THE Radio Constructor

RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 15 NUMBER 4
A DATA PUBLICATION
PRICE TWO SHILLINGS

November 1961

The Oxford Tachometer

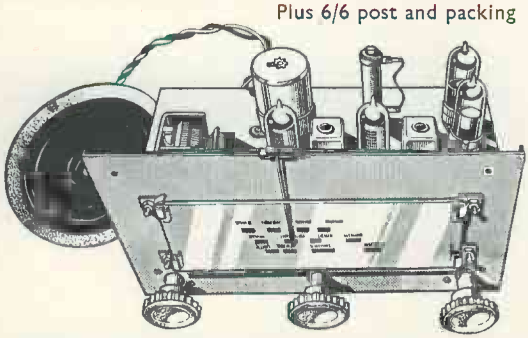
- Pocket A.G.C. "Cheater" for Mains Operated Receivers
- Infra-red Image Converters
- Transformerless Valve Output Stages
- Beginner's Dual Range T.R.F.
- Simple Valve Tester
- Understanding Radio, Part 4
- Radio Astronomy, Part 2
- JR1/JTL Stereo Tape Recorder Unit, Part 3
- Interpretation of Transistor Data

HARVERSON SURPLUS CO. LTD

2-BAND SUPERHET CHASSIS

WITH SPEAKER *ONLY* **£5.17.6**

Plus 6/6 post and packing



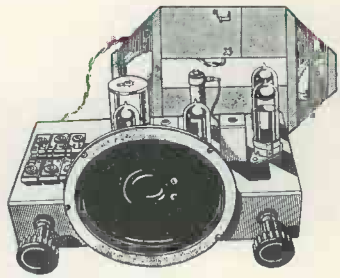
A quality 4 valve AC/DC superhet chassis made by a world famous manufacturer. Long and Medium wave coverage. Fitted with a cord and drum reduction tuning drive and attractive illuminated glass dial (size 6½" x 2½"). Controls: volume on/off, tuning and wave change. The receiver is self-powered, employing a mains dropper and a valve rectifier. Chassis dimensions 6½" x 9" x 5½" high. Supplied complete with a good quality 5" loudspeaker, valves (UCH42, UAF42, UL41, UY41), AC/DC mains input lead, ivory knobs, etc.

Don't hesitate, Order Now ! This unbeatable bargain is bound to sell out quickly at only £5.17.6, plus 6/6 post and packing.

4-STATION PRESET CHASSIS

ONLY **£4.17.6** WITH SPEAKER

Plus 6/6 post and packing

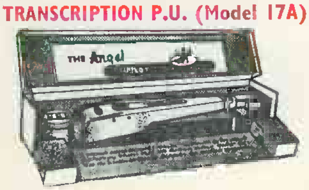


A compact, 4-station preset mains transportable receiver for operation from AC/DC mains. Two simple controls, volume on/off and 4-position station selector. The latter is set to Light Programme (Long Wave), Third Programme, Home Service and Light Programme (Medium Wave), but may of course be adjusted to alternative selections if required. A frame aerial with throw-out extension is supplied, making this receiver ideal as a general purpose transportable set for the home. A fully smoothed power supply is provided from AC/DC mains input by a mains dropper and a valve rectifier. The good tonal qualities are assisted by the provision of a quality 5" speaker, which is ready-mounted on the chassis (this is easily detachable if alternative positioning is required). Valve line-up: UCH42, UAF42, UL41, UY41. This chassis (size 9" x 6½" x 5½" high) is supplied complete with valves, knobs, mains lead, aerial, etc. It is beautifully made by a famous maker, and is a first-class buy at the rock bottom price of only **£4.17.6** plus 6/6 post and packing.

AM RADIOGRAM CHASSIS

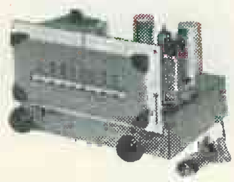
A chassis of distinction by a famous maker. Covering Long, Med. and Short waves, plus gram position, this chassis (size 15½" x 7" x 6½" high) incorporates the latest circuitry, using fully delayed a.v.c. and negative feedback. Controls: tone, volume on/off, wave-change (L.M.S. and gram), tuning. Tapped input 200-250V a.c. only. An attractive brown and gold illuminated dial with matching knobs make this one of the most handsome, in addition to being one of the best performing, chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads, etc. OUR PRICE ONLY plus 4/6 post & packing **£9.19.6**

THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)



A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at **£5.15.0** Plus P. & P. 5/–

HARVERSON'S FM TUNER KIT



At last a quality FM Tuner Kit at a price you can afford. Just look at these fine features, which are usually associated with equipment at twice the price!

★ FM tuning head by famous maker. ★ Guaranteed non-drift. ★ Permeability tuning. ★ Frequency coverage 88–100 Mc/s. ★ OA81 balanced diode output. ★ Two i.f. stages and discriminator. ★ Attractive maroon and gold glass dial (7" x 3"). ★ Self powered, using a good quality mains transformer and valve rectifier. ★ Valves used ECC85, two EF80s and EZ80 (rectifier). ★ Fully drilled chassis. ★ Everything supplied, down to the last nut and bolt. ★ Size of completed tuner 8" x 6" x 5½". ★ All parts sold separately.

£4.19.6 Plus 8/6 P.P. & Ins.

Circuit diagram and illustrations, 1/6 post free.

OUTPUT STAGE AND SPEAKER FOR FM TUNER UNIT

All parts including speaker, ECL82 valve and simple instructions to make two-stage output unit, for converting f.m. tuner into f.m. receiver.

ONLY **45/–** plus 4/6 P. & P.

E.M.I. 4-SPEED RECORD TURNTABLE AND PICK-UP

Heavy 8¾" metal turntable. Low flutter performance, 200/250V shaded motor with tap at 80V for amplifier valve filament if required. Turnover LP/78 head.

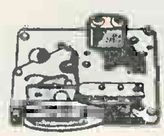
89/6 COMPLETE Plus 4/6 P. & P.

SUPER STEREO KIT MARK II

A kit of ready-built units only requiring interconnection. Comprising two midget 3W amplifiers, push-button switch, transformer, control unit (bass, treble and vol.), power pack, two speakers, indicator light, valves (ECL82, EZ80 range), and comprehensive instructions.

£3.9.6 plus 6/6 P. & P.

FM TUNER HEAD



A permeability tuned tuner head by a famous maker, supplied without valve (ECC85).

18/6 plus 1/9 P. & P.

Valve 8/6 extra

83 High St. Merton SW19

CHErrywood 3985/6

Please turn page for more Bargains

Introducing . .

HARVERSON'S Monaural Amplifier Kit

39/6

In response to numerous requests from delighted purchasers of our "SUPER STEREO KIT" we have produced a "MONAURAL AMPLIFIER" on similar lines.

★ A UCL82 valve provides a triode amplifying stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size 7" x 3¼" x 6¼" high).

★ Modern circuitry design, good quality o.p. transformer (to match 3Ω) keep hum and distortion to a low level.

★ The controls, volume on/off and tone, are complete with attractive cream and gold knobs.

★ The amplifier has a built-in fully smoothed power supply, using a good quality mains transformer (a.c. mains only) and metal rectifier.

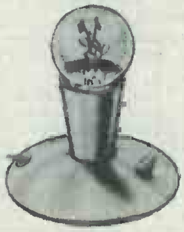
★ All you need is supplied including easy to follow instructions which guarantee good results for the beginner and expert. All components, leads, chassis, valve, knobs, etc., are first grade items by prominent manufacturers.

OUR PRICE 39/6
Plus 4/6 Post and Packing

5" LOUDSPEAKER TO SUIT, 14/6 EXTRA

ALL PARTS SOLD SEPARATELY

CHILD'S NURSERY LAMP



A child's night light of unusual design. Contemporary styled lampholder of robust construction finished in either red or yellow. Entirely safe (bulb socket shielded from "prying fingers",) complete with flex and a push-button switch. 200/250 volts a.c. only. The low-consumption bulb element is made in the shape of either flowers or angel fish, and when switched on, glows in fluorescent colours (the flowers pink with green leaves, or the fish green with purple weed). Made by a famous manufacturer and originally priced at 29/6.

Please state lampholder colour preference and whether fish or flower element is required.

OUR BARGAIN PRICE ONLY 10/9
plus 9d. post and packing

SUPERHET CHASSIS — LESS VALVES & CABINET

Modern AC/DC chassis with printed circuit and ferrite rod aerial. Although not completely built, the main components are mounted. L. & M. wave coverage, 4 valves (UBF89, UCL83, UCH81, UY85). Everything supplied except valves and cabinet. With speaker and simple instructions.

£3.6.6 Plus 3/6 P. & P.

TRANSISTOR AMPLIFIER KIT

A complete kit of parts to build a compact 4-transistor amplifier, with volume control and printed circuit board. Two GT3 driver transistors, transformer coupled. Output 1 watt from matched pair GT15. Supplied with output transformer and 2½in. 3 ohm speaker. Ideal for record player, etc.

OUR PRICE 59/6 P. & P. 4/6

CONDENSER/RESISTOR PARCEL

50 mixed pF Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor.

P. & P. 1/- **ONLY 10/-**

AT ½ PRICE WHILE THEY LAST!

GOLDRING MU-METAL CASED CARTRIDGES

Sapphire styli. Brand new and boxed

OUR PRICE £2.15.0 *Plus P.P. 1/6 inc. ins.*

BARGAIN MONTH FOR TRANSISTORS

POWER		GET102	7/6
OC36	10/-	XA103	8/6
OC44	9/-	PXA101	9/6
OC45	8/-	PXA102	9/6
OC71	5/-	**AMERICAN**	
OC75	6/6	2N388	6/6
OC76	6/6	2N1485	6/6
OC78	6/6	2S712	7/6
OC78D	6/6	**DIODE**	
GET15	9/-	OA81	3/-
GET15 (matched pair)	16/6		

Postage 6d. each

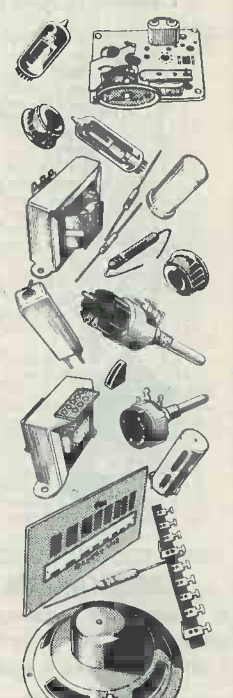
TRANSISTOR SPEAKER

Weston Electric 3Ω speaker. Size 2½" x 1⅝" deep. 12/6 P.P. 1/-

THE HARVERSON COMPLETE FM/VHF RECEIVER KIT £6.19.6

At last! A complete FM Receiver in kit form.

Specially designed with the home constructor in mind, this kit enables the construction of a completely self-contained VHF receiver at a fraction of the normal cost of comparable equipment. This is basically a quality self-powered FM tuner plus 2 separate audio amplifier stages and output transformer and speaker.

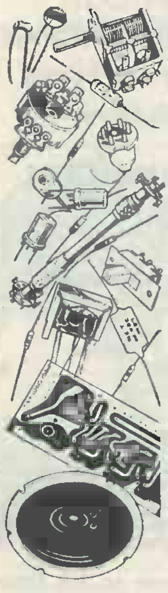


★ FM tuning head by famous maker
★ Guaranteed non-drift
★ Permeability tuning
★ Frequency coverage 88–100 Mc/s
★ OA81 balanced diode output
★ Two i.f. stages and discriminator
★ Self-powered, using a good quality mains transformer and valve rectifier
★ Valves used: ECC85, two EF80s, ECL82 and EZ80 (rectifier)
★ Fully drilled chassis
★ A good quality speaker
★ Well designed output transformer
★ Attractive maroon and gold glass dial
★ Two output stages (using ECL82 valve)
★ Everything supplied, down to the last nut and bolt
★ Compact size
★ All parts sold separately

OUR PRICE £6.19.6 Plus 4/6 P. & P.

HARVERSON SURPLUS CO. LTD

THE HARVERSON 6 TRANSISTOR PLUS DIODE SUPERHET KIT



A first class 2 waveband transistor superhet in kit form.

★ Printed circuit panel (size $8\frac{1}{8}$" x $2\frac{3}{4}$")

★ 3 Pre-aligned I.F. Transformers

★ Output Transformer

★ 5" 5Ω Speaker

★ High gain Ferrite rod aerial

★ First grade G.E.C. transistors

★ Push-Pull output

All parts down to the minutest item with simple instructions.

ONLY **£6.19.6** Plus 2/6 P. & P.

Cabinet to Suit (if available) 15/– extra.

4 TRANSISTOR AMPLIFIER KIT AND $2\frac{1}{2}$ INCH SPEAKER

All the components to make a quality transistor amplifier. Printed circuit panel size $3\frac{3}{4}$" x $2\frac{1}{2}$". 4 G.E.C. transistors. Low loss miniature transformers and quality $2\frac{1}{2}$" speaker. Ideal for a record player amplifier, intercom, baby alarm, etc. With simple instructions.

ONLY **59/6** Plus 2/6 P. & P.

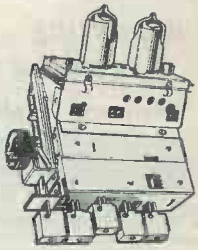
MODEL CONTROL UNIT KIT WITH RELAY

A miniature 4 transistor model control receiver with relay. Ideal for boats or aircraft. Guaranteed range 1 mile in air and $\frac{1}{4}$ mile over water.

ONLY **57/6** Plus 2/6 P. & P.

PLEASE TURN OVER FOR MORE BARGAINS

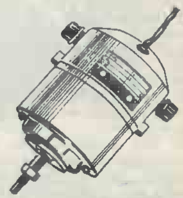
CYLDON PUSH BUTTON TV TUNER



A compact TV tuner of superb design adjustable to any channel. 5 push buttons (on/off and 4 channels). Brand new. Complete with valves (30C15 and 30L15).

ONLY 75/- Plus 4/6 P. & P.

1/6 H.P. MOTOR



140 watt (approx. 1/6 h.p.). Series wound, 220/250 volt 50 cycle motor. Off load 14,000 rev/min., on load 8,500 rev/min. Ideal small saw, sewing machine, etc. Post free. 30/–

MINIATURE EARPHONE WITH CORD, SUB-MINIATURE PLUG AND SOCKET

A deaf aid type earpiece of top grade quality. Gives an exceptionally crisp reproduction of both speech and music. Brand new and fully guaranteed. Two types available. CR-5 high impedance crystal, MR-4 low impedance magnetic. Either type ONLY **7/6** Plus 1/– P. & P.

MAINS PORTABLE SOLDERING IRON

Probably one of the most outstanding soldering instruments yet produced, this iron has a detachable handle which can be placed over the bit and barrel, enabling it to be carried in complete safety even when hot. The provision of an extremely stable 30W element makes this ideal for transistor and all similar lightweight application. Brand new in P.V.C. bag, with lead and plug. ONLY 18/9 plus 1/3 P. & P.

HARVERSON'S TRANSISTOR TUNER

At last a compact transistor tuner! Although primarily designed as the partner to our transistor amplifier, this tuner will give excellent results with any good amplifier. We are confident that you will agree that the T.R.F. circuit employed gives a comparable performance to a superhet. Complete Kit including ferrite rod aerial, midget volume control, 2 diodes and 1 transistor, printed circuit board ($2\frac{1}{4}$" x $2\frac{1}{2}$") and instructions.

ONLY **39/6** Post Free

TAPE DECKS

B.S.R. Monardeck (single speed) $3\frac{3}{4}$" per sec., simple control, uses $5\frac{3}{4}$" spools, £7.5.0 plus 5/6 carr. and ins. (tapes extra).
COLLARO STUDIO DECK £11.5.0 plus 5/6 carriage and ins. (tapes extra).

CRYSTAL MIKES

T.S.L. Stick Mike ... 22/6
ACOS (latest model) ... 18/6

PLESSEY SPEAKER

8" x 5" 3Ω Speaker, large Pot ... ...12/6 P.P. 1/6

HI-FI STEREO MONAURAL AMPLIFIER

A 5 valve Hi-Fi amplifier with switched stereo-monaural operation. Output 3 watts per channel, provision for bass and treble speakers on each. Volume and tone controls fitted both channels. All housed in stylish blue/grey metal case with gold finished knobs and trimmings. **£9.19.6** Plus 4/6 P. & P

WHARFEDALE 12" HI-FI FULL FREQUENCY SPEAKER

Model SUPER 12/FS/AL. Aluminium voice coil, 15 ohms, 17,000 lines, foam plastic suspension, 15–30 watts peak. Brand new in maker's cartons. List £17.10.0.
OUR PRICE **£12.19.6** Carriage 7/6

The new "AVO" Mk. IV Valve Characteristic Meter is typical of the ingenuity of design and high standard of workmanship that exemplify all of the multi-range instruments in the wide "Avo" range.

It is a compact and comprehensive meter that will test quickly any standard receiving valve or small transmitting valve on any of its normal characteristics under conditions corresponding to a wide range of DC electrode voltages. The method of measuring mutual conductance ensures that the meter can deal adequately with modern TV receiver valves. It does many useful jobs too numerous to mention here, but a comprehensive pamphlet is available on application.

List Price **£92** *complete with Instruction Book and Valve Data Manual*

AVO LTD

AVOCET HOUSE . 92-96 VAUXHALL BRIDGE ROAD . LONDON S.W.1.

VICtoria 3404
(12 lines)

A MEMBER OF THE METAL INDUSTRIES GROUP OF COMPANIES

REMEMBER POPPY DAY

THE WORLD-FAMOUS Heathkit DAYSTROM RANGE OF EQUIPMENT

For the Discerning who require
THE BEST PERFORMANCE AT MINIMUM PRICE

4-WAVEBAND TRANSISTORISED PORTABLE RECEIVER, Model RSW-1

This possesses Medium, Trawler and two Short-wave bands and is mid-way between the domestic broadcasting and professional general communications receiver. Ideal and inexpensive for those who wish to listen to world broadcasts, shipping and aviation communications, etc. It is not the set to buy if you wish only to enjoy domestic broadcasting. In a handsome solid leather case, it has retractable whip aerial and socket for car radio use. **£22.10.0**

TRANSCRIPTION RECORD PLAYER (STEREO)

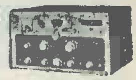
Model G.L.58

Manufactured by Goldring-Lenco. This 4-speed unit is fitted with a G60 pick-up arm. Infinitely variable speed adjustment from 33⅓ to 80 r.p.m. Fixed speed of 16 r.p.m. Its balanced turntable (3¾ lb) reduces rumble, wow and flutter to very low level. The unique lowering device fitted provides absolutely safe means of placing pick-up on record. **£20.12.2**

HI-FI FM TUNER

This model is available as two units which, for your convenience, are sold separately. They comprise an R.F. Tuning Unit, Model FMT-4U (**£3.5.0** including purchase tax) with I.F. output of 10.7 Mc/s, and an Amplifier Unit complete with attractively styled cabinet, also power supply and valves. Model FMA-4U (**£11.11.0**) making a total equipment cost of **£14.16.0**

AMATEUR TRANSMITTER Model DX-100U

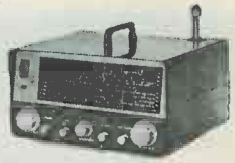


The most popular Amateur transmitter in the world requires no introduction to Amateurs the world over. It covers all bands from 160–10 metres. Self-contained, including power supply, modulator and V.F.O. 150W D.C. input. **£81.10.0**

TRUVOX TD-1 Mk. 6 TAPE DECK

This mono/stereo Tape Deck, designed to semi-professional standards, is a very high quality piece of equipment. Limited quantity available at the greatly reduced price of **£29.15.0**

THE "MOHICAN" GENERAL COVERAGE RECEIVER Model GC-1U £38.15.0



In the forefront of design, with 4 piezo-electric transfilters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised portable or fixed station receiver for both Amateur and Short wave listeners. Other features include printed circuit boards, telescopic whip antenna, tuning meter and large slide-rule dial of approximately 7.0". Uses 10 transistors.

MONEY-SAVING "PACKAGED DEALS"

For the benefit of customers wishing to purchase several units of their Hi-Fi equipment at the same time, useful price reductions are offered. Such "Packaged Deals" may include RECORD PLAYERS and TAPE DECKS of your personal preference, not necessarily featured in our catalogue. Two money-saving examples are given below and quotations for your own special requirements will gladly be sent on request.

GL-58 Transcription Unit	£20.12.2	TA-1M	£18. 2.6
S-33 Stereo Amp.	£12. 8.6	Collaro "STUDIO"	£17.10.0
Twin SSU-1 Speakers		USC-1	£18.18.6
(Bookcase Type)	£21.15.0	MA-12	£10.19.6
	£54.15.8		£65.10.6
	Packaged £50.19.0		**Packaged £59.10.0**

PRICE OF TAPE DECK PURCHASES WITH AMPLIFIERS

TA-IM with Collaro **"STUDIO"**	£30.10.0
TA-IS with Collaro **"STUDIO"**	£35.14.0
TA-IM with **TRUVOX** Mk.6	£46.17.6
TA-IS with **TRUVOX** Mk. 6	£52.1.0

All prices include free delivery U.K.
Deferred terms available over £10.

THE "COTSWOLD

THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15½" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32-20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£21.19.0**

HI-FI EQUIPMENT CABINETS

The "GLOUCESTER" (open)

You have four different equipment cabinets designed to meet the wide variety of tastes and requirements. There is the 'CHEPSTOW', for those who have minimum floor space; the 'MALVERN' in contemporary design for the Tape and Gram. enthusiast, and the 'GLOUCESTER' Mk. I and II for those with traditional tastes. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. Send for details of whole range. Prices from £11.5.6 to £17.18.6.

Available direct from **DAYSTROM LTD** DEPT. RC11 GLOUCESTER

Easily-built Equipment Heathkit DAYSTROM of excellent quality

AT MUCH LOWER COST

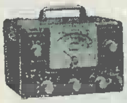
TA-1M

O-12U

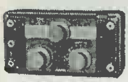
DC-1U

S-33

DX-40U



AG-9U



UJR-1

MA-12

TAPE RECORDING/REPLAY AMPLIFIERS, Models TA-1M and TA-1S. Available both monophonic (TA-1M) and stereophonic (TA-1S) and the former can be modified later to stereo with modification kit TA-1C. Special features include bias level control, thermometer type recording level indicators, press-button control. Attractive metal case. TA-1M **£18.2.6** TA-1S **£23.6.0**

GRID DIP METER Model GD-1U. A very handy instrument for the lab., the amateur, or Service Engineers. Complete set of plug-in coils provided covering 1.8 Mc/s to 250 Mc/s. Additional plug-in coils at 15/– extending range to 350 kc/s. 1mA panel meter used. **£10.9.6**

TRANSISTORISED version of above, model XGD-1, 1.75 Mc/s to 45 Mc/s **£10.8.6**

5" OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/cm, 3 c/s to over 5 Mc/s. Rise time, 0.08 μsecs or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. **£36.10.0**

2¾" PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5" x 8" x 14". Wt. 10½lb. **£19.10.0**

DECADE CAPACITANCE BOX: DC 1U. Provides capacity values from 100 mmf to 0.111 mfd in 100 mmf steps. Ideal for experimental development and design work. **£6.5.6**

VALVE VOLTMETER: V-7A. The world's largest-selling VVM. Measures volts to 1,500 (DC & RMS) and 4,000 pk. to pk.; resistance 0.1Ω to 1,000MΩ DC. D.C. input inpedance 11 Megohms. **£13.0.0**

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn. at 2½ watts per channel. **£12.8.6**

HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl. Many special features. **£26.12.6**

AMATEUR TRANSMITTER: DX-40U. 75W CW; 60W pk. c/c phone; 40W into Aerial. **£32.10.0**

HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono in average room (left "in the white"). Legs £1.1.0 extra. **£10.17.6**

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequency and attenuator. **£19.19.6**

JUNIOR TRANSISTOR RADIO: UJR-1. Youngsters are not excluded from our kit programme. This special single transistor set is an excellent introduction to radio and an instructive present. **£2.16.6**

TRANSISTOR PORTABLE RADIO UXR-1 In elegant solid hide case, with golden relief. Six transistors, dual-wave, fine reproduction, very easy to build. **£14.18.6**

SINGLE CHANNEL 12 WATT HI-FI AMPLIFIER: MA-12. Ideal for stereo conversions, etc. Generous auxiliary power provided. **£10.19.6**

COLLARO "STUDIO" TAPE DECK. This extremely attractive and compact 3-speed monaural tape deck features digital counter, pause control and piano-key switches. **£17.10.0**

(Following models not illustrated)

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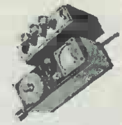
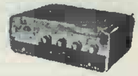


GD-1U and XGD-1

OS-1

V-7A



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SSU-1

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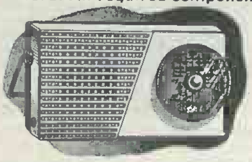

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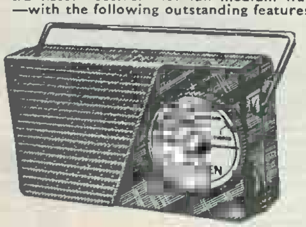

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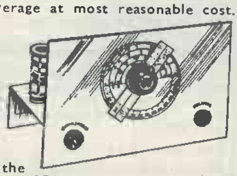

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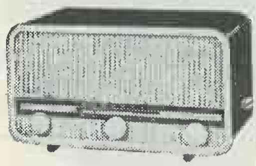

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Ranges: A.C. Voltage: 10, 50, 100, 500, and 1,000 volts (10,000 ohms per volt). D.C. Voltage: 5-25, 50, 250, 500, and 2.5k. (20,000 ohms per volt). D.C. Current: 0-50 microamps. 0-2.5 m/a, 0-250 m/a. Resistance: 0-6k, 0-6 meg. (300 ohm and 30k at centre scale). Capacitance: 10 pF to .001 mfd. .001 mfd. to 1 mfd. Decibels: —20 to +22 dB.

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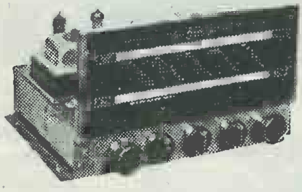

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3V4	7/6	6SJ7M	6/6	EBF80	10/–	P61	3/6
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/–	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/–	12A6	7/6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/–	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/–	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
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16/450v.	3/–	8+8/500v.	5/–	32+32/350v.	5/-
16/500v.	4/–	8+16/450v.	3/9	32+32/450v.	6/–
32/450v.	3/9	8+16/500v.	5/6	32+32+32/350v.	7/–
25/25v.	1/9	16+16/450v.	4/3	50+50/350v.	7/–
50/25v.	2/–	16+16/500v.	6/–	64+120/350v.	11/6
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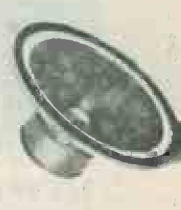

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SILVER MICA. 10% 5 pF to 500 pF, 1/–; 600 pF to 3,000 pF, 1/3; close tolerance (plus or minus 1 pF), 1.5 pF to 47 pF, 1/6; ditto 1% 50 pF to 815 pF, 1/9; 1,000 pF to 5,000 pF, 2/–.

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CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction 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 hand-written or typewritten, lines should be double spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw 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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TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

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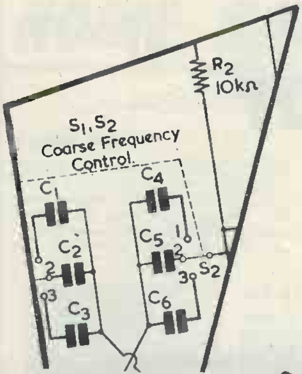
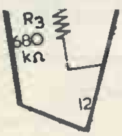


The circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential data

suggested circuits



No. 132 A POCKET A.G.C. "CHEATER" FOR MAINS OPERATED RECEIVERS

IT OFTEN HAPPENS, WHEN SERVICING work is being carried out on a television receiver, that a fault is suspected which may be the result of incorrect functioning of the a.g.c. line or of incorrect operation in a circuit which is controlled by the a.g.c. line. Faults of this nature are especially difficult to trace in television receivers because a.g.c. voltages are not developed in the same manner as in valve sound receivers. Thus, in a receiver employing a mean level a.g.c. circuit, the a.g.c. voltage is proportional to the signal level appearing at the anode of the video output valve, and no a.g.c. voltage would be provided at all if an unmodulated signal from a signal generator were fed to the receiver. At the same time, incorrect values of a.g.c. would be given if a sine wave modulated, or frequency modulated, signal were applied from the test gear. If the television receiver employs gated a.g.c. it is necessary to apply a test signal with correct sync pulse modulation if the proper a.g.c. voltage is to be obtained.

Both of these difficulties may be overcome by connecting a d.c. test voltage of low source impedance to the a.g.c. line. The a.g.c. line may then be given any desired potential, and the performance of the receiver can be evaluated with simple test-meter, signal generator, or wobbulator equipment.

A low impedance source of d.c. for application to the a.g.c. line is useful also when aligning i.f. stages. Manufacturers of television receivers frequently state that i.f. alignment, whether at fixed frequencies or by wobbulator, should be carried out with the a.g.c. line held at a certain fixed potential.

A.G.C. faults in valve sound receivers are, because of the simplicity of the circuits involved, much less difficult to trace. Nevertheless, it is occasionally helpful to be able to inject fixed a.g.c. voltages into such receivers, either for trouble-shooting or for alignment and performance checks.

The "Cheater"

This month's circuit is for an a.g.c. voltage "cheater" which is designed to meet applications of the type just described, and which has the advantage of employing inexpensive components which will normally be readily available in the average service workshop. The device obtains its power from the heater circuits of the receiver under test, and it can be built into a small case suitable for service jobs away from the bench.

The circuit of the device accompanies this article. As may be seen, it has three fly leads fitted with crocodile clips, one of these being connected to the chassis of the receiver under test. A second clip is coupled into the heater chain of the receiver; in the diagram it is connected to the junction between the second and third heaters from the chassis end of the chain. The third fly lead is clipped to the a.g.c. line at any convenient point.

The a.c. voltage appearing at the junction of the two heaters in the circuit is applied to the crystal diode via the limiting resistor R_1. The diode rectifies, causing a d.c. voltage which is negative of chassis to appear on the upper plate of the reservoir capacitor C_1. This voltage is smoothed by R_2 and C_2 and is applied to the potentiometer R_3. The slider of R_3 may then be adjusted to tap off any desired voltage, this voltage being fed to the a.g.c. line of the receiver.

The resistance between chassis and the slider of R_3 at any point along the track will be sufficiently low to swamp that appearing between the a.g.c. line and chassis in a conventional receiver. In consequence, the voltage provided by R_3 will not be noticeably altered by the receiver circuitry (or by any a.g.c. voltages which may happen to be generated in the receiver) and the a.g.c. line will be held at a steady potential. At the same time, the low current drawn by the unit from the receiver heater chain will have negligible effect on the potential at the junction of the two heaters to which connection is made.

It will be noted that the connection provided by the fly lead to the chassis of the receiver under test completes both the a.c. circuit to the rectifier and the d.c. circuit to the a.g.c. line.

Design Points

The main limiting factors in the circuit are given by the limiting values for the crystal diode rectifier. Resistor R_1 limits the current passed by this rectifier during charging pulses in C_1 and, especially, during the initial charging surge in C_1 when first connecting up or switching on. If, for instance, the circuit were connected to an a.c. supply of 25 volts r.m.s., the maximum possible initial charging surge would be of the order of 75mA. This figure assumes zero forward resistance in the diode and short-circuit condition in C_1. The peak inverse voltage applied to the diode for the 25 volts a.c. input would be 70 volts.

The maximum forward surge current for an OA81 or OA91 is 500mA, and the average maximum inverse voltage is 90 (reducing to 75 at 75°C for the OA81 and at 60°C for the OA91). The figure of 75mA surge current just quoted obviously represents safe working conditions, and the inverse voltage of 70 is just within the maximum specified under worst conditions. The circuit could in consequence operate satisfactorily with an applied a.c. voltage of 25. In practice, however, it would be preferable to work to a maximum input a.c. voltage of 20, thereby maintaining a comfortable safety margin.*

The d.c. voltage appearing across C_2 was checked with a prototype circuit, and was found to be approximately 0.8 times the r.m.s. value of the applied a.c. Thus, an input voltage of 6.3 caused a d.c. voltage of 5 to appear across R_3, whilst an input voltage of 20 resulted in a d.c. voltage of 16.

Construction

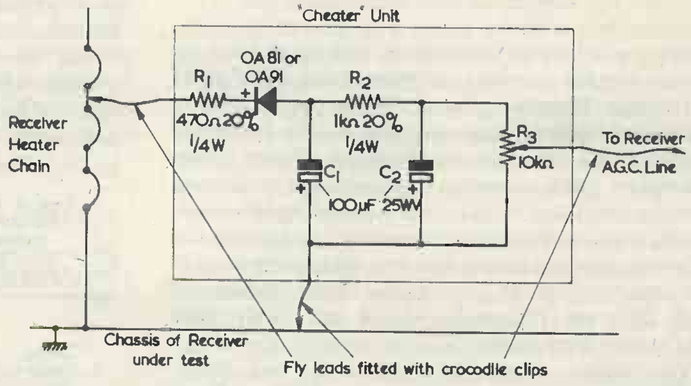
The construction of the a.g.c. "cheater" is a very simple matter, as there are no problems of layout. Miniature components will enable the unit to have small overall dimensions.

A useful method of making up the unit would consist of mounting the components in a small box made of insulating material. The box could then be placed at any convenient point near, or even on, the chassis under test without risk of short-circuits. The two fly leads connecting to chassis and the a.g.c. line may be kept fairly short, if desired, but that coupling to the heater supply should be some 2ft long. This is because the most convenient point for connecting into the heater chain may appear at a relatively distant point, such as at the base of the cathode ray tube.

It will be helpful to fit the potentiometer R_3 with a scale calibrated in volts. This scale could correspond to the d.c. output given when the a.c. input is, say, 10 volts, the reading given being mentally multiplied by the appropriate factor to suit the a.c. voltage employed. The calibration may be carried out with the aid of a d.c. voltmeter connected between chassis and the slider of R_3. Subsequently connecting the slider to an a.g.c. line should not upset the calibration to any serious extent.

The Unit In Use

As may be gathered, the device will prove easy to use in practice, the only prior requirement being that a point in the heater chain having a convenient voltage with respect to chassis be selected before connecting the appropriate clip. For most television alignment requirements a voltage range, from R_3, of zero to some 8 volts negative of chassis should be quite adequate. This voltage range will also be sufficient when tracing faults such as i.f. or tuner unit instability. Higher voltages may be required if it is intended to bring any particular stages close to, or beyond, cut-off, and the a.c. input voltage may then be adjusted accordingly. It should be borne in mind that it is generally preferable to avoid a.c. voltages greater than 20. Some television receivers have two a.g.c. lines in the vision circuits, these being decoupled from each other by relatively high value resistors. Applying the "cheater" to either line should enable its potential to be adjusted without markedly changing the potential on the other. The "cheater" could also be applied to the common point feeding the lines, whereupon it will control both at the same time.



In mains operated sound receivers having a series heater chain, the "cheater" may obtain its a.c. supply by tapping into the chain, as with the television receiver. A d.c. voltage of 5 will be available from receivers having parallel-connected 6.3 volt heaters (provided that one side of the heater circuit is connected to chassis), and this will be sufficient for a number of servicing and alignment checks. The "cheater" could not, however, be used if a parallel 6.3 volt heater circuit was balanced about chassis, as the resultant d.c. voltage would be too low.

