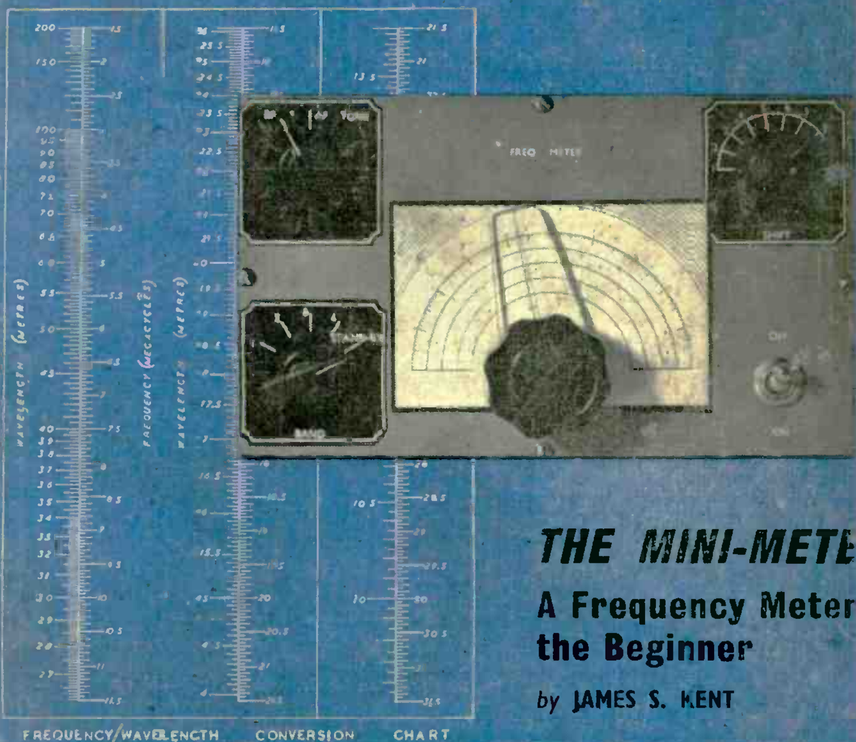
Introducing the Jason "Jupiter" Stereo Pre-Amp & Amplifier

VOLUME 11
NUMBER 11
JUNE
1958

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS



THE MINI-METER

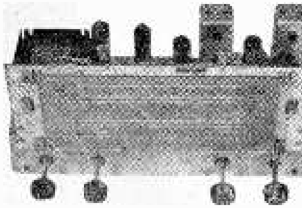
A Frequency Meter for the Beginner

by JAMES S. KENT

Included in this issue

"MINI-7" TRANSISTOR POCKET SUPERHET, Part 2
SELF-CALIBRATING TRANSISTOR TESTER, Part 2
3-VALVE MAINS T.R.F. RECEIVER
USING SURPLUS METERS
SIMPLE TRANSITRON OSCILLATOR
UNDERSTANDING TELEVISION, Part 6

DATA Publications 1/6



1958 RADIOGRAM CHASSIS

THREE WAVEBANDS	FIVE VALVES
S.W. 16 m.–50 m.	LATEST MULLARD
M.W. 200 m.–550 m.	ECH42, EF41, EBC41,
L.W. 800 m.–2,000 m.	EL41, EZ40

12 month Guarantee. A.C. 200/250V, 4-way switch. Short-Medium-Long-Gram. A.V.C. and negative feed-back. 4.2 watts. Chassis 13½" x 5½" x 2½". Glass dial 10" x 4½" horizontal or vertical available. 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Immediate delivery

BRAND NEW £10.10.0 Carr. 4/6

TERMS: Deposit **£5.5.0** and 6 monthly payments of **£1**
MATCHED SPEAKERS: 8" **17/6**, 10" **25/-**, 12" **30/-**

COLLARO
HIGH FIDELITY AUTOCHANGER

MODEL RC456

For 7", 10", 12" Records, 16, 33, 45, 78 r.p.m.

4 SPEEDS — 10 RECORDS
WITH STUDIO "O" PICK-UP XTAL

BRAND NEW IN MAKER'S BOXES

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Suitable player cabinets	**49/6**
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2 valve 2-stage amplifier and 6½" speaker ...	**72/6**
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Brand new and fully guaranteed 12 months

Designed to play 16, 33, 45, 78 r.p.m. Records 7", 10", 12". Lightweight Xtal pick-up, turnover head, two separate sapphire styli, for standard and L.P.

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SPECIAL SINGLE PLAYER KIT

COLLARO 4-speed Gram-Pick-up Unit	**£4 . 12 . 6**
Handsome portable case 17½" x 13½" x 7½"	**£2 . 5 . 0**
Ready-built 3 watt amplifier with two valves and 7" elip. speaker, printed circuit	**£3 . 12 . 6**

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465 kc/s slug tuning miniature can 2½" x 1" x 1". High Q and good band width. By Pye Radio. Data sheet supplied.
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For Cathode Ray Tubes having heater-cathode short circuit and for C.R. Tubes with falling emission. **Type A.** Low leakage windings. Ratio 1:1.25 giving a 25% boost on secondary: 2V, 4V, 6.3V, 10.3V, 13.3V, **10/6** each; ditto with mains primaries, **12/6**
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Ditto for 6 volt tubes, only **17/6** each
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All isolation transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE.—It is essential to use mains primary types with TV receivers having series connected heaters.

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HIGH STABILITY. ½W 1%, **2/-**. All preferred values 100Ω—10MΩ. Ditto 5% 100Ω—5MΩ **9d.** each.

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15 watt		2/-

15,000 ohms–50,000 ohms, 5W, **1/9**; 10W, **2/3**

WIRE-WOUND POTS Pre-set min. TV type. Knurled slotted knob. All values 25 ohms to 30k, **3/-** each. 50k, **4/-** Ditto Carbon Track 50k to 2 Meg, **3/-**
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W/W EXT. SPEAKER CONTROL 10Ω, **3/-**
O/P TRANSFORMERS. Heavy duty 50mA, **4/6.** Multi-ratio push-pull, **7/6.** Miniature 3V4, etc., **4/6.** Small pentode, **4/6.** Hygrade push-pull 7 watts, **15/6** Mullard "510" 6k or 8 kΩ. **30/-**
L.F. CHOKES 15/10H 60/65mA, **5/-**; 10H, 85mA, **10/6**; 20/15H, 120/150mA, **12/6**; 5H, 250mA, **15/-**
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CRYSTAL MIKE INSERT by Acos
Precision engineered. Size only 1⅜" x 3/16". Bargain price **6/6** No transformer required

HEATER TRANS. Tapped 200/250V 6.3V 1½A, **7/6**
ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d.**
0.3" FORMERS 5937/8 and cans TV1/2. ¾" sq. x 2⅜" and ½" sq. x 1⅜", **2/-** complete with cores
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3**
TYANA. Midget Soldering Iron. 200/250V or 230/250V, **16/9.** **SOLON MIDGET IRON**, 25W, **24/-**
MAINS DROPPERS. 3" x 1¼". Three adj. sliders, 0.3A 750 ohms, **4/3**; 0.2A 1,000 ohms, **4/3**
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MIKE TRANSF. 50-1, **3/9**; 100:1, potted, **10/6**
LOUDSPEAKERS. P.M. 3 ohm. 2½" and 5", **17/6**; 7" x 4" Goodmans, **21/-**; 4" Hi-Fi Tweeter, **25/-**; 8" Plessey, **19/6**; 6½" Goodmans, **18/6**; 10" R.A., **30/-**, 12" Plessey, **30/-**; 8" M.E. 2.5k field tapped, o.p. transformer, **24/6**; 15 ohm Plessey 10W 12", with tweeter, **97/6**; Stentorian HF1012 10" 3 to 15 ohms 10W, **99/6**
CRYSTAL DIODES. G.E.C., **2/-**; GEX34, **4/-**
40 CIRCUITS FOR GERMANIUM DIODES, 3/-
TUNING AND REACTION CONDENSERS 100pF, 300pF, 500pF, **3/6** each, solid dielectric
H.R. HEADPHONES 4,000 ohms, brand new, **16/6** pr.
SWITCH CLEANER FLUID, squirt spout, **4/3** tin
TWIN GANG CONDENSERS. 365pF, miniature, 1⅜" x 1½" x 1¾", **10/-**. 0.0005 standard with trimmers, **9/-**; less trimmers, **8/-**. Midget **7/6**; 50pF single, **2/6**

GARRARD 4-speed Single Record Player with GC2 Hi-Fi Xtal Turnover Head for 78 r.p.m. and L.P. Space required 14" x 12½", 2¾" above, 2 1/16" below. Model 4 SP—BARGAIN **£8** post free

Written guarantee with every purchase

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Buses 133 or 68 pass door S.R. Stn. Selhurst

Aluminium Chassis. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½" sides. 7" x 4", **4/6**; 9" x 7", **5/9**; 11" x 7", **6/9**; 13" x 9", **8/6**; 14" x 11", **10/6**; 15" x 14", **12/6**; 18" x 16" x 3", **16/6**

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Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.

