THE **Radio Constructor**

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 17 NUMBER 6
A DATA PUBLICATION
PRICE TWO SHILLINGS

January 1964

TRANSISTORISED HOME-BUILT CLOSED CIRCUIT TELEVISION

Fixed Frequency Audio Oscillator • "Veronica" 2-Transistor Receiver

Two Fine Receivers

RADIO PRODUCTS
EDDYSTONE
TRADE MARK

THE EDDYSTONE '840c'

The Eddystone "840c" is an [illegible] a pleasing two-tone grey finish lead to a most [illegible]
List price £62. [illegible]

THE EDDYSTONE '940'

The Eddystone "940" is a larger and more elaborate communications receiver, with a correspondingly better performance. It has two fully tuned radio frequency stages and two intermediate frequency stages; variable selectivity with a crystal filter; built-in carrier level meter and push-pull output stage. Sensitivity is very high and outstanding results can be expected. Workmanship, construction and finish are all to the usual high Eddystone standards. Styling is modern, with two-tone grey finish.
List price £125. 0s. 0d.

THERE'S AN
EDDYSTONE
COMMUNICATIONS RECEIVER
FOR ANY FREQUENCY
BETWEEN
10 kc/s and 1,000 M/cs

Please write for full Technical Specifications to the Manufacturers

STRATTON & CO. LTD., BIRMINGHAM, 31

LASKY'S RADIO

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.

LASKY'S FIRST AGAIN!

NOW OFFER TO THE HOME CONSTRUCTOR, FULL SHORT WAVE COVERAGE

THE SKYROVER AND THE "SKYROVER" DE LUXE

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

SPECIFICATION: Superhet, 470 kc/s. All Mullard Transistors and diode. Uses 4-U2 batteries. 5" Ceramic Magnet P.M Speaker. Easy to read Dial Scale. Band Spread Tuning. 500mW Output. Telescopic Aerial and Ferrite Rod Aerial.

WAVEBAND COVERAGE. 180–576M, 31–94M, and Band Spread on 13, 16, 19 and 25 metre Bands.

Can be built for **£10.19.6** *P. and P. 5/– extra*

THE SKYROVER. 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.

All Components Available Separately. Data for each receiver, 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries, 2/8d. extra. Four Leakproof batteries, 3/4d. 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 be built for **£12.19.6** *P. and P. 5/– extra*

THE SPRITE

CAN BE BUILT FOR **79/6** *P. and P. 3/6 extra*

★ Six-Transistor Superhet Miniature Personal Pocket Radio
★ Long and medium wavebands
★ Ferrite Rod Aerial
★ I.F. Frq. 470 kc/s
★ 3" speaker
★ Printed circuit 2½" x 2"
★ In Plastic Case. Size 4" x 2½" x ¾".

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and L.F. stages. Driver and Output stages ready built with all components mounted on the printed circuit. The SPRITE pre-assembled, plus cabinet, speaker and all components for final construction, can be built for 79/6. Postage and package 3/6 extra. Data and instructions separately 2/6. Refunded if parcel is purchased. Real calf leather case, wristrap, personal earphone and case for earphone and battery, 12/6 the lot extra. Make no mistake this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

TRANSFILTERS by BRUSH CRYSTAL CO.

TO-01B 465 kc/s ± 2 kc/s
TO-01D 470 kc/s ± 2 kc/s
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6/6 each P. & P. 6d.

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All New and Guaranteed

GET.S1, GET.S5, GET.S6—2/6; 837A, 874P—3/6; OC.45, OC.71, OC.81D—4/6; OC.44, OC.70, OC.76, OC.81 (Matched pair 10/6)—5/6; AF.117, OC.72, OC.75, OC.170, OC.171, OC.200—6/6; OC.25, OC.42, OC.43, OC.73, OC.82D—7/6; OCP.71—9/6; OC.28, OC.201, OC.204—15/–; OC.205, OC.206—19/6.

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Brand new tape recorder motors. Single phase, fully shrouded. 200–250V A.C. ⅜" x ¼" spindle with detachable pulley, fitted switch. Suitable for tape decks, record players and many other uses. P. & P. 3/6. **14/11**

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BOY'S TRANSISTOR RADIO. Ready built, 2-transistor pocket radio. In attractive plastic case. Size only 4" x 2½" x 1". Fitted with 2½" loudspeaker. Socket for personal earpiece and telescopic aerial. Works from single PP3-type battery. Fully tunable over full Medium waveband. Supplied complete with earpiece, telescopic aerial, carrying purse and 9 volt battery. Ideal Birthday Present.

LASKY'S PRICE 42/- with all accessories. Post Free.

6-Transistor Pocket Radio. Fully built. 4" x 2½" x 1", with 2½" speaker. Uses single PP3-type battery. Supplied complete with personal earpiece and leather case. Tunable over full Medium waveband. **LASKY'S PRICE 79/6** complete with all accessories. P. & P. 2/6.

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Can now be built absolutely complete for **£9.19.6**

★ Small size. Will fit any car
★ 12 volt operation
★ New Hybrid circuit
★ Transistor output
★ New type Brimar valves
★ No Vibrator, 12 volt H.T. & L.T.
★ T.C.C. Printed Circuit and Condensers
★ Tuned R.F. stage
★ Medium and long waves
★ Permeability tuning
★ 7" x 4" elliptical speaker

Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list, 2/6 post free (returned if you order).

REALISTIC 'SEVEN'

★ 7 Transistor Superhet
★ 350 Milliwatt output into 4" high flux speaker
★ All components mounted on a single printed circuit board, size 5¼" x 5¼" in one complete assembly
★ Plastic cabinet, with carrying handle, size 7" x 10" x 3½" in Blue/Grey.
★ 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 oustanding Receiver. The Realistic '7' including Transistors, Cabinet, Speaker, etc., and Full Instructional Data can be built for

£5.19.6 P. & P. 4/6

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

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By popular request a De Luxe version of the well-proven 'Realistic Seven' now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING, covered in attractive washable material, with superchrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. ALL FOR ONLY £1 EXTRA. P. & P. as for Standard model.

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HI-FI AMPLIFIERS — TUNERS — RECORD PLAYERS

S-33

S-99

GL-58

HA-12

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. Sensitivity 200mV. **£13.7.6**

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

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. **£5.2.6**

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GOLDRING LENCO TRANSCRIPTION PLAYER. Model GL-58. With G-60 pick-up arm and Ronette 105 cartridge. **£18.19.2**

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SUGDEN MOTOR UNIT "CONNOISSEUR CRAFTSMAN". Heavy duty motor operating at 33⅓ and 45 r.p.m. Very heavy 12″ turntable. Virtually no rumble. **£16.6.6**

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

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TEST INSTRUMENTS

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

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

V-7A

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

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

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AUDIO VALVE MILLIVOLTMETER. Model AV-3U. 1mV–300V A.C. f.s.d. 10 c/s to 400 kc/s. **£16.10.0**

RF-1U

AUDIO SINE-SQUARE WAVE GENERATOR. Model AO-1U. Covers 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V, distortion less than 1%. **£14.15.0**

O-12U

5″ OSCILLOSCOPE. Model O-12U. Has wide-band amplifiers, essential for TV servicing, FM alignment, etc. Vertical frequency response 3 c/s to over 5 Mc/s, without extra switching T/B covers 10 c/s to 500 kc/s in 5 ranges. **£35.10.0**

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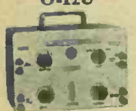

S-3U

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. **£12.18.0**

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RESISTANCE/CAPACITANCE BRIDGE. Model C-3U. Measures capacity 10pF to 1,000μF, resistance 100Ω to 5MΩ and power factor. 5–450V test voltages. With safety switch. **£10.10.0**

TRANSISTOR RADIOS

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

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. **£12.11.0**

UXR-1

TRANSISTOR PORTABLE RECEIVER. Model RSW-1. In a handsome leather case, it has retractable whip aerial and socket for car radio use. Covers Med., Trawler and two S wave bands. **£19.17.6**

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

UJR-1

FOR THE MUSICIAN

PA-1

PA AMPLIFIER PA-1. The ideal compact unit for VOCALISTS, INSTRUMENTALISTS, RECORDS, with 50W (100W pk output), 2 Heavy Duty Speakers. Variable TREMOLO Elegant modern cabinet. Send for full specification.
£54.15.0
Legs optional extra 17/6 set of 4.

ELECTRONIC ORGAN
(fully transistorised)
Ideal for Soloists, Home use, Groups. Full 20 WATTS VOLUME. Matching bench **£14.10.0** extra. **£187.10.0**

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250 AMERICAN HEATHKIT MODELS

Now obtainable for direct delivery from U.S. plant to your U.K. address. *Illustrated catalogue* and full details of mail order scheme can be obtained from us for the nominal charge of 1/– post paid.

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.

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We offer a really efficient Mail Order Service on all items stocked. All cash orders are dealt with on the day of receipt.
★ Hire purchase orders are subject to slight delay but this is kept to the absolute minimum.

● ILLUSTRATED LISTS

Illustrated lists are available on LOUDSPEAKERS, TAPE DECKS, TEST GEAR, GRAMOPHONE EQUIPMENT, AMPLIFIERS. Any will be sent free upon request.

● AMPLIFIER KITS

We have full stocks of all components for the Mullard 510, Mullard 3-3, Mullard 2 and 3 Valve Pre-amp, Mullard Stereo, Mullard Mixer, GEC912 Plus. Fully detailed list on any of these sent upon request. Instruction Manuals: All Mullard Audio Circuits in "Circuits for Audio Amplifiers", 9/5. GEC912, 4/6. All post free.

● MARTIN AUDIO KITS

A range of high quality transistor amplifying equipment is now being produced by MARTIN ELECTRONICS.
Included are 3 and 10 watt Amplifiers, Pre-amplifiers, Mixer and Input Switching Units. Please write for full details.

● STEREO COMPONENTS

Morganite ganged potentiometers as specified for the Mullard circuits. ★ Log/Anti-Log, 500k, 1 meg., 2 meg. ★ Log/Log, 50k, 250k, 1 meg., 2 meg. ★ Lin/Lin 250k, 500k, 1 meg, 2 meg. All 10/6 each. Postage extra.

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MULLARD. Current production types, not rejects. All in makers' boxes. Postage 3d. on each.
AF114, 11/–; AF115, 10/6; AF116, 10/–; AF117, 9/6; OC44, 8/3; OC45, 8/–; OC70 and OC71, 6/6; OC72, 8/–; OC72 Matched Pairs, 16/–; OC78, 8/–; OC81,8/–; OC170, 8/6; OC171, 9/–. Any other Mullard type obtained promptly. Ask for quotation.

● NEW MULLARD CONDENSERS

Mullard Miniature Foil and Polyester condensers as used in the latest TV and Transistor sets.
Miniature Foil. 30 volt working for Transistor sets. .01mfd, 7½d.; .022mfd, 9d.; .047mfd, 9d.; .1mfd, 11d.
Polyester Tubular Capacitors. Moulded outer case designed to withstand accidental contact with the soldering iron. Tolerance 10%.
125V range: .01mfd, .022mfd, .047mfd, all 9d. each; .1mfd, 1/2; .22mfd, 1/3; .47mfd, 1/6; 1mfd, 3/–.
400V range: .001mfd, .0022mfd, .0047mfd. .01mfd, .022mfd, all 9d. each. .047mfd, 1/2; .1mfd, 1/3; .22mfd, 1/6; .47mfd, 2/5. Postage extra.

● MINIATURE ELECTROLYTIC CONDENSERS

Latest miniature types by Mullard and Radio Spares.
RADIO SPARES. All 15V, 2mfd, 4mfd, 5mfd, 8mfd, 10mfd, 16mfd, 32mfd, 50mfd, 100mfd, all 2/3 each. Postage extra.
MULLARD. 2mfd, 10V, 1/9; 4mfd, 4V, 1/9; 10mfd, 16V, 1/8; 16mfd, 10V, 1/8; 25mfd, 4V, 1/8; 25mfd, 25V, 1/3; 32mfd, 2.5V, 1/8; 32mfd, 40V, 1/8.

● "SYNCHROTAPE" RECORDING TAPE

Low-priced British tape, all reels fitted with leaders.
Standard Play: 600ft (5″), 13/6; 850ft (5¾″), 17/–; 1,200ft (7″), 21/–.
Long Play: 900ft (5″), 17/–; 1,200ft (5¾″), 20/–; 1,800ft (7″), 30/–. Post free.

● TAPE RECORDING EQUIPMENT

TAPE DECKS
ALL CARRIAGE FREE

	Cash Price	Hire Purchase Deposit	Mthly Pmts.
COLLARO STUDIO. Latest model. Two track. Bradmatic Heads	£10.19.6	£2. 3.6	12 of 16/4
Four Track, Marriott Heads ...	£17.17.0	£3.12.0	12 of 26/2

MARTIN TAPE AMPLIFIER KITS

Tape Amplifiers
For Collaro 8311-V 2-Track £11.11.0; 8311-4-V 4-Track £12.12.0.
Tape Pre-Amplifiers
For Collaro 8312-CP 2-Track £8.8.0; 8312-4-CP 4-Track £9.9.0.
Drop through assembly for mounting 8312 Pre-Amp under Collaro Deck, £1.11.6.
Carrying Cases with speaker. For Collaro Deck and 8311 Amplifier £5.5.0.
H.P. TERMS available on decks, amp. and cases. Ask for quote.

MULLARD TAPE PRE-AMPLIFIER KIT

We stock complete kits and all separate components for the Mullard Tape Pre-Amplifier. Fully detailed list available.

● LOUDSPEAKERS

GOODMANS: Axiette 8″, £5.5.7; Axiom 10″, £6.5.11; Axiom 201 12″, £10.7.0; Axiom 301 12″, £14.10.0; Audiom 51 Bass 12″, £8.14.0; Audiom 61 Bass £13.14.0; Trebax Tweeter, £6.4.0; XO5000 Crossover Unit, £1.19.0.
WHITELEY: HF1016 10″, £7.0.0; HF1012 10″, £4.7.6; HF816 8″, £6.0.0; T816 8″, £5.13.6; T10 Tweeter, £4.8.3; T359 Tweeter, £1.10.6; CX3000 Crossover Unit, £1.11.6; CX1500 Crossover Unit, £2.0.0.
H.P. Terms available on all speakers.

● ARMSTRONG EQUIPMENT

	Cash Price	Hire Purchase Deposit	Mthly Pmts.
TUNER AMPLIFIERS			
Model 227 Stereo	£48.15.0	£9.15.0	12 of £3.11.6
Model 227M Mono	£33.18.0	£6.18.0	12 of £2. 9.6
Model 226 De Luxe Stereo ...	£56. 0.0	£11. 0.0	12 of £4. 2.6
Stereo 55 Stereo	£29.18.0	£5.18.0	12 of £2. 4.0
RADIOGRAM CHASSIS			
Model AF208 AM/FM	£21. 4.0	£4. 4.0	12 of £1.11.2
TUNERS			
Model T4B FM	£20. 8.0	£4. 2.0	12 of £1. 9.11
Model ST3 Mk2 AM/FM	£25.12.0	£5. 2.0	12 of £1.17.11

Makers literature available on any item

● JASON F.M. TUNERS

We stock all parts needed for the construction of these excellent tuners. All parts can be supplied separately but we can offer attractive reductions in price if all items are purchased at same time as follows:

FMT1	£6.12.6	FMT2 (less power) ...	£7.15.0
FMT2 (with power) ...	£9.12.6	FMT3 (less power) ...	£9. 9.6
FMT3 (with power) ...	£11.7.6	Mercury 2	£10.14.6
JTV/2	£14.12.6		

Hire Purchase Terms available. Ask for list.

● P.W. STRAND, MAYFAIR & SAVOY UNITS

We stock parts for the P.W. Strand Amplifier, Mayfair Pre-Amplifier and Savoy FM Tuner. Detailed price lists are available.

● LATEST TEST METERS

	Cash Price	Hire Purchase Deposit	Mthly Pmts.
AVO Model 8, Mark II	£24. 0.0	£4.16.0	12 of £1.15. 2
AVO Model 7, Mark II	£21. 0.0	£4. 4.0	12 of £1.10.10
AVO Multiminor Mark 4 ...	£9.10.0	£1.18.0	12 of 14/4
T.M.K. TP10	£3.19.6	£1. 3.6	3 of £1. 2. 0
T.M.K. TP5S	£5.19.6	£1.15.6	3 of £1.11. 4
T.M.K. Model 500	£8.19.6	£1.15.6	12 of 13/8
TAYLOR MODEL 127A ...	£10.10.0	£2. 2.0	12 of 15/8

Full details of any of the above supplied free on request.
The AVO models 7 and 8 are both latest models from current production —not to be confused with Government surplus.

● OUTPUT TRANSFORMERS

GILSON: W0696A, W0696B, 50/6, post 2/6. W0710, 55/6, post 2/6. W0892, 62/3, post 2/9. W0767, 27/–, post 1/6. W01796A, 57/6, post 2/6. W01932, 84/–, post 3/–.
PARTRIDGE: P3667, 75/–, post 2/9. P4131, 75/–, post 2/9.
PARMEKO: P2629, 47/6; P2642, 45/–; P2643, 47/6. All plus post 2/9; P2641, 29/6, post 2/–; P2928, 17/–, post 2/–; P2932, 41/–, post 2/6.
ELSTONE: OT/ML, 49/6, post 2/9; OT/3, 27/6, post 2/6.

● MAINS TRANSFORMERS

GILSON: W0741A, 63/–, post 4/–; W0839, 48/9, post 2/9; W01328, 58/6, post 3/6; W01288, 58/–, post 3/6; W01566, 80/–, post 4/6; W01341, Choke, 36/–, post 2/–.
PARMEKO: P2631, 35/–, post 2/9; P2630, 54/9, post 3/3; P2644, 76/6, post 4/–; P2930, 41/–, post 3/–; P2931, 56/9, post 3/3.
ELSTONE: MT/MU, 49/6, post 3/3; MT3/M, 38/6, post 3/–; MT/510, 46/3, post 3/3.

● GRAMOPHONE EQUIPMENT

ALL LATEST MODELS
ALL POST FREE

	Cash Price	Hire Purchase Deposit	Mthly Pmts.
RECORD CHANGERS			
GARRARD AUTOSLIM (Mono PU)	£7. 2.6	£1. 8.6	12 of 11/2
GARRARD AUTOSLIM De-luxe AT6 (Mono PU)	£11. 9.0	£2. 6.0	12 of 16/11
GARRARD AUTOSLIM AT6 (Stereo/Mono PU) ...	£12. 5.4	£2. 9.4	12 of 18/–
B.S.R. UA14 (TC8 Mono PU) ...	£6.19.6	£1. 7.6	12 of 11/–
B.S.R. UA14 Monarch (TC8S Stereo/LP/78)	£7.19.6	£1.11.6	12 of 12/4
B.S.R. UA16 (TC8 Mono PU) ...	£7.19.6	£1.11.6	12 of 12/4
B.S.R. UA16 (TC8S Stereo/LP/78)	£8.19.6	£1.15.6	12 of 13/8
SINGLE RECORD PLAYERS			
B.S.R. TU12 (TC8 Mono PU) ...	£3.17.6	£1 4.6.	3 of £1.1.0
B.S.R. GU7 (TC8 Mono PU) ...	£4.18.8	£1. 8.8	3 of £1.6.8
GARRARD SRP10 (Mono PU) ...	£5.9.11	£1.12.11	3 of £1.9.0
TRANSCRIPTION UNITS			
GARRARD 4HF (GC8 PU) ...	£16.12.6	£3. 6.6	12 of £1.4.5
PHILIPS AG1016 (S/M PU) ...	£12.12.0	£2.10.0	12 of 18/6

Many of the above can be supplied for stereo working. See our Gramophone Equipment List for details.

● TERMS OF BUSINESS

Cash with order or C.O.D. We charge C.O.D. orders as follows: Up to £5, minimum of 4/2.
Over £5 and under £10, 2/8. Over £10, no charge. Postage extra on **CASH orders under £5 except where stated. Postage extra on overseas orders irrespective of price.**

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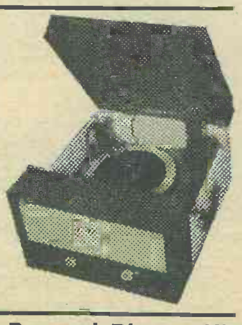

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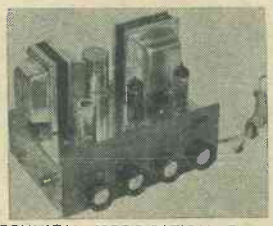

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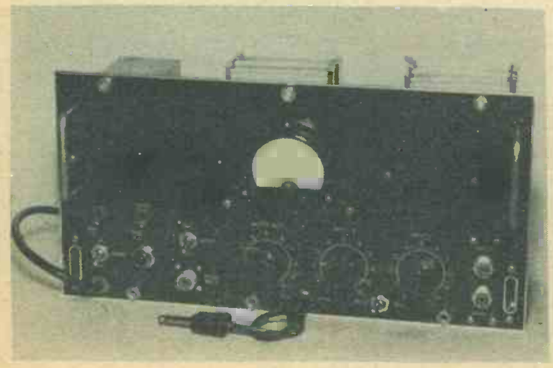
Converting the IM-81/UP Standing Wave Indicator to a High Gain Quality-built Tape Amplifier

By B. N. LOVE

GOOD QUALITY WAR SURPLUS EQUIPMENT IS NOT so plentiful today as it was in the immediate post-war years, but from time to time releases of some later equipment are made, often in mint condition. One such piece of equipment is the U.S. Navy Type IM-81/UP Standing Wave Indicator which, as the name implies, is a test meter for u.h.f. aerial circuits. This may seem rather remote from a tape deck amplifier, but the basic instrument is essentially a well designed, high gain audio amplifier. It contains a well smoothed mains power supply, two high gain voltage amplifiers, an output beam tetrode and a twin diode operating as a rectifier feeding a high quality moving coil meter in the output stage. (This meter is supplied with a double pole switch and output socket so that it may be used as an external d.c. meter of 1mA f.s.d. without any modification.)

The instrument becomes a piece of test equipment only when it is fed from plug-in u.h.f. probes. It is very solidly constructed and beautifully finished, is housed in a top quality crackle finished cabinet with detachable lid and is of comparatively recent manufacture. (Two samples converted were dated 1952.) The h.t. smoothing units are 8μF 600 working volt paper capacitors, while anode and cathode decoupling components are octal based plug-in units. The whole instrument is very well engineered and all components are first rate. As these instruments cost only £4 10s. in the author's area (at the time of writing) they would in any case be a sound buy on components value alone.



A front view of the converted Indicator

Power Supply

Although the mains transformer is designed for U.S.A. mains supplies, i.e. 115 volts 60 c/s, it is quickly modified to U.K. standards of 240 volts 50 c/s by a cheap and simple modification which dissipates no heat. The live lead of the mains cable is removed from one tag of the "On/Off" switch and a good quality series capacitor is inserted. (See Figs. 1 and 2.) The "old faithful" U.S.A. metal-cased "bathtub" capacitors are ideal for this purpose if they are not less than 600 volt working. The capacitance required is best found by trial and error owing to the tolerances in value commonly found with this type of capacitor.[1] Start with 2μF in series first. Plug into the mains, switch on and check the heater volts on V_2. The panel lamp may not glow at this stage as it is in series with the heater of V_4 and is thus dependent on correct voltage for brilliance. The heater of V_2 will probably read at a figure below 6.3 volts. Now add 1μF in parallel with the 2μF capacitor in circuit and check the heater of V_2 again. Adjust up or down with 0.5μF units until the heater volts are correct. It is better to have the heater volts slightly under-run than vice versa, as V_1 will be subject to hum injection if over-run. The h.t. rail should be close to 250 volts. In the first sample modified, a total of 2.5μF was sufficient, while a second unit required 4μF. As the "bathtub" capacitors were chosen at random from stock, tolerances on the stated values could account for the differences.

A mains dropping resistor of appropriate value and rating can be used in place of the series capacitor but a heavy duty component would be required, a great deal of heat would be generated, and additional ventilation would have to be provided. The advantage of the series capacitor lies in the fact that, although it offers the necessary impedance to the 50 c/s mains to drop the voltage to 115 volts, it absorbs no power in doing so and hence remains quite cold in operation.

[1] When a series dropping capacitor is used in the manner described here there is always the risk of damage to the associated equipment should it break down. Unexpected results are also possible when the capacitor is used in conjunction with a component which may offer inductive reactance, such as a mains transformer. A further point is that the final value of capacitor required should be determined when the equipment is warmed up and is drawing full h.t. current. Readers who feel that the risk of damage due to capacitor breakdown or other factors is high could use a step-down autotransformer or, less preferably, a dropper resistor to give the required 115 volt input. —EDITOR.

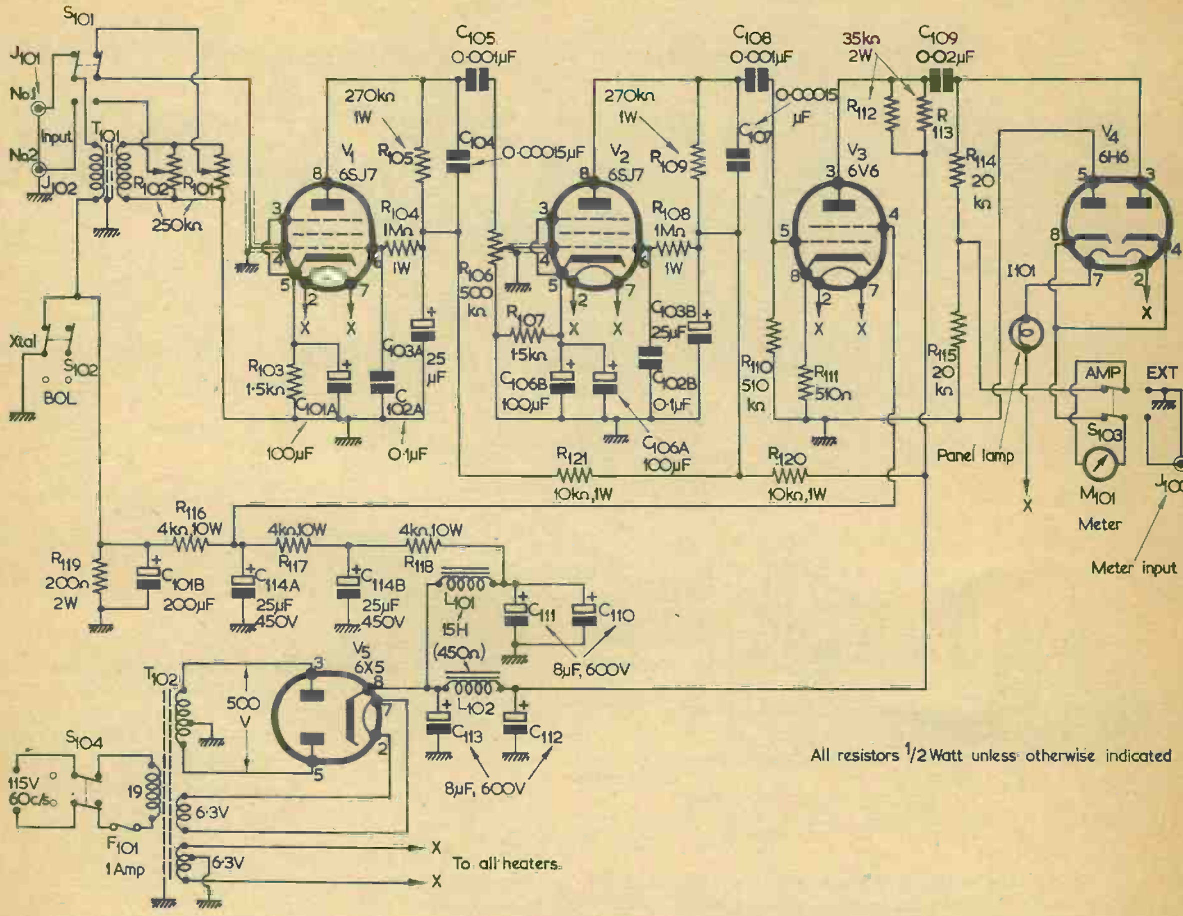


Fig. 1. The complete circuit of the IM-81/UP Indicator in its original form

If a screened input lead direct from a high impedance head on a tape deck is now connected across the potentiometer marked "Input 1" (R_{101}) and the adjacent switch put to "No. 1", the output from a tape can be heard by connecting headphones (in series with a 0.1μF capacitor) across the anode load of the 6V6 output tetrode. No audio output stage is fitted in the unmodified instrument and details for this appear in the conversion instructions which are given later in this article.

The Circuit

The full circuit of the unmodified Indicator unit is shown in Fig. 1. This shows an almost conventional line-up for a three stage audio amplifier, but further inspection reveals that there are several differences. The input transformer T_{101} is designed to match either a crystal u.h.f. probe or a bolometer into V_1 grid circuit, and it has a primary to secondary resistance ratio of 1:5 but a turns ratio of only 1:2.2. Constructors should bear this in mind when considering using this item as a matching transformer for pick-ups or microphones, etc. If the transformer is removed, the two inputs can be switched for mixing. The first two stages then follow standard practice and have a listed response of 500 c/s–2 kc/s linear within 3dB. This pass band is adequate for speech and can remain untouched if used for reproducing club lectures or talking books from tape. The type 6SJ7 valves give high gain and remarkably low hum level, the sensitivity being 15μV input for full meter deflection at the frequencies given. The small values of capacitors connected across the anode loads of V_1 and V_2 (C_{104} and C_{107}) prevent parasitic oscillation at radio frequencies. At the same time, low frequency motor-boating is prevented by adequate, or even generous, decoupling capacitors.