* The average maximum inverse voltage of 90 (reducing to 75) quoted here corresponds to a maximum *peak* inverse voltage of 115 (reducing to 100) for the diodes specified. It could be said, therefore, that working to a maximum of 20 volts a.c. input (which is perfectly adequate for the present application) represents quite a large safety margin.

Television Society to organise repeat of Colour Television Refresher Course

Following the current interest in colour television which has been stimulated by the recommendations to the Pilkington Committee, and discussions in the Press, the Television Society organised a Refresher Course on Colour Television—the first lecture of which took place on Monday 18th September.

The bookings for this series of lectures have been so heavy that the Society has arranged to repeat these lectures in 1962 on Mondays 1st, 8th and 15th January and Fridays 5th, 12th and 19th January. The meetings will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, commencing at 6.45 p.m., when the lecturers will again be Mr. S. N. Watson, B.B.C. Designs Department, and Mr. G. B. Townsend and Mr. P. Carnt of the G.E.C. Hirst Research Centre. The enrolment fee is one guinea for members of the Television Society and two guineas for non-members.

Early application for enrolment forms from the Television Society, 166 Shaftesbury Avenue, London, W.C.2, is advised.

infra-red image converters

INFRA-RED IMAGE CONVERTERS ARE AVAILABLE ON the surplus market at a price of the order of £1 or so. They were used during the war for a variety of military purposes, and can be extremely useful to the amateur experimenter. These image converters will convert the infra-red radiation arriving from any objects into a visual image which can be seen on a small screen within the instrument. It is thus possible to use the apparatus to render any hot objects visible or to view any object illuminated with infra-red radiation even if no visible light whatsoever is present.

The image converter consists of two parts, namely the image converter tube itself and the power supply. These two pieces of equipment can be used to detect a source of heat in a darkened room, but if a complete picture is required on the screen of the image converter it is also necessary to use a lens to focus an infra-red image on to the internal coating of the front face of the image converter tube. The image formed is inverted, but this can be avoided if a suitable erector lens is employed in addition to the apparatus already mentioned. A filter which will transmit infra-red radiation but not visible light is extremely useful and, for some work, essential.

Image Converter Tube

One of the most commonly used image converter tubes is the CV148 which is shown diagramatically in Fig. 1. These tubes consist of a cylindrical evacuated enclosure of Pyrex glass about 5cm in diameter by 4cm in length. There are only two connections to the tube; the anode is connected to a metal ring at the back of the tube and the cathode is connected to a ring of a conducting material cemented around the edge of the front face.

Principle of Operation

The internal face of the front window, the cathode, is coated with a semi-transparent silver-caesium oxide mixture. This has a bluish-grey tinge and acts as a photo-cathode, since it will emit electrons when excited by infra-red radiation of wavelength up to just over 1μ.

The emitted electrons are attracted to a fluorescent screen (usually of Willemite) which is kept at a positive potential of between 3 and 6.5kV with respect to the cathode. The fluorescent screen may be marked with a graticule and is parallel with the cathode and 5mm behind it. The brightness of any point on the screen depends on the number of electrons arriving at that point per second, this, in turn, being controlled by the intensity of the infra-red radiation striking the corresponding point on the cathode. The image converter may be considered as a photocell, the anode of which consists of a fluorescent screen.

The screen is normally observed from the end window which is remote from the cathode. Resolutions of up to 350 lines per inch can be obtained, equivalent to about 600 lines across the whole screen. The image is green.

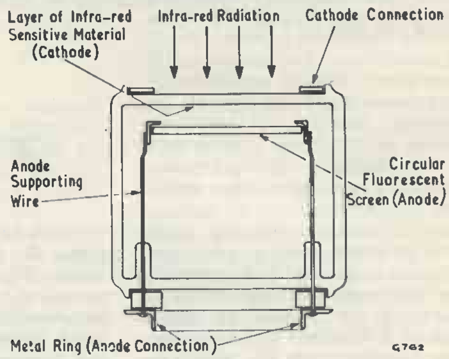


Fig. 1. An image converter tube

Power Supply

The tube requires between 3 and 6.5kV at approximately 10^{-9} amp (one thousandth of a microamp). A conventional transformer power supply can be used, but this has the disadvantage that it is not portable and may not be very safe. A vibrator supply could also be considered.

Zamboni Piles

Surplus image converters are usually supplied with e.h.t. from a number of Zamboni piles, each of which really consists of a large number of very small dry cells. Each pile is cylindrical, about 9in long and ¾in in diameter. The cellulose nitrate body is an insulator and brass caps are screwed on at each end.

In dry air the voltage between the brass caps is over 1kV when measured with an electrostatic voltmeter, but the maximum continuous current available is only about 10^{-9} amp owing to the high internal resistance of the piles (nearly 10^{10} ohms). Therefore if there is any appreciable leakage path (such as will occur on any day when the humidity is high), the terminal voltage of the pile will drop to a small fraction of its original value. In service instruments the Zamboni piles and connections to the image converter tube are completely sealed in a plastic container which effectively prevents leakage paths.

It has not been found possible to obtain any voltage reading from a Zamboni pile with even the most sensitive moving coil instrument, as the pile cannot supply the necessary current. If a Zamboni pile is giving a reading of, perhaps, 1kV on an electrostatic voltmeter and both ends of the pile are touched simultaneously, the leakage path through the person's body immediately reduces the voltage to a negligible value. Nothing at all can be felt and the Zamboni pile is thus an absolutely safe method of obtaining an e.h.t. voltage for low current tubes such as image converters.

Fig. 2. Diagram of a Zamboni pile. About eight of these piles are used in a typical surplus image converter

Internally each Zamboni pile contains over a thousand paper discs pressed together by means of a spring. Each disc is coated on one side with a mixture of manganese dioxide, zinc chloride and gelatine and on the other side with tinfoil. Each coated disc is about 0.004in thick and provides an e.m.f. of 0.8 volt per disc. Zamboni piles last for many years. A typical Zamboni pile is illustrated in Fig. 2.

The pile voltage is quite small at winter temperatures, whilst at high temperatures the discs tend to dry out and the internal resistance becomes larger. The writer has found that piles dated 1942 are still in working order.

Use

Initial experiments may be carried out using any hot object such as a poker which is just below red heat or a piece of resistance wire carrying a current which is just not sufficient to cause the wire to emit visible light. An ordinary electric lamp bulb provides more infra-red radiation than visible light, but a filter is required to cut off the visible radiation before it can conveniently be used for image converter experiments

Military applications include detecting the infrared radiation from homing beacons, etc., in which a telescope is usually employed to receive the radiation. The image converter tubes even found an application in vehicle driving at night. There are many possible scientific and practical applications (e.g. in viewing the processes involved in the manufacture of panchromatic plates), and these image converters will provide the enthusiast with cheap and instructive experience in an unusual branch of electronics.

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

Oscilloscope Unit Type ANA-11, Dynamic Mutual Conductance Valve Tester Type 177.—P. E. Slater, 4 Boscombe Avenue, London, E.10, requires to borrow or purchase the instruction manuals or circuits of these ex-U.S. Forces equipments.

* * *

Collins TCS12 Receiver.—L. Coleman, 118 Coleford Bridge Road, Mytchett, Nr. Aldershot, Hants, is in need of the circuit diagram for this receiver—particularly with reference to the 12-pin power plug. Willing to purchase.

* * *

Etronic Radiogram Model EGU5330.—A. G. Ariyoh, 19 Dempster Road, London, S.W.18, wishes to borrow or purchase the manual or circuit diagram.

Tape Recorder.—G. Marshall, Brook Cottage, Gt. Cornard, Sudbury, Suffolk, has obtained an ex-B.B.C. tape recorder believed to be made by Beam-Echo with Brennell deck (make and type plates removed), vertical operation. Valve line-up—EF40, EF40, EL41, EF40, EL41 and EZ40. Can any reader supply the circuit of this unit and also any modifications.

* * *

Magnetic Loop Circuit.—F. Croxson, 37 Canterbury Avenue, Ilford, Essex, urgently requires, for the benefit of a friend, the circuit and instructions for a magnetic loop from the radio or t.v. The system should enable the signal source to be set at normal listening level and allow the user to make use of the induction coil incorporated in his hearing aid.

Transformerless Valve Output Stages

By J. B. Dance, M.Sc.

THE USE OF AN AUDIO OUTPUT TRANSFORMER to match the optimum load impedance of the audio power amplifiers to that of the speaker had always been regarded as an unfortunate necessity in practical circuits, until power transistors were made which could be used to feed a speaker directly without the use of an output transformer. This is one of the fields in which transistor circuits have preceded the corresponding valve circuits.

At one time it seemed unlikely that it would ever be possible to match the optimum load of a pair of push-pull valves, which is of the order of 10kΩ, to that of a conventional type of loudspeaker of about 2 to 15Ω impedance. (Cathode follower power output stages are not, in general, satisfactory.) Fortunately, however, efforts have been made to bridge the impedance gap from both sides. Loudspeakers can now be made with impedances up to about 800Ω and new valves have been designed for use in unusual push-pull output circuits which require much lower optimum loads than conventional circuits. Satisfactory direct matching can be obtained with such techniques.

Transformer Disadvantages

Output transformers for use in high fidelity amplifiers are invariably expensive and difficult to design, as they must have a level response over a wide frequency range and, assuming the transformer is included in the negative feedback network (as it is in all good amplifiers), it must cause little phase shift. It is this phase shift which imposes a limit to the amount of feedback and, hence, to the maximum possible reduction in distortion. In addition the transformer wastes power, tends to introduce distortion (especially at the ends of the frequency spectrum) and does not give complete coupling between the two primaries. In Class B amplifiers the transformer can cause much more distortion. There are therefore very good reasons for attempting to design a circuit which does not employ an output transformer.

It must not be forgotten, however, that the output transformer not only serves as a matching device but also isolates the h.t. supply from the speaker, allowing one side of the latter to be earthed. In addition it couples the two halves of the push-pull output stage.

Circuitry

In the conventional push-pull stage one valve anode feeds each of the two sections of the transformer primary winding, these being effectively in series. The transformer primary should therefore present an impedance to the valves of about twice the optimum load required by a single valve. The new type of circuit to be discussed is shown in Fig. 1 (which omits bias arrangements for simplicity).

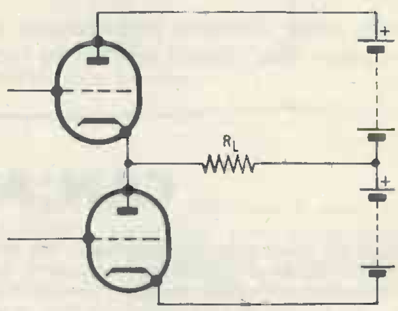


Fig. 1. The push-pull stage

The two valves are effectively in parallel across the speaker load (R_L in Fig. 1) so that the impedance of R_L for optimum loading of the valves should be about one half of the optimum load for a single valve. Thus the type of circuit shown in Fig. 1 requires an optimum load of about one quarter of that required by a conventional push-pull stage using the same type of valves.

In a conventional push-pull stage the two cathodes are effectively connected together, but in the type of circuit shown in Fig. 1 the anode of the lower valve is connected to the cathode of the upper valve. It can be seen from the circuit that the current flowing through the load, R_L, is equal to the difference between the anode currents taken by the two valves. If the "no signal" anode current taken by both valves is the same, no current will flow through R_L under these conditions. If the grid of the lower valve becomes, say, momentarily more negative, its anode current will decrease. The current flowing through R_L is equal to the excess current flowing through the upper valve over that in the lower valve. If at the same time the grid of the upper valve becomes more positive with respect to its cathode (the cathode is not at earth potential with respect to signal voltages), the anode current of the upper valve increases. This further increases the difference between the anode currents of the two valves and therefore the current through R_L increases. A moment later the current in the lower valve may be greater than that in the upper valve and the excess current will flow through R_L in the opposite direction.

In practice the signal voltage between the grid and cathode of the one valve is made equal and opposite to that between the grid and cathode of the other valve, i.e. these voltages are in push-pull. The anode current of one valve will momentarily increase by the same amount as the anode current of the other valve decreases; both of these changes cause currents to flow through R_L in the same direction. During the next fraction of a second the current will flow through R_L in the opposite direction. The two valves make equal contributions to the load current and true push-pull operation is thus obtained.

Ideally there is no alternating voltage across the h.t. supply, i.e. there is no alternating potential between the anode of the upper valve and the cathode of the lower valve.

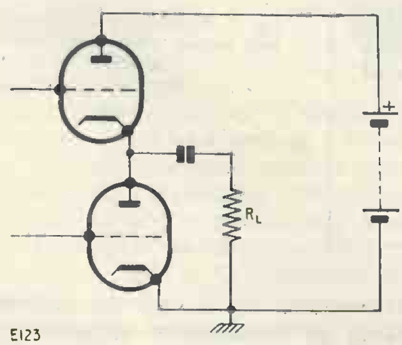


Fig. 2. In this circuit the load is capacitively coupled

H.T. Isolation

The circuit of Fig. 2 (in which bias arrangements are omitted) is similar to that of Fig. 1, except that capacitive coupling is used to isolate the h.t. supply from the speaker.

Transformer Disadvantages

Circuits such as those shown have become known by the rather confusing name of "single ended push-pull" but perhaps "single ended output" would have been somewhat better, as this name makes it clear that it is the output from the valves into the load which is single ended.

The EL86 and UL84

The h.t. voltage of Fig. 2 has to supply the two output valves in series. The voltage required is therefore twice that for a single valve. This might not appear at all convenient at first, but the Mullard EL86 valve requires an h.t. supply of only 100 volts for anode currents of about 57mA and is especially suitable for use in single ended push-pull circuits.

The EL86 has a maximum heater-cathode voltage rating of 200. This is most important, as the cathode of the upper valve in the type of circuits being discussed will be at a d.c. potential equal to half the h.t. voltage above earth and an a.c. signal voltage of up to a little less than this may be superimposed on it. Thus a considerable potential difference may be present between the heater and cathode of the upper valve. Some data about the EL86 is given in Table 1. The UL84 is a similar valve and had a 0.1A heater so that it is suitable for use in 0.1A series heater chains. The heater voltage of the UL84 is 45.

Table 1—EL86

Heater: Voltage 6.3 volts
Current 0.76 amps

Limiting Values;

Max. anode dissipation 12 watts
Max. V_a and V_{g2} 250 volts
Max. screen-grid dissipation 1.75 watts.
Max. cathode current 100mA
Max. $R_{g1\text{-cathode}}$ 500kΩ
Max. $R_{htr\text{-cathode}}$ 20kΩ
Max. $V_{htr\text{-cathode}}$ 200 volts

Input Requirements

The output of the Fig. 2 circuit is single ended but a push-pull input voltage is required to supply the two valves. In conventional push-pull circuits one side of each of the inputs to the power valves is earthed. In the Fig. 2 circuit one side of the input to the lower valve is earthed but neither side of the input to the upper valve can be earthed with respect to either a.c. or d.c. The upper valve must be provided with an input so that, at a certain time, its grid goes negative with respect to its cathode by the same amount as the grid of the lower valve goes positive with respect to its cathode. Owing to the fluctuations at signal frequency of the cathode potential of the upper valve, the common types of phase splitter circuits cannot be used without some modifications. The methods by which the push-pull input voltages can be obtained will be considered in connection with the three practical circuits to be discussed.

Economy or Quality?

It has already been indicated that transformerless audio output stages have the advantage that the cost of an expensive output transformer is completely avoided. In addition heavy negative feedback can be easily applied without the troubles which occur owing to phase shift in the output transformer. The choice of a suitable circuit will depend primarily on whether economy or the best possible fidelity is the principal requirement. The circuits to be discussed (Figs. 3, 4 and 5) cover a wide range of uses; they will be considered in increasing order of complexity.

Economy Circuit

If the principal objective is economy, the circuit of Fig. 3 provides a good solution. A suitable power supply is also shown. V_1 is a pre-amplifier (not a phase splitter) and the lower valve, V_2, is fed with a single input from V_1. The input voltage for V_3 (which must be in push-pull with the input voltage to V_2) is derived from the voltage drop across the cathode bias resistor of V_3 due to the flow of the anode current of V_2 through this resistor.

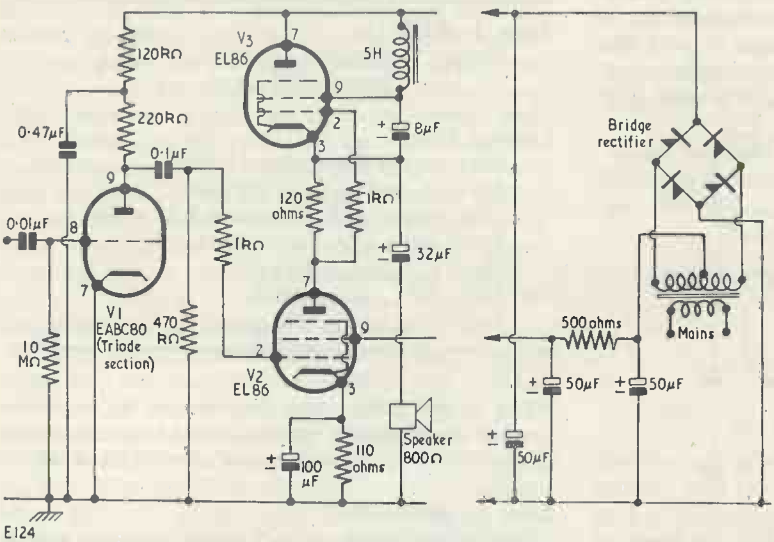
The values of the electrolytic capacitors shown are as small as possible consistent with good bass response. The cathode resistors have a tolerance of ±5% and the other resistors ±10%. The choke in the screen grid circuit should not be less than 5 Henries if the bass response is to be good.

If the h.t. supply is 300 volts, the circuit will provide an output of 9 watts over the frequency range 20 c/s to 250 kc/s at a total harmonic distortion of about 10% without any feedback. The distortion would normally be reduced by feedback. It should be noted that the output from the circuit really is 9 watts—not as in 9 watts conventional amplifiers where an appreciable part of the output power is lost in the speaker transformer.

Distortion

If the input for the upper valve is derived as shown in Fig. 3, it will contain the second harmonic distortion produced by the lower valve, V_2. Thus the output of V_3 will contain not only the second harmonic distortion produced from the signal in the normal way, but also that produced by amplification of the distortion initially produced by V_2. These two distortion components in V_3 will be out of phase. The distortion produced in V_3 in the normal way will cancel in the load with that produced by V_2, but the distortion in V_3 produced by amplification of the distortion generated in V_2 will not normally be cancelled.

Some degree of cancellation of the second harmonic distortion produced by amplification in V_3 can be achieved by reducing the second harmonic distortion produced in V_2 by using an unbypassed cathode resistor for that valve, but this is not very satisfactory as the output impedance



E124

Fig. 3. An economy transformerless output stage with power supply

is increased and a higher input voltage is necessary. A better method is used in the Fig. 3 circuit, namely the working point of V_3 is moved towards Class AB operation (by making the bias resistor 120Ω as opposed to the 110Ω of V_2). The second harmonic distortion produced by V_3 is then greater and more than neutralises the out of phase second harmonic distortion produced in V_3 by amplification of the distortion from V_2; the distortions produced by the two valves then tend to cancel in the load in the usual way. This method can, however, give exact cancellation of second harmonic distortion only at one particular value of output power. The following two circuits (Figs. 4 and 5) employ separate phase splitters and this problem does not then arise.

The cathode load resistor, R_2, is returned directly to the cathode of V_2 so that the signal input to V_2 is not affected by the signal voltage which will exist across C_6 at low frequencies. The bias resistors R_9 and R_{10} should have the values shown when the h.t. supply voltage is 300, but their values should each be increased to 260Ω if the h.t. supply is 250 volts.

The h.t. voltage for the phase splitter is taken from the screen grid of V_3 rather than directly from the h.t. supply, as the signal output voltage across the load is thus prevented from developing a large voltage across C_5 which would impair the push-pull balance of the stage. The resistor R_{11} compensates for the screen current taken by V_3; it was not required in the circuit of Fig. 3, as the screen current of V_3 is much smaller when the operating point is moved towards Class AB.

The power output for the circuit of Fig. 4 is 8 watts when the h.t. supply voltage is 300. The capacitor C_5 should be a paper component. Speaker impedance may be 800Ω and satisfactory results should be given if all resistors have a tolerance of ±10% except R_2, R_5, R_9, R_{10} and R_{11}. The latter could, with advantage, be ±5%.

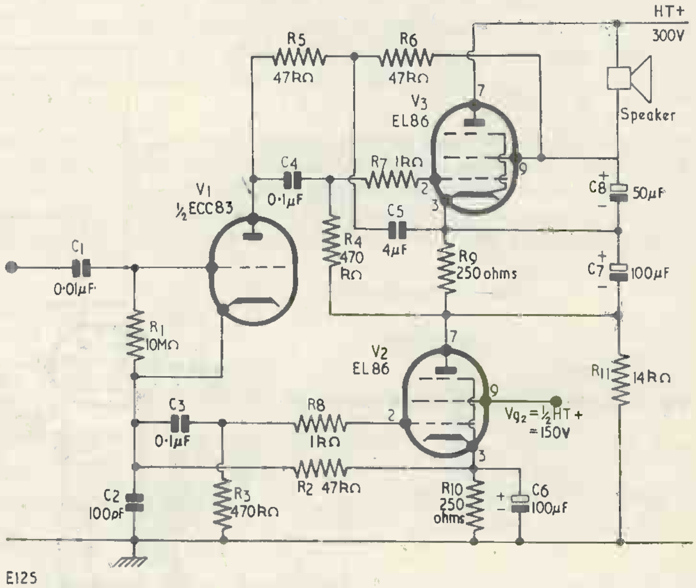


Fig. 4. A general purpose circuit

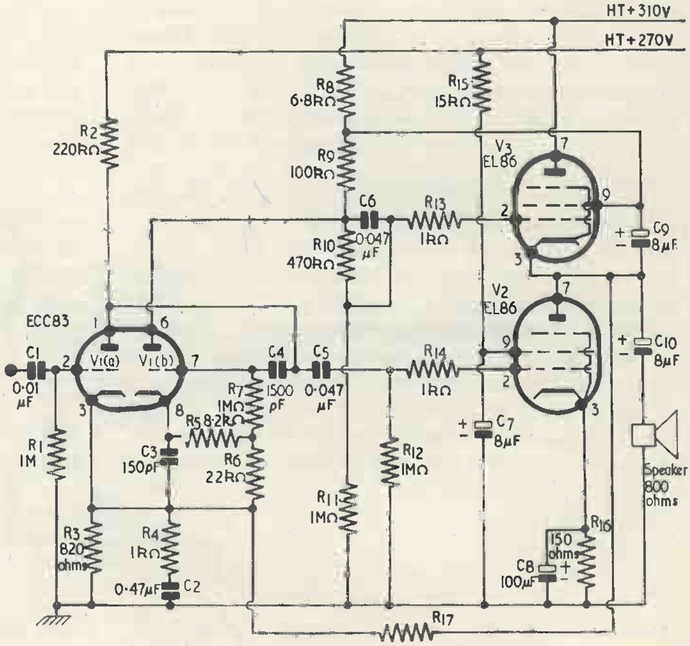
General Purpose Circuit

The circuit shown in Fig. 4 employs half an ECC83 double-triode as a cathode follower phase splitter. The valve has equal resistors in its anode and cathode circuits (R_5 and R_2). The 4µF capacitor, C_5, is large enough to prevent any appreciable alternating voltage of the signal frequency appearing across it; the one side of R_5 is therefore effectively connected to the cathode of V_3 if only signal currents and voltages are being considered. The other side of R_5 is connected to the grid of V_3 via C_4 and R_7. Thus V_3 receives the necessary input voltage, although its cathode potential is varying at the signal frequency. R_4 maintains the grid of V_3 at the same d.c. potential as the anode of V_2, the resistor R_9 providing the cathode bias. R_7 and R_8 are merely grid stoppers.

High Fidelity Circuit

The high fidelity circuit shown in Fig. 5 employs an ECC83 double-triode in addition to the two output valves. The first triode section, $V1_{1a}$ of the ECC83 acts as a preamplifier and the second triode section, $V1_{1b}$ is a phase inverter which gives no gain. The output from the first triode section is applied to the grid of V_2 via C_5 and R_{14} and the output from the phase inverter to the grid of V_3.

A portion of the output voltage is fed back to the ECC83 and positive feedback is applied across R_3. The distortion given by this circuit is very low and is virtually limited to that given by the preamplifier alone. The feedback resistor, R_{17}, could be replaced by two variable RC networks the response is flat within ±3 dB up to about 250 kc/s. An input of 24 millivolts will provide an output of 50 milliwatts. Speaker resonances at low frequencies are heavily damped, as the output resistance of the circuit is reduced to about 20Ω by the negative feedback. This is very low when compared with the speaker impedance of about 800Ω.



E126

Fig. 5. A high quality transformerless circuit

so that the amount of feedback and hence the gain could be made frequency dependent. Such tone control circuits have the advantage that they do not cause a loss of gain. Alternatively a tone control circuit could be placed in the amplifier input together with an additional stage of amplification; no phase shift would then occur in the feedback loop.

The two resistors R_5 and R_6 in the phase reverser stage should be of ±5% tolerance, but all other resistors may be of ±10% tolerance.

Performance

This type of circuit will give an output of about 10 watts at 0.3% total harmonic distortion and

Acknowledgement

The writer wishes to thank Mullard Ltd. for sending him their publications containing details of transformerless audio output stages. All of the circuits shown in this article have been designed by Mullard Ltd.

References

1. Output Transformerless Amplifiers—A General Review. *Wireless World*, Feb. 1957.
2. More Transformerless Amplifiers. *Wireless World*, March 1958.
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NEXT MONTH . . .

CONVERTING THE MN26C RECEIVER

Beginner's Dual Range T.R.F.

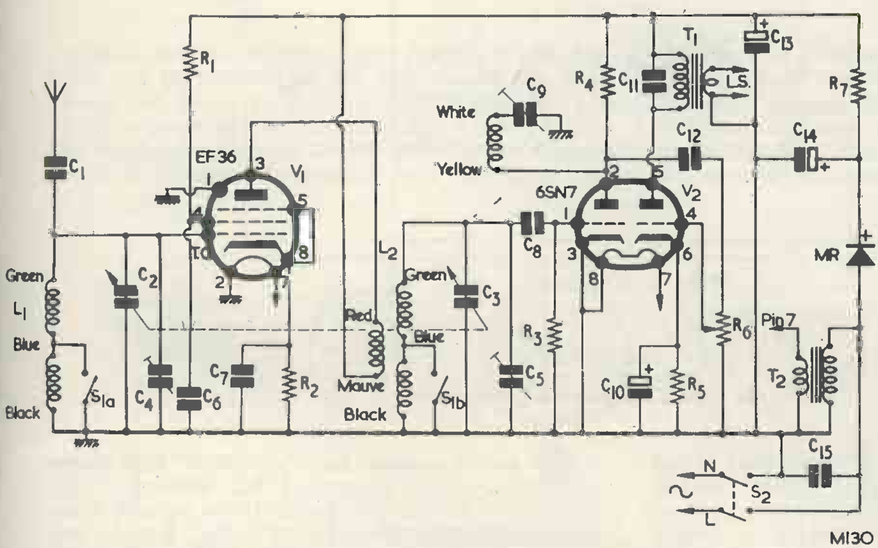
By

A. A. Baines

The receiver described in this article will be particularly attractive to the beginner because of its versatility and simplicity. It must be pointed out, however, that, if the heater transformer specified is employed, the chassis is connected to one side of the a.c. mains supply and that full precautions against accidental shock must be observed in consequence

THE RECEIVER TO BE DESCRIBED WAS BUILT FOR use in a bedroom and should be of particular interest to the younger members of the radio fraternity in that it is inexpensive, not critical with respect to component values or valves, and forms an ideal basis for experiments.

The original requirement called for the reception of local stations only and for the cost to be within the means of the constructor; this ruled out the building of a superhet, and reliance had to be placed on the spares box to provide as many of the parts as possible.



A r.f. stage was desirable, not only to give enhanced sensitivity and selectivity, but to overcome also the necessity of having to use a detector stage with variable regeneration which would complicate tuning for an inexperienced person. The choice of detector and output valves was somewhat limited by the discovery that only a 30mA rectifier was available; however, many triode and pentode r.f. valves will provide around 500mW power output for a consumption of 10–12mA when used in an output stage, and this degree of output is more than enough for the average bedroom.

A small cabinet was to hand which dictated the size of the chassis, and it was seen that there would not be sufficient space to include three valves having International Octal bases. Consequently, it was decided to incorporate the detector and output stage

Components List

Resistors

R_1 100kΩ
R_2 470Ω
R_3 3.3MΩ
R_4 220kΩ
R_5 1kΩ
R_6 500KΩ pot, log
R_7 1kΩ 2W
(All resistors ½W unless otherwise specified.)

Capacitors

C_1 0.01μF 750WV
C_2, C_3 500pF 2-gang
C_4, C_5 60pF trimmer
C_6 0.1μF 350WV
C_7 0.05μF 150WV
C_8 100pF mica
C_9 250pF preset
C_{10} 25μF 12WV
C_{11} 0.01μF 350WV
C_{12} 0.01μF 350WV
C_{13} 16μF 350WV
C_{14} 8μF 350WV
C_{15} 0.01μF 750WV

Miscellaneous

L_1, L_2 Repanco DRM3 (L_1 primary not used)
T_1 Output transformer (see text)
T_2 Heater transformer, 6.3V, current to suit valves employed
MR Half wave rectifier, 250V 30mA
$S1_{a-b}$ Wavechange switch
S_2 On-off switch (ganged with R_6)
V_1 EF36, EF37, EF39, etc. (see text)
V_2 6SN7, 6SL7, ECC33, etc. (see text)
L.S. 3in dia. 3Ω

in one valve by the use of a double-triode type. This also assists in keeping the overall costs low.

Dual range coils were to be used, the reception of the Light Programme largely being a hit and miss —mainly miss—affair on the Medium waves in the locality. The final circuit used is shown in Fig. 1.

It will be seen from the circuit diagram that the primary winding of the aerial r.f. coil L_1 is not employed, since it was found in practice that with the aerial in use (10ft wire) a direct connection to the tuned coil improved sensitivity with only an almost undiscernable reduction in selectivity. An EF36 is used as a conventional tuned r.f. amplifier with the anode series-fed through the primary of the intervalve r.f. transformer L_2.

and the volume control R_6. This part of the valve acts as an output valve with the primary of any small output transformer as the anode load; the transformer actually used originated from a battery set and has a turns ratio of around 60:1. Any similar component whose primary is capable of carrying 12mA would be quite suitable.

The power supply of the receiver consists of a 6.3V heater transformer, a 30mA metal rectifier and two electrolytic smoothing capacitors. A rectifier of higher rating could be used and the electrolytics could be in the same can which would give an economy of space; also, the capacity of either electrolytic capacitor could be increased up to 32μF or thereabouts, if desired. The heater transformer can be replaced by a "converter" type mains transformer with a separate h.t. winding. This would then permit the chassis to be isolated from the mains and the use of a "converter" transformer is recommended to anyone who wishes ultimately to experiment with the circuit. If a heater transformer is used then the isolating capacitor C_1, in the aerial lead, is essential. Also, the chassis should be completely enclosed in an insulating cabinet, the grub screws of the knobs being deeply recessed or covered with wax.

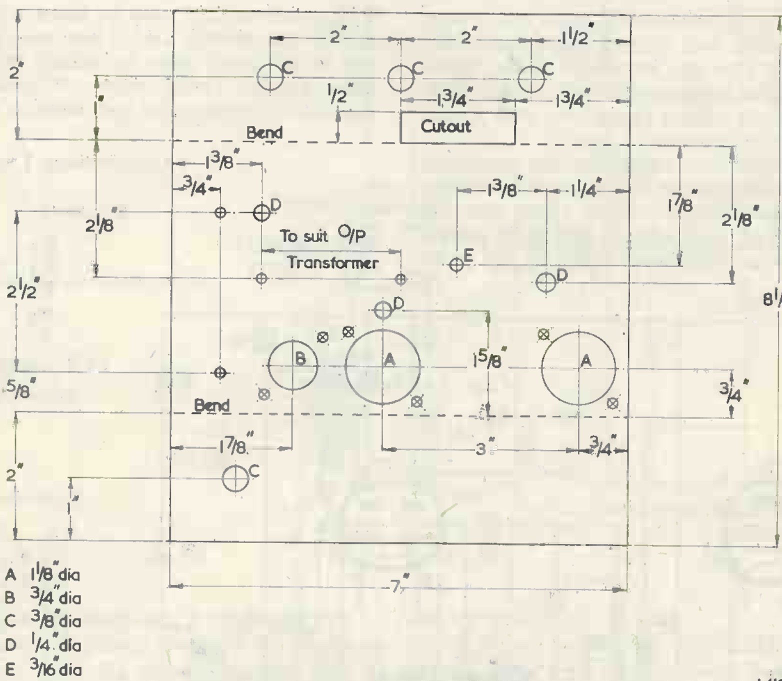


Fig. 2. Main drilling details—below chassis view

The tuned secondary of this transformer is fed via C_8 to the grid of one half of a 6SN7 double-triode acting as a leaky grid detector; this type of detector being chosen in preference to others, quantity rather than quality being required in this instance. A higher value for R_3 than is usually the case was adopted for a similar reason.

The Repanco coils have a regeneration winding on L_2 and this was connected as shown in Fig. 1 through C_9, a 250pF preset trimmer. C_9 was adjusted, on completion, well below the point of oscillation but, even so, it gave a useful improvement in gain. Care must be taken in adjusting this component as too tight a coupling will result in extreme distortion.