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80 Ω Coaxial Cable

Semi-air spaced Polythene insulated ¼" dia. stranded core. Ideal Band III **9d.** yd
Losses cut 50%

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Air-spaced Coaxial **1/6** yd

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Sockets 1/- **Outlet Boxes** 4/6
Balanced Twin Feeder, per yd **6d.**, 80Ω or 300Ω
Twin Screened Balanced Feeder, 1/6 yd, 80 ohms
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P.V.C. CONN. WIRE, 10 colours, single or stranded, **2d.** yd. Sleeving, 1, 2mm, **2d.**, 2, 3mm, **3d.**, 6mm. **5d.** yd
5" **RADIO SCREWDRIVERS, 6d.** each
NEON MAINS TESTER SCREWDRIVERS, 5/3
SOLDER RADIOGRADE, 3 yds **9d.**, ¼lb **2/6**
Sentercel Rectifiers. E.H.T. Type Flyback. Voltages: K3/25 2kV, 5/-; K3/40 3.2kV, 7/-; K3/45 3.6kV, 7/6; K3/50 4kV, 8/-; K3/100 8kV, **14/6**
50 cps voltage 30% of above ratings
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Miniature Contact Cooled Rectifiers. 250V 50mA, 8/6; 250V, 85mA, **9/6. Selenium Rect.** 300V 85mA, **7/6**
Coils. Wearite "P" type, **3/-** each. Osmor Midget "Q" type, adj. dust core, from **4/-** each. All ranges
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2/450V	2/3	8+8/500V	6/-	16+16/450V	5/6
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16/450V	3/6	16/500V	4/-	64+120/275V	7/6
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Full Wave Bridge Selenium Rectifiers. 2, 6 or 12V 1½A, **8/9**; 2A, **11/3**; 4A, **17/6**. Free charger circuit
Charger Transformers. Tapped input 200/250V for charging at 2, 6 or 12V 1½A, **15/6**; 2A, **17/6**; 4A, **22/6**

12/6 PURETONE RECORDING TAPE
1,200ft on standard fitting 7" metal reels. Spare reels 7" metal, **2/3**; 5¾" plastic, 3/-; 7" plastic, **4/-**
SUPERIOR 1,200ft plastic tape, **21/-**, on 7" plastic reels

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Tunable Channels 8, 9 and 10, Gain 17dB, Cascode Circuit. Complete kit with ECC84 valve, plans and instructions, **29/6** less power, or **49/6** with power pack. Plans only, **1/6**

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Morse Keys, good quality, **2/6**. **Buzzers** 3/6

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Pocket receiver kit, 4½"x3"x1½" complete with cabinet, all parts and transistors. Super-regenerative circuit, price **99/6.**

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SUPERHET COIL PACK 27/6
Miniature size high Q dust cored coils. Short, Med., Long. Gram. switching with connection diagram. 465 kc/s i.f.

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Complete kit with cabinet 4½" x 3" x 1½". All components and instructions. **15/-**, or with pair of H.R. headphones to match, **30/-**

New boxed VALVES 90-day Guarantee

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1T4	8/6	6Q7	10/6	EB91	6/6	HABC80	12/6
2X2	2/6	6SA7	10/6	EBC33	8/6	HVR2A	7/6
3S4	8/6	6SJM	10/6	EBC41	10/6	MU14	10/6
3V4	8/6	6SN7	8/6	EBF80	10/6	P61	6/6
5U4	8/6	6V6G	7/6	ECC84	12/6	PCC84	12/6
5Y3	8/6	6V6GT	8/6	ECF80	11/6	PCF80	11/6
5Z4	10/6	6X4	7/6	ECF82	11/6	PCF82	11/6
6AM6	8/6	6X5	7/6	ECH42	10/6	PCL82	11/6
6B8	5/6	7S7	10/6	ECL82	12/6	PEN25	6/6
6BE6	7/6	12AH8	10/6	EF39	7/6	PL82	10/6
6BH6	10/6	12AT7	10/6	EF41	10/6	PY80	10/6
6BW6	10/6	12AU7	9/6	EF50	5/6	PY81	10/6
6CH6	10/6	12AX7	9/6	Equip.		PY82	10/6
6D6	7/6	12BE6	9/6	EF50	8/6	SP61	5/6
6F6	7/6	12BH7	10/6	Sylv.		UBC41	10/6
6H6	3/6	12K7	8/6	EF80	10/6	UCH42	10/6
6J5	6/6	12Q7	8/6	EF92	5/6	UF41	10/6
6J6	7/6	35Z4	9/6	EL32	5/6	UL41	10/6
6J7	8/6	80	10/6	EL84	10/6	UY41	10/6
6K6	6/6	807	6/6	EY51	12/6	U22	10/6
6K7	5/6	954	1/6	EZ40	10/6	X79	10/6

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"R.E.P. MINI-7"

(As described in this issue)

POCKET TRANSISTOR PORTABLE

AT LAST! A pocket-sized SUPERHET Transistor Portable for medium and long wave reception THAT REALLY WORKS, and at a price YOU can afford.

- Utilises 2 White Spot, 4 Red Spot and 1 R.F. Transistor **specially selected to our specification by leading manufacturer**
- Push-pull output
- Powered by two 3V miniature transistor batteries
- Attractive plastic case, finished in dove grey with scarlet knobs. Size only $5\frac{1}{8}'' \times 3\frac{1}{8}'' \times 1\frac{1}{16}''$
- Hi-Grade $2\frac{1}{2}''$ p.m. loudspeaker
- Ferrite Slab Aerial
- Drilled and eyeletted Paxolin Chassis

Easy to follow practical and theoretical diagrams and itemised price list available separately at 1/6, post free

NOTE.—For those who purchase the complete set of components from us we shall be pleased to carry out alignment of completed receiver for **15/–** plus p. and p.—**provided there are no faults in assembly.**

JASON!

We have long been noted as London's Leading Stockists. The combination of CLYNE/JASON is your key to satisfaction. All components stocked for the Jason Standard FM Tuner, Fringe Area FM Tuner, "Mercury Switch Tuned FM Feeder, "Argonaut" AM/FM Chassis, J.4-4 and J.2-2 Stereophonic Pre-amplifiers, etc. Your enquiries invited.

The "*New Look* RAMBLER" *(as described in May issue 1957)*

Your summer holiday will not be complete without our most popular All-dry Battery Portable Superhet, now available with a new cabinet of even more attractive appearance. Finished in two-tone RED/GREY "Lionide," it is washable and unscratchable. The standard cream plastic top panel, engraved in red and green, completes the overall "air of quality." This receiver has everything: quality, sensitivity, economy and ample volume. Employs a high quality 5" loudspeaker and the following popular readily obtainable miniature valves: 3V4, 1R5, 1S5, 1T4. All necessary components, including cabinet, can be supplied, ex-stock, at the *original* Special Inclusive Price of **£7.7.0** plus 2/6 p. and p. (less batteries). Uses all-dry 1.5V l.t. (1/6), 90V h.t. (10/–). Easy-to-follow instruction booklet containing practical and theoretical diagrams and itemised price list available separately at 1/6 post free.

RAMBLER MAINS UNIT

Enabling the above receiver to be used on a.c. mains, fits snugly into battery compartment. Completely self-contained in metal case measuring only $7'' \times 2\frac{3}{4}'' \times 1\frac{1}{4}''$. All necessary components ex-stock at only **47/6** plus 1/6 p. and p. or assembled and tested at **£3.5.0.** Instruction booklet and itemised price list available separately at 9d. post free.

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All components, as specified, available ex-stock, including headphones, at a Special Inclusive Price of **42/–** (less battery) plus 2/– p. and p. B114 battery 8/– extra. Instruction envelope and itemised price list available separately at 9d. post free.

AM, FM, AM/FM, CHASSIS, TUNERS, AMPLIFIERS, LOUDSPEAKERS, CABINETS, TAPE RECORDERS, RECORD PLAYERS, VALVES, COMPONENTS, Etc., Etc.

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Low voltage, halogen quenched

GEIGER—MUELLER TUBES at 55/- each

A large contract purchase from famous manufacturer enables us to make an exclusive offer of these highly sensitive gamma counters. Straight from production, individually tested and fully guaranteed.

Specification

- Effective length: 11.8cm. Standard British 4-pin base
- Background count: 90/min.
- Plateau: Minimum length 80V. Slope 5% per 100V
- Working potential: 400-450V
- Current: 0.001 µA to 1 µA at 100 to 6,000 c/min.
- Response: exceeds 30,000 c/m
- Dead time: 100 µsec. at 6,000 c/m. Rise time: 5 to 10 µsec. at 6,000 c/m
- Temperature range: —55°C to +60°C
- Gamma efficiency: 1%
- Stainless iron electrode

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HIGH FIDELITY AMPLIFIER

and Mk. 2 CONTROL UNIT

by Jack Cooper

A new addition to our Radio Reprint series (RR6), this book of 24pp., plus laminated plastic board cover, is a worth while addition to the Hi-Fi enthusiast's bookcase.

In addition to the material reprinted from our December 1957, January and February 1958 issues, two new chapters have been included, these giving much useful information on Signal Sources for use with the amplifier and on Choosing a Loudspeaker.

Complete circuit and constructional details of the balanced phase inversion amplifier are given, including point-to-point diagrams.

PRICE 2/6 *Postage 2d.*

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(By W.B.)

1¾" round. Depth 1". Impedance 3Ω 27/- tax paid
2" x 3" elliptical. Depth 1⅜". Impedance 3Ω 33/- tax paid
Sub-miniature Output Transformers for above:
Type A single ended, ratio 18.2/1
Type B push-pull, ratio 10.3/1
Type C push-pull, ratio 8/1
All ¾" x 7/16" x ⅝" 12/6 each

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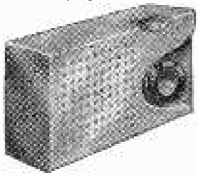
(Page 798)



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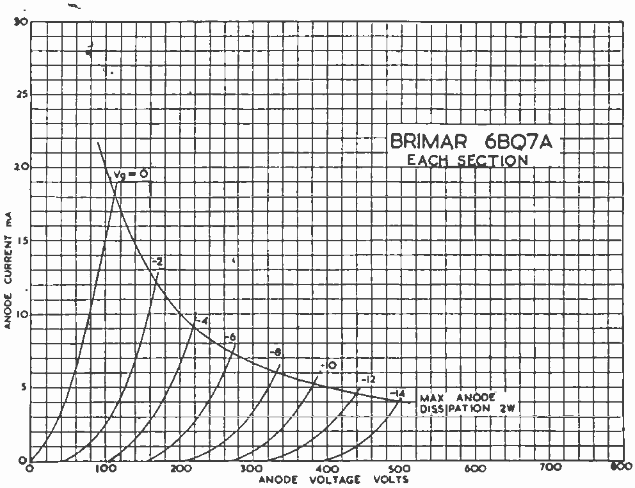
TYPICAL CHARACTERISTICS

Heater voltage	6.3 volts
Heater current	0.4 amp
Anode voltage	150 volts
Cathode bias resistor	220 ohms
Anode current	9mA
Mutual conductance	6.4mA/V
Amplification factor	39
Anode resistance	6,100 ohms
Grid cut-off voltage (I_a—10μA)	—10 volts approx.



