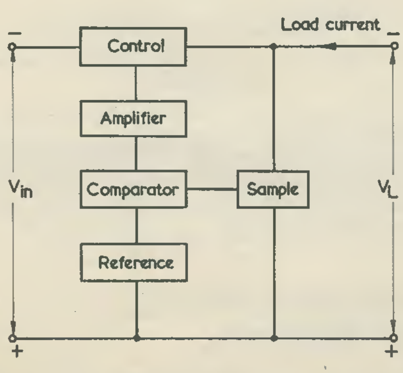


Fig. 1. Block diagram of a regulated power supply

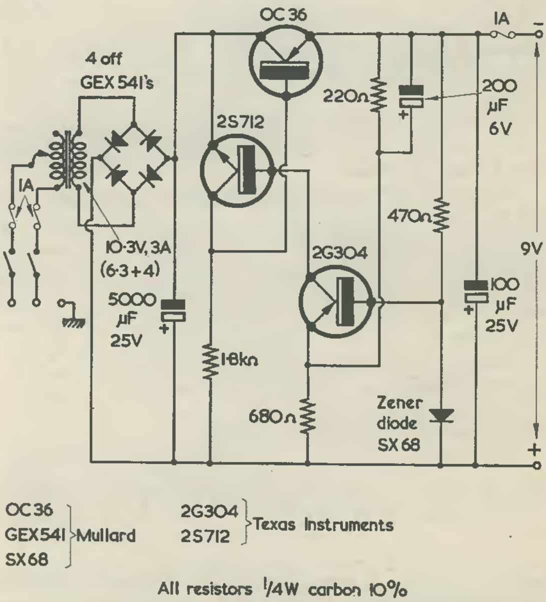
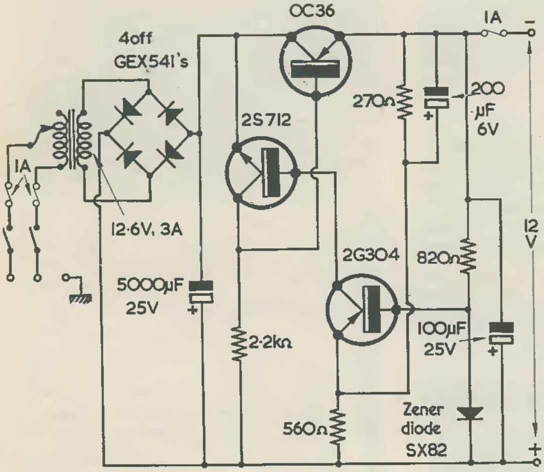


Fig. 2. Circuit of the complete 9 volt power supply. (The SX68 has a zener voltage lying between 6.5 and 7.2 at 5mA)



OC36, GEX541, SX82 — Mullard
2S712, 2G304 — Texas Instruments

All resistors 1/4W carbon 10%

Fig. 3. Circuit of the complete 12 volt power supply

A 9 Volt 1 Amp Power Supply

This supply gives a fixed output voltage, and the circuit is shown in Fig. 2.

The transistor OC36 should be on a heat sink having an area of 20 sq. in. The rectifier diodes do not require heat sinks.

Maximum current=1 amp.

A.C. ripple at 1A load is less than 40mV peak-to-peak.

The volt drop over a current range of 0–1A is less than 0.3 volt.

If it is required that the output voltage be made exactly 9 volts then the 220Ω resistor may need slight adjustment. Thus adjustment may be necessary due to the 5% tolerance on the reference zener diode (SX68) and the tolerances on the 220 and 680Ω resistors.

A 12 Volt 1 Amp Power Supply

This supply is identical in form to the previous one, but the component values have been changed slightly. The circuit is shown in Fig. 3.

Apart from the output voltage, the details given for the 9 volt supply apply here.

If it required that the output voltage be made exactly 12 volts, then the 270Ω resistor may need slight adjustment. This adjustment may be necessary due to the tolerance on the reference zener diode and the tolerances on the 270 and 560Ω resistors.

A 9–12 Volt 1 Amp Power Supply

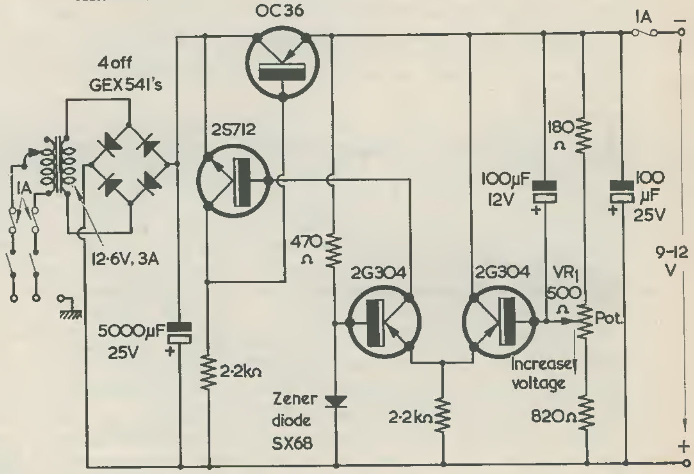
This supply is slightly more elaborate than the previous ones. The output voltage can be varied between 9 and 12 volts by means of VR_1. The circuit is shown in Fig. 4. The ripple on the output is approximately one quarter of that of the previous two circuits.

Again, the OC36 should be mounted on a heat sink having an area of 20 sq. in., and the rectifier diodes do not require heat sinks.

Maximum current=1 amp.

A.C. ripple at 1 amp load is less than 10mV peak-to-peak.

The volt drop over a current range of 0–1A is less than 0.3 volt.



OC36, SX68, GEX541 — Mullard
2G304, 2S712 — Texas Instruments

All resistors 1/4W carbon 10%

Fig. 4. Circuit of the complete 9–12 volt variable power supply

Conclusion

The circuits given in this short article show that it is possible to design regulated supplies which are suitable for normal use without resorting to elaborate and expensive techniques.

Electronic Organ Constructors' Society

Interested readers should note that the address of the new secretary is—Mr. E. W. Kirk, Kinross, Elmgrove, Kirby Cross, Frinton-on-Sea, Essex.

SOME NOTES ON THE *Electric Bass Guitar*

By **R. A. JEFFERY**

THE BASS GUITAR IS A VERY POPULAR INSTRUMENT, and the author feels that many musically inclined home-constructors and servicemen might benefit from the points given in this short article. Some general principles of equipment will be discussed, together with an amplifier design and details of a suitable loudspeaker and enclosure.

Bass Guitar Amplification

Bass guitar amplification involves several important factors not found in either domestic music amplification, or even in standard guitar amplification.

Firstly, when a bass guitar sound is being reproduced in a large hall, the efficiency of the speaker and enclosure decreases. That is to say, to produce sufficient volume level for correct balance with the associated group, a very large amount of power must be delivered to the loudspeaker. The large powers required by the bass guitar (which involves a frequency range of between 42 c/s and about 200 c/s) produce very high strain on the following parts of the loudspeaker:

(*a*) The outer cone support.
(*b*) The inner cone support.
(*c*) The joint between the voice coil former and the cone.
(*d*) The connecting leads between the terminals and the voice coil.

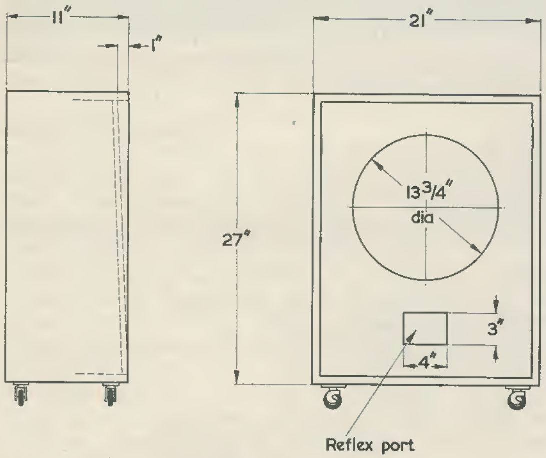


Fig. 1. A suitable reflex enclosure which may be home-constructed

The other major problem is the enclosure. To produce an acceptable sound quality, this has to be extremely large. To be portable, however, it must be small, and so a compromise has to be reached. The enclosure used by the author combines the two above qualities admirably, and details of this are given later.

The enclosure must also be very strong, but as light as possible. Above all, it must produce no resonances or rattles.

The amplifier, too, requires careful choice. It has three main requirements:

(*a*) It must have as low a distortion and background noise level as possible.
(*b*) It should have a power reserve of at least 20 watts.
(*c*) It must have a frequency response which is initially flat, but which can be altered readily to include up to 14dB or so cut or boost at the lower frequencies.

The amplifier chosen by the author to meet this specification is the Leak "TL25 Plus", combined with the Leak "Varislope III" pre-amplifier. This has a distortion level of well below 0.1% total, and performs absolutely perfectly at all volume levels. It has a power reserve of 25 watts, and a background noise which is virtually inaudible. The author employs the "Varislope" with full bass boost, but the actual sound is left to the taste of the musician.

It may be interesting to note that many people imagine that the bass guitar itself is the least important part of the equipment, and that all bass guitars produce the same sound. This is not true. Bass guitars differ in price between some £20 and £170, and produce a wide variety of sound qualities. The author uses a Burns twin pick-up model which combines an excellent fretboard and sound with an economic price.

The Impedance of the Instrument

Nearly all electric and bass guitars employ the magnetic type of pick-up. This consists of a long magnet with pole-pieces around which is wound a coil of fine copper wire. The whole assembly is placed under the strings of the guitar. As the metal strings vibrate, a voltage of the same frequency as the vibrating string is produced by the coil.

In more expensive pick-ups, an individual coil assembly is used for each string and the coils are then connected in series and coupled to the controls, but the principle is the same.

The impedance of the magnetic pick-up is usually around 1kΩ. The "Varislope" pre-amplifier used by the author has a microphone input designed to take low impedance sources at a flat response and with a sensitivity of 4mV. As the output can be reduced on the guitar by means of the volume control fitted, an excellent match is achieved with this microphone input.

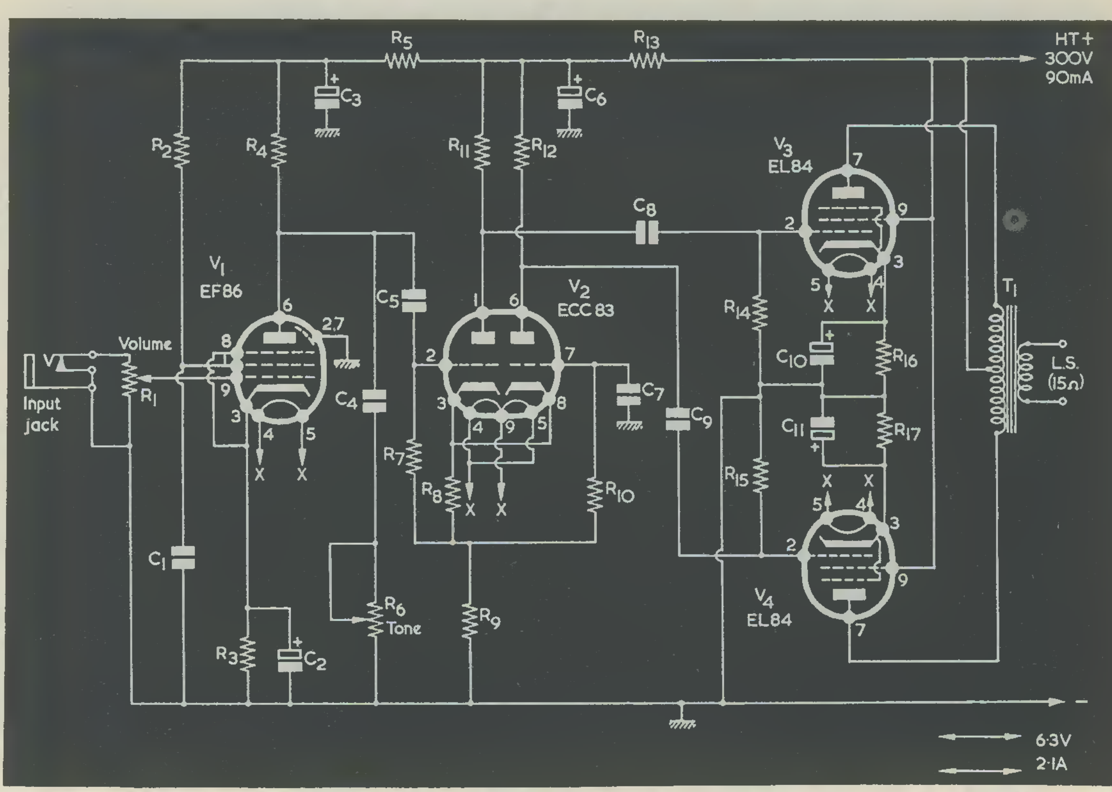


Fig. 2. Circuit for a 17 watt amplifier for use with the bass guitar. In the event of instability, 1kΩ series grid stoppers may be inserted close to the grids of V_3 and V_4

Components List
(Fig. 2)

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

R_1 250kΩ potentiometer, log track
R_2 470kΩ high-stability
R_3 2.2kΩ
R_4 120kΩ high-stability
R_5 39kΩ
R_6 1MΩ potentiometer, linear track
R_7 1MΩ
R_8 1kΩ
R_9 47kΩ
R_{10} 1MΩ
$R_{11,12}$ 100kΩ matched 5%
R_{13} 22kΩ
$R_{14,15}$ 180kΩ matched 5%
$R_{16,17}$ 270Ω matched 5%, 1 watt

Transformer
T_1 Output transformer. 8kΩ (anode-to-anode) to 15Ω. Primary centre-tapped, 40mA.

Capacitors
(All capacitors 350V wkg. unless otherwise stated)

C_1 0.1μF
C_2 50μF electrolytic 12V wkg.
C_3 32μF electrolytic
$C_{4,5}$ 0.1μF
C_6 32μF electrolytic
$C_{7,8,9}$ 0.1μF
$C_{10,11}$ 50μF electrolytic 25V wkg.

Valves
V_1 EF86
V_2 ECC83
$V_{3,4}$ EL84

Speaker
Goodmans Audiom 61 Bass

Input Socket
Jack with self-shorting contact

A Speaker Enclosure

A suitable enclosure is illustrated in Fig. 1, this being employed by the writer. The sloping baffle board is made from $\frac{3}{4}$in chipboard, and the remainder of the enclosure from $\frac{3}{4}$in plywood. The inside of the enclosure is lined with cellulose wadding 1in thick, and it is important to ensure that all joints are firmly and securely made so that there are no rattles or resonances. The cabinet is fitted with a back so as to completely enclose the speaker, the only aperture, apart from that for the speaker, being the reflex port.

When high levels of sound are required, the enclosure may be used laying on its side. This permits transmission of the bass frequencies through the floor and gives added efficiency. The castors at the base of the cabinet are for transport only.

The loudspeaker used in this enclosure is the Goodmans 15in Audiom 81 Bass model. This has a power handling capacity of 25 watts, and the cone edges are specially treated to give correct termination.

If it is desired to begin on a more modest scale, a 12in Goodmans Audiom 61 Bass can be employed with the amplifier shown in Fig. 2. This provides quite an acceptable output quality at a maximum power around 15 watts.

Simple Capacitor Tests

By ***G. A. W. PARTRIDGE***

EXPERIMENTERS FROM TIME TO TIME USE SECOND-hand components in order to avoid the expense of purchasing new ones for general research work.

This article deals with the testing of capacitors to see that they are in reasonably good condition before putting them to use, thus helping to avoid disappointment at some later stage.

Types of Capacitors

There are many kinds of capacitors on the market, but they can be divided into two main types, the non-electrolytic and the electrolytic. The former can be used in a.c. and d.c. circuits, but the latter are for d.c. operation only.

Both types can, however, be subjected to the "charge and discharge" test shown in Fig. 1. Small capacitors from about 0.001 to 1μF can be charged by connecting them across a 3 volt battery, leaving them for about 10 seconds and then discharging through a pair of headphones. A sharp click should be heard. This test will show up an open or short-circuit, as both faults will prevent the capacitor from charging up.

Larger capacitors, especially the electrolytic types, should be tested in a different manner and with a higher d.c. voltage, but the latter should not be above the rating of the capacitor. A voltage of 100 will be suitable in most cases. The charging current should be left on for a short while, and then the capacitor disconnected and left for some 30 seconds. It is then discharged through a voltmeter. After the initial "kick" of the needle the voltage should gradually die away to zero. The charging circuit should be fitted with a 1 amp fuse in order to protect it from a possible short-circuit in the capacitor. It is most important that the positive terminal of an electrolytic capacitor be connected to the positive side of the d.c. charging supply. Connecting the capacitor with incorrect polarity may lead to serious damage.

Measuring Capacitance

There are two well-known methods for measuring the capacitance of non-electrolytic capacitors. These consist of the voltmeter and the bridge method. The former is suitable for capacitors from about 0.001μF upwards when a 50 c/s supply voltage is used. Higher frequencies will enable lower values to be tested. The applied voltage must be somewhat lower than that at which the capacitor is rated. The second method is the bridge system. Neither method can be used for electrolytic capacitors as they involve the application of a.c.

Fig. 2 illustrates the voltmeter method. In this case the capacitor is connected to a 240 volt 50 c/s supply through a 10kΩ non-inductive resistor.

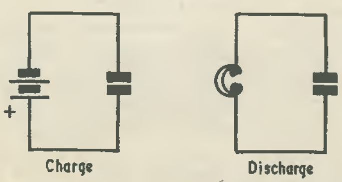


Fig. 1. A simple charge and discharge test

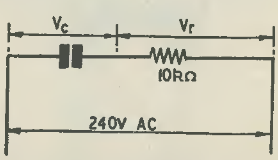


Fig. 2. Measuring capacitance by the voltmeter method

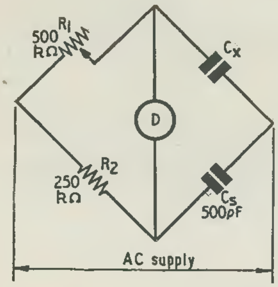


Fig. 3. The capacitance bridge

First, the current in the circuit is found from:

$$I = \frac{V_r}{R} \text{ amp}$$

If V_r is found to be 1 volt then:

$$I = \frac{1}{10,000} \text{ amp}$$

The capacitance is now found from:

$$C = I \times \frac{1,000,000\ \mu F}{2\pi f V_c}$$

If we assume the voltage across the capacitor (V_c) to be 239, then:

$$C = \frac{1}{10,000} \times \frac{1,000,000}{2 \times 3.142 \times 50 \times 239}$$
$$= 0.0013\mu F$$

It is essential that the voltmeter has a very high resistance, therefore a valve voltmeter should be employed.*

The bridge method is shown in its simplest form in Fig. 3. The variable and fixed resistors are both non-inductive. C_s is a reliable capacitor of known value, and C_x is the capacitor under test. The circuit could be connected to a 50 c/s 12 volt supply taken from, say, a bell transformer, or to a 1,000 c/s oscillator. D is a detector in the form of a pair of headphones, or an oscilloscope. The variable resistor is adjusted until the signal detected by D is at its lowest point, whereupon the value of C_x is found from:

$$C_x = \frac{C_s R_2}{R_1}$$

When R_1 is not calibrated its resistance can be measured with an ohmmeter after it has been disconnected from the circuit.

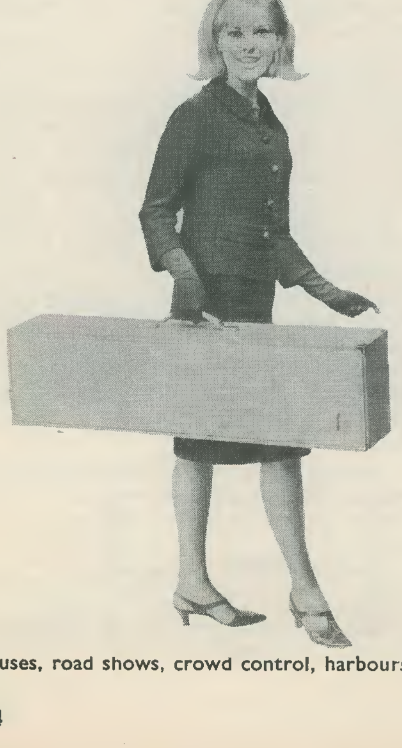
If, after adjustment to minimum signal, R_1 of Fig. 3 is found to be 300kΩ, then:

$$C_x = \frac{500 \times 250,000}{300,000}$$
$$= 417\text{pF}$$

By changing the value of C_s, other capacitor ranges can be accommodated.

* The formula for capacitance with the circuit of Fig. 2 and an applied a.c. of 50 c/s is $C = \frac{1,000,000\ V_r}{314\ V_c\ R}$ μF. See M. J. Darby. "Direct Measurement of Capacitance and Inductance", page 767, May 1963 issue.—EDITOR.