As the 6V6 output stage is only required to give an indication on a meter, no audio output is provided. The anode load is simply two 35kΩ 2 watt resistors in parallel. To assist in maintaining the calibration of the meter, this stage is stabilised by a well smoothed h.t. supply to the screen grid of the

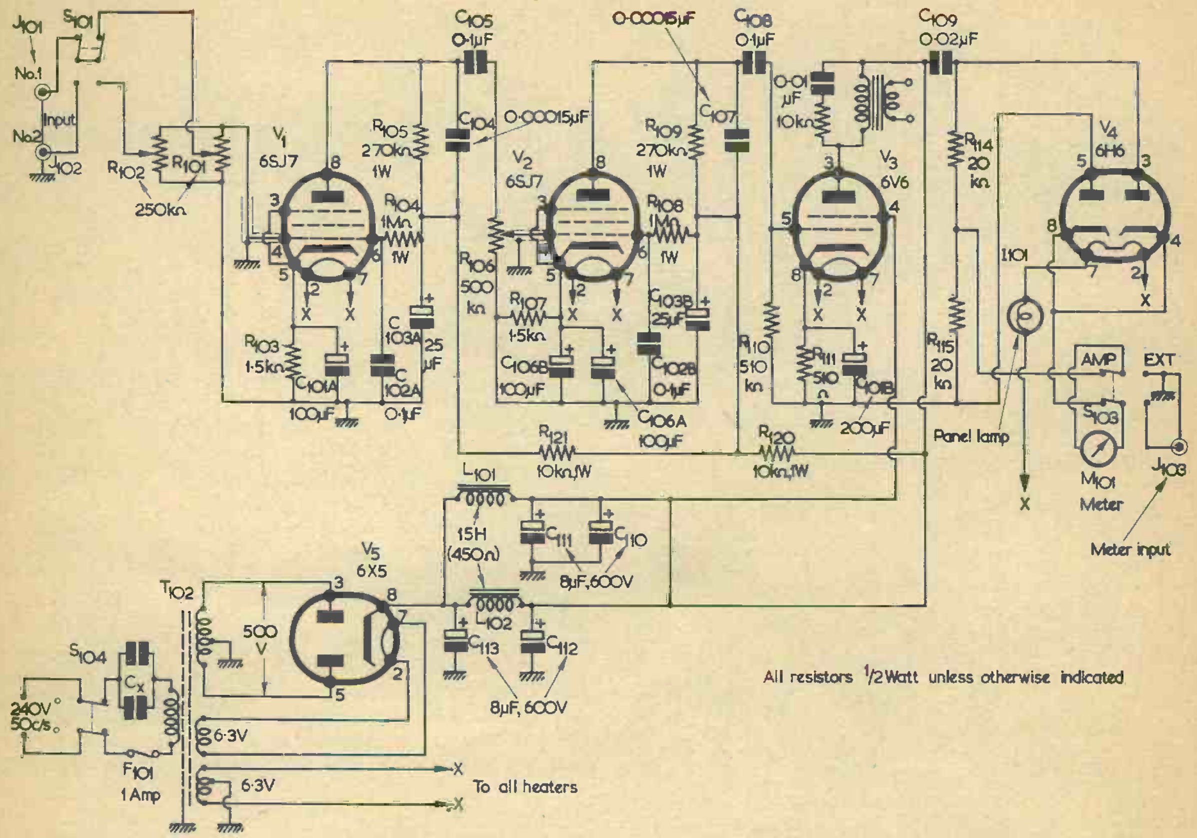


Fig. 2. The circuit of the Indicator after modification. The meter circuit associated with the 6H6 is not now in use

6V6. An extension of this supply feeds a small h.t. voltage to a panel socket and switch for operating the external bolometer.

The output from the 6V6 is fed via a 0.02μF capacitor to a 6H6 twin diode wired as a simple full wave rectifier. As the 1mA meter is in circuit with the strapped cathode and centre tap of the two 20kΩ resistors, it always shows the mean d.c. output from the 6V6. With a sine wave input from an audio signal generator, the meter will record a steady level.

Conversion

The circuit of the modified indicator is shown in Fig. 2, and the conversion procedure is carried out in the following manner.

(1) *Power Supplies*

The series capacitors C_x can be mounted beneath the chassis in the vicinity of the mains transformer where there is adequate space. (See Fig. 3 and illustration.) If "bathtub" capacitors are used they can be bolted directly on to the chassis side. If tubular types are used, they should be firmly mounted on tagboards. If the panel lamp glows at high brilliance almost immediately after switching on, this will indicate either too much capacitance or a leaky capacitor. The unwanted section of the existing h.t. circuit is disconnected simply by removing R_{116}, R_{117} and R_{118} together with their tagboard. These are high wattage clip-in resistors and are located on a long slim taboard at the rear of the chassis. C_{114A}, $_{114B}$ is a twin, octal based electrolytic capacitor and this is removed to the spares box. C_{101B} remains in position as it is also part of a twin unit, the other half of which provides cathode bypass for V_1. The spare choke and its 8μF units are now connected into the main h.t. line as shown in Fig. 2. L_{101} and L_{102} are each rated at 35mA. When the output stage is fitted with a speaker transformer the overall h.t. current will exceed the rating of either one of the two chokes. By wiring them in parallel, their current handling property is doubled and is quite adequate for the increased h.t. current. It is true that this also halves their total inductance, reducing it to 7.5 henries, but the addition of the two extra 8μF smoothing units compensates for this and the hum level remains excellent. A further advantage of combining the two chokes in parallel is that their effective d.c.

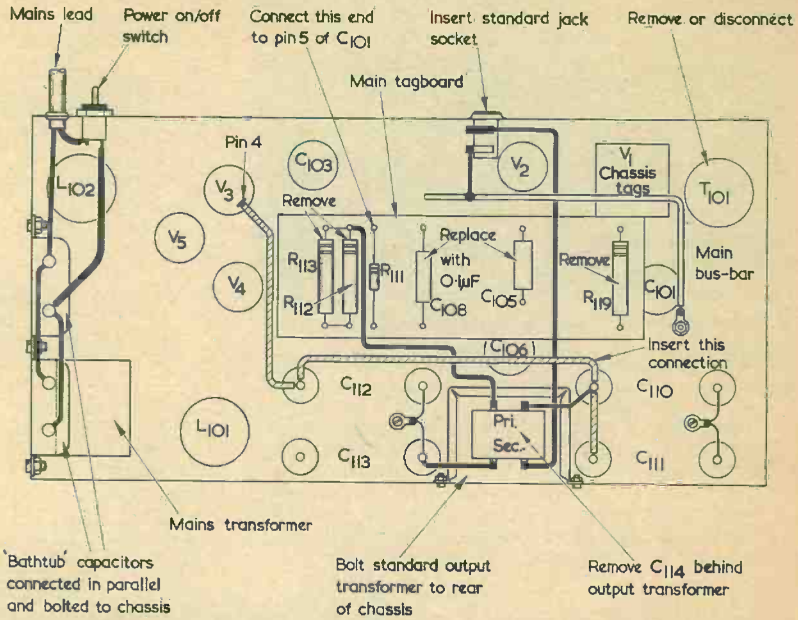


Fig. 3. A detailed below-chassis view showing the general layout and the principal steps involved in the conversion

resistance is also halved, from 450Ω to 225Ω. This again compensates for a voltage drop which would have occurred with increased h.t. current through a single choke. The only wiring necessary at this stage to effect these changes is a single link between the unearthed terminal of C_{110} to the unearthed terminal of C_{112}. (See Fig. 3.)

(2) *Output Stage*

Four modifications are made here. The screen grid of the 6V6 is connected to the nearest h.t. positive point. An orange coloured lead coming from pin 4 of the 6V6 runs close to the h.t. terminal of C_{112}. The orange lead should be cut near this point and connected to the terminal. This puts the screen grid at h.t. potential. As all components are very clearly marked, either on their cases or at a nearby point on the chassis, there should be no difficulty in locating wiring points. The unused half of C_{101} (C_{101B}) is now re-connected as a cathode bypass capacitor across the 510Ω cathode resistor of the 6V6. The white lead running from pin 5 of the octal holder of C_{101} to the "Xtal/Bol" switch on the front panel is removed from the switch tag and connected to the unearthed end of R_{111}, which is mounted on the main under-chassis tagboard. This effectively puts C_{101B} back in a useful circuit, improving the gain of the output stage. A simple tone-correcting circuit is now inserted in place of the two parallel anode load resistors R_{112} and R_{113}. Again, these are clearly marked on the main tagboard, and each has a value of 35kΩ at 2 watt rating. Remove these two resistors and wire in a 10kΩ half-watt resistor in series with a 0.01μF capacitor across the tagboard between the tags left vacant by their removal. (See Fig. 2.) This circuit gives a degree of treble cut and can be adjusted in values to suit the listener's ear. Finally, the 6V6 anode circuit is fitted with a standard pentode replacement type output transformer.[2] With the earlier removal of the high wattage h.t. resistors, there is ample space at the rear of the chassis for mounting the transformer.

[2] A ratio between 40:1 and 50:1 should be adequate for matching the 6V6 to a 3Ω speaker.—EDITOR.

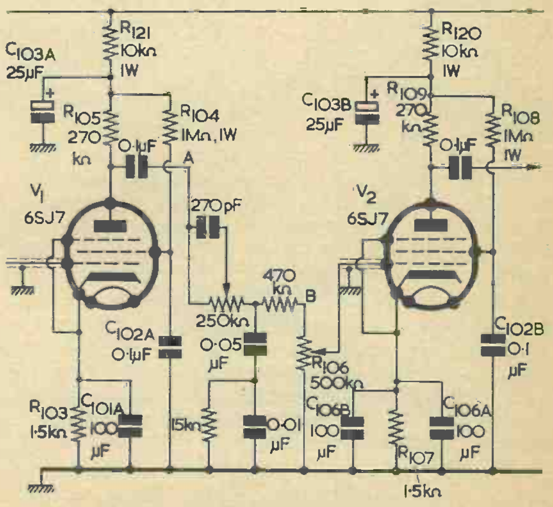
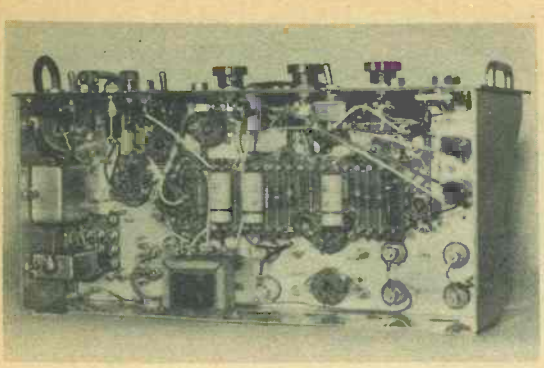


Fig. 4. A suggested tone control network for insertion between V_1 and V_2. The additional components appear between points A and B. If desired, R_{102} (Input 2 Gain) may function as the 250kΩ potentiometer, only Input 1 being retained



Below-chassis view of an Indicator modified by the author. The series mains capacitors, Cx, can be seen at the left hand edge of the chassis. The output transformer is fitted to the rear of the chassis, R_{116}, R_{117} and R_{118} having been removed. Also visible is the speaker jack socket at the "Bol/Xtal" switch position. (The two coils at the right of the chassis are for switched local station reception, in conjunction with a crystal diode, and they do not appear in the modification described in the text)

One primary lead connects to the nearest h.t. point and the other primary lead is connected to pin 3 of the 6V6. Connect one side of the secondary to chassis and the other to a socket on the front panel. (See Fig. 3.) A 3Ω speaker connected to this socket completes the output stage. For convenience a jack socket can be mounted at the front with one terminal connected to chassis, via the bus-bar. A standard jack socket will mount comfortably in the hole given by removing the "Xtal/Bol" switch.

(3) *Amplifier Stages*

The amount of work done on the amplifier stages is largely a matter of personal choice, as experienced constructors will have their own ideas about inserting tone control circuits between V_1 and V_2. A fairly typical network is shown in Fig. 4. In its unmodified form, the Indicator has too narrow a response and while this is improved by the output stage modifications, the fitted anode to grid coupling capacitors of V_1 and V_2 should be replaced with higher values. Remove the two moulded mica capacitors C_{105} and C_{108} and replace them with 0.1μF 350 volt components. From V_2 right back to the input, all signal handling circuits have their chassis points connected to a heavy tinned copper bus-bar in accordance with good amplifier construction and if connections are made to or removed from this bus-bar, a really hot iron with a substantial bit must be used. The grid circuit of V_2 contains a 0.5MΩ potentiometer marked "Master Gain Control". This is the chief volume control in the converted Indicator and requires no modifications. Input leads are well screened and V_1 is mounted on a double sprung anti-microphonic valveholder supported above the chassis. Heaters are centre-tapped to reduce hum and cathode bypass capacitors are quite generous in value.

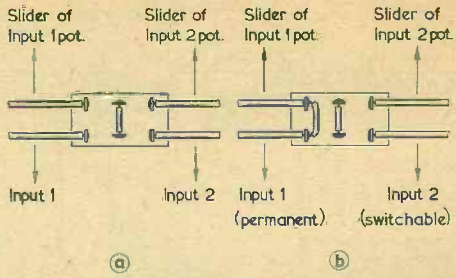


Fig. 5 (a). The input switch wired for selecting either Input 1 or Input 2
(b). An alternative method of wiring which allows mixing and fading

(4) *Input Circuit*

The modified input circuit given in Fig. 2 shows the original matching transformer removed and the input switch rewired to select either Input 1 or Input 2. If the two inputs are required simultaneously for continuous mixing, the pair of tags at each end of the switch should be short-circuited to give permanent connections to the sliders of the two input controls. This wastes a switch, however, and a better arrangement is shown in Fig. 5 (*b*), where the switch is still in circuit and can cut out the unwanted input as required. Note that in the modified input circuit the grid of V_1 is permanently wired in screened cable to the top end of both input potentiometers and not to their sliders. If this is not done, the slider nearest chassis would tend to shut down the input to V_1 even if there was full input to the second potentiometer.

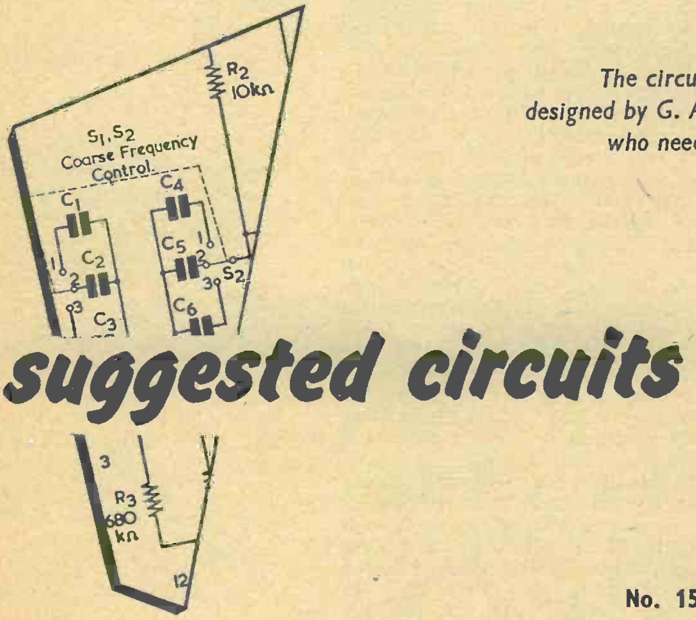
Finally R_{119}, a 200Ω 2 watt resistor, which is situated at the extreme end of the main tagboard, is removed. If left in circuit it will be in parallel with the cathode bias resistor of the output stage and would reduce the bias voltage. The "Xtal/Bol" switch is now redundant and can join C_{114} in the spares box. The input sockets on the Indicator are of the now-familiar screw-on coaxial type. Coaxial plugs for these sockets are fairly readily obtainable on the surplus market, and for permanent noise-free connections they are quite excellent. If frequent changes of input are required, it may be more convenient to fit standard TV coaxial sockets.

Final Conversion Points

After the conversion has been carried out as described above, a final check of wiring should be made to see that all circuits are correctly wired. Wherever the removal of an original component leaves a loose lead inside the chassis, trace the wire back to its previous terminal or tag and clip it off cleanly. Take care not to cut any second or third lead running to the same point, unless it is obviously not required in the converted circuit.

Conclusion

While this instrument will be recognised as a well designed job, no pretence is made that the conversion will produce high fidelity results. In any case, simple single ended output stages are not designed for or expected to produce high quality. The modified unit does have high gain, however, and a very pleasing response when modified. The keener tape enthusiast could use the unit as the basis for a complete record-replay amplifier. With a more generous mains transformer fitted push-pull output can be incorporated, a bias oscillator fitted and the meter used as a record level indicator. On the other hand, the few shillings involved in getting the indicator working to the condition described in this article are more than justified by the results.



suggested circuits

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

No. 158 The "Chicane" A.F. Oscillator

A.F. OSCILLATORS ARE ALWAYS useful for servicing work or for morse practice and the like, and it is frequently advantageous to design such oscillators with the minimum number of components. The present article describes an oscillator which has an exceptionally small quantity of components, and it has the further advantages that these are not critical in value and that only a low voltage power supply is required.

The author hopes that he will be excused a little mild chicanery if he initially introduces the circuit of the oscillator in the manner shown in Fig. 1. As may be seen, the oscillator comprises only one transistor, two capacitors and a resistor. Yet, when a pair of high impedance phones are connected to the output terminals, they reproduce a sinusoidal a.f. tone at a volume which is significantly higher than comfortable listening level!

Colpitts Oscillator

Most readers will have spotted the trick which has been employed, and this becomes more obvious if we introduce the phones into the diagram, as we do in Fig. 2. It may now be seen that the oscillator uses the Colpitts configuration, and that the phones which reproduce the tone

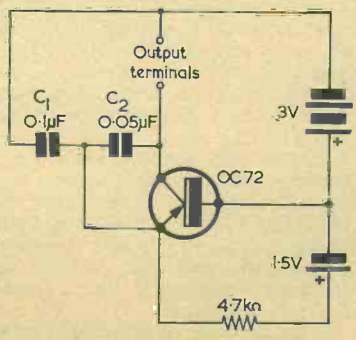


Fig. 1. The "Chicane" a.f. oscillator. This causes a sinusoidal a.f. tone to be heard in high impedance phones connected to the output terminals

also provide the inductance for the tuned circuit. Despite this artifice the circuit is still a perfectly practicable proposition, and it can prove to be of considerable use in any application where a fixed frequency a.f. oscillator is required.

The basic a.c. Colpitts oscillator circuit is shown in Fig. 3. In this diagram the tuned circuit is provided by the inductor and the series combination of C_1 and C_2. It may, perhaps, be helpful to assume earthed emitter operation for the moment, whereupon we can say that signal voltage at the collector appears at the base 180° out of phase, as is required for amplification, and that the earthy tap into the tuned circuit appears at the junction of C_1 and C_2. In fact, however, the operation of the circuit can be explained just as readily from the point of view of an earthed base or an earthed collector transistor.

The Colpitts oscillator has the advantage that no tap into the inductor is required; but it is difficult to translate the a.c. circuit of Fig. 3

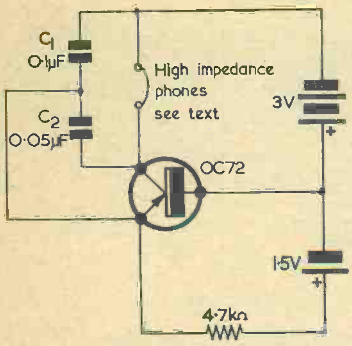


Fig. 2. When the headphones are introduced it may be seen that a Colpitts configuration is set up, the inductance of the phones and C_1C_2 providing the tuned circuit. An OC72 transistor is shown, but equivalent results can be given by other types

into a practical equivalent running from a single power supply without introducing several extra resistors. These are required to isolate the emitter for a.c. and to bias the base. It may also be necessary to include an additional capacitor to provide a.c. coupling from the base to the upper end of the tuned circuit. A possible circuit running from a single power supply is shown in Fig. 4, and this is manifestly wasteful of components.

The simplest solution consists of employing two batteries for the supply, as in Fig. 2. In this circuit the upper end of the tuned circuit (given by the inductance of the phones and the series combination of C_1 and C_2) is coupled direct to the base by way of the 3 volt battery. Also, the emitter is automatically isolated for a.c. via its bias resistor, which is in any case a necessary adjunct for correct transistor operation.

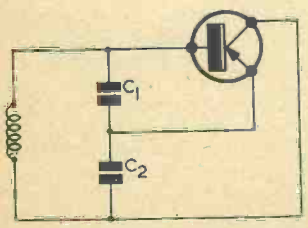


Fig. 3. The a.c. circuit for the Colpitts oscillator. C_1 and C_2 correspond to the similarly identified components in Figs. 1 and 2

Results with the Prototype

A prototype was wired up to the circuit given in Fig. 2, and it employed an OC72 together with a pair of 2,000Ω phones (i.e. two 2,000Ω earpieces in series). The component values shown were found by experiment, and resulted in the generation of a tone at around 1,000 c/s. The values of C_1 and C_2 may need adjustment to provide the desired tone if phones having inductances significantly different from those employed by the author are used. Whatever the values employed, C_2 should always have a lower capacitance than C_1. With the prototype, it was found that reliable oscillations were produced when C_2 had a value lying anywhere between $\frac{1}{2}$ and $\frac{1}{10}$ that of C_1. This relationship is to be expected from a consideration of Fig. 3, where it will be noted that a higher reactance in C_2 ensures that the emitter tap into the tuned circuit will be less than half-way from the base end.

The value of the emitter bias resistor (4.7kΩ) was also determined by experiment, and it provides a collector current which lies between the upper and lower extremes at which oscillation ceases. Variations in bias resistance affect the frequency of the a.f. tone, possibly because they cause alterations in the collector current flowing through the phones and, hence, the incremental inductance which these offer. With the value specified here, the collector current in the prototype was 0.2mA.

The two headphones in series were then exchanged for a single 2,000Ω earpiece. The oscillator functioned just as reliably, but the frequency of oscillation increased slightly due to the reduced inductance in the tuned circuit. A personal earphone with a nominal impedance of 1,000Ω and a d.c. resistance of approximately 600Ω* was next tried and reliable oscillation occurred once more, this time at about 4 kc/s. The frequency of oscillation in the last two instances could, of course, be reduced by increasing the values of C_1 and C_2.

Finally, two other transistors were used in place of the OC72. One was an unbranded "a.f. type" and the other an OC44. Both gave the same results as the OC72, and it would appear from this that the type of transistor employed in the circuit is not unduly critical.

Since the internal resistance of the 3 volt battery is in series with the coupling to the base, this battery was

*Personal earphone type 'A' (1,000Ω impedance) Henry's Radio Ltd.

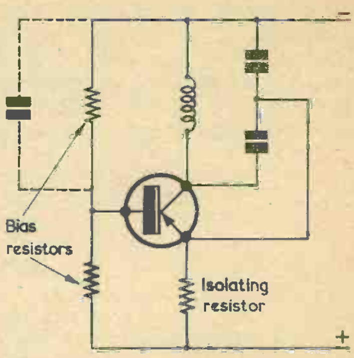


Fig. 4. A possible method (not checked by the writer) of wiring a Colpitts oscillator to run from a single supply. The capacitor shown in dotted line may be needed to provide an a.c. coupling from the transistor base to the upper end of the tuned circuit

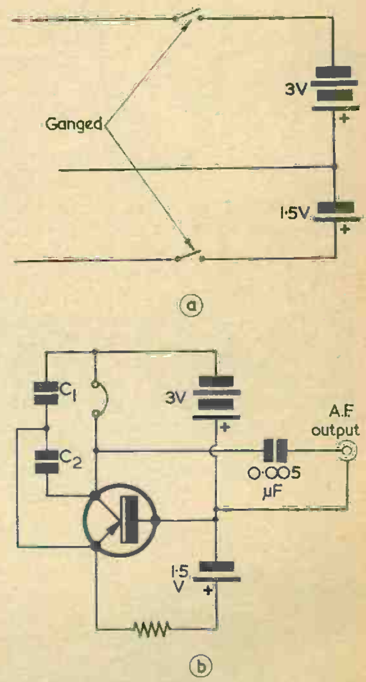


Fig. 5 (a). It is necessary for the on-off switch to interrupt two of the supply leads. A suitable circuit is shown here (b). An a.f. output may be obtained, via a 0.005μF capacitor, from the collector and base of the transistor shunted by a 10μF electrolytic capacitor. The addition of the electrolytic capacitor had no noticeable effect on oscillator operation, and it was felt that there was little point in including it in the circuit.

Further Points

Several further points need to be finally dealt with.

If the oscillator is to be used for morse practice, a key can be conveniently inserted between the positive terminal of the 1.5 volt cell and the 4.7kΩ resistor. It should be possible to connect a further pair of 2,000Ω phones in parallel with those shown in Fig. 2, the values of C_1 and C_2 being increased, if it is felt necessary, to offset the effect of the reduced inductance in the tuned circuit. The writer did not check the prototype with more than one pair of phones.

If an on-off switch is to be incorporated, it should break any two of the supply connections. A suitable switching circuit is shown in Fig. 5 (*a*).

The circuit is capable of offering an a.f. tone for application to any medium or high impedance circuit. This tone may be taken from the base and collector of the transistor by way of a 0.005μF isolating capacitor, as shown in Fig. 5 (*b*).

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.

Hallicrafters S38C Receiver.—D. J. Atkins, 6 Newfield Road, Coventry, Warks., wishes to borrow or buy the manual and/or circuit for this receiver.

* * *

Ekco Car Radio, Model CR61.—T. Inkester, 13 Dormer Place, Leamington Spa, Warks., requires the circuit and/or valve line-up or any information on this receiver.

* * *

Grundig Service Manual.—C. J. Barber, 29 Higher Cadewell Lane, Torquay, Devon, wishes to obtain a copy of the manual for the "Specialist" tape recorder TK820/3D (complete, not abridged).

* * *

Canadian No. 19 Mk. III Tx/Rx.—D. Gomez, 50 Grove Park Gardens, London, W.4, requires the circuit or service manual.

HRO Senior MX Communication Receiver.—H. Ross, 577 Dumbarton Road, Dalmuire West, Clydebank, Glasgow, would like to purchase the handbook and coils J. H. G.

* * *

Crystals.—F./O. V. J. Reynolds, R.A.F.V.R., G3COY, requires to know where the following crystals may be obtained (any type of base)—3715, 3752 and 4925 kc/s.

* * *

R103 Mk. II Receiver.—D. Elliott, 25 Princess Drive, Kirby Muxloe, Leics., wishes to borrow the circuit or any modification information.

* * *

Hallicrafters "Sky-Buddy" Receiver.—A. Harper, 136 Gill Street, Benwell, Newcastle-on-Tyne 4, requires the service sheet or any information on this communications receiver.

Fixed Frequency Audio Oscillator

A. S. Carpenter
A.M.I.P.R.E.

REGULAR READERS MAY REMEMBER THAT IN AN earlier issue of this journal a simple mains power pack was described[1] to which small pieces of equipment could be connected. In a subsequent issue details of an easily made alignment aid were given.[2]

The fixed frequency audio oscillator to be described here is another simple, but handy accessory, which may similarly take its power from the power unit previously discussed.

[1] "Small Power Supply Unit", by A. S. Carpenter, *The Radio Constructor*, August 1962.

[2] "An Oxo Tin Alignment Aid", by A. S. Carpenter, *The Radio Constructor*, October 1962.

The present unit can be useful as a signal injector, and has the particular advantage that its output waveform is a harmonic-rich square wave. If the frequency chosen for the oscillator is, say, 1,000 c/s it will be possible to hear the odd or even harmonics, when the fundamental tone is injected at suitable points into a receiver or amplifier.

In this way it is frequently possible to isolate the offending stage in faulty equipment, whereupon a closer inspection can reveal the actual component responsible. The unit may also be used to energise a bridge, modulate an r.f. generator, or meet other requirements in which an audio tone is needed.

The Circuit

From Fig. 1 it may be seen that the oscillator proper, around $V_{1(a)}$, is of the phase shift type. Energy from the anode to the grid passes through the network formed by R_1, R_2, R_3, C_1, C_2, C_3, these components causing the a.c. at the anode to be displaced in phase through 180° at an audio frequency.

A phase shift oscillator can easily be constructed around a single triode or pentode, a fairly high gain valve normally being used to overcome the losses in the phase shift network. The valve specified here is not a type which is normally selected for low frequency work, but it does, nevertheless, perform well in the present application. It must be noted that on no account should an ECC81, ECC82 or ECC83, be used with the layout shown, as the pin connections differ.

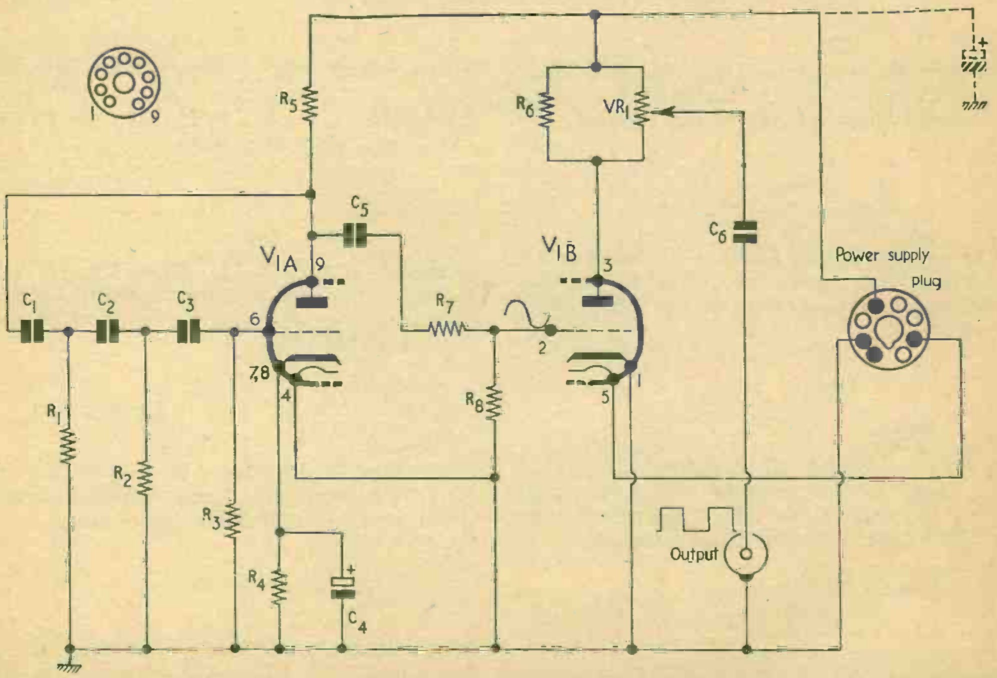


Fig. 1. The circuit of the oscillator unit. The power supply plug shown is intended to be fitted to a power unit described in a previous issue. (The electrolytic capacitor illustrated in dotted line is fitted in this power unit.)

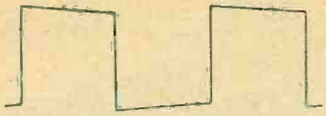


Fig. 2. Typical output waveform

The output from a phase shift oscillator is normally reckoned to be a sine wave but it might, in practice, be anything but pure. Some notes concerning this are given later.

Although it is possible to provide a moderately wide frequency coverage with the phase shift oscillator this is rarely attempted, at any rate, in simple amateur equipment, the fixed frequency operating mode being considered adequate. Where wide band working is essential the Wien bridge principle is more likely to be employed.