The detected output is fed from the anode to the grid of the remaining half of the 6SN7 through C_{12}

To align the receiver, set the trimmers C_4 and C_5 and preset capacitor C_9 to minimum capacitance (i.e. unscrewed) and select a station at the low wavelength end of the scale such as the West Home Service on 206 metres. After the set has warmed up, C_4 is adjusted to bring the station on to the dial

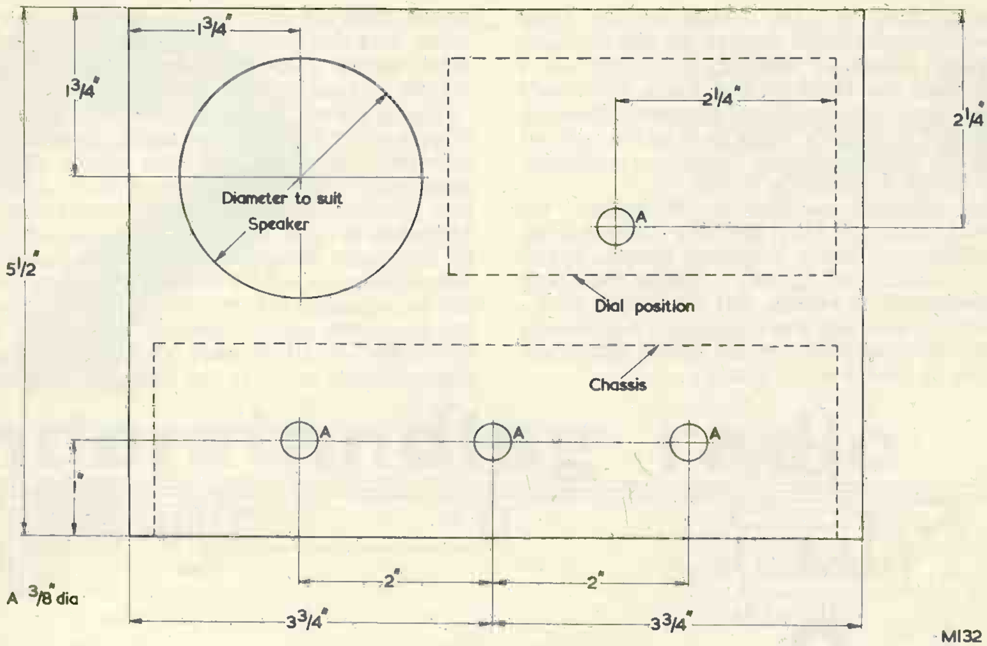


Fig. 3. Front panel drilling details

reading and C_5 varied to give maximum volume; this can be repeated at the high end of the band using the Third Programme on 464 metres. The final settings of the trimmers are a compromise between those given at the low and high wavelength ends of the scale. In practice there should be little difference in optimum settings at these two points. Having lined up the Medium wave band as efficiently as possible, remembering that the selectivity does not approach that of a superhet and that some "spread" and overlap of the stations may consequently be present, switch to Long waves. The

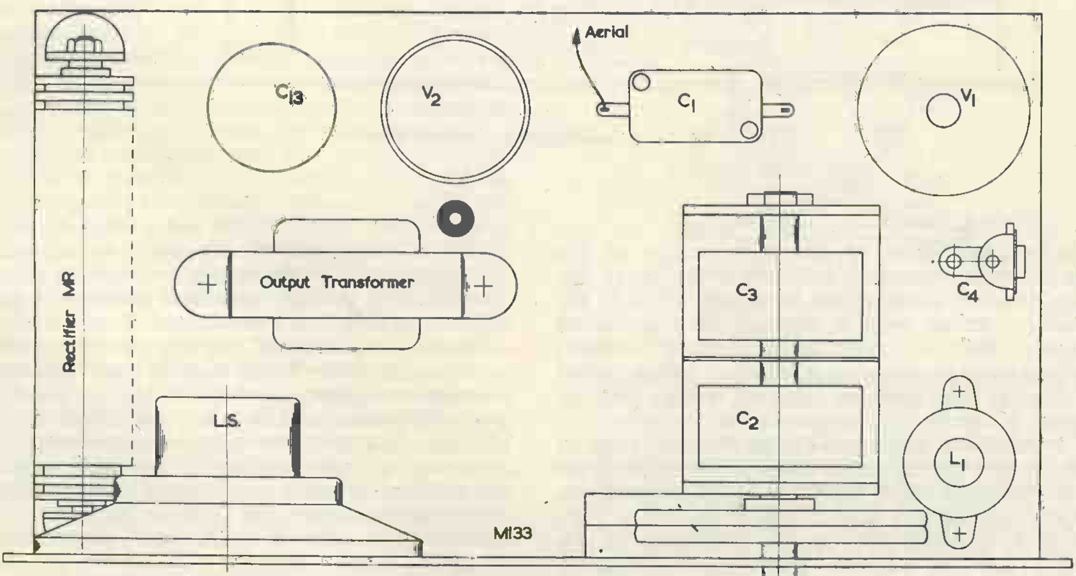


Fig. 4. Above-chassis component layout

Light programme at 1,500 metres on the Long waveband should be heard close to the dial position. If a greater degree of accuracy in lining up is required, then the Medium and Long wave coils should be fitted with individual trimmers, these, in company with C_4 and C_5, being switched in and out of circuit on the appropriate bands by additional contacts on the wavechange switch.

Having achieved satisfactory alignment, the regeneration capacitor C_9 is carefully screwed down until oscillation or heavy distortion occurs, whereupon it is backed off slightly. Check over both bands completely to ensure that the setting of C_9 is satisfactory, and seal the capacitor. Adjustment of C_9 may have an effect on the tuning which can be rectified by means of C_4 and C_5.

anode leads are short and do not run close to each other, and that heater wiring is kept well away from other wiring. Decoupling and h.t. leads can wander a little without creating undesirable effects.

The question of substitute values and valves is often a worry for beginners having limited resources and some guidance with this circuit may be of assistance. The values of the resistors and capacitors are not critical and can be varied within large tolerances of up to 50%; C_2 and C_3 should, however, be that value designated by the coil manufacturer, 500pF being correct. For the V_1 position, the EF36 can be replaced not only by its direct equivalents but by almost any r.f. pentode with a 6.3V heater; EF37, SP61 or EF50 being suitable. There are also many suitable valves in the miniature series such as

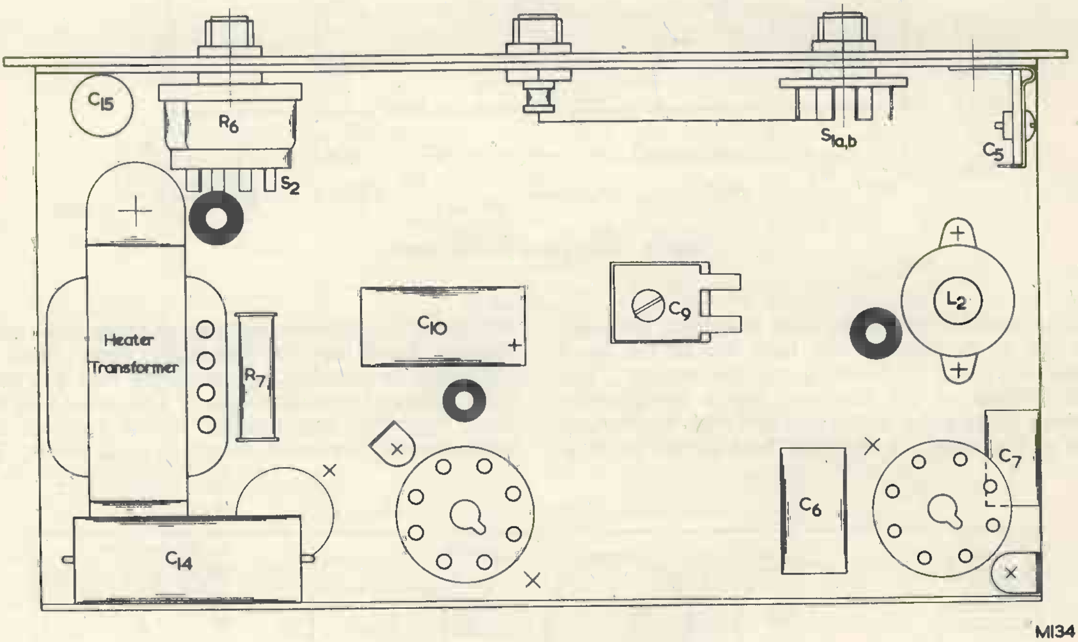


Fig. 5. Below-chassis component layout

As an indication of the performance of the receiver when equipped with a 10ft aerial, all the main Regional programmes have been heard in the evening together with a number of Continental stations. With a longer aerial, volume increases but selectivity becomes poor, whereas with an aerial of 3 to 4ft the reverse is the case, except that the volume of the local station remained the same.

Details of the chassis and front plate are given in Figs. 2 and 3 but the actual dimensions can be varied to suit personal requirements or actual components. General component layout only is shown in Figs. 4 and 5, it being felt that the simplicity of this receiver does not warrant a point-to-point diagram. The only important wiring details are that grid and

6AM6, EF80 and EF40. Reference to valve tables will show whether the screen-grid can be fed with the full h.t. voltage, in which event R_1 can be reduced to 4.7kΩ or even deleted.

An ECC33 and a 6SL7 have been tried in the V_2 position, the latter giving slightly more volume. If other twin-triodes such as the 12AU7 or 12AT7 are available these could be tried, the choice of valve not being critical. However, keep a watch on the total heater consumption to ascertain that the transformer rating is not exceeded as some of these valves have a remarkable capacity for amps!

Alternative valves in the V_1 or V_2 positions may, of course, require different valveholders and valveholder connections to those shown in Fig. 1.

understanding radio

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

part 4

By W. G. MORLEY

IN LAST MONTH'S ARTICLE IN THIS SERIES WE introduced the basic relationship between e.m.f. current and resistance. We also discussed power, and saw that resistors may be called upon to dissipate significant amounts of power in the form of heat. Finally, we examined wirewound resistors, pointing out that the amount of power such resistors can dissipate in free air is roughly proportional to their surface area. We shall now continue with the subject of heat dissipation in wirewound resistors.

Heat Conduction

Normally, heat is dissipated from a resistor handling a significant amount of power by means of radiation and convection. An additional method of losing heat is by conduction and it is occasional practice to construct wirewound resistors in such a manner that conduction may take place.

A typical example of a resistor which may be partly cooled by conduction is shown in Fig. 10 (*a*). In this diagram a flat metal strip is covered, over the length on which the resistance wire is to be wound, by an insulating material. After the wire is fitted, a protective insulating coating, similar to that shown in Fig. 9,[1] is applied. The complete resistor is fitted with tags and the flat metal strip protrudes from either end of the resistor section proper.

Fig. 10 (*b*) illustrates the resistor mounted to a metal plate by means of two bolts, nuts and spacers. The resistor now loses heat in three ways: first, by radiation from its surface; secondly, by convection currents in the air which surrounds it; and, thirdly, by conduction through the mounting bolts and spacers to the metal plate. The latter, in its turn,

[1] Published in last month's issue.

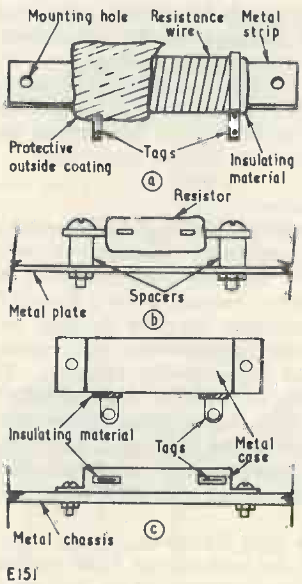


Fig. 10 (a). A wirewound resistor whose design enables part of the heat it dissipates to be conducted away
(b). The resistor of (a) mounted on a metal plate. Heat is conducted to the plate via the central metal strip of the resistor and its mounting bolts and spacers
(c). An alternative design which also enables heat to be lost by conduction. In this case the resistor is almost completely enclosed in a metal case, the tags protruding through insulated sleeves. The lower view shows the resistor mounted on a metal chassis

then loses the heat it acquires from the resistor by radiation and convection. As may be imagined, the amount of heat which can be lost by the metal plate increases with its area and its access to free air. Also, the amount of heat which may be conducted to the plate depends upon the efficiency of the thermal coupling between the central metal strip of the resistor and the plate; and it would be helpful here to use mounting bolts and spacers with thick cross-sections and to ensure that there is a large contact area between individual members along the heat-conducting path.

With careful design, the overall heat dissipation of the arrangement of Fig. 10 (*b*) may be made significantly greater than that provided by a similar sized resistor mounted in free air. Consequently, the resistor can be given a smaller size than its free air counterpart, a factor which is of considerable advantage in equipment where space is limited. In conventional designs, the metal plate of Fig. 10 (*b*) would be provided by the metal chassis on which the equipment which includes the resistor is built.

Alternative designs to that shown in Fig. 10 (*a*) and (*b*) may be encountered, the main deviations being given in the cross-sectional shape of the central metal section of the resistor.

An occasionally encountered variant is illustrated in Fig. 10 (*c*). In this instance the resistor is almost completely enclosed in a sheet metal case, the latter being bolted flat against the equipment chassis to provide efficient transfer of heat.

Resistors of the type just discussed, with which heat is partly dissipated by conduction to an external metal body, are used more frequently in American than in British equipment.

Carbon Resistors

Carbon resistors differ from wirewound resistors in that the resistance material is provided by a homogeneous mass or film, partly or wholly composed of carbon, instead of by a length of wire.

Carbon resistors may be divided basically into two categories: *composition* (or *composition-type*) resistors, and *high-stability* resistors. Composition resistors may, in turn, be divided into two further categories, these being those where the "composition" appears in the form of a solid rod and those where the "composition" is deposited in the form of a coating over an insulated tube.

Composition Rod Resistors

In order to understand how composition rod resistors are manufactured, it will be helpful, first of all, to quickly examine the manner in which plastics such as Bakelite are moulded. In the latter process, the Bakelite resin[2] is available initially in the form of powder (or pellets), this being poured into a mould. The mould is then closed under pressure and its temperature raised. The increased temperature results in the powder melting and flowing throughout the mould, after which a reaction called polymerisation (or "curing") takes place. Polymerisation causes the resin to become set into the shape of the mould. The polymerised resin may now be removed, whereupon it will be found that it has changed to a hard homogeneous mass having the shape imparted to it by the mould. This is, basically, the method of manufacturing all pieceparts employing Bakelite resins, or resins of similar type.

In order to modify the properties of the moulded material (i.e. its hardness, colour, electrical properties, etc.) it is common practice to mix in "fillers" with the resin powder before the latter is put into the mould. Such fillers may consist of relatively inert materials such as wood flour, or nylon or asbestos fibres. Cheaply obtained fillers may be added, also, to reduce the cost of the final product, and they do this by displacing an equivalent volume of the more expensive moulding powder. After polymerisation, the fillers are suspended under pressure throughout the bulk of the moulded material.

Composition rod resistors are processed in basically the same manner. Before polymerisation the composition consists of a mixture of particles of carbon (or graphite, a mineral form of carbon) together with a resin powder and, possibly, a proportion of powdered insulating filler. The mixture is subjected to pressure and temperature and the resin polymerises, causing the carbon particles, and insulating filler, if used, to be suspended under pressure throughout its bulk. The result is a hard mass of material moulded into the shape of a rod which offers resistance between its two ends, the value of resistance depending amongst other things upon the relative proportions of carbon, resin and insulating filler in the original mix. The suspended carbon particles in the composition rod make contact with each other under the internal pressure of the polymerised structure, the contact pressure between individual particles varying the overall resistance of the rod. It is difficult to control these internal pressures during manufacture, and it is difficult, also, to maintain constant particle size and ingredient proportions in the original composition mix. Because of these two points, composition rod resistors cannot be manufactured to give specific values of resistance but have to be made, instead, so that they fall into relatively wide ranges of value. They are then selected more closely by individual measurement.[3]

Composition-coated Resistors

Resistors having composition coated over an insulated rod employ somewhat similar manufacturing techniques. In this instance the composition mix is sprayed over an insulated rod, the resin being present in the form of a varnish. Again, the temperature is raised to allow polymerisation to take place, with the result that the mix sets into a hard coating on the rod, and resistance is available between the two ends. The insulated rod on which

[2] The term "resin" is applied to all plastics materials capable of being polymerised by heat in the manner described here.

[3] It should be noted that the resistance of processed composition rod resistors may be reduced, if desired, by depositing a conductive copper band around the centre of the rod. This is known as a "copper spray".

the coating is deposited is normally glass tubing, although ceramic rods or tubes may also be used. As with composition rod resistors, coated composition resistors may not be manufactured to specific values of resistance, but have to be selected after processing. It is possible, however, to modify the resistance of a composition coated resistor after processing by cutting a spiral groove through the coating. This lengthens the resistive path between the two ends of the coated rod and thereby increases the resistance.

High-Stability Resistors

High-stability resistors are manufactured by depositing a film of crystalline carbon on to the outside surface of a rod or tube made of high quality ceramic. The carbon is obtained by the breakdown, or "cracking", of a hydrocarbon gas at high temperature. It is usual to cut a spiral groove in the carbon film after processing to achieve the resistance value finally required. Because of the manufacturing process, high-stability resistors are sometimes referred to as "cracked-carbon" resistors.

Terminology

A brief note concerning terminology needs to be made at this point.

What are described here as carbon resistors are frequently referred to elsewhere as composition, or composition-type, resistors, these adjectives embracing not only resistors which employ a composition mix but high-stability types as well. Texts employing these terms sometimes eschew the use of the term "carbon resistor", presumably because the conducting material employed in a composition mix may conceivably be other than carbon or carbon-based. Other texts use the adjective "carbon" in the same manner as is employed here.

Resistor Connections

Until recent years, practically all carbon resistors were fitted with tinned copper lead-out wires to enable connection to be made to the resistive element. A typical method of fitting lead-out wires is illustrated in Fig. 11 (*a*). In this diagram the lead-out wires are wrapped (typically, one and a half times) around the ends of a composition rod, a reliable connection being effected by depositing a metallising material with good conducting properties on to the wire and the adjacent rod surface. This type of lead-out wire connection has been almost completely superseded (except for some large size

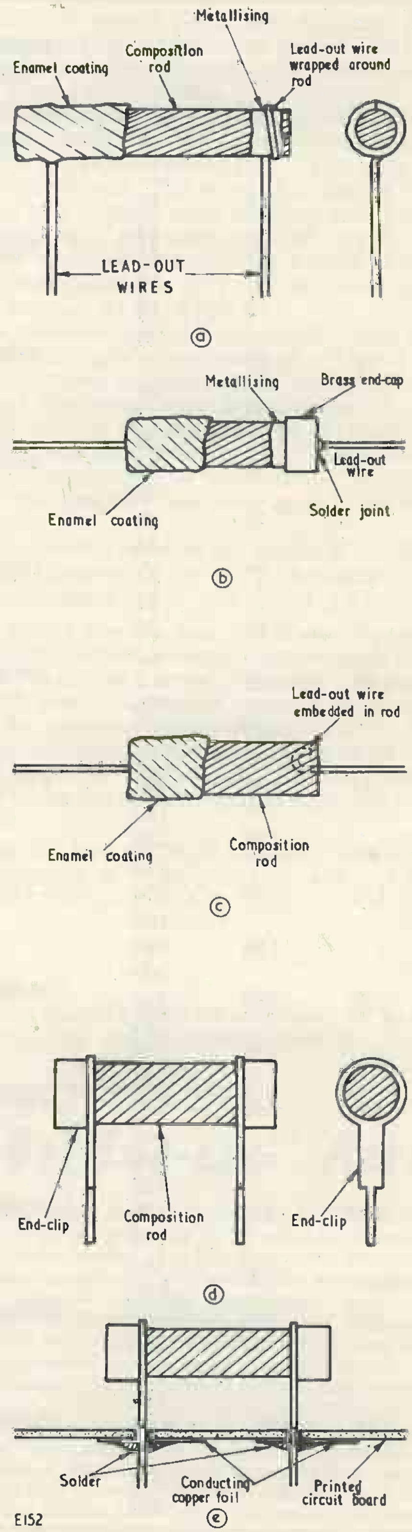


Fig. 11 (a). Lead-out wires fitted to a composition rod resistor
(b). An alternative method of fitting lead-out wires which has largely superseded that shown in (a)
(c). In this diagram the lead-out wires are embedded in the composition rod
(d). Resistor terminations suitable for printed circuit applications. ("Pluggable resistors", similar to that shown here, are the subject of a Registered Design by Erie Resistor Limited.)
(e). The resistor of (d) fitted into a printed circuit board

TABLE III
Preferred Resistor Values
(All resistances in ohms)

±20%	±10%	±5%
10	10	10
		11
	12	12
		13
15	15	15
		16
	18	18
		20
22	22	22
		24
	27	27
		30
33	33	33
		36
	39	39
		43
47	47	47
		51
	56	56
		62
68	68	68
		75
	82	82
		91
100	100	100
		110
	120	120
		130
150	150	150
		160
	180	180
		200
220	220	220
		240
	270	270
		300
330	330	330
		360
	390	390
		430
470	470	470
		510
	560	560
		620
680	680	680
		750
	820	820
		910
1000	1000	1000
		1100
	1200	1200
		1300

±20%	±10%	±5%
1500	1500	1500
		1600
	1800	1800
		2000
2200	2200	2200
		2400
	2700	2700
		3000
3300	3300	3300
		3600
	3900	3900
		4300
4700	4700	4700
		5100
	5600	5600
		6200
6800	6800	6800
		7500
	8200	8200
		9100
10000	10000	10000
		11000
	12000	12000
		13000
15000	15000	15000
		16000
	18000	18000
		20000
22000	22000	22000
		24000
	27000	27000
		30000
33000	33000	33000
		36000
	39000	39000
		43000
47000	47000	47000
		51000
	56000	56000
		62000
68000	68000	68000
		75000
	82000	82000
		91000
100000	100000	100000
		110000
	120000	120000
		130000
150000	150000	150000
		160000
	180000	180000
		200000

±20%	±10%	±5%
220000	220000	220000
		240000
	270000	270000
		300000
330000	330000	330000
		360000
	390000	390000
		430000
470000	470000	470000
		510000
	560000	560000
		620000
680000	680000	680000
		750000
	820000	820000
		910000
1.0M	1.0M	1.0M
		1.1M
	1.2M	1.2M
		1.3M
1.5M	1.5M	1.5M
		1.6M
	1.8M	1.8M
		2.0M
2.2M	2.2M	2.2M
		2.4M
	2.7M	2.7M
		3.0M
3.3M	3.3M	3.3M
		3.6M
	3.9M	3.9M
		4.3M
4.7M	4.7M	4.7M
		5.1M
	5.6M	5.6M
		6.2M
6.8M	6.8M	6.8M
		7.5M
	8.2M	8.2M
		9.1M
10.0M	10.0M	10.0M
		11.0M
	12.0M	12.0M
		13.0M
15.0M	15.0M	15.0M
		16.0M
	18.0M	18.0M
		20.0M
22.0M	22.0M	22.0M

resistors) by that illustrated in Fig. 11 (*b*). In Fig. 11 (*b*), brass caps make firm contact to the ends of the rod. To further ensure reliable connection, the ends of the rod may be metallised (possibly with a thin deposit of copper) before the caps are fitted. This type of lead-out connection is employed also with high-stability resistors and composition coat resistors.

Another method of making connection to a composition rod resistor is illustrated in Fig. 11 (*c*). In this diagram the lead-out wires are fitted to the composition rod before polymerisation, whereupon they become imbedded therein during processing.

Many present-day composition rod resistors do not have lead-out wires at all, being fitted instead with end-clips having extensions capable of being passed through the holes of a printed circuit board. The end-clips make contact to the rod in the same manner as do those of Fig. 11 (*b*), and are adaptations of them. Fig. 11 (*e*) illustrates the manner in which the end-clips of Fig. 11 (*d*) are soldered to the conducting foil of a printed circuit board.[4]

To identify the position of the lead-out wires relative to the body of a resistor, those shown in Fig. 11 (*a*) are described as *radial lead-outs*, and those in Figs. 11 (*b*) and (*c*) as *axial lead-outs*.

Insulated and Non-Insulated Resistors

Carbon resistors are made either as insulated or as non-insulated types. *Insulated resistors* are normally covered with a thick protective coating of "cement" or resin, or are fitted with a protective ceramic tube. *Non-insulated resistors* are covered with a film of paint or enamel only, and even this may be omitted in some cases. High-stability resistors are normally of the insulated type in order that the carbon film, which can be easily damaged, may be adequately protected.

Values and Tolerances

Carbon resistors employing composition rods or composition coated tubes are normally available with values ranging from some 10Ω to 22MΩ, whilst high-stability types normally have values extending from some 10Ω to 10MΩ.

All mechanical and electrical devices are manufactured to meet specified *tolerances* (these governing dimensions, performance, etc.). The same applies to resistor values. The value of a resistor is always quoted as a nominal value together with a tolerance expressed as a percentage of that value. Thus, a resistor which is described as having a value of 100Ω with a tolerance of ±10% may have any value lying between 90 and 110Ω.

Composition rod and composition coat resistors are normally given tolerances of ±5%, ±10% or ±20% of their nominal value. Since resistors are selected for value after manufacture, it is fairly certain that a particular batch of manufactured resistors will yield more ±20% components than ±5% components. In consequence, resistors with closer (i.e. smaller) tolerances tend to be the more expensive.

High-stability resistors are usually given tolerances ranging from ±1% to ±5%, typical commercial tolerances being ±1%, ±2% and ±5%.

To reduce storage and manufacturing problems the nominal values of present-day resistors are fitted into a "preferred" series of figures. These figures are such that, if a resistor out of a batch does not meet the tolerance rating of one nominal value it can still fall into the tolerance rating of an adjacent value. Such a resistor can, in consequence, be stored under the second nominal value and tolerance rating.

Table III lists preferred nominal resistor values, for tolerances of ±20%, ±10% and ±5%, over the range 10Ω to 22MΩ.

Next Month

In next month's issue we shall carry on to resistor colour-coding, and to variable resistors.

[4] "Pluggable resistors", similar to that illustrated in Fig. 11 (*d*), are the subject of a Registered Design by Erie Resistor Limited.

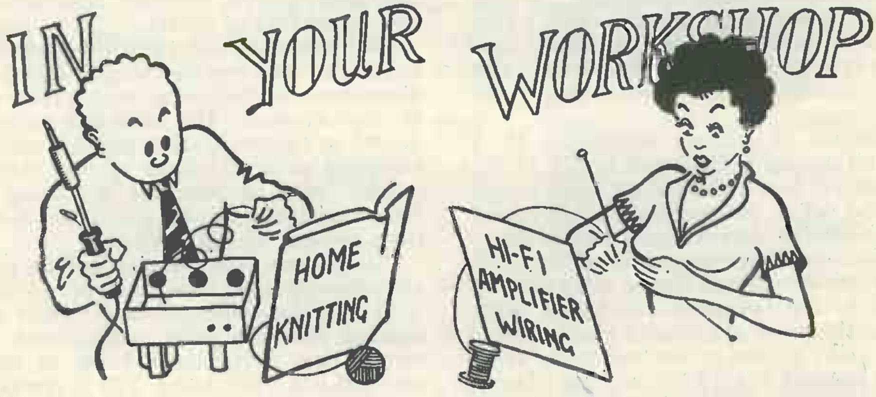
Canberra and Oriana use "Belling-Lee" Aerials

Two special broadband aerial arrays designed by "Belling-Lee" are being used on board the 45,270-ton *Canberra*, owned by P. & O. Orient Lines. These aerials enable the ship to pick up programmes on all possible channels of the world's television, and during the preliminary trials of the 42,000-ton *Oriana*, which plies the same route as the *Canberra* and is equipped with a similar television system, the aerials were subjected to a force 9 gale which they withstood without any damage. Television programmes continued to be received up to 120 miles from the transmitter.

The complete television system was designed and engineered by Marconi's Wireless Telegraph Co. Ltd., and contracted and installed by the Marconi International Marine Communication Co. Ltd, to provide a completely co-ordinated television service. The installation provides for the reception of television broadcasts employing the 405-line system used in Britain, the 625-line system used in Australia and the greater part of Europe, and the 525-line system used in the United States, Canada, Japan and some South American countries.

Where alternative programmes are available, viewers can change from one channel to another by using the normal channel selector on the receiver. Thus, while the ship is in the U.K. area, either the B.B.C. or I.T.V. programes can be selected at the receiver, and elsewhere the same switch will select any of the local stations operating in Bands I and III.

The *Canberra* carries more than 3,200 passengers and crew, and has fifty television receivers installed with provision for a further three-hundred. Internally generated programmes derived from a film library can be fed into the system when the liner is on the high seas and out of television range from shore. (Courtesy: Belling-Lee Ltd.)



This month Smithy the Serviceman's able assistant, Dick, finds himself under a cloud of large dimensions. Smithy's ire is, however, considerably alleviated by the pleasure he obtains from discussing hints received from readers

"I APPRECIATE THAT THE CROCKS in this Workshop have always been somewhat inadequate and graceless", said Smithy grumpily, "but *this* is ridiculous"!

The Serviceman's assistant, Dick, gazed unconcernedly at the motley array of utensils arranged alongside the Workshop sink.

"I don't know," he remarked, after a moment. "You must admit they're all *there*."

"That's a description", replied Smithy unkindly, "which, at the moment, I would not apply to anything or *anyone* in this Workshop."

Dick sighed. Whilst he realised that Smithy's moods of ill-humour were infrequent and short-lived, he had to admit that the Serviceman had had a very tiring and trying time ever since work had commenced that morning. A vague thought that he might possibly have been partly responsible for Smithy's grouchiness crept into his mind.

"I'm sorry, Smithy," he remarked, experimentally.

"What about?"

"That soldering iron you asked me to pass over earlier on. In future I'll always pass over soldering irons handle first."

Smithy cast a steely glance at his assistant.

"The fact that your carelessness", he said, "has resulted in my having received very severe and probably quite incurable burns is nothing compared with the other indignities and irritations to which I have been subjected up to now."

Smithy's expression darkened as he pondered on the injustice of his lot.

"There is, for instance", he pointed out, "the matter of that 200µF electrolytic which was charged up to 250 volts. Engineers should make sure that they discharge components of this nature before leaving them around for their guvnors to pick up."

"You must admit it got discharged in the end, though," remarked Dick, an appreciative grin at the memory flitting across his face.

"I'll say it did," said Smithy indignantly. "Through my fingers!"

The Serviceman continued to glare at his assistant.

"In further consideration of this morning's unhappy events", he carried on, "I will gloss over the fact that you have blown the Workshop fuses no less than three times since 10 o'clock. This is not because your attempts to draw more current from the mains than they are designed to give do not cause inconvenience, but because they involve no immediate risk to my own person. I shall similarly attempt to forget your spending half an hour trying to get a two-band a.m. set to pick up the Light programme on 1500 metres."

"How was *I* to know it was a Medium and Short wave model?"

"By looking at the dial, of course, you silly ass!" exploded Smithy.

Getting Down To It

Fortunately for Dick, it was at this moment that the battered Workshop kettle gave voice, and Smithy's complaints were drowned by its piercing whistle. Bad-temperedly, the Serviceman sat down and waited for his mid-morning tea.

Dick, busy at the sink, decided to change the conversation.

"Do you know, Smithy," he said, "we haven't had a session on readers' hints for quite a while."

"Now you come to mention it", said Smithy non-committally, "that's perfectly true."

"How about having one during tea-break?"

Smithy turned the idea over in his mind for a moment.

"Fair enough," he said eventually, temporarily dismissing his grumbles. "We'll have a bash now."

As Dick had hoped, Smithy's ill-humour was soon evaporating at the thought of a change from subjects immediately pertaining to the Workshop. Indeed, the Serviceman was positively cheerful as he walked over to his bench and took a sheaf of letters from a drawer.

"We'll start straight away," Smithy called out.

He walked back and selected a letter.

"Now here's the first one", continued the Serviceman, "and it's a useful dodge for removing eyelets without damaging their surroundings. All you do is to thread the offending eyelet with a taper BA tap. A suitably chosen tap will cut away enough material for the eyelet to split neatly in two with no damage to the material around it."

"That's a good idea," commented Dick. "I suppose it would apply mainly to eyelets which were firm enough not to rotate."

"I think that would be the size of it," agreed Smithy, as he selected another letter. "Now, the next hint has to do with fitting or removing pilot lamps in awkward positions in radios or other equipment."

"I've met them", commented Dick, who was now pouring out the tea. "Those lamps are sometimes *really* hidden away in the chassis!"

"You're right there," agreed Smithy. "In fact, it is often extremely difficult to remove a lamp of this nature with the fingers alone, and you need some sort of flexible tool. What you can do here is to pass the tapered end of a rubber wire-grip sleeve over the glass bulb, whereupon the lamp can be quite easily fitted or removed regardless of how difficult its position is. (Fig. 1.)

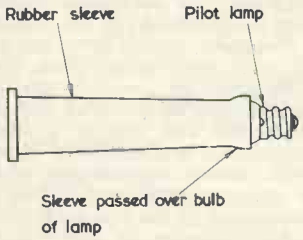


Fig. 1. Awkwardly positioned pilot lamps may be readily fitted or removed with the aid of a rubber wire-grip sleeve

Also, you can extend the flexible lamp holder given by the rubber sleeve by inserting the barrel of a fountain pen into its shouldered end. Once you've fitted or removed the lamp, the sleeve can be readily eased off it."

"I'm not quite with this rubber sleeve", confessed Dick. "Is it the cylindrical rubber sleeve you get on smoothing irons and things like that to prevent strain on the terminal connections?"

"That's exactly right," confirmed Smithy, "and our correspondent refers to the type used on Morphy-Richard smoothing irons as a typical example. Doubtless, other sleeves intended for the same purpose will work equally well."

More Hints

Dick placed Smithy's tea beside him, and the Serviceman's thoughts suddenly reverted to his previous complaint.

"You know, Dick," he remarked, "we've just got to get some new cups for the Workshop."

"I don't know what you're grumbling at," replied his assistant. "You have at least got a *china* cup."

"Yes", protested Smithy, "but look at it! It's got 'For My Ever-Loving Mum' written on one side of it and 'A Present From Brighton' on the other."

"Well, what's wrong with that?"

"It doesn't befit the dignity of this establishment", pronounced Smithy. "The senior member should not have to drink his tea from a cup which is plastered all over with maudlin sentiment. It's unseemly."

"I'm drinking out of a glass," Dick reminded him.

"You're drinking out of a half-pint glass beer tankard," Smithy corrected him. "A fact which is, again, not in keeping with the standards we should observe. Where did you get that tankard from anyway?"

"So far as I remember," replied Dick quickly, "you brought it in one New Year's morning."

"Did I?" said Smithy. "Oh well, let's take a look at some more of the hints we've received."

Smithy sipped his tea and examined the letters he was holding.

"Ah," he said. "Now we have two good ones here all in one letter. The first hint describes a neat way of mounting transistors such as the OC45 or OC72. (Fig. 2.) You fit a

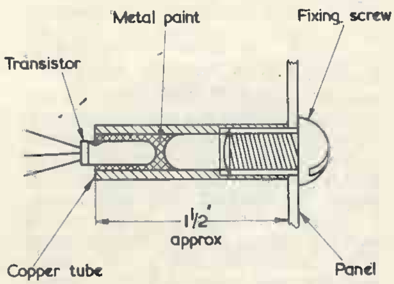


Fig. 2. A simple mounting for transistors which offers physical protection as well as a measure of heat dissipation

small piece of narrow gauge copper tubing over the transistor, a drop of metal paint being put in first to act as an adhesive with reasonably good heat conducting properties. The other end of the tube is fitted to a panel by means of a screw, the tube having previously been tapped for this. Alternatively, a self-tapping screw could be used. The whole assembly then provides a useful mounting for the transistor, as well as offering a small heat sink and protecting it from damage.

"The second hint in this letter is especially useful for panel mounting meters which are fitted in positions where they are relatively unprotected. If the bottom of a plastic bottle is cut off, the remaining tube will often fit over the meter housing (Fig. 3), and this can be used to

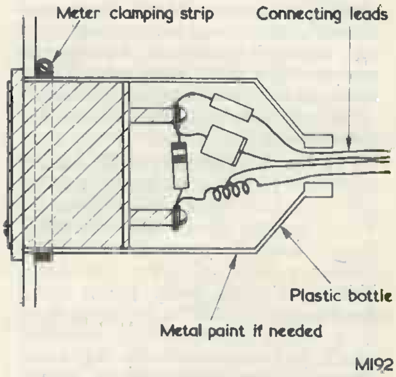


Fig. 3. A protective cover for components associated with a panel-mounted meter

provide a convenient dust-proof case for the components associated with the meter. The leads to the components and meter may be led out through the top of the bottle. If the bottle is coated with metallising paint the latter may be earthed by the meter clamping strip, thereby providing a simple screen for the whole assembly."

"That's a smart idea," said Dick approvingly.