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Radio Constructor

incorporating THE RADIO AMATEUR

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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

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TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

QUERIES. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

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Suggested Circuits

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

No. 91 A Simple Line Output Stage Protection Circuit

Over the last five years or so, line output stages in directly viewed television receivers have settled into a constant basic design form. This design form employs two valves, one of these being the line output valve and the other the booster, or efficiency, diode. The line output valve normally functions in the manner of a switch connected in series with the combined inductance provided by the line output transformer and deflector coils, whilst the booster diode rectifies, and causes to be stored in a reservoir condenser, energy which would otherwise be dissipated during the line cycle.

It is common practice for the line output valve to be biased by means of a grid leak returned to cathode and a series grid condenser. The drive waveform from the line timebase then causes grid current to flow at its positive peak, with the result that the grid condenser becomes charged and the average bias voltage appearing at the line output grid becomes equal to the average voltage, below the positive peak, of the drive waveform.

This set of conditions can only exist, however, during the time when the drive waveform is applied to the line output grid. If, due to a fault in the line timebase, the drive waveform stops, the line output grid at once assumes zero potential with respect to its cathode. At the same time the boosted h.t. voltage disappears, and the normal h.t. voltage is applied, via the booster diode and the line output transformer windings, to the line output anode. Despite the reduced h.t. voltage at its anode the line output valve, under conditions of zero bias, may now commence to pass a current well in excess of that normally maintained. This excess current can easily cause damage to the windings of the line output transformer and to the line output valve itself. Also, the booster diode, h.t. rectifier, and smoothing choke of the receiver may be similarly over-run, and may similarly suffer damage.

The risks which are undertaken by the use of a grid leak biased line output stage are not, of course, unknown; and attempts have been made, in various designs, to provide safety devices, or circuits, for the line output stage. The most obvious safety device is a fuse in series with the h.t. supply to the line output anode. Fuses of conventional type are not always successful here, unfortunately, this being possibly due to the fact that in some cases the overload current may only be of the order of two to three times the running current, with the result that long-term deterioration of the fuse may occur. What may be a more probable reason for the unsuitability of a fuse is the fact that some line output valves, especially when new, are liable to pass occasional heavy surges of current. These surges, being of an intermittent nature, can cause fuses to blow but may not damage the components or valves through which they flow. Slow-acting fuses would appear to offer an answer to the surge problem, provided that they can differentiate between overload and running conditions over very long periods of time.

The points just discussed can be amplified considerably but, whatever arguments are made for or against fuses, the fact remains that whereas it was commercial practice to insert fuses in series with the h.t. feed to the line output stage some years ago, such fuses are not now employed; and the main reason for their deletion is that they were liable to fail from time to time under what appeared to be quite normal conditions of operation.

It would appear from the above that some simple protection device for television line output stages is very desirable, and that it might be worth while attempting an approach which did not rely upon fuses. This month's circuit suggests a relatively simple method of applying protection, and it employs a technique for obtaining a negative voltage from a conventional television chassis which might be unfamiliar to some experimenters and which may help them to resolve design problems involving negative voltages in different applications. The circuit discussed this month is presented in the form of a possible modification to existing televisors, but it must be stressed that it may not function satisfactorily with all receivers. A simple check must first of all be carried out to see whether the modification can be fitted to any specific model, and this is also described. The safety modification cannot be used with receivers where the line output stage is of the self-running type.

Due to the fact that a number of steps are involved which require a reasonably good working knowledge of television circuitry, the writer would not really advise that the modification be attempted by the beginner who has had no television experience.

Checking for Suitability

The line output protection circuit operates basically on the very simple principle of disconnecting the earthy end of the line output grid leak from chassis and connecting it to a point which has a negative potential with respect to chassis. Provided that this negative potential is not greater than the average potential of the drive waveform

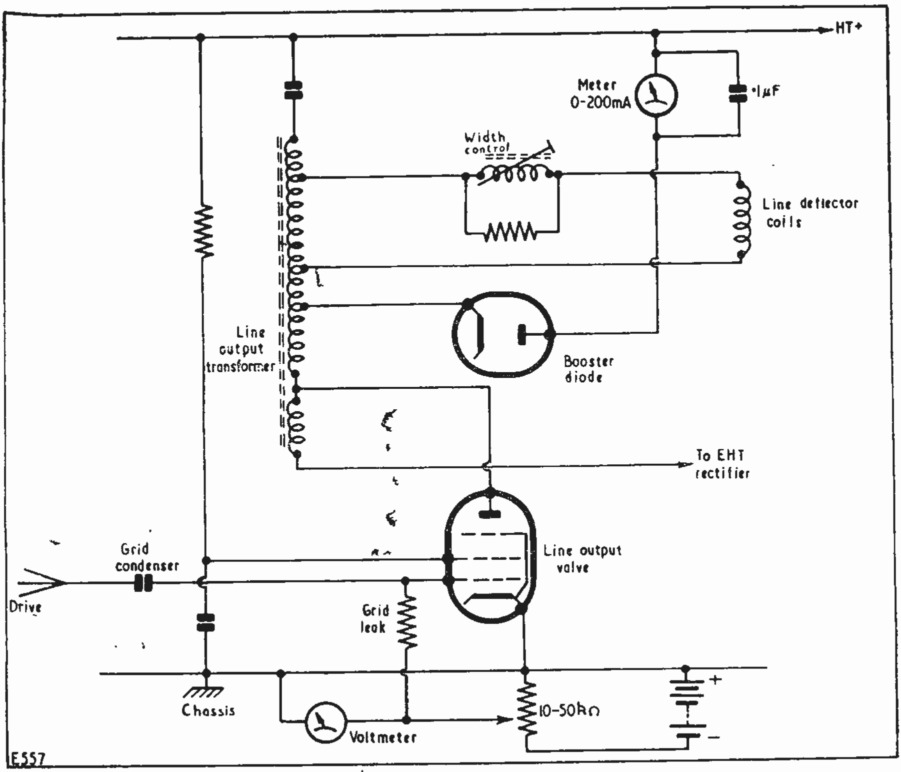

Fig. 1. A typical line output stage, illustrating how a check may be made to ensure that a protection circuit can be employed

below its positive peak, grid current will still flow at that positive peak and the grid should still receive the same input. In practice this supposition may not hold entirely true because the shape of the drive waveform may be qualified by the point, relative to the bias potential, at which grid current commences to flow. As a result the introduction of negative bias may cause a slight change in drive waveform shape, and this point has to be checked before the modification is fully carried out.*

Fig. 1 illustrates a simple test circuit which may be employed for checking the suitability of a line output stage for the safety modification. The earthy end of the line output valve grid leak is disconnected from chassis and is coupled to the slider of a potentiometer connected across a source of d.c., thereby enabling a continuously variable potential to be applied to the grid leak. The potentiometer should be positioned close to the line output grid leak, and should have a value of some 10 to 50kΩ. The source of d.c. voltage can consist of a suitable dry battery, and its potential should lie between 20 and 50 volts.

In order to maintain a check on operating conditions it is advisable to insert a meter in series with the h.t. supply to the line output anode before commencing the check for suitability. This meter would, preferably, be inserted in series with the connection to the booster diode anode, as shown in Fig. 1. The 0.1μF condenser connected across the meter provides a safety measure, insofar that it prevents pulse voltages at line frequency being built up across this instrument. (In the event that the experimenter may feel it more convenient to insert the meter in series with the line output cathode, it should be pointed out that this is rather bad practice. Even though the meter may insert a low amount of resistance, this will still almost certainly be large enough to upset the line output stage operating conditions.)

It is recommended in Fig. 1 that a voltmeter be connected between the slider of the potentiometer and chassis. The provision of a voltmeter at this position is not entirely necessary, provided that voltage readings may be taken after the potentiometer has been set to its final position. If only a single testmeter is available this could then be employed for checking anode current and, afterwards, for reading the voltage tapped off by the potentiometer. A sufficiently accurate idea of the voltage provided by the potentiometer during the check should be given by judging the amount of rotation given to its slider.

To commence the check of the line output stage it is first of all necessary to choose a period when a test pattern, such as Test Card C, is being transmitted. The slider of the potentiometer should be initially set to the earthy end of its track; this causing the line output grid leak to be at chassis potential, as would occur normally. The televisor should next be switched on and allowed to warm up for some ten minutes or so. (Line output stages usually take a little time to "settle down" to running conditions.) Carefully observing the screen, the slider of the potentiometer should then be slowly advanced until the negative voltage required by the line output valve for safe working conditions is reached.† This voltage will vary for different line output valves but will normally lie between 12 and 20 volts. If there is no variation in line linearity, width, brilliance, and anode current when this voltage is reached, then it may be assumed that the line output stage is capable of being modified. The reason for checking for changes in line linearity is that these would help in indicating changes in drive waveform shape. At the same time, changes in width would point to changes in waveform, and in e.h.t. voltage. It is doubtful if there would be any variations in brilliance which would not be accompanied by marked changes in any of the other parameters, but the point has of course to be observed.

The above check would be made more comprehensive if it were possible to measure the e.h.t. voltage and examine the drive waveform at the line output grid with an oscilloscope whilst the bias voltage was being adjusted. However, the writer has assumed that an e.h.t. meter and an oscilloscope may not be readily available to the experimenter.