In a simple phase shift oscillator of the type presented here the operating frequency is altered if the value of any of the capacitors or resistors included in the shifting network is changed. When, in the prototype, R_2 was replaced by a 47kΩ resistor in series with a 250kΩ variable resistor, it was found possible to vary the audio note between 880 and 1,050 c/s approximately. This suggests an excellent way of adjusting the unit fairly accurately, if required, a suitable B.B.C. tuning note, or even a piano, being used as a reference.[3]

Components List

Resistors

(All fixed resistors 10%, ¼W, unless otherwise stated)

R_1	100kΩ
R_2	100kΩ (see text)
R_3	100kΩ
R_4	2.2kΩ ½W
R_5	39kΩ (see text)
R_6	100kΩ
R_7	6.8kΩ
R_8	100kΩ (see text)
VR_1	500kΩ pot lin

Capacitors

C_1	470pF 5% Polystyrene
C_2	470pF 5% Polystyrene
C_3	470pF 5% Polystyrene
C_4	25μF 12 w.v. electrolytic
C_5	0.047μF paper
C_6	0.1μF paper

Valve

V_1 (*a*) (*b*) ECC84

Chassis

4¾ x 2¼ x 1¾in

Miscellaneous

5-way tagstrip (one end-tag only may be earthed)
B9A valveholder with skirt and screen
Coaxial output socket. (Belling-Lee L604/S, or equivalent)
3-core cable
Octal plug

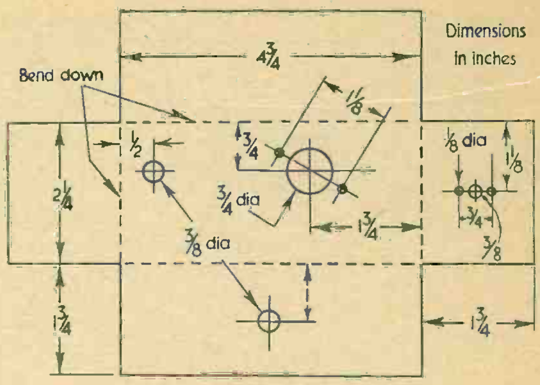


Fig. 3. Details of the chassis

The Second Triode

When the oscillator is functioning correctly a sine wave at about 1,000 c/s appears at the grid of $V_{1(b)}$ and may be extracted from this point if required. If, however, it is allowed to pass through $V_{1(b)}$ shaping occurs, and a square wave results. This may be extracted via VR_1 and the output socket provided. In the prototype a reading of some 20 volts was obtained here on a transistor voltmeter calibrated in r.m.s. values when VR_1 was set to maximum output. The output waveform monitored on a high input impedance oscilloscope is shown in Fig. 2 and, with the prototype, was not greatly degraded when VR_1 was adjusted, except at very low output.

Beginners might be puzzled at the location of VR_1, and the "chassis" connection to its track might not at first be obvious. If it is remembered that the h.t. rail is effectively at chassis potential for alternating currents, due to the electrolytic capacitor shown in broken lines in Fig. 1 (and situated in the power unit already described), the matter will be less perplexing.

General Points of Interest

Although constructors with no means of checking the waveforms will find the unit extremely useful, those who do possess oscilloscopes might find the following remarks of interest.

Several factors must be borne in mind if it is desired to obtain a good sine wave at $V_{1(b)}$ grid, and the values chosen for C_4, R_4 and R_5 affect the shape considerably. It might be beneficial to fit a 250kΩ variable resistor initially in place of R_5. If such a control is carefully manipulated the output waveform (at pin 2) can be made to give a good sine form, the purest wave normally being synonymous with lowest amplitude. Because of this fact, it might be necessary to employ a waveform which is slightly less perfect.

[3] The C two octaves above Middle C has a frequency of 1,047 c/s, and the B immediately below this a frequency of 988 c/s. Normally, the B.B.C. transmits a 1,000 c/s tuning signal on the Home Service and Television frequencies. See "B.B.C. Tuning Signals", *The Radio Constructor*, June 1962.—EDITOR.

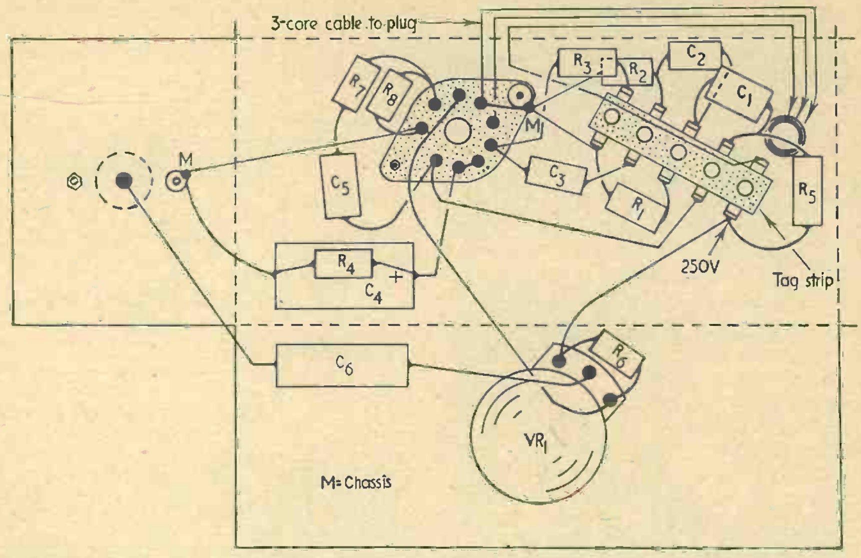


Fig. 4. Wiring layout below the chassis. With respect to the 5-way tagstrip, it is important to note that the only tag which may be at chassis potential is that nearest the valveholder

The inclusion of R_7 is desirable, or oscillation might not occur due to damping. The square wave output mark-space ratio can be varied by modifying the value of R_8.

Constructional Notes

Only a very small chassis is necessary, as may be seen from Fig. 3. It might, alternatively, be possible to make use of a 2-oz tobacco tin. A complete wiring diagram is given in Fig. 4, where it will be noted that all wire-ended components are neatly anchored to a small tagstrip. The type of tagstrip used is unimportant provided it has not less than four chassis isolated tags. Supplies are picked up from the power unit mentioned by means of a 3-core cable or by three flexible leads (with differently coloured insulation and plaited together) terminated at the remote end by an octal plug. A grommet is necessary at the hole on the chassis top plate for the power supply leads.[4]

Testing the Unit

Assuming that no wiring faults exist, testing may be carried out by temporarily connecting a pair of high impedance headphones to the output socket. If no phones are available the pick-up sockets of a broadcast receiver may be used. With the oscillator connected to the power unit and the mains switch closed, a strong audio note should be heard due to the oscillator. The frequency of the note may then be judged, or otherwise adjusted as mentioned earlier.

[4] It is not, of course, essential to employ the power supply described in the August 1962 issue. Any isolated power unit offering 6.3 volts at 0.33 amps for the ECC84 heater, and an h.t. voltage of 220–250 at 20mA may be used instead. Such a power unit should have one side of the heater supply and h.t. negative at chassis potential, and the h.t. output should be shunted by an electrolytic smoothing capacitor having a value of 32μF or more.—EDITOR.

TSR2 AIRCRAFT WILL USE **EMI RADAR**

The TSR2 strike reconnaissance aircraft is to be fitted with two new forms of electronic aids to aerial reconnaissance developed by EMI Electronics Ltd.

The first, known as Sideways Looking Radar, can provide an accurate map of the territory over which the aircraft is flying. Radar lobes extend out on either side of the aircraft and thus avoid giving advance information, to the enemy's counter measures, of the aircraft's arrival.

The second is known as Line Scan and consists of an optical scanner which provides pictorial information of the ground as viewed from the aircraft. This information can be stored in the aircraft or transmitted to a ground station whilst the aircraft is still in flight, automatically producing a photograph of a strip of the ground along the aircraft's track at the ground station. Thus, reconnaissance information is available even if the aircraft should not return.

Speech-on-Light System for Communication

C. MORGAN

THE NEED FOR A SIMPLE BUT efficient system of communication recently arose between two friends. Connection by way of wires was out of the question, and the writer was approached to see whether he could offer any solution to the problem. After some thought he recalled a system of communication that had been used many years ago to provide contact between an aircraft and the ground. This method was known as "speech-on-light", and it had considerable success, as long as the aircraft was visible from the ground, at a range of about half a mile or less. Outside that range the system became unusable.

The basic method of operating a speech-on-light link is to modulate a steady light source with an audio frequency. The fluctuations in light are then converted to a.f. voltages by a distant photo-cell, applied to an amplifier, and reproduced as audio once again.

A Practical System

The writer decided to see whether this system could be put into use with simple components and equipment, and he found that results were far better than had been anticipated. Due to the nature of the components employed, particularly at the transmitting end, there was a loss of the higher audio frequencies but, whilst this prevented the transmission of music without considerable distortion, speech could be received with perfectly adequate clarity. The system that was finally devised worked satisfactorily over a distance of 100 feet.

The transmitter consists of an amplifier coupled, by way of an audio transformer, to a small filament bulb. Also connected into the bulb circuit is a battery that causes the bulb to be partly illuminated. The a.f. from the transformer then varies the intensity of light from the bulb and, in consequence, modulates it. See Fig. 1.

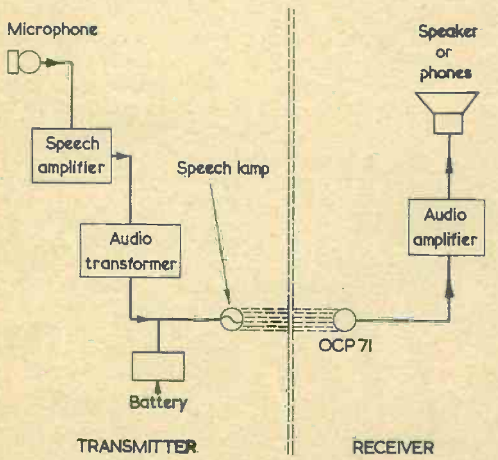


Fig. 1. The basic "speech-on-light" communications system

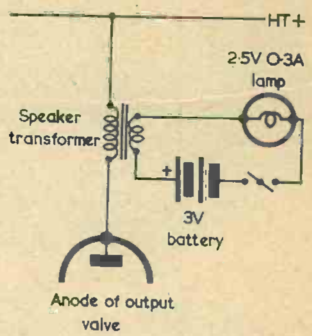


Fig. 2. Connecting the transmitting lamp and battery to the output stage of an a.c. mains receiver. The receiver speaker is disconnected

At the receiver, an OCP71 phototransistor picks up the modulated light beam and offers an a.f. output which is fed to an audio amplifier. The output from the latter then feeds a speaker or a pair of phones.

In order to obtain a useful range it is desirable to fit a focusing lens or mirror to both the transmitting lamp and receiving phototransistor.

In the writer's case, the amplifier employed at the transmitting end consisted of the triode and pentode a.f. stages of an a.c. mains radio fitted with pick-up sockets. The model used had a double-wound mains transformer, with the result that all additional wiring was isolated from the mains supply with a consequent reduction in the risk of shock. The output transformer in the receiver was identified, and the connections to the secondary disconnected from the speaker. A 3 volt battery and a 2.5 volt 0.3 amp torch bulb were then connected in series with the secondary as shown in Fig. 2.

When these connections are made the bulb will, of course, become illuminated. The next process consists of connecting an aerial to the receiver, turning the volume to minimum and tuning in to a station. No sound will, of course, be heard because the speaker is disconnected, but if the volume control is turned up slightly it will be noted that the light from the bulb commences to fluctuate in sympathy with the signal being received. The volume control should not be turned up too high because excessive signal level from the output transformer may cause the bulb to burn out. The volume control should, for similar reasons, be set to minimum when changing from one waveband to another.

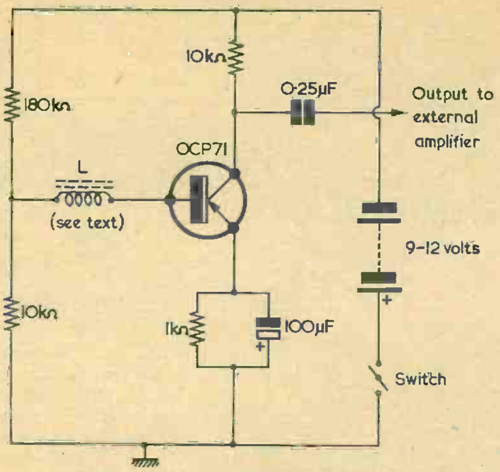


Fig. 3. The circuit in which the OCP71 is employed

After this, a suitable microphone can be connected to the pick-up terminals of the receiver. The writer initially employed an ex-G.P.O. carbon microphone, complete with step-up transformer and energising battery, and this offered more than adequate output. Later, a small moving coil speaker was used instead of the carbon microphone (but still employing the step-up transformer) and, whilst the available output was reduced, the quality of the modulation was noticeably improved.

After the microphone has been connected into circuit, operation may be checked by observing the bulb whilst speaking into the microphone. If there is a fluctuation in the light from the bulb then operation is satisfactory. The receiver volume control will need to be set up for best conditions when the microphone is in use, and it should be remembered that excessive a.f. at the receiver output transformer can still cause the bulb to burn out.

The Receiver

At the receiving end, all that is required is an OCP71 with associated components, and another a.f. amplifier. The writer employed a tape recorder amplifier, but it is probable that a two valve amplifier, as used at the transmitter, should prove adequate. Alternatively a small transistor amplifier could be used.*

The OCP71 is connected up in the circuit shown in Fig. 3. In this diagram the inductor L consists of an a.f. choke. A smoothing choke as employed in a power pack is quite satisfactory here, but a small physical size is desirable in order to reduce the bulk and weight of the OCP71 unit. Fortunately, the limited audio frequencies

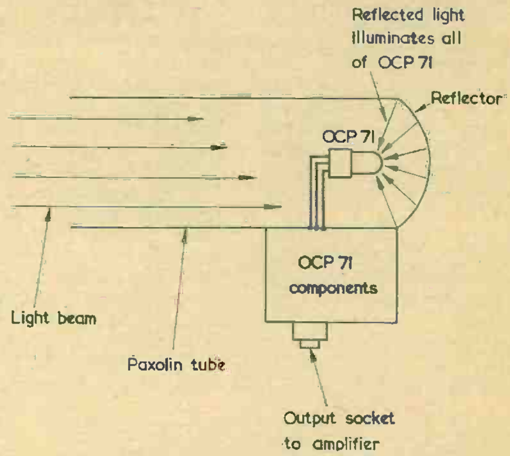


Fig. 5. The OCP71 receiving assembly

over which the communications system is required to work do not call for a critical value of inductance in this component.

Mounting the Lamp and Photo-transistor

Both the lamp and the photo-transistor can be mounted in similar housings. The lamp housing is shown in Fig. 4 and, as may be seen, this comprises a Paxolin tube fitted at one end with the bulb and its reflector. Two small sights fitted to the outside of the tube

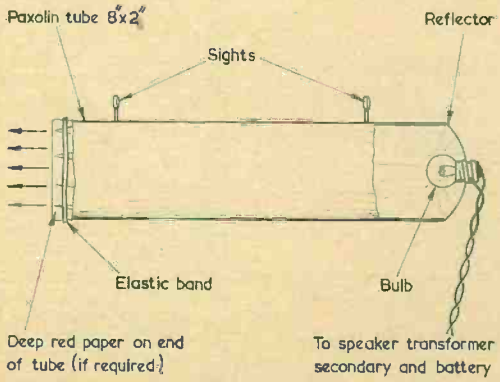


Fig. 4. The transmitting bulb, reflector and housing

* The type of amplifier in an installation of this nature is a matter for experiment. However, unless there is a close coupling via the optical path between the transmitting lamp and the OCP71, it would appear that an amplifier with somewhat greater gain than that offered by the a.f. stages of a valve radio would be needed.—EDITOR.

assist in aligning the lamp on to the OCP71. An interesting point is that, since the OCP71 is sensitive to infra-red radiation, performance is hardly affected if a red filter is fitted in front of the lamp. The writer found that he could, indeed, obtain satisfactory results by simply employing red paper as a filter. The result is that communication is still obtained, even though the beam of light becomes virtually invisible.

The receiver housing is shown in Fig. 5, and this is very similar to that used by the transmitting lamp. The phototransistor is mounted in a horizontal position with its base away from the reflector. This ensures that all of its light-sensitive area is illuminated by the light from the transmitter.

The reflector employed at the receiver is a glass type and that used by the writer had measurements of 5cm x 5cm (i.e. diameter and focus). Suitable reflectors are available through some photographic dealers. It is important to note that the OCP71 housing should never be pointed directly at the sun, as the intense light then focused on the cell may ruin it.

The twenty-ninth in a series of articles which, starting from first principles, describes the basic theory and practice of radio

part 29

understanding radio

By W. G. MORLEY

IN LAST MONTH'S ARTICLE WE CONTINUED OUR discussion on i.f. transformers, showing that these fall within the category of "band pass filters". A number of band pass filter circuits were then considered. We concluded by introducing the subject of screening at radio frequencies, dealing in particular with the screening cans which are fitted to i.f. transformers, and the manner in which these constrain the magnetic field about such transformers. We shall now carry on to examine how screens may be used to prevent capacitive couplings.

Screening-Capacitive

In Fig. 180 (*a*) we see two metal plates mounted in air. Since air is an insulator and the two plates are conductors, a capacitance exists between them. As we saw when we initially introduced capacitors,[1] we can draw lines of electric force between the two plates as in Fig. 180 (*b*), these representing the electric field between them.[2]

In applications of the type encountered in radio it is feasible for the plates to appear in a single item of equipment, and to be connected up in such a manner that an alternating voltage is applied to one, whilst the second plate connects to a load. Both the source of alternating voltage and the load will have a common connection by way of the metal chassis of the equipment, whereupon we have the basic circuit which is shown in Fig. 180 (*c*). Since, in Fig. 180 (*c*), capacitance exists between the two plates, a proportion of the alternating voltage on the left-hand plate will appear on the right-hand plate also. In consequence, a proportion of the alternating voltage appears across the load.

In some instances, the capacitive coupling between the generator and the load may be undesirable, whereupon steps have to be taken to reduce it. One simple method of reducing the coupling is to increase the distance between the two plates; but it may not be possible in practice to obtain sufficient spacing to reduce the capacitance to an adequately low level. An alternative approach consists of interposing a metal *screen*, as in Fig. 180 (*d*). The screen is connected to chassis, with the result that the lines of electric force which previously existed between the two plates are now interrupted, and a new field appears between the left-hand plate and

[1] In "Understanding Radio" part 8, April 1962 issue.
[2] Such a field exists when the plates have differing potentials, as will be the case in the examples of capacitive coupling to be discussed here.

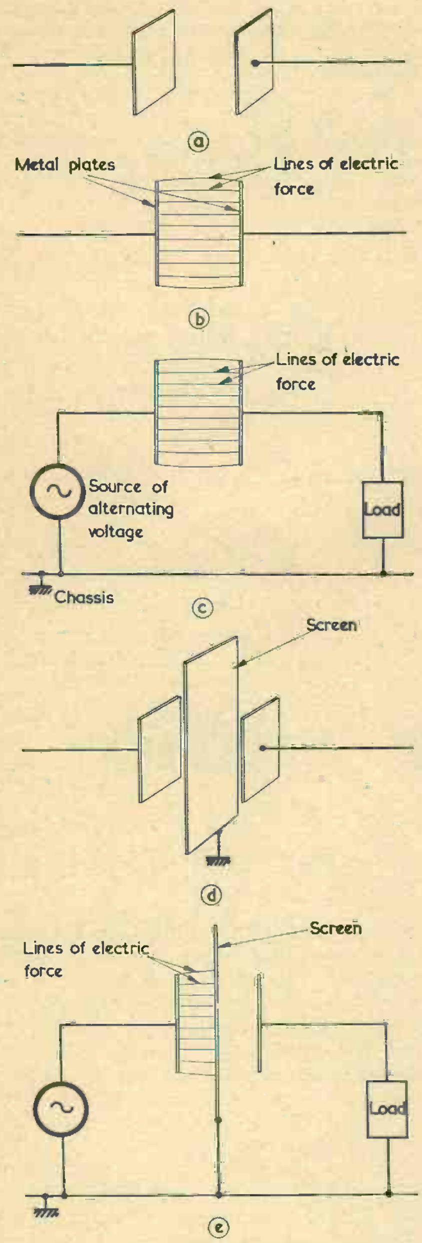


Fig. 180 (a). A capacitance exists between two metal plates positioned as shown here
(b). The presence of capacitance is indicated by an electric field between the plates when they have differing potentials
(c). In this basic circuit, a proportion of the alternating voltage appears across the load, which may be a resistor or an impedance
(d). Interposing a screen between the two plates
(e). The screen interrupts the capacitive coupling between the plates

the screen. See Fig. 180 (*e*). There is now no field between the left-hand plate and the right-hand plate, whereupon no capacitive coupling exists between the two and none of the alternating voltage appears across the load. The capacitance coupling has been broken by the screen.

In practical radio work it is only rarely that an unwanted capacitive coupling appears between two plates of the type shown in Fig. 180. Instead, the unwanted coupling will occur between wires, terminals, solder tags, and so on. Nevertheless, the capacitive coupling between such conductors may still be interrupted, as with the plates, by interposing a screen connected to chassis. We use the plates here merely for convenience of illustration.

When discussing Figs. 180 (*d*) and (*e*) we stated that, after the screen had been introduced between the two plates, there was no capacitive coupling between them. This is not entirely true, however, because it is possible for a small proportion of the electric field to extend around the edges of the screen and thereby still permit a small capacitive coupling to exist. This capacitive coupling can be reduced to negligible proportions by increasing the area of the screen, or it can be removed altogether by completely enclosing one or other of the plates, as in Fig. 181 (*a*) or (*b*). Since, in both these instances, the electric field about the left-hand plate cannot pass further than the screen, the capacitance between the plates drops to zero.

To function correctly, it is necessary for the screen to be connected to chassis. In Fig. 182 (*a*) we see the same set of conditions as we had in Fig. 180 (*e*), with the exception that the screen is not connected to chassis. What happens in this instance is that lines of electric force extend to the screen from the left-hand plate and that similar lines of force carry on from the screen to the right-hand plate. The effect is the same as that demonstrated by the two capacitors shown in Fig. 182 (*b*), the left-hand capacitor being given by the left-hand plate of Fig. 182 (*a*) and the screen, and the right-hand capacitor being given by the screen and the right-hand plate of Fig. 182 (*a*). The screen does not, in consequence, reduce the capacitive coupling between the two plates. We may see, therefore, that if we employ a screen to remove capacitive couplings between conductors, it is essential that the screen be connected to the chassis of the associated equipment. This is analogous to adding a chassis connection to the two capacitors of Fig. 182 (*b*), giving the circuit shown in Fig. 182 (*c*) in which it is obvious that none of the alternating voltage can appear across the load.

A further point which may now be introduced is that the screen will be less effective if there is a significant resistance or impedance in series with its connection to chassis. The analogous circuits of Figs. 182 (*b*) and (*c*) would then take up the form shown in Fig. 182 (*d*).

Finally, we should consider what occurs if the screen does not present a completely unbroken surface to the conductors. An instance is given in Fig. 183, wherein the screen has an aperture. This diagram also illustrates the electric field conditions which exist about the aperture. Because the metal of the screen around the aperture offers a greater attraction to the field from the left-hand plate than does the distant right-hand plate, most of the field travels to the screen instead of to the right-hand plate. Thus, the capacitive coupling between the two plates is considerably reduced by the perforated screen, even if it is not entirely brought to zero. In practice, it is usual to find that screens with a number of perforations can reduce capacitive coupling to negligibly low proportions if the perforations are small in area compared with the area of metal around them. The capacitive coupling which finally results depends upon the size and number of perforations, and the spacing between the conductors and the screen. Perforated screens are of value for some applications, a typical instance being given when it is desired to allow the passage of air through the screen for ventilation.

Coil Screening

We introduced the question of screening by way of the i.f. transformer screening can and we should, therefore, return to this application before dealing with any further aspects of screening.

As we may now see, the metal screening can fitted to the i.f. transformer prevents both inductive and capacitive couplings between the transformer and

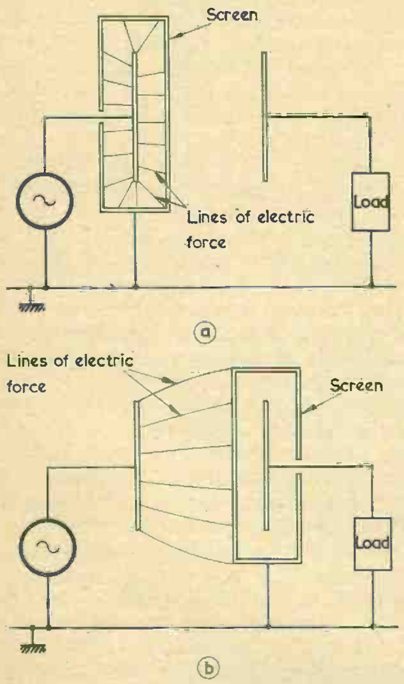


Fig. 181 (a). Complete screening between the two plates may be achieved by having one enclosed by the screen. (A small hole is provided in the screen for the lead-out wire)
(b). Complete screening is also provided if the other plate is enclosed by the screen

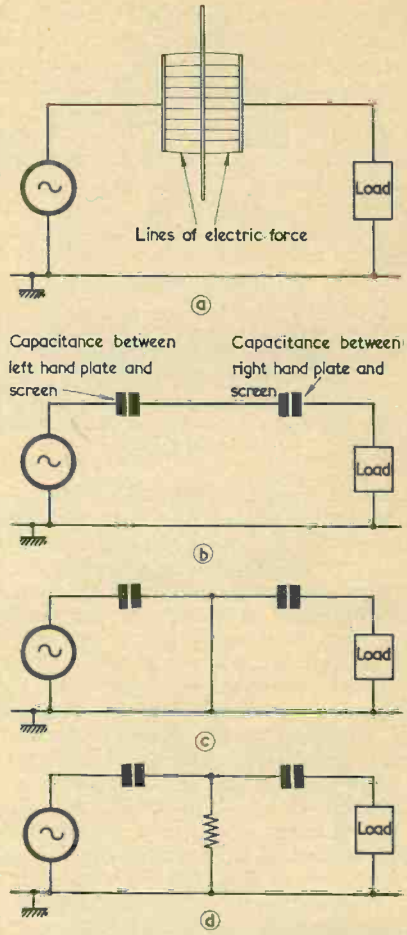


Fig. 182 (a). If the screen is not connected to chassis it does not interrupt the capacitive coupling between the plates
(b). The screen and plates of (a) can be represented as shown here
(c). The effect given by connecting the screen to chassis
(d). The efficiency of the screening is reduced if resistance (or impedance) is inserted in the chassis connection to the screen

components mounted close to it. Inductive couplings are prevented because the magnetic field about the transformer coils is changing at radio frequency, and this sets up currents in the inside surface of the can which produce opposing fields. Thus, the magnetic field can only enter the material of the can for a small distance before the opposing fields cause it to be almost completely cancelled out. Capacitive couplings are prevented because the can is connected to chassis, and the electric fields from the coils and wiring pass to the inside surface of the can and no further. The typical i.f. transformer cans we have discussed employ unperforated metal, apart from the fact that small holes are provided

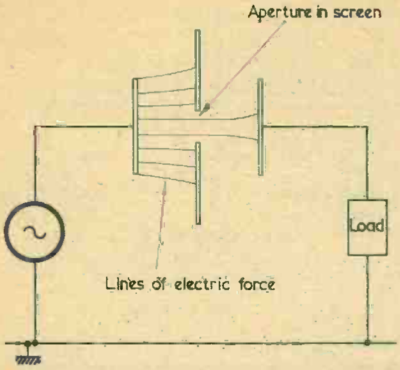


Fig. 183. If the screen has an aperture most of the field passes to the screen, but some may pass through to the second plate

to allow trimming adjustments to be made. Also, the cans do not entirely enclose the transformer, as the bottom part is left open. In instances where a very high degree of screening is required, the transformer assembly could be mounted on to a metal chassis having small apertures for the passage of connecting wires or solder tags, causing the transformer to become almost completely enclosed by metal at chassis potential. For most radio receiver applications it is not necessary to provide this additional screening at the bottom of the transformer, and all the lead-out wires or tags may pass through a single large hole in the chassis.

It is frequently desirable to screen r.f. coils other than i.f. transformers, and the procedure followed is the same as for the i.f. transformers. A typical example is shown in Fig. 184, in which we see a simple r.f. transformer fitted inside a screening can.

The screening can around a coil operating at radio frequency constrains its magnetic field since the latter induces opposing fields in the material of the can. Because of this, power is dissipated in the can. It follows that the can may cause a reduction in the efficiency of the coil, and hence its Q. In practice, this effect is not serious provided that there is adequate clearance between the outside of the coil and the inside surface of the can. The opposing

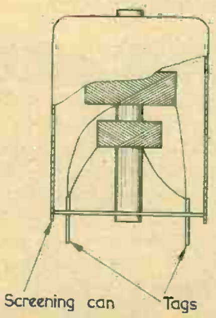


Fig. 184. R.F. coils are fitted in screening cans in the same manner as i.f. transformers

fields generated in the material of the can also reduce the effective inductance offered by the coil but, here again, the effect is not serious provided that adequate clearance exists. The relationship between clearance and reduction in Q or inductance is somewhat complex, but it is safe to assume as a "rule of thumb" that there will be no serious losses in either Q or inductance provided that the clearance between the outside of the coil and the internal surface of the screen is, in all directions, equal to, or greater than, the coil radius.

A different state of affairs exists with pot core coils. In this instance almost all the magnetic field flows through the material of the core, and it is possible for a screen to approach the outside surface of the core very closely without causing an excessive reduction in Q or inductance.

There is, as we have seen, a capacitance between a conductor and a screen. When the conductor and screen are close together this capacitance may be sufficiently high to modify circuit operation, and this represents a point which has to be borne in mind during radio design work. If, for instance,

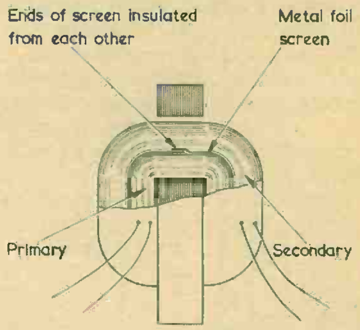


Fig. 185. Inserting a screen between the primary and secondary of an iron-cored transformer

the spacing between a screening can and a coil is low, the resulting capacitance between the turns of wire in the coil and chassis could alter the resonant frequency of the coil. In practice, however, the capacitance to chassis offered by a coil screening can only becomes troublesome when the clearance is smaller than the minimum needed to prevent a serious drop in Q and inductance, and so the question of excessive additional capacitance to chassis does not arise in the case of the coil. Nevertheless, it is usually desirable to ensure that connecting wires to the coil, and parallel fixed capacitors in the case of an i.f. transformer, are not allowed to take up positions which are very close to the inside surface of the screening can. The capacitances to chassis resulting from very close positioning of wires or fixed capacitors may, in some cases, adversely affect the performance of the component.

In the case of pot core coils, the method of assembly normally ensures that capacitances between the screening can and coils (and coil lead-out wires) are sufficiently low to have little serious effect.

Screens and Shields

It will be helpful at this stage to summarise the points we have discussed with respect to screening and shielding, and to show their relationship with frequency.

Magnetic fields generated by iron-cored coils and transformers may be shielded by a sheet of magnetic material, the latter ranging from mild steel to one of the high permeability alloys such as Mumetal. For optimum shielding efficiency the magnetic material should completely enclose the component radiating the field, or the component which is affected by it. Shielding of this nature is effective over power and audio frequencies. Magnetic fields at radio frequencies may be screened by a sheet of metal which needs to be a good conductor rather than have good magnetic properties. Currents induced in the conducting material produce opposing fields which nullify the effect of the original field. Again, for optimum screening, the screening material should completely enclose the component concerned.

Alternating electric fields may be screened by interposing between conductors a screen which is connected to the chassis of the equipment in which the conductors appear. To ensure optimum screening around a particular component, the latter should, once again, be completely enclosed by the screening material. It is important to note that screening of electric fields applies at power and audio frequencies as well as at radio frequencies since the function of the screening is to interrupt capacitive couplings, which may exist at all frequencies.

We may now see that, to shield an inductive component at power and audio frequencies, we need to place a shield of magnetic material around it. If we connect the shield to the chassis of the associated equipment it prevents capacitive couplings as well. To constrain the magnetic field about a component operating at radio frequencies, we place a screen of conducting material around it. This screen also prevents capacitive couplings when it is connected to chassis.