"It *is* knobby, isn't it?" agreed Smithy. "Here's another one: 'If you need a good insulating adhesive for coil winding the following recipe may be of interest. Take a 2 oz. bottle of amyl acetate and dissolve in it small pieces of polystyrene until fairly thick. The remains of polystyrene plastic models will do nicely here. The resultant varnish is quick drying and burns readily, so it should be kept well corked.' "

Dick looked thoughtful.

"I suppose," he remarked, after a moment, "that, after you've applied this adhesive and the amyl acetate has evaporated, you're left with solid polystyrene."

"That's right," said Smithy. "The amyl acetate acts as a solvent. I should add that the adhesive may not stick too well to smooth surfaces such as Bakelite unless it has something to which it can 'key'. However, if you apply it all round the coil it will leave a solid wedge of polystyrene which should hold everything in position quite nicely. If you apply the adhesive to cotton or rayon covered wires it will stick to the covering very well indeed. And, of course, polystyrene is a very good insulator."

"How do you recognise polystyrene?"

"Well," said Smithy, "it's a hard, clear plastic material which gives a characteristic 'ring' when struck. If you ever encounter any transparent plastic coil formers these will almost certainly be made from polystyrene."

"Are any other plastics used for coil formers?"

"In commercial receivers", replied Smithy, "you may encounter almost any of the commonly used plastics. These include nylon, Bakelite, polythene and polypropylene. The natural colour of nylon and polythene is a milky white, nylon being the harder material. Polypropylene is a recently introduced material which has approximately the same characteristics as polythene except that it may be less flexible. Bakelite is, of course, a very hard opaque material. All of these are easily distinguishable from polystyrene because the latter is so transparent."

"Fair enough," said Dick. "Have you any more hints?"

"Quite a few," replied Smithy. "However, I feel that another cup of tea is called for."

Smithy watched equably as his assistant re-filled his cup.

"I must admit", he remarked, "that going through these hints is a very pleasant occupation. It even enables me to forget your further misdemeanours of this morning."

"Oh, come off it, Smithy," said Dick, a little impatiently, "we've been into all those already."

"One thing I haven't referred to yet", said Smithy, his voice taking on a note of indignation at the memory, "is the business of your checking the resistance between h.t. positive and chassis in that television receiver you were servicing."

"Accidents can occur at the best of times," said Dick defensively. "It was just unfortunate that the set happened to be switched on at the time! You must admit I took the test prods off very quickly."

"But not quickly enough," censured Smithy. "We now have a testmeter whose needle is permanently bent at 60 degrees. Dear, oh dear me, I can still hear the thump it gave when that pointer whanged against the end-stop!"

Dick's face showed an unhappy expression.

"I certainly seem", he remarked, "to be in the doghouse today."

"You are, indeed," commented Smithy. Then there's the matter of the Workshop typewriter. I shan't forget that in a hurry."

"Here's your tea, Smithy," said Dick hurriedly. "Let's get back to the hints."

Heat Shunt

"Very well", said Smithy, once more dismissing his complaints from his mind. "I'll continue."

He sipped his fresh cup of tea.

"Right," he said. "Well, here's another little idea which can save a lot of fuss. It's a simple heat shunt for soldering transistors."

"You mean, something to replace the taper-nosed pliers you hold in your third hand?"

"That's the idea," replied Smithy, chuckling a little in spite of himself. "It's very simple really, and it consists merely of a small spiral spring. You pop this over the transistor lead you're soldering (Fig. 4)

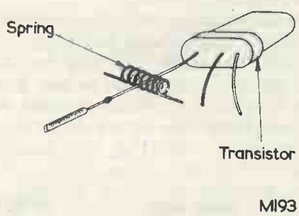


Fig. 4. An unconventional and quickly-fitted transistor lead-out heat shunt

and it provides quite a large mass of metal to conduct the heat away. I would personally avoid using springs having any enamel covering here, incidentally, and would suggest that the best material for the spring would be phosphor-bronze or beryllium-copper if available."

"It's a very useful idea," commented Dick, "and it certainly wouldn't take long to fit the spring on to the appropriate lead-out wire."

"I couldn't agree more," said Smithy. "Now here's another letter which has two hints in it. The first concerns the 250mA contact-cooled metal rectifiers which are used in a number of television receivers. If these go faulty they shouldn't be thrown away because they can supply quite a lot of useful hardware in the form of washers. To take an example a Westinghouse 14RA-1-2-8-3 rectifier provided, after it had been opened up, no less than 60 washers, each of these being 0.198in thick, 0.799in external diameter and having an 0.255in diameter hole. Quite a useful addition to the spares box, those!

"Another hint suggested in this same letter concerns B7G valves. These may be transported in the aluminium containers used for the packing of cigars with practically no risk of breakages. The valves are cushioned by grommets at each end. Our correspondent points out that a set of B7G television valves (6AT6, 6AM6, 6D2 and EF92) have been carried around in this manner for seven months in a tool box containing an electric drill, a 65 watt soldering iron, spanners, hammers and bolt croppers, without any damage whatsoever."

Smithy paused for a moment and took another sip at his tea.

"There are two further ideas in this letter," he continued, "which, whilst really falling into the category of 'common knowledge', are still well worth mentioning. Thus, there is the point that an 0–5 amp a.c. ammeter inserted in series with the a.c. supply can provide a useful indication of receiver faults. Open-circuit heaters, short-circuits across the mains supply, and failure or short-circuit of the h.t. supply may all be discovered by watching the meter whilst the receiver is warming up. I understand that this is a fairly common technique on the Continent, by the way. There is also the dodge of magnetising a screwdriver or spanner by holding a magnet close to it, thereby enabling a steel screw or nut to be held when being fitted into awkward corners."

"That's a useful one," agreed Dick. "Funnily enough, most of our screwdrivers and spanners in the Workshop seem to become magnetised on their own!"

"Yes, I've noticed that myself," said Smithy. "I suppose it's because they accidentally thump against speaker magnets and things like that during use."

"Any more ideas?"

"Yes," replied Smithy, taking up a further letter. "Here's another. This has to do with wire-ended components. Such components are usually stored in boxes which, apart from the risk of damage, can make finding the values required rather difficult. This snag may be overcome by making the components up into chains and hanging them up wherever convenient. (Fig. 5.) Components can be classified in both wattage (or working voltage) and value by making each chain in one particular wattage, and having the values go up along the chain. It doesn't take a second to locate the component you want in a chain, unhook it, and rejoin the chain afterwards. As you can see, the idea is extremely simple and effective."

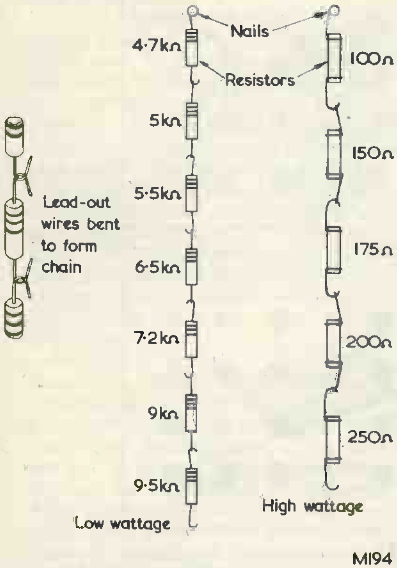


Fig. 5. Wire-ended components may be stored in chains as shown here. This enables individual values to be quickly selected.

Knob Removal

"Well, we've certainly had some useful tips in this session," declared Dick. "Any more?"

"There's an excellent one here", replied Smithy, "which describes a method of overcoming that curse of service engineers—control knobs which stick on their shafts."

"I know," said Dick bitterly. "What usually happens is that the knob flanges are right up against the surface of the cabinet panel and you can't get any purchase on them at all."

"It's a common complaint," confirmed the Serviceman. "And that's where the present hint comes in useful. You take an 18in length of figure-8 section flex and split the middle section for about 2in. (Fig. 6 (*a*).) The loop thus formed is next pushed over the knob. (Fig. 6 (*b*).) The ends of the flex are finally drawn tight and the knob removed by pulling the wire away from the cabinet panel. (Fig. 6 (*c*).) As you can see, this method of knob removal results in no scratches on the panel and it gives an even tension on the under-surface of the knob."

"It also prevents broken finger nails on the part of the service engineer," chimed in Dick.

"Very definitely," agreed Smithy. "Incidentally, my 'Present From Brighton' needs re-filling again. It doesn't seem to have much capacity."

"Don't you mean capacitance?" said Dick, as he once more picked up Smithy's cup and took it over to the teapot.

Smithy ignored his assistant's remark.

"I wonder where that cup *did* come from," he mused.

"It's a mystery," said Dick. "Are you sure you didn't bring it in yourself?"

"Me?" said Smithy. "I've never been to Brighton in my life. With a surname like mine I couldn't face the hotel receptionists."

Dick absorbed this information in silence.

"Anyway," continued Smithy, "we shall have to get some new cups in soon. Next time you're going around the town, call in at Woolie's and pick up some of their blue and white striped cups. The type they use in the B.B.C. t.v. plays!"

"Fair enough," said Dick. "Do I detect, from your tone of voice that I am now more or less forgiven for my misdemeanours of the morning?"

"I suppose so," grunted Smithy wearily. "Apart from the typewriter business, that is. I had a lot of affection for that poor old typewriter, battered wreck that it was."

"All I did was overhaul and lubricate it," protested Dick hotly. "Which is precisely what you instructed."

"I didn't instruct you to pour half the oil can into it," replied Smithy severely. "When I went to use it I found it sitting in a pool of oil with little fountains gushing up every time I pressed a key. I only typed two words with it and the paper looked like parchment! Anyway, it's nearly time we got back to work."

Groupboard Wiring

"Can't we discuss just one more hint?"

"All right," conceded Smithy. "But, after that, we really must get back to the grind. The next idea covers a very handy form of groupboard construction which is especially useful when knocking up experimental circuits. The raw material is cheap, being pegboard (made of hardboard) of the type having holes every ½in. It is obtainable at any Do-It-Yourself shop. Also required are brass paper fasteners of the bifurcated type, those being available at any good stationers for about 3s. 6d. a gross.

"It is a good idea to buy a strip having a width which includes, say, four holes, and cut this to a suitable length as required. Lay the components on top of the board and, at every hole in the proximity of a component lead, push in a paper clip from underneath. This is best done by holding the board over the edge of a table and moving it on to the table as the fasteners go in. The components are next moved off carefully, their relative positions being maintained or noted, whereupon the peg-board will now have a number of fasteners sticking up. (Fig. 7 (*a*), view 1.) The fastener legs are next opened out flat and, with the aid of a small screwdriver, bent back upon themselves with the ends tucked into the centre. (Fig. 7 (*a*), views 2, 3 and 4.) The components may then be soldered into the triangular spaces formed by the fastener legs.

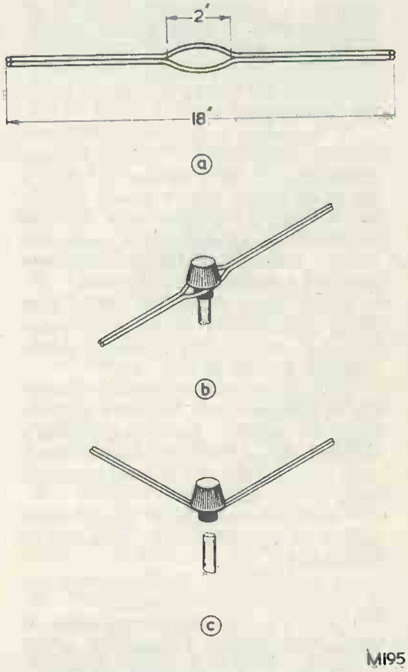


Fig. 6. Successive stages in removing a tight control knob. An 18in length of figure-8 section twin flex is shown in (a). The 2in loop at the centre of the flex is passed over the knob in (b), and the latter is removed by pulling the flex outwards, as at (c)

"Each component is now secured through the board to a separate contact formed by the head of the fastener on the reverse side. These heads may be next joined together with insulated wire as required by the circuit. (Fig. 7 (*b*).)

"Removable spade terminals may also be accommodated by bending the legs of a fastener around the spade and then soldering at the middle. (Fig. 7 (*c*).) Another useful point about the idea is that the holes in the peg-board will accommodate many transistors types having round bodies. Such transistors may be mounted in these holes, whereupon they remain comfortably in position during and after wiring."

Final Try-out

With an air of finality, Smithy picked up the letters he had just read and took them back to the drawer in his bench.

"And that, my lad," he announced, "is that. It's back to work now, and I only hope that your progress for the rest of this morning will not be marked by as many catastrophes as we have had up to now."

"Dash it all, Smithy," complained Dick, "you do carry on, you know! Accidents are bound to happen every now and again."

"I suppose they are," conceded Smithy reflectively. "And, I must admit that I am, perhaps, being a bit more niggly than I would usually be. I think, really, that it's the typewriter business that's upset me most. I used to enjoy tapping out the odd letter on that machine."

"Well, give it another trial," said Dick eagerly. "I spent quite some time on overhauling it, and it surely can't be as bad as you say."

Resignedly, Smithy walked over to the typewriter and inserted a fresh piece of paper. He experimentally tapped one of the keys several times, and watched the carriage as it moved over to the left.

"Well, I must admit that it does run a lot smoother than before," he remarked.

"I *knew* you'd find an improvement," said Dick, gratified.

"And there isn't quite the same oil geyser effect when I press any of the keys."

"The oil has probably drained through by now."

"Also," continued Smithy, rattling the space bar experimentally, "the squeaks it had seem to have completely cleared."

"Ah, well," said Dick modestly, "that's what happens when you have an *engineer* on the job."

Continuing, idly, to rattle the space bar Smithy turned round to his assistant.

"Perhaps", he commented, "I have round again to confront his assistant. But Dick, judging discretion to be the better part of valour, had fled.

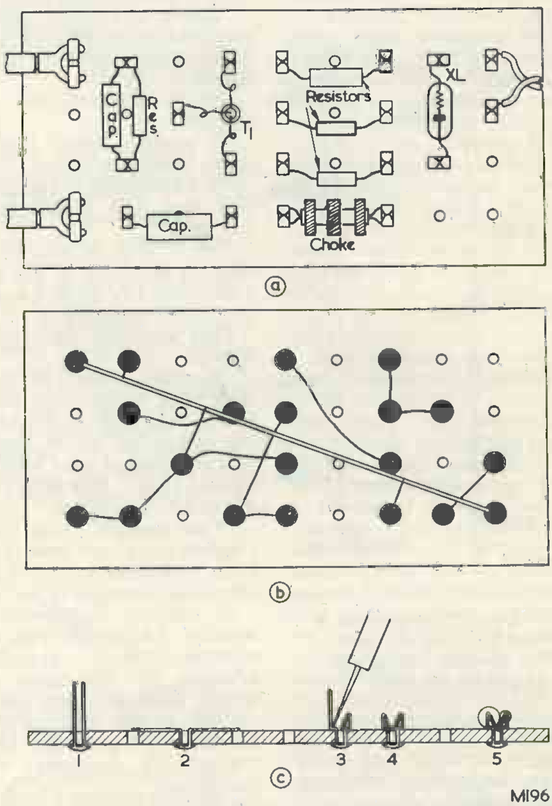


Fig. 7 (a). How paper fasteners may be fitted to pegboard to provide component lead-out anchor points
(b). Connections to the paper fastener heads may be made below the board as illustrated here
(c). Components mounted above the pegboard

misjudged you after all!"

Dick volunteered no answer, and there was a sudden strained expression on his face which caused Smithy to turn back to the typewriter. He saw that the carriage was now projecting from the left hand side of the machine by almost its entire length. Fascinated, Smithy continued to operate the space bar. The carriage travelled several further spaces to the left, then detached itself from the machine and fell neatly into the waste paper basket at the side of the table.

The fuming Serviceman turned

Editor's Note

The hints described in this month's episode of "In Your Workshop" were contributed (in the order in which they appear) by T. E. Millsom, London, N.19; M. R. George, London, S.E.9; J. Anderson, Bramhall, Cheshire; P. Winterbottom, Blackburn, Lancs.; M. Shapland, Seaford, Sussex; D. Powell, Long Eaton, Notts.; B. Slight, Buckland, Hants; G. Cooper, Liverpool 18; and G. E. Dunning, Morden, Surrey.

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

FRENCH SUPERSONIC FIGHTER TO HAVE MARCONI DOPPLER

Marconi's Aeronautical Division disclose that a substantial order has been received from the French Government for their AD300 series of doppler navigators, together with specially-designed navigation computers. These will be installed in the *Mirage III* French supersonic strike fighter.

NEWS AND COMMENT . . .

Family Favourites

We all know the old adage "human nature is much the same the whole world over". We were reminded of this when reading about radio and t.v. programmes from eastern Europe. We have our "Archers", "Mrs. Dale's Diary" and "Coronation Street". In Hungary one of their most popular t.v. programmes is the "Szabo Family"—a series on the life of a Hungarian family. They, too, have Third Programme type broadcasts, for example, Hungarian Radio has broadcast "Romeo and Juliet" and "Henry V" as part of a cycle of Shakespeare's plays.

Moving to Bulgaria, Sofia Radio features a series on agriculture—"Perfection Through Knowledge"—a competition programme. Questions from the sphere of agriculture are put to listeners and a time limit set for the submission of answers. After the answers have been examined, a fresh programme gives model answers, announces the winners and puts further questions. Small prizes, most of them being text-books, are given. Larger prizes are presented for the best answers submitted in a winter's series.

One forms the impression of a more stolid type style of programmes compared with ours and some, no doubt, would guess that "Perfection Through Knowledge" could easily be used for Government propaganda rather than as a disinterested dissemination of knowledge.

It could be misleading to compare our licence figures with those of these countries, the basis on which they are issued not being known, but it is interesting to compare the ratio of t.v. to radio licences. In Czechoslovakia for example it appears that sound only licences outnumber those of t.v. by more than three to one, whereas in Great Britain and N. Ireland the ratio is almost exactly reversed, t.v. being predominate.

Does this indicate that we have a higher standard of living?

Looking Ahead

From America we hear that hospital patients in the future may have their temperature, pulse and breathing under constant watch from a central control point on each hospital floor by means of a simple system of tiny electronic measuring and radio transmitting devices.

Miniaturised telemetering transmitters are being developed by the Radio Corporation of America to pick up and transmit a variety of such measurements, including temperature, rate of breathing and heart action. Built into tiny packages that can be conveniently worn by patients, the devices keep a constant check on these routine functions and transmit the information to an aerial installed in a room or ward. From the aerial, the data is fed to a central location for constant monitoring by a nurse or doctor.

At present continuous monitoring of all patients is impracticable and the first application is expected to be that of dealing with surgical recovery cases.

Amateur Radio

The Derby and District Amateur Radio Society recently held an exhibition as part of its 50th anniversary year celebrations.

The Society incorporates the Derby Wireless Club which was founded in 1911, and it is claimed that it is the oldest Wireless Club in the country—if not in the world. The London Wireless Club which eventually became the Radio Society of Great Britain was formed in 1913.

In connection with the exhibition, a most interesting booklet *Fifty Years of Radio* was published. Included is a brief year-by-year history of Amateur Radio in Derby and many interesting facts about radio in general are mentioned such as the year of formation of the American Radio Relay League, changes in licence conditions, etc. Copies of this booklet can be obtained for the price of 2s. 6d. from Mr. F. C. Ward, 5 Uplands Avenue, Littleover, Derby.

Talking of exhibitions reminds us of the Radio Hobbies Exhibition sponsored by the Radio Society of Great Britain to be held in the Royal Horticultural Society's Old Hall, Vincent Square, Westminster, from 22nd to 25th November.

Exhibitors will include the Army Navy and Royal Air Force and, among the exhibits, will be communication receivers from both home and overseas, transistor components, kits of parts for build-it-yourself receivers, transmitters and television sets. Aerial equipment will also be a feature.

Mr. Henry Loomis, Director of the Voice of America, is to open the exhibition.

Coinciding with the final day of the Show, the British Amateur Radio Teleprinter Group is holding its A.G.M. on the evening of 25th November at "The Old Rose", Medway Street, Westminster, a few minutes walk from the Old Horticultural Hall. It will be an informal get-together, and snack-bar facilities will be available. Further details of this event may be obtained from the Hon. Secretary, B.A.R.T.G., "East Keal", Romany Road, Oulton Broad, Lowestoft, Suffolk.

Beware of the Music

Notice outside the swimming pool at Chateau Thierry: "Interdit aux chiens et aux transistors".*

Peterborough in *The Daily Telegraph*.

In Brief

● At the end of September the AVO Mobile Demonstration Unit embarked from Harwich on a vigorous two-month tour of Western Germany, Italy, France, Switzerland and Yugoslavia.

The unit, designed by the AVO Sales Staff carries the full range of AVO electrical, electronic and nucleonic test equipment. It extends to the European user a full Technical Sales and Advisory Service.

● The Tin Research Institute announce that their book *Notes on Soldering* is now available in the Spanish language.

Readers may obtain the English, or the Spanish translation if preferred, from the Headquarters of the Institute, Fraser Road, Perivale, Greenford, Middlesex, on application.

● Thirteen complete television camera channels have been ordered from EMI Electronics by Radiotelevisione Italiana for use in their studios at Milan and Turin.

● "Scrambler" telephones, used as a means of ensuring privacy, are now within the means of most business men. Westrex Co., of Cricklewood, London, is marketing a portable transistorised device specifically developed for use with the standard telephone system.

● Three teenagers were recently fined £15 each at Bilston, Staffs, for operating pirate radio transmitters. All their equipment was confiscated.

● Mr. Roy Thomson, chairman of Thomson Newspapers Ltd., and Scottish Television Ltd., forecast in a recent t.v. interview that television will become more competitive and cut-throat as is the case now in both the U.S.A. and Canada.

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* "Dogs and transistors forbidden"—*Editor*

Cover Feature

The

Oxford Tachometer

Described by
HUGH GUY

SPECIFICATION

Range

0–8,000 r.p.m.

Accuracy

±3% of full scale.

Engine

4–6–8 cylinder, coil-ignition I.C.E.

Supply Voltage

12.5V d.c. nominal. Specified accuracy maintained over range 12 to 15V.

Load Current

0.17 amps, including lamp.

Connections

Three leads, two to battery, one to contact-breaker.

Separate plug/socket for meter.

Either positive or negative earthed systems.

Units and Dimensions

(*a*) Electronic unit comprising printed board accommodating high grade components mounted in mild-steel case measuring 4½ x 2½ x 1½in deep approximately, affixed by means of two No. 6 self-tapping screws under dash, or on bulkhead, etc.

(*b*) Meter comprising 3½in diameter moving coil circular scale instrument with clearly printed scale, in polished aluminium case with satin-anodised bezel, and fitted with rear-scale illuminating lamp. Reinforced bracket and U clamp facilitates simple mounting at bottom of dash by means of two No. 6 self-tapping screws. Overall meter dimensions—4in diameter, 1¾in deep.

Calibration

Electronically, either by a.f. signal generator or a.c. mains supply. No road tests or comparison with speedometer required.

Description

The Oxford Tachometer comprises two separate units, namely the electronic unit and the meter unit. The electronic unit may be used with any 1mA instrument but the meter unit is designed specifically for use in conjunction with the electronic unit. The circuit is given in Fig. 1.

Basically the electronic unit converts the pulses generated by the contact breaker of the distributor into a shaped waveform which is then used to deflect the meter movement in direct proportion to the engine rate of revolution. The characteristics of the waveform are determined by the special pulse transformer which utilises the magnetic properties of the grain orientated steel used in the laminations. Care should be exercised in handling this transformer as any severe mechanical shock, caused by dropping it for example, can modify its characteristics.

The meter unit is based on a high grade moving coil instrument specially calibrated from 0 to 8,000 r.p.m. and has a scale illuminating lamp. It is mounted by means of a U clamp on to a specially reinforced bracket. This bracket minimises the risk

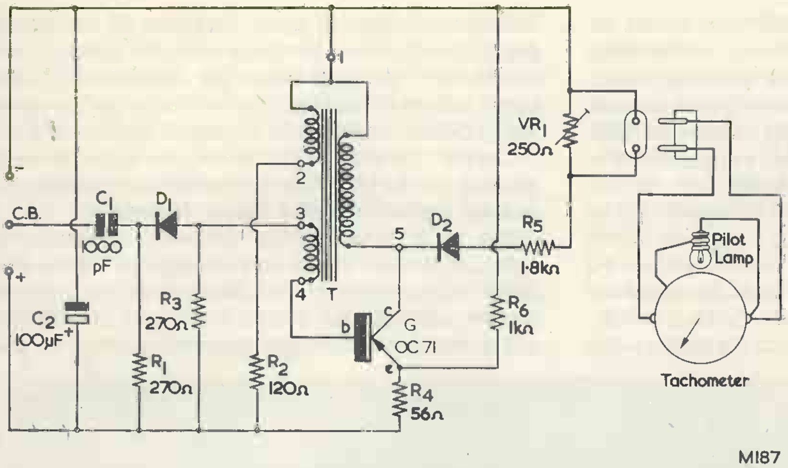


Fig. 1. Circuit of the Oxford Tachometer. Note that the meter case must be earthed in order to illuminate the scale. For cars fitted with a "negative-earth" battery, see text

of damage to the instrument movement by vibration.

The two units are connected by means of a length of flex on the meter terminated in a plug.

Assembly and Wiring

The circuit is accommodated on a printed wiring board. Before commencing assembly check the components against the parts list and then select the components indicated on the printed wiring layout diagram, Fig. 2. Bend the wires to the appropriate length and mount the resistors and capacitors as shown, leaving them just clear of the board. Do not mount the transistor G or diodes D_1 and D_2 yet.

The electrolytic capacitor C_2 is mounted underneath the board. Note the polarity required; the can lead is taken to the negative strip.

Next mount the transformer T pushing it well home on the underside of the board so that its terminals just project on the printed side of the board. Lightly solder all the connections using a small iron.

Fix the preset control VR_1 with the locking nut on the spindle on the underside of the board, using the plastic lock nut to secure the control to the board. Align the three contacts on the control with the holes in the board and connect three short links between control and holes using 22 s.w.g. tinned copper wire.

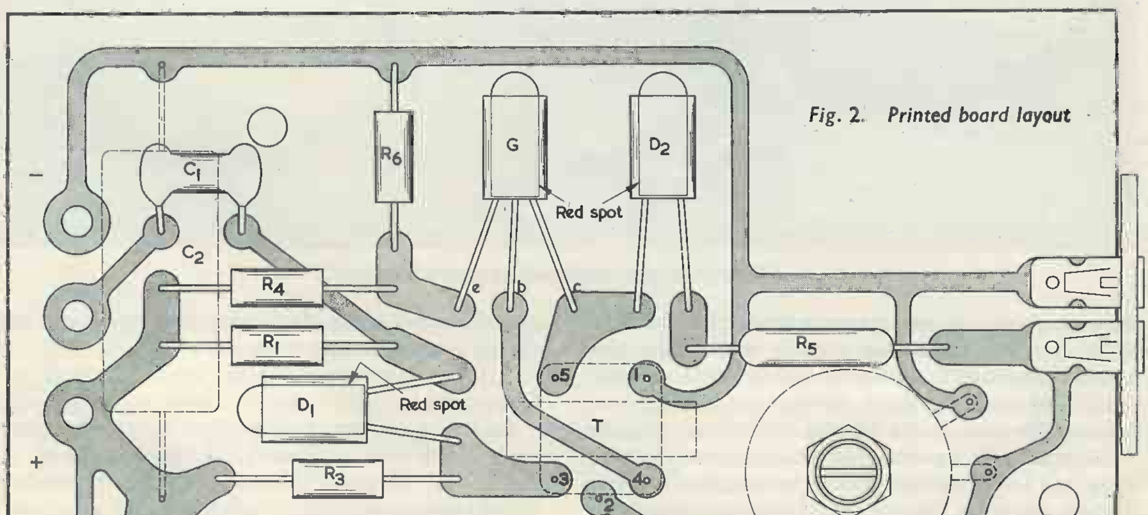


Fig. 2. Printed board layout

Around the edges of the board a thin outline of copper may remain from the printing and etching process. This should be removed near the outlet socket and input terminals to prevent short circuits occurring. Solder the outlet socket in position and mount the three supply terminals, using three $\frac{3}{8}$in 6BA screws so that the screw heads are on the underside of the board. Fix each screw with a washer and nut.

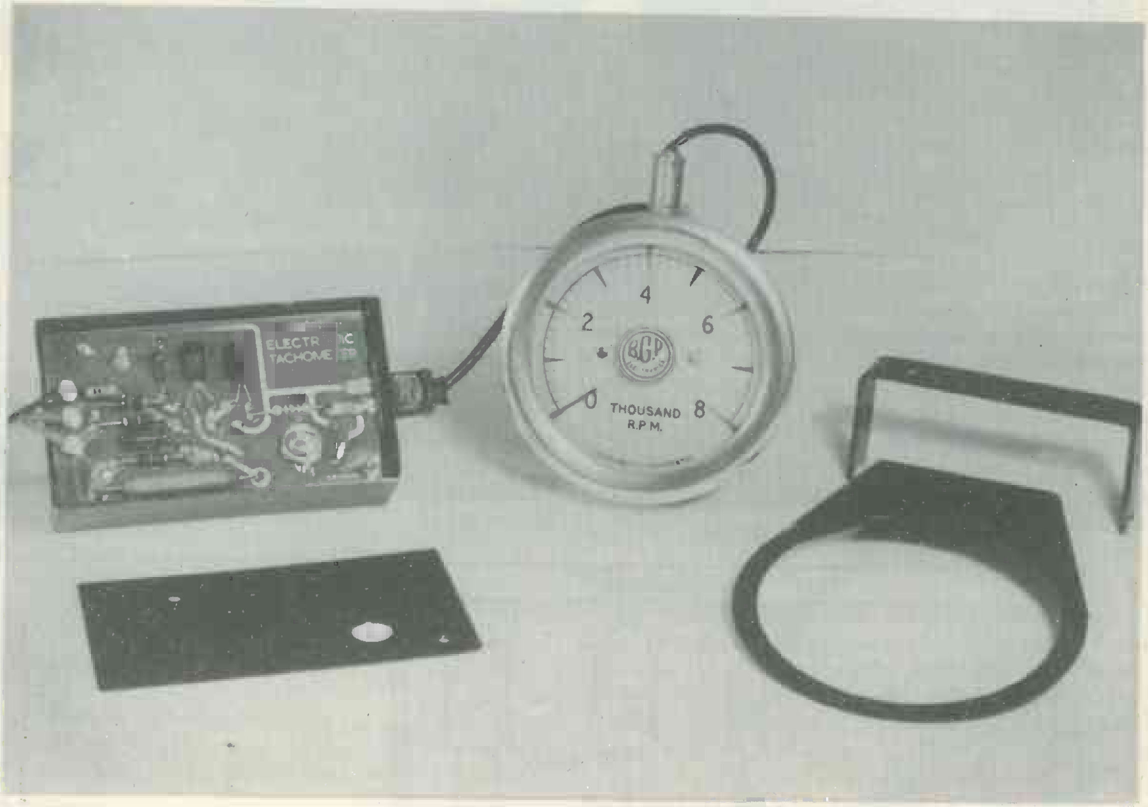
The diodes D_1 and D_2 should next be wired in circuit. These are clamped in plastic holders which should first be mounted in the board. Carefully note the correct way of connecting the diodes, as identified by the position of the red spot on each. Care too must be exercised in soldering the diodes (and later, the transistor), as these devices can easily be destroyed by an excess of heat. The leads should be clamped with a pair of pliers to dissipate the heat whilst the soldering operation is in progress, keeping the pliers between the iron and the semiconductor.

The three supply leads for the unit may now be terminated, each in a 6BA solder tag at one end and a 2BA solder tag at the other.

One final step remains on the electronic unit. Associated with the outlet socket is an insulating panel which must be positioned to insulate the socket from the case when the completed printed board is fixed in the case. Secure the insulating panel with adhesive, checking its alignment whilst doing so.

Connect the three leads, the red one to the terminal marked +, the black one to the terminal marked −, and the green one to the centre terminal.

The meter unit for the Oxford Tachometer is supplied already wired and consists of the tachometer calibrated from 0–8,000 r.p.m., its support bracket, a U clamp, a scale lamp and lampholder and a length of twin flex terminated in a two-pin plug. One pin of the plug is identified by a white spot on the plug housing.



The complete unit wired and ready for testing

Calibration

At this stage the complete tachometer has been wired with the exception of the transistor G. Before this transistor is wired in circuit the method of calibration must be chosen.

Two methods are available, one involving the use of an audio frequency signal generator, the other utilising the 50 c/s a.c. mains.

In the case of the a.f. signal generator the transistor may be mounted in its holder and wired in circuit, observing the required position of the red spot. The output from the generator should be square waves (or pulses) in the frequency range 10–300 c/s, and of about 30 volts amplitude. This signal must be coupled into the centre terminal of the electronic unit when the latter is connected to a 12.5 volt supply, which may be derived from a series of dry cells of suitable output. (The earth lead from the signal generator should be connected to the positive terminal on the unit.) The meter unit should be coupled to the outlet socket, taking care to connect the plug so that the white spots on case and plug are adjacent. For the time being the pilot lamp should be removed from the lampholder.

A simple formula relates the frequency of the signal generator to the corresponding engine r.p.m.

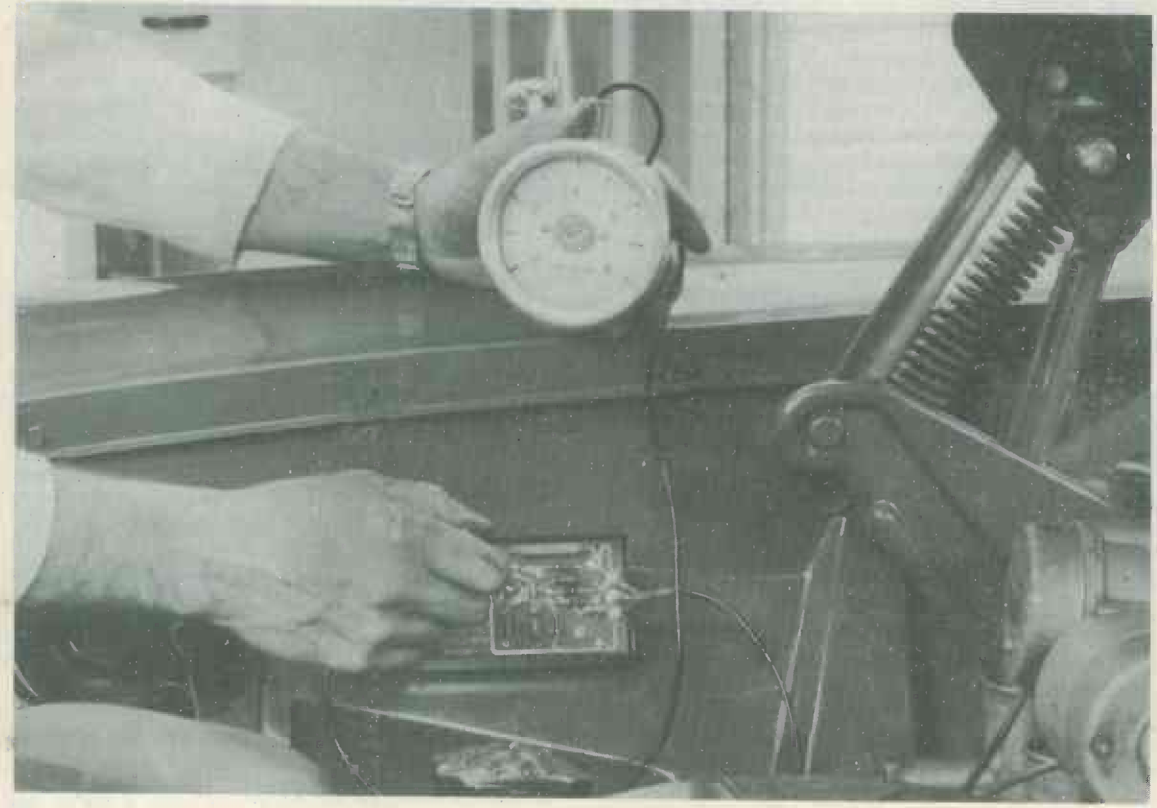
$$\text{Frequency} = \frac{(\text{r.p.m.}) \times (\text{no. of cyls.})}{120}$$

Hence a four cylinder engine running at 3,000 r.p.m. is equivalent to a signal frequency of 100 c/s. Using this formula the appropriate frequency may be determined for any given rate of revolution and a series of points can be calibrated over the scale, the preset control being set to give the best set of readings.