If minor changes in any of the parameters just mentioned occur, the experimenter must decide whether these are sufficiently large to merit a decision against employing the safety modification. It should be borne in mind that if the application of negative bias causes a reduction in line output efficiency which does not seriously prejudice the entertainment value of the reproduced picture, there is still a slight risk of under-running the e.h.t. rectifier filament, with consequently shortened life.

It may be thought that the grid bias voltages mentioned above (12 to 20 volts) are rather high, especially when it is assumed that they would not upset line output stage operation. In practice these figures are not excessive, as the peak-to-peak value of the

* The fact that the protection circuit applies a negative fixed bias to the line output valve is the reason for stating that the circuit cannot be employed with self-running line output stages. It would be difficult to make such stages start without a preliminary condition of zero bias.

† For valves of the PL81 class this will be of the order of 16 volts or more. The valve manufacturers' literature should be checked for other valve types.

drive waveform in many televisors is frequently of the order of 100 volts or more.

After the check just described has been completed, it is advisable to switch off the receiver and allow the line output valve and efficiency diode cathodes to cool. The receiver may then be switched on again to ensure that the application of negative bias does not adversely affect operating conditions immediately after warm-up.

The Negative Bias

If the receiver has shown itself capable of being modified, it next becomes necessary to provide a negative voltage equivalent to that given by the battery and potentiometer. Fig. 2 illustrates how this may be done.

In Fig. 2 an 0A71 diode (now superseded by the 0A81—ED.) is connected to the a.c. developed across the bottom three heaters in the receiver chain. It is assumed that an r.m.s. a.c. voltage of approximately 18.9 (3×6.3 volts) is provided at this point. The diode functions as a rectifier, causing a d.c. voltage to be built up across the reservoir condenser C_1 and the load resistor R_2. Under these conditions a d.c. voltage of 20 to 25 should appear across R_2, these figures corresponding to a current flow through R_2 of 2 to 2.5mA. The peak inverse voltage given by the circuit (the d.c. voltage across the reservoir condenser plus the peak value of the applied a.c.) is of the order of 64 volts (assuming 25 volts across C_1) and this falls within the maximum inverse rating of 75 volts for the 0A71 at 60°C. ambient temperature. The 300Ω series resistor R_1 is included as a limiting component, and it limits the forward current to 100mA (the maximum specified for the 0A71 is 150mA) even under conditions of short-circuit in C_1. In practice, the value specified for R_1 is more than adequate, as the crystal diode does not, in the average receiver, even have to withstand switching-on surges (which could cause high peak currents to flow). This is due to the fact that the a.c. voltage appearing across the heaters normally rises slowly after the receiver has been switched on.

In order to apply the requisite proportion of the negative voltage developed across R_2 to the line output grid leak, it is first of all necessary to carry out the initial check mentioned above. R_2 may then be replaced by two resistors in series whose total value is 10kΩ, and at whose junction the required voltage appears.

As was mentioned above, the a.c. voltage assumed in Fig. 2 is 18.9 r.m.s. It is possible that some receivers may not have three 6.3 volt heaters at the earthy end of the chain, in which case it becomes necessary to tap off from the chain a suitable a.c. voltage for the rectifier circuit. In most instances it should be possible to obtain an a.c. voltage lying between 12 and 20 volts, and this should give sufficient negative voltage for the purposes required here. Due to the necessity of keeping within maximum inverse voltage ratings it would be unwise to employ a.c. voltages above 20 volts when an 0A71 is employed, unless the ambient temperature around the crystal diode is known to be low, a condition which does not always exist in television chassis. As a guide it is worth pointing out that at an ambient temperature of 25° C. the maximum inverse voltage rating of an 0A71 increases from 75 to 90 volts. If it is quite impossible to obtain a sufficiently low a.c. voltage, an 0A91 could be employed instead of the more commonly encountered 0A71. The 0A91 has a maximum inverse voltage rating of 100 at 75°C. ambient temperature. The use of an 0A91 involves no circuit changes.

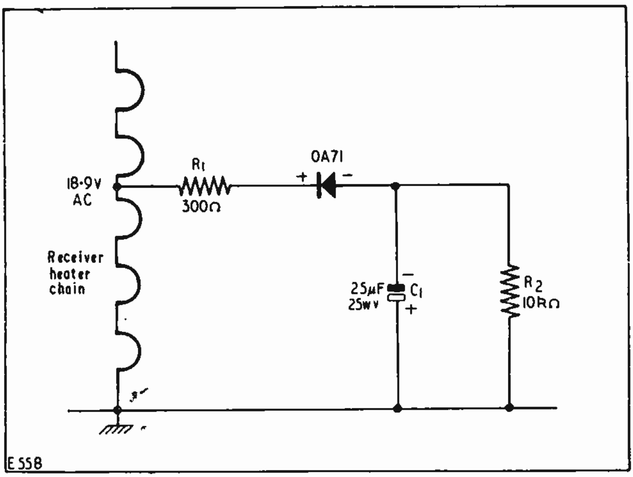

Fig. 2. Obtaining a negative bias voltage from the heater chain

In response to many requests from readers, Smithy the Serviceman, together with his able assistant Dick, continues to run the Workshop.

"SMITHY," CALLED OUT DICK DEJECTEDLY, as he entered the Workshop one sunny Monday morning, "you're looking at the world's original mug!"

The Serviceman, who had opened up the Workshop some minutes before and was holding a soldering iron close to his cheek preparatory to applying it to a chassis, started in surprise.

"Drat it," he complained vexedly. "Dick, you must never startle me like that again. You nearly made me burn myself with this iron. Thinking about it, though, I suppose I should say in all fairness that if you're a mug, so am I for not breaking myself of the habit of checking soldering iron temperatures against my cheek. I'll be branding myself for life one of these days."

This prospect did little either to increase or to relieve Dick's gloom. He merely nodded, as though the idea of elderly service engineers scorching their features with soldering irons every now and again was just an accepted part of existence.

"I'll never learn," Dick stated, after a period of moody silence. "I wouldn't mind so much," he added, "if my aunt hadn't warned me against doing precisely what I did."

"Just one moment," protested Smithy. "Whilst I am only too ready to offer sympathy, my present reaction to your statements is entirely one of curiosity. Also, I must remind you that, during the firm's time—which commenced precisely ninety seconds ago—we're supposed to be thinking of things connected with radio only. I don't quite know what it was that your aunt told you not to do, but the possibilities, where a young man like yourself is concerned, appal me."

"But it *is* to do with radio," lamented Dick. "The clanger I dropped was a technical clanger. And on, of all things, a simple four-plus-one medium and long wave set which had just gone weak on one of the bands."

Aunty's Advice

Smithy looked interested.

"We could do with some help around here," he commented, "and it's not everyone who has electronic aunts capable of dishing out good sound technical advice. D'you think she might be interested in working here?"

Despite himself, Dick grinned.

"This particular aunt of mine," he remarked, "is like the James Thurber woman who thought that, if you don't have bulbs in each light socket, all the electricity leaks out and gets around the house. However, there's one thing she's really good at, and that's making blackcurrant wine."

Dick paused reflectively for a moment.

"You're veering," Smithy remarked.

"Yes, I am rather," admitted Dick. "But I feel that it is entirely due to the stress of events. What happened is that I was at my aunt's place yesterday and I noticed that the little radio she uses was very weak on medium waves. With the result that I offered to have a look at it there and then."

"And what did your aunt say?"

"She was very pleased with my offer, but she asked me wouldn't it be better if I took it in to work, so that I could get what she described rather vaguely as 'meters' to assist me."

"She sounds a very sensible aunt to me," Smithy commented gravely.

"Well, the only meter she's ever seen," said Dick, "is the one she puts shillings in for the gas. But, as you say, she is very sensible. What is more, she turned out to be dead right. I, being big-headed and armed only with my trusty Woolworth's screwdriver, decided to tackle the set right on the spot, with the result that I made what can only be described as a complete and utter mess of it."

"I think I'll take over from here," commented Smithy, assuming a brisk, professional manner. "First of all, let me get an idea of the situation. What sort of set was it?"

"As I said just now," replied Dick, "it was a very simple little five-valve set. Four valves in the radio section proper, and one valve as rectifier. It was an a.c./d.c. medium and long wave model."

"Fair enough," said Smithy. "And the symptoms?"

"Well, the set worked O.K. on long waves, but on medium waves it was pretty weak and most of the stations had a whistle of some sort behind them."

"I presume that the whistles changed in frequency as you tuned through the stations?"

"That's right," said Dick. "You could go right through zero beat, but this didn't necessarily agree with the best tuning position. About the only local station which didn't have a whistle was the Light Programme on 247 metres, together with some of the stations between it and the high frequency end of the dial. Funnily enough, the Light Programme on 247 metres came up quite loudly, too."

"That's interesting," commented Smithy. "Did the stations come up on the correct parts of the dial?"

"I didn't bother to check," replied Dick. "In any case, is it important? After all, you know as well as I do that the tuning dials on some of the cheaper sets aren't all that accurate."

Smithy sighed a little but made no comment.

"Anyway," continued Dick, after a moment, "I decided that the best thing I could do was to whip the chassis out of the cabinet and give it a quick look through. I gave the grid of the double diode triode a touch and there seemed to be plenty of life in the a.f. section. And so I next had a go at the i.f.'s."

Smithy raised an eyebrow.

"What happened then?"

Dick looked a little shamefaced.

"Well," he explained, "I was working in a dark corner of the room and, when I popped my screwdriver into the first i.f. can I tackled, I must have done so at the wrong angle. Anyway, there was suddenly a hefty spark, which could only point to my having shorted out h.t. The spark was so unexpected that my hand jumped a little, whereupon I dug my screwdriver further into the can and, so far as I know, into the i.f. coil itself. Anyway, the set at once expired and that was that."

"What did you do next?"

"There wasn't much I *could* do," said Dick lamely. "With only a screwdriver to help me I felt that the best thing I could do in the circumstances was to leave the set at my aunt's house and go back tonight with a new i.f. transformer."