We have, up to the present, used the term "shield" for the instance where a power or audio frequency magnetic field is constrained, and "screen" for the instances where magnetic fields at radio frequency and electric fields at all frequencies are constrained. These terms conform with fairly general usage in this country, but it will be found that "screen" is frequently used for all three applications as, also, is "shield". Thus, the terms "screen" and "shield" may, in general, be considered as being synonymous.[3]

Newcomers to radio may find themselves a little confused at the use of the term "chassis" with respect to screen connections. As will be appreciated more readily when we come to deal with valve and transistor circuits, it is common practice to provide a piece of electronic equipment with a metal chassis or frame which offers a common connection for all components handling signal currents at radio and audio frequencies. Small items of equipment may not have such a chassis, all the components being mounted on one or more sheets of insulating material. Nevertheless, equipment of this type will still normally employ a common connection for the individual circuits, and this offers the same function as a "chassis". Sometimes, a connection to "chassis" is described as a connection to "earth", in the same way as a connection to the chassis of a car is described as a connection to "earth". Thus, the screen of Fig. 180 (*e*) may be described as being "connected to earth" or as being "earthed". This practice can occasionally introduce a little confusion, however, because some electronic chassis are connected directly to earth[4] whilst others are not. When referring to connections to chassis, it is best, in general, to avoid the term "earth".

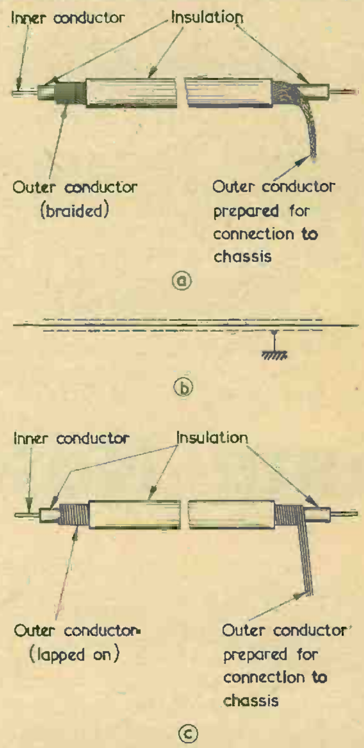


Fig. 186 (a). A typical example of screened cable. The outer conductor consists of a number of fine wires braided together
(b). The circuit symbol for screened cable. Also shown is a connection from the outer conductor (represented by the broken lines) to chassis
(c). An alternative type of screened cable, in which the outer conductor consists of a number of fine wires lapped over the internal insulation

Other Screening Applications

Before concluding on the subject of screening,

[3] It should be mentioned that British Standard 204: 1960, *Glossary of Terms Used in Telecommunication and Electronics*, specifies "screen" for all three applications, giving "electric screen", "magnetic screen" and "electromagnetic screen" for screens which constrain, respectively, electric fields, magnetic fields, and magnetic and/or electric fields. American usage is to use "shield" for all three instances much more frequently than "screen".

[4] That is, to a conductor which makes good contact with the earth itself.

several further applications need to be discussed.

In iron-cored transformers it is frequently desirable to insert a screen between the primary and secondary (or secondaries) to reduce capacitive coupling between these windings. The coupling which results is then almost entirely inductive. A screen of this nature may be introduced during winding in the form shown in Fig. 185. In this diagram a strip of metal foil, typically copper, is wound on after the primary, its width being the same as the winding width and its length being such that it forms a complete turn with a small amount of overlap. The two ends of the strip are insulated from each other to prevent the flow of induced current. The foil strip is connected to chassis and provides a useful reduction in capacitive coupling between the two windings.

Another application is offered in *screened wire* or *screened cable*. Screened wire consists of one or more insulated conductors inside a concentric outer conductor, the latter being connected to chassis. (See Figs. 186 (*a*) and (*b*).) The outer conductor then reduces capacitive couplings between the inner conductor, or conductors, and any other components or conductors in the vicinity. Usually, the outer conductor consists of thin strands of wire braided together, as in Fig. 186 (*a*), but a recently introduced alternative has the outer conductor lapped on only, as in Fig. 186 (*c*). Despite the fact that the lapped outer conductor possesses some inductance it functions satisfactorily in practice, especially at audio frequencies, and is cheaper to produce.

Screened wires and cables tend to exhibit a relatively high capacitance between inner and outer conductors. This fact is of importance, as the capacitance can be of significance in some applications.

Next Month

We have now concluded our consideration of the basic elements of radio, and have dealt with resistance, capacitance and inductance, the form taken up by practical resistive, capacitive and inductive components, and the manner in which such components may be used in combination. We shall carry on, next month, to sound reproducing devices.

Some Notes on the "Crystella" FM Tuner

BY SIR JOHN HOLDER, BART.

The "Crystella" crystal controlled f.m. tuner, described in our February and March 1963 issues, has resulted in considerable interest amongst readers. As a result of queries raised and further experience obtained, the author of the original articles passes on some additional notes and information

Components List

THE FOLLOWING AMENDMENTS AND CORRECTIONS should be made to the Components List (page 519, February issue). C_{14} should be ceramic, R_{20} should be 47kΩ, and L_3 should employ 18 s.w.g. wire. If desired, C_{15} and C_{16} can be silver-mica instead of ceramic.

Aerial

The necessary aerial depends on B.B.C. signal strength, and local advice should be taken. In many cases a length of twin flex, parted in the centre and opened out to form a horizontal dipole 5 feet long, will be adequate. This should be secured to a picture rail at right angles to the transmitter.

Usually, the higher the aerial and the further it is away from road traffic, the better; but if the lead-in is more than a few yards long, concentric TV feeder cable should be used. The tuner is not intended to be used with balanced twin feeder.

Adjustment of L_2

The function of L_2 does not appear to be generally understood. Most of the gain of multi-valve v.h.f. tuners takes place in the converter and i.f. stages, and any attempt to peak the anode circuit of V_1 usually leads to design disadvantages in other directions; so that L_2 is to be regarded as mid-way between aperiodic and sharply-tuned. Little extra gain will result from operating it with the core positioned other than in the centre of the coil. Even with an effective coupling capacitor of less than 5pF, L_2 has considerable effect on L_3 and the correct adjustment of L_2 is that which allows the oscillator to function correctly and, at the same time, passes adequate signal to the mixer.

Adjustment should, therefore, proceed in the following manner. Start with the core in the centre of L_2 and adjust L_3 for good oscillation on all three programmes, as described in the article. Next, switch to "Light Programme" and gradually withdraw L_2 core towards the chassis end of the coil. It will be found that signal strength, as evidenced by the voltage developed at Test Point 1, increases slightly, but that a position will be reached where the oscillator suddenly stops working. If, now, the core is screwed in again until oscillation recommences, the optimum setting of L_2 will have been obtained.

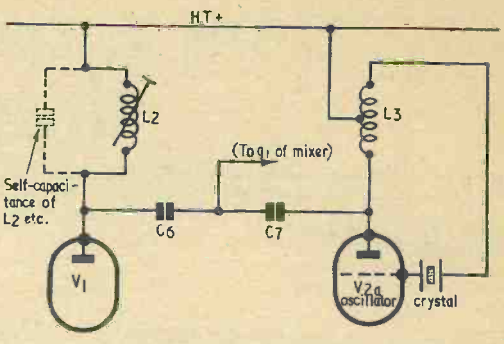
This cessation of oscillation is a feature common to crystal and tuned-anode tuned-grid oscillators. What happens is that, when the anode limb is effectively tuned to the same frequency as that of the grid or crystal, phase relations become such that the impulses which ought to maintain oscillation occur at the wrong moment. The full explanation is interesting but rather involved and mathematically-minded readers are referred to, for instance, the oscillator sections of the Admiralty Handbook. The remedy is to detune one of the circuits slightly, so that the resonant frequency of the anode limb is slightly lower than that of the grid limb.

Two Types of Valveholder

Some readers have queried the use of two types of valveholder. P.T.F.E. is expensive and easily damaged by heat during soldering, so it is only specified because it has to be. The crystal-holder and, to a less extent, the valveholder for V_2, are in parallel with the crystal, which has a very high Q indeed. Bridging the crystal with a material which has anything more than the lowest possible loss at v.h.f. will result in reduction of Q.

Adjustment of the Oscillator Coil

A few readers complain that they cannot get L_3 to tune down to the required frequency band. This could be a manifestation of the L_2 peculiarity mentioned above, or it could be that the wiremanship capabilities of readers have been underestimated and that they have reduced strays to a phenomenally



low value! Whatever the cause, there is no harm in increasing the nominal inside diameter of L_3 to $\frac{15}{32}$ (for instance, by wrapping sticky paper or plastic round the winding former). In some cases, $\frac{1}{2}$in inside diameter may be better. The author's tuner has worked quite well with any of these three diameters. In fact, the exact size of L_3 is not as important as that of L_2.

One reader solved the problem by increasing C_7 to 10pF. Using C_7 as a tuning capacitor is not a very efficient method and can lead to complications because it only bridges half of the coil. Another reader added a core to L_3. This, also, is not recommended.

The expedient of adding one more turn is fraught with many difficulties and would have little effect because, with a coil of this kind, dimensions are more important than the number of turns.

An Alternative for L_2

If the reader, even after reading these notes, has difficulty over front-end adjustment, he may care to try the version of L_2 originally specified by Standard Telephones and Cables Ltd. This consists of six turns of 20 s.w.g. enamelled copper wire wound on to the same sized former as the previous coil, but in such a manner that the turns touch one another. The advantage of this coil is that it makes it easier for a constructor to reproduce the prototype accurately. The disadvantage, in this case, is that it may mean purchasing another reel of wire for the sake of less than a foot. If, when using the Crystella coil, the oscillator will work with the slug in the centre and cease working on the "Light Programme" when the slug is withdrawn to a certain point, the constructor can take it that his coil is correct and that there is no need to make any change.

Incidentally, if the constructor already possesses 18 s.w.g. enamelled wire, six touching turns of this will serve.

Inter-Relation of L_2 and L_3

The diagram accompanying these notes, shows part of Fig. 1 of the article re-orientated to show the coupling of L_2 to the anode half of L_3 and, also, why altering the value of C_7 is not a satisfactory way of tuning L_3. All irrelevant details have been omitted.

Cold Cathode Diodes and Their Uses

By J. B. Dance M.Sc.

THE USE OF COLD CATHODE DIODES, OFTEN KNOWN as "neons", has the great advantage that the associated circuitry is usually simpler than when hard valves are employed to perform the same work. This is partly, but not entirely, due to the fact that no heater wiring is required for cold cathode circuits. Cold cathode diodes are widely used in computing equipment, as they are reliable in operation (when used correctly) and are relatively small and inexpensive.

One of their main limitations is that they cannot operate at high frequencies. The reason for this is that, once the gas is ionised by an applied voltage, a definite time must elapse before the ions disperse after the voltage has been removed. Nevertheless for switching speeds not greater than some hundreds per second, cold cathode tubes are extremely useful.

Basic Theory

Cold cathode valves contain a gas at a fairly low pressure (usually less than 10cm of mercury pressure). The gas is normally one of the inert gases (helium, neon, argon, krypton or xenon) or a mixture of two or more of these gases.

When a voltage is applied to a cold cathode tube, the type of I_a/V_a curve shown in Fig. 1 is obtained.

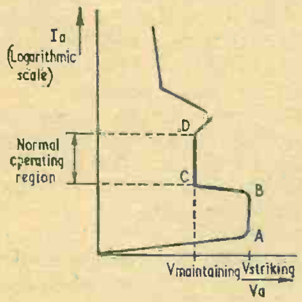


Fig. 1. Cold cathode diode characteristics

The initial straight portion of the graph up to point A represents very small currents of the order of 10^{-15} to 10^{-12} amp; this is known as the Townsend current. As the number of ions increases with increasing applied voltage, breakdown occurs at point A. The voltage at point A is known as the striking voltage; it varies considerably from tube to tube and depends on the size and geometry of the electrodes, the composition and pressure of the gas used and even the type of metal used for the electrodes.

Once the discharge has passed point A on the characteristic the point of operation moves rapidly through the region A to B and then through the region B to C where the incremental resistance of the tube is negative. The region C to D is stable and is the part of the curve on which cold cathode tubes are normally operated. The current through the tube in this region of the characteristic is almost independent of the applied voltage. There is therefore an obvious use for cold cathode valves as voltage stabilisers.

In the region of the characteristic from C to D the current passing is determined by the external circuit resistance. If this resistance is reduced, the current through the valve increases, but the voltage across it remains virtually constant. If, however, the external circuit resistance is decreased until the point D in Fig. 1 is reached, a further reduction of the resistance leads first to an increase and then to a decrease of the anode to cathode voltage across the valve. Eventually an arc is formed.

Mechanism of Emission

In normal valves electrons are emitted from a heated cathode. In cold cathode valves the applied electrode voltage first causes some ionisation. The positive ions formed are attracted to the cathode and they hit the cold cathode at a speed which is great enough to cause electrons to be emitted from it.

In order that ionisation shall occur and that the valve shall strike without delay, it is necessary that a few ions shall be present in the gas. Enough ions are usually provided by the effects of cosmic rays, the few radioactive atoms which every substance contains and the light falling on the tube. If the valve is placed in brilliant light, the striking voltage may be reduced appreciably owing to an increase in the ionisation when no voltage is applied. Conversely, if the valve is used in complete darkness, it may not strike easily. Those for use in complete darkness may therefore contain a small quantity of a radioactive gas such as tritium which provides the necessary ionising radiation. Care should be taken not to break the glass envelope of such valves, or the radioactive gas will escape.

The work function of a material is a measure of the work which must be done to extract an electron from it. Oxide coated cathodes are normally used in thermionic valves because they have a low work function (i.e. they emit electrons easily). In cold cathode types, the material of which the cathode is composed must be chosen carefully so that it has a suitable work function. The characteristics of the tube are affected considerably by the choice of the cathode material. Sometimes an active coating is placed on the surface of a metal cathode.

Some Applications

Voltage Stabilisation

Most readers will be familiar with the use of a cold cathode voltage stabiliser in the type of circuit shown in Fig. 2. When the valve is operated in the

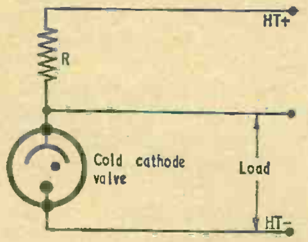


Fig 2. The cold cathode diode as a voltage stabiliser

portion of the curve of Fig. 1 between the points C and D, the voltage across it remains almost constant as the current through it varies. Suppose that for some reason the current taken by the load of Fig. 2 increases slightly. The current taken by the stabiliser will then decrease slightly (by the same amount as the load current increases) so that the total current passing through the resistor R is constant. The voltage drop across R will therefore be unchanged and the output voltage, which appears across the valve, will also be constant.

If the supply voltage should increase for any reason, the voltage across the valve will be increased for a few thousandths of a second, after which the valve will draw more current. This increased current will pass through R and hence the voltage dropped by R will increase so that the output voltage is kept constant. Thus the output voltage to the load will be kept constant no matter whether the load current or the supply voltage changes.

The performance of a voltage stabiliser is not perfect. Some slight voltage variation will occur as the current through the valve is changed, but this effect is very much smaller than the variations which would occur if no stabiliser were employed.

The resistor R of Fig. 2 may be chosen so that, when the load is connected, the stabiliser operates at a point somewhere near the centre of the flat C to D region of the Fig. 1 curve. The current which must pass for this condition to be satisfied is the mean of the maximum and minimum currents specified by the makers of the particular valve concerned. The circuit will then be effective against changes of voltage in either direction provided that the operating point remains in the C to D region of Fig. 1.

If the load is liable to be disconnected, care must be taken to ensure that the current drawn by the stabiliser will not then exceed the maximum permissible figure.

Practical Example

Suppose that an oscillator or other piece of equipment requires a stabilised supply of 90 volts (approximately) at 10mA and that the supply is to be obtained from a 200 volt h.t. line. The value of the resistor in Fig. 2 must be calculated.

A suitable stabiliser to provide 90 volts is the 90C1. This requires a current of between 1 and 40mA. Let us assume that the stabiliser will normally take about 15mA, this being about the middle of the range. There is no point in operating the valve at exactly 20.5mA, as this merely wastes some current. The total current passing through the resistor of Fig. 2 will therefore be the sum of the tube and load currents, i.e. 15+10=25mA. The supply voltage of 200 volts must be dropped to the required 90 volts and the voltage difference will appear across the resistor. The value of the resistor will therefore be

$$R=\frac{V}{I}=\frac{200-90}{25\times 10^{-3}}=\frac{110}{25\times 10^{-3}}=4.4\text{k}\Omega$$

A 4.7kΩ resistor (the nearest 10% preferred value) could therefore be used. The 10^{-3} in the above expression converts the milliamps into amps. The power dissipation of the resistor required $=VI=110\times 25\times 10^{-3}=2.75$ watts.

Relaxation Oscillators

An extremely simple type of relaxation oscillator can be constructed using the type of circuit shown in Fig. 3. The capacitor takes time to charge

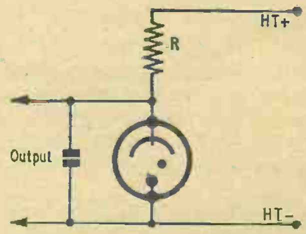


Fig. 3. Cold cathode diode in a relaxation oscillator circuit

through the resistor, but when the voltage across the capacitor reaches the striking voltage of the diode, the capacitor discharges itself quickly (but not completely) through the diode. This continues until the potential across the capacitor falls to a value which is less than the maintaining voltage of the diode. The capacitor then charges up again and the cycle is repeated.

The output waveform from this type of circuit is approximately a sawtooth, as shown in Fig. 4. The frequency is determined by the applied voltage, the value of the anode resistor and the value of the capacitor. The larger the value of the capacitor and of the resistor, the lower the frequency of oscillation.

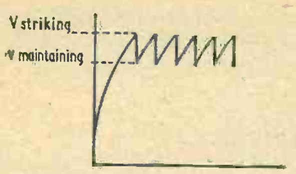


Fig. 4. Output waveform of a relaxation oscillator

The larger the value of the supply voltage, the greater the frequency. The striking and maintaining voltages of the cold cathode valve also affect the frequency.

The peak value of the discharge current of the Fig. 3 circuit may be very large and it is often wise to limit this by placing a much smaller resistor than R in the cathode circuit of the valve or in series with the capacitor. The output voltage can be taken from across this resistor if desired and, by a suitable choice of circuit, either positively or negatively going pulses can be obtained.

Special types of diode are manufactured (known as "difference diodes") in which the difference between the striking and maintaining voltages is much greater than in the more common types. These diodes provide much larger output voltages.

Relaxation oscillators of this type are often useful because of their simplicity when compared with valve or transistor oscillators. For example, constructors of signal generators for radio frequencies usually require a source of audio modulation to be available. The simplest method of obtaining this modulation (but not necessarily the best) is by the use of a relaxation oscillator using a miniature cold cathode valve.

Indicator Lamps

Neon indicator lamps have the advantages of extreme simplicity and a long life which is free from sudden failure. A resistor must always be employed between the supply voltage and the tube to limit the current passing through the tube to a safe value. Indicator tubes can operate from an a.c. or d.c. supply.

Small neon indicator lamps are usually operated at a voltage of about 65. If they are fed from a 240 volt supply, a 330kΩ series resistor would be satisfactory.

Some large cold cathode tubes used for lighting are fitted with an internal resistor so that they can be fitted directly into an electric lamp socket. One electrode is of a spiral shape. They are useful when a small amount of light is required overnight, as their current consumption is very small.

Another type of neon indicator lamp is finding many applications in counting equipment. A common anode is normally employed with ten separate cathodes. The supply voltage is connected (through a series resistor) to the anode and one of the cathodes. A certain number between 0 and 9 then appears as a red glow in the valve, the particular number depending on which of the ten cathodes has been used. If six of these are employed side by side, numbers up to 999,999 can be displayed. The number is displayed only a very minute fraction of a second after the voltage is placed across the anode and appropriate cathode.

Some indicators are also manufactured in which various letters of the alphabet can be displayed. Hence electronic circuitry can control the display of a number of words. Other indicators are available which display plus and minus signs, fractions, the decimal point, etc.

A.F. Transmission Switches

The current passing through a cold cathode diode can be modulated at an audio frequency and the valve will then pass audio signals. The current through the valve always passes in the same direction, but its value increases and decreases at an audio frequency.

Special types of cold cathode diodes have been developed for this purpose in which undesirable attenuation of the audio signal and noise level are kept to a minimum. These are known as "speech tubes".

When cold cathode diodes are employed in this way, they can be used to switch on and off the audio signal. This is effected by alteration of the steady potential applied to the valve. Thus the diode can replace considerably more complicated relays and switches; in addition it has the advantage of operating more rapidly than the normal electro-mechanical relay.

Monitors

Cold cathode diodes can be used as monitors to provide a visual indication when the voltage in a circuit reaches a certain pre-determined value. For example, the anode current of a valve falls during its lifetime owing to decreased emission from the cathode. A neon monitor could be placed between the anode and another suitable point in the circuit so that when the anode current fell to some pre-determined value (representing the end of the valve's useful life), the rise in anode voltage caused by the reduced anode current would cause the neon to strike. The service engineer would then know immediately which valve should be renewed.

Pulse Storage

A cold cathode diode can be used in the type of

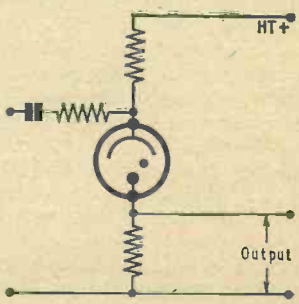


Fig. 5. Cold cathode diode pulse storage circuit

circuit shown in Fig. 5 for storing pulse information. The h.t. supply voltage is not sufficient to strike the tube, but is sufficient to maintain the discharge once the tube has struck.

When a positive pulse is fed into the anode circuit via the capacitor, the anode voltage is momentarily increased to a value which is large enough to strike. The h.t. supply then maintains the discharge.

The "difference" types of cold cathode tube mentioned in the second application are the most convenient type for this application. If the pulse available is a negative pulse, a similar type of circuit can be used, but the pulse is fed to the cathode of the cold cathode valve. The cathode or anode resistor is often replaced by a relay. The relay is closed when a pulse is applied and remains closed until the anode voltage is cut off.

By careful choice of circuit values, the same type of circuit can be used as a coincidence storage circuit in which the diode will only strike when a positive and negative pulse are applied at the same time.

Circuits of this type are widely used in computers.

Decade Valves

Valves are now manufactured which contain thirty cold cathodes in one envelope. Ten of these are main cathodes and the other twenty are guide electrodes. Under appropriate operating conditions the visible discharge will move from one main cathode to the next main cathode as each pulse is fed in. The number of pulses (from 0 to 9) fed into the circuit can then be read off directly by merely noting the position of the discharge. Several of these valves can be placed one after the other in a suitable circuit so that any number, however large, may be read off. These tubes are extremely valuable for counting equipment such as that used with Geiger counters, etc. The maximum operating speed varies from about 4,000 evenly spaced pulses per second up to 20,000 pulses per second. The counting rates are lower for randomly spaced pulses and depend on the accuracy required.

Conclusion

In conclusion it may be stated that cold cathode diodes can be used for many purposes in modern equipment. This article has only attempted to outline a few of them.

Closed-Circuit TV for Canadian Vessel

Another Marconi Marine export order for a closed-circuit television system to aid the handling of a large vessel in restricted waters, was recently negotiated through the Canadian Marconi Company with the Canadian shipowners, Mohawk Navigation Co. Ltd., of Montreal.

The vessel is the 24,000 d.w. bulk carrier *Silver Isle*, built earlier this year at the Eire shipyard of Verolme Cork Dockyard Limited. The *Silver Isle*'s normal summer trade route entails making transits of the St. Lawrence Seaway many times during a season, and with a vessel of 730 feet in length and all-aft bridge construction, frequent negotiation of locks and canals presents obvious difficulties. For instance, when in the loaded condition, the nearest point ahead observable from the bridge is more than 800 feet distant from the stem, and even further when the ship is light.

It was therefore decided by the Mohawk Navigation Co. Ltd. that the installing of a closed-circuit television system would do much to overcome this problem of restricted vision by providing the captain and pilot with an unobstructed view to as close as 60 feet ahead which would otherwise have been unobtainable due to the all-aft bridge construction of the vessel. Because the light grasp of the camera is greater than that of the human eye it is also anticipated that the installation could assist pilots to make transits in conditions of poor visibility which might otherwise induce them to tie up and wait for clearer weather.

The Marconi Marine television installation on the *Silver Isle* employs a pan and tilt camera unit fitted in a waterproof housing mounted on the foremast some 50 feet above the waterline and 36 feet back from the stem. This location gives an unobstructed picture on the bridge monitor screen of any activities down to 60 feet immediately ahead of the vessel and also on the forecastle head. By means of the pan and tilt remote controls fitted alongside the bridge monitor, the camera can be rotated through 340° in the horizontal plane and can also be tilted up 5° and down 55° in the vertical plane. With this facility the camera can be brought into such a position as to provide on the monitor a point of reference—for example the jackstaff or stemhead—from which the observer can gauge distance and bearing of jetties, lock entrances, tugs, buoys or small craft which might otherwise be invisible from the bridge. Other facilities that can be controlled from the bridge include a heating system in the weatherproof casing to stabilise its performance and dry out any internal condensation that might be caused by cold spray striking the casing, and a windscreen wiper to reduce the effects of spray and rain.

The system, including cables, but with the exception of the monitor, which was supplied by C.M.C., was air-freighted to Montreal and installed by technicians of the Canadian Marconi Company.

NEWS AND COMMENT . . .

TV v. Press

The press must adapt its content and presentation to meet the challenge of television and exploit the advantages of the written word over the fleeting image. This was the conclusion of an international seminar held recently at Strasbourg, on the subject "The Written Press in the Television Age".

The Seminar was organised by the International Centre for Higher Education in Journalism, with the assistance of Unesco, and was attended by journalists from 20 countries.

There was no pessimism about the ability of the press to survive the challenge of the new media. Press, radio and television were held to be complementary, each with a special role in the modern world. They had strengths and weaknesses, and as time went on, each medium would tend to concentrate on the things which it did best.

Although commercial television was a competitor of newspapers in the economic sense, in other respects it could be an ally. Newspapers should, in fact, capitalise on television, taking advantage of the familiarity it brought of people and events, and reporting in depth to satisfy the interest which television stimulated.

It was noted that during the last 8 years, the number of daily newspapers in the world had declined, while total circulation had increased by 20%; the number of radio receivers had increased by 60% and television receivers by 200%. There were now ten times as many television receivers as there were in 1950 and the total today was almost half the world figure for daily newspaper circulation.

Communication research, especially in the United States, had produced some very significant findings about the effects of t.v. on other media, and the attitudes of readers and viewers. Television viewing, in the United States had taken a very large portion of a family's leisure time. Estimates of 35 to 40 hours a week of viewing per household emerge from most research studies.

Television had made its greatest gains in being seen as a major source of international and national news. The newspaper retained its old dominance for local news.

Bacteria Power

A long-life electric battery which draws power inexpensively from harmless bacteria has been developed in the United States. Known as a "Biological Fuel Cell", it has a theoretical life expectancy of more than 50 years during which it produces electricity continuously. The cell harnesses the energy of thousands of bacteria inside it and makes this energy available in the form of electricity.

A pilot model of the cell—which produces enough energy to power a transistor radio, a small light bulb or a miniature motor—has been designed for educational and demonstration purposes in schools by the Electron Molecule Research Company of San Antonio, Texas.

The main components of the model are 12 plastic containers, about the size of small ink bottles, filled with brown powdered rice husks, and a bag full of bacteria similar to yeast or bread mould. The bacteria are mixed with water and the rice husks, which decompose as the bacteria "feed" on them. Electric energy resulting from this process is picked up by a strip of copper which serves as a positive connection, and a strip of aluminium which serves as a negative connection. These metal connections protrude from each plastic container and are joined by wire to the radio, light bulb or motor to be supplied with electricity.

The unit is self-contained, and needs no outside connections, but each cell container requires an opening for air intake.

Once assembled, the unit needs no attention except occasional refilling with rice husks and water for the thousands of industrious "worker" bacteria which reproduce themselves indefinitely.

Taped Noise

Residents living near large military and civil airfields frequently complain about the deafening roar of powerful aircraft engines during running up, taking off and landing. Noise, its generation and suppression, is today the subject of much research, for as more powerful aero engines are produced the noise abatement problem becomes more and more acute.

Even Rolls-Royce aero engineers have their noise problems and, to help solve these during installation stages, professional tape recorders have been supplied by EMI. Using these tape recorders, a research programme is in progress at the Rolls-Royce Flight Research and Development Establishment at Hucknall, near Nottingham.

Noise intensities are recorded on two-channel EMI TR90 professional tape recorders in a control room near the test beds and subsequently played back for frequency spectrum analysis. Data obtained by positioning microphones at varying distances and angles from the noise source enable a polar diagram of noise energy to be produced.

Without using tape recorders, Rolls-Royce engineers would find it both costly and unpractical to carry out analyses. Engines would need to be run up for several hours and large quantities of expensive fuel used. But tape recordings can be taken over a few minutes of engine running time.

Besides the more obvious advantages of speed, economy, and simplified procedures of recording noise levels on magnetic tape, large masses of data can be stored and subsequently replayed for analysis, as often as necessary. During most studies, rapid variations of noise levels occur and it is not possible to note accurately the fluctuations from meter readings when using conventional testing methods.

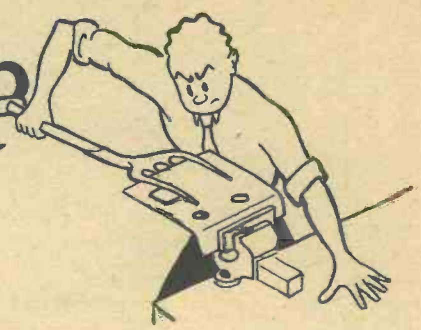
Television Stills

The Bulletin of the Association of Broadcasting Staff recently reported that Siemens (Germany) have introduced apparatus which can record television stills electronically to be reproduced as often and as long as required.

The general principle of magnetic recording is used, but instead of using tape, a disc of similar material is used. This disc is 40 cm. in diameter and when in use revolves at 3,000 r.p.m. on a horizontal axis which, in relation to the magnetic heads, is equivalent to a tape speed of 50 m.p.s. This gives a recording bandwidth of up to 10 mc/s. The disc is supported on a layer of air which maintains a stable distance of approximately 1/1,000 mm between the disc and the recording heads.

The discs can store information equivalent to ten complete pictures. These can, of course, be stored indefinitely as in the case of other magnetic recordings.

IN YOUR WORKSHOP



This month, Smithy the Serviceman and his able assistant Dick embark unwillingly on the New Year, only to find that there is nothing for them to do! In consequence, the two devote their time to a session dealing with readers' hints

THERE IS A CERTAIN MAGIC about New Year's Day. We know that it is only a date on a calendar and that, were it not for the fact that eleven days were dropped from the month of September in 1752, we might well be celebrating New Year's Eve on what is now the 20th of December. Even so, New Year's Day provides a dividing line between what has gone and what, incurable optimists that we are, we hopefully look forward to in the year to come. The Old Year passes, and we depict it as a shambling bearded old man who stumbles off unmourned into the irretrievable past. The New Year arrives, and we visualise a clean-limbed youth who is bounding with energy and promise, who is erect of body and alert of eye, and who faces the future with absolute confidence and complete lack of fear.