In the absence of a signal generator an alternative ingenious and accurate method may be used to calibrate the tachometer, utilising the photo electric properties of semi-conductors.

First, the black paint around the bulb of the OC71 transistor should be carefully removed with a razor blade, and then the transistor soldered in circuit. Do not mount it in its holder at this stage, but leave it standing clear of the board.

Couple up the two units as previously described and connect a 12.5 volt supply to the circuit.



Checking the completed unit on a 4 cylinder engine

Now take an ordinary mains reading lamp and position the bulb, which should be of about 60 watts rating or more, in such a manner that the light from the lamp falls directly on the transistor. The lamp will need to be placed about 6in from the transistor and the time taken for the operation should be kept to a minimum to avoid overheating it.

At some position of the lamp, the light output will trigger the circuit into operation. Two modes of oscillation can generally be induced and the lowest *steady* reading on the meter is the one indicating correct triggering conditions.

A filament lamp operating on 50 c/s a.c. mains heats up and cools down twice per cycle and hence the light output is really flickering at 100 cycles per second, although it cannot be perceived visually.

The tachometer, however, will respond photo-electrically to this impulsing under the conditions described and because a frequency of 100 cycles per second corresponds to a rate of 3,000 r.p.m. on a four cylinder engine, the preset control should be adjusted to give this reading. (The required setting, of course, varies as previously described with 6 or 8 cylinder engines.)

Having completed this simple calibration, the holder should be slipped over the transistor and the leads bent to enable the holder to be mounted on the board.

Calibration by this means sets the instrument to within an accuracy of about ±2%, this being the stability of the mains frequency. The overall accuracy of the tachometer, taking into consideration non-linearity, meter calibration and supply voltage variation, yields a figure of better than ±3% of full scale.

Installation Instructions

The electronic unit should preferably be mounted inside the car, say under the dashboard, but if this proves to be inconvenient a suitable place under the bonnet should be found where the unit will not be overheated by the engine nor subjected to water sprayed from the wheels.

The unit is fixed by means of two No. 6 self tapping screws through the bottom of the case. Two holes should be drilled 3in apart in the mounting surface using a No. 34 (0.111in dia.) or $\frac{7}{64}$in drill. Having fixed the case, the wired-up printed circuit board is screwed in position by means of two $\frac{3}{8}$in mounting pillars, tapped 4BA. The lid is secured to these same pillars.

Find a suitable mounting position for the meter by sitting in the normal driving position and holding the meter, ensuring that a clear view of the scale is obtained when it is mounted at some appropriate point at the bottom of the dashboard. (See front cover illustration.) An ideal solution, of course, is to mount the meter in the dash panel if there is room and to those with the necessary facilities a hole of $3\frac{3}{4}$in diameter should be cut. Since this operation is beyond the scope of most users, however, the specially reinforced bracket is supplied.

This bracket is fixed by means of two No. 6 self-tapping screws and holes as previously described should be drilled $1\frac{3}{4}$in apart under the dashboard. Mount the bracket, and then finally the meter after the wiring instructions below have been followed.

Wiring Instructions

Connections between the car electrical system, the electronic unit and the tachometer are quite straightforward and are shown in the diagram of electrical connections, Fig. 3. This diagram indicates connections for cars in which the positive terminal of the battery is earthed. Very few cars are exceptions in this respect but instructions follow later for negative-earthed systems. If in doubt about this matter examine the car battery and ascertain whether the positive terminal (usually indicated with red paint or a + sign) is bonded to the metalwork of the car

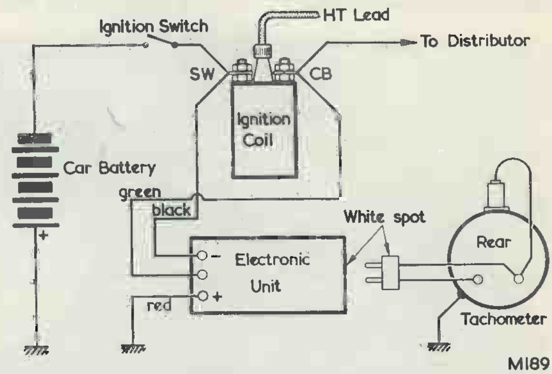


Fig. 3. Diagram of the electrical connections to the car ignition system (for "positive-earthed" systems)

by means of a cable or heavy flexible braiding. If it is, then the system is a "positive-earth" arrangement and the wiring diagram can be safely followed.

Connect the green and black leads to the ignition coil terminals as shown. If no convenient earthing point is available for the red lead, link it to one of the securing screws under the case, ensuring that the metalwork at the point of contact is clean.

A few elementary precautions must be observed when connecting the meter. In the first instance there must be continuity between the case of the meter and the metalwork of the car since this provides the return path for current through the pilot lamp. To facilitate this, lightly scrape the paint away on the mounting bracket around the fixing screw holes and at the bracket's points of contact with the U clamp. This latter clamp should also be cleaned around the fixing holes and at its edges.

Before testing the tachometer in situ disconnect the lamp circuit by removing the scale lampholder from the meter case. This will protect the meter against any error of plug connection. The meter plug should be connected so that the identifying white spots on plug and case are adjacent.

Now switch on the car's ignition. If the meter is connected correctly, the needle will give a slight kick in a clockwise direction and starting the engine will confirm correct connection. If the meter is inadvertently connected the wrong way round the needle will endeavour to move in an anticlockwise direction and the meter plug should be reversed accordingly.

Having ascertained that the electronic tachometer is functioning correctly, the scale lampholder may be replaced.

Negative-earthed Systems

With negative-earthed systems, the connections from the electronic unit should be wired as follows:

Red lead to SW on ignition coil.
Green lead as before to CB.
Black lead to earth.

Disconnect the lead to the scale lamp from the right hand meter terminal and add sufficient extra lead to enable it to be connected to the SW terminal of the ignition coil.)

Test the system as previously described.

In Conclusion

Wiring and installation of the Oxford Tachometer is complete and the complementary pair of units will now give the constructor an accurate indication of his engine speed at all times.

Irregularities in performance can be identified immediately. Erratic running due to mistuning or faulty ignition will be indicated by sporadic flickering of the needle. This effect can also be produced by transients developed by electric petrol pumps in certain instances but this is only occasionally troublesome at idling speeds and can often be cured by fitting a capacitor directly across the terminals of the pump.

Although the tachometer can be used in conjunction with any 1mA moving coil instrument, the circuit has been designed specifically to facilitate an elementary and foolproof method of calibration so that a highly accurate electronic tachometer can be built without recourse to expensive test equipment or unwieldy road tests. With this the constructor will undoubtedly agree.

Components List

2 270Ω ½ watt 10% carbon resistors
1 56Ω ½ watt 10% carbon resistor
1 1kΩ ½ watt 10% carbon resistor
1 1.8kΩ ½ watt 5% HiStab resistor
1 120Ω 3 watt wirewound resistor
1 1,000pF ceramic capacitor
1 100μF 30V wkg. electrolytic capacitor
1 Pulse transformer—Deakin Phillips Electronics Ltd.
1 250Ω potentiometer
2 OA5 Mullard diodes
1 OC71 Mullard transistor
3 Transistor clips
1 Printed wiring board
1 Outlet socket and insulator
1 Case with fixing pillars and lid
1 Potentiometer lock

Miscellaneous

2 ⅜in Fixing pillars, tapped 4BA
2 ¼in 4BA screws
2 4BA washers
4 No. 6 self-tapping screws
3 ⅜in 6BA screws
3 6BA solder tags
6 6BA nuts
6 6BA washers
3 2BA solder tags
3 1 yd. lengths connecting wire (green, red, black)
22 s.w.g. tinned copper wire
Solder

Meter Unit (supplied ready assembled)

1 3½in circular scale moving coil instrument, calibrated 0–8,000 r.p.m.
1 Mounting bracket
1 U-clamp
1 Lampholder
1 14V M.E.S. pilot lamp
1 2 pin plug
1 1 yd. length black twin flex
3 2BA solder tags
(Lampholder to solder tags: Ready wired)

Most of the components are available from regular advertisers in *The Radio Constructor*. A complete kit of parts may be obtained from Deakin Phillips Electronics Ltd., 79A High Street, Staines, Middlesex.

BOOKLET RECEIVED . . .

Kendall & Mousley Ltd., 18 Melville Road, Edgbaston, Birmingham 16, have forwarded to us a copy of their latest publication entitled *Amplifiers and Feeders*. This booklet includes full constructional details, circuits, etc., of a number of direct-coupled amplifiers (both single-ended and push-pull) in addition to some feeder units—these latter being either valve or transistor designs—"straight" or superhet. The booklet itself is of quarto size (8 x 10 ins) comprising some 25 pages plus cover. Well laid out point-to-point diagrams are liberally interspersed throughout the pages, this making the construction of any of the units described a very easy matter—even for the beginner. The booklet itself is duplicated and the subject matter well presented. Copies are available direct from Kendall & Mousley Ltd. at 3s. 6d. each plus 4d. postage.

Radio Astronomy

PART 2

by

FRANK W. HYDE
F.R.S.A., F.R.A.S.

Space observation from the surface of the Earth has, over recent years, been greatly extended by the introduction of Radio Astronomy techniques. Radio Astronomy is still a very young science and, because of this, it offers especial scope for the imaginative amateur who will already be conversant with the basic electronic principles involved.

The article which follows is the second of an important series commissioned from the foremost amateur authority in this country. Our author, Frank W. Hyde, appeared recently in the B.B.C. television programme "The Sky at Night".—Editor.

Aerials and Their Applications

The aerial is the first link in the chain of instruments used for the detection of radiation from extra-terrestrial sources. It is necessary, therefore, that this should be made as efficient as possible. The amount of radiation that an aerial can intercept is dependent upon its area. This being the case the sensitivity of an installation can be increased by enlarging the size of the aerial array. In radio astronomy we are not only concerned with sensitivity but also with direction. Our aerials must, therefore, then have a quality known as resolution. Adequate resolving power is one of the problems of the radio astronomer. Compared with an optical telescope the resolution of a radio telescope is very poor, for example, the 200in Mount Palomar telescope which is an optical reflector has a mirror with a diameter of 5 metres and its resolution is 0.02 seconds of arc. This means that objects which are not closer together than 0.02 of a second can be distinguished one from the other. Comparing this with the Jodrell Bank telescope, which is 250ft in diameter, the resolution at a wavelength of 1 metre is something of the order of 45 minutes arc.

In describing the resolution factor of a radio telescope we speak in certain terms. We refer to the polar diagram of the aerial array in terms of

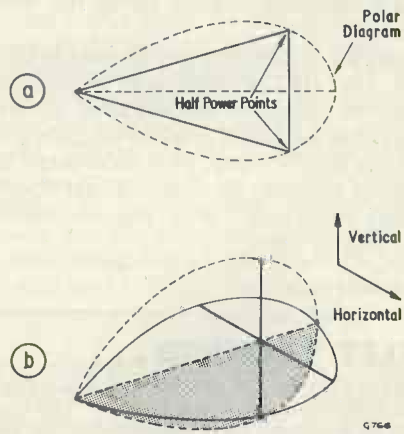


Fig. 2 (a). The half-power points are those points on the polar diagram where the power =0.707 of peak (b). The modes of the polar diagram are at right angles to each other its *beam width* at the *half-power points*, in Fig. 2(a) these terms are illustrated. The polar diagram in this instance is shown in one plane only, but ii should be remembered that it also applies to a plane at right angles, and this is illustrated in Fig. 2(b). The polar diagram of an aerial is governed by the size and extent of the aerial array.

There is a simple formula for finding the beam width of an aerial, this is:

$$\frac{57.3 \times \text{the wavelength in use}}{\text{the width of the aperture of the aerial in wavelengths}}$$

It will be clear from this that the higher the frequency we use the easier it is to obtain high resolution in single aerial systems.

Types of Aerial

The first type that we shall consider is the dish or bowl. The incident energy falling on the reflector is brought to a focus where an aerial element is provided for the collection of this energy. It is important that the aerial element be of such a size that it will fully illuminate the bowl, i.e. that the polar diagram of the aerial element should have such an angle that it exactly equals the half-power points at the diameter of the bowl. This will ensure that the maximum amount of energy is passed on to the receiver by the aerial.

The advantage of this type of aerial is that the frequency of the system can be changed very easily over wide limits. The aerial at the focus may be changed without the necessity of making changes to the main structure itself. There are, of course, limiting factors to the range over which this can be usefully done. The two principal limitations govern the highest frequency that can be used effectively and the lowest frequency that provides a sufficiently narrow beam width. In the case of the highest frequency the limit is set by the accuracy of the curvature that can be maintained in the bowl itself. The profile tolerance, as it is called, must be within one-eighth of a wavelength. If we take the Jodrell Bank telescope as an example, the accuracy of the 250ft bowl must be within one inch of a true paraboloid to operate at full efficiency at a wavelength of 10 centimeters. At the other end of the spectrum the limit would be of the order of 20 metres (15 Megacycles). The resolution in these two cases differs very widely and the beam width at the low frequency end of the spectrum is about 14 degrees. That of the high frequency end is about 10 minutes of arc.

The bowl offers a particular advantage over other types of aerial in that the polar diagram is the same in whichever direction we measure it. This means that the aerial will respond to all degrees of polarisation without alteration to the main structure, and this facilitates quick changes should the need arise.

Sometimes the bowl is combined with others in a group, or sometimes with a different type of aerial. One application of the combination of bowls was made by Christiansen in Australia. He used two

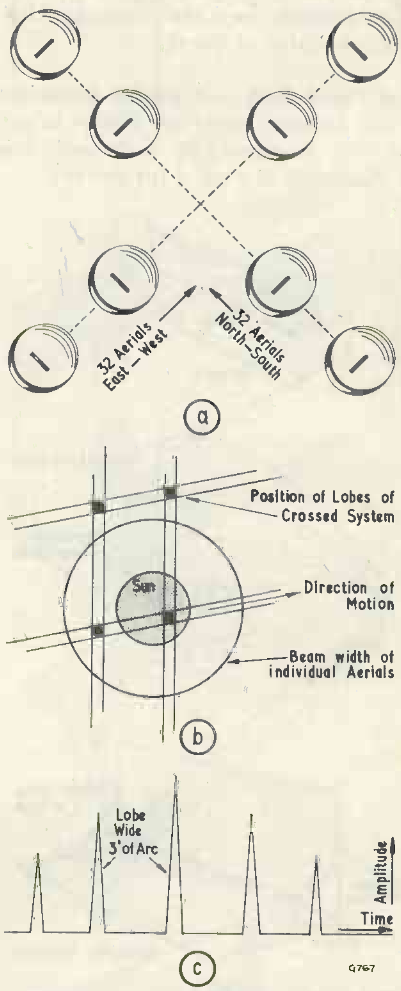
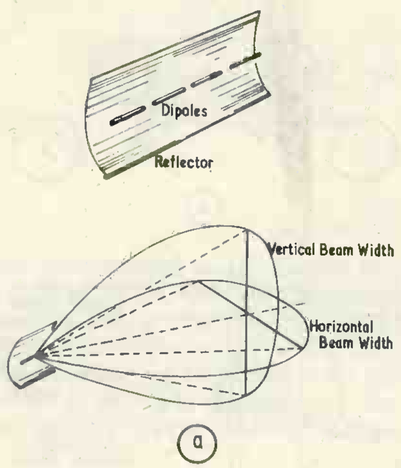


Fig. 3 (a). Sixty-four bowl type aerials arranged as a Mills Cross
(b). Lobes caused by crossing aerials make successive scans of disc of sun possible. Disc of sun is 30 minutes approx.
(c). Total beam width

groups of 32 parabolic aerials, each 19ft in diameter arranged in the form of a Mills Cross. (Figs. 3 (*a*) and (*b*).) The array was used for scanning the disc of the sun and the pencil beams provided by such an aerial were only 3 minutes of arc wide. This enabled Christiansen to determine the radio brightness across the disc of the sun, clearly indicating the conditions of radiation in the areas of sun spots. The radio heliograph as it is called, was the first of its kind to be put into operation. The bowl type of aerial lends itself to arrangements whereby it may be steered and pointed to any part of the sky. This has many advantages over the fixed type of aerial array which depends upon the rotation of the earth to scan narrow strips of the sky.

Cylindrical Paraboloids and Corner Reflectors

These two types of aerial are similar in performance and will, therefore, be dealt with together. They are illustrated in Figs. 4 (*a*) and (*b*).



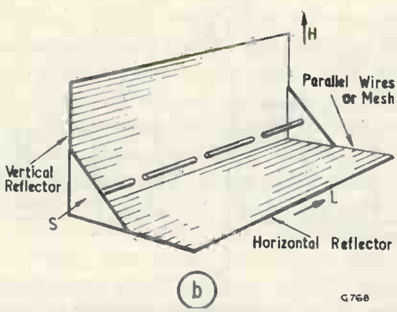


Fig. 4 (a). Cylindrical paraboloid aerial array and (below) relation of the two modes of the polar diagram of this type of aerial
(b). Corner reflector array having polar diagram similar to cylindrical parabolid array. The dipoles are arranged as a colinear array. L=2 wavelengths, H=0.7 and S=0.35 of wavelength respectively

Taking the corner reflector first, it may be said that this array represents an aerial reasonably easy to construct and economic to build. The materials for the structure may be wood or steel angle, or even steel scaffolding. The corner reflector consists of two sides which are set up at varying angles to each other. The most common type in use in radio astronomy are the angles of 60 and 90 degrees. For a number of reasons the 90 degree aerial is generally favoured both from the point of view of ease of construction and simplicity of operation. The optimum position of the aerial in the reflector is determined by the requirements of the work to be undertaken. A typical 90 degree corner reflector would be 2 wavelengths in length, 0.7 of a wavelength in height and 0.7 of a wavelength in width with the aerial placed at the focal point, which is at 0.35 wavelength from the apex.

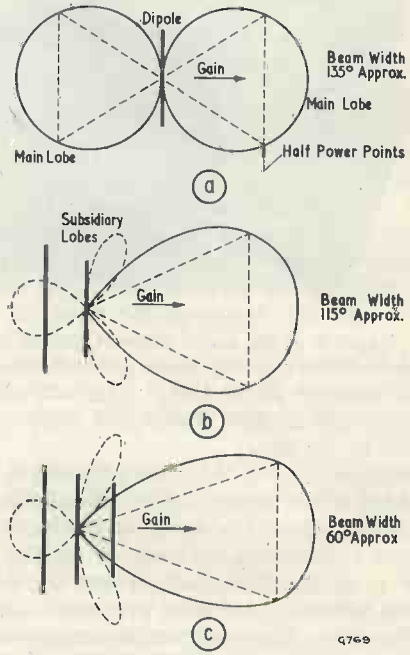


Fig. 5 (a). Polar diagram of a single dipole
(b). Polar diagram of dipole with added reflector
(c). Polar diagram of dipole with both reflector and director elements

The two sides are made to reflect the radiation collected by means either of wires stretched between the uprights parallel with the line of focus, or by the use of wire mesh such as chicken wire. Where the frequency is high and the relative size of the reflector system small chicken wire presents the simplest form of reflector. Where the array is large then the parallel wires for the reflectors or curtains are more satisfactory. Where very long corner reflectors are used which are many wavelengths in extent the aerial elements have to be correctly phased if the aerial is to work efficiently. This is the type of aerial which an amateur can construct without difficulty.

The cylindrical paraboloid is more difficult to construct since the degree of accuracy of curvature is important; the engineering is much more difficult and, generally speaking, the increase in efficiency from the amateur's point of view has no great advantage. The actual increase in efficiency over the ordinary corner reflector is some 25%. It has an advantage, however, in that it gives a better beam width in the plane at right-angles to the line of focus. At the higher frequencies this aerial is an extremely useful one, and it is this type of cylindrical paraboloid which is used by Professor Ryle at Cambridge. When they are small in size it is possible to make these aerials steerable in the same way that the bowl is steerable. Generally speaking, they are fixed in an east to west direction and made steerable in altitude.

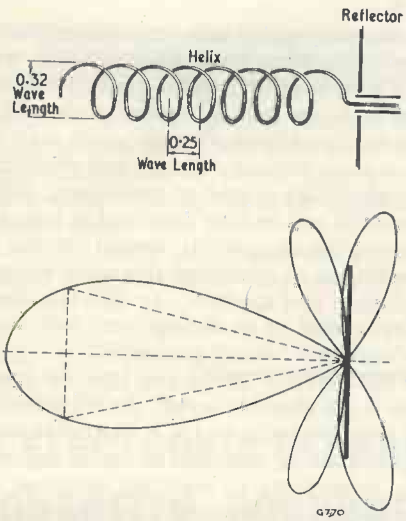


Fig. 6. (Above) Helical aerial having seven turns with a pitch angle of 12 degrees and a total length of 1.6 wavelength, and (below) polar diagram

Both the corner reflector and the cylindrical paraboloid may be used as interferometers in combination with one another or they may be crossed in the form of the Mills Cross, Fig. 3 (*a*), a type of aerial which will be described in detail in a later article.

The Multi-element Aerial with a Reflector

It must be explained that though those are often referred to as reflector aerials the manner of operation is quite different from that already described.

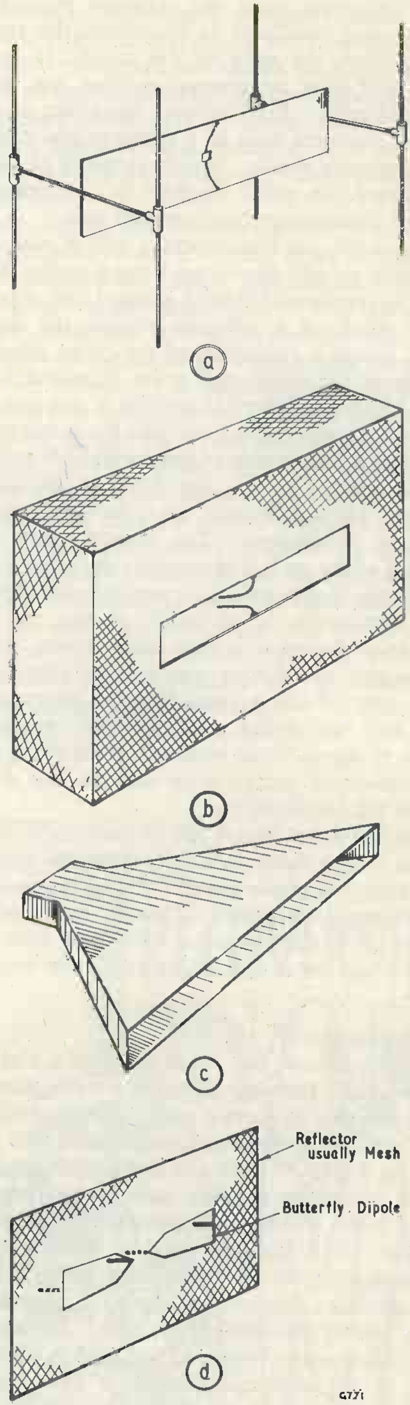


Fig. 7 (a). Skeleton slot aerial with reflector and director
(b). The boxed slot aerial. This has a very high impedance (1kΩ approx.) and is suitable for large groups

(c). Horn type aerial. This would be used at the focal point of a bowl or dish
(d). Butterfly aerial suitable for wide band measurements

In the following cases the reflector performs one function only and this is to reduce the radiation arriving from the back of the aerial. It does not collect and pass on energy as does the bowl or corner reflector. Fig. 5 shows the effect of adding parasitic elements such as a reflector and a director to the ordinary dipole. As the number of directors is increased the polar diagram is correspondingly modified, increasing direction and gain.

Referring to the illustration it will be seen that at (*a*) with a simple dipole we have a polar diagram which is evenly distributed around the dipole; at (*b*) the effect of a reflector behind the dipole is shown, giving a reduction of the polar diagram at the rear of the aerial and some increased forward gain. At (*c*) the effect of adding a director at the front of the aerial further narrows the polar diagram with an increase in gain in the forward direction.

These aerials, which are familiar to all radio engineers as yagi aerials may be used singly or combined in groups. The arrangement of the grouping of the aerials determines the polar diagram in both the horizontal and vertical directions. In radio astronomy it is usual to use horizontal polarisation except in special cases where the aerial is arranged to receive circular polarisation. A typical case of using yagis for this purpose arises when they are being used for the reception of telemetery signals from satellites, these being subject to variation of polarisation due to the Faraday effect in the ionosphere.

When the aerial arrays are of reasonable size it is possible to put them on a fully steerable mounting. The limitations of the use of the yagi type aerial are the frequency coverage. This is restricted to a comparatively narrow bandwidth and each group of aerials must be designed for a particular frequency.

The Helical Aerial

A variation of the multi-element aerial is the helical aerial. Here the elements are continuous and joined together to form a spiral. Only one mode of use is normal to radio astronomy and this is illustrated in Fig. 6. Here the dimensions are chosen to give maximum forward gain with a reasonably narrow beam width. It is characteristic of this type of aerial that it may be used to cover a band of frequencies with but little modification of the beam. If an optimum frequency is chosen then a change of two to one in frequency is possible. The aerial will accept all modes of polarisation and is particularly useful in the tracking of satellites and probes. If the frequency is high this type of aerial could also be made steerable. An example of a steerable group is that of the solar radio telescope at the Italian observatory at Arcetri. This is used for solar patrol and consists of a number of helices of various sizes fixed in front of a mesh reflector and so arranged that a wide band of frequencies is covered. At extremely high frequencies the reflector may be just a plain sheet of metal.

Other Types of Aerial

There are a number of aerials which are used for special purposes, and these are the skeleton slot, the boxed slot, the horn type of aerial which is used for very high frequencies and the butterfly type of aerial for wide bandwidths at a particular frequency. These are illustrated in Figs. 7 (*a*), (*b*), (*c*), (*d*).

The next type to be considered is the broadside array. The most commonly used is the Krooman array, this consisting of a number of dipole elements arranged in groups. Generally a group known as the "4 x 4" is the most useful, and this is illustrated in Fig. 8.

For the purposes of radio astronomy the dipoles may be mounted in front of a reflector which is either of wire mesh or parallel wires. No attempt is made to make the parasitic reflector resonant. This again is the simple type of aerial which may be built by the amateur without difficulty and which can give a reasonably high degree of resolution. Details of such an aerial will be fully described in later articles. This aerial, when used at certain of the higher frequencies, can be made steerable either equatorially or in altitude and azimuth. In fact this particular array lends itself to an arrangement very similar to Jansky's original "merry-go-round".

One final type of aerial can now be considered and this is the rhombic aerial. As its name implies, it is of rhombic form, and it is illustrated in Fig. 9. It may consist of one wire in each leg or, more usually, three wires to each leg enabling the frequency range to be extended. It is possible by this means to arrange a two to one frequency change and find special applications in the observation of solar radiation. Again, if the aerial is of reasonable size,

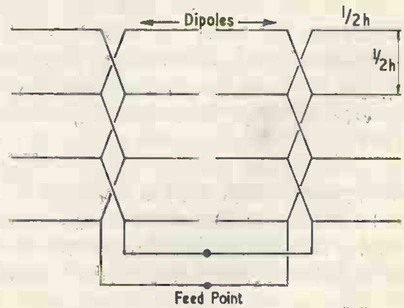


Fig. 8. The 4 x 4 Krooman array. Movement of feed point to right or left slews the beam. For radio astronomy, a reflector of mesh or parallel wires is used and this must be larger than the area of the dipole

it may be made steerable and a group of these was in fact used in Australia for solar observation. Where the lower frequencies are involved, since each leg should be at least two wavelengths long, a

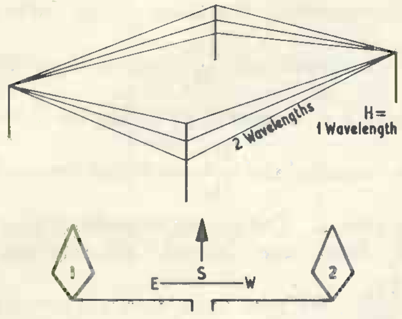


Fig. 9. Rhombic aerial array having multiple wires to secure benefit of wide frequency coverage and (below) two rhombics arranged as an interferometer

considerable amount of space is required and this often outweighs the advantages of its wide frequency coverage. Used, however, as an interferometer it does have certain uses in the lower frequency end of the spectrum.

The type of aerial to be used for a particular experiment is governed by the objects of that experiment. For simple purposes such as the observation of the sun in its daily variation, both quiet and active sun, the simple type of Krooman array is all that is required. Where higher resolution is necessary then two or more aerials may be combined together, or a special type of aerial may be designed for the particular experiment to be carried out.

In the next article we shall consider the design of an aerial based on the Krooman array for operation at two frequencies. These frequencies will be 85 Megacycles and 200 Megacycles. Those readers who intend to enter this field of experiment may already have receivers which will operate in one or other of these two ranges. A communication receiver is a very good intermediate amplifier and it will therefore be possible to use the R1155 at a low intermediate frequency, or the AT88 CR100 at a high intermediate frequency of around 30 Megacycles. To these receivers may be added adaptors applicable to the particular frequency in use. One very good solution of this problem is the standard television turret, the coils being arranged to cover one or more bands in which an enthusiast may be interested. This is in fact one method that the writer uses himself, and such a receiver will be described in detail in a later article.

(*To be continued*)

PYE ELECTRONIC EXCHANGE IN QUANTITY PRODUCTION

Pye Telecommunications Limited of Cambridge announce that the Pye 20-line electronic telephone exchange is now in quantity production. The exchange, which has no moving parts and is completely silent in operation, is the result of a four-year development programme, the last two years of which have been mainly devoted to extensive field tests under working conditions, which have proved very successful.

The exchange, which is a private internal system, has a wide potential application in shops, offices and factories. Since it is impervious to dust and vibration, it is suitable for installation in locations such as mills, works sites, etc., where conditions are unfavourable to mechanical exchanges

The exchange is provided with the new British G.P.O. type instruments in colours and a novel feature, known as "Quick Dial"—each telephone dial is adjusted for double-speed, giving a very pleasing fast connection.

The exchanges are available on seven-year rental terms in addition to the more usual 14-year contracts.

Service is ensured through 30 Pye Telecommunications service stations through England, Scotland, Northern Ireland and Wales equipped with radio-controlled service vans.

Interpretation of Transistor Data

Part 2

By **V. T. ROLFE***

Characteristics

THERE ARE A NUMBER OF WAYS IN WHICH THE characteristics of a transistor may be specified, and each of the accepted methods has its own particular advantages and limitations. Before considering the various systems, it is proposed to introduce some typical curves for grounded base and grounded emitter connections. The various systems can then be examined in conjunction with these curves and fully understood.

Grounded Base

The circuit is shown in Fig. 10. There are four parameters which can be varied—the collector voltage V_c, the collector current I_c, the emitter voltage V_e and the emitter current I_e.

If V_c is kept constant and V_e varied, I_e and I_c will also vary. From a series of readings taken, curves can be plotted of I_e/V_e, I_c/I_e and I_c/V_e.

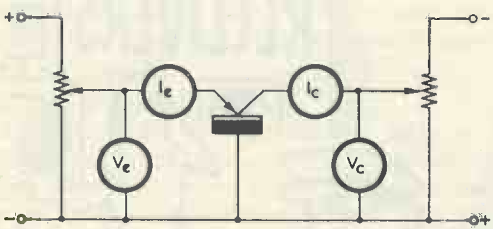


Fig.10 M178

The first of these, I_e/V_e (Fig. 11 (*a*)) refers only to the input circuit, and therefore, may be termed the Input Characteristic. The second (Fig. 11 (*b*)) gives the relation between input and output current and is known as the Transfer Characteristic. The third is a combination of these two characteristics, and is also a transfer characteristic, but can be disregarded.

If readings are now taken of I_c/V_c with fixed input conditions the Output Characteristic (Fig. 11 (*c*)) is obtained. Furthermore, the output characteristic can be measured for various values of input current.

Each of these three curves tells us something about the transistor. If we take an operating point, such that $V_c=-4.5V$, $I_c=2mA$, we can find from the input characteristic, the slope of the curve at this point. The reciprocal $\frac{\delta V_e}{\delta I_e}$ will give us the input impedance r_{in}. Similarly, by taking the slope of the transfer characteristic $\frac{\delta I_c}{\delta I_e}$ we obtain the small signal current gain, α. The output impedance r_{out} can be derived from the output characteristic since $r_{out}=\frac{\delta V_c}{\delta I_c}$. We now have three parameters which apply to the transistor at the operating point

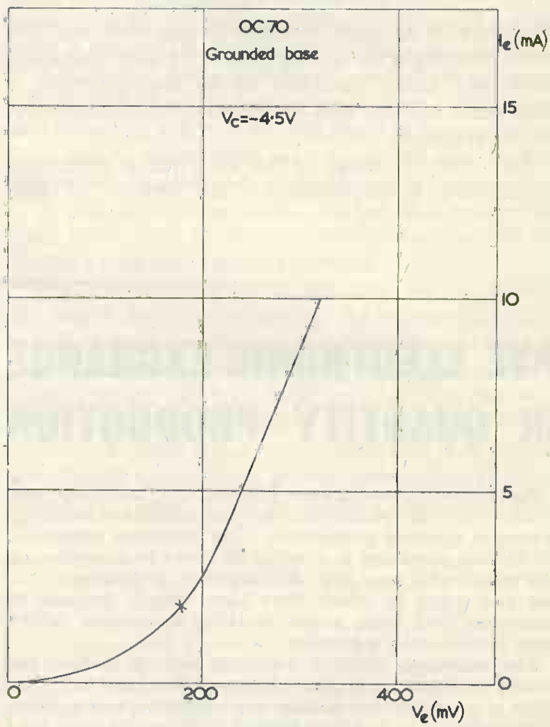


Fig.11a M179

chosen. These are measured under "static" conditions, without any load in the collector circuit, and assuming that the source impedance of the emitter circuit is zero.

With transistors, the input impedance is affected by the collector load, and the output impedance is affected by the source impedance in the input circuit. It is therefore necessary to consider the

* Mullard Ltd.