"Well, all I can say," commented Smithy, "is that it was a good thing that this happened at your aunt's place. Because she will, at least, keep quiet about your abortive attempts to fix her set. And to think that, only last month, I was commending you on your abilities, and telling you that I was prepared to let you loose in customers' houses."

"I suppose I did make a pickle of it," confessed Dick, "but, after all, I needn't have told you about it!"

"That's true enough," Smithy remarked, unbending a little. "And I suppose that we all have our off-days now and again. Anyway, I don't like the thought of that set lying around in your aunt's place so perhaps you could pop round at lunch time and bring it in. We'll get some 'meters' on it in here this afternoon."

"O.K. Smithy," said Dick gratefully, "and thanks a lot. Don't forget that, after we've fixed the damage I did to the i.f. transformer, we still have to find the original fault. Let's hope it doesn't take too long."

"I already have a fairly good idea where it is," remarked Smithy, grinning at Dick's surprised expression, "but I'm not entirely certain, and so I won't say any more until we've got the set on the bench."

With which remark Smithy left the somewhat mystified Dick to his own devices, and proceeded to start on the day's work.

Basic Analysis

During the midday break Smithy's assistant picked up his aunt's receiver and brought it back to the Workshop. Smithy was engaged in his lunch time crossword puzzle when Dick re-entered.

"As this set is going to be repaired 'on the house'," the Serviceman remarked, looking up from his newspaper, "it mightn't be too bad an idea if you devoted the last ten minutes of your lunch time to at least fixing up the mischief you did last night."

Now that Dick had the offending receiver in front of him his spirits had risen considerably. Like many people engaged in servicing work, one of the things which occasionally plagued him was the thought of an annoying fault which could not be tackled, merely because the chassis was not immediately available. The bedtime beverage advertisements which refer to such events as bus conductresses punching tickets in the small hours of the morning could well depict a service engineer tossing in his bed whilst mentally analysing faults on a tantalising chassis many miles away at work.

of wire left on the condenser and I'm re-soldering it up now."

"Fair enough," said Smithy. "And let that experience be a warning against poking metal screwdrivers into the i.f. transformers of sound receivers unless you're certain you're locating with the core or trimmer screw. In most sound receivers the i.f. primaries run straight from the h.t. line, which means that if you short them to chassis you get a spark which is as big-and fat as the electrolytic across h.t. can make it. Shorting out the h.t. supply rarely puts new life into a receiver; and the firework display can often make you jump and damage something else as, indeed, happened last night. I think I should add that the risk of shorting h.t. used to be far worse with some of the older i.f. transformers, even when your screwdriver was located with their trimmers in perfectly legitimate fashion.

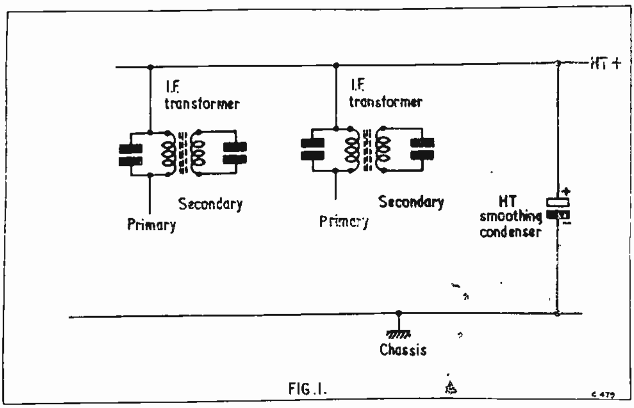

Fig. 1. In a conventional sound receiver the i.f. transformer primaries are connected directly to the h.t. positive line. Accidental short-circuits to chassis during alignment are, in consequence, liable to cause heavy sparks

Dick made a comment about "heartless guv'nors grinding the faces of their juniors" and proceeded to work on the receiver. Behind the cover of his newspaper, Smithy grinned to himself.

Shortly afterwards, the Serviceman made the last entry in his crossword, gazed at the completed puzzle triumphantly, and put his paper away. He then rose from his chair, lit a cigarette, and wandered over to Dick.

"Well, how's it going, lad?" he asked.

"Not too bad, Smithy," replied Dick. "I hadn't done too much damage with my screwdriver after all. The fat spark I got last night must have been caused by my touching h.t. positive inside the can (Fig. 1), but the only harm I did was to break one lead of the condenser across the primary away from its tag. Fortunately, there's plenty

The adjusting screws of these trimmers often had h.t. on them and you had to guard quite carefully against causing damage because of this. Whenever I lined up transformers of this type I always tried to use an insulated trimming tool. If an insulated tool wasn't available I would follow a second-best course of fitting a little sleeving over a metal screwdriver (Fig. 2). This gave a fair degree of safety. There aren't so many i.f. transformers of that type knocking about these days, but it's a point you want to watch."

Whilst Smithy had been talking Dick had repaired the i.f. transformer and had re-fitted it to the chassis. He was about to reach over for the output lead from the bench signal generator when Smithy stopped him.

"Did you touch any of the i.f. cores last night?" he asked.

"No," replied Dick, "they're all in the same position as they were when I started."

"I see," said Smithy, thoughtfully. "In that case, I'm going to take the risk that the i.f. transformer you've just repaired is now O.K., and I'm going to start off from exactly the same point that you did last night."

With this comment Smithy plugged the receiver into the mains supply and connected a short aerial to it. (Apart from final check purposes, Smithy rarely used the large outside aerial for repairing sound receivers. On the assumption that most of his customers employed a few yards of wire around the picture rail as an aerial, he did nearly all his work on sound receivers with aerials of similar type inside the Workshop.)

Smithy switched on the receiver and set the wavechange switch to the long wave position. After a few moments the set commenced to function.

"Ah, there we are," commented Smithy, adjusting the controls. "Now, let's first of all tune in a station. The Light Programme on 1,500 metres will do very nicely. As you can see, this is appearing almost exactly at the correct point of the tuning scale. Your comment this morning about not relying on the accuracy of tuning scale calibration may be true enough for small deviations. If you have large deviations, however, you should begin to suspect things. That is a point we shall check in a moment when we try out this set on medium waves.

"In the meantime I would like to show you that you can often get a rough idea of what the i.f. alignment of a sound receiver is like by swinging the tuning condenser across a station. This is especially true on the long wave band where a relatively large movement of the tuning condenser causes only a small change in oscillator frequency. Now, in this receiver the i.f. alignment seems to be quite reasonable. The signal appears to weaken symmetrically on either side of the correct tuning position, and even my own ageing ears can detect some slight top-cut when we're spot on tune. I would say that the i.f. transformers here are as well aligned as are those of any other low to middle-fi receiver of this class. I'm not saying that a little run through with the signal genny wouldn't raise an added dB or so; but we shan't bother about that yet, as we have a little more important business in hand."

Smithy switched to medium waves and experimented with the tuning condenser.

"Ah," he said, with some satisfaction, "my hunch appears to be correct. You said this morning that the Light Programme on 247 metres was clear of whistles and that it wasn't as weak as other stations on the band. As a matter of fact it's coming up here at about 280 metres. Now our local Home Service is on 285 metres* and here it is now."

Dick looked at the tuning scale interestedly.

"Why, it's appearing at 350 odd metres."

"Exactly," Smithy replied. "Now why do you think that should be?"

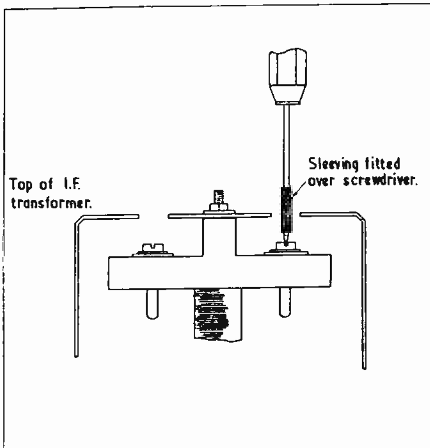

Fig. 2. I.F. transformers of older types had trimmers whose adjusting screws frequently connected to h.t. positive (sometimes via the primary coil). A safety precaution whilst aligning such transformers consists of fitting sleeving over the screwdriver used for trimming

"Just a moment," said Dick. "Let me think. Now, if the stations are coming up at the wrong parts of the dial it means that the oscillator is tuning at the wrong frequency; because it is the oscillator which, by converting it to the intermediate frequency, really selects the signal you receive. The tuning condenser needs a little extra rotation past the correct scale position for a station at the high frequency end of the band, and a lot of extra rotation past the correct scale position for a station lower down. This means that the tuning condenser has to provide more and more capacity, as you go lower in frequency, to bring in the stations you want."

"Well?" prompted Smithy.

Dick pondered.

"Why, of course!" he exclaimed. "The oscillator tuned circuit has a padding con-

* Readers wishing to trace the locality of the Workshop by this information are reminded that Smithy is liable, at times, to prevaricate a little if this assists his argument!

denser in series with it (Fig. 3), and if this has gone low in value the tuning condenser has to make up the loss itself. The effect is bound to get worse as you go down the band in frequency, because it's at the bottom of the band that the padding condenser has greatest effect. Now, why in heaven's name didn't I tumble to that before?"

falling out of the coil, the first would argue a really ham-handed tinkerer getting at the set, and there's no history of that here." Dick looked a little uncomfortable. "The second eventuality, that of shorted turns, is credible but is one of those things that only happens once in a blue moon.

"I'm a little puzzled, though, at the fact that you didn't notice that sensitivity and background hiss dropped progressively as you went down the medium wave band. At this time of the year Continental stations don't come up at full strength until quite late in the evening, so I suppose you may not have heard enough stations to make comparisons at different parts of the band. Also, so far as background hiss is concerned," Smithy added, gently, "this *can* be masked if the tone control is adjusted for maximum top-cut."