Wharfedale Portable Public Address System Type PA.30



This new product from Wharfedale is a *complete* P.A. system comprising amplifier, six speakers and microphone (with full size floor stand) all housed in a portable case. The amplifier is powered by 12 heavy duty flashlight batteries or by a built-in mains unit for 110–250V a.c. 40–60 c/s.

Brief Specifications:

POWER OUTPUT	30 watts max. peak.
FREQUENCY RESPONSE	Within 2dB 100 to 8,000 c/s.
INPUTS	Mic . . . low impedance. Aux . . . high impedance (for tuner tape or crystal pick-up).
SPEAKERS	Six 5in, specially designed Wharfedale speakers with the latest Neoprene flexible surround.
OUTPUT	Two Jack sockets for 15Ω speakers, (int. & ext.).
MICROPHONE	Omni-directional high grade dynamic with on/off switch.
CASE DIMENSIONS	$36\frac{3}{4} \times 7\frac{3}{4} \times 9\frac{7}{8}$in.
WEIGHT	Less than 42lb.
FINISH—CARRYING CASE	Tan leatherette with satin aluminium fittings and matching grille cloth.
—AMPLIFIER	Aluminium chassis housed in an oiled teak case. The panel is in two colour green with satin trim and knobs to match.
PRICE (U.K.).	£69. 10s. 0d.

Ideal for schools, churches, social events, dance bands, pop groups, circuses, road shows, crowd control, harbours, Yacht clubs, auction sales, etc., etc.

understanding radio

By W. G. MORLEY

Rectifiers—The Reservoir Capacitor

In last month's issue we commenced an examination of the diode as rectifier, dealing in particular with its use for supplying, from the a.c. supply mains, a direct high tension voltage for valve equipment. We saw that a half-wave rectifier, employing one diode, allows half-cycles of rectified voltage spaced at half-cycle intervals to appear across a load resistor; whilst the full-wave rectifier, employing two diodes, provides half-cycles of rectified voltage with no intervals between them.

We turn, now, to a third type of rectifier circuit.

The Bridge Rectifier

Fig. 256 (*a*) illustrates four diodes connected in a *bridge rectifier* circuit. The four diodes allow a rectified voltage to appear across the load, two of the diodes conducting for one half-cycle of the applied alternating voltage and the remaining two diodes for the alternate half-cycle.

The operation of the bridge rectifier can be explained very simply in terms of electron flow, i.e. from negative to positive. Let us assume that, during one half-cycle, the lower terminal of the source of alternating voltage in Fig. 256 (*a*) is negative and that the upper terminal is positive. If an external conducting path exists, electrons may then flow from the lower terminal to the upper terminal.

A suitable conducting path is provided by V_3 and V_2. The electron flow starts, in consequence, from the lower terminal of the source of alternating voltage, through V_3 (from cathode to anode), through the load resistor (from left to right), through V_2 (from cathode to anode), and on to the upper terminal of the source of alternating voltage. Assuming that there is no voltage drop across either V_3 or V_2, the full half-cycle appears across the load. During this half-cycle electrons cannot pass through V_4 or V_1 because both these diodes present anodes, instead of cathodes, to the electron flow. As we know, electrons can only flow from cathode to anode.

During the next half-cycle, it is the upper terminal of the source of alternating voltage which is negative and the lower terminal which is positive. In this case an electron flow starts at the upper terminal, passes through V_1 (from cathode to anode), through the load (from left to right), through V_4 (from cathode to anode), and on to the lower terminal of the source of alternating voltage. Assuming no voltage drop in the diodes, the full half-cycle appears across the load once more, and it will be noted that the electron flow through the load is in the same direction as occurred in the previous half-cycle. Also, V_2 and V_3 present anodes instead of cathodes to the electron flow, and so these diodes do not conduct.

The voltage appearing across the load resistor is shown in Fig. 256 (*b*) and it will be seen that this consists of half-cycles without spacing, and is similar to that offered by the full-wave rectifier we discussed last month.

Both the full-wave and the bridge rectifier circuits offer the same type of rectified output and, because of this, it may be thought that there is little point in providing the two extra diodes required by the bridge circuit. However, both circuits have advantages and disadvantages which cannot be fully dealt with yet, although one basic factor may be raised at this stage. If the bridge rectifier of Fig. 256 (*a*)

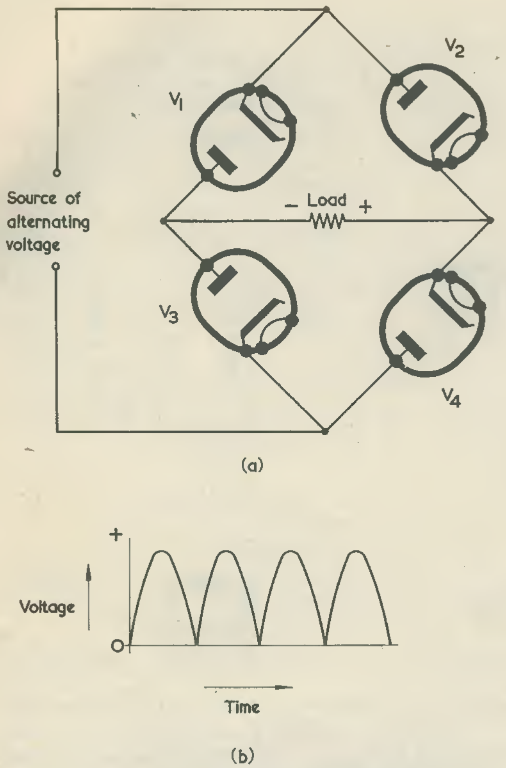


Fig. 256 (a). The bridge rectifier
(b). The voltage appearing across the load resistor in the bridge rectifier. This is presented as the voltage at the positive end of the resistor with respect to its negative end

is fed from the secondary of a transformer, the full alternating voltage appearing across that secondary is produced, in rectified form, across the load. With the full-wave rectifier the rectified voltage across the load has the same amplitude as that appearing across *half* the secondary only. Thus, for a given rectified voltage, the full-wave rectifier requires a transformer having twice as many turns in the secondary as does the bridge rectifier. This may present a significant disadvantage under some circumstances and particularly when very high rectified voltages (which necessitate large numbers of turns in the transformer secondary and especial attention to insulation) are required.

So far as domestic radio and television equipment is concerned, the bridge configuration is hardly ever used in high tension supply circuits employing valve diode rectifiers since, at the voltages and currents involved, half-wave and full-wave circuits offer perfectly adequate results. It should be mentioned, nevertheless, that there are alternative types of rectifier which function in a different manner to the valve diode[1], and that these may be frequently encountered in domestic equipment in the bridge configuration as well as in the full-wave and half-wave circuits.

A point which should be noticed in passing is that, whereas in the half-wave and full-wave rectifier circuits one end of the load is common with one terminal of the source of alternating voltage, there is no similar common connection in the bridge circuit.

The Reservoir Capacitor

The rectified voltage provided across the load by the rectifier circuits we have been examining is very different from the steady direct voltage we would obtain from a battery. If the rectified voltage is to be of use the irregularities in its waveform must be "smoothed out".

A circuit device which can assist towards this end consists of connecting a high value capacitor across the load resistor, as shown in Fig. 257 (*a*) where a half-wave rectifier is employed. The alternating voltage applied to the anode, and the rectified voltage on the cathode (which is that appearing across the capacitor) are then shown in Fig. 257 (*b*).

As is to be expected, the capacitor charges during the time when the rectifier conducts and discharges into the load when the rectifier is not conducting. During the first few cycles after applying the alternating voltage, the charge via the rectifier will be greater than the discharge into the load, but the circuit will soon arrive at a condition of equilibrium in which charge and discharge are equal. This is the condition illustrated in Fig. 257 (*b*). Starting at point A, the alternating voltage applied to the rectifier anode commences to become positive of that on the cathode and so the rectifier conducts. As a result, the capacitor commences to charge, and the voltage on its upper plate rises until we reach point B. At point B the falling alternating voltage reaches the same potential as the rectifier cathode, with the result that the rectifier ceases to conduct. The capacitor now discharges into the load and the voltage on the rectifier cathode falls until point C is reached. At C the alternating voltage reaches the same potential as that across the capacitor, and the rectifier once more commences to conduct and the capacitor to charge. From C to D (and E to F) we have the same process as occurred between A and B, and from D to E the same process as from B to C. One immediately obvious result is that, by adding the capacitor, we have obtained a rectified voltage which is much "smoother" than occurred previously.

An important point is that the rectifier does not conduct over the entirety of the half-cycle, as it did when we had the load resistor on its own. Instead, it conducts only when the anode goes positive of the voltage on the upper plate of the capacitor. The capacitor can be considered as a reservoir of charge, it being "topped up" during positive half-cycles when the level of the applied alternating voltage exceeds its own voltage level. Because of this fact, a capacitor connected in a rectifier circuit in this manner is referred to as a *reservoir capacitor*.

[1] These are, mainly, the selenium rectifier and the silicon rectifier and they will be discussed at a future date.

The rectified voltage in Fig. 257 (*b*) is still not the same as the steady voltage which would be provided by a battery but, as we have already remarked, the addition of the reservoir capacitor has caused it to become much "smoother". We may describe it as a direct voltage having an alternating *ripple*, the peak-to-peak amplitude of the ripple being the difference between its highest and its lowest points. Fig. 257 (*b*) also shows the mean, or average, direct voltage, which appears between the highest and lowest points of the ripple.

Fig. 257 (*c*) demonstrates the current which flows in the rectifier, the lettered points corresponding to those in Fig. 257 (*b*). At A, the rectifier commences to conduct and Fig. 257 (*c*) shows the onset of current flow at this point. The current rises to a peak corresponding to the peak in the voltage waveform, then drops again until we arrive at point B, where it reaches zero once more. There is a similar flow of current between the corresponding points C and D, and E and F.

When the rectifier of Fig. 257 conducts, the major current-limiting factors are its own internal resistance and any internal resistance which is present in the source of alternating voltage. Because of this the peak charging current can become very high; and it will certainly be considerably greater than the average current drawn by the load from the reservoir capacitor. Since the load draws current all the time whilst the rectifier *supplies* current for only a short portion of the cycle this relationship is, of course, to be expected.

In order to keep peak currents within safe limits and thus avoid damage to the rectifier, it is sometimes necessary to insert a *limiting resistor* between the source of alternating voltage and the rectifier anode, as shown in Fig. 258. If the source of alternating voltage is the secondary of an a.c. mains transformer, the effective internal resistance offered by this secondary[2] may be sufficient to provide the requisite limiting resistance.

Another factor is that, if the alternating voltage of Fig. 257 (*a*) is applied whilst the cathode of the rectifier is at emitting temperature and the reservoir capacitor is discharged, this capacitor will behave initially almost as though it were a short-circuit. In consequence, very heavy peak currents could flow through the rectifier during the first few cycles before the reservoir capacitor becomes charged if sufficient series limiting resistance is not included in the circuit.

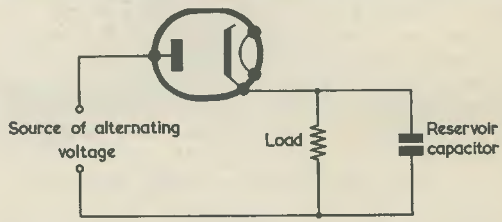
In practice, valve rectifier manufacturers specify minimum limiting resistance and maximum (or recommended) reservoir capacitance figures for their products under various circuit conditions. The circuit designer then knows that, provided he works within the limits laid down by the manufacturer, peak currents of the types just described will not be excessive.

[2] The effective internal resistance will consist mainly of the secondary resistance plus the resistance reflected into the secondary from the primary. See "Understanding Radio" in the July 1963 issue. Assuming a "perfect" generator, the resistance of the primary may be considered as a physical resistor in series with it. The reflected resistance in the secondary is, then, this resistance multiplied by the square of the secondary-to-primary turns ratio. For most work at home constructor level it is normally quite adequate to consider transformer secondary resistance on its own as providing the limiting resistance. Since the effective resistance is bound to be higher than this, a safety factor is automatically observed.

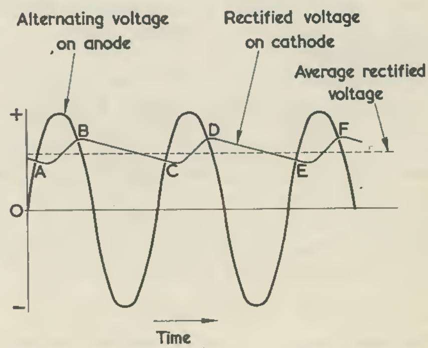
Varying the Load Resistance

Several further factors have to be considered before we leave our half-wave rectifier circuit of Fig. 257 (*a*).

Let us next see what happens if we increase the value of the load resistance, causing it to draw less current from the reservoir capacitor. If we increase the resistance to a very high value we will arrive at the set of conditions shown in Fig. 259. This diagram has the same lettered points A to F as occurred in Fig. 257 (*b*), and they correspond to the same events along the cycle. Because the current drawn by the load is now very small the reservoir capacitor is only slightly discharged at the points



(a)



(b)

(c)

Fig. 257 (a). Adding a reservoir capacitor across the load of a half-wave rectifier
(b). The alternating voltage applied to the rectifier anode and the rectified voltage at the cathode. Both voltages are with respect to the lower end of the load resistor
(c). The current flowing in the rectifier

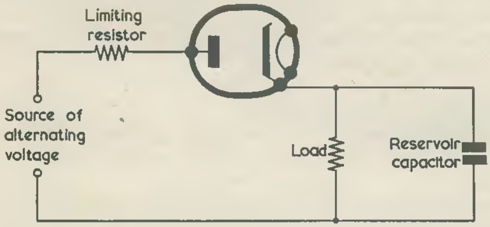


Fig. 258. Inserting a limiting resistor to prevent excessive peak currents in the rectifier

(A, C and E) where the rectifier commences to pass current. Also since, during the charging periods, the difference between the applied alternating voltage and the voltage on the cathode of the rectifier is much smaller than in Fig. 257 (*b*), the charging current peaks in the rectifier are less. So we learn that reducing the current drawn by the load resistor of Fig. 257 (*a*) causes a reduction in the current peaks passed by the rectifier. We can state, conversely, that an increase in load current causes an increase in the current peaks passed by the rectifier. This point is taken up in rectifier manufacturers' specifications, which quote maximum load currents.

Another important aspect which is evident from Fig. 259 is that the average rectified voltage shown here is considerably higher than occurred in Fig. 257 (*b*). Indeed, it very closely approaches the peak value of the applied alternating voltage. If we took the load resistor away altogether, so that the reservoir capacitor did not discharge at all, the average rectified voltage would become equal to the peak voltage.

The applied alternating voltage is specified in terms of its r.m.s. value, its peak value being equal to the r.m.s. value multiplied by 1.414.[3] In consequence it becomes possible, when load current is reduced, for the voltage across the reservoir capacitor to approach 1.414 times the r.m.s. value of the applied alternating voltage. If no load current flows, the voltage across the reservoir capacitor becomes equal to 1.414 times the r.m.s. value.

Thus, the presence of the reservoir capacitor enables rectified voltages to be obtained which, at low load currents, are greater than the r.m.s. value of the applied alternating voltage. As load current increases the rectified voltage drops, passing eventually below the r.m.s. value.

Finally, let us consider Fig. 260 (*a*). This shows the circuit of Fig. 257 (*a*) under the condition where the voltage across the reservoir capacitor is (due to negligible load current) virtually at peak level. At the same time, the applied alternating voltage is at the peak of the non-conducting half-cycle, with the result that the upper terminal of its source is negative

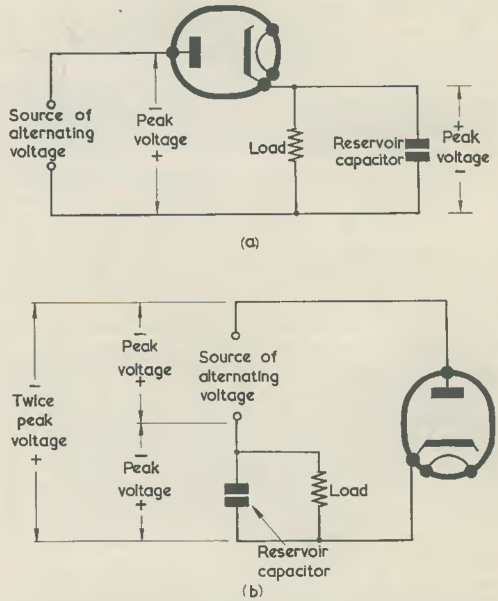


Fig. 260 (a). The situation which occurs at the peak of a non-conducting half-cycle when negligible current is drawn by the load
(b). If the circuit of (a) is rearranged, it may be seen that twice the peak voltage is applied, with non-conducting polarity across the rectifier

and the lower terminal positive. Peak voltage appears, therefore, across both the reservoir capacitor and the source of alternating voltage. If the circuit is rearranged in the manner shown in Fig. 260 (*b*) it can be seen that the peak voltage across the reservoir capacitor is in series with the peak voltage from the source of alternating voltage, causing *twice the peak voltage* to appear across the rectifier. This voltage, which is 2.828 times the r.m.s. value of the alternating voltage, is, of course, applied with non-conducting polarity to the rectifier. It is described as the *peak inverse voltage* which is offered by the circuit, and the rectifier employed must have adequate insulation and sufficient

[3] See "Understanding Radio", November 1962 issue.

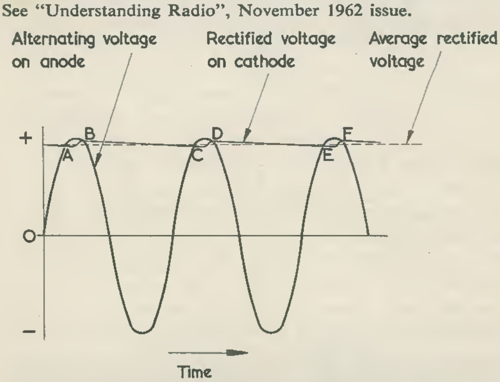


Fig. 259. If the load resistance is made very high, the reduced load current causes the average rectified voltage to closely approach the peak value of the applied alternating voltage

spacing between anode and cathode to be able to withstand it. Maximum peak inverse voltage ratings are always specified by the manufacturers of rectifiers for their products.

Whenever a rectifier is employed with a reservoir capacitor in the half-wave circuit of Fig. 257 (*a*) it is always assumed that the peak inverse voltage is 2.828 times the r.m.s. value of the applied alternating voltage even when a continual heavy load current prevents the voltage across the reservoir capacitor from reaching peak level. This precaution allows for the case where, under fault conditions, the load becomes open-circuit and draws no current. In many practical applications, also, the load is provided by other valves in the associated equipment, and these only draw current when their cathodes are at emitting temperature. It is readily possible for the rectifier cathode to be at emitting temperature whilst the other cathodes are not, whereupon load current becomes zero.

Some textbooks state that the peak inverse voltage for the Fig. 257 (*a*) circuit is 2.8 times the r.m.s. values of the applied alternating voltage. This is merely the 2.828 figure we have discussed here corrected to two significant figures.

Next Month

In next month's article we shall examine the performance of the reservoir capacitor in conjunction with the full-wave rectifier and will see, also, how the rectified voltage across this capacitor may be further "smoothed".

Sensitive Sound-Operated Switch

By J. SPENCER

This article describes an extremely sensitive sound-operated switch circuit incorporating transistors. By the use of alternative transducers, the device may also be made to respond to vibration, or to the mechanical deflection offered by dropping minute weights on to a plate

THE MAJORITY OF PUBLISHED CIRCUIT DESIGNS for sound-operated switches are based on valve amplification of the microphone signal. The reduction in size and weight which results from the use of transistors, however, encouraged the writer to discover what could be achieved with them in this particular application, and the results are described in this article.

Applications

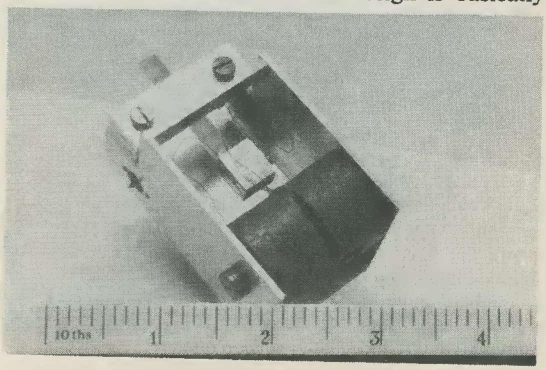
Sound-operated switches are frequently used in psychological experiments in which it is required to measure the time interval between the receipt of a message, for example, and the reply to it by the person being used in the experiment. In such cases the end of the measured interval is denoted by the start of the speech sounds and therefore a device in needed which will trigger in response to such speech sounds. It is not always desirable, or possible, to request that the person making the response should press a switch although this would be a much simpler alternative.