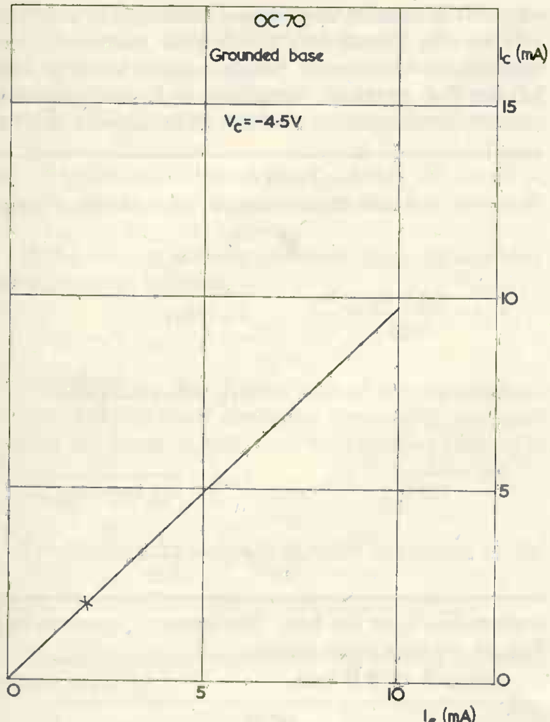


Fig. 11b

M180

effect on the input impedance of including a load in the output, and the effect on the output circuit of an impedance in the input circuit. This gives us a total of five parameters for the grounded base circuit:

- α —current gain.
- r_{in} —input impedance (with output short circuited to a.c.).
- *r_{11} —input impedance (with output open circuited to a.c.).
- r_{out}—output impedance (with input short circuited to a.c.).
- *r_{22} —output impedance (with input open circuited to a.c.).

These five parameters are used by Mullard and have been termed the Mullard parameters. They have the advantage of giving the designer an indication of the order of magnitude of input and output impedance likely to be encountered. For example the values r_{in} and r_{11} represent the values of input impedance with no load and with an infinite load respectively. In practice, with a finite load, the input impedance will lie somewhere between these two extreme values.

* In practice these measurements may be carried out by using a large inductance as load and source respectively. This has a high impedance at the frequency of measurement (usually 1 kc/s). The subscript numbers used are similar to those in the "h" and "y" parameters used later. A "1" is used to denote the input circuit and a "2" to denote the output circuit.

Grounded Emitter

Five similar parmeters can be written down for the grounded emitter configurations, α' (or β), r'_{11}, r'_{in}, r'_{out}, and r'_{22}. Another five parameters can be written down for the grounded collector configuration α'', r''_{in}, r''_{11}, r''_{out}, r''_{22}. The grounded emitter curves are shown in Fig. 12.

TABLE 1
Mullard Parameters

Grounded base	*Grounded emitter*	*Grounded collector*
α	$\alpha' = \frac{\alpha}{(1-\alpha)}$	$\alpha'' = \alpha' + 1$
r_{in}	$r'_{in} = \frac{r_{in}}{1-\alpha}$	$r''_{in} = r'_{in}$
r_{11}	$r'_{11} = r_{11}$	$r''_{11} = \frac{r'_{out}}{\alpha' + 1}$
r_{out}	$r'_{out} = r_{out}$	$r''_{out} = r_{22}$
r_{22}	$r'_{22} = \frac{r_{22}}{1 + \alpha'}$	$r''_{22} = r'_{22}$

The relation between these parameters is shown in Table 1.

This represents one approach to the problem. An alternative approach is to develop an equivalent circuit. Two such circuits are shown in Fig. 13.

In both these circuits there are assumed to be resistances (r_e, r_b, and r_c) associated with each of the external connections. The first circuit also includes an equivalent voltage generator with an output voltage of i_e, r_m, whereas the second circuit includes an equivalent current generator with an

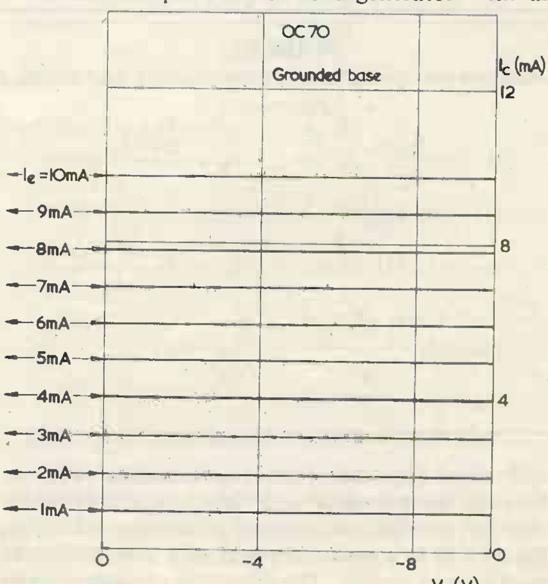


Fig. 11c

M181

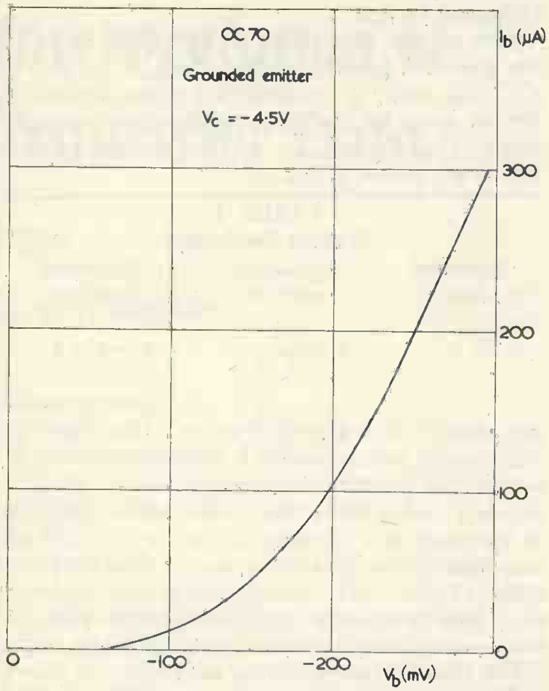


Fig.12a M182

output current of αi_e. These circuits can be used for either grounded base, grounded emitter or grounded collector configuration. Although these basic circuits look simple, the formulae which result when they are used in conjunction with circuit elements become quite involved. The relation between these parameters and the Mullard parameters is given in Table 2.

TABLE 2

Relation between T-network parameters and Mullard parameters

$\alpha = \dfrac{r_m}{r_c}$	$r_b = \dfrac{r_{11} - r_{in}}{\alpha} = r_{11}$
$r_{11} = r_e + r_b$	$r_c = r_{22}$
$r_{in} = r_e + (1-\alpha) r_b$	$r_e = \dfrac{r_{in} - (1-\alpha) r_{11}}{\alpha}$
$r_{out} = r_c \dfrac{(1-\alpha r_b)}{r_e + r_b}$	$r_m = \alpha r_{22}$
$r_{22} = r_c$	

A third approach is the mathematical one—to consider the transistor as a "black box". This idea will be familiar to readers conversant with line theory. It is a useful method and can in fact be used for any circuit. The transistor (or other circuit element) is considered as being shrouded in mystery—hence the "black box", with four terminals, two input and two output. Various signal voltages can be applied to these terminals and the resultant currents measured. A number of equations can be written down for the box. For instance, considering Fig. 14 we may write down:

$$i_{out} = A\ i_{in} + B\ v_{out}$$

TABLE 3

Relation between h-parameters and Mullard parameters

$h_{11} = r_{in}$	$\alpha = h_{21}$
$h_{12} = \dfrac{r_{11} - r_{in}}{\alpha r_{22}} \simeq \dfrac{r_{11}}{r_{22}}$	$r_{in} = h_{11}$
$h_{21} = \alpha$	$r_{11} = h_{11} + \dfrac{h_{12} . h_{21}}{h_{22}}$
$h_{22} = \dfrac{1}{r_{22}}$	$r_{out} = \dfrac{h_{11}}{h_{11} . h_{22} + h_{12} . h_{21}}$
	$r_{22} = \dfrac{1}{h_{22}}$

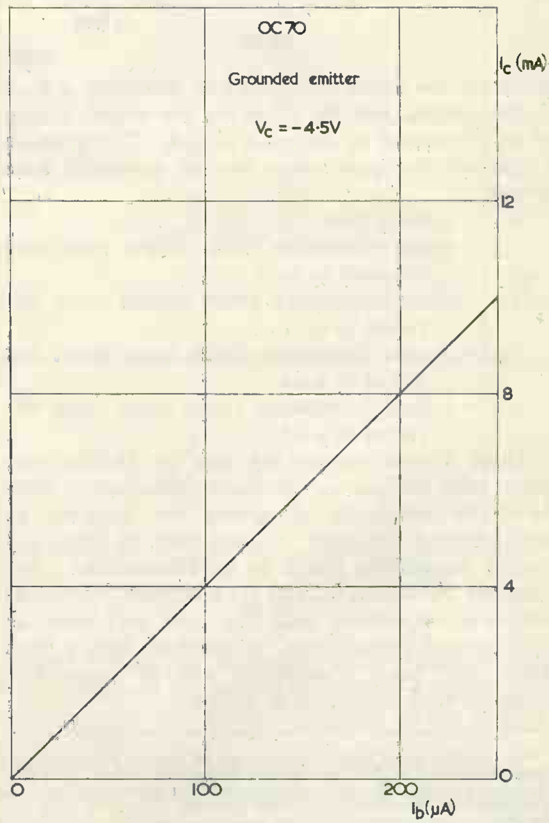


Fig.12b M183

This is the mathematical way of saying that the output current depends upon the input current and the output voltage. If for any reason the output current does not depend upon the input current, the equation is still valid; it simply means that A=O.

We can write down a number of these equations all of which will be true with suitable values of A and B. We can for instance write down:

$$v_{in}=C\,v_{out}+D\,i_{in}$$

If the output is short-circuited, $v_{out}=0$, and our first equation becomes:

$$i_{out}=A\,i_{in},\ \therefore\ A=\frac{i_{out}}{i_{in}}$$

A is therefore, the current gain of the transistor, α.

If instead of short circuiting the output, we open circuit the input, $i_{in}=0$, and the equation becomes:

$$i_{out}=B\,v_{out}\ \therefore\ B=\frac{i_{out}}{v_{out}}$$

From which we see that B is the reciprocal of the output impedance—the output conductance, $\frac{1}{r_{out}}$

Similar treatment applied to the second equation shows that

$$C=\frac{v_{in}}{v_{out}},\text{ the voltage feedback factor}$$

and

$$D=\frac{v_{in}}{i_{in}},\text{ the input impedance, } r_{in}.$$

These four parameters, one impedance, one admittance, and two ratios, are termed the *Hybrid parameters*. The mathematician uses the small letter h to denote this, and a small subscript 1 is used to denote the input circuit, a 2 being used for the output circuit. The four parameters are:

h_{11}—the input impedance (with output short-circuited to a.c.). (D).

h_{12}—the current gain (with output short-circuited to a.c.). (A.)

h_{21}—the voltage feedback factor (with input open-circuited to a.c.). (C.)

h_{22}—the output admittance (with input open-circuited to a.c.). (B.)

The relation of the "h" parameters to the Mullard parameters is shown in Table 3 and the relation between "h" parameters and the equivalent T-circuit is shown in Table 4.

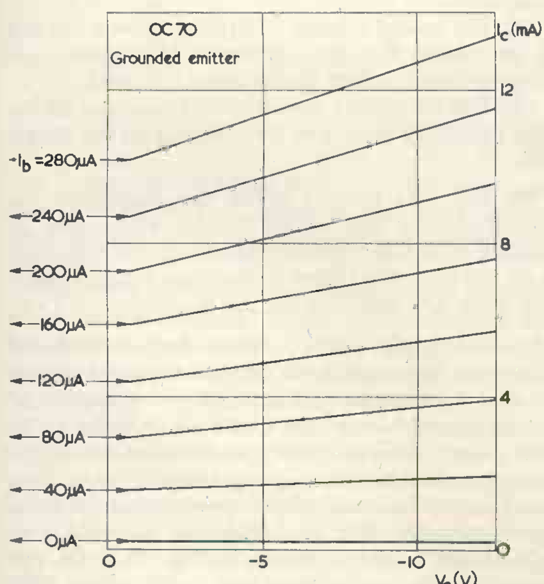


Fig.12c M184

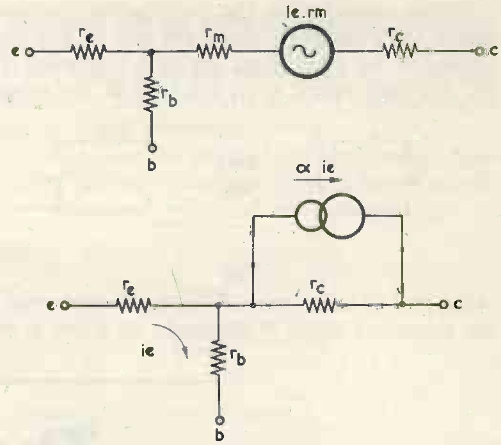


Fig.13 M185

TABLE 4

Relation between h-parameters and T-parameters

$h_{11}=r_e+(1-\alpha)r_b$	$r_b=\frac{h_{12}}{h_{22}}$
$h_{12}=\frac{r_b}{r_c}$	$r_c=\frac{1}{h_{22}}$
$h_{21}=\alpha$	$r_e=h_{11}-(1+h_{21})\frac{h_{12}}{h_{22}}$
$h_{22}=\frac{1}{r_c}$	$r_m=\frac{h_{21}}{h_{22}}$

All the above three systems can only be applied at low frequencies when the effects of capacities and phase changes within the transistor can be ignored. Manufacturers' data is usually measured at 1 kc for this purpose.

Before considering the parameters required to define r.f. transistors, there are one or two further points to be considered on low frequency types. All the parameters given are true at the operating

Fig.14

point but, as in the case of valves, they change when the operating point is changed. In Class B output stages the operating point changes widely with change of input signal, and it is of interest to see how α' changes with I'_c. (A graph showing this variation is given in Fig. 9, October issue).

When two transistors are used in Class B push-pull they must be matched so that they have similar values of α' both at high and low currents. In the case of the Mullard OC72 matching is carried out at 10mA and 80mA, and at both these points the ratio between the current gain of one transistor and the other must be $< 1.4 : 1$. Output transistors are also matched for similarity of input characteristics.

(To be continued)

The JR1/JTL Stereo Tape Recorder Unit

PART 3. By G. BLUNDELL

The JR1/JTL Stereo Tape Recording Unit offers stereophonic record and playback facilities, together with instantaneous tape monitoring. It is employed with a stereo amplifier. The unit can also allow all tape tracks to be recorded and played back in conjunction with a monaural amplifier or amplifiers, the instantaneous monitoring facilities still being retained for this application

THE OPERATION OF THE JTL WILL NOW BE explained in terms of the controls as shown in Fig. 21.

(1) Function switch, having three positions—mains on-off/playback/record. In the first two positions the outputs of the recording amplifier are short-circuited to chassis so that voltage surges in the h.t. line due to switching on and off cannot magnetise the heads. The connections to this switch may be interlocked with the deck switches to help to prevent accidental erasure of tape recordings.

(2) The record amplifier switch has three positions—stereo/upper/lower—and controls which track is being recorded.

(3) The playback amplifier switch has two positions, one being "stereo and upper track", and the other "lower track". In conjunction with this switch the main amplifier control must be switched either to stereo or mono.

Separating the record and playback controls makes it possible to record one track while listening to the other, or to transfer music from one track to another at the same time, mixing in further recordings if required.

(4) The monitor switch may be set to allow either the original programme or the recording to be heard.

(5) Playback volume. This is adjusted in conjunction with the monitor switch so that the original and recording are at the same volume to facilitate comparison of the two.

(6) The record volume control is set with the aid of the Magic Eye level indicator to prevent programme peaks, which would cause overload.

(7) The signal/bias switch allows the level of the high frequency biasing to be observed on the Magic Eye.

(8) The bias control varies the output of the oscillator, and may be set by the Magic Eye or checked with the monitor switch. If the bias level is set too high, the higher frequencies will be erased, and if set too low they will be boosted.

(9) Tape speed control. While many decks make provisions for a switch on the speed control, it was felt that the extra complication of the wiring would not be justified since this control is unlikely to be used often. Therefore, the speed change correction control was incorporated in the unit. Any two speed corrections may be incorporated but the most useful two are 3¾in and 7½in per second. The appropriate circuit is shown in Fig. 20. 15in per second could be useful to the purist, while 1⅞in might be useful for recording voice when long

periods have to be monitored.

(10) Balance control. This operates only on the playback amplifier and is intended for adjusting minor variations in the circuit. Only the professional user would be able to balance the recording channels correctly and this would be incorporated in an associated mixer unit.

They are quite efficient for t.v. purposes, of course, but do not give good hum screening. Therefore, a type of t.v. cable with a tightly woven mesh must be chosen. A flexible centre wire is also necessary in order to avoid breakage.

Care must also be taken with the record head leads; although this head can have a lower inductance of, say, 100 millihenries, thereby reducing the problems.

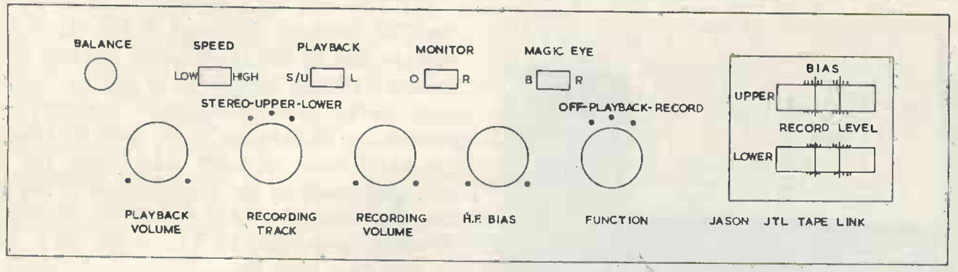


Fig. 21. Front panel controls

Lead Capacitances

Although it obviously is attractive mechanically to build the tape electronics on to a chassis attached to the deck, there are many snags. Firstly, the design would be tied to a particular deck; secondly, electrostatic hum problems due to the presence of mains leads would necessitate very thorough screening; and, thirdly, the magnetic field problems would be worsened by the presence of the mains transformer.

Normal screened wires cannot be used because their capacitance is too high. Three feet of such a cable would have a capacitance of 220pF.

Hum Problems

Hum is a problem for the amateur constructor because it can often be caused in so many ways that it is difficult to diagnose precisely the cause of the trouble. The only solution is to examine each likely cause in turn and reduce it as much as possible.

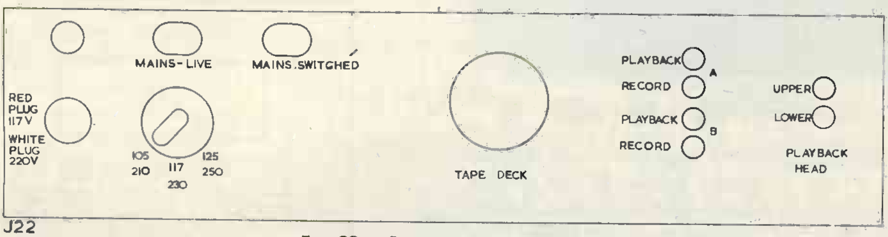


Fig. 22. Rear panel connections

It is therefore a better idea to fit the electronics into a separate box, even if this does involve screened leads with the attendant stray capacitance problems.

There are some playback heads now available which have an output voltage of 10 millivolts, but they have an inductance of one Henry and may be very easily resonated by excess capacitance. It would be necessary to use very low capacitance coaxial cable with a capacitance of 5pF per foot and then use no more than 3 or 4 feet with such heads. The more normal heads have an inductance of about 0.5 Henry and, with these standard t.v. coaxial cable having a capacitance of under 20pF per foot may be used. Some of the cheaper types of t.v. cable have a very open mesh on the wire braiding and these are not suitable for the present application.

(1) An obvious major cause is heater hum entering the grid circuit through valve inter-electrode capacitances. In the early stages this can only be safely eliminated by using d.c. heating on the valve.

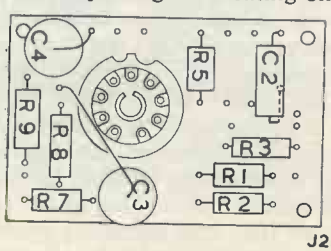


Fig. 23. Preamplifier printed circuit

(2) Mains transformer fields. We obviously do not want our mains transformer on a separate chassis, and so it is necessary to study how hum from this source can enter a circuit. One of the older methods of preventing hum was to use an earthed bus-bar and although this usually helped, there could still be trouble if used unintelligently.

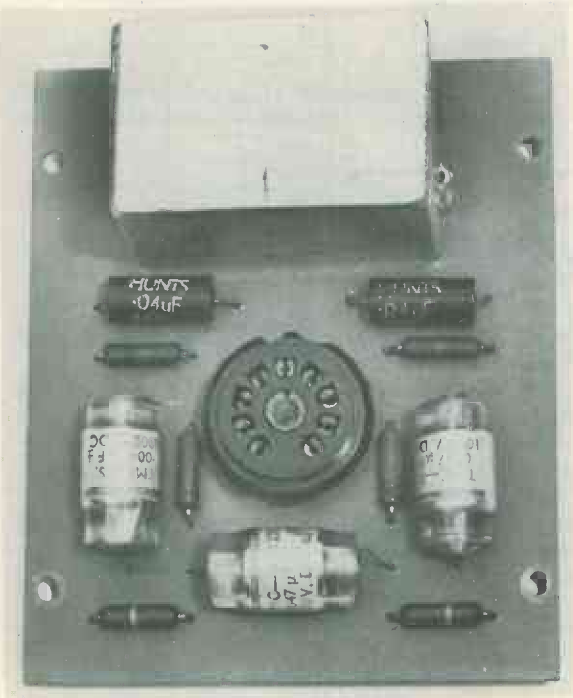


Fig. 24. View of the oscillator printed circuit

It is necessary to prevent any particular circuit from forming a loop around a section of the chassis and thus allowing a magnetic field to induce a hum into the loop. This can happen at points other than earth returns, so that an earthed bus-bar is not an infallible cure.

This particular problem has been especially studied in the layout of the JTL unit and therefore the point-to-point wiring diagram should be carefully followed.

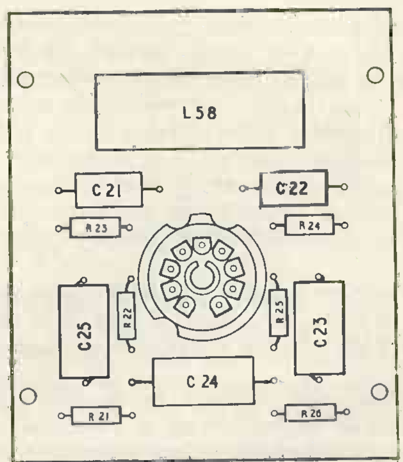
An obvious method of reducing these troubles is to run the mains transformer at low flux density. The MT58 in this design is in fact running at 54,000 lines per square inch.

(3) Another circuit point where hum can be introduced is in the reservoir capacitor circuit. It is good practice to position the first smoothing capacitor as close to the rectifier as possible and connect the transformer tapping to the same point on the chassis. The loop consisting of the rectifier, mains transformer and reservoir capacitor carries large peak currents, and if these are allowed to circulate to the more sensitive stages, hum will be injected into those stages. This is the reason why the earth return of the heaters of V_1 and V_2 from pin number 5 must be taken back to a point near the rectifier. If it is connected to the printed circuit, the residual hum will be injected into the input circuit and cause trouble.

(4) The tape deck metalwork must be bonded to the JTL chassis, otherwise it will carry a high a.c. voltage due to the capacitance existing between the motor windings connected to the a.c. mains and the metalwork. The connection between tape deck metalwork and chassis must never be effected by the playback head screened lead, since the small a.c. current caused by the capacitances in the motor will cause a voltage to be injected into the input circuit. A vitally important feature of the deck connections is, therefore, that the screened leads to the playback head must not be connected to the metalwork of the tape deck.

The deck may, however, be safely earthed using the screened cables to the recording and erase heads since these do not carry audio signals. The audio signal travels along one screened lead and back along another, but is not present in the screening.

(5) Hum may result from magnetic fields entering the heads directly. The windings of the playback head are balanced to reduce this likelihood and the head is screened; but obviously there still has to be an opening for the tape and a gap so that the signal



J25

Fig. 25. The oscillator printed circuit

can be reproduced. The head is necessarily mounted near the motors and therefore this is likely to be the point where most trouble occurs. Some head manufacturers supply wings of mu-metal which are attached to the arms carrying the pressure pads so that the head is almost completely enclosed when the tape is playing. Others set the head rather deeply back into the mu-metal can to achieve the same effect.

(6) Other equipment mounted near the tape deck may have transformers with high external fields. In this case, if the equipment cannot be moved it may be necessary to rotate the mains transformer to give minimum hum pick-up. Obviously if a fresh layout is being planned these points can be watched. If, for example, a tuner having its mains transformer on the left of its chassis is mounted close to the deck, then the tuner should be positioned to the left of the deck to increase the distance between the mains transformer and playback head.

Interlocking

Some decks are fitted with switches which help to prevent accidental erasure of a wanted recording. To make a recording it is then necessary to switch both the JTL function switch and the deck switch before a recording can be made. This extra safety factor can only be added when the deck is suitably equipped. For example, the Wright and Weaire deck has a separate position for record and playback and therefore its switch can be linked to the JTL. It is essential, though, that both the h.t. switch and the head short-circuiting switch marked SH in Fig. 20 be used. If the h.t. interlock only is used, two dangers may result: the resulting surge on the h.t. line may magnetise the heads; and there is the fact that, although the bias has been removed the recording signal has not, and a distorted signal will be recorded on the tape. The interlocking can only be used therefore when there are three separate switch functions available ganged to the deck control—two of these being used for short-circuiting the heads, and the third for switching h.t.

The Collaro deck, as normally supplied, has only one switch available, and therefore h.t. interlocking cannot be used and plug pins 8–9–10–11 should be connected together as shown in Fig. 20.

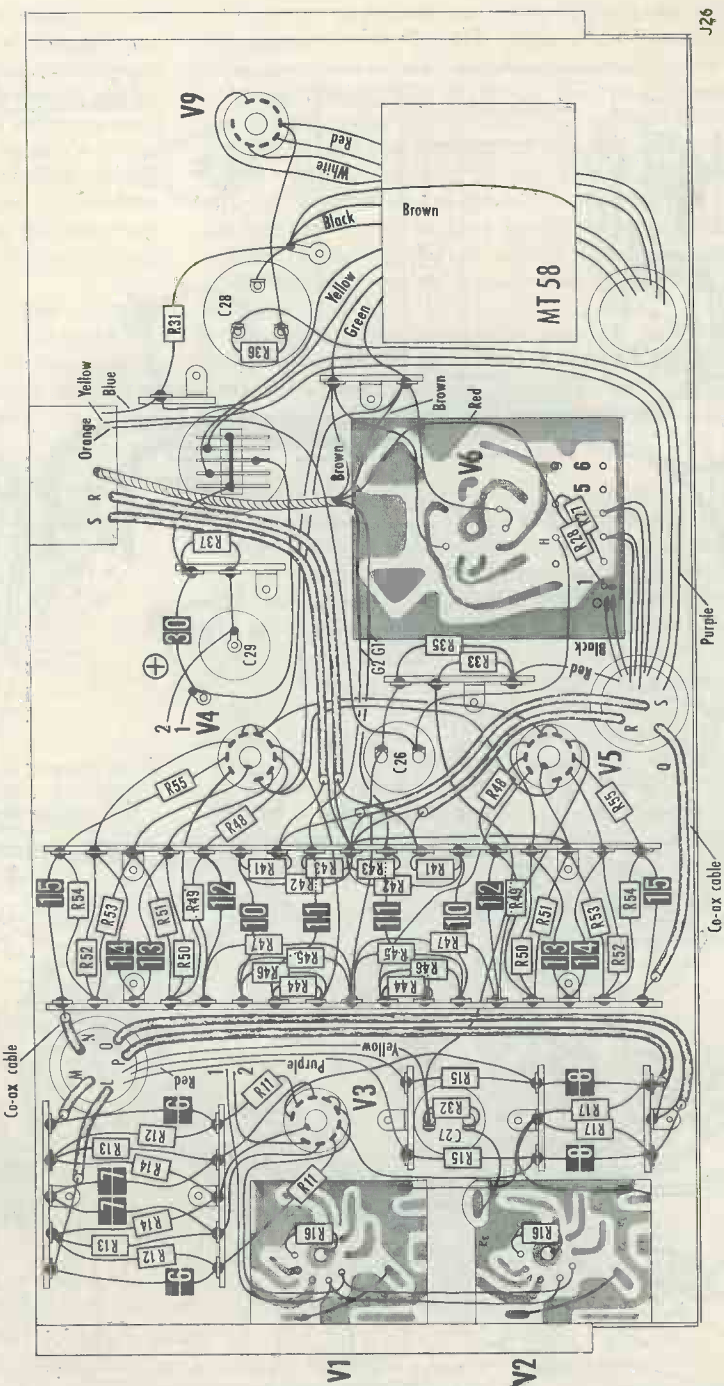


Fig. 26. Point-to-point diagram (under-chassis)

The Wright and Weaire deck also requires current to hold a solenoid and this may be connected to pins 8 and 9.

Constructional Notes

The layout of the chassis should be followed

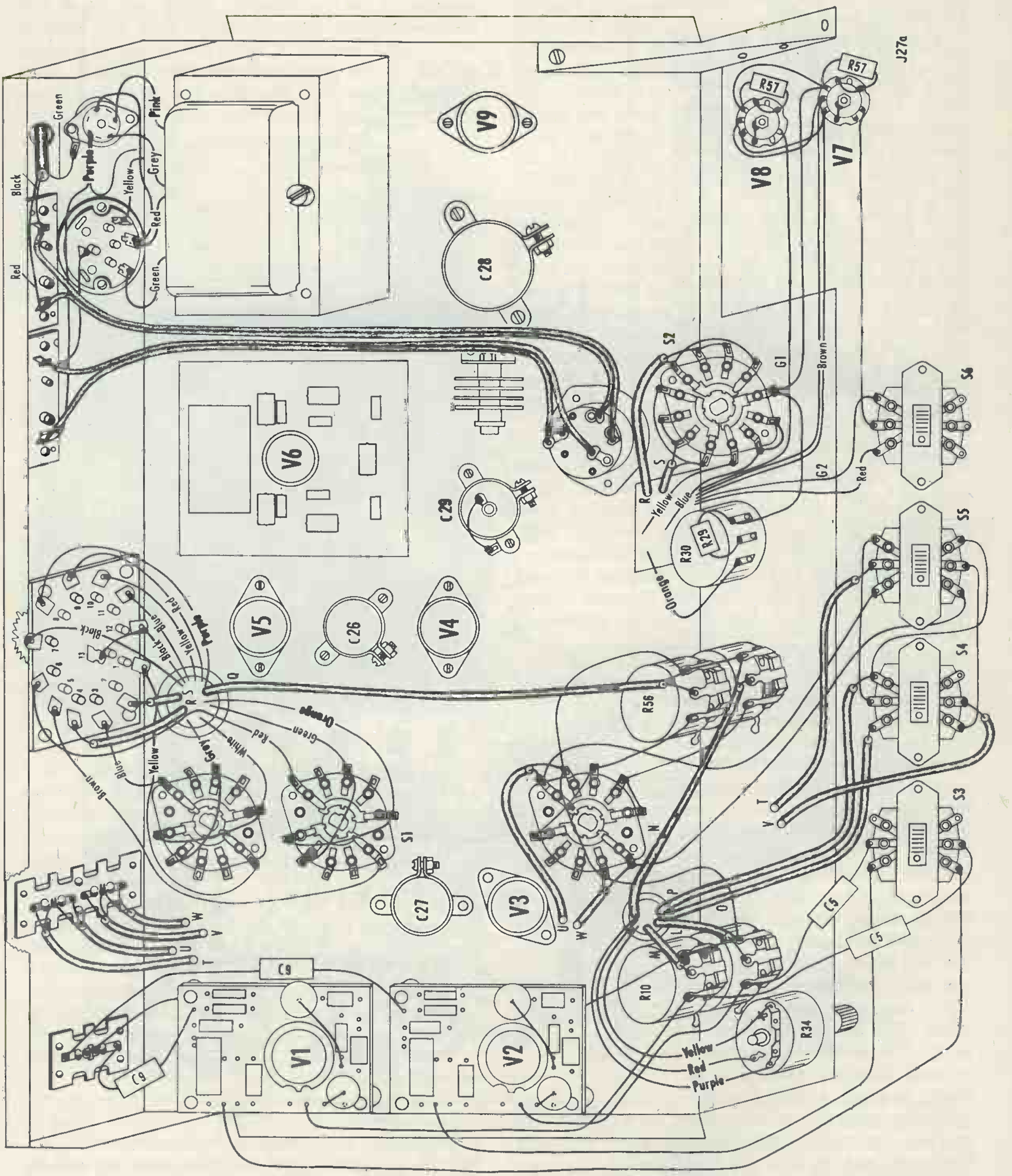


Fig. 27 (a). Point-to-point diagram (above-chassis). Note that the switch wafers are drawn as seen from the rear of the chassis. The four switches S_3–S_6 are mounted on $\frac{5}{16}$in spacers. The input sockets at the rear have insulating pieces at the front to prevent the earth tags from touching the chassis closely, even though it might be thought that improvements could be effected. For instance, the tag panel could be wired more tidily but the foremost point in the design was that h.t. tags should not be positioned next to grid tags or tags carrying head components. Any tagstrip will leak, especially under humid conditions, and the effects of such leakage can be obviated by reasonable layout. Therefore, tags carrying h.t. and the anode load resistors have been mounted on one tagstrip adjacent to each other.

The same considerations apply to the wiring of the function switch wafer S_2. Although both h.t. and head connections are made to the same wafer, there is no possibility of leakage because there is an earthed tag to act as a guard between.

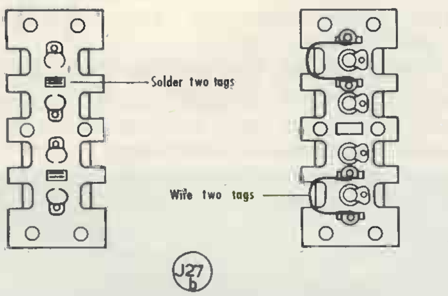


Fig. 27 (b). Two types of 4-way sockets showing the different arrangement of the earthing tags. The same variation may be found in the twin socket

Wire the wafers of switch S_1 leaving the joints unsoldered except for the cases where no further wires are to be added. Wire the wafer of switch S_2.

Mount the printed circuit on the chassis, noting the spacers under the preamplifier printed circuit; and fit all the components to the rear connection panel. Mount all controls, valveholders, tagstrips and components except the mains transformer. Fit the tagstrip wiring, making good mechanical joints, but not soldering, before adding the components. Then add the mains transformer and finish the wiring.

Next, the deck connections must be wired, care being taken when soldering the coaxial cable that heat does not melt the insulation and cause a short-circuit. The wiring of particular decks will be dealt with later.