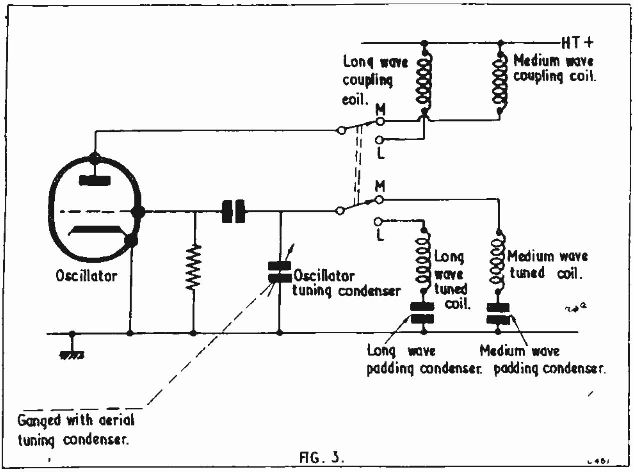

Fig. 3. In order that it may cover the requisite tuning range, the oscillator coils of sound receivers normally have padding condensers connected in series. Shifts in padding capacity cause bad tracking and result in incorrect tuning scale calibration

Lining Up

"Why, indeed?" answered Smithy, drily. "Anyway, as I said before, we all have our off-days, and so I don't suppose I should criticise. It just happens that your off-days spread over greater periods than other people's!

"However, to return to your diagnosis, you're almost certainly correct. If I had been in the position you were in last night I would have proceeded in the same manner as we have done up to now. I would first of all have given the set a quick run over the bands and, whilst on long waves, I would have made a rough check of i.f. alignment in the manner I've just described. A check of this type doesn't take a second and can be particularly useful if you're working without instruments.

"The incorrect positioning of the stations on the medium wave scale would have stuck out a mile to my mind, whereupon I would immediately have suspected a low capacity padding condenser. With the qualification, however, that the oscillator dust core could be madly out of alignment or that the oscillator coil might have lost inductance due to shorted turns. Both of these possibilities are remote. Apart from the core actually

"I seem to have broken every rule in the book," wailed Dick. "I shall have to take a lot more care in the future. Anyway, let's have a look at that padding condenser."

Whilst Dick located and checked the padding condenser, Smithy remarked that he would almost certainly find it to be a fixed component. "You don't often find variable padders these days," remarked the Serviceman.

Cause and Effect

After a further ten minutes or so Dick had checked the offending condenser, found it to be, in fact, low in value and had replaced it. On switching on again the receiver reverted to its correct performance. Dick quickly touched up the alignment and finally pronounced the set as being repaired.

"Excellent," said Smithy, "and, as you can now hear, all the heterodynes have disappeared from the band. This being due, of course, to the fact that the set is tracking properly and the aerial coil is able to let the right signals in and keep the wrong signals out."

"My aunt will be very pleased about this," said Dick. "So don't be surprised if you find a bottle of blackcurrant wine on your bench tomorrow morning!"

A light of understanding suddenly shone in Smithy's eyes.

"Am I correct in assuming," he said, slowly, "that your aunt makes *lots* of wine?"

"Oh, yes," said Dick innocently, "she's always at it. Every now and again one of her bottles of wine blows a cork, but she just takes it in her stride!"

"And could I also be right," continued Smithy, "in assuming that you might have had a glass of it last night before you started work on the set?"

"Oh, I had quite a few glasses," replied Dick readily. "I think it's very nice wine."

Smithy chuckled.

"Young man," he laughed, laying a hand on Dick's shoulder, "I have decided that your mistakes of last night are to be forgiven and forgotten!"

Dick looked up at the Serviceman with a surprised expression on his face. But all the queries he put to Smithy only elicited mocking laughter, with no attempt at a serious reply whatsoever.

A *miniature* TEST CLIP

By **D. F. MARSHALL**

With the advent of transistors and other miniature components, the conventional crocodile clip becomes far too large and clumsy for experimental use. A simple type of miniature clip which is both suited to current circuit requirements as well as being capable of easy manufacture by the home constructor, is outlined in Fig. 1.

The body of the clip is made from the polythene inner of standard coaxial cable, the inner conductor being removed. A groove is cut in the body to a suitable depth to accommodate the terminating wire of the components in use. This groove is most easily cut by running the tip of a hot soldering iron around the co-ax. Any proud portions thrown up by the use of the iron may be removed by gentle sandpapering.

The clip itself is made of some material such as piano wire. (A suitable source is the B or G string of a guitar—this also has the merit of temporarily suspending unwanted skiffle interference.) The clip is bent into shape at the "working" end with a small pair of wiring pliers and then inserted into the polythene body. The lead-out is then made by bending the central conductor at right-angles to the body, twisting the lead-out wire around the conductor, finally bending the central conductor back on itself along the body of the clip. To finish the whole assembly a rubber sleeve is slipped over the end of the clip.

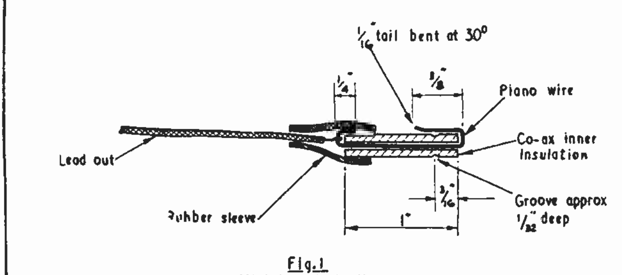

Fig. 1
Miniature test clip

UNDERSTANDING TELEVISION

PART 6

By W. G. MORLEY

The sixth in a series of articles which, starting from first principles, describes the basic theory and practice of television.

In last month's issue we introduced the subject of cathode ray tubes and described the basic operation of electron gun assemblies. We also devoted some time to the development history of the cathode ray tube up to its present form. This month we shall proceed to some of the essential factors of cathode ray tube design.

Beam Deflection

Up to the present we have discussed the beam of electrons which is emitted by the cathode of the electron gun, and which is accelerated towards the screen of the cathode ray tube by its anode or anodes. We have not as yet described how the beam is deflected nor how it can be made to focus at the screen. These points we shall now commence to examine.

It is possible to focus or deflect a beam of electrons in a cathode ray tube either by electrostatic means or by magnetic means. In television receivers either electrostatic means or a combination of electrostatic and magnetic means may be employed for focusing, whilst deflection is almost always carried out by magnetic means. This is a different technique from the method of deflection employed in cathode ray tubes intended for use in oscilloscopes and similar instruments, wherein both focusing and deflection are carried out electrostatically.

Although electrostatic deflection is hardly ever employed in cathode ray tubes intended for television purposes, it would be of assistance if we were to quickly examine the techniques it employs, as these principles help in the understanding of electrostatic focusing.

Fig. 27 illustrates the basic requirements of an electrostatic deflection system. In this diagram the beam of electrons travelling towards the final anode is made to pass between two pairs of parallel plates mounted consecutively at right angles to each other. The purpose of the pair of plates marked "X" is that of deflecting the beam in the horizontal direction, whilst the purpose of the plates marked "Y" is that of deflecting the beam in the vertical direction. Control of the degree of deflection is then obtained by the simple process of applying certain potentials to the plates.

The functioning of either of the two pairs of plates may be understood with the aid of Fig. 28, wherein we have a beam of electrons passing through one pair of plates. In Fig. 28 (*a*) it is assumed that the top plate has a potential which is more positive than that of the lower plate. In consequence, the electrons of the beam become attracted towards the more positive top plate and are repelled by the more negative lower plate, and the beam is deflected upwards. In Fig. 28 (*b*) the reverse holds true. In this case the lower plate is made more positive than the top plate, with the result that the beam is attracted towards it and is repelled from the top plate, and the beam becomes deflected downwards. The amount of deflection suffered by the beam varies according to the potential difference existing between the two plates and, because of this, it becomes possible to apply any desired amount of deflection to the beam by varying this potential difference.

the first instance the fixed deflection would cause a stationary spot to appear on the screen of the cathode ray tube whilst, in the second instance, a line would be traced out. If the deflection plates were employed in a television cathode ray tube, a continually changing potential would be applied, and this would take up the form illustrated in

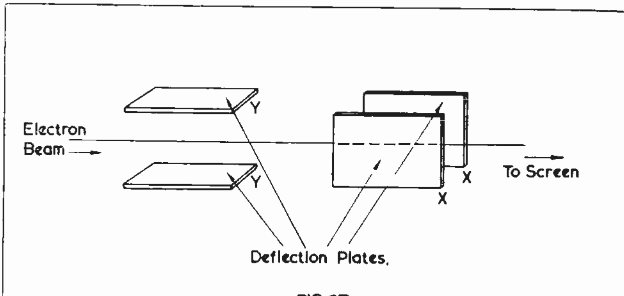

FIG. 27

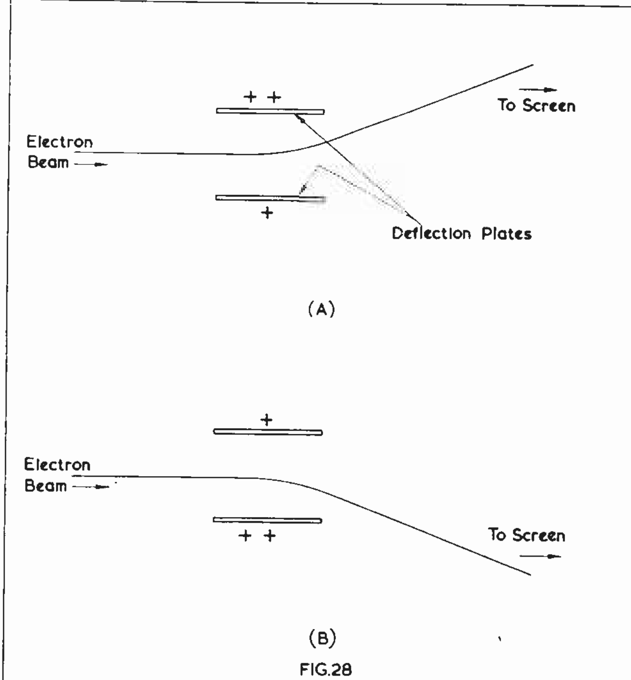

FIG. 28

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Fig. 27. How horizontal and vertical deflection of an electron beam may be obtained by electrostatic means. Fig. 28 (a). Simplified diagram illustrating the action of a pair of deflection plates. The symbols "+" and "++" indicate lower and higher positive potentials respectively. Fig. 28 (b). If the lower deflection plate has the higher positive potential, the beam is deflected downwards.