In everyday employment a sound-operated switch can obviously be used whenever the primary event which must be signalled or recorded is an acoustic disturbance of some sort. A good practical example would be given by the automatic switching on and off of a tape recorder during an intermittent commentary. The commentator can then concentrate on talking without the necessity of remembering to switch on the recorder every time a remark is made. Anyone who has tried this will know that it is very easy to forget when the reporting is irregular in time.

Other obvious applications are given by an acoustic burglar alarm, the use of a sound-operated switch circuit as the detecting part of an automatic telephone answering system or as a detector of other than acoustic phenomena if the input microphone is replaced by some different form of transducer. An example of this last category will be described later.

A Practical Circuit

The circuit that was finally evolved is given in Fig. 1. It can be seen that the design is basically



The general appearance of the transducer

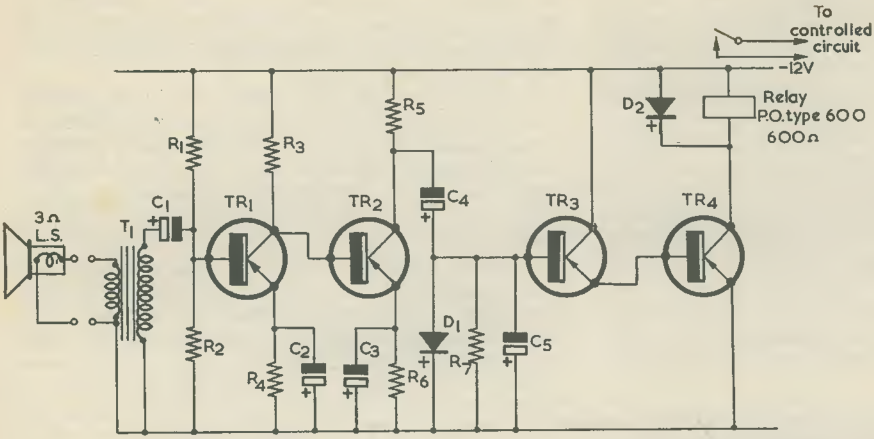


Fig. 1. The circuit of the sound-operated switch. The loudspeaker is employed as a pick-up microphone

Components List (Fig. 1)

Resistors
(All resistors ¼ watt 10%)

R_1	100kΩ
R_2	4.7Ω 4·7kΩ!
R_3	8.2kΩ
R_4	220Ω
R_5	2.2kΩ
R_6	470Ω
R_7	56kΩ

Capacitors
(All capacitors are electrolytic)

C_1	8μF 3V wkg.
$C_{2,3}$	100μF 3V wkg.
C_4	8μF 15V wkg.
C_5	4μF 6V wkg.

Semiconductors
TR_1 OC75
$TR_{2,3,4}$ OC83
$D_{1,2}$ OA81 or similar

Transformer
T_1 Input step-up transformer (see text)

Relay
P.O. type 600, 600Ω coil. Contact sets as required

Loudspeaker
3Ω loudspeaker. (Employed as microphone—see text)

a two stage amplifier, in which the first stage consists of a two-transistor d.c. coupled a.c. amplifier whose rectified output is the input signal to the two-transistor d.c. amplifier which forms the second stage. The advantages of d.c. coupling for the first stage are that it is easier to obtain gain without, as is so often the case, obtaining instability as well, and fewer components are required than with a similar a.c. coupled amplifier. The difficulty about d.c. coupling is that transistor spreads, leakage current changes with temperature and similar effects are passed along the chain of transistors. For this reason TR_1 is fully stabilised by base and emitter resistors, and only two transistors are used in this stage.

Experiments were tried using three transistors but it was found to be extremely difficult to obtain a repeatable d.c. condition for the three transistors when they were interchanged. Also a higher supply voltage became necessary to allow the third transistor to handle the current swing adequately.

In order to avoid shunting the output of TR_2, and thus obtain reasonable gain, the rectifier load should be as high as possible. This then requires that the second stage amplifier should consist of two transistors in cascade because a comparatively high current is required from the output transistor (approximately 20mA). It might be possible to use a more sensitive relay and thus require only one transistor in the second stage. However, the switch would then almost certainly be less sensitive and more expensive to make because low resistance, low current relays cost much more than one transistor of the type used in the present circuit.

The reservoir capacitor and the diode load resistor, R_7, shown in Fig. 1 are compromise values which give optimum performance with the Type 600 relay specified. Reducing the resistance value reduces the gain of the first stage amplifier and increasing it leads to trouble with the second stage amplifier. This is because any collector leakage currents in TR_3 develop a voltage across the resistor which, if it is too high, can cause TR_3 to conduct sufficiently to drive TR_4 into conduction in the absence of input signal. This state of affairs is more likely to occur at higher temperatures and with a transistor which has a high collector leakage current. The value given is suitable for temperatures up to 25° C. If the circuit is only to be used at lower temperatures, say below 15° C., then the resistor can be increased to 68kΩ.

If any difficulty is experienced in that, when the battery is initially connected, the circuit energises the relay and keeps it energised for more than a second or so, the first remedy is to interchange transistors. This ought to cure the trouble but, if not, then it may be necessary to reduce the value of R_7. Similarly, the value of C_5 may be changed to suit a particular application. If a larger capacitor is used the circuit will take longer to respond and it will, in effect, ignore short sound pulses. Also the relay will be slower to break after the end of a sound. Conversely, if a smaller capacitor is used the circuit will give a rapid response, but there is then the risk that short sound pulses will again be missed because the relay requires a minimum of several milliseconds in which to close. This latter possibility can be overcome by substituting a more expensive 1,000Ω high-speed relay for the Type 600 relay, but it will then be found that the relay tends to chatter instead of closing reliably.

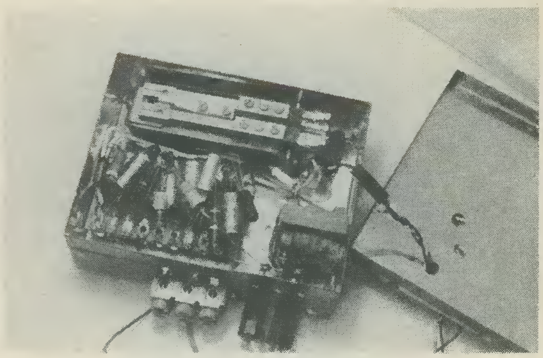
Consequently, the circuit illustrated provides the best all-round performance; although changes may improve it for any specialised purpose that experimenters may require.

Operation

The circuit has been built twice using different sets of components (mostly 20% tolerance at that) except for two of the transistors and both circuits worked "straight off the assembly line". It is unlikely, therefore, that any troubles will be met apart from those already mentioned. Under no-signal conditions a milliammeter in the battery line should show a reading of 4.5 to 5.5mA. The reading rises as the signal increases up to a maximum of about 25mA, at which stage the relay will have closed. If the no-signal current is more than about 6.5mA the cause, assuming no faulty components, is almost certain to be high leakage current in TR_3 causing appreciable current to flow in TR_4. The remedies for this condition have been described.

To give an idea of the sensitivity of the device, when an inexpensive 3Ω 8in loudspeaker was used as a microphone at one end of a 30ft room, normal conversation at the other end triggered the circuit when the speakers' voices were low-pitched. There was less response to high frequency sounds, but this may have been due to the large loudspeaker employed as a microphone.

The calculated input impedance of the circuit



The components of Fig. 1 can be fitted in a small neat case, as shown here

is of the order of 820Ω, and the input transformer specified matches this to a 3Ω microphone (i.e. a loudspeaker). The transformer must be altered if it is desired to use a microphone of different impedance in accordance with the usual formula for matching turns ratio.*

Vibration Transducer

As mentioned previously, the circuit may be used to detect any type of event providing the event generates an a.c. signal. An interesting field of experiment lies in the use of a vibration transducer, in which an a.c. signal results from a physical movement. This could be given by a coil moving in the field offered by two permanent magnets, as in Fig. 2.

A basis for such a transducer which was found perfectly satisfactory is to use two Eclipse No. 823C

* The transformer employed by the writer had a ratio of 1:16.5 and consisted of an ex-R.A.F. component, Ref. No. 10K/684. A close equivalent which should work satisfactorily is the Repanco TT25 transformer. This has a ratio of 1:20 and is intended for matching a moving-coil microphone to a transistor circuit.—EDITOR.

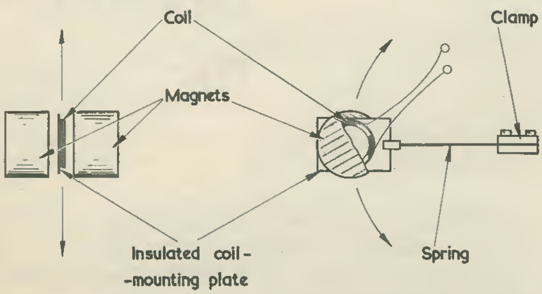


Fig. 2. The basic method of operation of the vibration transducer. The coil swings between the two magnets

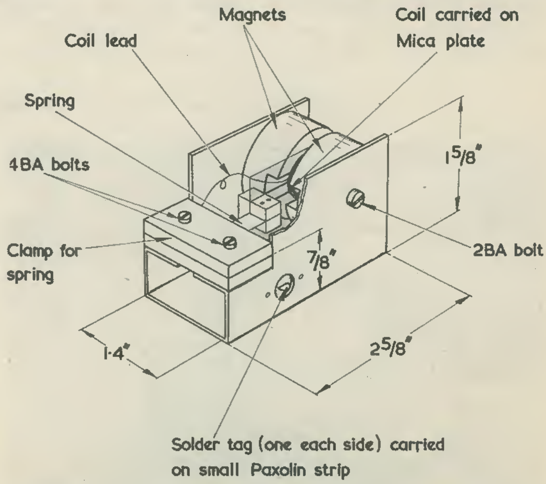
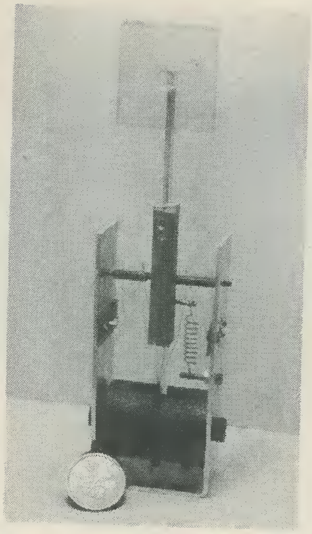


Fig. 3. The dimensions of the vibration transducer constructed by the writer



Adding a deflection plate and centring spring

button magnets (obtainable at most good tool shops) with a 60-turn coil of 36 s.w.g. copper wire moving between the poles of the magnets. The d.c. resistance of the coil is about 4Ω so that the output can be fed directly into the transformer primary of Fig. 1.

Fig. 3 and the illustration show the dimensions and general appearance of the transducer. The spring is of the type employed for pendulum suspension in a grandfather clock and was obtained from a watchmaker. The coil was mounted on a flat mica sheet secured to the end of the spring by a small home-made metal bracket.

The important objective to achieve with the suggested device is that the two magnets should be as close to each other as possible to minimise flux leakage. The dimensions given allow a bit of leeway in this respect. If a neat flat coil swinging accurately in the plane of the pole surfaces is achieved then washers can be inserted behind each magnet to reduce the excess gap until the coil is just not touching either magnet throughout its range of movement.

It will be found that the very low d.c. resistance presented to the unit by the input transformer primary winding gives extremely effective electrical damping of the coil. With the coil open-circuited the oscillations resulting from a small deflection of the spring are visible for about one minute as they decay. When short-circuited, the coil appears to flick back to its original position with very slight overshoot after the same deflection of the spring.

If a small deflector plate is fitted to the free end of the spring, the unit can be used as a counter of small articles dropping down a chute, for example. In this application the maximum count rate will be determined mainly by the Type 600 relay. With the circuit of Fig. 1 it should be possible to count at rates up to 4 items per second.

Finally, if a balanced pendulum arrangement is adopted, with a light spring centring the pendulum, an extremely sensitive device can be made of similar general construction to that used above.

A unit of this type made by the writer had a small mica plate mounted at the remote end of the pendulum. See illustration.

A 5 milligramme weight falling from a height of 1 centimetre on to this plate was sufficient to trigger the circuit reliably. Small abrupt changes in low velocity air or gas flows can also be detected in this way, or the unit could be used to signal the arrival of rain. In the latter application any unwanted effects due to wind must be eliminated by suitable enclosure.

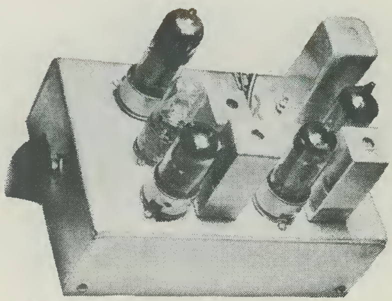
It will be obvious by now that the circuit described, together with suitable transducers, can form the starting point for a fascinating variety of experiments at a fairly low cost in equipment. For those who are fortunate enough to possess a recording milliammeter then it should be easily possible to modify the fourth transistor stage to give a d.c. output proportional to the magnitude of the input signal.

Brenell in Australia

The Brenell range of tape recording equipment excited considerable interest at the recent British Exhibition in Sydney. The Brenell Australian agents, RCA of Australia PTY Ltd. have in consequence, quadrupled their already large orders for Brenell machines.

The "Crystarlet"

Crystal-controlled F.M. Tuner



Part 1 *By* **SIR JOHN HOLDER, Bart.**

As a successor to his popular "Crystella" f.m. tuner, our contributor now introduces the "Crystarlet". The "Crystarlet" incorporates four valves and has the special feature of crystal-controlled switched station selection. This first article describes the circuit and gives details of coil construction. In the concluding article, to be published next month, full instructions are given for chassis assembly and alignment

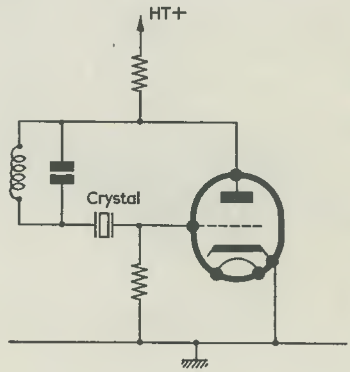
RIGHT AT THE OUTSET, THE WRITER FEELS THAT the following warning should be given to intending constructors of this tuner.

Experience shows that, on receipt of intermediate frequency coils and ratio detector coils, many readers find it difficult to resist the temptation to alter the core settings so that, when they have constructed the tuner and set out to adjust the front end, they fail to hear any signals. These coils are adjusted before leaving the factory and little or no further adjustment is needed when external circuits are connected to them. In consequence, no core adjustments whatsoever should be made until the receiver is complete and is ready for alignment.

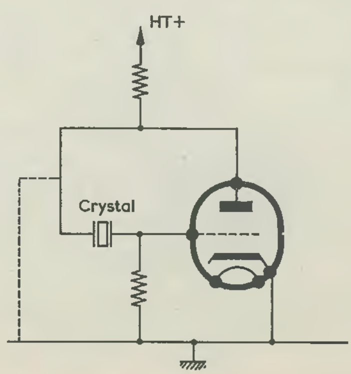
The "Crystarlet"

This tuner, as its name implies, is a smaller and simpler version of the "Crystella" which was described in the February and March 1963 issues of *The Radio Constructor*.[1] It is intended for reception in the main service areas of the B.B.C's v.h.f. broadcast transmitters, with the "Crystella"

[1] Sir John Holder, "The 'Crystella' F.M. Tuner", *The Radio Constructor*, February and March 1963. See also the following by the same author: "Notes On the 'Crystella' F.M. Tuner", January 1964, and "A Crystal Controlled Oscillator For F.M.", August and September 1961.



(a)



(b)

Fig. 1 (a). Coupling a tuned circuit resonant at the fifth overtone of the crystal between the oscillator anode and the crystal
(b). The inductance in the tuned circuit of (a) is so low at the fundamental crystal frequency that it will function as a direct connection, as shown here. To overcome this effect, a high-value bypass capacitor may be tapped into the inductor of the tuned circuit at a neutral point (with respect to operation at the fifth overtone). The path to chassis is indicated by the dashed line

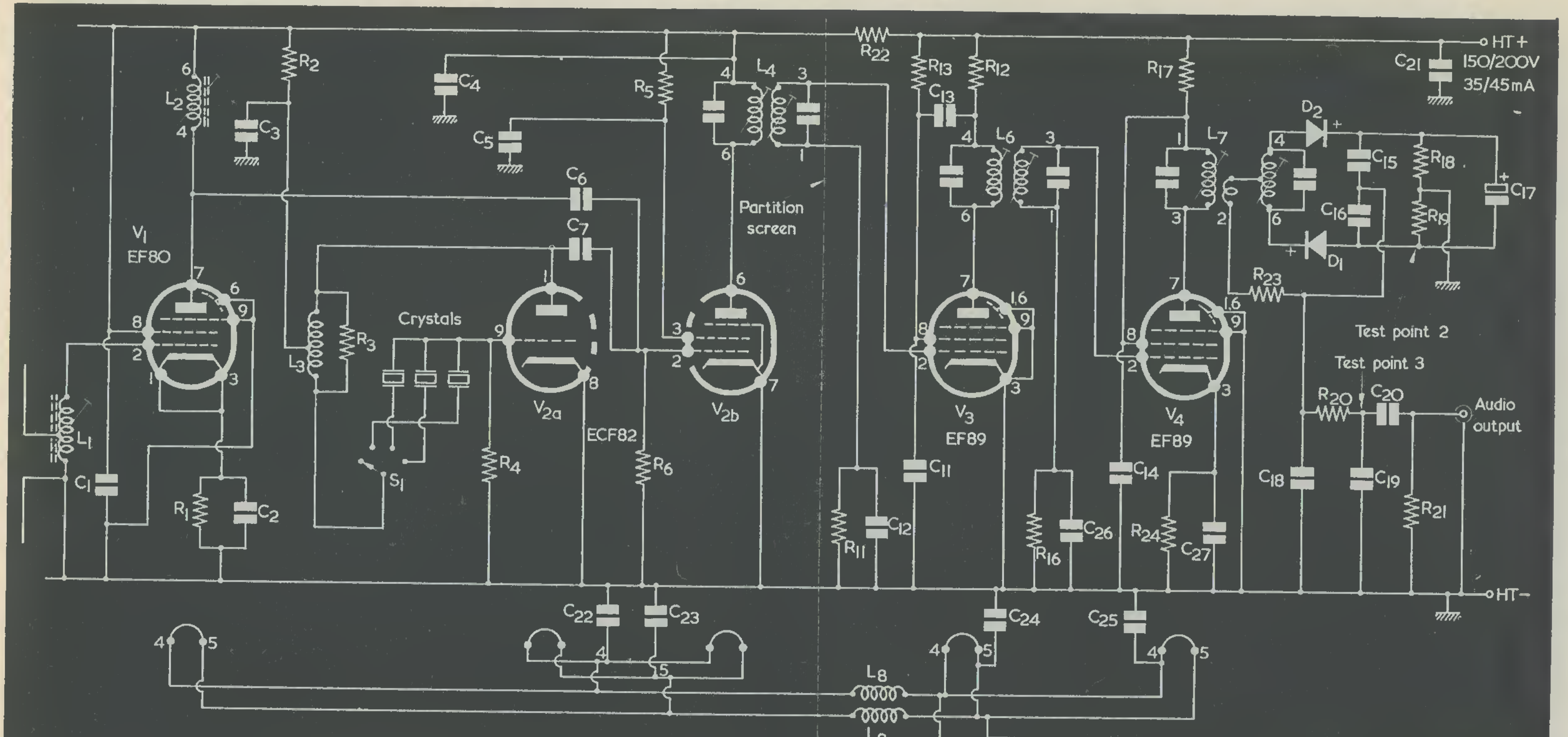


Fig. 2. The complete circuit for the "Crystarlet" f.m. tuner unit

Components List

Resistors
(All 20% ½ watt unless otherwise stated)

R_1	270Ω
R_2	10kΩ
R_3	22kΩ
R_4	27kΩ
R_5	33kΩ
R_6	270kΩ
R_{11}	1MΩ
R_{12}	1kΩ
R_{13}	33kΩ
R_{16}	100kΩ
R_{17}	10 to 22kΩ (See text of Part 2)
R_{18}	10kΩ 10%
R_{19}	10kΩ 10%
R_{20}	47kΩ 10%
R_{21}	1MΩ
R_{22}	270Ω
R_{23}	150Ω
R_{24}	330Ω

Capacitors
(All 20% unless otherwise stated)

C_1	5000pF ceramic
C_2	1,000pF ceramic
C_3	5,000pF ceramic
C_4	5,000pF ceramic
C_5	1,000pF ceramic
C_6	15pF ceramic or silver mica
C_7	8.2pF ceramic or silver mica
C_{11}	5,000pF ceramic
C_{12}	150pF silver mica
C_{13}	5,000pF ceramic
C_{14}	5,000pF ceramic
$C_{15,16}$	200 or 220pF silver mica or polystyrene 10% (Both must be the same value)
C_{17}	4μF electrolytic, (150V wkg.)
C_{18}	200 or 220pF silver mica or Polystyrene
C_{19}	1,000pF silver mica 10%

retained for the fringe areas; although there are indications that, even here, the "Crystarlet" may be a serious rival to its predecessor.