Thus might have we expected Smithy and Dick to appear as they started work on the particular New Year's morning when our episode opens. We could well, for instance, call in on the Workshop around 10 o'clock, to witness the scene of cheerful and efficient activity which would be presented by the Serviceman and his assistant as they go busily and happily about their duties.

But what is this? It's 10 o'clock, and the Workshop is securely locked and completely empty! And who are these two broken figures who shuffle wretchedly to the door? Are they vagrants who are bent on depredation, or are they tramps wandering aimlessly from one inconsequent point to the next? It is only when the elder of the two inserts a trembling key into the door that our outraged gaze reveals to us the awful truth.

Starting Work

"Blimey," said Dick, as he stumbled into the Workshop after Smithy, "what a *night*"!

Smithy raised a quivering hand to his brow and glanced at his assistant through bloodshot eyes.

"You have already," he remarked shortly, "said that three times as we were walking up to the door."

"Still," continued Dick inexorably, "it really *was* a night!"

Smithy groaned.

"The only trouble with New Year's Eve," he complained, "is that it comes too soon after Christmas. I'm getting far too old for all these continual festivities!"

Dick directed an experienced eye at the Serviceman, then went over to the Workshop sink. As the sound of clattering utensils reached his ears Smithy visibly cheered. When, eventually, a cup of steaming hot tea was placed alongside him, there were signs that he was already making progress towards his usual form.

"Well," he remarked uncertainly, after a moment. "We're both very late this morning. Perhaps we'd better think of getting some work out of the way."

"There's nothing to do except a couple of radios," replied Dick, glancing carelessly at the shelves, "and they're both waiting for new parts which haven't come in yet."

Smithy looked relieved.

"Perhaps," he remarked tentatively, "we'd better do a few routine jobs, then."

"Like cleaning the place up a bit?"

"That's right."

"We did that yesterday afternoon," said Dick.

"Did we?" replied Smithy hazily. "Dear me, yesterday afternoon seems to be a very long time ago!"

"I know what we *could* do."

"What's that?"

"We could have a nice little sesh," said Dick, "with readers' hints. We haven't had a go with these for ages now."

"That's an excellent idea," said Smithy, manifestly relieved at the suggestion. "And it's just what we need for a morning such as this."

The Serviceman rose and wandered towards his bench. He opened a drawer and extracted a sheaf of letters.

"There are quite a lot here," he announced, "so I'd better get down to the first one straight away."

The Serviceman selected a letter and studied it carefully.

"Now, this hint," he remarked, "has to do with cathode-heater shorts in valves. These can be especially difficult to find in TV sets having series heater chains, and it isn't usually possible to find them with an ohmmeter because they only come on when the associated valve is hot. Again, although it's possible to locate a cathode-

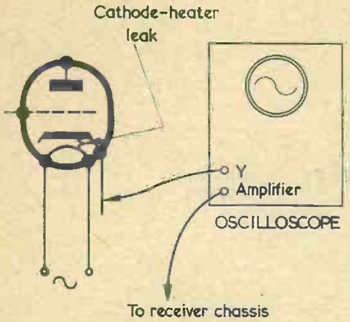


Fig. 1. Cathode-heater shorts may be traced very quickly with the aid of an oscilloscope

heater short by valve substitution, this tends to be rather a long-winded process if there are a number of valves under suspicion. Also, you can be pretty certain that the duffy valve is going to be a type which you haven't got in stock!"

"What's the solution?" asked Dick.

"Just one of those nice, simple ideas," replied Smithy, "that some of us never seem to think of! It's to trace the cathode-heater short with a 'scope (Fig. 1). Slap a lead from the Y amplifier on to the suspect cathodes one after the other, and the one with the short will show up a 50 c/s trace straight-away."

"That's a good idea," remarked Dick impressed. "It sounds to me like a real time-saver."

"It should be," confirmed Smithy. "Presumably, the 'scope timebase should be set up so that the 50 c/s trace just fills the screen. You will then be able to recognise the 50 c/s leakage immediately, without being confused by other signals on the cathode. Incidentally, our correspondent states that the trace shows up very noticeably even with very small amounts of leakage."

Smithy looked again at the letter in his hand.

"There's another hint here as well," he continued, "which should be very useful if you're working on an a.c./d.c. chassis and have to disconnect the mains supply every now and again. All you do is to clip a lead to the anode end of the audio output transformer primary, the lead connecting to earth via a capacitor and resistor in series. (Fig. 2). If you connect the receiver to the mains wrong way round, you then get a loud hum from the speaker which gives you immediate warning. The series resistor and capacitor can be a permanent installation on the bench, and you can pick up the earth connection from the earth in the mains wiring. The capacitor needs to be good and reliable and I would suggest that it should have a d.c. working voltage of 1,000."

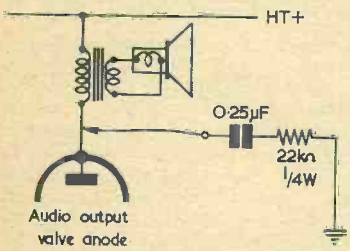


Fig. 2. A simple method of indicating a live chassis during servicing. The earth connection is, of course, not common to the chassis of the receiver under test

Transistor Leads

Smithy picked up another letter from the pile at his side.

"Now here's a nice simple hint," he announced. "As you know, there have been a number of complaints in various magazines recently about the short life of transistors due to leads breaking off after they have been used in more than one circuit. A solution consists of placing a small amount of glue, such as Evo-stik, at the point where the leads leave the body of the transistor. (Fig. 3). This supports the leads and lessens the tendency for them to break off. Even if they do break off, it's still quite a simple process to carefully chip away the hardened glue, and to fit a new lead to the stub that's left."

"That's quite a neat scheme," said Dick. "You could use it also for other components, such as wire-ended moulded mica capacitors and so on."

"You could, indeed," agreed Smithy. "I don't know, incidentally, what the electrical properties of most of the adhesives we handle are like. Since they might exhibit a little leakiness, particularly before they're finally set, the idea needs to be used with a little care. However, if you're really worried about electrical properties you can always use a polystyrene dope as the glue."

"Fair enough," commented Dick. "Let's have another hint!"

"Okeydoke," replied Smithy, picking up another letter. "Now, here are two simple ideas which fall into the hardware department. It's often necessary to fit a nut in an awkward part of a chassis, especially if you want to run it on to a screw as well. With the dodge given here, you hold the nut between the ends of a pair of tweezers, the latter being kept tight by sliding a rubber grommet down the arms. Not only can you position the nut with this device but you can also turn it round as well, so that it becomes threaded on to the bolt. Without the grommet it is necessary to hold the tweezers tight at the same time as you turn them."

"Which is liable to result," commented Dick, "in spiral fingers."

"Indeed it is," replied Smithy. "And that can be a very unpleasant complaint, too! To hold the nut, it is desirable to file the ends of the tweezers flat. Or you could, of course, use eyebrow pluckers."

Smithy paused and sipped his tea.

"The second hint in this letter," he continued, "is more or less along the same lines, but it is concerned with putting *screws* in awkward places. You take a plastic knitting needle and cut off the point. You then file the end so that it takes up a screwdriver form, but with a fairly thick blade. This blade can be pushed into the slot of the screw you're trying to position whereupon, if it is a sufficiently tight fit, it will hold it securely until you've bunged it into its hole."

"Very elegantly put."

"Thank you," replied Smithy, as he selected another letter. "Now, here's a neat little idea which is just the job for this time of the year. It makes use of those aluminium cigar tubes which are normally thrown away after Christmas. The idea consists, quite simply, of boring a hole at the end and of using the tube as a solder dispenser." (Fig. 4).

"That's a knobby idea," said Dick. "In the future, you'll be able to tell the social status of an engineer merely by seeing what cigars he smokes for his solder dispensers!"

"Perhaps so," chuckled Smithy. "Anyway, it's about time that a spot more tea was forthcoming."

"Righty-ho," said Dick, as he rose to take Smithy's empty cup. "Incidentally, I must point out that you haven't half cheered up over the last ten minutes or so. You looked like the Wreck of the Hesperus when I first saw you this morning."

"Ah yes," said Smithy, "but that was only because I had been engaged, over New Year's Eve, on technical duties."

"Technical duties?"

"Technical duties," replied Smithy firmly. "The members of my club decided to have an inconspicuous little gathering to mark the end of the Old Year. As this occasioned the use of a microphone and amplifier, I offered my services in an advisory capacity."

"I bet you did, too," chuckled Dick. "What time did they chuck you out?"

"I retired to my bed," said Smithy with dignity, "at about 4 o'clock this morning. My responsibilities were such that I had to make certain that the amplifying system was safely switched off before I finally departed."

"It's a wonder that that club of yours doesn't get raided," grinned Dick, handing Smithy a fresh cup of tea. "My uncle was telling me about all the things which went on there on Christmas Eve."

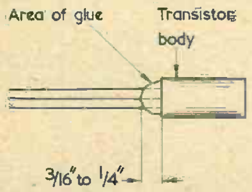


Fig. 3. Transistor lead breakage can be reduced by applying glue to the lead-out point, as shown here. The choice of adhesive is discussed in the text

Smithy sighed. One of his great regrets in life was that, amongst Dick's multitudinous aunts and uncles, one of the latter was the steward at his club.

"We celebrated Christmas Eve," he remarked mildly, "in a perfectly proper and respectable manner."

"What about the chap who poured white sauce over your head, then?"

"That was just a minor diversion during dinner," said Smithy. "Fortunately, I was wearing a crash helmet at the time."

Cascode Pre-amplifier

For once Dick was silenced and Smithy was able to return to his sheaf of letters undisturbed.

"Here are two really good ones," he announced after a moment, "and they both appear in the same letter. The first describes a very neat way of obtaining a cascode aerial pre-amplifier from an old TV turret tuner. Very often, turret tuners are discarded because they are old models or because the mixer and oscillator section has become irreparably damaged. Provided that the circuit is OK from the aerial input up to, and including, the band pass coils between the cascode and the mixer, a turret tuner can be employed as a very useful aerial pre-amplifier. The idea is so attractive, in fact, that it might even be worthwhile buying one of the manufacturers' surplus tuners that are knocking around nowadays at about ten bob or so each. What you do is to strip the oscillator and mixer section back to the band pass coils, then couple a length of coaxial cable to the contacts which connect to the secondary of those coils. (Fig. 5). You next connect the aerial to the input of the tuner and the secondary of the band pass coils to the aerial input socket of the receiver, whereupon you have a cascode aerial pre-amplifier which can give you a considerable amount of gain, and which can be switched to any channel in Bands I and III for which coils are fitted."

"Blimey," said Dick, impressed. "That *is* a crafty wheeze!"

"Very crafty," agreed Smithy. "The gain given by the pre-amplifier can be increased on one channel by realignment of the trimming capacitors on the tuner chassis. Personally, I would leave the aerial coil trimmer, if one is fitted, severely alone, and concentrate on that which couples to the primary band pass coils. This should have quite a considerable effect on results. If you were to make a trimmer adjustment at a Band III channel, it would probably hold good for the Band III channels on either side as well. The adjustment might even hold good for Band I channels also. Incidentally, this pre-amplifier idea might be of interest to the

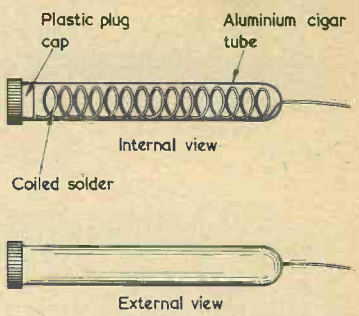


Fig. 4. Aluminium cigar tubes, which tend to be plentiful at this time of the year, make convenient solder dispensers

TV Dx boys, as well as to people who are trying to get a bit more gain for ordinary viewing."

"What about power supplies for the pre-amplifier?"

"I would suggest that you use a separate power pack," said Smithy. "And one with an isolating mains transformer as well, so that the pre-amplifier chassis is not at mains potential. Apart from all the other precautions, you would need a proper aerial isolating circuit if the tuner had a live chassis, and it is, I think, easier to use an isolated power supply instead. Anyway, let's get on to the second idea in this letter."

Smithy paused for a few seconds.

"This second hint," he pronounced, "has also to do with pre-amplifiers. There are many Band I aerial pre-amplifiers still skulling around from the days before Band III came on the air, and they are still capable of being used with present day receivers if you're prepared to do the necessary retuning. If a present day receiver has the standard 405 line intermediate frequencies of 34.65 Mc/s vision and 38.15 Mc/s sound, you simply retune the pre-

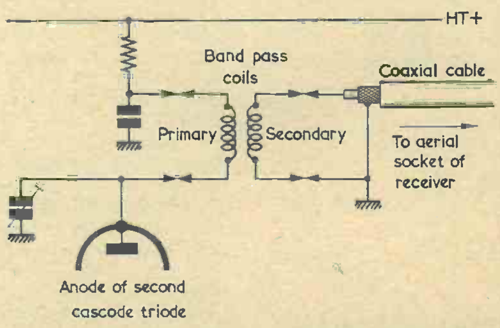


Fig. 5. A television aerial pre-amplifier can be made from a discarded turret tuner. The output, at signal frequency, is taken from the secondary of the band pass coils

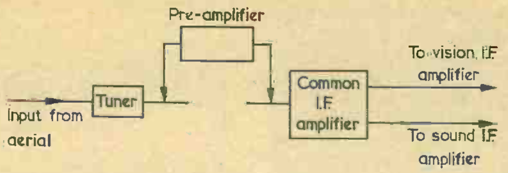


Fig. 6. Increasing the gain of a television receiver by inserting a re-aligned Band I pre-amplifier between the tuner unit and the common i.f. amplifier stage

amplifier to cover this range and insert it between the tuner unit output and the output to the common i.f. amplifier. Provided that the tuner in the receiver has a 75Ω output, as many have, the pre-amplifier will then function as an additional i.f. amplifier stage without any mismatches. (Fig. 6). It may be necessary, with some Band I pre-amplifiers, to add a turn or two to the coils to get them to tune down to 34.65 and 38.15 Mc/s. The unit should give sufficient bandwidth to give equal amplification to both sound and vision i.f.'s. If you wanted to you could, of course, peak the pre-amplifier at either of these i.f.'s. The pre-amplifier works on all channels and, if the job is done properly, it can provide a considerable amount of extra gain."

"That," commented Dick enthusiastically, "is a really knobby idea. From now on, I'm keeping my eyes open for any old Band I pre-amplifiers which may be knocking around. *And* turret tuners!"

"As you like," said Smithy absently as he picked out another letter. "But let me get on to the next hint. The one I've got here should be of interest to the service engineer who has to dig around on printed circuit boards. When it's difficult to get access to the underside of a board, an easy way of obtaining points for voltage readings consists of making up a couple of adaptors. One of these is for B7G valves and the other is for B9A valves.

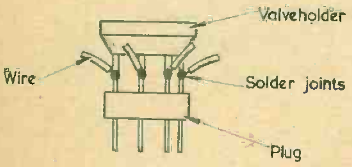


Fig. 7. A valve adaptor which enables voltage readings to be taken on the component side of printed circuit boards

You simply solder the tags of a valveholder to those of a B7G or B9A plug, as the case may be, at the same time soldering in short lengths of tinned copper wire. (Fig. 7). When you want to take voltage readings you then remove the valve from the printed circuit board, insert the adaptor, and re-plug the valve into the socket on the adaptor. Your voltage readings can then be taken from the short lengths of wire soldered to the tags in the adaptor."

"This," pronounced Dick, "is one of those cases where, by devoting a few idle minutes to knocking up a simple servicing device, you can save a considerable time later when everything's at panic stations!"

"Very true," replied Smithy. "And you've now got yourself a nice little job! We could use a couple of those adaptors in the Workshop."

"Fair enough," replied Dick. "I'll send in my estimate shortly."

Transistor Connections

"There's another hint here," said Smithy, ignoring his assistant's comment, "and this is concerned with transistor connections without soldering, and without the hazards that that process sometimes involves. You first of all make several little coils, each of which is formed by close-winding about six turns of 20 to 22 s.w.g. tinned copper wire round a medium-sized sewing needle. (Fig. 8). You require one of these coils for each lead of the transistor which is to be handled. The coils are soldered to the tags to which the transistor is to connect, whereupon they form short 'tubes' to receive the transistor leads. These leads are inserted until they bottom on to the solder joints, after which the coils are flattened out with pliers. All the turns of each coil short-circuit together, and the coils become virtually solid extensions of the tags. This scheme works perfectly in practice, and grips the transistors so firmly that they can only be pulled out of contact when considerable force is exerted."

"That," remarked Dick, "is quite a novel idea."

"It is, isn't it?" agreed Smithy, taking up another letter. "It's rather like a wire-wrap connection in reverse. Funnily enough, one of the two dodges in the next letter also employs a needle. To make a 'socket' for a personal earphone you simply pierce two holes at each conductor in a length of clear twin flex having a 'figure 8' cross-section. (Fig. 9). The holes are

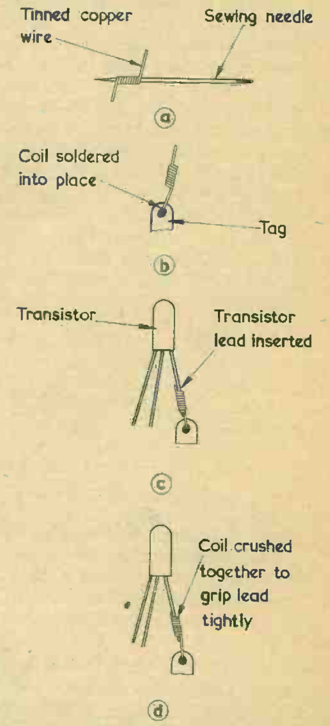


Fig. 8. Solderless connections for transistor lead-outs. In (a) tinned copper wire of 20 to 22 s.w.g. is wound around a medium-sized sewing needle to form a small coil, which is soldered to the appropriate tag in (b). The transistor lead-out is then inserted (c), and the coil flattened with pliers, as in (d)

spaced to take a miniature two-pin plug, which is then pushed through the holes and makes contact with the conductors. A dodge of this nature can, of course, be adapted to meet a number of other requirements where low voltages and currents are involved, and you could insert single plugs into the flex instead of twin plugs.

"The second dodge in this letter has to do with soldering irons.

We all of us know that you can add an 'extension bit' to a soldering iron by wrapping a length of copper wire on to the bit. Normally, however, this expedient isn't always as successful as we expect it to be. What the present idea does is to take the scheme one stage further by flattening the section of the wire which is in contact with the bit, so that there is a much more efficient transfer of heat. You start with a length of $\frac{1}{16}$in diameter copper wire and flatten most of this to half-thickness with a hammer. (Fig. 10). You then coil the flat part tightly round the bit, the remaining round part providing the extension."

Final Hints

Smithy put the letter back on his bench, and hold out his cup.

"Blimey," said Dick, "*more* tea?"

"Of course," replied Smithy. "All this talking is making me thirsty!"

Obligingly, Dick rose once more to replenish the Serviceman's cup.

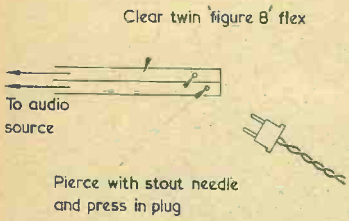


Fig. 9. A "socket" for personal earphones, or similar low voltage and current devices

"I've just remembered something," called out Smithy, as Dick busied himself with the Workshop's battered utensils.

"What's that?"

"You talked about me being under the weather this morning," said Smithy. "But what about *you*? You looked like something the cat had brought in when I first saw you!"

"I may have looked a little *tired*," replied Dick, cautiously, "but that was only because I, also, was acting in an advisory capacity during the New Year's Eve celebrations."

"Where at?"

"Joe's Caff."

"Good gracious," exclaimed Smithy. "It's ages since you went there, isn't it?"

"There *was* a period," admitted Dick, "when the gang kept away, but that's over now."

"What happened?"

"You know that he's always altering the place round and giving it a new name," explained Dick. "Well, earlier on last year he decided to go all satirical. He had the place plastered with pictures of David Frost and covers from *Private Eye*, and he changed the name to 'The Institution'."

" 'The Institution'?"

"That's right," said Dick. "It's the nearest word he could find to 'The Establishment'."

"Was it a success?"

"Not really," replied Dick. "You see, he then started being satirical to customers. The result was that they started being satirical back to him, and it ended up with everybody getting all cobbed up."

"Cobbed up?"

"Getting the needle."

Smithy considered this information for a moment.

"I don't see," he remarked eventually, "why anyone should get upset because of a little satirical conversation."

"You don't understand what being satirical is," said Dick impatiently. "Being satirical means insulting people."

Smithy decided to change the topic.

"Has he changed the place around since then?" he asked.

"Oh yes," said Dick enthusiastically. "Now that the Beatles have introduced the Liverpool Sound, he's got the place all done up to look like a cellar. He's even put in a stage at one end, complete with six power points."

"Six power points?"

"For the guitars, of course," explained Dick. "Also, he's got a big mural of the Mersey Tunnel on one wall and he's changed the name to 'I'm All Right, Wack'."

"Very enterprising."

"Isn't it?" agreed Dick. "Anyway, we had our own little group in there last night, and we were really swinging. It was the best New Year's Eve I've ever had."

"What do you call your group?"

"We're 'The Woodlice'," replied Dick proudly, "and I'm in charge of all electronics!"

"I can see," remarked Smithy, "that there is a great future ahead of you in the field of music."

"I'm certain there is," replied Dick assuredly. "I'm a real wiz-king with the vibrato and the reverb!"

"I have no doubt of it," said Smithy. "Anyway, let's get back to our hints."

"As you like," said Dick equably.

"Right," said Smithy, picking up a further letter. "Now, I've got another hint here which is also in the soldering iron category. What you do is to drill a hole with a diameter of about $\frac{1}{8}$in and a depth of $\frac{1}{4}$in in the bit of a large soldering iron. (Fig. 11). The hole does not interefere with the working of the iron but, when the iron is standing on its rest, it forms a miniature solder pot. You fill the hole with solder, whereupon you can tin any wires or lead-outs you handle simply by dipping their ends into the hole."

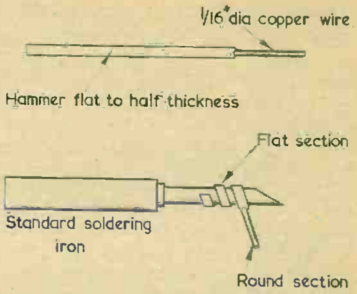


Fig. 10. A simple and efficient method of obtaining an extension soldering iron bit

Smithy picked up a further letter.

"There's another tip here about soldering irons," he continued, "and it will have to be the final one for today, I'm afraid. This hint has to do with a simple but effective soldering iron rest which can be made up in just about one minute. The rest is formed from a length of galvanised iron wire to a shape which can stand up on its own and which can take the barrel of the iron as well. (Fig. 12). A good choice of wire is given by the type which is used for binding parcels."

Starting The New Year

With an air of finality, Smithy took the letters from his bench, and returned them to their drawer.

"And that," he pronounced, "will have to be the last hint for this particular session."

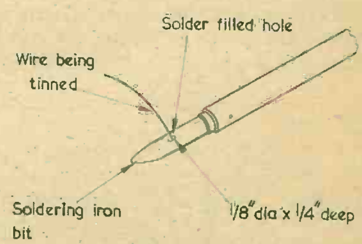


Fig. 11. A modification to a large soldering iron which enables lead-out wires to be conveniently tinned

"There were certainly a good selection," said Dick. "Will we be having another go at readers' hints soon?"

"I hope so," said Smithy, "because I still have quite a few in hand. We'll have another sesh as soon as we possibly can."

"Fair enough," said Dick comfortably. "What's next on the agenda for today?"

Smithy looked around him.

"As you remarked earlier on," he said, "there isn't really a great deal to do. I propose, therefore, that we commence 1964 by taking the first day off."

"And I," said Dick, "will second that! At the moment, there's nothing I want to do more than get back into bed."

"The same here," agreed Smithy.

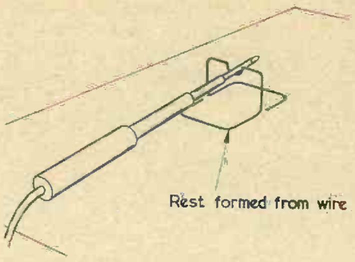


Fig. 12. A simple soldering iron rest, which can be quickly made from galvanised iron wire

"I've still got a bit of 1963 left to sleep off, yet!"

And so it was that, five minutes later and with mutual cries of "Happy New Year", our pair marched out of the Workshop. They were not now the shambling figures who had entered earlier, but were men who carried their heads erect and looked with confidence upon the promise of the coming twelve months, secure in the knowledge that they had both the drive and the ability to see the New Year through. Provided, of course, that nobody expected them to do any work on 1st January.

The hints described in this month's episode of "In Your Workshop" were contributed by Gregory J. Powell, Philip R. Blakeney, C. D. Auger, V. Allison, P. J. Burridge, W. A. Hodges, T. Kamester, Charles Lee and P. G. Martin.

Further hints for this feature are welcomed, and payment is made for all that are published.—EDITOR.

ELECTRONIC TOUCH BUTTON

By M. J. DARBY

THE CERBERUS GK11 TUBE IS POSSIBLY UNIQUE amongst all electronic tubes in that it is operated from a person's finger. When the tube is touched it emits an orange glow and can be made to operate a relay; furthermore, the tube continues to glow after the finger has been removed. The GK11 is basically a cold cathode trigger tube, the trigger being the external electrode which is touched and thus brought to earth potential. A steady potential is applied between the anode and cathode whilst the whole circuit swings above and below the earth potential by means of an applied alternating voltage. When the button is touched,

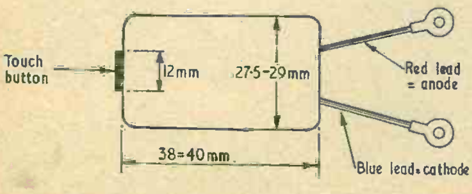
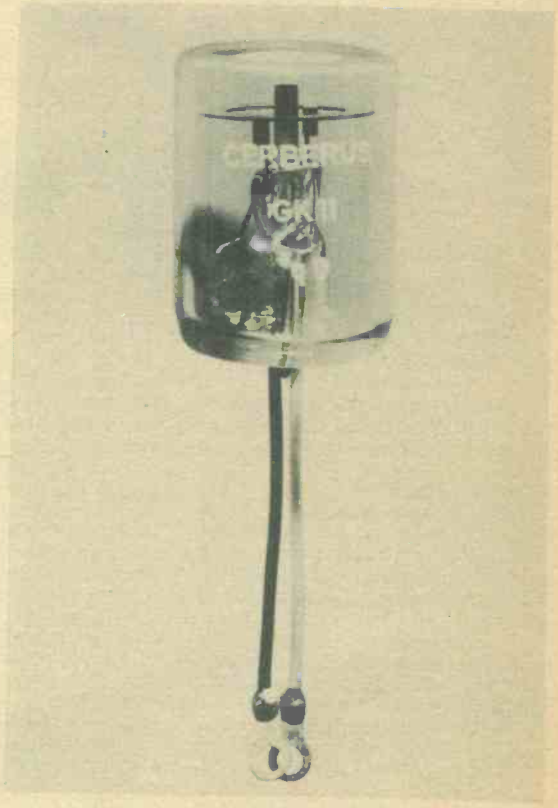


Fig. 1 Dimensions of the GK11 tube



The Cerberus GK11 "touch button" tube

a minute capacitive current flows to the finger and this current causes the main anode-cathode gap to fire. The anode current can be used to provide an output pulse to operate other circuits or to operate a relay, etc.

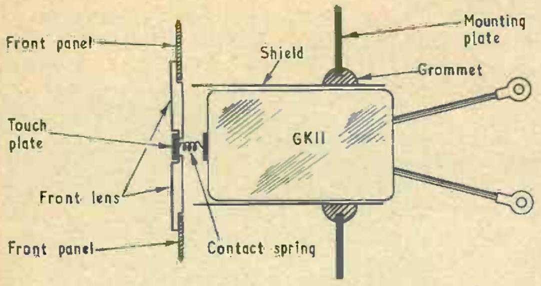


Fig. 2. Mounting the GK11

The shape and size of the unmounted tube are shown in Fig. 1. The tube must be mounted in a shield before use as shown in Fig. 2. A small metal touch plate makes contact with the touch button on the tube by means of a spring as shown. Transparent material surrounds the touch plate; it is through this material that the light emerges from the glowing tube.

Circuit

The type of circuit in which the tube can be used is shown in Fig. 3. The shield is connected to the cathode through a 1MΩ resistor. A floating d.c. supply of 220 volts ±5% is required and an a.c. supply of 110 volts ±10%.

In actual practice the circuit of Fig. 4 is likely to be more convenient than that of Fig. 3, since no separate d.c. supply is required. The 2μF capacitor effectively connects the cathode of the tube to the "live" lead as far as a.c. is concerned and the voltage on the cathode is therefore alternating with respect to earth. This ensures that a triggering current will flow when the button is touched. The diode in the cathode circuit provides a suitable d.c. supply, and it should have ratings of not less than 60mA and 700 volts peak inverse.

Applications

One use for this type of tube occurs in industry when certain operations must be performed in succession. If the circuit is so arranged that these operations can be performed by touching a number of GK11 tubes, the number of tubes glowing at any one time immediately indicates how many of the operations have been carried out.

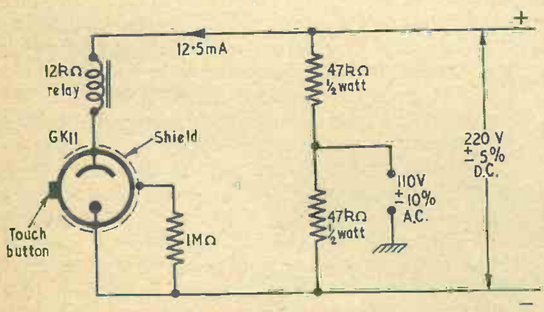


Fig. 3. A circuit for the GK11. Neither side of the d.c. supply should be earthed

The amateur experimenter can also devise uses for GK11 tubes. For example, if two GK11 tubes are used as part of a motorised t.v. tuner switch, one can immediately see which programme one is watching by merely noting which GK11 is glowing. When the non-glowing GK11 is touched, the relay in its anode circuit can be used to operate the motor which changes the channel whilst, at the same time, switching off the power supply to the GK11 tube which was initially glowing. The power supply to this tube is restored when the motor comes to rest. A number of GK11 tubes could, of course, be used in receivers having more than two channels.