Testing

Carefully check the wiring and examine for short-circuits. Remove the rectifier valve V_9 and switch on to the playback position. Note immediately whether valves V_1, V_2, V_3 are alight. Their heaters are quite dim and may not be seen in a bright light. If a meter is available, check that there is 19 volts at pin 9 of V_3. This check shows that the d.c. rectifier system is working. Switch the monitor switch to "Original". If a radio is connected to the amplifier this should now be heard. Switch the monitor to the recording position and plug in the rectifier. Some noise should now be heard from the front end in the form of a faint hiss and a slight

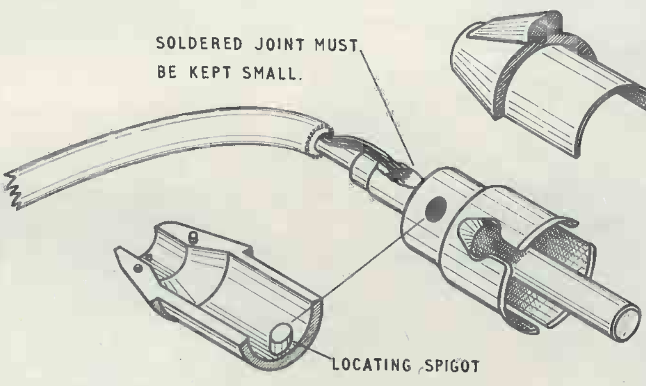
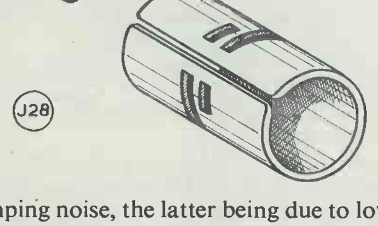



Fig. 28. Assembly of the audio plug

The usual admonitions apply: Do not use any flux other than that contained in good quality cored solder. Make sure the soldering iron is hot enough to allow the solder to flow freely. Build neatly because it will facilitate checking.

First fit the components to the two printed circuits following the layout of the components as shown in Fig. 23. Next, assemble and solder the oscillator printed circuit as shown in Fig. 25 and in the photograph, Fig. 24.

thumping noise, the latter being due to low frequency noise generated by the first valve cathodes.

If a test tape is available the playback amplifier response may be tested. If only a blank tape is available, it should be possible to hear an increase in the background noise when the tape is passing the head. This effect is most noticeable when there is plastic leader at the beginning of the reel. As the leader finishes and the tape begins the noise should rise, showing that tape noise is above circuit noise. Check that the controls are in the following positions: (1) Balance control approximately central; (2) Speed to "High"; (3) Playback switch to "Upper"; (4) Monitor switch to "Recording"; (5) Set Signal/Bias switch to read bias setting; (6) Playback volume, half-way; (7) Recording switch to "Upper"; (8) Recording volume half way; (9) Bias half rotation.

Next set the function switch to "Record". The Magic Eyes should now light up; the top one being partly closed. Adjustment of the Bias control should vary this indication, whereupon the bias oscillator is shown to be working. Set the signal/bias switch to read signal level, and the Eye should now vary with the programme input. Switch on the deck and a recording should now be made and heard. Adjust the recording volume so that the peaks in the Magic Eye display are at least ⅜in apart. Operate the monitor switch and vary the playback volume until no difference in level is heard. Adjust the bias so that frequency response is as close as possible to the original.

When everything is set correctly it should be difficult or impossible to tell the difference between the original and the recording—either in the frequency response, distortion, or background hiss.

These tests will make it obvious that all radio programmes are not to the same high standard. Before becoming too despondent about results, wait for a good live broadcast to really show off the results of which the circuit is capable.

Fig. 29. Preparation of the ends of the screened wire. The first example shows the end of the braiding covered with the outer insulation, the earth connection not being required

H.F. Bias Tappings

The optimum bias tappings vary for each make of head. As shown in Fig. 20 the settings suited a number of the popular makes of heads but methods of optimum setting will be given later.

Faults

From the various descriptions given some of the possible faults will be obvious.

(1) High surface noise: Playback or recording head magnetised. Head defluxer required.

(2) Thumping noises when switched to record but with record volume turned down. This is caused by the recording head being magnetised.

(3) Imperfect erasure of the previous recording. The obvious cause here is lack of oscillator voltage. However, it is not easy to completely erase a tape, particularly quarter track, when misalignment of the heads may be a contributory cause. Even if the erase head is only 5-thousandths of an inch up or down compared with the other heads, there is still likely to be a thin fringe of the tape which cannot be completely erased. The answer to these problems is the bulk eraser, which operates from the a.c. mains. It subjects the tape to saturating magnetic fields which completely remove any residual magnetism.

This particular problem has been more acute recently with the introduction of high coercivity tapes. Single gap erase heads appear to be able to reduce the remanant magnetism by about 50/55dB, any increase in the erase power merely saturating the pole tips and heating the head. However, a second pass of the tape across the erase head will remove this residual amount; and the answer may be that the tape manages to recover slightly after the first erasure. To combat this problem many German erase heads now have double gaps, and these give an erasure of 65dB, which is more than adequate.

The head itself may, therefore, be responsible for the imperfect erasure if the trouble is only slight.

(4) Distortion coupled with accentuated treble—too little bias.

(5) Hum. See the section above on hum, particularly in relation to the earthing of the head leads. Obviously the first test is to disconnect the head plugs. If the hum still persists, the fault would then be in the JTL unit.

(6) No recording, although the Magic Eye is operating. This may be due to a head lead broken or plug contact faulty. Do not check continuity of the heads with a meter unless a head defluxer is available. The heads will be immediately magnetised by the application of an ohmmeter.

(7) Same fault as 6. Switch wiring wrong so that when the signal is connected to one amplifier, the bias is connected to the opposite head. Check all head leads carefully.

(8) Playing back, a distorted version of another signal can be heard. The distorted signal may be from a tuner connected to the amplifier, this being recorded because the function switch is not shorting the output of the recording amplifier.

To be continued.

RADIO *topics*

By RECORDER

THE PHOTOGRAPH REPRODUCED herewith shows two remotely controlled television cameras which are now in full operational use in the B.B.C. News Studio at Alexandra Palace. These cameras are operated from a remote control desk and are capable of providing all the adjustments required during a news programme.

The News Cameraman

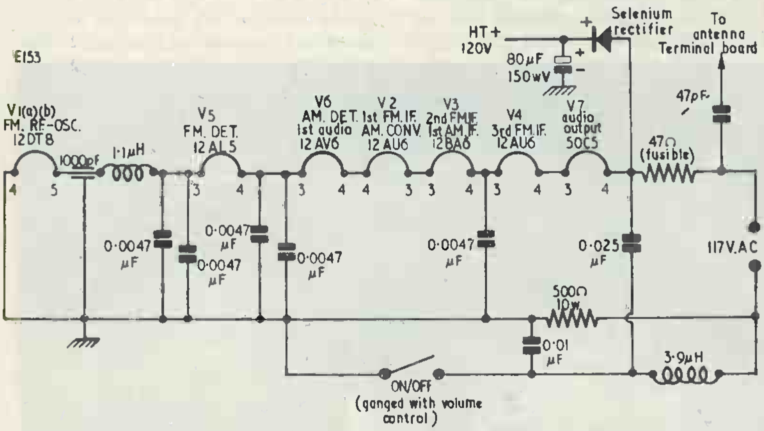
The story behind the introduction of the B.B.C.'s robot cameras highlights some of the problems which occur in broadcasting and which are

(Copyright B.B.C.)

B.B.C. robot cameras in action. These two cameras are remotely operated from the vision control room not generally appreciated by the public. Without remote control, the job of the cameraman on news duty tends to be somewhat dull. Most of his time is spent in watching the newsreader and the best he can hope for to break the monotony of his job is an occasional lens change or the introduction of a caption or map. News broadcasts may appear brisk and varied to the viewer but most of the inserts which give the programme life come from separate telecine machines, and these are outside the province of the cameraman. For this reason, the B.B.C. has given a lot of thought to the use of remotely controlled cameras which can be operated directly from the vision control room and which may, therefore, release cameramen from this rather dull work. The installation shown here provides the answer which has been worked out by the B.B.C.

The overall Alexandra Palace installation comprises five remotely controlled vidicon cameras, four of which may be operated remotely from a specially designed desk. The fifth camera is a spare. All four operational cameras may be controlled by one person, although programme complexities at Alexandra Palace make it necessary for two to perform this task. The camera outputs are displayed on monitors in front of the control desk, whilst vision mixing and cutting between cameras is carried out with the same production equipment as would be used with manually operated cameras.

The remote control facilities available are zoom, focus, iris, pan and tilt. Six pre-set shots for each camera may be set up during rehearsal, these being selected as required when the programme is being transmitted. Thus, one camera may be switched out, set to the next shot whilst off the air, and then cut in as required. A seventh position on the selector control for each camera couples it to a control box by means of which each of the camera adjustments may be controlled manually from the remote point. This box is designed so that only one hand is needed to operate the camera, all functions except iris being combined into a single horizontally mounted control lever. Pushing this lever forward or backward controls the zoom, turning it right or left pans the camera, and rocking the lever causes the camera to tilt up or down. A small knurled ring at one end of the lever controls focus, and a separate knob looks after the iris setting. This method of control is adequate for such items as a speaker moving in front of and pointing to a map in the studio.



Continual Heater Supply

A domestic receiver in which the valve heaters are never switched off is quite definitely a news-worthy item. Such a receiver has been recently introduced in U.S.A. by Westinghouse Electric Corporation, to whom we are grateful for the information which follows.

The Westinghouse H-761N7 receiver (H-762N7 in an alternative cabinet) is an a.m./f.m. model, and it has the special feature that the valve heaters continue to run, at a reduced temperature, when the set is switched off. The accompanying circuit diagram shows the heater circuit employed. There are seven valves in the receiver, the series heater chain adding up to a total of 122 volts for a current of 0.15 amps. As may be seen, the valves are quite conventional types.

When the on-off switch is closed, the lower 117 volt a.c. supply terminal is connected to chassis and the bottom end of the heater chain via the 3.9µH choke. At the same time, the upper a.c. supply terminal connects to the top end of the chain by way of the 47Ω fusible resistor. Thus, practically all the supply voltage is applied to the valve heaters, which then operate in normal fashion. A conventional half-wave rectifier coupled in after the 47Ω fusible resistor provides an h.t. potential, at the reservoir capacitor, of 120 volts. When the on-off switch is opened, the 500Ω 10 watt resistor is inserted between the lower a.c. supply terminal and chassis, causing the heaters to receive approximately half their normal operating voltage. Also, the rectified h.t. potential drops to some 50 volts. The reduced h.t. potential is retained, presumably, to avoid cathode poisoning.

This method of operation has a number of advantages. Firstly, it allows the receiver to operate approximately 5 seconds after switching on, instead of after the usual delay of 25 to 40 seconds. Secondly, the fact that the heaters run at half voltage ensures continuous warm and low-humidity conditions in the receiver, thereby extending component life and reducing oscillator and other circuit drift. Thirdly, there is a large reduction in switching-on heater current surges, with the result that valve life may be extended. Tests carried out by Westinghouse indicate a definite improvement in total life span when a heater circuit of this type is used.

Obviously, the low standby heater current condition given by the circuit is only applicable if the receiver is turned off by its own switch. If the mains supply is switched off externally all heaters go cold. The power consumption when the receiver is in the standby condition is approximately 14 watts, and Westinghouse state that this can result in a yearly cost, in U.S.A., of $1.50 to $5.00.

A final, incidental point is concerned with the 47pF capacitor connected to the upper supply terminal. The receiver aerial terminal board has two terminals connected, via isolating capacitors and resistors, to the 300Ω f.m. input circuit, one side of which is at chassis potential. Coupling the upper plate of the 47pF capacitor in the diagram to the hot aerial input terminal allows the a.c. power line to serve as an f.m. aerial.

New Word

"A *kinescope*, also called *telefilm*, is a film recording both of picture and sound of a television programme, in other words, it is the cinematographic reproduction of the programme as it is seen and heard on the TV screen."—UNESCO Report No. 32, *Film and Television in the Service of Opera and Ballet and of Museums*.

I'd always thought that a kinescope was a television picture tube.

Mobile Stations—Beware!

I reproduce in full, and with due acknowledgments to source, a letter sent to the Editor of the Australian journal *Amateur Radio* by VK2AMA. This was published in the May issue of this journal under the above subheading, and was later reprinted in the July issue of *Radio, Television and Hobbies* (also produced in Australia) where I first encountered it. I don't know whether the conditions described in New South Wales are applicable to this country, but the letter certainly gives food for thought.

"Editor 'A.R.', Dear Sir,

"I would like to draw the attention of all Radio Amateurs to a most unusual hazard upon which I have come across recently. It concerns chiefly mobilers, whose ranks are mounting daily, and it was while I was operating 40 mx mobile myself recently, during my annual vacation, that this potential danger impressed itself upon me.

"It concerns the use of electric blasting caps to set off explosive charges and the hazard is found most commonly along main roads and highways where road works, etc., are in operation and of course where amateur mobilers are very likely to be found.

"In N.S.W. it is customary for road signs to be exhibited in the vicinity of road works where blasting caps are being used and these state 'BLASTING — SWITCH ALL RADIO TRANSMITTERS OFF'. Piqued by one of these signs, I enquired of the Dept. of Main Roads of N.S.W. for more particulars. They referred me to an article published in *The Explosives Engineer* of Sept.-Oct. 1951, wherein this matter is discussed rather fully and I would like to quote some of the relevant passages in order to familiarise amateurs with the problem and so avoid unpleasant consequences, both to persons and Amateur Radio in this country.

" '*The wires of an electric blasting cap can act as an antenna and pick up radio energy, and if the configuration of wires is just right, and the radio transmitter is close enough, the bridge wire in the cap can be heated sufficiently by the radio frequency current produced in the wires so that the cap can be exploded.*

" '*The current needs to be of the order of* 0.25 *ampere or more.*

" '*The greatest danger arises when the two wires of the cap have a total length equal to one half wavelength with the cap in the middle. A serious danger also exists if one wire is one quarter wavelength and the other is grounded close to the cap.*

" '*It has been reported that an electric blasting cap placed in the rear compartment of a police car which had a transmitter was exploded while the transmitter was operating.*

" '*In experiments with a* 100 *watt Amateur Radio it was possible to shoot electric blasting caps* 20 *to* 30*ft below the horizontal antenna.*'

"The article then goes on to suggest '*the desirable minimum distance of separation between radio broadcasting transmitters and such blasting operations*'. These include:

'1. *Input power between* 0 *and* 30*W*—100*ft*.

2. *Input power between* 30 *and* 100*W*—200*ft*.'

"It is suggested also that '*for closer distances the transmitter should be kept stricly turned off and preferably locked.*'

"On reflecting these statements, one realises that a 33ft lead to one of these electric blasting caps is quite feasible and indeed probable, and it happens to form a resonant half wave on 40 mx, our commonest mobile band, with the cap situated at a current peak in the centre. This condition holds too with lead lengths of odd multiples of 33ft which are even more likely to occur. The current necessary to set the cap off is also very little and, by way of comparison, it is similar in magnitude to the current in a small torch globe.

"So with these thoughts in mind, I suggest that amateurs watch for any blasting signs should they be using their transmitters and that they at least cut their carrier smartly until well past the potential danger zone."

Prefabricated Printed Circuits

Veroboard, manufactured by Vero Electronics, South Mill Road, Southampton, has been available for some time now, but it still deserves mention here because of its considerable usefulness to the technician and experimenter. Basically, Veroboard resembles a printed circuit board in that it consists of $\frac{1}{16}$in thick synthetic resin bonded paper material to which are bonded strips of copper foil 0.0015in thick. With Veroboard, however, the copper foil appears as continual parallel strips 0.1in wide and spaced apart by 0.1in. The board is pierced along the centre line of the conductors by 0.052in diameter holes, these appearing at 0.2in intervals. Looking at the non-copper side, therefore, the holes take up a peg-board appearance with 0.2in pitch.

The great advantage with Veroboard is that circuits may be set up on it without the necessity of making a printed circuit copper pattern. Each connection group in the circuit couples to one of the parallel strips of copper, the component lead-out wires being passed through the holes in the board and soldered to the copper in normal printed circuit fashion. The hole pitch chosen (0.2in) is compatible with all wire ended components and most printed circuit components. If it is desired, for greater flexibility, to interrupt one of the copper strips, this may be done with a Vero Spot Face Cutter type VB3011. The cutter resembles a twist drill, but has a flat cutting edge and a protruding centre spigot which engages with one of the holes in the Veroboard. Rotating the cutter in a drill brace removes the copper over an 0.2in diameter circle, thereby ensuring a clean break in the conductor. Other accessories include drilling templates to take the tags of B7G, B9A or Octal printed circuit valveholders, and crystal diode or transistor holders.

Veroboard is supplied 4.8in wide and 18in long, with 21 conductors running parallel to the longer side. The board is protected with a flux preservative, and may be readily cut down to smaller sizes if required.

TV Dx

Mr. I. C. Beckett of Buckingham weighs in this month with a report of his first-ever Band III Dx. At the time of writing, Mr. Beckett has received the West German Test Card on 203.25 Mc/s vision. This occurred on 1st September from 11.23 to 12.00 and from 12.16 to 12.24. Also received has been another test card (country uncertain) on 182.25 Mc/s and on 189.25 Mc/s. All these were 625 line negative video modulation.

Just as I was getting this month's "Radio Topics" ready for the post (two days after deadline—it's no wonder Editors get ulcers!) two extremely interesting letters from old hands at the t.v. Dx business arrived. As I shall have to check with their writers before publication these letters must, I'm afraid, hang over till next month. However, I can at least mention a point one of them raises: where can you get 625 line components in this country?

At the time of writing this is a difficult one to answer although, with a bit of luck, there may well be some manufacturers' 625 line surplus knocking around on the market.

A Simple Valve Tester

By J. M. Charles

Editor's Note: The valve tester described in this article is capable of displaying on a cathode ray tube an approximation to the IaVg characteristic of a valve under test. It employs simple and ingenious circuitry, and we would present it as an experimental item of equipment.

THE AUTHOR DESIGNED THIS VALVE TESTER TWO years ago when he wanted to test some valves for a service job. He felt from personal experience that meter type testers take a great deal of setting up and so he decided to try a method in which the characteristic curve of the valve under test could be observed visually. The curve shown by the tester is the IaVg characteristic.

The tube used is the ex-government VCR139A, which has a 3in diameter face. A larger tube could easily be used.

The Circuit

The tube circuit employs normal oscilloscope

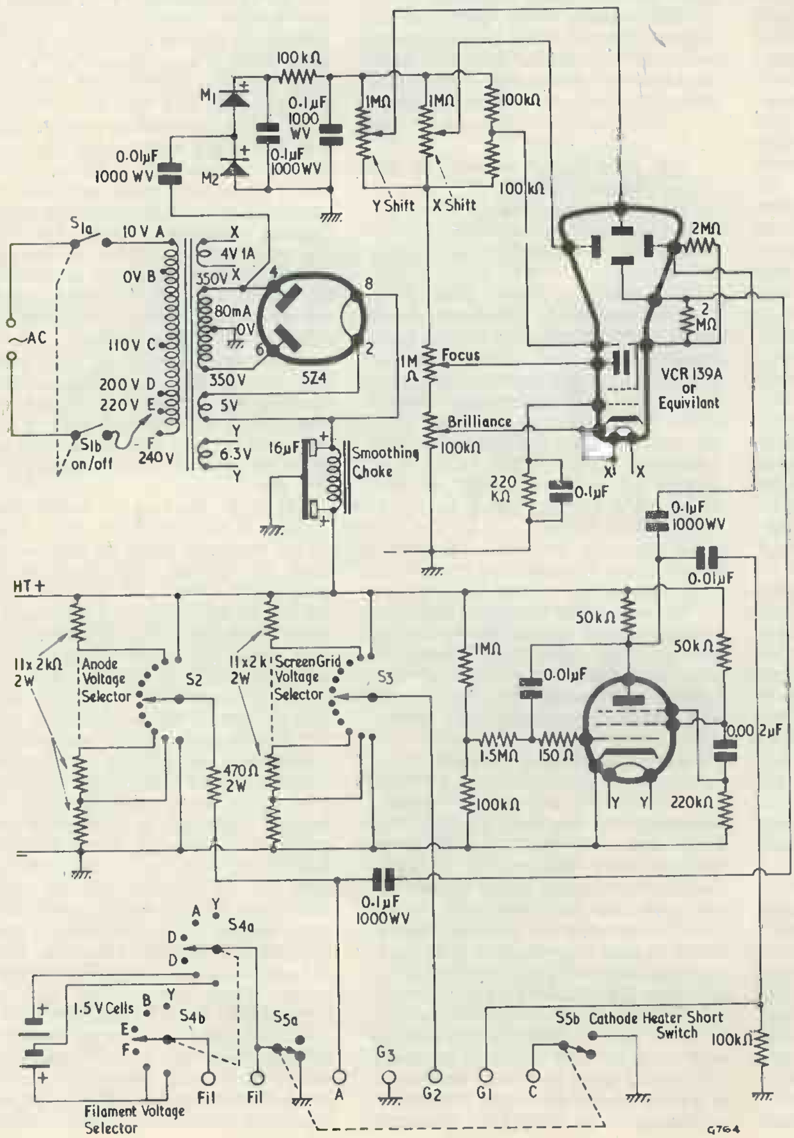


Fig. 1. The circuit of the tester. The oscillator may be an EF50, 6J7, or any similar valve. M_1 and M_2 are high voltage metal rectifiers, such as the S.T.C. K3/25. The cathode-heater short switch, S_5, is shown in the position where in the cathode of the valve under test is open-circuit and the filaments are connected to chassis. For mains valves S_5 is normally in the alternative position

practice, the brilliance control being in the cathode circuit and the focus control in the second anode circuit. Of the shift controls, the X shift is pre-set inside the unit, whilst the Y shift is brought out to the front panel since the trace moves slightly with variations in anode voltage.

The timebase is a fixed frequency transitron oscillator using an EF50, 6J7 or any similar valve. The signal is fed from the anode of the oscillator via a capacitor to the X plate of the tube and, via another capacitor, to the grid of the valve under test. A small resistance always appears in the anode circuit of the valve under test, and the signal developed across this is fed via a capacitor to the Y plate of the tube.

The test voltages for the valve are obtained by means of two 12 position switched potentiometers (S_2 and S_3) across the h.t. supply for the anode and screen-grid, and by means of a 2 pole 6 way switch (S_4) for the most frequently encountered filament voltages. The only standard test which has been incorporated is for cathode/heater shorts (S_5). In this test the cathode can be disconnected and one side of the filament earthed, whereupon, if there is a short circuit, the curve on the screen will remain with the cathode open. S_5 must, of course, be in the position where the filament is earthed for battery valves. The author refrained from continuously having the filament earthed as this makes the chassis live.

The h.t. power pack is a normal receiver type employing a 5Z4 full wave rectifier, the various filament voltages being obtained from the tapped input side of the transformer for a.c. valves and from two cells for d.c. filaments of 1.5V and 3V. A voltage coupling circuit provides e.h.t. for the cathode ray tube.

Construction and Operation

Fig. 2 shows the general outside layout of the tester. The front panel has the tube aperture, together with focus, brilliance, Y shift and voltage controls. On top are the valveholders and a flying top cap lead, all connected to ten sockets. Flying leads from the appropriately indicated points of Fig. 1 (A_1, G_3, G_2, Fil, etc.) are then plugged into these sockets as required for the particular valve under test.

When testing a valve the electrode leads are put into the appropriate sockets, the test voltages adjusted, and the valve fitted into its socket. The unit is then switched on and the Y shift adjusted to put the trace of the curve near the centre of the screen.

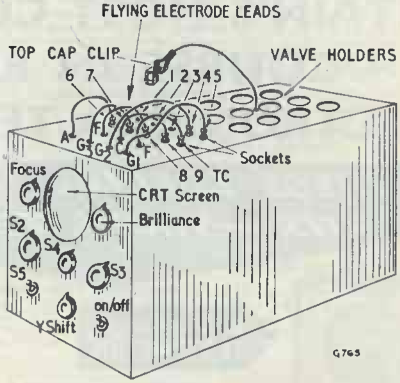


Fig. 2. Outside appearance of the valve tester

Results

Despite its simple nature, the valve tester described here provides a useful trace for each valve tested. There is no necessity for a variable attenuator following the anode of the valve under test as, even with such types as the 807 or EL38, the trace does not go out of view. Trace heights for two typical valves are: 6V6 approximately 2½in, and EF80 approximately 1¼in.

It is important to note that some of the filament voltages in the tester are obtained from the primary of the mains transformer. Because of this, certain settings of the selector switches may cause the chassis (and the case if this is not made of insulating material), together with any metal parts or wires connected to the chassis, to become live with respect to earth. This point must be borne in mind because of the consequent danger of shock. The risk may be obviated by obtaining the various filament voltages required from suitable secondaries of a second mains transformer, and not from the primary of the existing transformer.

MINISTRY EVALUATE MARCONI "SIXTY SERIES" EQUIPMENT

The Marconi "Sixty Series" VHF communications equipment AD160 recently underwent tropical flight trials conducted by the Ministry of Aviation.

Installed in a Hastings aircraft, the equipment was flight tested between the United Kingdom and Bahrain, with tests at high ambient temperatures carried out at Bahrain. Ranges in excess of 130 nautical miles were constantly obtained at an altitude of 10,000 feet and the set operated satisfactorily throughout the test period. The performance was described as excellent.

This series of equipment has already been specified by B.O.A.C. as standard fit for their Vickers VC10 aircraft and by B.E.A. for their de Havilland Trident.

CHECK *with these* BARGAINS


1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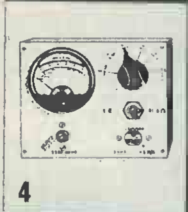
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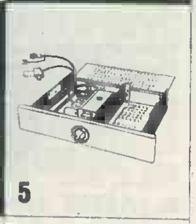
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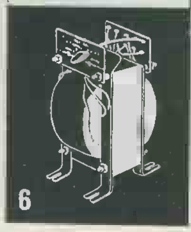
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EASY TERMS AVAILABLE EXCEPTING AUTO-CHANGES

1 **3-TRANSISTOR POCKET RADIO** with miniature **SPEAKER, FERRITE ROD, and 2 GERMANIUM DIODES. The only 3-transistor radio available at the price. Build it in 1 evening!** Tunable over M/L waves. Complete with easy-to-follow instructions and all components (less batteries obtainable anywhere 1/3). **27/6.** P. & P. 2/6. (All parts available separately.)

2 **5-TRANSISTOR POCKET RADIO.** Size 4¾" x 3½" x 1½". Output 200 m/W. Five first quality transistors. Push-pull output. Fitted 2 " high-flux moving coil speaker. Medium and long wave. Internal high gain ferrox aerial. Twin coloured case in red and black. All parts available separately. Circuit-diagram 1/6. Free with kit. No aerial or earth required. 59/6. P. & P. 3/6.

3 **OSCILLOSCOPE for D.C. and A.C. APPLICATIONS.** A high gain, extremely stable differential Y-amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurements of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-pull X amplifier; Fly-back suppression; Internal Time-base Scan Waveform available for external use; pulse output available for checking TV line O/P Transformers, etc. Provision for external—I/P and CRT Brightness Modulation. A.C. mains 200/250V £15.15.0, P. & P. 8/– or 30/– deposit, plus P. & P. 8/– and 12 monthly payments of 26/6. FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.

4 **A.C./D.C. POCKET MULTI-METER KIT.** 2" moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wirewound pot (for ohms zero setting), toggle switch, resistor and rectifier. 19/6. P. & P. 2/–. Wiring diagram 1/– free with kit.

5 **CHANNEL TUNER.** Will tune to all Band I and Band III stations. Complete with P.C.C.84 and P.C.F.80 valves (in series) I.F. 16-19 or 33-38. Can be modified as an aerial converter (instructions supplied). 32/6, plus 4/– P. & P. **HEATER TRANSFORMER** to suit above, 200-250V, 6/–, plus 4/– P. & P.

6 **MAINS TRANSFORMERS.** All with tapped primaries. 250–250V 70mA, 6.3V 2A, 10/6. P. & P. 3/6. 280–0–280 70mA, 6.3V 2A, 6.3V 1A, 10/6. P. & P. 3/6. 280–0–280 120mA, 6.3V 2A, 6.3V 3A, 17/6. P. & P. 3/6.

7 **NO MORE FLAT BATTERIES.** 6 and 12 volt, 2 amps. Charge your own battery overnight with this wonderful little charger. A.C. mains 200/250V, 6" x 3" x 3" incorporating mains fuse. Attractive silver hammer finish, complete with leads and battery clips. Only 21/–. P. & P. 3/6.

9 **SIGNAL GENERATORS.** Cash £6.19.6 or 25/– deposit and 6 monthly payments of 21/6, P. & P. 5/6. Coverage 100 kc/s to 100 Mc/s on fundamentals and 100 Mc/s to 200 Mc/s on harmonics. Case 10" x 6½" x 5½". Three miniature valves and Metal Rectifier. A.C. mains 200/250V. Internal modulation of 400 c.p.s. to a depth of 30 per cent; Modulated or unmodulated R.F. output continuously variable 100 millivolts. CW. and mod. switch, variable A.F. output. Magic eye as output indicator. Accuracy ± 2%.

10 **SIGNAL GENERATORS.** Cash £4.19.6. P. & P. 5/6. Coverage 120 kc/s to 84 Mc/s. Case 10" x 6½" x 4½". Size of scale 6½" x 3½", 2 valves and rectifier. A.C. mains 230-250V. Internal modulation of 400 c.p.s. to a depth of 30 per cent modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch variable A.F. output and moving coil output meter. Accuracy ±2%.

11 **BATTERY RECORD PLAYER AND AMPLIFIER.** 45 r.p.m. "Star" motor "Acos" crystal pick-up, 3 transistor, push-pull amplifier complete with transistors. Output 500 milliwatts, 49/6, P. & P. 4/–.

12 8-watt **PUSH-PULL 5 VALVE AMPLIFIER.** A.C. mains 200-250V Size 10½" x 6½" x 2½". 5 valves. For use with all makes and type of pick-up and mike. Negative feedback. Two inputs, mike and gram, and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 kc/s, ± 2 dB; 4db down to 20 kc/s. Output 8 watts at 5 per cent total distortion. Noise level 40 db down all hum. Output transformer tapped for 3 and 15 ohms speech coils. For use with Std. or L.P. records, musical instruments such as guitars, etc. Suitable for small halls, £3.19.6, P. & P. 7/–. Crystal mike to suit 15/–. P. & P. 2/–. 8"P. M. Speaker to suit, 12/6. P. & P. 2/–.

13 **B.S.R. MONARCH UA8 WITH FUL-FI HEAD.** 4-speed, plays 10 records, 12", 10" or 7" at 16, 33, 45 or 78 r.p.m. Intermixes 7", 10" and 12" records of the same speed. Has manual play position: colour, brown. Dimensions: 12½" x 10¾". Space required above baseboard 4¾" below baseboard 2¾". Fitted with Ful-Fi turnover crystal head, £6.19.6, P. & P. 5/–. **With Stereo Head £7.19.6.** P. & P. 5/6.

14 **TRANSISTOR TESTER.** For both P.N.P. and N,P,N, transistors incorporating moving coil meter. In metal case, size 4½" x 3¾" x 1¼". Scale marked in gain and leakage, 19/6, P. & P. 3/–.

15 **PUSH-PULL OUTPUT STAGE** inclusive of transistors with input and output transformers to match 3 ohms speech coil, suitable for use with the POCKET RADIO. Kit of parts, including transistors, 19/6, P & P. 2/–. Wiring diagram 1/6, free with kit.

16 **PORTABLE AMPLIFIER.** On printed circuit for A.C. Mains 200/250V. Size 4" x 3" with tone and volume control. Complete with valves: ECL82 and EZ80. Output 2 watts. 39/6, P. & P. 3/–.


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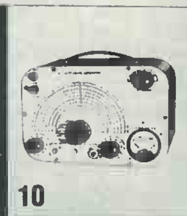
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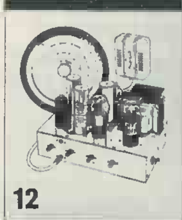
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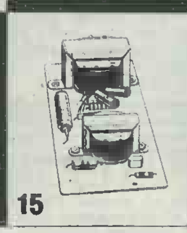
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16

RADIO & T.V. COMPONENTS (Acton) LTD.

23d HIGH STREET, ACTON, LONDON, W.3.

ALL ENQUIRIES S.A.E.
GOODS NOT DISPATCHED OUTSIDE U.K.

"6 plus 1" TRANSISTOR RADIO KIT

BEST EVER VALUE!

MANUFACTURERS' SURPLUS BARGAIN OFFER.—Further Kit supplies now available. Original purchases of this popular kit were rapidly sold out. This kit is a modern sensitive quality circuit Receiver Unit with all the latest features. Six BVA transistors and 1 diode, printed circuit, Med. and Long waves. Ferrite aerial, car radio coupling coil 500mW. Push-pull output into 3 ohm speaker, attractive gilt dial and slow-motion tuning, etc. Size approx. 8" x 2½". Cabinet size 9" x 5½" x 3¾".

KIT of Parts including printed circuit, **5 gns.** Set of 6 Transistors and 1 Diode **45/–** P. & P. 2/6.

BARGAIN OFFER
Complete Kit £6/19/6 less Speaker Carr. 2/6

3 ohm Speaker 7" x 3¾"—ONLY **15/6**. P. & P. 1/6. Send 3d· stamp for full details. Circuit and Instructions **1/6**. Cabinets **25/–** extra.

New Boxed VALVES All Guaranteed

1T4	6/–	ECC83	8/–	PCC84	9/6
1R5	7/6	ECL82	10/6	PCF80	9/6
1S5	7/6	ECL80	10/6	PCL83	12/6
3S4	7/6	EF80	8/–	PCL84	12/6
3V4	7/6	EF86	12/6	PL81	12/6
DAF96	9/–	EL84	8/6	PL82	9/6
DF96	9/–	EY51	9/6	PL83	10/6
DK96	9/–	EY86	10/–	PY32	12/6
DL96	9/–	EZ81	7/6	PY81	9/6
ECC81	8/–	GZ32	12/6	PY82	7/6
ECC82	8/–	EM81	9/6	U25	12/6

Electrolytics All Types New Stk.

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25/25V	1/9	8+8/450V	4/6
50/12V	1/9	16+16/450V	5/6
50/50V	2/–	32+32/275V	4/6
100/25V	2/–	50+50/350V	6/6
8/450V	2/3	60+250/275V	12/6
4/350V	2/3		
16+16/450V	5/6	100+200/275V	12/6
32+32/450V	6/6		

Ersin Multicore Solder 60/40 3d. per yard. ¼lb. **2/6**, etc.

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Famous American Columbia (CBS) Premier Quality Tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT! Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

	Standard	Long Play	Double Play
5"	600ft, **15/–**	900ft, **19/6**	1,200ft, **31/6**
5¾"	900ft, **16/6**	1,200ft, **22/6**	1,800ft, **39/6**
7"	1,200ft, **21/–**	1,800ft, **32/6**	2,400ft, **47/6**

Post and Packing, per reel, 1/–, plus 6d. each for additional reels.
SPECIAL OFFER—3" mfrs. surplus tape, 225ft, **5/6**. P. & F. per reel 6d.
Plastic Tape Reels, 3" **2/6**, 5" **3/–**, 5¾" **3/3**, 7" **3/6**.

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High grade low loss Cellular air spaced Polythene—¼" diameter. Stranded cond. Famous mfrs. **Now only 6d. per yard. Bargain Prices—Special** lengths 20 yds. **9/–**. P. & P. 1/6. 40 yds. **17/6**. P. & P. 2/–. 60 yds. **25/–**. P. & P. 3/–. Coax Plugs **1/–**. Sockets **1/–**. Couplers **1/3**. Outlet Boxes **4/6**.