The "Crystarlet" uses the same S.T.C. triple crystals as the "Crystella". The advantages of these were fully explained in the "Crystella" articles.[2]

Design Considerations

With only four valves, one has the choice of two i.f. stages and no limiter, or one i.f. stage and a limiter which is only partially effective because the signal has received insufficient amplification. A ratio detector works best with a fairly large signal but if the first of these choices is adopted and the detector has to do all the limiting, whereupon its components have to be very carefully chosen and great pains taken to see that it is carefully balanced.

If the normal type of grid limiter is used for the second choice, there will be barely enough signal for the detector to work properly, because the grid limiter contributes little or no gain.

There is a way out of this which consists of accepting that limiting will be partial only. A partial limiter can then be used which does not give 100% limitation and which also provides a good measure of amplification.

In this way, the ratio detector can be worked under optimum conditions where it will not only give a low-distortion audio output, but will also clean up nearly all of any residual a.m. interference which may be present.

Another advantage of this solution is that, as there is gain to spare, we can use i.f. coils which have a lower L/C ratio. This means that not only will the constructor find that little or no departure from the makers' adjustment is needed when external circuits have been added, but that the coils will also be more immune from the effects of capacitance variation resulting from temperature changes or ageing.

The Limiter

The normal limiter employs a valve operated at a very low h.t. potential, so that the characteristic curve shrinks to diminutive proportions. Interference which has a large amplitude will thus cause the grid to bias the valve to cut-off and "punch a hole" in the received signal. When starved in this way, however, the valve is not able to contribute any worthwhile signal gain.

The "Crystarlet" limiter employs a normally operated variable-mu valve, its limiting action depending on the fact that a resistance-capacitance combination having a time-constant of 10 microseconds included in its grid circuit. The valve is also cathode-biased to a point on the characteristic curve where a small change of grid bias causes a large change in the gain. The valve will thus be unaffected by a steady frequency modulated carrier, but the time-constant is small enough to cause it to bias the valve to a low gain during the rapid rise of impulsive interference. At the same time, the time-constant is large enough to allow amplitude modulation to exert a kind of automatic gain control which irons out the amplitude variations which an f.m. signal inevitably acquires, thus reducing the demands on the ratio detector.

Gain Control

There are arguments both for and against automatic gain control of f.m. receivers. None is provided in the "Crystarlet" because the resulting reduction in overall gain which always accompanies

[2] These crystals appear in the Standard Telephones & Cables Ltd. triple crystal unit type 4434. A suffix letter corresponds to the B.B.C. transmitter with which the particular unit employed should be used.—EDITOR.

C_{20} 0.05µF paper
C_{21} 5,000pF ceramic
C_{22} 5,000pF ceramic
C_{23} 5,000pF ceramic
C_{24} 1,000pF ceramic
C_{25} 1,000pF ceramic
C_{26} 100pF silver mica or polystyrene 10%
C_{27} 10,000pF ceramic

Valveholders
All preferably skirted
V_1, V_2 B9A } p.t.f.e. or ceramic
Crystal B7G }
V_3, V_4 B9A Nylon-loaded

Sundries
Chassis (see drawings)
Coaxial aerial input socket
S_1 Single-pole 4-way (Prototype employs Radio Spares Midget 3-pole 4-way)
Small reel of 20 s.w.g. enamelled copper wire
Tagstrips, bolts, nuts, self-tapping screws, connecting wire, etc.

Valves, etc.
V_1 EF80
V_2 ECF82
V_3 EF89
V_4 EF89

Crystals—STC type 4434/ to suit locality
$D_{1,2}$ Mullard OA81

Coils
L_1, L_2, L_3 } Home-wound (See text)
L_4, L_6 } I.F. Transformers Maxi-Q type IFT 11/10.7 (Denco)
L_7 Ratio Discriminator type RDT 1/10.7 (Denco)
L_8, L_9 } Home-wound (See text)

its use would nullify all the gain advantages just described.

Since there is no automatic adjustment of gain it is necessary to make a pre-set adjustment so as to bring the strength of the signal at the ratio detector within the working limits at the locality where the tuner is to be used. This is easily carried out by varying the value of the anode voltage dropping resistor for the variable-mu limiter valve. This point is discussed in detail in Part 2, to be published next month.

The Oscillator

The oscillator is the same as that used in the "Crystella" except that a slightly different coil is used.

The crystals—one for each programme and all in the one glass envelope—are inserted in the grid circuit of the oscillator valve where they allow excitation only at the fundamental frequency of the crystal selected or at a harmonic.

An additional broadly-tuned LC circuit restricts oscillation to the correct harmonic or overtone, this being the fifth. If this were a simple LC circuit, the inductance at the fundamental frequency would be so low that it would merely connect the oscillator anode to the crystal. This would then vibrate in the parallel mode at its fundamental frequency and generate an exciting voltage at this frequency across the grid resistor. See Figs. 1 (*a*) and (*b*).

To overcome this, the inductance of the LC circuit has a tapping connected to chassis via a large capacitor. This virtually short-circuits the anode a.c. voltage at the fundamental frequency (as shown dashed in Fig. 1 (*b*)), but the LC circuit is arranged in the form of a bridge which is balanced at the frequency of the correct overtone. At this frequency, the tapping is at a neutral point and there is no drain of energy.

The balancing of the bridge is made easy in this tuner by the fact that the component values are so chosen that the bridge is in balance when the two portions of the inductance on either side of the tap are visibly equal.

The Circuit

Fig. 2 shows the complete circuit for the tuner. Superficially, it follows that of the "Crystella" very closely, except that V_3 of the "Crystella" and its accompanying transformer have been omitted. In fact, the same component numbering has been retained as far as possible, so that direct comparison between the two circuits can be made.

There are, however, certain practical differences. Apart from the altered i.f. coils and limiter, the main difference is an increased use of home-wound coils. Readers have shown that they enjoy "do-it-yourself" work of this kind, and all the coils used have practical advantages. None of them is difficult to construct, if tackled in the right way, and the same gauge of wire has been used throughout.

There are two resistors and a capacitor additional to those used in the "Crystella". R_{23} is a refinement which improves the action of the ratio detector at high signal levels. It was included inside the screened assembly of the previous coil, but here it is added externally.

The bias resistor R_{24} and bypass capacitor C_{27} serve to bring the variable-mu limiter to the point on the curve where the limiting action is greatest. Under difficult conditions, such as weak signal, powerful interference or multi-path reception, it might be worthwhile experimenting with different anode voltages and values for R_{23}, but the value specified for this resistor here has been found to give good all-round results.

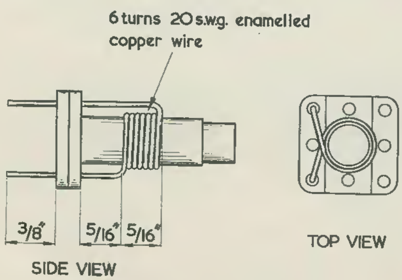


Fig. 3. The construction of L_2

Constructing the Coils

Enamelled 20 s.w.g. copper wire is used for all the hand-wound coils and two have tapping points.

The easiest way to construct a tapping is in the following manner. First take a suitable length of wire and determine where the tapping point is to be. To do this it may be necessary to initially construct a dummy coil using a spare piece of wire, mark the tapping place, unwind it again, and then use this wire to indicate the tapping position on the wire which is actually to be used. Having found the correct position, bend the wire into a "V" and continue round with one end until a light loop or curl is formed. Pinch this curl as tightly as possible using pliers. Next thoroughly scrape all the enamel off the outside of the curl, also inserting the point of the knife into the curl and twisting it round. When clean, tin both sides and fill with a blob of solder so that no curl remains.

Before fixing any of the coils in the tuner, the ends should be fashioned and cut so that they lie exactly over the position where they are to be soldered in place.

Using enamelled wire there is a danger that solder stuck to enamel may give the appearance of a good joint. In every case the coil ends should be well scraped and tinned before the coil is fixed in place.[3]

The Aerial Transformer

L_1 is an auto-transformer consisting of four turns touching one another, would as tightly as possible on to a 0.30in diameter square-based Bakelite former and tuned with a v.h.f. type slug. It does not have a screening can.

The aerial is connected to a tapping $1\frac{1}{2}$ turns up from the bottom. Before mounting on the chassis, slide the coil off the former. Mount the former inside the chassis (one of the aerial socket bolts is shared between the socket and the former). Next slide the coil in place again and push it down as far as it will go. When the ends have been soldered to the grid of V_1 and the adjacent chassis tag, they will hold the coil in position.

As a refinement, the grid lead could be appreciably shortened by cutting away the base of the former so as to leave only the thick part with the threaded fixing holes. It could then be bolted down as close as possible to V_1 valveholder, for which purpose it will, of course, be necessary to alter the fixing holes in the chassis.

A suitable coil former for L_1 is the Denco component Ref. 5000A/4 or 6E.

The V.H.F. Anode Coil

Some readers had difficulty in getting the "Crystella" oscillator to work, because its circuit was incorrectly loaded by L_2. This point will be further discussed in Part 2. Meanwhile, it can be stated that part of the reason for the incorrect loading was that L_2 had been made insufficiently accurately. So that the prototype coil can be more easily duplicated, a slightly different coil is used in the "Crystarlet" and it is designed to measure correctly when the turns of the coil touch one another.

To make the coil, wind 6 complete turns of 20 s.w.g. enamelled copper wire on to a 0.30in diameter Bakelite former. This former is to be mounted on top of the tuner and fitted with a screening can. A suitable former is the Denco 5000A/4 or 6E and the can may be a Denco Ref. 1.

After winding, the ends of the coil should be bent down and passed through holes 4 and 6 of the former base, the end further from the base passing through hole 4. Next cut the ends so that they project about $\frac{3}{8}$in when the coil is in the centre of the former. Push the coil down a little further and scrape the enamel off the protruding parts.

The coil can now be re-centred and fixed in place with a touch of solder where the ends pass through the eyelets in the base. Care should be taken that this solder will not cause a short-circuit to the screening can. The completed coil is shown in Fig. 3, and it is fitted with a v.h.f. core.

The Oscillator Coil

Many types of oscillator coil for the L_3 position were tried, but the self-supporting type with spaced turns was found to be the most suitable. The use of formers and dust-cores made it difficult to maintain the balance of the bridge. Correct balance is more important than the dimensions of the coil, as long as the latter are within certain limits. It will be shown later that correct adjustment of L_2 is more important than adjustment of L_3, provided the latter is made correctly to measurement.

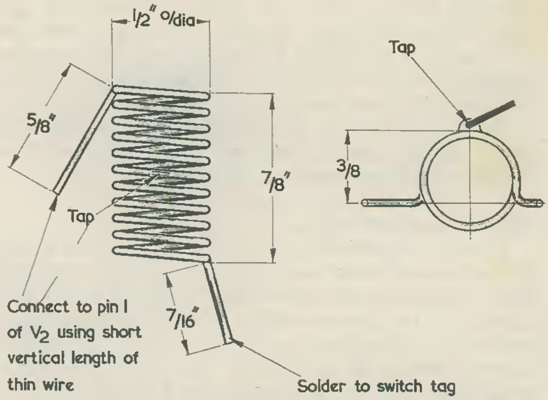


Fig. 4. The oscillator coil L_3. References to V_2 and the switch tag are with respect to the layout diagram of Fig. 9, which will be published next month

To construct L_3, take a 2 foot length of 20 s.w.g. enamelled copper wire and make a tapping point at the centre. Then, starting at the tapping point wind $5\frac{1}{4}$ turns in a clockwise direction on to a $\frac{7}{16}$in rod, such as the non-threaded portion of a bolt. Turn the former round and wind on $5\frac{1}{4}$ turns at the other end. When completed, the coil should consist of $10\frac{1}{2}$ turns, having the appearance of a left-hand thread. If held with the rod pointing away from you, the far end of the coil should hang down on the left and the near end on the right, with the tapping point at the centre and on top. The dimensions are shown in Fig. 4.

Pull out the coil so that it measures between $\frac{3}{4}$in and $\frac{7}{8}$in long with the turns equally spaced. If the winding tension has been correct, the outside diameter will be $\frac{1}{2}$in.

Bend one end sharply at right angles so that it points towards you nearly parallel to the axis of the coil. Bend the other end at right angles but so that it comes forward at a slanting angle.

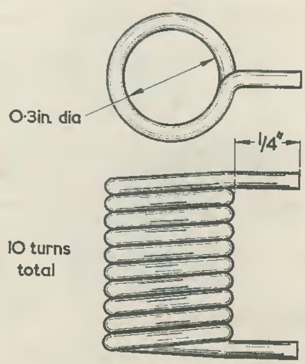


Fig. 5. Construction of the heater chokes L_8 and L_9

[3] In the coil-winding instructions which follow references are made to installation on the chassis, the wiring and layout diagrams for which will appear as Figs. 8 and 9 in the concluding section to be published next month. It is desirable to clear the question of coil construction in the present instalment and readers will find that any outstanding points will be clarified next month.—EDITOR.

Cut the forward end, so that it projects by $\frac{7}{16}$in and cut the rear end so that, when the front end is in position touching the switch tag, the rear end lies vertically above pin 1 of V_2 valveholder. Scrape the ends well and tin them.

By now, the coil will probably be a shapeless mess! If so, put it back on the former and re-fashion it so as to make a neat job.

The Heater Chokes

There is insufficient room for the type of heater chokes which were used in the "Crystella", so self-supporting chokes are used. These should each consist of 10 close-wound turns of 20 s.w.g. enamelled wire, wound on to a spare 0.30in diameter former which is afterwards removed. The ends should be bent at right angles so that they project sideways, and cut to $\frac{1}{4}$in as shown in Fig. 5.

Warning

We started with a warning. Let us finish this instalment with another, intended specially for those who are constructing an f.m. tuner for the first time. This is that *v.h.f. is definitely different!* At these frequencies a fraction of an inch of wire has an appreciable inductance, so that if the constructor departs ever so slightly from the instructions as to the position of components, or attempts to make the wiring tidy by putting in right-angled bends and so on, he may find that the tuner will not work. Even the intermediate frequency wiring must follow the shortest possible routes. This is because there is a v.h.f. harmonic which can be radiated and which, if it finds its way into the front end, will cause instability, blocking or loss of sensitivity.

The "Crystarlet" is the outcome of much careful thought and experiment. When correctly constructed according to the instructions, it will be found to be a very stable and easily adjusted tuner.

(*To be concluded*)

"A-PEALING"

door chimes

By R. Bebbington

In these ingenious two-tone door chime units the chimes are derived from a transistor oscillator.

"A-PEALING" AND REALISTIC DOOR CHIMES THAT can be easily constructed by readers are the subject of this article. The circuits described are full transistorised, the only mechanical device being the bell-push. The layout is by no means critical and the disposition of the components may be altered to suit individual requirements without impairing the results.

Single-ended Version

The first circuit, shown in Fig. 1, is extremely easy to build and will give adequate volume for reasonably quiet situations, the prototype being heard at a distance of 25 yards. Basically, it consists of an oscillator followed by an output stage driving a miniature loudspeaker. One obvious advantage of the transistorised circuit lies in the economy of the power supplies. Only one 9 volt battery is required and this supplies current only when the bell-push is operated. To produce the chime-like decay effect that one associates with bells, a slowly discharging electrolytic capacitor, C_4, supplies the oscillator and output collector voltage momentarily after the bell-push has been released.

A modified Hartley oscillator has been chosen because it is frequency-independent of supply voltage variations. This is most important as, otherwise, the decay note would vary in pitch as the electrolytic capacitor discharged.

The second note to be sounded is obtained by arranging that a contact on the bell-push connects an additional capacitor, C_2, across the tuned circuit, L_1,C_1. As the power supply contact is designed to make first, the second note will sound fractionally after the first note is heard, i.e. when the tuned circuit is modified by the extra capacitor. On release of the bell-push this extra capacitor is disconnected and the original note is repeated during the decay period. Thus three notes are

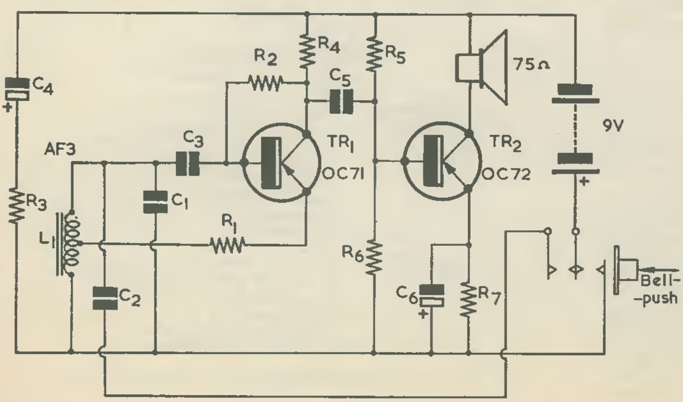


Fig. 1. The circuit of the single-ended unit

Components List (Fig. 1)

Resistors
(All resistors ¼ watt, 10%)

R_1	180Ω
R_2	39kΩ
R_3	22Ω
R_4	470Ω
R_5	12kΩ
R_6	2.2kΩ
R_7	33Ω

Capacitors

C_1	0.1μF
C_2	0.05μF
C_3	0.05μF
C_4	1,000μF electrolytic 12V wkg.
C_5	0.1μF
C_6	100μF electrolytic 6V wkg.

Note: C_1 and C_2 may require selection or adjustment to produce the desired tones.

Inductor
L_1 Centre-tapped choke type AF3 (Repanco)

Transistors
TR_1 OC71
TR_2 OC72

Bell-Push
Modified push-button (see text)

Loudspeaker
75Ω moving-coil

Battery
9 volt battery

Components List (Fig. 3)

Resistors
(All resistors ¼ watt, 10%)

R_1	220Ω
R_2	39kΩ
R_3	3.9kΩ
R_4	4.7kΩ
R_5	270Ω
R_6	5Ω

Transistors
TR_1 OC71
$TR_{2,3}$ OC72

Bell-Push
Modified push-button (see text)

Loudspeaker
3Ω moving-coil

Battery
9 volt battery

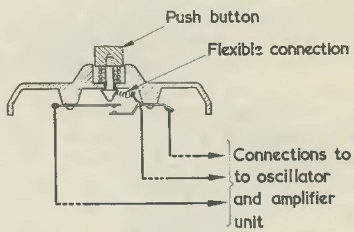


Fig. 2. Modifications to the bell-push

Capacitors

C_1	0.1μF
C_2	0.05μF
C_3	0.05μF
C_4	250μF electrolytic 12V wkg.

Note: C_1 and C_2 may require selection or adjustment to produce the desired tones.

Inductors

L_1	Centre-tapped choke type AF3 (Repanco)
T_1	Driver transformer type TT45 (Repanco)
T_2	Output transformer type TT46 (Repanco)

heard in all, with the middle note at a lower pitch determined by the auxiliary capacitor value. Any musical interval may be chosen, the component listed giving a pleasant-sounding minor third.

Bell-Push Assembly

So far as the bell-push is concerned, if a suitable switch having two make contacts is available it is an easy problem to adjust it so that one contact makes before the other. Unfortunately, most switches available to the writer lacked the professional look, and as the bell-push was to adorn the front door, it was decided that a standard commercial item would be more elegant. A second contact was inserted that closed fractionally after

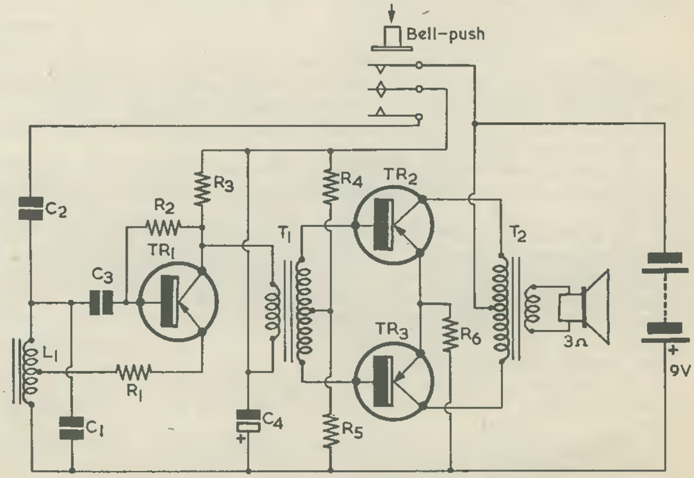


Fig. 3. The circuit of the alternative push-pull version

the original contact in order to switch the auxiliary tuning capacitor. See Fig. 2. Arrangements will obviously differ depending on the layout of push-button assembly purchased, but it should not be difficult to adapt it to the requirements illustrated. Contacts from an old relay or switch may be used to augment or replace the original contact if necessary. The problem is not a difficult one.