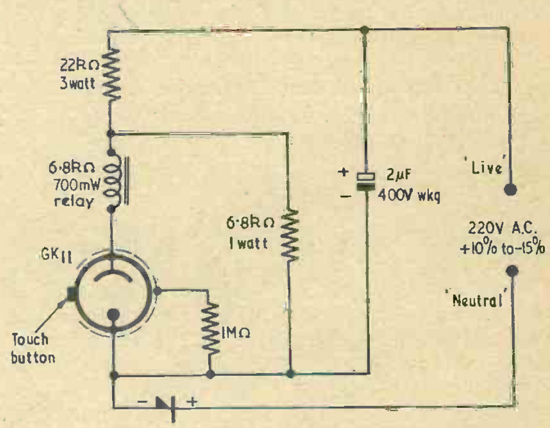


Fig. 4. Operating the GK11 directly from the mains supply

Acknowledgement

The circuits described in this article have been designed by the manufacturers of the GK11 tube, Messrs. Cerberus Electronics of Männedorf, Switzerland, from whom full details can be obtained. Cerberus tubes are available from Walmore Electronics Ltd., 11–15 Betterton Street, Drury Lane, London, W.C.3. It should be noted that the GK11 is a direct equivalent to a previous Cerberus tube coded GR22.

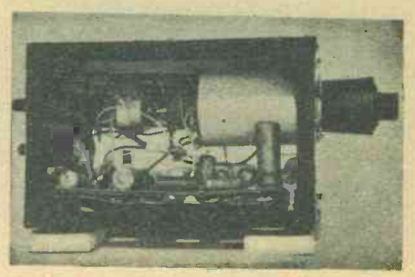
BASIC DATA FOR THE GK11

Minimum anode to cathode breakdown voltage	260 volts
Maximum anode to cathode maintaining voltage	85 volts
Maximum cathode current	15mA
Minimum cathode current	8mA
Life expectancy	Greater than 10,000 hours (Probably more than 10^7 ignitions)

(As in all trigger tubes, the discharge will be extinguished only when the anode to cathode voltage falls below the maintaining voltage.)

Cover Feature

TRANSISTORISED HOME BUILT CLOSED CIRCUIT TV



Part 1—R. Murray-Shelley and T. Ian Mitchell

The first in a series of four articles describing the construction and operation of an amateur-built closed circuit television camera. The camera, which is fully transistorised, provides an r.f. output at any channel in Band I and it may, in consequence, be used in conjunction with a conventional domestic television receiver

The availability of reasonably priced components has now put the field of closed circuit television well within the province of the amateur. This branch of electronics has some most interesting facets, and the construction of closed circuit television equipment should be within the capabilities of a large number of people.

Most people are familiar with the basic principles involved in the production of a television picture. Closed circuit television equipment—particularly that in the lower price brackets—tends towards simplification of circuitry compared with that employed in broadcast television work.

Interlacing

Television signals transmitted by the broadcasting authorities give pictures of the so-called "interlaced" type. Here every other line comprising the picture is scanned alternately, the scanning spot being made to scan the remaining lines during the next field period. Pictures produced by this method are of excellent quality, the relative positions of the scanning lines remaining constant. Unfortunately, this type of interlaced scanning can only be satisfactorily achieved when there is a constant relation between the line and vertical deflection frequencies. On a 405 line system, the line frequency is 10.125 kc/s and the field frequency is 50 c/s. In order to generate the associated pulses, which have a constant ratio to each other as regards frequency, a standard pulse generator must be used. This is normally operated at a frequency of 20.25 kc/s, the required line and field frequencies being obtained by division using binary scaling circuits. The standard pulse generator is normally stabilised by locking it to the frequency of the supply mains by a diode comparison circuit.

A large number of closed circuit television cameras produce a picture having "random" interlace. Here the line oscillator is free running and the vertical oscillator is normally locked to the mains frequency. There is thus no direct relation between the line and field frequencies, and therefore no true interlace is possible. It is characteristic of this method of scanning that the lines appear occasionally to merge or "pair". Despite this, very good results can be obtained. It is important, however, that the line oscillator should be relatively stable if steady pictures are to be obtained. Fig. 1 shows a block diagram of a camera employing full interlace facilities. A camera having random interlace and a free-running line oscillator is shown in Fig. 2. It is obvious how much simpler the circuitry becomes.

Output facilities

The output from closed circuit equipment is either in the form of a video signal (1 volt in an impedance of 80Ω is standard) when it is used to drive special monitor receivers, or the composite signal consisting of video, sync pulses and blanking pulses is used to modulate a simple r.f. oscillator normally tuned to a channel in Band I. The camera can then be used with a normal domestic television receiver merely by applying the camera output to the aerial socket of the receiver. It is sometimes necessary to detune either the receiver or the camera oscillator slightly to compensate for the fact that the output will be in a double sideband configuration, compared with the vestigial sideband system normally employed. Some difficulty is also occasionally experienced when using cameras having free-running line timebases with receivers having flywheel synchronisation. An r.f. output is not usually employed in very high definition systems which, in any case, require special monitor receivers.

The Vidicon Tube

It is probably true to say that the heart of a television camera is the pick-up tube. In many respects this is similar to the normal cathode ray tube found in a receiver. The functions of the two tubes are complementary, one converting a pattern of light and dark into a series of electrical impulses, the other performing the reverse process. Broadcast cameras now normally employ Image Orthicon tubes. The majority of small closed circuit units, however, are fitted with 1in Vidicon tubes. This is one of the most recently developed of all the tubes available and operates by using the principle of photoconduction. Compared with other types of tube it is relatively cheap. A broadcast quality Vidicon can cost over £130, though industrial grade tubes are somewhat cheaper. There is available, however, an "Amateur" grade at the very reasonable price (at the time of writing) of £12. This tube is substandard in that it has rather more blemishes on the target than better quality specimens, with which it is electronically identical. The writers have used such a tube with very acceptable results. The Vidicon is small in size, being only about 6½in long by 1in in diameter. The scanned area of the target is ½ x ⅜in, which is convenient since it allows standard 16mm cine lenses to be used in the optical system.*

A picture reproduced by way of the CCTV camera described in this series of articles, in conjunction with a standard 14 in domestic television receiver (F/6.3. 1/30-sec, close-up lens, 13in from screen)

Fig. 3 shows a diagrammatic representation of

* As is explained in more detail in Part 2, the "Amateur" version of the Vidicon, type 10667M, is available from E.M.I. Electronics Ltd., Valve Division, Hayes, Middlesex, or from Golden Rule Electronics Ltd., South View Laboratories, Litlington, Nr. Royston, Herts.—EDITOR.

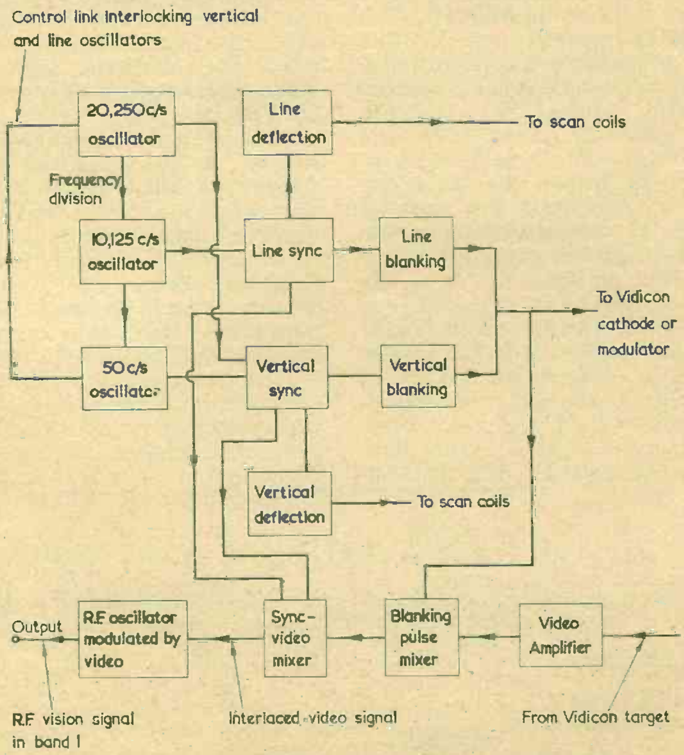


Fig. 1. Block diagram illustrating the camera stages required for full interlace working

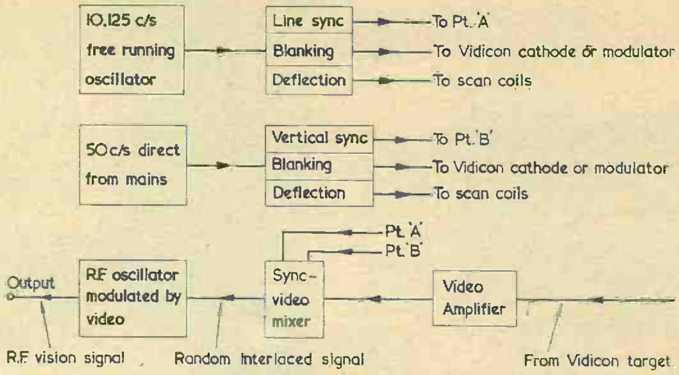


Fig. 2. The much simpler camera circuits needed with a free-running line oscillator

the tube electrodes. The electron gun assembly is similar to that in a conventional cathode ray tube. An indirectly heated cathode is used and electrons emitted from this are accelerated by the anode A1. The grid, or modulator, G1, serves to control the beam current by varying its electrical potential. This is always negative with respect to the cathode. The electron beam is of low velocity, and this is an advantage since no e.h.t. is therefore required. The beam current is very small—normally about 0.2μA. A very narrow, sharply focused beam is required, and focusing is effected by a combination of an electro-magnetic and an electro-static field. The magnetic field is produced by a coil extending almost the whole length of the tube, and the electro-static field is generated by applying a suitable potential to the wall anode A2. Electrically connected to A2 is a fine mesh A3 whose function is to decelerate the electrons before they strike the target, and to act as an ion trap. The electron beam is made to scan the target surface by the application of suitable external magnetic fields.

The Target

A sectional view of the target is shown in Fig. 4. It consists of an optically flat glass faceplate, on the inner surface of which is a transparent conductive film electrically connected to the target connector, which takes the form of an external metal ring. Deposited on this conductive film is a very thin layer of a photoconductive material. This material has a high transverse resistance in darkness, which decreases with increasing illumination. The scene to be televised is sharply focused on to the film by means of a lens system.

The operation of the target is perhaps easiest to understand if it is assumed to consist of a large number, some 220,000, of small sensitive elements. Each of these elements can be thought of as being a small capacitor (formed between the "tube" side of the photoconductive film and the transparent conducting layer), which is shunted with a light dependent resistor (formed by the photoconductive material itself). The capacitor is connected on one side to the target connector and thence via a load resistor to a positive voltage of about 30. (Fig. 5).

The target is now scanned by the beam and the surface of the target facing into the tube is stabilised at about the cathode potential. Thus, there exists a potential difference between the two plates of our capacitor, it being charged almost to the potential applied to the target connector. If the particular element which we are considering happens to be in darkness, the resistance exhibited by the light dependent resistor will be high, and therefore very little of the charge on the capacitor will leak away. If however the element is illuminated, the potential across it will be diminished in proportion to the level of the illumination. A pattern of positive charges corresponding to the parts of the optical image is thus produced on the inner surface of the target. The next time that the electron

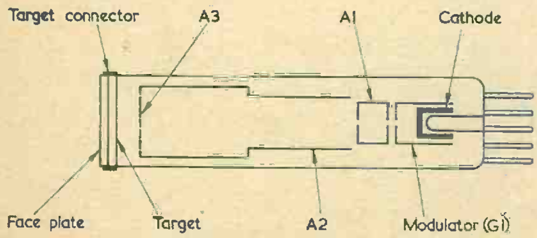


Fig. 3. A diagrammatic representation of the electrodes in the Vidicon tube

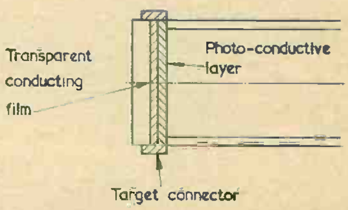


Fig. 4. Detail showing a section through the Vidicon target

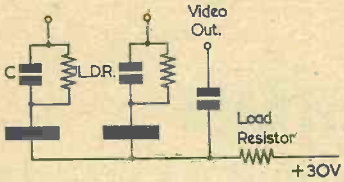


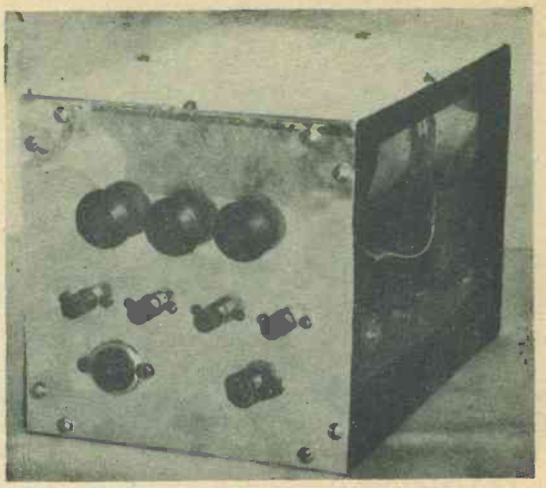
Fig. 5. The target can be considered as a large number of small capacitors shunted by light dependent resistors

beam sweeps past, electrons are deposited and neutralise these positive charges. As a result of this action a variable current flows in the target load resistor. The time during which the electron beam actually rests on an individual element of the target is called the examination time. The remainder of the time before the electron beam next comes along is termed the storage time. The ratio of the examination time to the storage time is about 1:200,000 for a 405 line system. This ratio will be somewhat larger for a 625 line system. Since the charge drawn from the capacitor is that which has accumulated during the storage time, it follows that a given CCTV camera is more sensitive when operated on 625 lines than on 405 lines. The output from the tube is relatively large and is at a high impedance. It must be considerably amplified before it can be of practical use.

The Video Amplifier

The amplifier used for amplifying the tube output must satisfy some rather stringent conditions. Let us suppose that the camera unit is to operate on 405 lines and have a resolution equivalent to 300 "vertical lines" across the picture; it can then be shown that the video amplifier must have a bandwidth of at least 2.7 Mc/s. That means that it must amplify signals whose frequency ranges from only a few c/s to several Mc/s, all to the same degree. To do this calls for careful design and construction. The signal-to-noise ratio of the amplifier must be kept low for obvious reasons. Some provision is also normally made to correct for non-linearity in the Vidicon characteristics.

Operation on 625 lines and higher line standards calls for video amplifiers having still higher bandwidths. In general, the resolution of the Vidicon tube is good and is practically limited only by the bandwidth of the amplifier.



The rear of the camera head, showing the operating and pre-set controls

Amateur-Constructed Equipment

Amateur-built closed circuit television equipment usually takes the form either of very low definition electro-mechanical systems using disc scanning methods, or of flying spot transparency scanners. Neither of these methods can really compare with camera channels based on the Vidicon tube just described. By using the "Amateur" grade Vidicon mentioned, a very satisfactory camera chain can be constructed at relatively low cost.

Next month the circuit of a camera suitable for home construction will be described. It can be built at a cost of under £35 if the smaller components are already available, it is fully transistorised, and it can be used in conjunction with almost any domestic television receiver, including those with flywheel sync. The construction is relatively simple, the most difficult part—the construction of the magnetic lenses—being avoided by the use of commercially-made components.

(*To be continued*)

G.P.O. Orders Two Solartron Data Logging Systems

The Research Branch of the Engineering Department of the General Post Office, Dollis Hill, London, has placed a contract for two Data Logging Systems, total value of £28,000, with the Solartron Electronic Group Ltd., Farnborough, Hampshire, specialists in this field.

The equipment will be used for the measurement and recording of the electrical parameters of planar type transistors during and after manufacture.

The Solartron System connects different circuit configurations to the transistors and measures the associated parameters. Off-limit readings of certain critical parameters can change the sequence of scanning.

The system will resolve leakage currents down to 2.0×10^{-11} amperes.

All the control and display equipment is designed to operate in an ultra-clean area with its attendant design considerations.

TRANSISTORISED TELEVISION CIRCUITS

PART 3 By Gordon J. King, Assoc.Brit.I.R.E., M.T.S., M.I.P.R.E.

In this series of articles, our contributor has, up to now, described transistorised television tuners and transistorised sound and vision i.f. amplifiers. The present article carries on to deal with sound and video amplifiers, together with a.g.c. and contrast control circuits

Audio and Video

THE AUDIO STAGES OF A TRANSISTORISED TELEVISION set are very similar to those of an ordinary transistorised radio set or amplifier. Some models feature a driver stage fed from the sound detector via an interference suppression circuit in front of a class B output stage; other models use a pre-amplifier in front of the driver with or without a suppression circuit.

Maximum audio output for about 10% total distortion is often of the order of 1 watt. While most models employ a driver transformer of some kind, not all use a speaker transformer, and some have provision for plugging in a "personal listening" earpiece which can be operated either by itself or in conjunction with the speaker.

The audio stages and interference suppression circuit of the Pye Model TT1 are shown in Fig. 8. Audio from across the detector load (R_{14} in Fig. 4, Part 2) is coupled to the interference suppressor diode through the electrolytic capacitor C_{25}. Resistors R_{18} and R_{19} connect the diode across the supply voltage to provide "forward conduction". This means that the diode offers a low impedance to the a.f. which, under normal conditions, is passed on to volume control R_{20} through the second electrolytic coupling capacitor C_{27}.

Interference Suppression

In the event of a burst of impulsive interference, such as that created by car ignition systems and electrical appliances, the interference transient waveform fed from the sound detector is of such polarity that it tends to combat the forward conduction of the diode and, in fact, causes it to cease conducting. The interference transient is thus prevented from being passed on to the volume control. In practice, the transient pulse is considerably attenuated, and the suppressor diode is held in a high impedance condition governed by the time constant of R_{19} and C_{26}, the values chosen here offering the best compromise between sound quality and suppression efficiency. It is the charge on C_{26} which holds the diode at cut-off during the time-constant period. This circuit is remarkably simple yet highly effective.

Audio Circuits

The driver transistor TR_9 is a fairly straightforward grounded-emitter circuit with the collector loaded by the primary of the driver transformer T_4. The base is biased by the potential divider comprising R_{21} plus R_{22} and R_{23}, with R_{21} and C_{29} forming a low-frequency filter. D.C. stabilisation is provided by R_{25} and degeneration is avoided by C_{30}.

The class B output stage (TR_{10} and TR_{11}) is also conventional. The output pair of transistors is biased by R_{26} and R_{27} for almost complete collector current cut-off (complete quiescent cut-off is usually avoided to minimise cross-over distortion), and stabilisation is provided by R_{28}. Higher order harmonics generated at the cross-over point are suppressed by the R.C. combination R_{29} C_{31} across the primary of the output transformer, and further improvement in quality is achieved by the negative feedback loop through R_{24}, from the collector circuit of the output transistors to the base of the driver.

Deviations

In the Perdio "Portarama" set a transformerless audio output stage is employed. This uses two transistors in a form of class B circuit and a driver transformer with two separate secondary windings. A pre-amplifier stage is used in front of the driver transistor, and a jack socket is employed for energising an earpiece. The transformerless output stage is described in the literature.[1]

Video Amplifier

A big problem in the design of transistorised

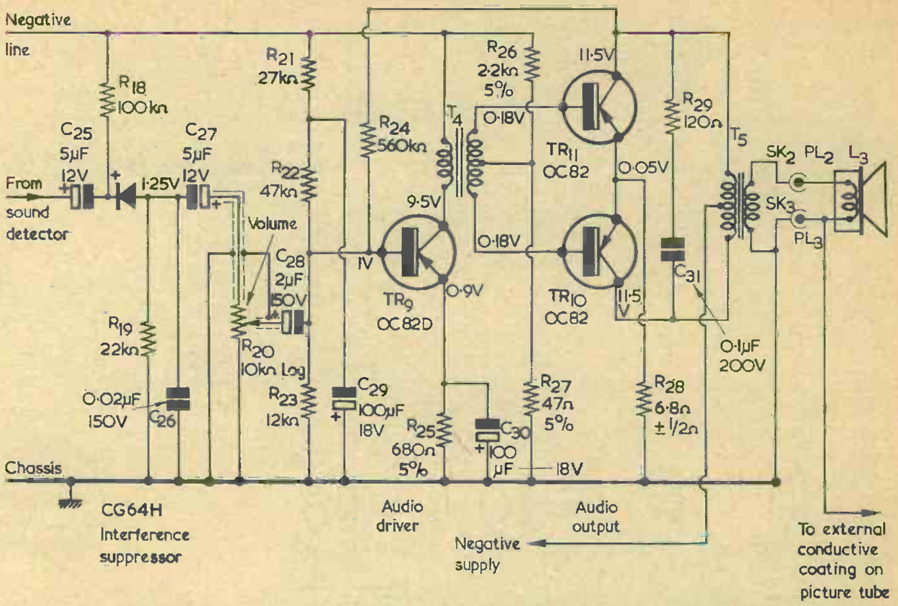


Fig. 8. The interference suppressor and audio stages of a typical transistorised television receiver

television sets has been associated with the video amplifier. We are here, of course, considering a receiver which is to operate from, say, a 12 volt car battery as well as from a mains power unit. This means that the basic design must be for a supply voltage around 10 to 11 volts (allowing for voltage drop in the connecting cables). The problem is that about 50 volts of video signal are needed to drive the picture tube. How do we get a 50 volt drive from a 10 volt supply?

The obvious solution is to use a step-up transformer. Unfortunately, this is not a simple thing to manufacture for a wide video passband, and it is not used in practice. There have been various experiments associated with the design of a picture tube which would operate within the drive limitation of a video amplifier working from a 10 volt supply, but nothing at this stage appears to have come of them.

Another method put forward[2] was the "beanstalk" amplifier, due to L. E. Jansson. This system achieves a high drive voltage by the use of a series chain of transistors having voltage or dissipation limits which prevent their providing the output singly, the amplifier being energised from a considerably higher voltage source than that of a car battery. A system of five voltage multiplying stages has been used successfully in this configuration.

This method is somewhat obsolete now, though, for transistors are available which will give a video output of some 60 volts provided a sufficiently high voltage is available to energise them. The Mullard AF118 transistor is a typical example.

Apart from voltage and dissipation limitations, the feedback capacitance of a transistor forms a major limitation to its use as a wideband video amplifier. With increase in frequency, this capacitance reduces the input impedance of the transistor and thus shunts the input circuit and attenuates the applied signal. The limitation is accentuated at the high voltage gains associated with the video amplifier stage.

The Mullard AF118, for example, uses the alloy-diffused technique which keeps the feedback capacitance down to about 1.8pF. As already intimated, the output signal obtainable from a transistor is limited by the voltage that can be applied to the collector and by its dissipation ratings. The alloy-diffused technique gives a high collector breakdown voltage and, with the AF118, up to almost 70 volts of video can be obtained (provided the collector voltage is available, of course) at full bandwidth. This transistor is, in fact, used in the Perdio "Portarama" set.

Pye Video Stage

The Pye uses a V15/20R transistor in the video output stage, as is depicted in Fig. 9. The collector of this transistor is loaded by the video load resistor R_{65} and a second resistor, across which the sync pulses are developed, R_{64}. With the video compensating chokes, L_{10} and L_{11}, this circuit has much in common with the anode circuit of the video stage of an ordinary television set. R_{63}, across L_{11}, is simply to prevent the inductor from ringing, and acts as a damping device.

It will be seen that the collector circuit is fed from a -60 volt power supply. This supply, along with a further -60 volt supply and a $+60$ volt supply, is obtained by rectifying some of the pulse voltage developed across a separate winding on the line output transformer. This scheme is commonly used in transistorised television sets to secure the required

References

1. *Reference Manual of Transistor Circuits*, Mullard.
2. Bryan R. Overton, *Transistors in Television Receivers*, Journ. Television Soc., Vol. II, No. 8, July–September 1958, pages 444–468.

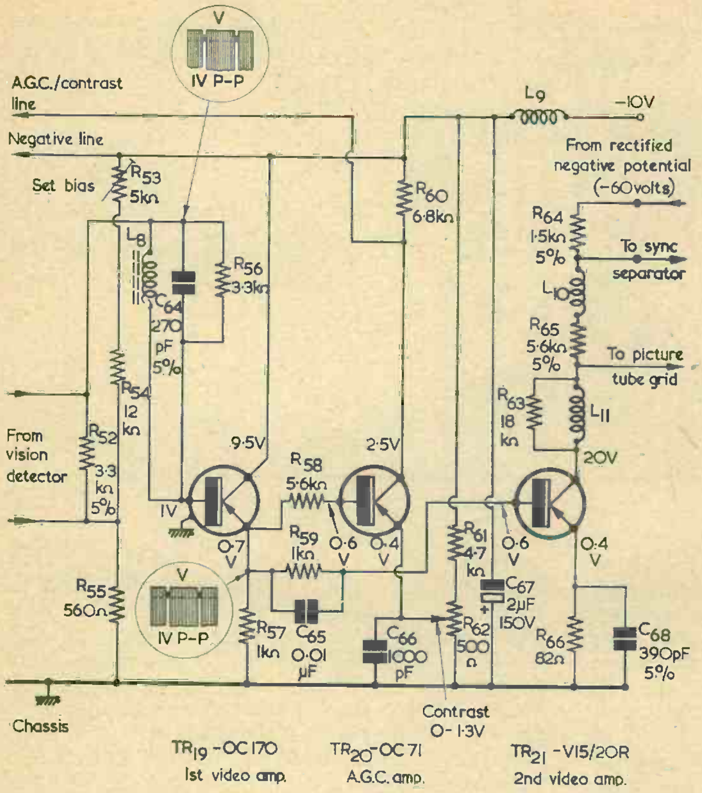


Fig. 9. Two stages of video amplification are provided by TR_{19} and TR_{21}. The video drive to the picture tube grid is about 50 volts, and this is made possible by the use of a special video output transistor energised from a —60 volt source derived from the line output stage. TR_{20} is the a.g.c. amplifier, and it controls the gain of the tuner and i.f. stages both automatically and manually

collector voltage for the video amplifier transistor and for other things, as we shall see later.

Emitter-follower Amplifier

In Fig. 9 the video amplifier stage, TR_{21}, is driven by a pre-amplifier or first video amplifier, TR_{19}. This pre-amplifier or driver should preferably have a high input impedance, so as not to load the vision detector unnecessarily, whilst at the same time providing a relatively low output impedance to drive the video amplifier. The ideal configuration to satisfy both of these conditions is, of course, the emitter-follower (equivalent to the valve cathode-follower), and this circuit is used almost universally as the video driver.

Thus, the emitter circuit of TR_{19} is d.c. coupled to the base circuit of TR_{21}. Base vias for TR_{19} is provided by the potential divider comprising R_{53} plus R_{54} and R_{55}. The bias conditions are adjustable by the preset resistor R_{53}, and since the base of TR_{21} is tied direct to the emitter of TR_{19} it follows that adjustment of TR_{19} bias will also affect the bias on TR_{21}.

With the Pye TT1, the bias preset resistor should be adjusted until 0.4V d.c. exists across either R_{55} or C_{59} or C_{61} (the latter two components appearing in Fig. 6, Part 2).

L_8, tuned by C_{64} and damped by R_{56}, forms an i.f. beat rejector, and should be adjusted for maximum suppression of the 3.5 Mc/s dot pattern on the picture. A degree of video compensation is given by R_{59} and C_{65}, while L_9 in conjunction with C_{67} prevents the video signal from getting into the power supply circuits.

A very similar arrangement is employed in the Perdio receiver, but here the bias preset resistor is located in the base d.c. circuit of the video output transistor.

Video Polarity

From Fig. 6 in Part 2 it will be seen that the vision detector supplies a negative-going video signal, which is applied to the base of TR_{19}. The emitter of TR_{19} supplies a signal of the same polarity to the base of TR_{21}, which means that a positive-going picture signal is present at the collector of this transistor. This, of course, is suitable for applying to the grid of the picture tube.

In the Perdio set the vision detector diode is connected the opposite way round, so that a positive-going video signal is produced. Since the Perdio video stages are similar to those of the Pye receiver in Fig. 9, it follows that a negative-going video signal is produced in the collector circuit of the output transistor. This is, in fact, the case, and on this model the video is taken to the cathode of the picture tube, as with valve receiver practice. The transistor bias conditions have to be adjusted, of course, to suit either a negative- or positive-going detector signal

Deriving Vision A.G.C. Bias

The waveform at the emitter of TR_{19} in Fig. 9 shows that 1 volt peak-to-peak of composite video signal is applied to the base of the output transistor TR_{21}. This signal is also applied to the base of TR_{20}, which is an a.g.c. amplifier.

The signal is really the d.c. component of the rectified video signal, and TR_{20} serves to amplify this while also reversing its polarity (a phase reversal occurs between the base and collector signals of a transistor). The voltage at TR_{20} collector is therefore representative of the signal amplitude at the vision detector. An increase in signal amplitude results in the voltage at TR_{20} collector going less negative which, as explained in Part 2, then reduces the gain of the vision channel. A decrease in signal has the opposite effect.

Contrast control is given by a potentiometer, R_{62}, across the 10-volt power supply in series with R_{61}, the slider of the control connecting to the emitter of TR_{20}. The emitter potential and, therefore, the reverse bias on the base of TR_{20} are thus controllable by the contrast potentiometer, and the detector output level at which the a.g.c. action commences is also variable. This is, again, a simple yet highly effective circuit.

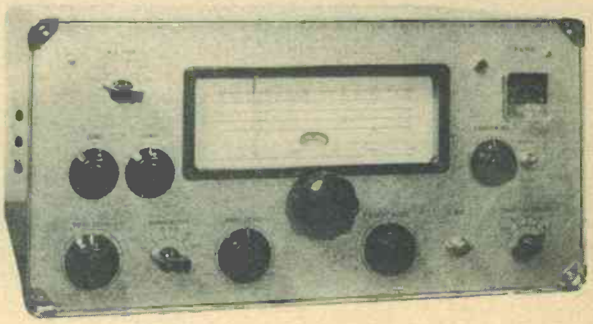
The video waveforms at the base and emitter of the first video amplifier show that there is no voltage amplification, as such, but it will be appreciated that TR_{19} achieves its very important matching operation without loading the vision detector and while supplying both the a.g.c. amplifier and the final video amplifier.

The next article in this series will discuss the line timebase and the picture tube biasing arrangements.

(To be continued)

TRADE REVIEW . . .

The Commando II S.S.B. Transmitter



REGULAR USERS OF THE AMATEUR bands need no convincing that the change over from the a.m. to the s.s.b. mode of radio telephony is in full swing. Those who have already made the change, need no theoretical discussions to convince them of the wisdom of their decision.

The construction of an amateur bands s.s.b. transmitter is quite a formidable undertaking compared with that of an a.m. rig, and it is not surprising therefore to find that there is a ready market for commercially made s.s.b. transmitters. We were therefore pleased to have the opportunity of giving the latest transmitter in this class an extensive trial.

The Commando II SSB Transmitter, is being produced by a specialist division of Mosley Electronics Ltd., in Norwich, England. As can be seen from the photograph, it is a compact, attractive unit, with everything, including power supply, contained in one cabinet 19½in long by 9½in high by 12½in deep. With the limited space most amateurs have these days, this compactness is a useful feature. The attractive appearance of the cabinet, finished in a grey hammer-tone, has considerable eye appeal.