If desired, the potential difference between the two plates may be fixed, whereupon a constant deflection of the beam results; or it may be continually changing, whereupon the beam becomes deflected accordingly. In Fig. 29. Due to its shape the waveform shown in this diagram is known as a *sawtooth waveform*, and it is interesting to note the manner in which it deflects the electron beam. Let us assume that point A in Fig. 29 corresponds to the case where the top deflection plate of Fig. 28 is most positive with respect to the lower plate. The beam will in consequence be deflected upwards by the greatest amount. As we proceed along the waveform the positive potential decreases until we reach point B, at which point both plates hold the same potential. Between points A and B the beam will have suffered less and less deflection until, at point B, there will be no deflecting force acting upon it at all and it will pass straight between the plates. After point B the top plate becomes more and more negative with respect to the lower plate, and the beam now becomes deflected downwards, the amount of deflection still being proportional to the potential difference between the plates. At point C the beam undergoes the greatest amount of downward deflection. We next proceed to point D, and in so doing, quickly revert to greatest deflection in the upward direction again.

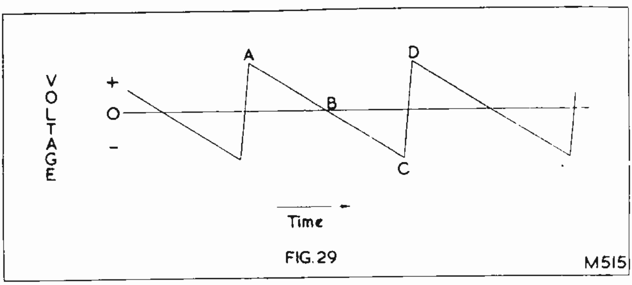

Fig. 29. A sawtooth waveform. This could be illustrative of the potential difference applied to a pair of deflection plates in a television cathode ray tube.

The cycle of events just carried out is exactly what is required for the deflection of the beam for television purposes. The relatively slow deflection of the beam which occurs between points A and C provides the movement required for scanning, whilst the relatively quick movement between points C and D provides the retrace.

Returning to Fig. 27, in which we have the two sets of deflection plates at right angles to each other, we now become able to deflect the beam over the scanning pattern required by the television system. The two "X" plates of Fig. 27 will provide our horizontal deflection, and so we may apply to these plates a sawtooth whose frequency is the same as that employed for horizontal deflection at the transmitting camera. The two "Y" plates will provide vertical deflection, and we may therefore apply to these plates a sawtooth waveform whose frequency is equal to the frame frequency at the transmitting camera. Provided that we keep our sawtooth waveforms synchronised with the deflection waveforms at the transmitter, we then become able to reproduce the required picture.

This description of electrostatic deflection has been of value to us here not only because it helps in an understanding of electrostatic focusing but also because it introduces, in a very simple manner, the sawtooth waveform which is employed in television for purposes of deflection. We do not want to spend much more time on electrostatic deflection but, before carrying on, it must be mentioned that the potential held by the deflection plates relative to the cathode of the tube is normally of an order which does not cause interference with the accelerating action of the anode or anodes in the cathode ray tube. Thus, in a typical practical tube, the deflection plates may have a potential approaching, or equal to, that of the final anode. This could result in the deflection plates having an average potential of, say, 1kV positive of cathode, whilst the sawtooth applied to them causes their individual potentials to shift by, say, 100 volts negative and positive of this average.

As was stated above, electrostatic deflection is not employed in modern television cathode ray tubes. This is due to the fact that the wide deflection angles dictated by the economics of receiver production necessitate very high sawtooth voltages. These are not easy to generate and raise difficulties due to the attendant risks of flashover and breakdown. Also, electrostatic deflection is liable to introduce a basic form of distortion at the edges of the scan, this being caused by the fact that, for wide deflection angles, the amount of deflection provided at the edges is not directly proportional to the applied deflecting voltage.

Electrostatic Focus

Whilst electrostatic deflection is not of much help in modern television receivers, electrostatic focusing provides a considerable advantage. This is because it obviates the necessity of employing bulky and relatively expensive magnetic focusing units.* Television cathode ray tubes employing electrostatic focusing have been in use in this country for several years and, so far as commercial manufacture is concerned, may eventually completely oust tubes which require magnetic focusing.

(It should be pointed out that all television cathode ray tubes, whether "electrostatic" or "magnetic"—the term qualifies the type of focusing required—employ an elementary form of electrostatic focusing by reason of the action of the grid-cathode assembly. However, this only provides preliminary focusing of the beam inside the electrode structure, and not on the surface of the screen.)

Electron optics† is not an easy subject, and it would be best, at this stage, to content ourselves with fairly elementary examples of "electron lenses." It first of all becomes necessary to consider, in simple terms, the action of an electrostatic field on an electron in motion.

In Figs. 28 (*a*) and (*b*) we saw that, if we have two deflection plates on either side of the electron beam, the electrons in that beam are attracted towards the plate which has the higher positive potential, and are repelled by the plate which has the lower positive potential.

An alternative method of showing this effect consists of drawing lines of electrostatic force between the two plates, as shown in Fig. 30 (*a*). In the diagram arrows are given to the lines of force, these indicating their direction, which is always towards the higher positive potential. These lines of force, incidentally, constitute an electrostatic *field*. If an electron enters this electrostatic field, as it does in Fig. 30 (*b*), the lines of force act on the electron and cause it to be deflected in the direction of the arrows. In Fig. 30 (*b*) the electron is only partially deflected by the electrostatic field through which it travels. If the electrostatic field had been greater (i.e. if the upper plate had been made more positive) the electron would have been deflected through a greater angle; this culminating in the case where, with a sufficiently strong field (i.e. with the upper plate made more positive again) the electron would actually be forced to move in the same direction as the lines of force and would end up by striking the upper plate itself. Also, the electron would be deflected through a greater angle than it is in Fig. 30 (*b*) had it stayed in the electrostatic field for a longer time. This longer time would occur if either: (*a*) its velocity were reduced or, (*b*) the plates were made longer, causing a consequent lengthening of the field.

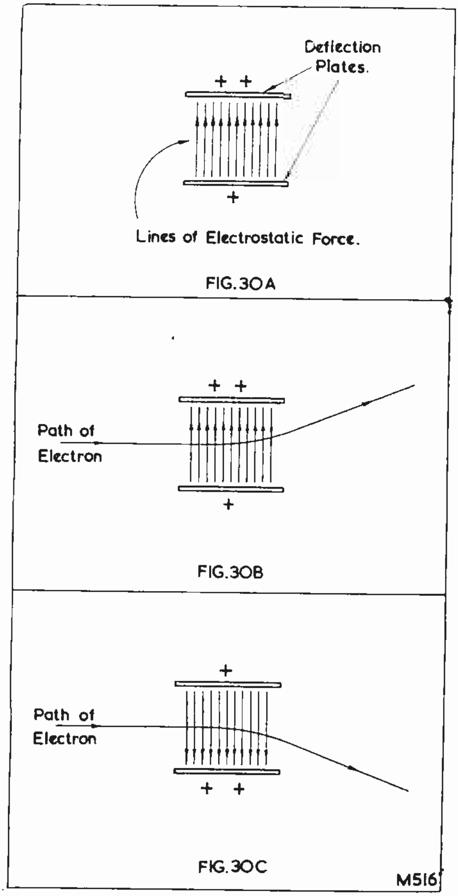

Fig. 30 (a). An electrostatic field exists between two electrodes when a potential difference exists between them. Fig. 30 (b) and (c). The electrostatic field causes electrons to be deflected in the same direction as the lines of force.

If the electrostatic field shown in Fig. 30 (*b*) is reversed by making the lower plate more positive than the upper plate (see Fig. 30 (*c*)), then the direction of the lines of electrostatic force would be in the downward direction, and the electron would consequently become deflected downwards.

*Magnetic focusing is dealt with in next month's issue.

†The process of treating electron beams as rays of light and of controlling their direction of movement by means of electrostatic fields.

It will be noticed that Figs. 28 (*a*) and (*b*) and Figs. 30 (*b*) and (*c*) are almost identical, with the exception that Figs. 30 (*b*) and (*c*) show lines of electrostatic force whilst Figs. 28 (*a*) and (*b*) do not. In Figs. 28 (*a*) and (*b*) we contented ourselves with saying, in effect, that an "electron is attracted towards the more positive plate, and is repelled from the more negative plate."