Three connections are taken from the bell-push to the oscillator and amplifier unit. It is essential that the last contact to close is wired to the auxiliary capacitor, C_2.

Push-Pull Version

Almost any amplifier can be adapted to follow the modified Hartley oscillator circuit but, as we get away from the simple single-ended stage, the problem of battery economy becomes significant. Whereas before, the charge in the electrolytic capacitor was sufficient after releasing the bell-push to provide oscillator and output current and maintain the sound for a second or two, increased output power demands severely curtail this decay time. One solution is to leave the amplifier permanently across the supply and merely switch the oscillator. Unfortunately this is rather wasteful. Yet, without the decay, the chime lacks charm. Necessity being the mother of invention, a compromise was sought and found in the push-pull circuit of Fig. 3. Whilst no originality is claimed, one must admit that it is different.

Coupling is achieved throughout by means of transformers, the primary of the driver transformer being in the collector circuit of the oscillator. The need for the paralleled 3.9kΩ resistor, R_3, may not be obvious but it helps, in practice, to stabilise the frequency during the decay period. Conventional d.c. stabilisation of the OC72 bases is by a resistance chain comprising a 4.7kΩ and a 270Ω resistor. The primary centre-tap of the output transformer is connected permanently to the 9 volt battery but as the transistor bases are virtually at emitter potential when the bell-push contacts are open, only a modified leakage current will flow. This is a matter of a few microamps. However, when the push-button is pressed the oscillator drives the output stage which is now fully conducting because of the potential applied to the base circuit. On release, the 250μF capacitor C_4 supplies current for the oscillator and d.c. bias chain only, thus permitting a decay time of several seconds since the main collector current is drawn directly from the battery.

Extension loudspeakers of the usual 3Ω type can be installed in a workshop or garage remote from the main speaker—an advantage not shared by electro-mechanical door chimes. Furthermore another bell-push can easily be arranged to serve, say, the back door, this having a different chime combination.

The push-pull version shown in Fig. 3 has been in use, at the time of writing, for two months, and has attracted a lot of interest. The battery employed is still that originally fitted.

New TV/'Phone Aerial Revives 300-year-old Telescope Invention

Scientists at the St. Mary Cray, Kent laboratories of Standard Telephones and Cables Limited have produced a new low-cost aerial for the very-short-wave (microwave) radio links that beam TV pictures between studios and transmitters and carry hundreds of telephone calls between cities and towns.

The new £175,000 TV/telephone link between London and France, now being built for the G.P.O., will be the first to use the new STC aerial.

The aerial uses an idea originally put forward in 1672 by Professor Cassegrain of Chartres University while working on the improvement of astronomers' telescopes. The principle involves double focusing to obtain sharper and clearer images.

As a result of this modern application of Professor Cassegrain's invention to microwaves, which behave like light beams and can be focused in the same way, the 29ft high "hog-horn" aerials used on many radio towers can now be replaced with Cassegrain aerials of only 12½ft diameter without loss of performance.

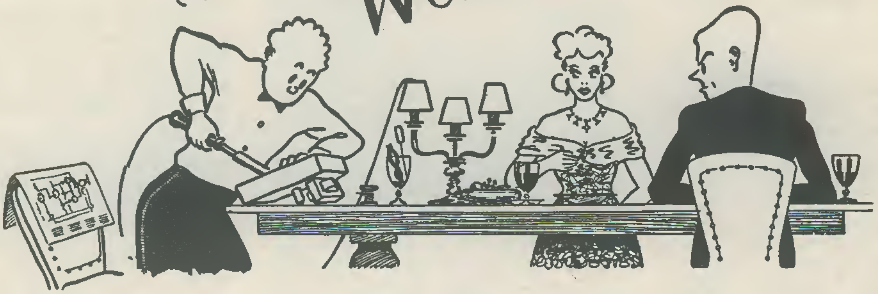
The STC Cassegrain aerial is not only half the size but also one-quarter the cost of the equivalent hog-horn aerial. The reduction in weight also means that strengthening of tower structures is no longer required.

The Cassegrain principle

In the Cassegrain telescope a small convex mirror is placed near the focus of the main, large concave mirror. The received image is viewed through a hole in the large mirror. The incoming rays are therefore subjected to focusing and refocusing.

When applied to microwave aerials the radio energy is collected by a 12ft 6in diameter concave reflector and directed on to a 6in diameter convex reflector near the horn-shaped end of the circular waveguide that feeds the energy down the tower to the receiving equipment. The transmission process is exactly the reverse, the double focus action producing an extremely parallel and efficient microwave beam aimed exactly at the next radio tower, some 40 miles away.

IN YOUR WORKSHOP



This month, Smithy the Serviceman, aided as always by his able assistant Dick, investigates the mysteries of a comparative newcomer to television receivers—the voltage dependent resistor

"THERE WON'T," PRONOUNCED Dick, looking up from his coupon, "be any Treble Chance at all in next year's pools."

"Won't there?" asked Smithy interestedly, entering a cross against Sheffield United. "What will there be, then?"

"You'll have to predict," replied Dick, "the number of players sent off during the game. You'll score one point for each player sent off. Also, there'll be half a point for each spectator run in by the law and, if there's a free fight between players and spectators, you get an extra ten points bonus as well!"

"That," sighed Smithy, putting his ball-point pen to one side, "would just about suit me down to the ground. I couldn't do worse with a pool like that than I have done over the last few weeks."

"No luck?"

"Very little," said Smithy cautiously. "The odd £150,000 still continues to elude my grasp."

The Serviceman leaned back and reached for his tea. Outside there was a scene of desolation, as the late January snow turned gradually into slush under an incessant cascade of rain. Small icicles hung like stalactities from the upper framework of the windows, melting gradually into the water that flowed over them and dripped from their tips. A bleak wind blew fitfully, sending little scurries of rain first against one window and then another.

Inside the Workshop, however, all was warm and snug. Dick and Smithy had just consumed their lunch, this being a repast, it should be added, which was far more nutritious and sustaining than their usual newspaper-wrapped mid-day meals. Smithy had astounded Dick in the middle of the preceding week by suddenly adding a saucepan to the motley collection of culinary utensils which disgraced the Workshop, and the pair had put it to use immediately for the preparation of hot meals cooked in their tins, a process which merely involved filling the saucepan with water and obviated any messy cleaning up afterwards. On the first day they had enthusiastically regaled themselves on Heinz Oven Baked Beans, to be succeeded on the following day by Heinz Spaghetti With Tomato And Cheese Sauce. The next day had seen a return to the baked beans and then, after the week-end, the spaghetti. And thus the menu alternated. Today was Thursday and it had once more been the turn for baked beans.

Thursday was also the day for the Pools.

The Hanger Door Opens

"Did you," asked Smithy, suppressing a minor burp, "put Spurs down for a draw?"

"I might have done," replied Dick guardedly, as he copied the number of his postal order into the coupon.

"There's no need," said Smithy peevishly, "to be as secretive as all that."

Decisively, Dick folded his coupon and postal order, inserted them into the envelope and stuck the flap down securely.

"It doesn't pay," he said darkly, "to pass on details of one's own coupon. In any case, I've finished mine and I want to talk about something technical instead."

"I wondered how long it would be," grumbled Smithy, "before you opened the hanger door again. Let's get it over with!"

"I'm bumping into a lot of gadgets in TV sets these days," said Dick, immediately seizing Smithy's offer, "which are beginning to puzzle me a little."

"Such as?"

"Such as these," replied Dick, reaching for a service manual lying on his bench and indicating several symbols on the circuit.

"Oh, those!" commented Smithy carelessly. "There's nothing complicated about them, they're just v.d.r.'s."

"Come again?"

"They're just v.d.r.'s," repeated Smithy. "The abbreviation stands for voltage dependent resistors."

"Oh," said Dick doubtfully. "What do they do, then?"

"In general," replied Smithy, "they behave in rather the same manner as clamping devices. Although that is, perhaps, rather over-simplifying matters."

"I'll say it is," snorted Dick sarcastically. "I ask you what

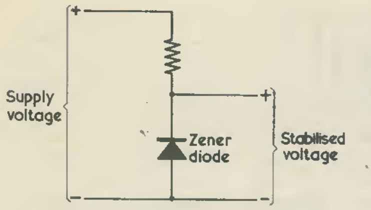


Fig. 1. Employing a zener diode to obtain a stabilised voltage. The voltage across the zener diode remains very nearly constant despite changes in supply voltage

voltage dependent resistors are for and all you say is that they're rather the same as clamping devices!"

"That's true enough," replied Smithy defensively.

"Very well, then," persisted Dick. "What are clamping devices?"

"That's easy," replied Smithy, entering another cross in his coupon. "A typical example of a clamping device is a zener diode."

"How on earth," continued Dick, an agonised frown creasing his forehead, "can a resistor function in a similar manner to a zener diode?"

Smithy pushed his coupon to one side.

"O.K. Dick," he chuckled, "I'll put you out of your misery!"

The Serviceman drew a notepad towards him.

"Let's commence," he said, "with zener diode. If we start right from basic, we can say that the zener voltage of a semiconductor diode is the voltage, in the reverse direction, at which the insulating properties of the semiconductor material break down. Once breakdown occurs, the voltage across the diode increases only slightly for increases in current and so the diode can be used as a voltage stabiliser or a voltage reference."

Smithy scribbled a circuit on his pad, after which he sketched out a graph.

"The zener diodes we use in practice," he resumed, "are silicon diodes specifically manufactured to do the job, and they can appear in a circuit such as this. (Fig. 1). The voltage-current graph for the diode normally looks something like this, (Fig. 2), in which the diode passes negligible current until the voltage approaches the zener region. Current then starts to flow and, after it's reached a certain level which may be around 2 to 10mA with most types of diode, the curve flattens off. As current increases above this point there is a slight increase in voltage, but this is very small when compared with the increase in current. So, provided the zener current flowing through the diode is sufficiently high to be on the flatter part of the characteristic, the diode makes a very useful voltage stabiliser. The maximum zener current you can pass is, of course, that specified by the manufacturer of the particular diode you're employing."

"Where," asked Dick, "does this clamping device business come in?"

"The zener diode," replied Smithy, " 'clamps' the voltage at the zener level. You would get the same effect if you had an ordinary diode in series with a battery. (Fig. 3). At input voltages which are smaller than the battery potential the diode does not conduct. If the input voltages are raised, the diode conducts and 'clamps' the output voltage at battery potential. Or, to be precise, very slightly above battery level. The ordinary diode and battery offers approximately the same result as the zener diode; provided, of course, that the polarities of the battery voltage and the input voltage are right way round. Incidentally, the diode in my last circuit can be called a 'clamping diode' when its function is to clamp input voltages at a predetermined level."

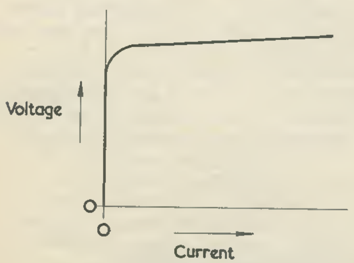


Fig. 2. The voltage-current characteristic of a typical zener diode

V.D.R. Curve

"Well," conceded Dick. "That explains the clamping bit. Where does the v.d.r. come in?"

"Ah!" replied Smithy. "Now, this is where things begin to get a bit more interesting! A voltage dependent resistor is a resistor whose resistance decreases as the voltage across it increases. The result is that it gives you a voltage-current curve something like this. (Fig. 4). When the voltage rises from zero so also does current, but the latter does not rise in a linear manner. As voltage increases, current increases by a disproportionately high amount; which is another way of saying that, as voltage increases, the resistance of the v.d.r. drops. Do you notice anything of interest in the curve I've just drawn?"

Dick screwed up his eyes and concentrated.

"Not for the moment," he confessed, "except that it bears out what you've been saying about resistance dropping with increase in voltage. Wait a minute, though!"

"Yes?"

"Isn't it," asked Dick hesitantly, "a little like the zener diode curve? It seems to have the same flattening-off effect."

"That," said Smithy approvingly, "is my boy! You're quite right about the similarity to the zener diode curve, and it is because of this flattening-off effect that you can start thinking about the v.d.r. as a clamping device. To get best results you have to operate the v.d.r. on the flatter part of its characteristic, and this is near the maximum current you can allow to flow through it. The maximum current is, of course, that which meets the maximum dissipation figures set by the manufacturer."

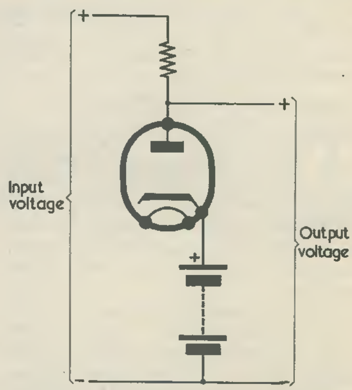


Fig. 3. Using a diode and battery as a clamping device. The output voltage remains slightly in excess of battery potential for all input voltages above that of the battery

"I can see," commented Dick, "the similarity with the zener diode quite clearly now."

"Good show," said Smithy. "Don't forget, however, that the v.d.r. does not offer by any means as flat a voltage-current characteristic as does the zener diode. Taking fairly typical figures, a v.d.r. intended to work at low voltage would have a potential across it of 5 volts at 1mA and about 18 volts at 50mA, whilst a typical zener diode could have a voltage across it of, say, 6 at 1mA and 6.4 at 50mA. Thus, the v.d.r. goes up in voltage by over 3 times for an increase in current of 50 times, whereas the zener diode only goes up in voltage by 6 or 7%. The higher voltage v.d.r's appear to be rather better in this respect, and a fairly typical result would be 40 volts at 0.1mA, and around 90 volts at 5mA. That's a change in voltage of slightly less than 2½ times for a current change of 50 times. Still not as good as a zener diode, but not bad."

"You used a different range of currents," objected Dick, "for the higher voltage v.d.r."

"Did I?" said Smithy absently. "That's probably because most of the high voltage v.d.r.'s we bump into in TV work pass lower currents."

"How high in voltage can v.d.r.'s go?"

"Before answering that," said Smithy, "I think I should mention that many v.d.r.'s are specified in terms of a reference voltage at a particular current. These voltages and current figures are fairly close to maximum dissipation and correspond to the flatter section of the voltage-current curve. Having introduced that point, I can add that the reference voltages for small v.d.r.'s of the type which would be mounted, say, on a printed circuit board may range from some 10 volts to more than 1,000. You can, incidentally, use v.d.r.'s at e.h.t. voltages also."

A Well-Known V.D.R.

"Blimey," said Dick impressed. "I've never heard of that before."

"Yes you have," contradicted Smithy. "What about our old friend, the Metrosil?"

"Is the Metrosil a voltage dependent resistor?"

"Of course it is," replied Smithy. "The particular units out of the Metrosil range that most of us who service TV sets have encountered are the Metrosil rods which connect between the final anode of the picture tube and chassis. (Fig. 5). Their function is to improve the regulation of the e.h.t. voltage applied to the tube. If e.h.t. voltage increases, the resistance of the Metrosil drops, and vice versa. And so the Metrosil counteracts excessive changes in e.h.t. voltage."

"Well, I'm dashed," exclaimed Dick. "We've been talking about v.d.r.'s all the time, and I never even thought about the Metrosil!"

"There we are, then," said Smithy soothingly. "Returning to the lower voltage v.d.r.'s, many of these appear in practical form with rather the same outline as a fixed resistor (Fig. 6 (*a*)). Alternatively, you may have a disc with lead-out wires coming from the centre on each side. (Fig. 6 (*b*))."

With an air that indicated the conversation was now closed, Smithy returned to his football pool coupon.

"Just a few more minutes," pleaded Dick. "We haven't even *started* on these v.d.r.'s yet."

"Let me finish this coupon off first," said Smithy. "If you want to make yourself useful you can get me a little more tea."

Obediently, Dick walked to the teapot and busied himself with the replenishment of Smithy's cup. His eye fell on the newcomer which now took pride of place alongside the Workshop sink.

"That saucepan," he announced on his return, "is a jolly good acquisition, you know."

The preoccupied Smithy gave a regal inclination of his head in acknowledgement.

"I really enjoyed my lunch today," continued Dick enthusiastically.

An avid look suddenly appeared in Smithy's eyes.

"What," he asked, "is it tomorrow?"

"Spaghetti."

"Good," said Smithy, with intense satisfaction.

He sat back and carefully examined his coupon.

"That should be all right," he announced. "I've only got one more cross to put in, and that's the one which has never failed to come up yet."

"Which cross is that?"

"The one," replied Smithy sardonically, "which you put against 'winning clients not wishing publicity'."

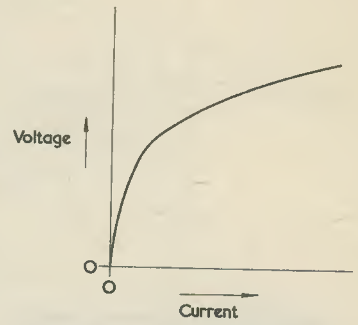


Fig. 4. The voltage-current curve of a voltage dependent resistor. The existence of a relatively flat top makes it fairly similar to the zener diode curve of Fig. 2

With a flourish, Smithy finished his coupon and quickly inserted it, together with the requisite postal order, into its envelope.

"Are you sure," asked Dick, "that that postal order is for enough money?"

"Of course it is," said Smithy. "I'm always very careful about things like that."

"Careful?" exclaimed Dick. "I'd say you were tight, myself. Blimey, it was only for 6d!"

"Quite enough, too," replied Smithy. "That's 24 lines at a farthing each."

"Is that *all* you spend on the pools, just 6d. a week?"

"Naturally."

"And *you're* grumbling about not winning anything."

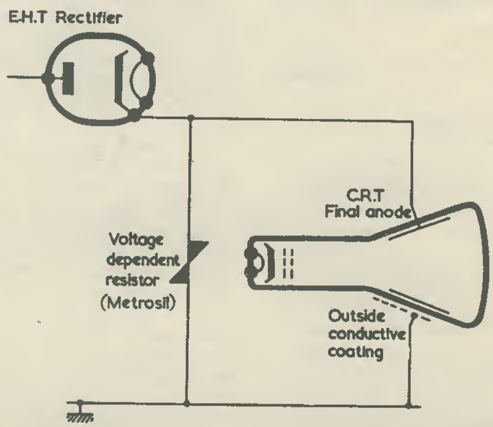


Fig. 5. Employing a Metrosil to improve the regulation of the e.h.t. voltage applied to the final anode of a c.r.t. (Metrosils are manufactured by Associated Electrical Industries Ltd.)

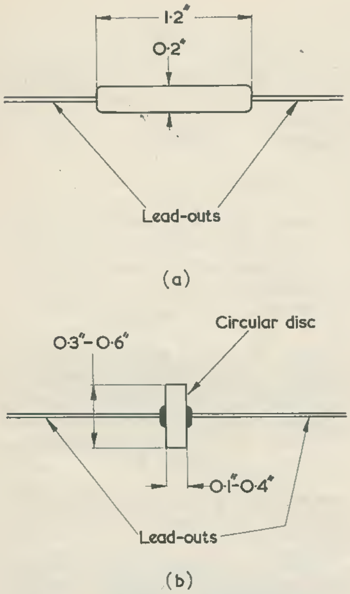


Fig. 6. Small voltage dependent resistors may appear in a similar form to normal resistors (a), or to disc ceramic capacitors with the leads protruding from the centre of the surfaces (b). The dimensions given here are representative and are only intended to give a general idea of size

"I don't," said Smithy guardedly, "do as well from the pools as I'd like. Anyway, have *you* ever won anything?"

"As a matter of fact," said Dick proudly, "I have. I got second dividend a couple of years ago."

"That sounds good," remarked Smithy, "How much did they pay out?"

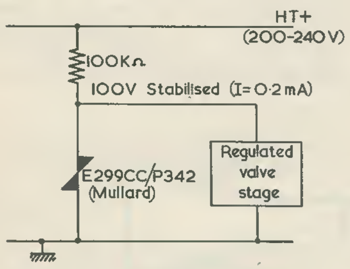


Fig. 7. An example showing the use of a v.d.r. to regulate the h.t. voltage fed to a stage in valve equipment. Despite variations in h.t. potential from 200 to 240 volts, the change in the potential applied to the valve stage is only of the order of 7 volts

"Eleven bob."

"Well," said Smithy. "It's encouraging, anyway."

"I suppose so," commented Dick moodily. "Anyway, how about getting back to these v.d.r.'s?"