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Latest 5 valve circuit based on Mullard's design. Magic eye and tone controls. Printed circuit already wired. A sensitive quality recorder **BSR Amp Kit 95/–. B.S.R. Tape Deck £8.10.0. Collaro Amp. Kit £6.5.0. Collaro Tape Deck £12.10.0. Set of 5 5 valves 45/–. Special Unit Kit Prices**—Send stamp for detailed list. Construction and circuit details **2/6. Bargain Complete Kit £16/10/0** Carriage **4/6**.

Condensers—Silver Mica. All values, 2pF to 1,000pF, **6d.** each. Ditto, Ceramics **9d.** Tub. 450V T.C.C., etc. .001 mfd., .01 and .1/350V, **9d.** .02–.1/500V **1/–**. .25 Hunts **1 6**. .5 T.C.C. **1/9**, etc., etc. **Close Tol. S/Micas**—10% 5pF–500pF **8d.** 600–5,000pF **1/–**. 1% 2pF–100pF **9d.** 100pF–500pF **11d.** 575pF–5,000pF **1/6**. **Resistors—Full Range** 10 ohms–10 megohms 20% ¼ and ½W **3d.**, ¾W **5d.** (Midget type modern rating) 1W **6d**, 2W **9d.** **Hi-Stab** 10% ¼W **5d.**, ½W **7d.** 5% ½W **9d.**, 1% ½W **1/6**. **W/W Resistors** 25 ohms to 10K 5W **1/3**, 10W **1/6**, 15W **2/–**. **Pre-set T/V Pots. W/W 25** ohms.–50 K **3/–**. 50 K–2 Meg. (Carbon) **3/–**.

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Designer-approved kits of parts:
FMT1, 5 gns. 4 valves, **20/–**.
FMT2, £7. 5 valves, **37/6**.
JTV MERCURY 10 gns.
JTV2 £13.19.6. 4 valves, **32/6**.
NEW JASON FM HANDBOOK, 2/6. 48 hr. Alignment Service **7/6**. P. & P. 2/6.

Speakers P.M.—3 ohms 2½" Elac **17/6**. Goodmans **18/6**. 5" Rola **17/6**. 6" Elac **18/6**. 7" x 4" Goodmans **18/6**. 8" Rola **20/–**. 10" R. x A. **25/–**. 9" x 6" Goodmans **25/–**. E.M.I. Tweeter **29/6**.

Speaker Fret—Expanded bronze anodised metal 8" x 8" **2/3**, 12" x 8" **3/–**, 12" x 12" **4/6**, 12" x 16" **6/–**, 24" x 12" **9/–**, 36" x 12" **13/6**, etc. etc.

TYGAN FRET (contemp. pat.) 12" x 12" **2/–**, 12" x 18" **3/–**, 12" x 24" **4/–**.

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Garrard TA Mk. 2	**£7.19.6**
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B.S.R. (TU9)	**79/6**
E.M.I. Junior	**89/6**
Auto-Changers	carr. 4/6
Garrard RC210	**£10.10.0**
Collaro "Conquest"	**£7.15.0**
B.S.R. (UA8)	**£6.15.0**
B.S.R. (UA8 Stereo)	**£6.19.6**
B.S.R. (UA14)	**£7.19.6**

SINGLE SCREENED LEAD—Standard size, **8d.** yd.; Ditto Lightweight for Pick-up, etc., **7d.** yd.; ditto lightweight for PVC sheathed, **9d.** yd.; Twin screened sheathed, **1/–** yd.

VALVEHOLDERS—Paxolin: Int. Oct., **6d. Moulded:** B8G, **9d.** each; **Nylon or Moulded Ceramic:** B7G, B9A unskirted, **9d.** each; B7G, B9A skirted, **1/–** each; B7G with Can, **1/6** each; B9A with Can, **1/9** each; EF50, B7G, **1/–** each; B9A ditto, **1/3** each.

ENAMELLED COPPER WIRE—¼lb reels· 14g–20g, **2/6**; 22g–28g, **3/–**; 30g–40g, **3/9**. Other gauges quoted for.

PVC CONNECTING WIRE—10 colours (for chassis wiring, etc.)—Single or standed conductor, per yd., **2d.**

"POCKET 6" TRANSISTOR RADIO KIT—Med & L/W size

Osmor Ferrite Ae **10/–**. Osc. Coil & 3 IF's **22/6**. Driver & O/P Trans. **22/–**. Tuning Gang **10/6**. 2½" PM Speaker **17/6**. Set 6 Transistors & Diode **45/–**. Printed Circuit **8/6**. Vol. Control **8/–**. W/C Sw. **3/6**. Cabinet & Dial **8/–**. Resistor Set **5/–**. Condenser Set **15/–**. Handbook, full details **1/6**.

Complete Kit *REDUCED PRICE* **£8/10/0** Carr. 2/6

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s $\frac{5}{16}$" diam.	**5/6**
Osc. Coil—$\frac{5}{16}$" diam. M/W.	**5/3**
M. & L.W.	**5/9**
Midget Driver Trans. 3.5:1	**6/9**
Midget O/Put Trans. Push-pull to 3 ohms.	**6/9**

Elect. Condensers—Midget Type 1mfd–100mfd, ea. **1/9**. 6V/12V wkg.
Ferrite Aerial—M. & L. W. with car aerial coupling coil **9/3**
Condensers—150v. wkg. .01 mfd., .03 mfd. **9d.** .05 mfd., .1 mfd. **1/–**. .25 mfd. **1/3**. .5 mfd. **1/6**. Etc.
Vol Controls—Midget Type with edge Control Knob. 5K, 47K, 1 M/ohm, ea. **2/6**.
Speakers P.M.—2½" EMI 3 ohms **17/6**. 7" x 4" Plessey 35 ohm **23/6**.
Ear Plug Phones—Min. Continental type, 3ft lead, jack plug and socket. High Imp. **8/–**. Low Imp. **7/6**.

TURRET TUNER BAND I/BAND III
Ex-mnfrs. current production offer—standard type 13-channel unit, 35/38 Mc/s I.F. Complete with PCC84 and PCF80 valves and coils for channels 1/3/9. No knobs or circuit diagram, but connection data supplied.
Clearance Bargain only 32/6. Carriage 2/6. Worth 5 Gns.

TRANSISTOR BARGAINS
Brand New—BVA 1st Grade

OC44	**10/6**	873	**9/–**
OC45	**9/6**	GET114	**6/6**
OC81	**7/6**	OC72	**7/6**
2/OC81	**15/6**	OC70	**5/6**
XA102	**10/–**	OC71	**6/–**
XA101	**9/6**	GEX34	**2/9**
XB103	**7/6**	OA70	**2/9**
XC101	**8/6**	OA81	**2/9**
874	**9/6**		

Surface barrier type SB305 **9/6** each *All Post Free*

SLEEVING—Various Colours 1mm, 2mm, **2d.** yd.; 3mm, 4mm, **3d.** yd., 6mm, **5d.** yd.

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New improved types, low capacity small size and tag terminated a.c. 200/250V. Secondaries nil, +25% +50% BOOST for 2V, 4V, 6.3V, 10.5V, 12V or 13V tubes. Each type **12/6** each. P. & P. 1/6.

TRIMMERS, Ceramic (Compression Type)—30pF, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, **1/9**.

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TUNING COND.—Twin Gang by J. B., etc. 365pF Midget, **8/6**; .0005 mfd Midget, **7/6**. Transistor Type, J. Bros. 00. Midget Twin Gang 208pF+176pF, **9/–**.

Wavechange SWITCHES, Midget Type—2 pole 2 way, 1 pole 6 way, **2/6** each; **1 pole 12** way, 2 pole 6 way, 3 pole 4 way, 4 pole 2 way, 4 pole 3 way, **3/6** each.

FUSEHOLDERS—Chassis Type: Single, **6d.**: Double, **9d.**; Panel Mounting Bulgin Type, **1/9**.

FUSES—Cartridge Type, Standard 1¼". All standard values 6mA–10mA, **4d.** each.

KNOBS—Modern Continental types: Brown or Ivory with Gold Ring, 1" dia, **9d.** each; 1⅛", **1/–** each; Brown or Ivory with Gold Centre, 1" dia., **10d.** each; 1⅜", **1/3** each. LARGE SELECTION AVAILABLE.

METAL RECTIFIERS, STC Types—RM1, **4/9**; RM2, **5/6**; RM3, **7/6**; RM4, **16/–**; RM5, **21/–**; RM4B, **17/6**.

STC RECTIFIERS—E.H.T. Type Fly-back Voltages: K3/25, 2kV, **5/–**; K3/40, 3.2kV, **6/9**; K3/50, 4kV, **7/9**; etc.

WESTINGHOUSE—Contact Cooled: FC116, 250V, 60mA, **11/9**; FC101, 250V, 200mA, **21/–**; FC31, 250V, 300mA, **28/6**.

SIEMENS TYPES—Contact Cooled: 250V, 50mA, **7/6**; 250V, 85mA, **10/–**; 250V, 125mA, **15/–**; 250V, 300mA, **26/6**.

Send for detailed bargain lists, 3d. stamp.
We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans., etc. Enquiries invited for Specials, Prototypes for small production runs. Quotation by return.

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SUB-MINIATURE COMPONENTS

1. Ferrite aerial with Long and Medium Wave Coils 4½" long for pocket superhet, complete with circuit showing component values etc. 7/6d.
2. Ferrite aerial as above, but ⅜" diameter, 8" long for table model receiver or portable. 10/6d.
3. Three I.F. Transformers with oscillator coil and circuit details to work with item 1. 19/6d.
4. Three I.F. Coils and oscillator to work with item 2. 23/6d.
5. Smallest possible electrolytics. 1MFD, 2MFD, 4MFD, 5MFD, 6MFD, 8MFD, 10MFD, 20MFD, 30MFD, 50MFD, 100MFD, 200MFD all 1/9d. each.
6. Smallest ¼ watt resistors all 10% values 5d. each.
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8. Miniature slide switch double pole change over 2/6d.
9. Edgewise volume controls 2K, 5K, 10K and 20K 2/6d. each.
10. Small edgewise controls with switch 2K, 5K, 10K and 20K 4/9d. each.
11. Red Spot Transistors tested and suitable all A.F. applications 2/6d.
12. White Spot Transistors tested and suitable as I.F. or mixer 3/6d.
13. Set of six transistors for superhet Mullards in original packets, fully guaranteed, comprising OC44, OC45, OC45, OC81D and matched pair OC81. £2 the set.

SPECIAL SNIP FOR THIS MONTH

The Pocket "6" as described alongside but fully made up ready to work.

£5.15.0 plus 2/6 post and insurance.

NOW THE MARK IV

Read these Testimonials

D. A. Hilton, Leigh, Lancs.
"I received 'Pocket 4' on Christmas Day. I made it up on Boxing Day and I am very pleased with the results. It brings in local stations and many foreign stations including Luxembourg at good strength. I am 13 years old."

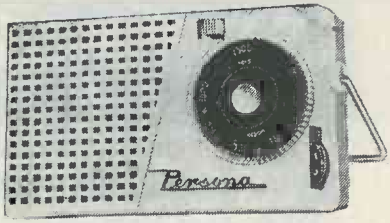
Mr. J. Bell, Wolverhampton.
"I am writing to express my satisfaction at the standard of your kit for your Pocket 4 Transistor set and also to state that it has come up to my expectations in regard to performance."

Mr. R. Belt, Newcastle-on-Tyne.
"I have built your Pocket 4 Transistor set, I am very pleased with it."

Mr. F. Jackson, Ickenham, Middx.
"I have built the Pocket 4 and am more than pleased with the results."

Mr. G. Bamford, Ramsgate.
"I find this set even better than you claim it to be and most certainly up to your usual standard of quality. I feel that nobody could fail to build it and get results. Even the first-time-ever novice, as your circuit diagrams and instructions are so clear and precise."

Mr. A. J. Simmonds, Welling, Kent.
"I purchased from you a week ago the Pocket 4 Transistor Kit, I put it together last night in 1½ hours, on switching on the set I was right on Radio Luxembourg. I must say thank you because not only has the set a very attractive appearance, it also behaves fantastically."



Our famous Pocket "5" which is doing yeoman service all over the country has been modified and improved to make it an even better receiver. The new features include:—

- New elegant dial graduated for Long and Medium Waves.
- Switched Long and Medium Waves.
- Slide switch on/off control.
- Printed circuit.
- Ferrite Rod Aerial.
- Improved reaction circuit.
- Positive spindle coupling to tuner.
- Battery containers.

The Pocket "5" of course retains its original r.f. circuit which means still no aerial or earth needed.

The Pocket "5" Mark IV uses 4 transistors, crystal diode, miniature loud speaker and has all the above refinements, complete in case as illustrated (less motif) 52/6, battery 10d., post and insurance 2/6. Motif 2/-.

Pocket "6" as Pocket "5" but with Moving Coil Speaker and Q.P.P. output stage, 95/-.

Seven days' approval.

Order in confidence. We allow you seven days to decide whether or not to make the set, you may return the parcel as received within this time and your money will be refunded in full.

Read some of the testimonials, over 1,000 of which have been received about our Pocket Receivers.

ELECTRONIC PRECISION EQUIPMENT LTD

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

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

Premier RADIO

23 Tottenham Court Road London W1 *Telephone* MUSeum 3451/2 *and* **309 Edgware Road London W2** *Telephone* PADdington 6963

THE WALTER Battery/Mains Transistorised Portable TAPE RECORDER

Original price 55 gns.

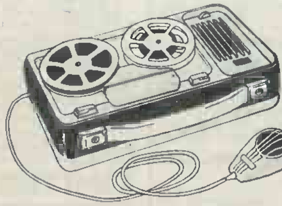
NOW ONLY **27 GNS.**

Plus P. & P. 20/–

No longer need you be restricted to indoor recordings for with this machine you can record and playback wherever and whenever you wish. Recordings made with the machine on battery operation maintains the Hi-Fi quality when played back on mains. These machines are supplied complete with Microphone, Mains Lead and all necessary accessories, they are brand new in manufacturers' original cartons. **Star Features**—★ 7 stage built-in Amplifier with separate bias oscillator and record level indicator. Push-pull output stage with negative feedback. Also separate feedback equalisation. ★ Full size, 3-watts undistorted output. ★ 7" x 4" High Flux Elliptical Speaker. ★ Large 5¾" sp 5¾" Spools. ★ 3¾" i.p.s. Tape Speed. ★ Revolution Counter. ★ Mixing facilities. ★ Super-impose facilities. ★ Safety device on record (preventing accidental erasure). ★ Volume on/off and Tone controls. ★ Magic Eye Tuning Indicator.

Summer Bargain Offer "THE CLARION"

Transistorised Battery Tape Recorder



Now only 16½ gns

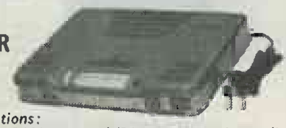
Batteries Extra 3/4 P. & P. 6/–

Original Price 25 gns.

Brief specifications—Constant governed speed of 3¾ i.p.s. Completely transistorised circuit. Recordings inter-changeable with other Recorders. Remarkable reproduction on both speech and music. Complete with Microphone, Tape and Spare Spool. Full range of accessories available.

Send for full descriptive literature

Introducing THE TELEFUNKEN STEREO HI-FI AMPLIFIER



For only **£9.19.6**

P. & P. 5/–

Brief specifications:

Power Output 5 Watts total (2½ watts per channel).

★ Frequency Response 30 c/s to 40 Kc/s 2dB. 45 c/s to 30 Kc/s ½dB.
★ Sensitivity sufficient for all normal inputs from Tape Recorders, Pick-ups, Microphones Radios.
★ Power Requirements 110, 125, 150, 220, 240 volts A.C.
★ Piano key selecting.
★ Preselected tone control.
★ Size 12" wide x 9" deep x 2" high.
★ Finish: Hammered enamel in grey/green with gold trimmings, Controls and press buttons in cream with black, blue and red lettering.

THE "MID-FI" A NEW DESIGN 4½W AMPLIFIER KIT

MAY BE BUILT FOR **95/-** plus 3/– P. & P.

A new circuit for the home constructor requiring a good quality med. powered amplifier for reproduction of records or f.m. broadcasts. Technical spec.: sep. bass and treble controls. Valves: EF86, EL84, EZ80. Voltage adjustment for a.c. mains from 200/250V, 3 or 15Ω imp. Neg. feedback. Size 7" x 5" x 2", overall ht. 5". Silver hammered finished chassis.

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FOR SALE. R206 with p.u., 50 kc/s to 30 Mc/s from 50 kc/s to 500 kc/s with adaptor supplied—£15. Short wave "6", old fashioned, working, £3. 10s. Tx/Rx 2-8 Mc/s, 22 set, fully valved, good condition, no p.u., £3. 10s. Power pack Gardner transformer, 275.250.0.250.275. 100mA. Double-choked treble smoothing L.T. 4.5V.C.T. 10A. £2. Control box BC226-A with 9 ft. flexible drive cable, £1. 10s. WANTED: "C" unit for 1475. Or will sell 1475 less "C" unit, working otherwise, £4. Wanted manual for B47. At home any a.m. Melhuish, 31 Shepherds Bush Green, London W.12.

FOR SALE. To clear—Valves, at 7s. 6d. each: 5Y3GT, 5R4GT, XFG1, RG1-240-A, 6BW6, 83, T20, VT136, 955 with base. At 4s. 6d.: 6AT6, 6SA7, 6SK7, 6AG7, 6BA6, VR150/30, DL92, IS5, EL91, IS4, 6V6, 5Z4GT, 12AT7, 3M4, ECC82. At 2s. 6d.: 6AG5, 6K7, VR91, 6B8, CV51. New accumulators: Willard Radio–20-2, 2 volt 7s. 6d.; Varley Dry VPT, 2 volt, 10s. Mic. transformer, Woden MT101, 7s. 6d. Rotary transformers: 12V in. 480V 40mA out. 12s. 6d.; 12V in. 285V 60mA out. 17s. 6d. Labgear Tx coils p.p. DSL 21 and 14, 5s. each. 10 watt mod. choke, 7s. 6d. Ditto, transformer, 7s. 6d. Linear L45 watt qual. audio amplifier, 200/250V a.c., £5. Prices shown include postage and packing. —"East Keal", Romany Road, Oulton Broad, Suffolk.

FOR SALE: 2 Mullard 12in tubes, 2-16in metal tubes, £1 each. Avo model 7 meter, £2. Ditto Mk2 as new, £11. Avo valvetester, £3. Barber popular lamp, 10s. 12in Viewmaster with Valradio tuner, no cabinet, £4. 150 watt auto-transformer, 7s. 6d. 50 old type valves, 3s. 6d. each. Many used components. Please enquire. WANTED: Allen transformer LO308.—Box No. F 134.

FOR SALE. Etronic Radiogram with Collaro auto-change, 78 only. Perfect working order, little used. Delivery free in London area or Essex. £6.—42 Canterbury Road, Holland-on-Sea, Essex. *Telephone* Holland-on-Sea 2013.

FOR SALE: Valves. Bargain offer of second-hand but unused valves. EF37A, 6s., 6J7G, 5s., CV1343, 4s. 6d., EF91, 3s. 6d. Many others at knock-out prices. Enquiries welcome, send S.A.E. P. & P. 4d. per valve, free on order over half a dozen.—Box No. F 135.

TRANSISTOR SUPERHET, ex- manufacturers, printed circuit, Long and Medium waves, aligned and tested, £6. S.A.E for full details Box No. F136.

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LEARN RADIO AND ELECTRONICS the NEW Practical way. Very latest system of experimenting with and building radio apparatus—"as you learn".—FREE Brochure from: Dept. RC10 Radiostructor, Reading, Berks.

MORSE CODE TRAINING. Special courses for Beginners. Full details from (Dept. R.C.) Candler System Company, 52 Abingdon Road, London, W.8.

PANL, recognised for many years as the unique one-coat black crackle finish. Brush applied, no baking. Available by post in eighth-pint cans at 3s. 9d. from G. A. Miller, 255 Nether Street, London, N.3.

continued on page 319

SMALL ADVERTISEMENTS

continued from 317

BABY SITTER

ALL TRANSISTOR BABY OR INVALID ALARM

Battery operated, push-pull, 400mW output. Low impedance microphone enables unit to be used up to 200 yards. Output on quality speaker.

★ GUARANTEED for 6 MONTHS and 100% SAFE.
★ Microphone is placed within 6ft of baby; twin flex is taken to amplifier unit and placed in any room required. COMPLETELY BUILT AND TESTED.

£5.10.0 P.P. 2/6.

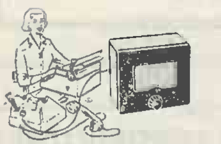
★ **Used All Night, Every Night. Battery Life 3 to 4 months.**

ALL TRANSISTOR

● TIME SAVER ●

OFFICE OR HOME TELEPHONE PICK-UP AMPLIFIER

★ No more "Holding on" wasting time waiting for your call to come through. When it does the amplifier can be switched off if required. No connections, just press the pick-up coil to back of phone as below. Fully Guaranteed.
★ **3 months battery life. 400mW output.**



BUILT, TESTED, READY TO USE

£5.10.0
P.P. 2/6.

TYPE 38 TRANSMITTER/RECEIVER

Portable Walkie/Talkie, complete with 5 valves, shown with cover removed. In new condition. Sold without guarantee but are generally workable.

★ Coverage 7 to 9 Mc/s variable tuning.
★ Requires 120 to 150 volt and 1½ volt batteries.
★ Range 3 to 5 miles.
★ Suitable battery, 10/6. P.P. 1/-.

22/6 P.P. 2/6

HEADPHONES with JACK PLUG, 6/- pair.
JUNCTION BOX, 2/6.
THROAT MIKE with JACK PLUG, 4/6.
5ft AERIAL ROD, 2/6.
(POSTAGE ON ABOVE 1/- PER ITEM.)

2 WATT POWER AMPLIFIER

★ Designed to boost up the output of Portable Transistor Radios when used in a Car. Works from 6 or 12 volt (state which) Car Battery—uses power transistor. All Parts 49/6. P.P. 2/-.

ADDON AMPLIFIER

250mW push-pull stage with 3in speaker. Converts any earphone radio to full loudspeaker. All parts 49/6. P.P. 1/6.
★ **Diagrams Free** ★

ALL TRANSISTOR MEDIUM LONG AND SHORT WAVE PRE-BUILT UNITS IN STOCK: FULLY ILLUSTRATED BOOKLET 2/6.

● AVO MULTIMETERS ●

AVO MODEL 7
Multi-Meter.
(List price £19.10.0.)
£12.10.0
Regd. P.P. 5/-. Complete with Test Leads and Batteries
Fully Guaranteed

TUBULAR LOUDSPEAKER UNIT

Extension portable speaker unit to give big set performance from any transistor pocket radio. Fitted **2** sizes of jack plug. **57/6** P.P. 1/6.

Transistors

We stock a transistor for every need from **3/6** each.

SEND FOR LATEST PRICE LIST

● MULLARD AND EDISWAN ●

★TRANSISTOR STANDARD AND MINIATURE COMPONENTS

We stock the largest range of components in the country for the home constructor.

WE HAVE YOUR ITEM IN STOCK.
Just ask and we will quote competitive prices.

● BRAND NEW METERS ●

1$\frac{1}{16}$in square 0/50 microamp, **39/6.**
1$\frac{1}{16}$in square 0/500 microamp, **32/6.**
1$\frac{1}{16}$in square 0/1 milliamp, **27/6.**
★**VU METER** (Volume Level Indicator). Calibrated in standard ranges, **42/6.**
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★ CRYSTAL LAPEL MICROPHONE
Ideal for tape recording.
Very sensitive.
17/6
P.P. 1/-.

★ LIGHT-WEIGHT 4,000 OHM HEADPHONES,

12/6
P.P. 1/3.

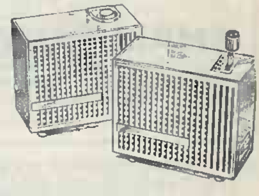
CRYSTAL MICROPHONES

ACOS 39-1. Stick Microphone with screened cable and stand (list 5 gns), **39/6.** P.P. 1/6.
ACOS 40. Desk Microphone with screened cable and built-in stand (list 50/-), **19/6.** P.P. 1/6.
ACOS 45. Hand Microphone with screened lead, very sensitive, **29/6.** P.P. 1/6.

★ **Brand New—Fully Guaranteed** ★

TRANSISTOR INTERCOMM

★ Two-way Intercomm. with clear reproduction. Incorporates unique buzzing system. 2 speakers, volume control. Cabinet sizes about 3¾ x 1¾ x 3½in. Ready to use.



★ Printed Circuit Amplifier. Fully guaranteed.

SUPPLIED IN PRESENTATION BOX WITH BATTERY AND 60ft WIRE. **10gns.**

★ ACOS Crystal Mic inserts, 2in, **12/6**; 1½in, **7/6**. ⅞in round or square **3/6**. P.P. 6d.

★ Submin. Condensers. All low voltages: 0.1, 0.25, 0.5, 1, 2, 4, 6, 8, 10, 16, 25, 30, 50, 100 mfd. All types, **2/-** each.

★ Standard Miniature: 1, 2, 4, 8, 10, 25, 30, 50, 100, 200, 250, 500 mfd. All types, **1/6 each.**

★ Sub-miniature Jack Plug and Socket, **3/6** complete. P.P. 6d.

★ **TELEPHONE PICK-UP COIL.** 2,000 ohms. With screened lead. Ideal for tape recording. Push on rubber sucker, **14/-.** P.P. 9d.

★2½in 8/10 ohm Speaker. U.S.A. Type, **15/6.**

★ 0/15 volt A.C. 2½in. Flush mounting, **8/6.** P.P. 1/-.

★ Standard Volume Controls, ¼in dia., 3in spindle: 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 meg, 2 meg, **3/6**, less switch; **4/6** with switch.

★ Low impedance Magnetic mikes (no matching required) ½ x ½ x $\frac{3}{16}$in; ¾in dia. x ¼in deep; 1¼in dia. x ¼in deep, ⅜ x ⅜ x ¼in. Ideal for amplifiers and hearing aids, **15/-** each.

★ Driver and Output Transformer (matched to 3 ohms), **9/6** pair.

★ 0/40/120 double scale Milliammeter (D.C.) 2in, flush mounting, **10/-.** P.P. 1/-.

★ 4.7 volt 1 watt Zener Diode, **15/-.**

★ 2½in Square Quality Speaker, 3 ohm and 8/10 ohm, **16/6** each.

★ 2½in 80 ohm Speaker, excellent quality, **15/6.**

★ 600 ohm Personal Car Phone with jack and socket, **10/6.** P.P. 9d.

★ Mercury Batteries: 1.3V, 2200mA/H, ⅜ x 1in dia, **2/6**; 1.3V, 5000mA/H, 2 x ⅝in dia, **2/6**; 1.3V, 500mA/H, ⅝ x ⅝in dia., **1/3**; 1.3V, 14000mA/H, 2¼ x 1¼in dia., **5/-.**

ALL COMPONENTS IN STOCK for **'WEYRAD'** 6-Transistor Superhet. Booklet **1/3** post free. Leaflet on request.

★ Miniature ⅞in diam. x $\frac{3}{16}$in edge volume controls with switch: 5k and 10k, **7/6** each; 5k, **7/6**; 50k, **8/6**; printed circuit.

★ 1000 ohm Personal Phone with Leads and Jack Plug and Socket, suitable for most Commercial Transistor Radios, **15/6.**

★ 9.065 Mc/s 3rd Overtone Crystal for all 27 Mc/s Model Control Transmitters, **12/6.**

★ Personal Earphones used with RANGER 2 and 3. British made, **12/6.**

★ 7 x 4in, 25 ohm Speaker, **22/6**; 7 x 4in, or high quality 3 ohm Speaker, **20/-.**

★ Pocket Iron, 220/250V A.C./D.C. 30 watts, complete with mains plug, case, etc. Handle unscrews to cover element enabling iron to be carried in pocket. Only **18/6.** P.P. 1/-.

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★ 12 to 24 volt Blower Motor, **15/-.** P.P. **16/-.**

★ Speakers: 3 ohm, 3in, **15/-**; 25 ohm, **22/6**; 5in, 3 ohm, **15/-.** P.P. 1/-.

★208+176pF '00' tuner, with screw, **8/6.** P.P. 9d.

ALL TRANSISTOR FM TUNER PRE-BUILT UNITS: FULLY ILLUSTRATED BOOK, 3/6.

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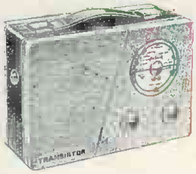
FULL AFTER SALES SERVICE—ILLUSTRATED BUILDING PLANS
● NO TECHNICAL KNOWLEDGE NECESSARY ●

DETAILS OF ANY MODEL ON REQUEST



"TRANSFIVE" PORTABLE

MEDIUM & LONG WAVE PORTABLE RADIO

- 325mW Push-Pull Output on 5in Speaker.
- Fully illustrated Plans.
- Easy to Build Printed Circuit.
- Carded Components.
- Mullard Transistors.

AFTER SALES SERVICE and FULLY GUARANTEED

Size $8\frac{1}{2} \times 6\frac{1}{2} \times 3\frac{1}{2}$in.

● Full coverage on Medium and Long wavebands. Excellent quality with full station separation. Car aerial socket.

TOTAL COST OF ALL PARTS **£6.19.6** P.P. 2/6.
NO EXTRAS TO BUY

● Building Plans and Prices FREE ON REQUEST ●

PRACTICAL TRANSISTOR CIRCUITS

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Contains easy to follow plans of 40 all transistor units, including light operated switches, amplifiers, transmitters, receivers, test oscillators, signal tracers, hearing aids, radio control, etc. All parts available separately.

● *Designed for the Home Constructor*

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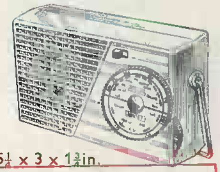
MEDIUM & LONG WAVE POCKET LOUDSPEAKER RADIO

- 250mW Push-Pull Output.
- Plainly marked Printed Circuit Board.
- 5 Mullard Transistors.
- Carded Components.

A new design, fully tunable on both wavebands. Guaranteed reception of Continental and local stations, including Luxembourg, anywhere with full station separation. Fitted Car Aerial and Earpiece Sockets.



Size $5\frac{1}{4} \times 3 \times 1\frac{3}{4}$in.

TOTAL COST OF ALL PARTS **£5.10.0** P.P. 2/-.
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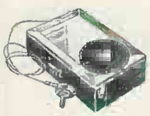
VERY EASY TO BUILD AND USE
You will be amazed by the performance

● Illustrated Instructions FREE ON REQUEST ●

★ RANGER 3 ★

NO EXTERNAL AERIAL OR EARTH—3-TRANSISTOR and 2 DIODES



Size $4\frac{3}{8} \times 3 \times 1\frac{1}{4}$in.

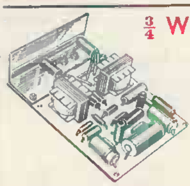
Personal Pocket Radio with 5 stages giving clear reception on medium wave, amateur top band and shipping.

- Easy to follow instructions with pictorial layout.
- Reception of **Radio Luxembourg** guaranteed (most areas).

Free Instructions and Price List on request. Easy to build.

ALL COMPONENTS
79/6 P.P. 1/6
NO EXTRAS TO BUY
Everything Supplied

$\frac{3}{4}$ WATT 4 TRANSISTOR AMPLIFIER



1 watt peak output.
$\pm$3dB 70 c/s to 12 kc/s.
Output to 3 ohm speaker.
9 volt operated.
Details on request.

Built and Tested
69/6 P.P. 1/6.

A printed circuit high gain amplifier size $4 \times 2\frac{3}{4} \times \frac{3}{4}$in using Mullard OC71/OC81D and 2-OC81 Transistors. Ideal for Intercomm., Record Player. Tuner Amplifier or any application requiring a quality and reliable amplifier.

3 TRANSISTOR AND DIODE PERSONAL POCKET RADIO

Quality Output on Personal Earphone.

A simple to build local station with personal earphone output. Built-in Ferrite Aerial and Battery lasting 9 months.

Size $4\frac{3}{8} \times 3 \times 1\frac{1}{4}$in.

ALL PARTS **37/6** P.P. 1/6

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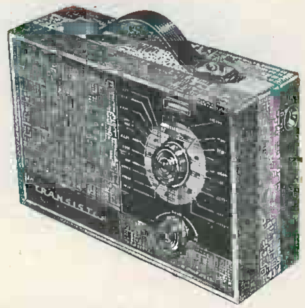
● $6–7\frac{1}{2}$ volt Garrard Turntable with crystal pick-up. Plays 45 r.p.m. Ideal for **1 Watt Transistor Amplifier. 79/6.** P.P. 1/6.

"CONTESSA"

6 TRANSISTOR MEDIUM AND LONG WAVE SUPERHET
★ TERRIFIC SENSITIVITY ★
UNBEATABLE IN PERFORMANCE AND APPEARANCE

COMBINED PORTABLE AND CAR RADIO



Employs the latest techniques. Double tuned IF'S, AVC and first-grade components are standard features. Excellent tone, sensitivity and selectivity on both wavebands. **Descriptive Leaflet on Request.**

★ 425mW Push-Pull Output.
★ 6 "Top-Grade" Ediswan Transistors.
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★ Full Medium and Long Wave Tuning.
★ High "Q" Internal Ferrite Aerial.
★ Car Radio Adaptation and AVC.
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TOTAL COST OF ALL PARTS **£10.19.6** P.P. 3/6
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★ RANGER 2 ★

PERSONAL POCKET RADIO

● Two Transistor Two Diode, fully tunable over Medium waves. Good reception of Radio Luxembourg. Size $4\frac{3}{8} \times 3 \times 1\frac{1}{4}$in.

All Parts **59/6** P.P. 1/6. **No extras to buy.**

● PICTORIAL PLANS AND DETAILS FREE ON REQUEST

TRANSISTOR TAPE RECORDER

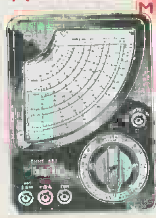
IDEAL FOR HOME, OFFICE OR TRAVEL

★ Built-in Quality Speaker.
★ Over 1 hour Play/Record.
★ Size $6 \times 8\frac{1}{4} \times 2\frac{3}{4}$in. Weight $2\frac{1}{2}$lbs.

SUPPLIED COMPLETE WITH MICROPHONE, TAPE, BATTERIES AND PERSONAL 'PHONE.
FULLY GUARANTEED. **12 GNS.**

★ POCKET TESTER ★

MODEL 200H



Volt-Ohm-Milliammeter.
★ Size $4\frac{1}{2} \times 3\frac{1}{4} \times 1\frac{5}{8}$in. Over 20 Scales.
20,000 Ohms/Volt!

Price, inclusive of Test Prods. Battery and instructions. **£6.19.6** P.P. 1/6.

Top Quality Meter—Fully Guaranteed.

10,000 ohm per volt version **£5.19.6** P.P. 1/6

POCKET IRON

★ Pocket Soldering Iron, 220/250V A.C./D.C. 30 watts, complete with mains plug, case, etc. Handle unscrews to cover element enabling iron to be carried in pocket, 18/6. P.P. 1/–.

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● EMI 4-Transistor Amplifier with speaker, tone and volume controls. Ready assembled. For use with crystal pick-ups as above. 6–9 volt operated. **89/6.** P.P. 1/6.

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