A standard s.s.b. transmitter circuit is used; trick circuitry of doubtful reliability having been avoided. A basic 435 kc/s crystal oscillator carrier generator is used and audio and 435 kc/s input is applied to a balanced modulator. A half-lattice crystal filter using vacuum mounted crystals rejects the unwanted sideband and carrier. Sideband attenuations of 40–45dB suppression and 50dB carrier suppression are obtained.

A further balanced mixer converts the 435 kc/s s.s.b. signal to a neutral frequency of 1995 kc/s. The use of this "neutral frequency" avoids the possibility of some kinds of spurious beat frequencies being generated. The makers have included this feature despite the extra components and crystals needed, in view of the technical advantages of this system and because it permits sideband selection. Two crystals are used in the heterodyning oscillator for this purpose and the normal sideband convention is observed with the sideband selector switch at normal, i.e. lower sideband on 80 and 40 metres and upper sideband on 20, 15 and 10 metres. When required, the opposite sideband may be obtained on the "invert" position of the sideband selector switch.

The v.f.o. operates over the range 3005–3505 kc/s. To minimise pulling, v.f.o. output is taken from an isolating cathode follower stage to a further balanced mixer stage. The mixer stage also receives 1995 sideband injection via a Class A amplifier stage. The output of the mixer gives a sideband signal in the range 5000–5500 kc/s according to the v.f.o. setting. The sideband signal is mixed with the output of a crystal oscillator in a final balanced mixer to provide sideband output on the amateur bands at correct sideband polarity. A three pronged attack on the problems of v.f.o. stability has been made. The v.f.o. is supplied with stabilised h.t. and is temperature compensated. In addition the v.f.o. is "insulated" against any possibility of "pulling" by means of a cathode follower isolating stage. The v.f.o. also runs continuously during "stand-by" periods so that long-period stability is assured. In practice, warm-up drift is so low that operation can commence directly from switch on. During several months of operation, no reports of drift have ever been obtained by the writer. The absence of drift is quite remarkable.

The low level amateur band side-band signal output from the mixer is applied to a driven stage which in turn drives the final power amplifier. This employs a pair of 6146's with stabilised screen supply and 750V anode supply, giving a ICAS rating for the 6146's of 180 watts plate input. Nine silicon rectifiers are employed in the h.t. and bias supply, twin fuses of the "slow blow" type protect against overloads. The oscillator and v.f.o. h.t. lines are stabilised.

VOX and change-over relays are provided, the latter having three pairs of change-over contacts brought to a noval socket at the rear of the chassis. A jack socket is provided for manual operation, which can be used with a "push-to-talk" switch on the microphone. The function switch has the following positions: Tune-up, Net, CW, Manual and VOX.

The transmitter is a pleasure to use. The tune-up procedure can be carried through without difficulty, though the drive control had to be advanced much further on all bands, than indicated in the operating instructions. Also the p.a. tuning and p.a. load control settings differed considerably from those suggested in the instructions. This was no doubt due to the aerial arrangements at the writer's station. However there was adequate drive on all bands and there is plenty of audio gain reserve. The v.f.o. dial, being an Eddystone type 898 is silky smooth and with the Function Switch at "Net", zero-beating with the station required is very easy indeed. The degree of v.f.o. bandspread is just about right.

Very good reports on transmission quality and stability have been invariably obtained and we have no hesitation in recommending this transmitter to those wishing to make a start on s.s.b.

The "Veronica"— 2-Transistor Receiver

By D. B. PITT

This article describes a simple receiver which may be constructed on a Veroboard printed circuit board. It also demonstrates the advantages of this material in the field of home-constructed projects

VEROBOARD[1] IS A STANDARD UNIVERSAL WIRING board which could be described as a logical development of the printed circuit. Unlike the ordinary printed circuit it is perfectly regular in form and consists of a series of parallel copper foil conductors, as may be seen from the photograph showing the underside of the "Veronica" receiver. The conductors are bonded to a laminated plastic board in the same manner as with a conventional circuit; but whereas the latter is intended, and can only be used, for one particular circuit, Veroboard can be employed for almost any circuit. All that is required is a little skill, which is soon learnt. No chemicals or complicated tools of any type are required at all.

The overall cost works out at a fraction (area for area) of that for the conventional printed circuit board, and Veroboard is much quicker to use since no time is wasted in tedious painting with "resists" or waiting for messy etching fluids to slowly nibble away unwanted metal. If this were not enough to attract the amateur constructor, there is the further fact that the board can be modified and re-used a number of times. If components are gently removed, the effects of previous circuitry can be put right quickly and simply.

[1] Veroboard is manufactured by Vero Electronics, South Mill Road, Regents Park, Southampton.

Each copper strip of the Veroboard is pierced at regularly spaced intervals. The type employed here has a hole spacing of 0.2in. Each strip is 0.1in wide and there is a spacing between strips of 0.1in. Thus there is a matrix pattern of holes with a pitch of 0.2in parallel to the strips and at right angles to the strips. The hole diameter is 0.052in. Component lead-outs may be passed through the holes and soldered to the copper part in the same manner as is used with conventional printed circuit boards. Because of the convenient 0.2in pitch, Veroboard layouts can be quickly sketched out, full size, on standard 1in graph paper.

Breaks and Links

In a circuit employing Veroboard it may be occasionally necessary to provide a break in a copper strip. The writer has found that this is easily accomplished with simple handy tools, such as a twist drill between $\frac{1}{8}$ and $\frac{3}{16}$in diameter. Since the copper is thin, it can be removed with a countersunk bit held in the fingers whilst using rather heavy pressure. Care should be taken to prevent the drill from slipping in case it scratches the board and causes damage to other strips.[2]

[2] This risk may be avoided by employing the special Spot Face Cutter Ref. VB3011, manufactured by Vero Electronics. This cutter has a spigot which locates in any Veroboard 0.052in hole, and it removes the strip over a 0.2in diameter circle.—EDITOR.

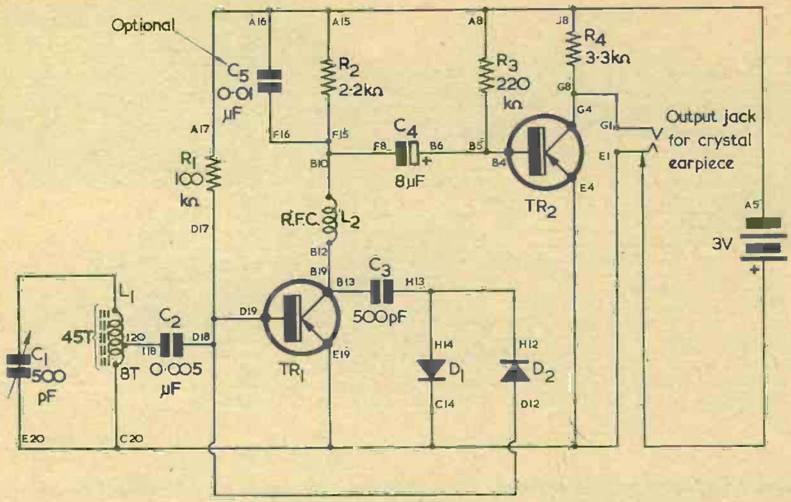


Fig. 1. The circuit of the "Veronica" receiver. The letter and figure references at each component indicate the corresponding copper strips and holes on the Veroboard sheet

Components List

Resistors (all $\frac{1}{4}$ or $\frac{1}{8}$ watt)
- R_1 100kΩ
- R_2 2.2kΩ
- R_3 220kΩ
- R_4 3.3kΩ

Capacitors
- C_1 500pF variable (see text)
- C_2 0.005μF
- C_3 500pF
- C_4 8μF electrolytic, 3V wkg.
- C_5 0.01μF (optional)

Inductors
- L_1 Ferrite rod aerial coil (see text)
- L_2 RFC 1.5mH (Henry's Radio Ltd.)

Semiconductors
- D_1,D_2 Germanium diodes
- TR_1,TR_2 See text

Earpiece
- Crystal type with socket (see text)

Battery
- 3 volt miniature

Cabinet
- Plastic or wooden, to suit receiver. Approx. internal dimensions 4 x 3 x 1in

Veroboard
- 1 sheet, hole pitch 0.2in. 10 strips x 20 holes (Henry's Radio Ltd.)

If a break has been accidentally made at an incorrect part of the board, this is not a disaster, since the gap can easily be repaired by bridging it with a piece of tinned copper wire, the ends of which pass through the two holes nearest to the break. The ends protruding on the non-copper side are clipped short and clinched over firmly. The bridging wire is then soldered to the strip at the two points of anchorage.

It is sometimes necessary to link one copper strip to another. This can be readily carried out by using a jumper, or link wire, positioned on the non-copper side and protruding through two holes in the strips it is desired to join. The ends are then soldered to the strips in the same manner as component lead-out wires. The length of jumper wire on the non-copper side may be insulated or not, as desired.

Soldering

As received, the board may appear to be tarnished. This effect is given by a protective coating on the copper which preserves the surface from atmospheric contamination and which makes a good quick solder joint possible even after prolonged storage.

Unless alternative positioning is required, each component is laid flat on the non-copper side of the board with its leads bent at right angles and passed through the appropriate holes. These leads are then clipped off short leaving, say, $\frac{1}{16}$ in visible, whereupon the stubs are bent over sharply to lie flat against the copper strip. The component is then clinched firmly to the board. The bending over is best done with a hard material, but this should *not* be harder than copper. A scrap of hard plastic or the handle of a knife will do; sharp steel objects should be avoided.

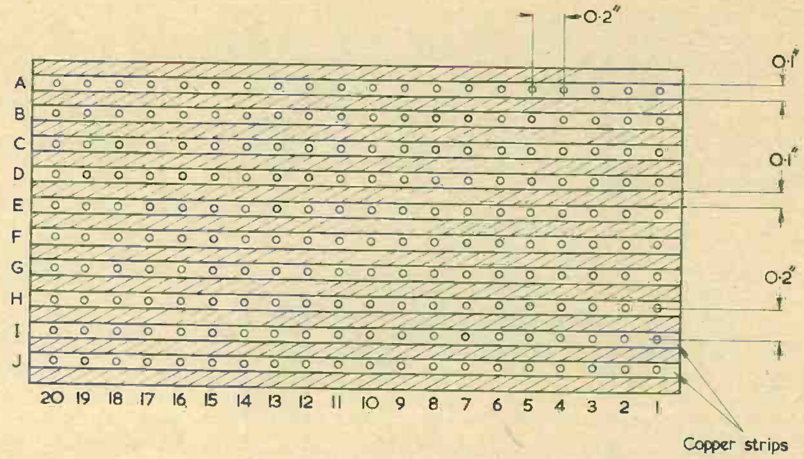


Fig. 2. The Veroboard employed for the receiver. This diagram also shows the letter and number references given in Fig. 1

Soldering should be carried out quickly, using an electric iron and a good quality fluxed solder. Prolonged heating can destroy the bond between the copper strip and the plastic base. Even this damage can, however, usually be repaired. The injured spot is bridged by a fairly stiff piece of tinned copper wire, this being laid flat on the copper strip with its ends passing through the two nearest holes to the point of damage. The ends are clipped, clinched over and the strip soldered in the same manner as is used for bridging gaps.

Building the "Veronica"

An almost infinite number of circuit combinations may be built up with the aid of Veroboard. In this article, the construction of a simple two-transistor receiver (whose circuit diagram is shown in Fig. 1) is described. The various constructional steps involved demonstrate very well the capabilities of Veroboard in the home-constructor field.

Because of the matrix pattern of Veroboard, a circuit can be built up from instructions which quote a number and letter reference for each connection. Fig. 2 illustrates the board required for the "Veronica" receiver, and it will be noted that it has ten copper strips, each with 20 holes. In Fig. 2 the strips are identified by the letters A to J and the holes by the numbers 1 to 20. In the constructional details which follow, each connection to the strip will be referred to by quoting the letter and number reference of the appropriate hole. Devotees of the game "Battleships and Cruisers" will need no second explanation! Fig. 2 illustrates the board with the copper side towards the reader.[3]

The first process is to make three breaks in the copper strips at B7, B11, D9 and H9. The strips are interrupted at these points in the manner described above. Next to be fitted are links between copper strips. These travel over the non-copper side of the board. Three links are required, one joining A9 to J11, one joining B8 to F9, and one joining C5 to E5.

The resistors come next and these should be $\frac{1}{4}$ or $\frac{1}{8}$ watt components. R_1 (100kΩ) is fitted between A17 and D17, R_2 (2.2kΩ) between A15 and F15, R_3 (220kΩ) between B5 and A8, and R_4 (3.3kΩ) between G8 and J8.

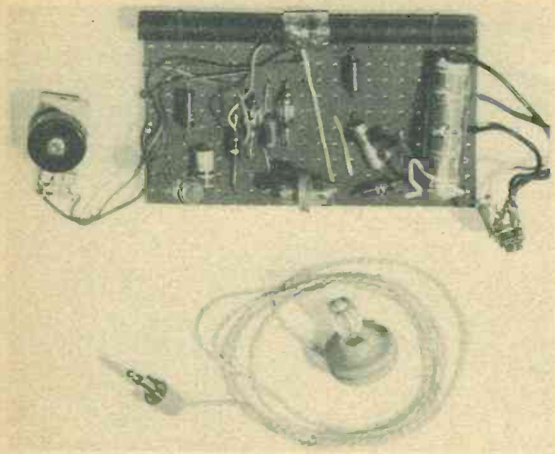
The resistors are followed by the fixed capacitors. These should all be miniature types. C_3 (500pF) connects between B13 and H13 and C_2 (0.005μF) between D18 and I18. C_4 (8μF electrolytic) connects between B_6 (positive) and F8 (negative).

The transistors are next fitted. One r.f. and one a.f. type are required and, in good reception areas, it should be adequate to employ surplus types. For moderate reception areas, TR_1 may be an OC44 and TR_2 an OC72 or OC81. For poor reception areas TR_1 could be an MAT100. Transistors should be soldered into circuit as quickly as possible, using a heat shunt in the normal manner. The lead-out wires should, preferably, be sleeved to prevent the risk of short-circuits. The transistors are *not* mounted close to the board, and there should be about 1in of lead-out wire above the non-copper side. The collector of TR_1 is connected to B19, the base to D19 and the emitter to E19. The collector of TR_2 is connected to G4, the base to B4 and the emitter to E4.

The transistors are followed by the diodes. D_1 connects between C14 (positive) and H14 (negative). D_2 connects between H12 (positive) and D12 (negative). Solder connections to the diodes should be made as quickly as possible, employing a heat shunt.

A number of flying leads are now required. These consist of suitable lengths of flexible insulated wire which connect to external components. The negative battery lead comes first, and this connects to A5. The battery may be any 3 volt type, that employed in the prototype being conveniently fitted at one end of the board, as shown in the illustration.

[3] Clear adhesive tape with numbers printed to correspond with holes or strips is available from the manufacturers of Veroboard.—EDITOR.

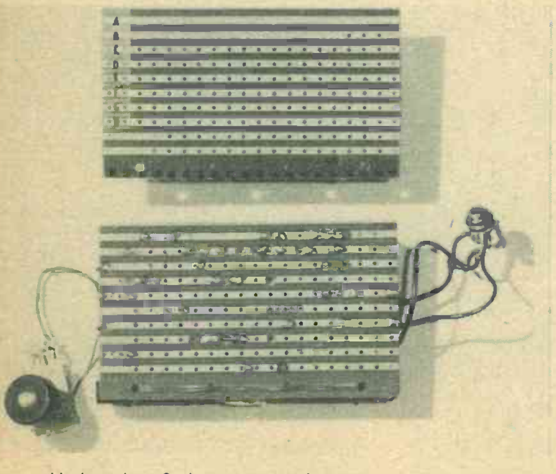


The "Veronica" receiver, complete with crystal earpiece

Connections are next made to the coil. This comprises 45 turns of 32 s.w.g. enamelled wire wound at the centre of a 4in length of ferrite rod having a diameter of ⅜in. Leaving a few inches of wire free for a lead-out at the start of the winding, first wind on 8 turns then twist a loop in the wire to form a tap. Finally, complete the 45 turns required, winding in the same direction, and leave a few inches spare at the finish. The coil may be fitted to the board in any convenient manner. In the prototype it was secured with an elastic band at the same edge as copper strip J. The coil described covers the medium waveband. Those who prefer the long waveband will need a coil of about 150 turns tapped after, say, the 50th turn.

The start of the coil connects to C20 and the tap to I20. The finish lead-out is connected later.

Next to be wired into circuit is the crystal earpiece socket. This consists of a socket which, normally, causes a circuit to be broken when the plug is inserted, as in Fig. 3 (*a*). In this instance it is



Underside of the completed receiver, alongside an unused sheet of Veroboard of the same area

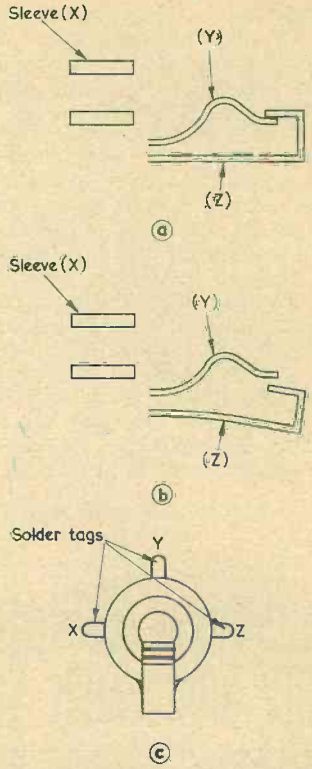


Fig. 3 (a). Detail showing the switching contacts on the crystal earpiece before modification. When the jack plug is inserted in the sleeve, contacts "Y" and "Z" break

(b). The contacts after modification. Inserting the jack plug now causes the contacts to make

(c). The tag layout of the socket modified for the prototype. The contacts are towards the reader

modified so that a circuit is made when the plug is inserted, as shown in Fig. 3 (*b*). The modification is carried out by carefully bending the "hook" of the switch contact down until the complementary contact (that which connects to the jack plug tip) *just* escapes from the embrace of the hook. It should now be found that inserting the plug causes the two contacts to make, and the action can be finally adjusted, if necessary, by a little squeezing with the fingers. The jack socket now functions as the on/off switch for the receiver, the latter being switched on when the jack plug is inserted. Fig. 3 (*c*) shows the layout of the tags on the socket modified by the writer. Tag "Y" of the socket connects by a flexible lead to E1, and tag "X" to G1. Tag "Z" connects direct to the positive terminal of the battery. The flexible leads to the socket should be of sufficient length to enable it to be fitted in a convenient position for any cabinet in which the receiver may be housed.

The tuning capacitor C_1 has next to be connected up and this is any miniature 500pF type. The writer employed a 500pF compression trimmer, replacing the adjusting screw with a larger one of the same thread and fitting a knob on the extension. The earthy terminal of C_1 (with a trimmer, this corresponds to the plate nearest the head of the adjusting screw) connects to E20. The non-earthy terminal connects to the finish of the coil. This latter lead may be conveniently anchored near the edge of the board to prevent strain on the coil wire. The leads to C_1 should be of sufficient length to enable it to be conveniently mounted in a cabinet.

The r.f. choke is the final component to fit, and it connects between B10 and B12. A choke between 1 and 2mH will be satisfactory, a suitable type being the 1.5mH choke available from Henry's Radio Ltd. It is mounted with its leads unshortened, so that its position relative to the coil on the ferrite rod may be adjusted. For long wave reception it will probably be preferable to employ a choke having an inductance of at least 2mH.

Final Points

The completed receiver may be conveniently fitted in a small plastic or wooden cabinet. The tuning capacitor and earpiece socket may then be mounted on the sides of the cabinet.

It is possible to vary sensitivity by adjusting the spacing between the choke and the ferrite rod, since this introduces a measure of regeneration. If feedback does not occur, the ferrite rod may need to be turned over and fastened the other way round. Under very poor conditions the rod may even have to be mounted on the same side as the r.f. choke. An extra 0.01μF capacitor used as an r.f. bypass may help, and it should be connected between A16 and F16. This capacitor is shown as C_5 in Fig. 1.

Under extremely favourable conditions (e.g. close to a broadcasting station) it may be necessary to reverse the diodes to avoid instability. It should be noted that reversing *one* diode only will prevent the receiving from functioning.

AN ECONOMICAL AMPLIFIER AND VARIABLE INDUCTANCE TUNER

by SIR DOUGLAS HALL, K.C.M.G., B.A. (Oxon)

Normally, a Class A transistor output stage has to draw a relatively heavy standing current if it is to handle input signals of both small and large amplitudes. In the amplifier described here, a novel circuit technique causes output transistor bias to vary with input signal amplitude. The amplifier is combined with a tuner to provide a complete 2-transistor receiver with the first transistor reflexed

Most transistor amplifiers use the Class B principle in order to obtain good output with moderate consumption from the battery. But some who employ receivers with this circuit seldom take advantage of the maximum output which is available to them, as a very few milliwatts will give good personal listening on a sensitive loudspeaker. In these circumstances Class B is not as economical as it might be, as its comparatively low efficiency means that quite often four transistors have to be used in place of two. Not only are two transistors required for the output stage, but an extra current amplifier is generally needed in a simple set.

The normal alternative is a straightforward Class A output transistor which, provided it is transformer coupled, will usually deliver its maximum power with one other transistor to drive it. But this output transistor must be biased so as to cope with heavy transients such as the occasional clash of cymbals, etc., and it accordingly takes the requisite amount of current needed for this contingency even though for 90% of the time it may have only a fraction of the maximum signal to deal with. This, again, is an uneconomical arrangement.

Economical Class A Circuit

The amplifier circuit to be described employs a single OC72 in the output. It is used as a Class A amplifier, but is arranged to draw the current it needs to cope with any input within the limits of its 40mW maximum output. Its standing current, however, is only about 1mA, and its driver, the only other transistor in the amplifier, also takes about 1mA. The amplifier operates like a Class B arrangement as regards fluctuating current consumption, but not in any other respect. The maximum output of 40mW is a good deal less than that of most Class B amplifiers, but it is very much more economical. It will be found that at a level suitable for a quiet room the needle of a milliammeter connected in series with one of the leads to the battery will seldom flick above 3mA. Volume fully adequate for a large room will require an average of about 4 to 5mA from a 9 volt battery with occasional short periods up to 10 or 12mA during a loud passage of music. Quality is good.

The amplifier circuit is shown in Fig. 1. TR_1 is a straightforward small-signal amplifier fed from the volume control VR_1. It is shown as an OC44 in order to operate satisfactorily with the special tuner to be described later. Also, in the interests of the tuner, a third input point is shown, connected to the collector of TR_1. Constructors who do not wish to use the special tuner can use any low frequency transistor for TR_1, including a surplus "red spot" variety. They can also leave out the third input point.

Components List
(Figs. 1, 2 and 3)

Resistors
- R_1 39kΩ
- R_2 10kΩ
- R_3 1kΩ
- R_4 150kΩ
- R_5 3.9kΩ
- R_6 15Ω
- R_7 4.7kΩ
- VR_1 5kΩ log potentiometer
- VR_2 50kΩ linear potentiometer

Capacitors
- C_1 100μF 12V wkg. electrolytic
- C_2 4μF 12V wkg. electrolytic
- C_3 100μF 12V wkg. electrolytic
- C_4 0.1μF
- C_5 100pF
- C_6 560pF
- C_7 82pF
- C_8 560pF

Inductors
- L_1 Rex LT44 (see text)
- L_2 See text
- L_3 See text
- T_1 Repanco TT49
- T_2 Rex LT700 (see text)

Semiconductors
- D_1 OA81
- D_2 OA81 or similar
- D_3 OA81 or similar
- TR_1 OC44 (see text)
- TR_2 OC72

Switches
- S_1 s.p.s.t. on-off switch
- S_2 s.p.d.t. wavechange switch

Miscellaneous
- Ferrite rod 8 x ⅜in diameter
- Speaker 3Ω impedance

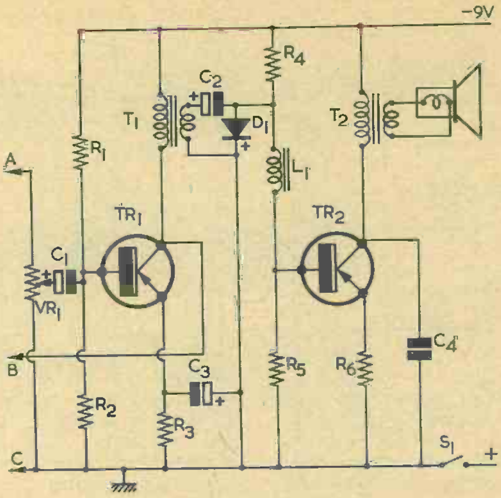


Fig. 1. The circuit of the economy Class A amplifier

After amplification by TR_1 the signal is applied to the primary of T_1 which is a Repanco TT49 interstage transformer. The blue lead of T_1 should be connected to the collector of TR_1 and the red lead to battery negative. The secondary can be connected either way round. The signal then appears across the crystal diode, D_1, an OA81. There will also be a d.c. component across D_1 and it is this which can increase the standing negative bias on the base of TR_2 to enable it to cope with the signal which has produced it.

Experiment proved that in order to prevent TR_2 from overloading it was necessary for the voltage of the audio frequency signal to be a little lower than the d.c. voltage. In other words it was necessary for some of the a.c. voltage which, after rectification by D_1 produced the d.c. voltage for bias, to be lost before it reached the base of TR_2.

It was also found that there was a preponderance of the higher audio frequencies and that it was these higher frequencies which caused overloading. L_1 was therefore introduced in the standing bias arrangements for TR_2. L_1 is an l.f. choke. In practice it is the secondary winding (black and white leads) of a Rex driver transformer, type LT44. The inductance of this winding is just right for the job it has to do. Its d.c. resistance is low, so that it has little effect on the d.c. voltage impressed on the base of TR_2. But at audio frequencies it forms a potentiometer with R_5 and introduces a loss of voltage which increases with frequency. The Rex LT44 is sold together with an output transformer type LT700 as a pair.* The LT700 is suitable for T_2, using the whole of the primary winding which gives a ratio of about 19 to 1.

Little comment is needed on other parts of the amplifier circuit except to mention that R_6 is not bypassed by an electrolytic capacitor since the current passing through it is constantly varying. A high capacitance in parallel with R_6 could cause unfortunate effects as the capacitor charged and discharged with the varying voltage.

The Tuner

Fig. 2 shows the circuit of the tuner which has been especially designed to be used with the amplifier just described. Fig. 3 shows the circuit of the units combined as a complete receiver.

* The LT44 and LT700 transformers are available as a pair, at low cost, from Henry's Radio Ltd. and other suppliers.

The tuner is unusual in three respects: first, because it employs variable inductance tuning by means of a ferrite rod which slides in and out of the two coils used for medium and long waves respectively; second, because only one winding is used for each waveband, and there is no coupling coil, reaction coil or tapping point; and third, because it makes use of the first transistor in the amplifier for amplification at high frequency before demodulation by D_2 and D_3. That is to say, it turns TR_1 into a reflexed amplifier with reaction.

L_2 is the medium wave coil and it

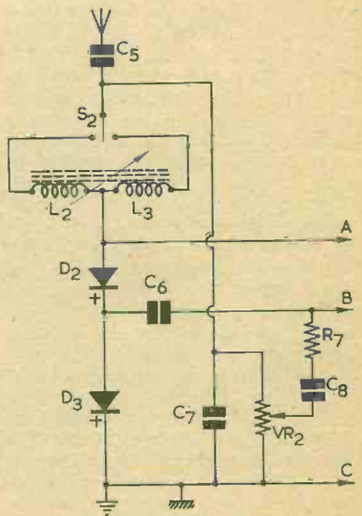


Fig. 2. The tuner section

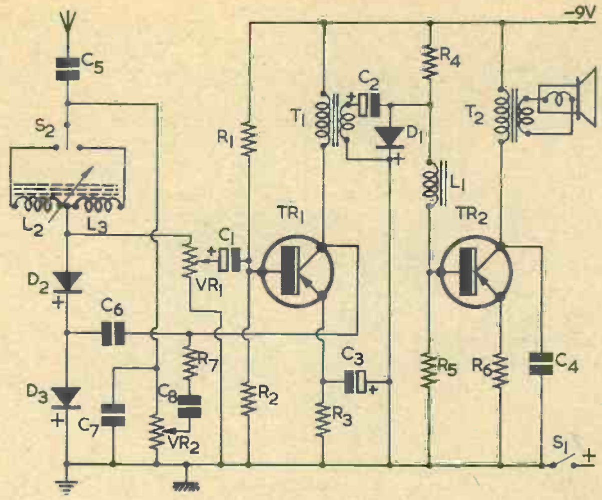


Fig. 3. The complete receiver given by the combination of tuner and amplifier

consists of 140 turns of 32 s.w.g. enamelled wire close wound on a 3in long sleeve made to fit a ⅜in ferrite rod. The coil will be between 2 and 2½in long. The sleeve is made of adhesive-backed plastic ("Contact" or similar), the paper backing being left on for an inch or so before winding a piece, 3in square, onto the rod. The sleeve should be made a nice easy sliding fit.

It will be seen that there are stray capacitances from each end of L_2 to earth, not to mention C_7, and consequently a capacitance tap at earth potential. When the tuner is connected to the amplifier the base-emitter circuit of TR_1 will find itself connected across a part of the tuned circuit and the aerial will similarly be connected to a part of this circuit. VR_1 will now be found to act as a high frequency volume control in addition to performing its normal function, and it must be set to a near-maximum position in order to obtain reaction. Reaction is controlled by VR_2. Some increase in selectivity can be obtained, when this is wanted, by turning VR_1 back a little so as to reduce the r.f. signal on the base of TR_1, and by increasing reaction by means of VR_2. The effect is rather similar to using a variable-mu volume control in conjunction with a reaction control in a t.r.f. valve receiver, except that there is a limit to the reduction in the setting of VR_2 which will still allow reaction effects to be obtained.

C_7 performs a dual function. First, as already stated, it operates in conjunction with stray capacitances to provide a suitable tapping point into the tuned circuit; second, in conjunction with L_3, which forms an efficient choke at medium wave frequencies, it acts as an anti-break-through arrangement when the long waveband is in use, all medium wave frequencies being rejected by L_3 and bypassed to earth through C_7.

L_3 consists of 600 turns of 38 s.w.g. enamelled wire pile wound in one continuous winding on a similar sleeve to that used for L_2. The length of the winding should be the same as that of L_2. The two diodes D_2 and D_3 are not critical, and do not need to be matched.