"Righty-ho," said Smithy. "Let's return to what we were talking about before I mentioned the Metrosil. I said that, whilst a v.d.r. does not have as good a stabilising performance as the zener diode, it still offers a fairly flat voltage-current characteristic and that changes in voltage are of the order of 3 times for a current change of up to 50 times. A v.d.r. wouldn't, in consequence, be as good as a zener diode if it was necessary to provide a stabilised voltage over a wide range of currents. But it could, on the other hand, be very useful if the range of currents over which it had to stabilise was low. Also, the v.d.r. can operate at much higher voltages than can a zener diode or, for that matter, a neon stabiliser tube. To show the usefulness of the v.d.r. when the range of currents is low, let's take a fairly typical practical example. Let's assume that we have an h.t. line in a piece of valve equipment which is nominally at 240 volts but which, because of poor mains regulation, is liable to drop to 200 volts. We have a valve stage in the equipment which requires a fairly well regulated h.t. voltage around 100, and it draws a current of 0.2mA."

Smithy rose from his chair and walked over to the bookshelf, where he extracted Volume 5 of the Workshop copy of the *Mullard Technical Handbook*.

"We should," he said, as he turned over the sheets of the Handbook, "be able to find a v.d.r. in the Mullard range which should just about suit this particular little job. Ah, here we are! The Mullard E299CC/P342 v.d.r. has a reference voltage of 100 ± 20% at 1mA. This should suit us quite nicely."

He scribbled a further circuit on his notepad.

"We now use," he continued, "the same sort of circuit as we would have for a zener diode or a neon stabiliser." (Fig. 7).

"In other words," chipped in Dick, "this circuit is true, and only the values have been changed to protect the v.d.r."

Smithy winced.

"Dear, oh dear," he protested. "You've made me forget where I was, now!"

"100 volts," said Dick helpfully, "at 1mA."

"Oh yes," said Smithy, "and, of course, the regulated stage draws 0.2mA at this voltage as well. Since the h.t. voltage varies between 200 and 240 we can start from the centre figure of 220 volts and work out a suitable value for the dropping resistor, which may then pass 1.2mA. That's 1mA for the v.d.r. and 0.2mA for the valve stage."

"That's easy," said Dick promptly, as he drew Smithy's pad towards him, "R is E over I, and E is 220 minus 100. Which comes to 120 volts. So R is 120 divided by 1.2. And *that* is, let me see now, 100 ohms!"

"I'll give you 100 ohms," snorted Smithy. "The answer should be in kilohms!"

"Sorry, Smithy," said Dick contritely. "I forgot we were using milliamps!"

"All right, then," grunted Smithy. "Anyway, we've got a series resistor of 100kΩ. Next, let's find the current in the v.d.r. when the h.t. voltage is 200. Assume here that you've still got 100 volts across the v.d.r. and that the valve stage still draws 0.2mA."

"Fair enough," said Dick. "I suppose that what we should do here is find the current in the 100kΩ resistor and subtract 0.2mA from it."

"That's the idea."

"Right", said Dick confidently. "This time we've got 200 minus 100 across the 100kΩ resistor, which is 100 volts. Now, R is E over I, so that I is E over R, which means that. . . ."

"For crying out loud," snarled Smithy. "The answer is 1mA. I've never known anyone like you for going through this 'R is E over I' rigmarole."

"You've got," said Dick, reproachfully, "to start somewhere."

"You're still starting," retorted Smithy, "when everyone else has finished. At 200 volts h.t. we've got 1mA in the 100kΩ resistor, so the current in the v.d.r. is 0.8mA. We next see what happens at the 240 volt h.t. potential. In this case, and using our previous assumptions, the voltage across the 100kΩ resistor is 240 minus 100, which is 140."

Smithy raised an arresting finger as Dick proceeded to scribble industriously on the pad.

"Don't bother," he said. "The current in the resistor will be 1.4mA, which means that 1.2mA flows in the v.d.r. Now let's have a look at the voltage-current curve for the E299CC/P342 and see what voltages correspond to 1.2mA, which occurs with the 240 volt h.t. line, and to 0.8mA, which occurs with the 200 volt h.t. line."

Smithy turned the sheet in his Handbook.

"Ah, here we are," he said triumphantly. "A current of 1.2mA corresponds to about 104 volts, whilst a current of 0.8mA corresponds to about 97 volts. So, although the h.t. voltage has shifted by 40 volts, the change in voltage applied to the controlled stage is only of the order of 7 volts. And the v.d.r. which does this little trick for us is only about the same size as a small disc ceramic capacitor." (Fig. 8).

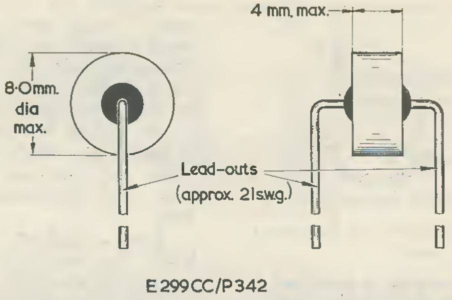


Fig. 8. The dimensions of the v.d.r. employed in the circuit of Fig. 7 (8mm=0.312in and 4mm=0.156in.). These dimensions and the data quoted in the text are taken from Mullard literature

Vertical Oscillator Stabilising

"That's neat," commented Dick, "that little v.d.r. certainly smooths out the voltage changes."

"It certainly does," agreed Smithy. "The figures we've just worked out are a wee bit approximate, because we assumed that the voltage across the v.d.r. was constant. And they don't, of course, allow for the tolerance on reference voltage for the v.d.r. Still, they *do* show the sort of regulation you're liable to get."

"I think I've got a circuit of the same type," said Dick, "in this service manual."

Dick stubbed his finger against a v.d.r. symbol on the dual-standard TV service sheet at his side. (Fig. 9).

"Ah, yes," said Smithy. "That's a pretty good example of a v.d.r. application. The stabilised stage in your circuit is in the vertical oscillator circuit. The amplitude of the vertical sawtooth provided by the triode and, hence, the height of the picture, varies in proportion to the applied h.t. voltage. This voltage is obtained from the boost supply and is regulated by the v.d.r. before application to the triode. Since the set is a dual-standard type the boosted h.t. voltage is liable to vary quite a bit as you switch the line output stage from 405 to 625 lines, and vice versa, but the v.d.r. prevents these changes from seriously affecting the voltage applied to the triode and, in consequence, the height of the picture."

Smithy paused for a moment.

"You may remember," he remarked, "that several months ago we were nattering about u.h.f. tuners, and I said that the low supply voltage required for these can be obtained with the aid of a zener diode.* I should now add that you can also obtain the low voltage with the aid of a v.d.r., by using a circuit like this."

Dick looked on as Smithy scribbled the circuit on his pad. (Fig. 10).

"What," he asked, "is the pre-set pot for?"

"Mainly to take up tolerances in the v.d.r. and series resistor," replied Smithy. "You set the pot up so that the requisite voltage is passed to the transistor circuits in the tuner. After setting up, the v.d.r. then maintains the voltage at a reasonably steady level."

"I see," said Dick. "Incidentally, I've noticed that v.d.r.'s are sometimes connected across the primaries of vertical output transformers."

"That's a common application," replied Smithy. "All they do there is to prevent excessive voltages appearing across the primary during flyback. The v.d.r. presents a high resistance at the relatively low voltages which occur during the scanning part of the cycle, and does not unduly affect operation here. On the other hand, it presents a low resistance at the high voltages which appear during flyback. Because of this, the flyback voltages are reduced in amplitude and the insulation requirements for the transformer are eased. Also—and this may be more important—the v.d.r. damps down any tendency for the vertical transformer primary to 'ring' at the resonant frequency provided by its own inductance and parallel strays. The latter effect could cause the first few lines after flyback to dance around a little."

"In this instance," remarked Dick,

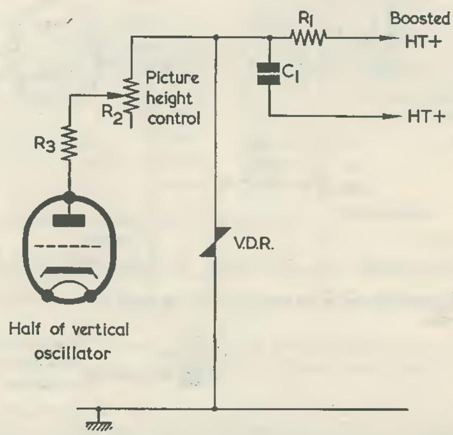


Fig. 9. A practical illustration, in which a v.d.r. is employed to stabilise the h.t. supply to a valve (the triode, which may be one-half of a multivibrator) in the vertical oscillator circuit of a television receiver. R_1 is of the order of 200kΩ; R_2, 1 to 2.5MΩ; and R_3 around 330kΩ. The decoupling capacitor, C_1, may be an electrolytic component of 1μF, and its negative plate is returned to h.t. positive rather than to chassis in order to reduce its working voltage

* "In Your Workshop", December, 1964 issue.

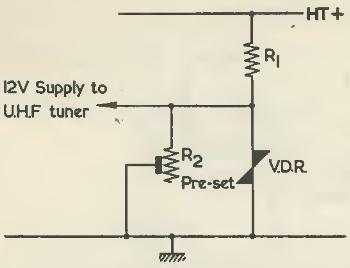


Fig. 10. Obtaining a stabilised 12 volt supply from the h.t. line of a television receiver for a transistorised u.h.f. tuner. Representative component values are R_1 10kΩ, and R_2 15kΩ

brightly, "the v.d.r. still functions as a clamping device."

"Oh, definitely," confirmed Smithy. "It offers a low resistance at a predetermined voltage level in the manner we've already discussed."

Line Output Stabilisation

"One thing that puzzles me," stated Dick, "is the fact that some sets seem to be using a v.d.r. for width control."

"Do you mean" queried Smithy, "that the v.d.r. is in the grid circuit of the line output valve?"

"That's right," confirmed Dick, "and it also couples to the width control."

"I know the type of circuit you mean," said Smithy, as he once more applied his pen to his notepad. "Basically, it's like this. (Fig. 11). As a matter of fact, circuits similar to this have been in use for quite a few years for e.h.t. regulation. It seems now that, in their present form, they provide width stabilisation for dual-standard sets as well."

"I am completely lost," confessed Dick, "in even trying to guess how the circuit works!"

"It's quite simple, really," said Smithy. "The important point to notice is that positive-going flyback pulses from the line output transformer are passed, via C_2 in my diagram, to the v.d.r. These pulses will, in practice, have an amplitude around 1 to 2kV or so. The v.d.r. fitted in the circuit reaches the flatter part of its voltage-current characteristic at about two-thirds of pulse amplitude, with the result, that, acting as a clamping device, it prevents the pulse tips from attaining any higher potential above chassis. Because of this, capacitor C_2 becomes charged such that the tips stay at clamping level. The waveform at the upper end of the v.d.r. then looks like this."

Smithy drew the waveform (Fig. 12 (*a*)).

"This waveform is applied to the grid of the line output valve via R_3," continued Smithy, "which, in collaboration with the relatively low impedance to chassis offered, via C_1, by the line drive circuits, causes it to be smoothed out to a steady voltage which is equal to the average voltage of the waveform. Now, the flyback peaks occupy a very small part of the overall waveform, with the result that the average voltage is quite close to the bottom part. It is, indeed, so close that it is negative of chassis."

Smithy drew another waveform on his note pad. (Fig. 12 (*b*)).

"Let's now see," he said, "what happens if the flyback peaks increase in amplitude, as I've shown in this second sketch. The first thing is that the positive pulse tips are held at the same position as before, because of clamping action of the v.d.r. So what happens?"

"If," said Dick, thoughfully, "the positive tips can't go any higher than the previous ones did, then I presume that the rest of the waveform must be displaced downwards."

"That's right," confirmed Smithy. "So?"

"Just a minute, Smithy," said Dick. "This needs a little cogitation. Ah yes, I've got it! If the rest of the waveform goes down, so also must the average voltage."

"Exactly," confirmed Smithy. "So you now have a circuit which causes the average voltage applied to the lower end of R_3 to go negative when the flyback pulses increase in amplitude. In the earlier versions of this particular v.d.r. circuit that was all that was of interest. If, due to any reason, the e.h.t. provided by the line output stage increased, so also did the flyback pulses applied to the v.d.r. The latter then caused an increased negative bias to be applied to the grid of the line output stage, thereby counteracting the increase in e.h.t. In our present circuit the device functions also to stabilise width, and it should be particularly useful in this respect with dual-standard sets where width might otherwise vary when switching from one standard to the other. An increase in width corresponds to an increase in flyback pulse amplitude and is thereby counteracted by an increased negative bias voltage from the v.d.r. You'll note that the width control, itself, is merely a potentiometer which applies a varying positive voltage via R_2 to the top end of the v.d.r. The potentiometer allows correct width to be achieved initially, and the v.d.r. circuit

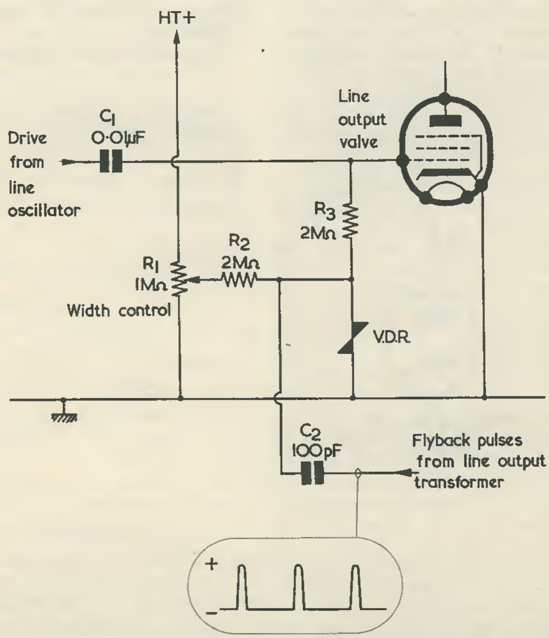


Fig. 11. A basic circuit, with representative component values, illustrating the use of a v.d.r. for picture width stabilisation

then stabilises it at that level."

Results Away

With an air of finality, Smithy pushed his notepad away and picked up the envelope containing his pools coupon.

"And that," he remarked, "is about all there is to say concerning v.d.r.'s for the moment. You don't happen to have the odd stamp on you, do you?"

Dick reluctantly drew a book of stamps from his pocket and passed one over to Smithy, who very carefully stuck it on to his envelope.

"Dash it all," grumbled Dick. "That's three stamps you owe me now."

"I'll pay you back," said Smithy, "out of my next winnings."

"Your *next* winnings? When did you last win?"

Smithy looked a little embarrassed at the direct question.

"Oh," he said, with an assumption of carelessness, "about a month or so ago."

"How much?"

"Only ten quid."

"*Only* ten quid, he says! How much did you win in the previous season?"

"All in all," said Smithy uncomfortably, "it must have come to about £30."

"And the season before?"

"Ah," said Smithy, "My luck was in then. I picked up around £65 or so!"

"You mean old devil," exploded Dick. "Here you've been winning fortunes on a sixpenny postal order each week *and* keeping quiet about it, and yet you're too stingy to even buy a stamp for the envelope. Do you know, Smithy, it's only my innate good breeding which prevents me from saying how much tighter than water-tight you are!"

"Don't be like that," retorted Smithy hotly. "After all, everyone has the same chance on the pools."

"Not with other people's stamps, they haven't."

Heaving a deep sigh, Smithy dug into his pocket and took out a handful of coins. He carefully counted out several of these and passed them over to Dick, who pocketed them immediately.

A thought crossed Smithy's mind.

"Whose turn," he asked belligerently, "was it to pay for today's baked beans?"

But we must draw a veil over the wrangle which followed this question. There is a widely-accepted meaning to the colloquial expression "not getting any change out of someone" but, if applied to Dick and Smithy, the phrase could have just as much the factual as the idiomatic interpretation!

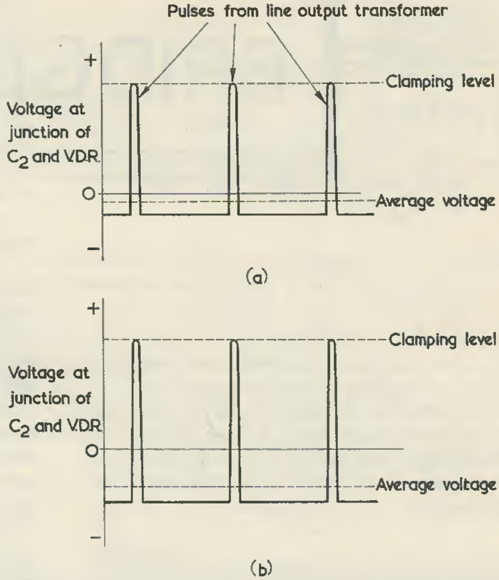


Fig. 12 (a). The v.d.r. of Fig. 11 holds the positive tips of the flyback pulses at clamping level. The average voltage of the waveform, at the junction of C_2 and the v.d.r., is then negative of chassis

(b). In this diagram the flyback pulses are longer, but their positive tips are still held at clamping level. The result is that the lower part of the waveform is displaced downwards and the average voltage goes negative. (Since the clamping effect offered by a v.d.r. is less abrupt than would be given by, say, a diode, the "clamping level" in (b) may in practice be slightly higher than in (a), but the small change will not affect the operation of the circuit)

New Miniature Bead Thermistors From Mullard Are More Robust And Have Greater Electrical Stability

As a result of improved manufacturing techniques new types of miniature bead thermistors announced by Mullard are more robust, have improved electrical stability and will work at a higher temperature than types previously available.

Four basic types are being offered, with resistance values (at 25° C) ranging from 1kΩ to 470kΩ. These consist of a basic encapsulated bead (VA3100 range) in three different mounting configurations; double-ended glass encapsulated (VA3200 range), glass-dipped (VA3400 range) and "thermometer type" mounting (VA3700 range).

The glass-dipped bead (VA3400 range) is a method of producing a thermistor which is more rugged, has a similar electrical performance and yet is only slightly larger than the naked bead.

Overall dimensions (excluding leads) are as follows:

VA3100	0.6mm dia. bead.
VA3200	10mm length x 2mm dia.
VA3400	1.5mm dia. bead.
VA3700	32mm length x 2.5mm dia.

Part Two

BRIDGE BUILDING

by **Craig Mackay**

The second of a series of four articles which deal, from a strictly practical viewpoint, with the design and construction of bridge networks

THIS MONTH WE SHALL CONSIDER THE VARIOUS methods of energising a bridge network.

If the bridge is intended purely for the measurement of resistance, then d.c. methods can be used. Generally, however, it is required to measure capacitance as well and possibly inductance, whereupon a.c. methods must be employed.

Frequency

It is important first to decide the frequency to be used.

The constructor will find that the sharpest indication of balance (null-point) is given when the bridge components are of a relatively low impedance.

Thus it might seem best to use a high frequency a.c. source because capacitive impedances are inversely proportional to the frequency of the alternating voltage applied across them, but we must not forget that, at these same high frequencies, the effect of small wiring capacitance becomes quite noticeable. Even the reactive component present in some resistors may become noticeable and tend to give incorrect readings.

Accordingly, it is usual to use a low frequency, between 50 c/s and 2,000 c/s, and sacrifice some of the sensitivity at the low capacitance end of the ranges.

Isolation

As was said last month, it is usually necessary to have the oscillator isolated from earth. The simplest and cheapest method of doing this is to use a transformer.

It is important to have a reasonably high voltage present across the bridge if good sensitivity is to be expected.

Sources

Probably the simplest method of energising an a.c. bridge is by employing a separate winding on the mains transformer.*

* When an a.c. energising supply is employed, care should be taken to ensure that stray capacitances to chassis are kept to a minimum. Their effect may be reduced by using twisted flex for source leads, as the individual leads will then have approximately the same stray capacitance to chassis.

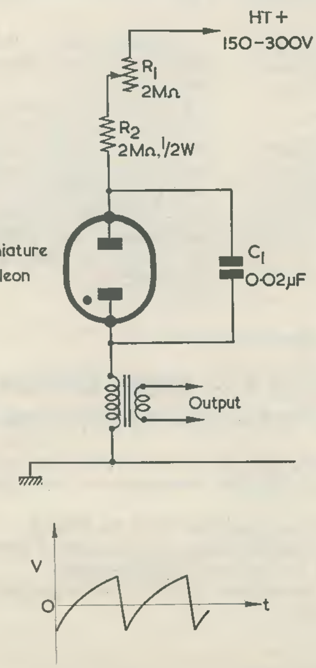


Fig. 9. A simple neon oscillator. The output transformer may have a ratio between 1:4 and 1:5

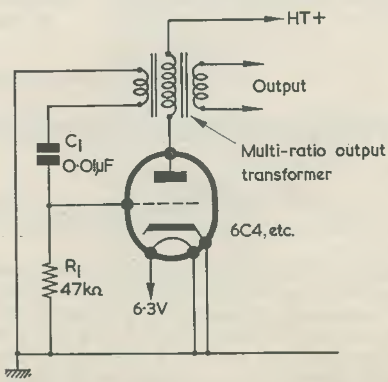


Fig. 10. A blocking oscillator. The manner in which a suitable transformer may be obtained is discussed in the text

If the final instrument is to employ valves and be run from the mains supply, it is essential that a good quality double-wound transformer be fitted to give the user the maximum possible protection. Such a transformer will have a 6.3V winding for the valve heater supply, and a winding for supplying the h.t. voltage. It is, therefore, comparatively easy to provide a third winding giving between 40 and 80 volts at some 20mA or, alternatively, to use say a 1:10 step-up transformer run from the 6.3V heater supply. A second, separate, mains transformer could also be used.

If high sensitivity is required on the lowest capacitance ranges, then it may be thought worthwhile to use a separate valve oscillator to supply the alternating voltage at a frequency higher than the mains frequency. There are a number of oscillator circuits which could meet this requirement, but it should be pointed out that the oscillator used must be capable of supplying a reasonable power to the bridge if the null-point is to be at all sharp.

All the following circuits are designed to operate at a frequency of approximately 1,000 c/s.

A simple neon oscillator circuit is given in Fig. 9. The neon shown here should not have any internal dropper resistor in its base. The capacitor C_1 across the neon charges up until the striking voltage of the neon is reached. The neon then becomes conductive, and the capacitor is quickly discharged until the voltage across the neon falls below extinguishing level. The process then repeats itself immediately. The output waveform is also shown in Fig. 9.

Fig. 10 gives the circuit of a simple single-valve blocking oscillator. This circuit makes a good a.c. source, and oscillates very easily. Almost any valve could be used. Fig. 10 shows a triode such as the 6C4, but a triode-connected pentode (EF91, EL91, EF80, etc.) could equally well be used.

The transformer in Fig. 10 is in no way critical, although trouble may be experienced in obtaining one which has three separate windings. A good and relatively inexpensive solution employed by the author has been to use a multi-ratio audio output transformer. The "speaker" connections are used for the grid winding. The main winding will be found to consist of a number of windings joined in series and, if the transformer is examined, it will be seen that these primary sections are joined at the tagstrip or terminals. If these wires are carefully unsoldered, it is a simple matter to isolate all the different windings, and various combinations of these windings in series can then be set up and tested for best results. Note that not all multi-ratio transformers are made in this way and that the component selected should be examined carefully before purchasing. If, when the circuit is initially set up it refuses to oscillate, then the two grid winding connections should be interchanged. The transformer can usually be heard "singing" in the same manner as the line output stage of a television receiver. The frequency of oscillation may be adjusted by changing the value of R_1 in Fig. 10, should the frequency be found to be too high or

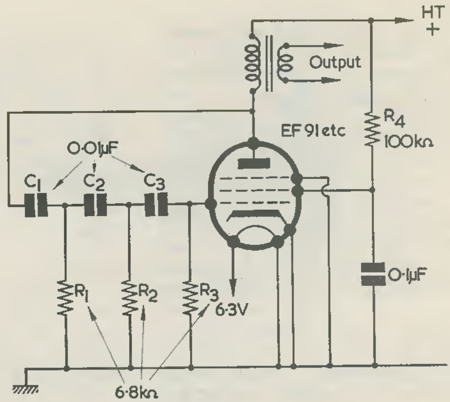


Fig. 11. A phase shift oscillator

too low. (A 100kΩ pre-set variable control could be fitted here until the desired frequency is found.)

Another useful oscillator circuit is shown in Fig. 11. This arrangement is the phase-shift oscillator

A simple two valve circuit is shown in Fig. 12, this having a multivibrator. The circuit of Fig. 12 provides a square wave output at about 1 kc/s.

If the constructor already has some type of a.f. source available in his workshop, then this could be used and save the expense of building a separate oscillator into the bridge.

Perhaps the best compromise consists of having the bridge energised from the mains, suitably stepped down (or from the 6.3 heater supply suitably stepped up by a separate transformer) with facilities provided for using an external oscillator if the null-point becomes indistinct when using mains frequency. This method is always used by the writer.

Coupling

Coupling the oscillator is not just a matter of connecting the transformer output winding across the bridge circuit.

It is important to include a limiting resistor in series with the winding in order to limit the maximum

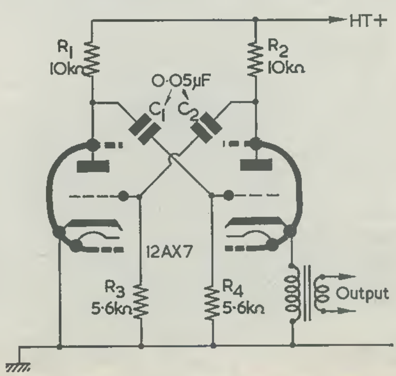


Fig. 12. A multivibrator

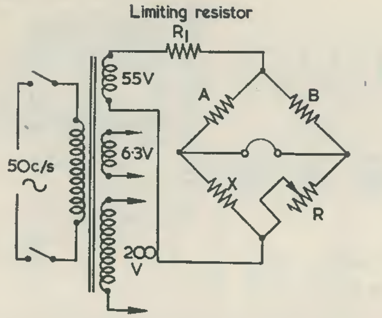


Fig. 13. Inserting a limiting resistor between the a.c. source and the bridge

current to a safe value, as determined by the dissipation ratings of the components in the bridge network.

Also, if the output from an oscillator is connected across a low impedance network, the damping produced in the oscillator circuit when excessive power is drawn could result in the circuit being unable to maintain the oscillations.

Fig. 13 shows how a limiting resistor, R_1, is added when the mains supply is the a.c. source. It will be immediately obvious that, when the bridge consists of low impedance components, the voltage across the bridge will be reduced. This does not generally, however, affect the sensitivity of the circuit.

When the bridge consists of high impedance components, R_1 has little effect on the voltage across the bridge, thus giving the maximum possible sensitivity.

In next month's article, the various methods of detecting the null-point will be examined.

(To be continued)

The New Dual-Standard TV Sets

PART 10

Gordon J. King

This article, the tenth in our series on 405–625 line receivers, examines the line timebase, carrying on to flywheel sync. Also discussed is the operation of a plug-in flywheel, sync unit, as fitted to current receivers

LAST MONTH WE SAW THAT the vertical timebase of a dual-standard model is the same as on both 405 and 625 lines, but that on 625 lines the radiated sync pulses may not be synchronised to the mains power frequency (asynchronous working). Extra-special attention is thus given to the h.t. smoothing of dual-standard models to avoid ripples on the picture which could otherwise arise from the low-frequency beat between the vertical sync pulses and the power frequency.

We also saw that switching over for the two standards is not needed in the vertical timebase, and that the sync pulses as applied to this timebase are similar on both standards, again without switching.

The Line Timebase

There are different problems entirely in the line timebase. Firstly, the repetition frequency of the line oscillator must be switchable from 10, 125 c/s on 405 lines to 15,625 c/s on 625 lines; and secondly, the line output stage must also be switchable in various ways to accommodate this frequency change in line drive. There are one or two other aspects with regard to line sync which we shall cover automatically as we progress through the line circuits.

Since a complete picture is composed of two interlaced fields on both standards, and since each field occupies one-fiftieth of a second with half the number of lines of a complete picture, it follows that on 405 lines the line repetition frequency must be 202.5 x 50, or 10,125 c/s, and on 625 lines 312.5 x 50, or 15,625 c/s.

This change in line repetition frequency is achieved by relatively simple switching in the line oscillator. A typical arrangement is revealed in Fig. 30. In this circuit V_{12} (the third valve along) acts as the line oscillator in blocking oscillator mode, with T_3 as the blocking oscillator transformer. It will be recalled that this type of line oscillator functions by reason of a capacitor charging through a resistor and then discharging over a controlled period by an oscillating valve. The oscillation is suppressed during the time of the charge and "turned on" for each discharge period. The oscillation is thus "blocked", hence the name of the arrangement.[1]

The blocking effect is controlled by a time-constant, and in the circuit under discussion the grid capacitor C_{134} and the associated grid circuit resistance (comprising R_{119}, R_{117} and the related potentiometers, P_8 and P_9) play a major rôle in this respect. The oscillatory feedback is between the control grid and the screen grid, the latter, in effect, acting as an anode. Thus, during the time of conduction of the valve, as the charging capacitor is charging, anode current rises through the anode load resistor and a sawtooth voltage appears across this component, as shown by waveform WF4.

Now, on 405 lines the resistance of the grid circuit is made up of R_{119}, R_{117}, P_9 and R_{116}, with P_9 allowing a variable adjustment of frequency to be made. The values are selected so that the oscillator works at 10,125 c/s with P_9 approximately at range centre. P_9 is thus the line hold control for the 405-line standard, and works in the usual manner.

[1] See, for instance, J. R. Davies, "Understanding Television"—Data Publications Ltd.—pages 195–201.

On 625 lines, however, SW3–5 changes over and the resistance in the grid circuit is given by R_{119}, P_8 and R_{116}. It will be seen that P_9 and R_{117} are deleted on this standard. Deleting R_{117} increases the line frequency by reducing the time-constant, and here the values are arranged so that the stage oscillates at 15,625 c/s when P_8 is set towards its centre of rotation.[2]

The value of this arrangement lies in the fact that the line lock can be at optimum on either standard independently, so that on changing from one standard to the other the need for line readjustment is avoided. Many dual standard receivers employ this technique, and incorporate separate 405 and 625 line hold controls.

A few sets, however, adopt a slightly modified arrangement, whereby a single control is featured. This is first adjusted for the best 405 lock and then, on the 625 standard and without changing the setting of the main line hold control, a second preset control is adjusted for optimum lock. Here, then, conditions are arranged so that optimum lock on both standards occurs at exactly the same setting on the main line hold control.

As a means of providing the required sawtooth amplitude from the anode of V_{12} over the two standards, switch $SW_{3\text{-}4}$ is arranged to parallel R_{121} with R_{120} on the "625" position. This, then, reduces the effective anode load from 100kΩ on 405 lines to 50kΩ on 625 lines. Similar switched correction may be found in models other than that under consideration.

Flywheel Sync

In 405 line fringe areas the need for flywheel controlled line sync has been felt, and many early 405 line models featured such circuits. The use of direct sync in areas of weak signal and interference tends to cause random horizontal displacement of picture elements from line to line. The line scan may be instigated a very small fraction of a second before the line sync pulse has risen to its full amplitude due to random noise and interference pulses, which have some of the characteristics of sync pulses.

This random "firing" of the line oscillator causes vertical parts of the picture to have ragged edges and leads to an impairment of definition.

Flywheel controlled line sync overcomes these problems because the line oscillator is given a "flywheel effect". That is, it continues to run at sync frequency for a short while even when line sync pulses are absent or when they become noise-laden or distorted. This is achieved either by the use of a

[2] As will be noted, P_8 and P_9 vary the positive potential applied to the grid resistor of the oscillator. They thus vary the time taken for the right-hand plate of C_{134} to reach cut-off voltage for the valve, and thereby provide a control of line frequency.—EDITOR.

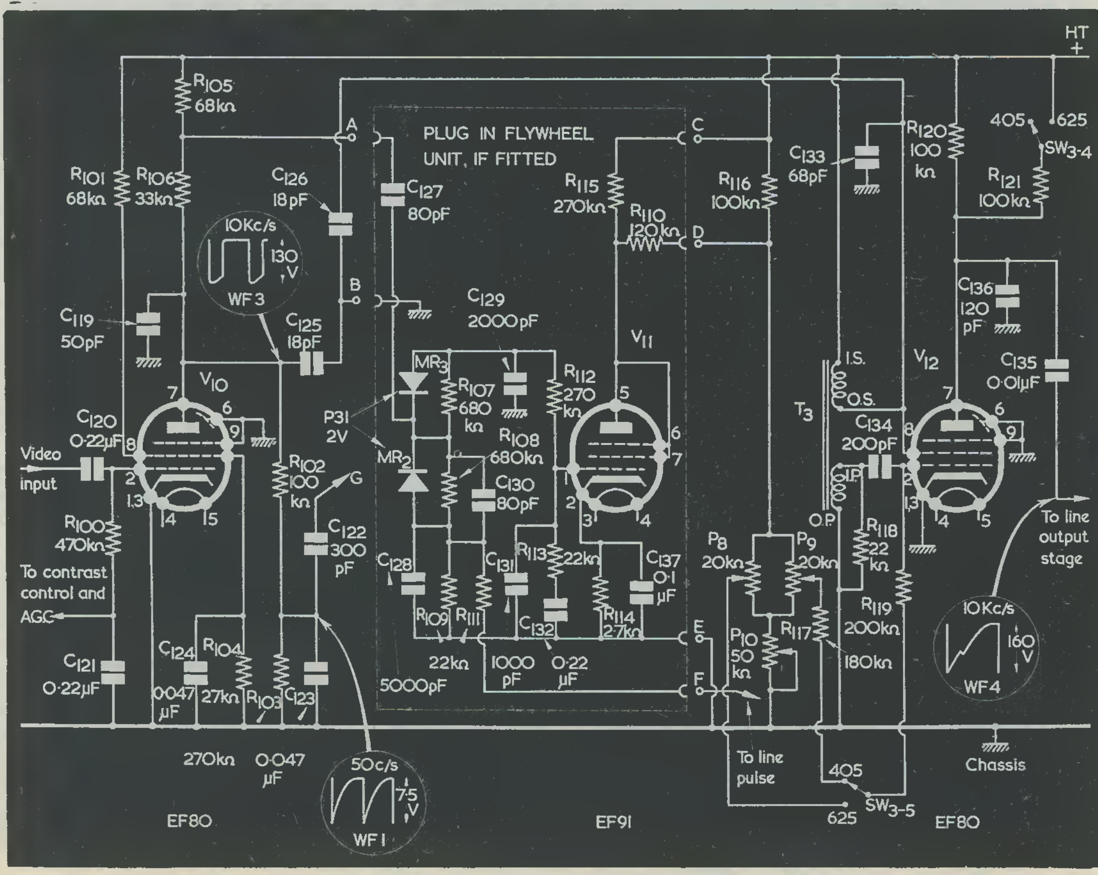


Fig. 30. This circuit section from a dual-standard set shows the sync separator, the flywheel controlled line sync and the line oscillator at valves V_{10}, V_{11} and V_{12} respectively

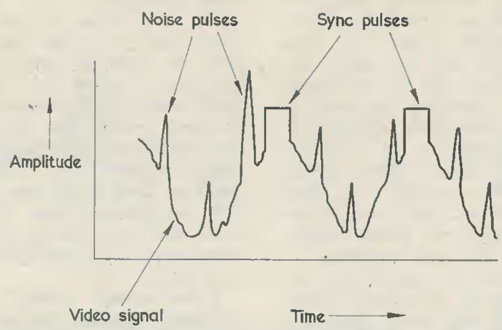


Fig. 31. As an interference pulse rises in a positive direction on the negative picture signal on the 625 line standard, the use of flywheel controlled line sync is desirable on this standard to avoid random "firing" of the line oscillator and consequent ragged vertical edges on the picture

tuned circuit or by a long time-constant control circuit. Most circuits operate by comparing the frequency of the sync pulses with that of the line oscillator in such a way that any deviation in frequency or phase produces a correction voltage which pulls the oscillator back into step with the sync pulses. A sort of "servo" arrangement!

Unfortunately, some of the early flywheel controlled line sync systems were somewhat touchy in practice. They tended to drift and they were not at all popular with service technicians. Eventually, as the TV signal over the country improved, they were almost all replaced by the direct sync arrangement, where the line sync pulses are fed direct to the line oscillator. Direct sync is shown in Fig. 30 in the section where C_{126} (from the anode of the sync separator valve, V_{10}) couples to the line oscillator.

Once again, the need for flywheel controlled line sync has cropped up, this time on the 625 standard. In Part 1 of this series[3] it was shown that on 625 lines the sync pulses correspond to almost 100% modulation. This means that any random noise or interference will rise from the vision waveform in the same direction as the sync pulses. See Fig. 31.

This is a dangerous situation, since it means that the line oscillator could mistake the noise pulses for sync pulses and "fire" irregularly or at the wrong time, thereby giving an exaggerated effect of ragged verticals or loss of line lock.

For this reason, then, dual-standard sets invariably embody flywheel controlled line sync either on the 625 standard only or on both standards. Some models have provision for the insertion of a flywheel controlled line sync unit as and when required.

The use of v.h.f. signals at the higher line scanning speed also aggravates the effect of noise in the line sync circuits. Noise, as distinct from interference, arises more on the u.h.f. channels because the noise content due to signal amplification increases with increasing frequency. To some extent (up to about 6dB) this is counteracted by the use of transistors in the u.h.f. tuner instead of valves.

Flywheel Unit

The circuit in Fig. 30 shows an inset circuit of a plug-in flywheel unit. When this is inserted in the chassis the direct sync feed is shorted to "earth" by connection B and instead, the sync pulses from the separator, V_{10}, are applied via connection A to a double-rectifier (using two rectifiers, MR_2 and MR_3) discriminator circuit. This discriminator also receives pulses from the line timebase via connection F (with connection E giving the "earth" return).

The design is such that when the sync pulses and timebase pulses are in step there is zero output across the discriminator. However, when there is a tendency for the timebase to run away from sync pulse frequency a voltage appears across the discriminator, the polarity of this depending upon whether the timebase is tending to run too fast or too slow. This voltage is applied to the control grid of the d.c. amplifier, V_{11}.

The anode of this amplifier picks up its h.t. voltage from connection C, while connection D is applied to the line hold control circuit of the oscillator. Under the condition of correct line lock the voltage at connection D is at a nominal value such that the hold controls can be set for optimum line lock. Should the oscillator frequency tend to wander, the voltage at connection D will either rise or fall, depending upon whether the oscillator is tending to veer on the fast or slow side.

This voltage, applied to the line hold control circuit of the oscillator, alters the oscillator frequency such as to bring it back into step with the sync pulses.

Note that the control voltage from the discriminator is applied to the control grid of the amplifier valve across an RC circuit of relatively long time-constant. This means that the control voltage is very little affected by noise pulses and that, once the control voltage for the correct line speed has been established, the oscillator will run at the correct frequency for a little while after the removal of the line sync pulses from the discriminator. The result is that noise and interference on the signal fail to have any significant effect on the timing of the oscillator.

There are several other ways of achieving the required end-result. A popular method makes use of a reactance valve. This is connected in parallel across the line oscillator tuning, and its virtual capacitance (or inductance) is caused to change so as to hold the oscillator in step with the sync pulses by the discriminator-derived control voltage. The discriminator may be after the style of that in Fig. 30.

In all flywheel systems a correction or control voltage is produced, usually by a discriminator, and this is fed either to the oscillator (as in Fig. 30) or to some other circuit which itself is capable of changing the speed of the line oscillator, so as to bring it into step with the sync pulses, and hold it there.

Sync Separator

The dual-standard sync separator is little different from its 405-only counterpart. In Fig. 30, V_{10} represents a conventional pentode sync separator. The way that this works both in terms of separating the sync pulses from the composite video signal and in producing a vision a.g.c. potential was fully detailed in Part 5 of this series.[4]

It will be seen that V_{10} produces both line and vertical sync pulses

[3] Published in the May, 1964, issue.

[4] Published in the September, 1964, issue.

(waveforms WF3 and WF1 respectively) the vertical pulses being fed to the frame interlace filter and thence to the vertical oscillator at output G.

Owing to the positive-going interference on the negative 625-line video signal (Fig. 31), noise and interference cancelling sync circuits are sometimes employed in the modern sets, but as we are now out of space we shall have to leave the description of these circuits until next month.

(To be continued)

Guide to Better Tape Recording

By Alan Ford

Has your tape recorder fallen into disuse now that the initial enthusiasm after purchase has died away? Or are you thinking of buying a new instrument? This article gives some general common-sense advice which applies to both instances, and it will help you to get maximum value from this fascinating hobby

A CONSIDERABLE TIME AGO THE POINT WAS reached when nearly every home had at least one sound receiver; similarly it is now the exception to find a household without a television set. Today the instrument showing every sign of following suit is the tape recorder. The shops are crammed with various models and both recorders and accessories are widely advertised. But although there is undoubtedly a steadily increasing sale of these instruments, the peculiar thing is that so few are *in use*!

In other words, Dad or Mum or the teenage sons and daughters eagerly make the down-payment, dash home, and play with the new toy for about a fortnight. They hear their own voices, which they nearly always don't like—and insist don't sound like that, other people's voices—which they insist *do* sound like that, baby saying "gug-gug-gug", and a few bars of pop music from the radio interspersed with Grandad coughing. Then the novelty wears off. The recorder, already covered with cigarette ash, and well out of adjustment after being played with by every child in the house and some from next door, is put behind the sofa or in the cupboard under the stairs and forgotten.