Tuning Assembly

It is necessary to contrive an arrangement whereby the ferrite rod can be moved in and out of L_2 and L_3 to vary the tuning. Constructors may have their own ideas on the best and neatest way to do this. In the prototype an 8in length of rod is used and the two coils are mounted at opposite ends of it and at a distance apart such that when the rod is fully in one coil it is fully out of the other, whilst still being steadied by the last ¼in or so of the sleeve (on which there is no winding). (See Fig. 4 (*a*).) The rod is held between a rubber rimmed wheel and a pair of rollers. The rollers are mounted in such a way that a small amount of adjustment

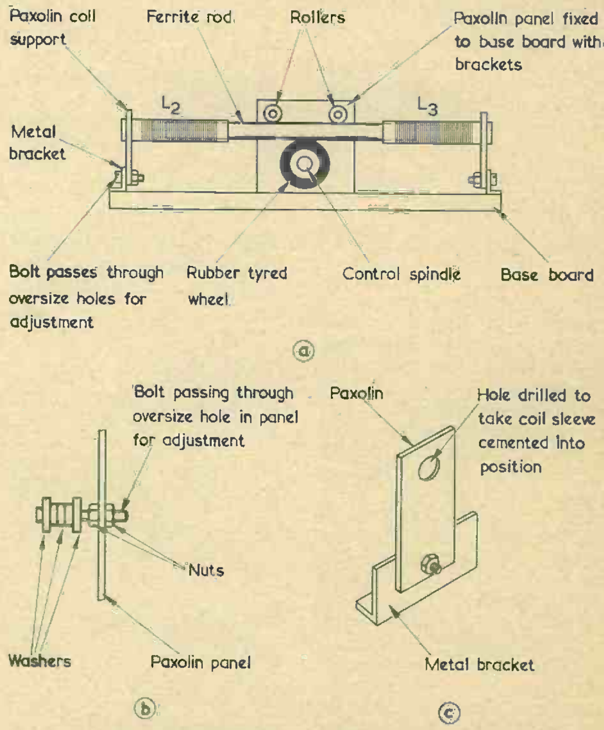


Fig. 4 (a) The manner in which the ferrite rod enters L_2 and L_3.
(b). Detail showing a simple construction for the rollers
(c). How the coil supports are assembled

is possible in the original setting up, so that smooth friction drive is obtained by turning the wheel. The drive should not be adjusted too tight or the rod may break. The rollers may be made up of washers, using larger ones at the outside, as shown in Fig. 4 (*b*). The bolts passing through the washers should pass through over-size holes in the panel to allow for adjustment. A Meccano wheel with a rubber tyre can be used for the drive. It is not possible to use a scale in conjunction with the wheel as there is always some slip with friction drive. The easiest way to indicate position is to mark the centre of the rod with a band of bright paint and mount the unit so that the painted band can be seen through a slot in the panel. Details of the coil supports are given in Fig. 4 (*c*).

The tuner will probably be found to pick up the local station without an aerial or earth, but some sort of aerial will generally be required in order to obtain good loudspeaker volume. An indoor aerial will be suitable in many places, especially if an earth is used, and the earth socket of a mains plug will be found very satisfactory. It will be found that aerial and earth connections can be reversed without any noticeable effect. However, if only an aerial is used, it must connect to the aerial terminal. An earth connection will be found more necessary on the long waveband.

The coverage on the medium waveband will be found to be from about 150 to 550 metres with neither aerial, nor earth connected, and from about 190 metres to about 570 metres with a long aerial in use and an earth connection. The long waveband will also be found to be fully covered in all circumstances and will reach nearly 3,000 metres with a long aerial and an earth connection. Selectivity may prove a problem in areas where there are two powerful medium wave stations near by. In such cases a short aerial should be used, and no earth.

It is obvious that the amplifier and the tuner may be built as separate units or together, to form a simple and very economical local station receiver. In the prototype the two units are made separately, but are mounted together in a small cabinet with a loudspeaker. The three connections to the amplifier are made by terminals so that it is an easy matter to disconnect the tuner and use the amplifier, complete with loudspeaker, with any other apparatus.

Kit Review

The Sky Rover 7-Transistor Medium and Short Wave Portable Receiver

THE SKYROVER PORTABLE IS, SO FAR AS HOME constructors are concerned, a comparatively new departure in that the frequency coverage includes, in addition to the medium waveband, a short wave general coverage band and four separate short wave bandspread ranges. The medium wave coverage is 180 to 576 metres (520 to 1,670 kc/s), the short wave general coverage 31 to 94 metres (3.2 to 9.8 Mc/s) whilst the four separate bandspread short wave ranges are 25 metre band (11.3 to 12.1 Mc/s); 19 metre band (14.5 to 16.3 Mc/s); 16 metre band (17.5 to 18.3 Mc/s) and 13 metre band (20.8 to 22.1 Mc/s).

Operating from four 1.5V torch batteries (Ever Ready U2), the circuit includes seven transistors and two diodes. A separate oscillator stage is incorporated for good short wave stability and one of the diodes has been included especially for improved a.g.c. action, necessary over the frequencies involved if satisfactory reception is to be maintained.

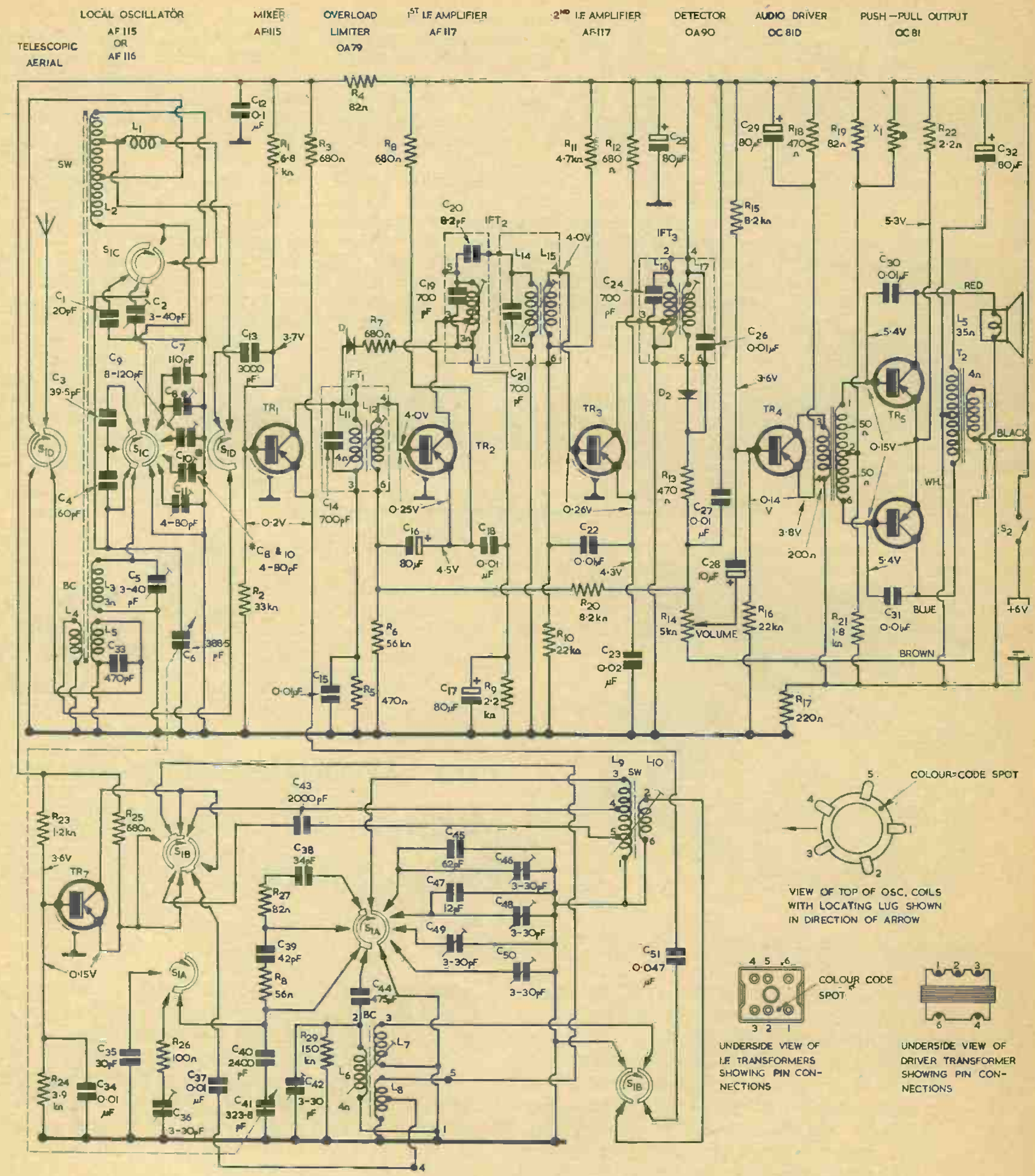
An internal ferrite rod aerial coupled with a telescopic collapsible aerial gives excellent reception on all frequencies and the 5in ceramic magnet speaker provides good tonal quality.

The transistor line-up is as follows: oscillator AF116; mixer AF115; i.f. stages (2) AF117; audio amplifier OC81D and output stage (class B push-pull) OC81 (2). The two diodes are OA90 detector and OA79 a.g.c. damping diode.

The cabinet is constructed of high impact plastic, attractively styled, with matching trim and carrying handle. The size in 10in wide, 6½in high and 3½in deep, and the weight including batteries is 5lb.

From the illustration it will be noted that an easy-to-read slide rule scale and waveband indicator are a feature of the design, further controls being for volume (combined with the on/off switch) and tuning.

The de-luxe version of the receiver has a technical specification similar to that described here but differs in that the cabinet is of wood covered with a



washable material, the cabinet itself being slightly wider. Additionally, a tone control and a car aerial input socket is provided.

The intermediate frequency of both models is 470 kc/s and the power output is 500mW.

Circuit

From this it will be seen that wavechange switch is shown in the medium wave position. The signal from the telescopic aerial is fed, via $S_{1(d)}$, to L_5 (telescopic aerial coupling coil). L_3 is the ferrite rod medium wave aerial coil and, from L_4 (medium wave base coil), the output is applied, via $S_{1(d)}$ and C_{13}, to the base of TR_1 (mixer AF115). L_3 is tuned by C_6 (one half of a two-ganged variable capacitor) and the trimmer C_5.

The oscillator (TR_7 AF116) is tuned by the variable capacitor C_{41} and L_6 (medium wave oscillator tuned coil) together with the associated padder and trimmer capacitors C_{40}, C_{42}, C_{44},

Components List

Resistors
(All fixed resistors 10% ¼ watt unless otherwise specified)

R_1	6.8kΩ
R_2	33kΩ
R_3	680Ω
R_4	82Ω
R_5	470Ω
R_6	56kΩ
R_7	680Ω
R_8	680Ω
R_9	2.2kΩ
R_{10}	22kΩ
R_{11}	4.7kΩ
R_{12}	680Ω
R_{13}	470Ω
R_{14}	5kΩ Log.
R_{15}	8.2kΩ
R_{16}	22kΩ
R_{17}	220Ω
R_{18}	470Ω
R_{19}	82Ω±5%
R_{20}	8.2kΩ
R_{21}	1.8kΩ±5%
R_{22}	2.2Ω±½Ω
R_{23}	1.2kΩ
R_{24}	3.9kΩ
R_{25}	680Ω
R_{26}	100Ω
R_{27}	82Ω
R_{28}	56Ω
R_{29}	150kΩ

Capacitors

C_1	20pF±10%
C_2	3–40pF trimmer
C_3	39.5pF±2.5%
C_4	60pF±2.5%
C_5	3–40pF trimmer
C_6	388.5pF variable capacitor
C_7	110pF, 125V wkg, ±10%
C_8	4–80pF trimmer
C_9	8–120pF trimmer
C_{10}	4–80pF trimmer
C_{11}	4–80pF trimmer
C_{12}	0.1μF
C_{13}	3,000pF
C_{14}	700pF, 30V wkg.
C_{15}	0.01μF
C_{16}	80μF, electrolytic, 6.4V wkg.
C_{17}	80μF, electrolytic, 6.4V wkg.
C_{18}	0.01μF
C_{19}	700pF, 30V wkg., ±5%
C_{20}	8.2pF±¼pF
C_{21}	700pF, 30V wkg., ±5%
C_{22}	0.01μF
C_{23}	0.02μF
C_{24}	700pF, 30V wkg., ±5%
C_{25}	80μF, electrolytic, 6.4V wkg.
C_{26}	0.01μF
C_{27}	0.01μF
C_{28}	10μF, electrolytic, 16V wkg.
C_{29}	80μF, electrolytic, 6.4V wkg.
C_{30}	0.01μF
C_{31}	0.01μF
C_{32}	80μF, electrolytic, 6.4V wkg.
C_{33}	470pF
C_{34}	0.01μF
C_{35}	30pF±10%
C_{36}	3–30pF trimmer
C_{37}	0.01μF
C_{38}	34pF, ±2.5%
C_{39}	42pF, ±2.5%
C_{40}	2,400pF, ±2.5%
C_{41}	323.8pF variable capacitor
C_{42}	3–30pF trimmer
C_{43}	2,000pF
C_{44}	475pF±1%
C_{45}	62pF
C_{46}	3–30pF trimmer
C_{47}	12pF
C_{48}	3–30pF trimmer
C_{49}	3–30pF trimmer
C_{50}	3–30pF trimmer
C_{51}	0.047μF, 400V wkg.

Inductors

L_1	Bandspread aerial shunt
L_2	Short wave aerial
L_3	Broadcast aerial
L_4	Broadcast base
L_5	Telescopic aerial coupling
$L_{6,7,8}$	Broadcast oscillator
$L_{9,10}$	Short wave oscillator
$L_{11,12}$	IFT_1
L_{13}	IFT_2 (primary)
$L_{14,15}$	IFT_2 (secondary)
$L_{16,17}$	IFT_3
T_1	Driver transformer
T_2	Output transformer

Transistors

TR_1	AF115
TR_2	AF117
TR_3	AF117
TR_4	OC81D
TR_5	OC81
TR_6	OC81
TR_7	AF116

Diodes

D_1	OA79
D_2	OA90

Printed Circuit Board
(Lasky's Radio Ltd.)

Speaker
5in circular

Cabinet, Knobs, etc.
(Lasky's Radio Ltd.)

Telescopic Aerial
(Lasky's Radio Ltd.)

Wavechange Switch Assembly
$S_{1(a)}$, (b), (c), (d), and associated coils (Lasky's Radio Ltd.)

Thermistor
X_1 (Lasky's Radio Ltd.)

the feedback winding being L_8. The output from the oscillator section is taken, via L_7, $S_{1(b)}$ and C_{51} to the emitter of TR_1.

On the short wave general coverage range, the inductances L_1 (bandspread aerial shunt coil) and L_9L_{10} (oscillator coil) are brought into circuit by operation of the wavechange switch. C_2 is the aerial trim capacitor, aerial trimmers for the short wave bandspread ranges being C_8 (Bandspread 1), C_9 (Bandspread 2), C_{10} (Bandspread 3) and C_{11} (Bandspread 4). All of these capacitors are part of a 6-way trimmer bank.

The trimmer capacitors for the oscillator section are C_{46} (Bandspread 1), C_{48} (Bandspread 2), C_{49} (Bandspread 3) and C_{50} (Bandspread 4).

The output from the collector of TR_1 is fed, via the windings $L_{11}L_{12}$ of IFT_1, to the base of the first i.f. amplifier transistor TR_2. The diode D_1 (OA79) operates, in the configuration shown, as an a.g.c. damper on high level signals. The resultant amplified i.f. signal is next passed to IFT_2, L_{13} being the primary winding and $L_{14}L_{15}$ being secondary and tertiary windings respectively. L_{13} is top-coupled to L_{14} via capacitor C_{20}. The output from IFT_2 is next fed to the base of the second i.f. amplifier TR_3, the output from the collector of this transistor being applied to the primary (L_{16}) of IFT_3. From the secondary winding of this transformer (L_{17}), the i.f. signal is fed to the diode D_2 (OA90), the volume control R_{14} functioning as the diode load. R_{13} is the diode decoupling resistor, the a.g.c. voltage being applied to the first i.f. stage via the resistor R_{20}.

The a.f. voltage tapped off by the slider of the volume control R_{14} is fed, via C_{28}, to the base of TR_4, this transistor operating as the audio driver stage. The output is taken from the collector and applied to the primary winding of the driver transformer T_1, the secondary winding of which connects to the bases of TR_5 and TR_6. The output from these transistors is fed to the output transformer T_2 and thence to the speaker. A degree of negative feedback to improve the overall audio response is applied to the volume control, R_{14}, via the secondary winding of the output transformer. The full power output is 500mW, the output stage operating in Class B push-pull.

In the circuit as shown, all switches are connected in the counter-clockwise "broadcast" (i.e. medium waves) viewed from the control knob end of the spindle.

Circuit Checking

The voltage readings shown in the rectangles were taken with a 20,000Ω per volt meter, the arrows indicating the points across which the meter should be connected. D.C. resistance readings are shown against inductors where these are 1Ω or greater.

Current readings should be as follows: quiescent 20mA; for 50mW output 45mA; and for 500mW (maximum) output 120mA. No other current consumption measurements should be attempted, further checks with respect to current being calculated from measured voltage drops across resistors.

When a signal generator is used for circuit checking, the direct output, via a d.c. blocking capacitor, should be utilised. When checking the i.f. circuits a 0.1μF capacitor should be used, the signal being injected at the aerial section of the ganged variable capacitor or TR_2TR_3 base circuits. To check the audio stages, inject a signal across the volume control, the "live" lead being blocked by an 8μF capacitor and the output meter being disconnected from earth.

All components for the Sky Rover receiver are available from Lasky's Radio Ltd., at £10 19s. 6d. plus 5s. postage and packing (less batteries). The de-luxe version is available at £12 19s. 6d plus 5s. postage and packing (less batteries).

Single Transistor Impedance Transformer

BY P. CLOUGH

A GREAT MANY CRYSTAL PICK-UP CARTRIDGES capable of very good quality are being sold at reasonable prices. These cartridges have to be matched to a high load impedance or a loss of quality results. Crystal microphones also have to be matched into a high impedance load for best results.

Transistors are inherently low impedance devices, and most constructors will have experienced difficulty in achieving best results when matching crystal devices to transistor amplifiers. The circuit shown is for a single transistor "impedance transformer" with an input impedance of over 1MΩ. The circuit is based on an emitter follower with a gain of 0.9 or greater.

The input is to the base of the transistor via C_1, and bias is applied, through R_1, by R_2 and R_3. This point is connected to the output of the amplifier via a large value capacitor, C_2.

The frequency response of this "transformer" was checked with several transistors and found to be flat to 20 kc/s. Careful checks failed to detect any distortion with an input of 2 volts when the amplifier was powered by a 9 volt battery, or 1 volt input with a collector voltage of 4.5 volts. Current consumption depends on battery voltage and the gain of the transistor, and it can range from 0.5mA for a "red spot" to 1.5mA for an OC44 transistor. The circuit is very tolerant of transistors and a first grade component is not necessary. The cost compares very favourably with a high grade matching transformer of conventional design, especially when the frequency response and absence of distortion are considered. No cheap or small matching transformer bears comparison with this circuit.

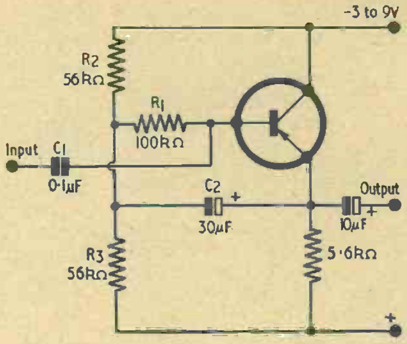
As already stated, the prototype was developed for use with a crystal pick-up, but a great many other uses have been found for its outstanding virtues.

Editor's Note

Let us assume, for convenience, that the emitter load is 6kΩ and that the α' of the transistor is 50. Further, that the input impedance of the transistor is 300kΩ (α' R_L) resistive, and that we commence with C_2 out of circuit.

Then, if input potential rises by 1 volt, the current drawn from the input is $\frac{1}{300}$mA.

If we now connect C_2, the left-hand side of R_1 rises by 0.9 volt. This causes a current to flow



through R_1 and the transistor input impedance (100kΩ+300kΩ) of $\frac{0.9}{400}$mA.

In consequence, the current now required from the input is $\frac{1}{300}-\frac{0.9}{400}mA=\frac{1.3}{1200}$mA. Therefore, input impedance with C_2 connected is $\frac{1}{\frac{1.3}{1200}}$ kΩ= 920kΩ.

It would appear that the circuit gives input impedances approaching or exceeding 1MΩ when the α' of the transistor is 50 or greater.

RADIO TOPICS . . .

by Recorder

TIME FLIES BY SO QUICKLY IN THIS bustling world of ours that it seems only yesterday when I was tapping out my contribution for last year's January issue. And, here we are, at the start of yet another year!

January is always a seasonal time for predictions and, to start the ball rolling, I would like to offer two prophecies of my own as an example of what I think lies before us in the future.

Transistors in the Future

This having been said, I'm afraid that I will *not* assume the mantle of Old Moore with my first augury. This is so obvious, indeed, that it hardly falls into the category of prediction; although it is still worth discussion. My first prophecy is that it won't be long now before transistors almost completely take the place of valves in all low-power electronic equipment.

The reasons for this statement are, of course, that transistors are more robust than valves, they take up less space, they consume less power and they dissipate less heat.

Due to the general superiority of the transistor, the future scene in the sphere of domestic radio and television offers rather a fascinating picture. The vast majority of transistor radios currently in production do not give as good a quality of reproduction as does a valve table radio. One reason for the lower fidelity is the fact that the average transistor radio offers a much smaller enclosure for the speaker than does a table radio. Secondly, the speaker itself is smaller. And thirdly, present-day transistor Class B output stages offer a higher distortion level per watt than do single-ended valve output stages. Two OC81s in a common emitter output stage give 10% total distortion at 1 watt, whereas the pentode section of, say, an ECL86 goes up to some 4 watts before distortion reaches the 10% figure. Similarly, our old friend the 6V6 offers only 8% distortion at an output of 5.5 watts. Also, we can connect our valves in push-pull, whereupon two ECL86 pentode sections give 4.5% distortion at 10 watts, and two 6V6s give 1% distortion at 12 watts. Not hi-fi admittedly, but still better to listen to than a maximum of 1 watt at 10% distortion.

I appreciate that these comparisons are by no means entirely fair, because the transistor instance assumes a battery supply, whereas the valve instance assumes a mains supply. With the transistors, Class B operation is very desirable because it reduces battery consumption as well as allowing greater audio output within the permissible dissipation figures for the transistors. Despite all this, I predict that future mains-operated radios will be completely transistorised with Class A output stages, and that such sets will be cheaper to produce than their valve equivalents, whilst giving a comparable quality of output.

So far as domestic television receivers are concerned, the transistor offers considerable advantages over the valve. As readers who have been following Gordon J. King's series on "Transistorised Television Circuits" will be aware, our manufacturers are already in production with transistorised sets. Two of the main advantages offered with transistorised television receivers are reduction in space and reduction in heat dissipation. In the old days of 70° cathode ray tubes, c.r.t. bulbs and necks took up so much space that they had to be housed in cabinets which were pretty well the same size as the boxes in which the tubes were originally packed. There was so much spare space inside the cabinet that designers could spread out the accompanying chassis as much as they liked. Nowadays we have 110° tubes with short necks, with the result that the receiver circuitry has to be compressed into a very small volume and has to be dispersed around the tube on a number of small chassis and sub-assemblies. The smaller space occupied by transistors eases the problems of such layouts very considerably.

Turning to the question of heat dissipation, the average valve TV receiver has a power consumption of about 140 watts or so, very nearly all of which is dissipated in the form of heat. The effect is roughly the same as would be given by fitting an electric light bulb of the same rating inside the cabinet. In some cases, the temperature inside modern valve TV cabinets reaches astonishingly high levels, and any reader who is sufficiently interested may like to experiment by inserting a thermometer inside the cabinet of his own set, particularly near the top (and well clear of e.h.t. components and terminals!). I have myself encountered, during summer time when the ambient temperature is high, temperatures of the order of 85°C. (Indeed, the wife of a friend of mine airs the family clothes by the simple expedient of placing them on top of the television receiver.) Such high temperatures are not helpful so far as the useful life of insulating materials is concerned, and they raise a lot of problems in the prevention of oscillator drift in tuner units. Change from valves to transistors and this very high heat dissipation falls to much more manageable proportions.

I would predict that, with domestic television receivers, the advent of the present transistorised portable will be followed by hybrid valve-and-transistor models. The latter will be intended for operation from the mains and will have transistors in all the signal, sync separator and, perhaps, sawtooth generator stages. Valves will then be retained for the line output stage and, possibly, the vertical output stage. The e.h.t. rectifier will probably remain a valve in both types of set because it is small, cheap and simple, and it does its job effectively.

Fuel Cells

A second prophecy for the future ranges much further ahead than does any prediction concerning transistors.

One of the more exciting developments at present in hand is concerned with the fuel cell. A fuel cell is roughly the same as a battery except that it derives its energy from the consumption of a fuel. At the time being, primary and secondary cells provide batteries which are too bulky and expensive for applications where a high level of power is required, and this has limited their use to a considerable extent. As an instance, a small number of vehicles employ secondary batteries as a source of power, but these consist only of such things as milk floats and the like which operate over restricted distances. Returning to general applications, the primary battery has to be discarded when it is exhausted, and the secondary battery has to be recharged from another source of electricity.

With the fuel cell electrical power is obtained by consumption of a fuel, whereupon a large number of applications for use in industry, transport and the home can be visualised. Fuel cells are being developed for space vehicles and (as reported in *New Scientist* for 7th November) are also under investigation as a replacement for the diesel-battery system in submarines. The fuels currently employed by working or experimental cells include hydrogen and oxygen, sodium, and certain oils and air. These are early days yet, however, and there seems little reason to doubt that cells capable of working with more readily available fuels may not be developed; or, alternatively, that means will not be found of producing the fuels presently required at lower cost.

It seems to me to be quite possible that the house of the future will not need to be connected to the electricity mains at all. Instead, it will have its own fuel cell which can be provided with a supply of fuel sufficient for, say, some six months or so. Provided that the cost of fuel per kilowatt-hour is less than the cost of fuel needed to run a comparable petrol-driven generator, the fuel cell should find its first domestic application at places which are remote from the mains electricity supply (in the same way as Calor gas cylinders are used at places which are remote from the mains gas supply). Eventually, fuel cells may well supersede the existing electricity supply itself, whereupon the pylons which spread across the country will become a relic of a past era.

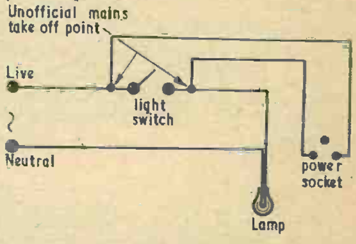
The output of a fuel cell is, like Washington, d.c., which means that it may not be suitable for some of our valve-operated domestic electronic equipment. But by that time all the equipment will be transistorised anyway!

Remote Control

One bumps into a few weird things now and again in the servicing game, and an experience which occurred during the apprenticeship of one of our readers, Mr. H. Leeming of Blackburn, is quite outstanding in this respect. Here's the story as Mr. Leeming passed it on to us.

"One day when caught without meter, neon indicator or test lamp, etc., I was confronted at a customer's house with a radio which had gone completely dead. After a preliminary examination had failed to produce any sign of life, suspicion fell upon the mains plug and its wiring. Examining the connections in this failed to reveal any fault and I wondered if the mains point itself was live.

"I asked the customer if he had anything which could be plugged into the mains to prove things one way or the other and he produced a vacuum cleaner. I duly plugged



How NOT to wire up a power point! See "Remote Control" this in and switched on at the switch on the handle. There was a slight hum from the vacuum motor and to my utter amazement the room light came on. I then found that with the vacuum cleaner plugged into the normal 3-pin socket to which the radio had previously been fitted *I could switch the room lights on and off by the switch on the handle of the vacuum cleaner.* The only sign of life from the vacuum cleaner was the slight hum from the motor.

"Investigation uncovered the fact that the plug had been wired by a 'do-it-yourself' friend of the customer, who had connected it to the two wires which go to the normal light switch.

"The radio, not being very powerful, could draw sufficient current through the resistance of the electric lamp to operate normally. It was in fact faulty on this occasion, with an open-circuit on-off switch.

"The customer had apparently never tried to operate the radio with the room lights on. This would, of course, have been impossible. The radio was taken into the shop for replacement of the on-off switch and the customer was told to get an electrician to correct his faulty socket, which I presume he did."

As She is Spoke

Finally, let me quickly quote a suggested translation culled from the B.B.C. sound radio programme "Top of the Form".

Double entendre is French for "a pair of headphones".

Happy New Year!

New Transistorised Oscillator

A new portable, general-purpose transistorised oscillator has been introduced by Standard Telephones and Cables Limited. Known as the 74306-A, it covers the frequency range 10 kc/s to 20 Mc/s in eight bands. Operation is from dry cells housed in the oscillator case or from an external d.c. supply.

The new oscillator, which uses printed circuit techniques in its construction, delivers output levels of 0 to —50dBm (continuously variable) into 75Ω unbalanced circuits; by means of a built-in transformer and a U-link the output can be fed into 140Ω and 600Ω balanced circuits at frequencies up to 600 kc/s.

Apart from its use as a general-purpose instrument, the 74306-A oscillator has applications in the testing and maintenance of multi-circuit open-wire or cable systems; including coaxial cable telephone systems; its frequency range includes the line, pilot and carrier frequencies of the latest 12 Mc/s coaxial cable systems.

The 74306-A weighs 15lb (6.8kg) approximately and measures 16¼ x 12½ x 7in (413 x 318 x 178mm).

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing.

Correspondence should be addressed to the Editor, Advertising Manager or the Publishers, as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Contributions on constructional matters are invited, especially when they describe the building of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether handwritten or typewritten, lines should be double-spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will re-draw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

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continued on page 429

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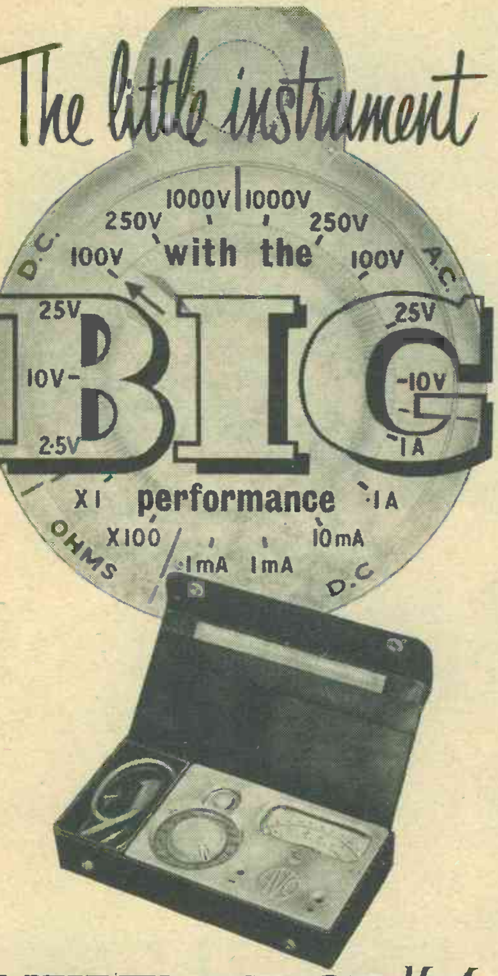

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6CD6G	18/-	30L15	8/9	ECH84	9/6	PCC85	6/9	UL41	6/9	OC35	18/-
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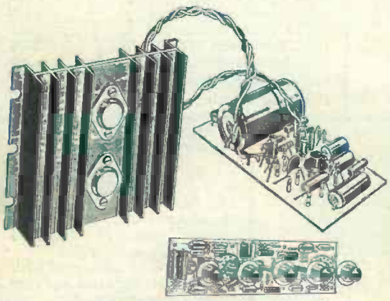

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