A Precision Instrument

A tape recorder is—or should be—a precision instrument which is flexible in application and capable of a very high standard of reproduction. It deserves to be used and maintained as carefully as any musical instrument, and in the same way that any true craftsman will care for his tools. The suggestions in this article are intended for both the owner whose machine now lies sadly idle and the prospective owner who wishes to make the fullest use of his recorder from the start.

Assuming that you already have a tape recorder, it is as well to be aware first of its limitations. Obviously you will not achieve recording-studio quality with a twenty-five guinea model, whatever the advertisements may say. However, unless you have one of the very cheapest machines, designed primarily for dictation, it should be possible to obtain pleasing results. If you are fortunate enough to have a semi-professional model, so much the better.

In any case, the first thing to do is to read the handbook again, carefully. Any tape recorder worth buying is supplied with some sort of handbook. The better the instrument, the more comprehensive the handbook will tend to be. Even if you've been using your machine for months you may be surprised how little you know of its possibilities. If you are technically minded, try to obtain the service manual as well. Even if you don't feel up to meddling with the electronics of the machine,

the service manual will give all sorts of information about lubrication points and general maintenance. These preliminaries are directed towards really getting to know your machine, for only then can you make the best use of it.

Buying a Recorder

Now for the matter of purchasing a new tape recorder. You will naturally want to spend as much as possible in order to equip yourself with a good machine, but beware, because price is not always a guide to quality. It is quite surprising how much you can pay for an instrument which may not in many respects be as good as a cheaper counterpart. However, as a very rough guide, an instrument of the semi-professional type would not normally cost less than sixty guineas. Incidentally, the buying of a second-hand machine can be a very tricky business, and it is not wise to contemplate such a move unless your technical know-how and facilities are up to it.

In buying a new recorder, and bearing in mind of course the amount of money you have available, here are some points to watch for:

(1) For serious recording a signal level meter is necessary; the magic eye type of indicator is not nearly so precise.

(2) The amplifier should have separate bass and treble controls.

(3) A built in mixer—i.e. two gain controls is a useful feature.

(4) Although an external speaker may be used for playback, the internal speaker should be of a reasonable size.

(5) A choice of tape speeds is useful though not essential.

(6) The deck should have a rapid rewind and wind-on without any kinking or spilling of the tape.

(7) There should be some sort of cueing indicator of the digital or clock type—a scale printed along the surface of the deck is not sufficiently accurate.

(8) Most tape decks have a "pause" control, and some have an arrangement for "inching" the tape, so that an exact spot may be found with ease.

(9) Take a look underneath the deck, if possible There should be three motors, but even if one motor is used for both feed and takeup spools, a separate one for the capstan is essential.

(10) There should be a reasonably heavy flywheel on the capstan spindle.

Lastly, the general impression conveyed on inspecting the tape deck should be one of solidity. Pay no attention to flashy trimmings. A somewhat austere appearance combined with a sturdy construction is usually the sign of a better piece of engineering. Naturally, the writer would like to be able to list machines that he has found good or bad value, bearing in mind the above points, but for obvious reasons this cannot be done. The only way in which the novice may further safeguard himself against buying an unsuitable machine is to join one of the many excellent tape recording clubs, where he will find no shortage of members willing to praise or condemn instruments they have handled.

Having finally bought your recorder, you will naturally be impatient to see how it performs, but take the time to read the handbook through at least once.

Before you can get the best out of the instrument, whether it is a new purchase or just reclaimed from behind the sofa, you will need practice. So the first thing to do is to take the reel of tape supplied and to try everything mentioned in the handbook. Record your own voice, noises like the wife washing up, the dog barking. Try the different speeds, different settings of the gain control, various positions of the microphone. Make recordings in several rooms—the acoustics will be found to vary amazingly. Try some outdoor recording—place the microphone on the window-sill and see if you can capture some birdsong or the clatter of a dustbin lid. When you have filled your tape with these various sounds, sit back in a quiet room with the handbook, and listen. Try the effect of erasing a tiny portion of the recording, or putting one sound on top of another if the recorder has this facility. In other words, experiment. After a few sessions of this kind you will become thoroughly familiar with your recorder and in a position to make some excellent recordings.

Microphones

Very often the microphone supplied with a recorder does not do it justice, or, in the case of some models, one is not supplied but must be bought separately. In this case a short discussion of various microphone characteristics may be helpful.

The most common types of microphone in general use for recording work are the crystal and dynamic. Crystal microphones are very variable in price and quality, but they have one general characteristic and that is their high output. Thus (if amplification is limited) they are very suitable for low intensity sounds such as birdsong. At their best they are capable of good quality music reproduction, where one pays accordingly. Finally they are of high impedance, which means they will match directly into most recorders.

The dynamic (or moving-coil) microphone generally gives a lower output but is capable of higher quality. Some of these models are of low impedance, which means that a matching transformer will normally be necessary, but this also allows much longer leads without the danger of hum pick-up.

Coming now to the higher priced professional types, which are pointless unless your recorder is of very high quality, we have the ribbon and capacitor varieties. Both are capable of excellent quality but they are convenient for indoor use only. In the case of the ribbon microphone, a thin corrugated aluminium foil is suspended between the poles of a powerful magnet. This foil is so delicate that a gust of wind could cause permanent damage, but indoors, where there is no danger of this, its excellent frequency response makes it the most widely used professional type. The capacitor microphone is probably the highest quality of all, but its one big disadvantage is that it needs a power unit, and is therefore inconvenient for outdoor use.

Taking the above details into consideration, the choice for serious amateur recording is likely to be either the crystal or dynamic microphone. At least one of the well known types can be supplied with a complete range of accessories such as stands, a parabolic reflector for distant work, and a variety of leads and connectors. The connectors and various soldered joints in microphone leads are important as they can be a source of unwanted noise, feeding as they do into sensitive amplifiers. Microphone leads are always screened with copper braiding to prevent the pick-up of mains hum.

Making a Studio

Recording live, that is through a microphone, is the most exacting use of a recording machine. If you wish to record a talk or perhaps rehearse a musical group, you will need a spare room which you can modify for use as a studio. A live recording taken in an ordinary room is seldom successful. There may be the sound of the clock ticking, a fire crackling, and an echo which you hadn't noticed before. Most rooms have an echo, but because we are used to this we do not consciously notice it. However, even a small echo can be quite enough to ruin a recording.

If you are lucky, and have an unused room available as a recording den, the cheapest way in which you can tackle the problem of echo, and at the same time make the room soundproof, is by the use of papier-mâché egg trays! The grocer will be only too willing to put these aside, as they are not returnable. About a foot square, and made of a soft sound-absorbing material, these trays are ideal Glue them to the walls, the ceiling and the door. A hardboard shutter to put over the window should be made, and treated similarly. The floor should be covered from wall to wall with carpet. Any old scraps will do, providing the result is thick. The furniture in the room should be the minimum. Since it is unlikely that you will be able to use an adjacent room as the recording booth, and fit a partitioning window, you will need a table in your studio for the recorder. The microphone must be as far away from this as possible to avoid picking up even the faint hiss of the tape running past the guides and heads. If the microphone is mounted on a table, this should be covered with felt or thick baize.

If you have done the sound-damping job well, the effect on entering should be one of claustrophobia. Try blindfolding a friend and leading him in, asking him to guess there he is. If after a word or two he doesn't think he's in the linen cupboard, you haven't finished! By the way, this will serve to emphasise just how much echo there is in a normal room; the absence of any reverberation in the studio produces a striking effect of being in a tiny cupboard.

Where there is no separate room available, for this treatment, the best possible use will have to be made of a living room or, perhaps, bedroom. In this case, draw the curtains, remove the clock, and if you have a folding screen, stand it about a foot away from the barest wall. In this way you will reduce echo and unwanted noise at least to some extent.

Naturally, for recordings of day-to-day events, a natural background is best. Items such as tea being poured, someone writing a letter, coal being put on the fire—such sound pictures as these should be recorded in their context and not in a studio.

Splicing Tape

One of the most convenient points about magnetic recording is that the tape can be spliced. By this means sounds can be removed, inserted, arranged in a different order, or even shortened. There are many excellent splicing kits available, complete with spools of coloured leader tape. Again, experiment is the best way to learn. Try recording a short speech, and then inching the tape past the playback head word by word. The words will, of course, be reproduced at a low pitch and very slowly, but the gaps between them will be quite clear. Using your splicer, cut off each word, and lay out the pieces of tape on a table. With a little thought you should be able to reshuffle the pieces of tape so that, when joined again, the resulting speech means something entirely different or is rubbish. The voice will be the same and may even sound natural but the text of the speech will be altered. This can be an amusing game, but one can see why tape recorded evidence is not accepted in British law courts!

Splicing should not be a matter of guesswork. For serious work you need a ruler and a stopwatch. If the tape speed is 7½in per second, a sound taking one second will occupy exactly 7½in of tape. Thus it is possible to be very accurate. For instance, a wrong note could be cut out of a musical recital, recorded again by itself and reinserted.

Very often one's interest in recording palls for the most absurd reason—namely that there is only one reel of tape! It seems a pity to erase interesting sounds through pure lack of space on the tape. The obvious solution is to build a tape library. Start with half a dozen reels and add to this number when possible. Store the tapes on a bookshelf or rack of some kind—a dish-drying rack is admirable. Keep a list of recordings, and if you are an experimenter note such details as equipment used, position of microphone, and so on. For those whose main interest is recording music, a gradually increasing collection of works will rapidly become a very much admired possession.

A few months after starting to record seriously, the writer found he had collected a number of oddments which need to be carried around with the recorder when used away from home. These include: a long mains lead which terminates in a three-pin connector, and a variety of mains plugs

—in fact *all* the British types —each fitted on about six inches of cable to a mating connector, thus enabling instant connection to any point; a number of "patch" leads for connecting between recorders, mixers, radio, etc; a splicing kit and various empty spools. It was found convenient to construct a case, to match the recorder, and store in it these items, together with microphones and stands.

An Absorbing Hobby

Tape recording can be an absorbing hobby with many variations. As a reproducer of music—perhaps from pre-recorded tapes, an instrument of correspondence, a critical ear by which to rehearse drama or music, an addition to cine photography, a record of momentous events . . . the tape recorder is a most flexible piece of apparatus.

Whatever your approach to this fascinating hobby you will be immensely helped and encouraged by joining the local tape recording club, where you will find many who share your problems and enthusiasms.

RADIO TOPICS . . .

by Recorder

UNCONVENTIONAL METHODS OF presenting information are always of interest and in my case the interest becomes considerably enhanced if the subject dealt with has to do with electronics. It was, therefore, with two-fold eagerness that I examined the new Mullard publication, *A Programmed Book on Semiconductor Devices.*

This publication is described as a "linear programmed instruction book", and it is based on *A Simple Explanation of Semiconductor Devices*, previously published by the Mullard Educational Service. *A Programmed Book on Semiconductor Devices* is believed to be the first of its kind published by an industrial organisation, and it was prepared for Mullard Educational Service by Educational Systems Limited of Ruislip, Middlesex.

Programmed Information

I should imagine that quite a few readers will, by now, be scratching their heads and wondering what on earth a "linear programmed instruction book" is. I, similarly, scratched my head, until I opened the Mullard book and started to use it.

A linear programmed text offers a new method of learning which is designed to let the reader participate to a very large extent, which can be studied at the reader's most suitable speed, and which is intended to make learning as easy as possible. The idea is to take the reader through individual steps in the description of the subject, each step requiring a written response. The written response necessitates a little (but quite painless) thought on the part of the reader and it means that, before he can proceed to the next step, he must convince himself that he has mastered the current one. The written responses are very simple, and they follow so obviously from what has gone before that the reader can never feel that something which is basically unexplained is being foisted on to him. The necessity of thought in writing the responses also ensures that the reader does not fall into the glazed-eye state which we must all have experienced at one time or another when working our way through a standard text-book. The act of participation makes the reader an active, instead of a passive partner in the business of acquiring information. There is the further fact that, with many people, the act of writing causes a fact to be committed far more permanently to the memory than occurs when merely reading or listening to the information.

This last paragraph mainly defines my own reaction to programmed learning after seeing it employed in the Mullard book, and it will probably also demonstrate how impressed I am by its possibilities. In the book itself, programmed instruction is described in more restrained terms, it being stated that programming involves breaking down the subject into small units called "frames", each of which requires a written response from the reader. The correct answer appears, incidentally, alongside each frame in the right-hand margin, and there is no necessity to turn to the back of the book or anything like that. Because it is difficult for some people, myself included, to avoid "seeing" the answer whilst concentrating on the text, the latter can be read with the aid of a specially-shaped cardboard mask which covers the correct answers until the associated line has been read and dealt with. Such a mask is provided with *A Programmed Book on Semiconductor Devices*. Also provided is a Colour Supplement which gives 24 diagrams in colour and which may be consulted whilst reading the text.

As an example of the technique, let's take a look at frames 77, 78 and 79 in Chapter Two—"The Transistor". After frame 76, the first in the chapter, has introduced us to the term "junction transistor" and the appropriate diagram in the Supplement, we have:

"77. The junction transistor consists of ....(how many?) regions of........................arranged in the sandwich form........................

"78. There are..................(how many?) external connections. You can see in the diagram that one is soldered to the emitter, one to the b........................ and one to the........................

"79. Each connection is placed on one of the impurity regions, the b........................ being in the middle."

The model answers, in the right-hand margin at the same level as the required written entries are, respectively, "three, germanium, p.n.p., three, base, collector, base." (The "p.n.p." refers to the type of transistor shown in the appropriate diagram.) Frames 77 and 78 require three answers, but most of the other frames in the book require only one or two.

I tried the text myself, working through the frames as instructed, and I was quite fascinated with the manner in which each new point was introduced and put over. There is a test at the end of the book which is intended to reinforce what has already been learned. This test could also be attempted before starting the book, as it will then give the reader an idea of what he already knows about semiconductors.

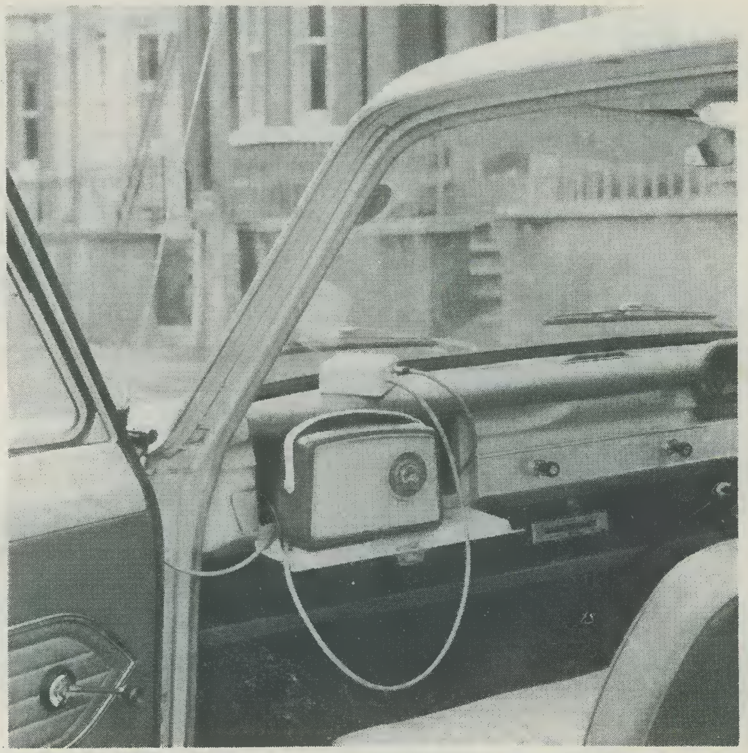
A Programmed Book on Semiconductor Devices is available, complete with its Supplement, from the Mullard Educational Service, Mullard House, Torrington Place, London, W.C.1, at a price of 3s. 6d., plus 6d.

postage. If you are a beginner and want to learn more about the basic functioning of semiconductor devices, I would say that the 3s. 6d. would be money well spent. Even if you know everything there is to know about semiconductor devices, an outlay of 3s. 6d. is still, in my opinion, worthwhile in order to gain experience in this new method of teaching by way of the written word.

New Addresses

Electronic Tubes Ltd. inform us of a change of address to Suffolk Works, 313 London Road, High Wycombe, Bucks. This new address is for service replacements of Marconi Valves and Emiscope cathode ray tubes.

Also moving into new premises, shortly, are the London headquarters of Standard Telephones and Cables Ltd. The office block being built in the Strand opposite St. Clement Danes—the Wren church famous for its "Oranges and Lemons" chimes and now the official church of the Royal Air Force—is to be the new H.Q. This new ten-storey building, to be completed in early 1965, will be air-conditioned and will be known as "S.T.C. House". Standard Telephones and Cables have expanded their business, including exports, by over 70 per cent in the past three years, and their present offices in Aldwych and Aldersgate have now become totally inadequate as a result.



The "King Karad" booster in use with a car aerial and transistor radio. This little device, which is shown here above the radio, offers a minimum of 20dB amplification without tuning over the entire medium and long wave bands, together with correctly designed matching to both the aerial and the receiver

Car Aerial Booster

My photograph this month shows the new "King Karad" car aerial booster and matching unit in action. This is the small device (measurements are $3\frac{1}{2}$ x $3\frac{1}{2}$ x 2in) which appears above the transistor radio, and it is claimed to be the first of its type in the world.

One of the two functions of the "King Karad" booster is to provide for transistor radios used in cars aerial amplification over the entire medium and long wave bands without any tuning adjustment whatsoever. The second function is to offer properly designed impedance matching both to the car aerial and to the transistor receiver. The result is that received signals turn the receiver a.g.c. hard on, whereupon the set gives a much improved performance and is far less responsive to ignition interference inside the car. With the booster in circuit there is negligible pick-up by the receiver ferrite aerial. Instead, there is high-level pick-up on the aerial outside the car, which is, of course, exactly what is required. As readers who have had experience with transistor radios in cars may agree, coupling the high impedance offered by a car aerial directly to the few turns of wire fitted on a transistor radio's ferrite rod can hardly be considered as the dictionary definition of the word "match". The input circuit of the "King Karad" booster is designed to offer a good match to even the simplest of car aerials, and its output circuit is similarly designed to match into the aerial socket input impedance of the transistor radio.

The booster employs a single-stage transistor amplifier in the common emitter mode with controlled feedback to obtain the required input and output impedances. The bandwidth is from 100 kc/s (3,000 metres) to 2,000 kc/s (150 metres), with a minimum gain of 20dB. The useful response is up to 3 Mc/s and models can be supplied to special order with a response up to 4 Mc/s.

The amplifier is built on a small printed circuit board and uses a Mullard OC45. An OC171 can be fitted when the extended response is required. A 9-volt PP4 battery supplies power, and has a life of several months. In use, the car aerial is simply plugged into the booster, whose output is then plugged into the transistor radio.

The retail price of the "King Karad" booster is 50s., and it is manufactured by Transistor Devices Limited, New Road, Brixham, Devon.

"Insulating Tape Effect"

Finally, a little bit of (quite useless) information about static electricity which may be of interest to the newcomer.

Take a roll of ordinary black insulating tape—the old-fashioned variety which is supposed to be sticky on one side but which, in practice, is pretty sticky on the other side, too—and, in a dark room, sharply peel the tape off the roll. If the tape is dry enough you will see a line of surprisingly vivid green light at the point where the tape leaves the roll. This only works when new tape is unrolled; putting the tape back on to the roll again and trying to get the green light a second time produces no results. The green light is caused by static electricity.

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continued on page 503

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continued from page 501

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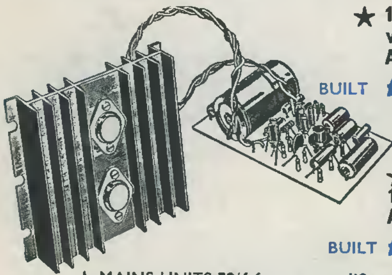

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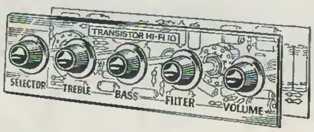

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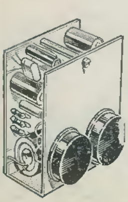

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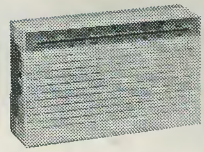

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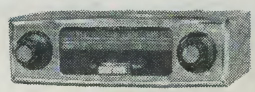

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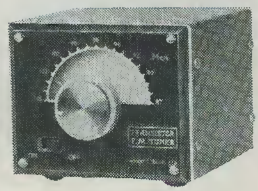

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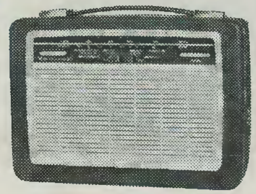

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