In Figs. 30 (*b*) and (*c*) we, somewhat more "correctly," considered the deflection of the electron in terms of the force exerted upon it by the electrostatic field through which it passes. The important point to remember is that the field always attempts to make the electron travel in the same direction as its lines of force.

and commences to accelerate towards it. Should the electron leave the cathode in a direction which would cause it to travel through the exact centre of the grid aperture, then the lines of force between grid and cathode are symmetrical about it and it would travel unimpeded along the straight line ABC. If, however, the electron leaves the cathode at an angle it becomes acted upon by the lines of force through which it passes. An electron travelling along the path AD would, for instance, find itself meeting a field whose direction is such that it tends to force it back to the cathode again. The acceleration provided by the positive anode causes the electron to continue forwards, however, with the final result that it traces

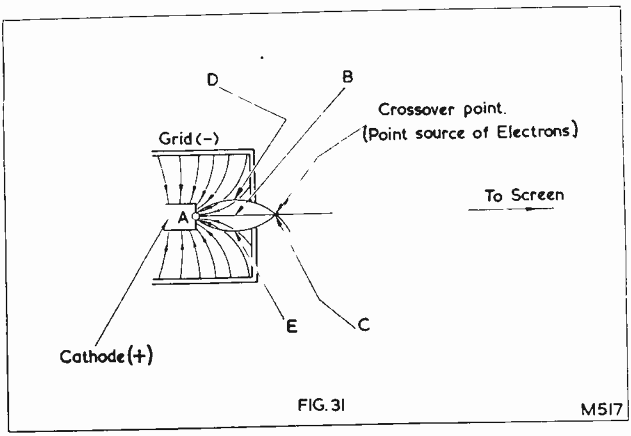

Fig. 31. The elementary focusing action provided by the grid and cathode of a cathode ray tube.

out the path ADC. Another electron can, in the same fashion, be caused to travel along the path AEC, and so on.

First Focusing Action

The first focusing action which is given by a cathode ray tube occurs in the cathode and grid assembly. This is the elementary process referred to previously in parentheses which is common to both "electrostatic" and "magnetic" tubes. The electrostatic forces present here are illustrated in Fig. 31, wherein we see the lines of force which exist between the grid and cathode. The direction of these lines of force is from grid to cathode, this being due to the fact that the grid is, conventionally enough, negative of the cathode. A further electrostatic field is provided by the positive anode (or anodes) following the grid. This anode is not shown in the diagram nor is the field it provides; and it will be adequate enough here to consider it as applying an accelerating force to electrons as soon as they leave the cathode.

When an electron leaves the cathode it at once falls under the influence of the anode

The result of the forces acting upon the electrons leaving the cathode is that all these are made to pass through point C, whereupon it could be said that they become focused at this point. Point C, the crossover point, is only slightly forward of the grid, and, at first sight, may seem to serve no obviously useful purpose. Nevertheless, point C offers the advantage of functioning as a *point source* of electrons, thereby enabling a second lens to cause a second focusing action to occur with the crossover point at the cathode ray tube screen itself. We know that this second lens may be either electrostatic or magnetic, but we shall concern ourselves this month with the electrostatic lens only.

The Electrostatic Lens

A typical electrostatic lens is shown in

Fig. 32. In th's diagram we see the electron point source given by the cathode and grid assembly, this being followed by the lens itself. The lens consists basically of two consecutive electrodes having large apertures, each being connected to a positive source of supply. In the diagram the two electrodes are shown as having similar shapes, but, as will shortly be seen, this is not entirely essential. The second electrode may be part of the final anode or a separate final anode could follow the lens.

positive potential. Directly between the inside surfaces of the two electrodes the lines of force are largely straight, but at the aperture edges they curve out in the manner illustrated. It is these curved lines of force which perform the focusing action.

Electrons leaving the point source immediately after the grid start to spread out again before they enter the electrostatic field of the lens. Thus, an electron following the path AB soon comes under the influence of the curved lines of force around electrode P.

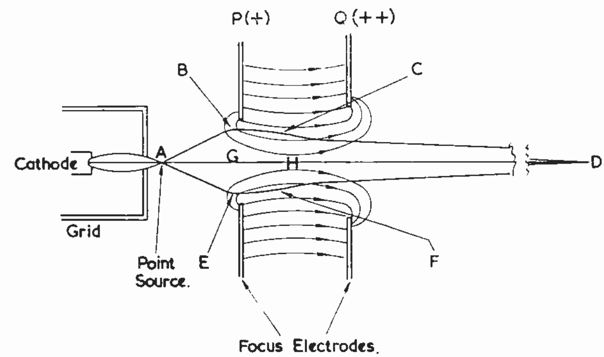

FIG.32

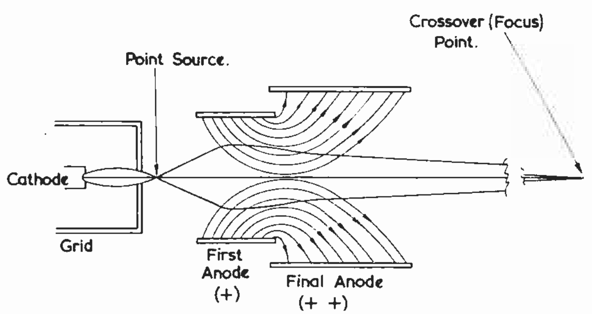

FIG.33

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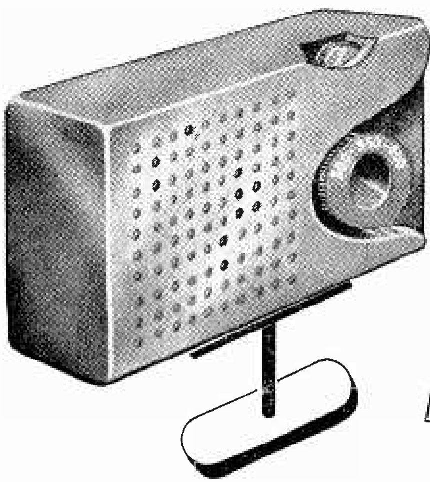
Fig. 32. A simple electrostatic lens. Fig. 33. An alternative type of electrostatic lens.

The two electrodes of Fig. 32 are connected to positive potentials, electrode Q having a higher positive potential than electrode P. In consequence, an electrostatic field is set up between the two plates, the direction of the lines of force being, as in our previous cases, towards the electrode having the higher

These lines of force cause the electron to be deflected in the same direction that they themselves have, whereupon the electron follows the inward-going path BC. At point C the electron starts to fall under the influence of the field around electrode Q, the

continued on page 815



The MINI-7 TRANSISTOR SUPERHET POCKET PORTABLE

This article covers the major steps in the construction of a 7-transistor portable—which is truly capable of being carried in a pocket or in a handbag. The Mini-7 offers an excellent performance with its own slab ferrite aerial, providing a volume level which is more than ample. It is housed in an attractive plastic cabinet of contemporary design

Part 2

***Described by* D. PETERS**

In last month's issue we discussed the circuit of the Mini-7 and embarked on the preliminary stages of its construction. In this, the concluding article, we shall complete construction, giving also details of alignment. The modification required for reception on long waves will be described as well.

Further Steps

Readers may recall that it was necessary, in the previous issue, to publish an assembly diagram (Fig. 3) which was not dealt with completely in the instructions then printed, but to which occasional reference had to be made. In the instructions which cover the next stage of construction it will be necessary to refer to Fig. 3 much more frequently, after which we shall proceed to the diagrams which accompany this month's article.

The ultimate step carried out last month was the fitting of the three transistors TR_1, TR_2 and TR_3. The next process consists of preparing the two-way trimmer block C_2, C_6, for mounting to the insulated circuit board. First of all cut off one end of the metal mounting strip on the block flush to its ceramic body such that, when the trimmer block is mounted as shown in Fig. 3, the figures "60" (indicating the capacity) will be nearer the speaker cut-out. (The tags projecting on the figure "60" side of the block are those connected to the top vanes, immediately under the adjusting screws.) It will be recalled that the 4BA ¼in countersunk screw at hole G was not finally tightened up in the last article. This screw is removed from the loudspeaker mounting pillar, and refitted such that it now secures the trimmer block. It is necessary to fit a 4BA solder tag under the 4BA screw head, as shown in Fig. 3. Fig. 3, in addition, illustrates clearly the position of the trimmer block. Also needed are two 4BA washers below the metal mounting strip of the trimmer block and the circuit board, these functioning as spacers. The ¼in 4BA screw is now finally tightened up.

With a piece of bare tinned copper wire connect together the solder tag, just fitted at hole G, and the two inside trimmer tags (those nearer the speaker cut-out). Next connect one end of C_7 (300pF) to the outer tag of C_6 (see Fig. 3), pass the other end through hole J, and solder to tag 4 of L_3, L_4. See Fig. 2. Identify the red p.v.c. covered lead which was, last month, soldered to the two-gang tuning condenser and, causing it to follow the route shown in Fig. 3, solder this to the outside tag of C_6, shortening as necessary. Similarly shortening as necessary, connect the green lead from the tuning condenser to the outside tag of C_2. For purposes of illustration Fig. 3 shows the red and green leads side by side, but in practice the green lead lays on top of the red lead. Neither lead should project excessively outside the area of the circuit board or it may foul the cabinet when the latter is, later, fitted.

The following wiring steps should closely follow the layout given in Fig. 3. Connect a p.v.c. covered lead from the solder tag at hole B to tag W of the on-off switch on the volume control assembly. Connect a p.v.c. covered lead from tag W of the switch to tag Z of R_9 (the volume control proper). Connect R_8 (3.3kΩ) between eyelet 14 and tag Y of R_9, ensuring that this resistor is clear of the tuning condenser moving vanes marked by a coloured band around the body or by a coloured body end).

Next connect C_{10} (0.01μF) between tags Y and Z of R_9. The electrolytic condenser C_{11} (8μF) is then fitted. This condenser is positioned vertically with respect to the board in the position shown in Fig. 3, and its leads should be bent accordingly. The negative lead of C_{11} is that nearer the board and this connects to eyelet 10. The positive end of C_{11} connects to tag X of R_9. No part of C_{11} should project higher above the board than the tags of the on-off switch. It is advisable to check, once more, that none of the components just fitted are liable to foul the moving vanes of the tuning condenser.

Transformer T_1 is next mounted on the circuit board. The tags of this component are identified by colour coding, and the transformer should be orientated such that these tags take up the positioning illustrated in Fig. 3. The transformer is secured by bending its bottom mounting lugs inwards, these straddling the width of that part of the circuit board at which it is fitted. Next, identify the black fly-lead of T_1. Cutting back as necessary, this fly-lead should be soldered to eyelet 2. Employing p.v.c.

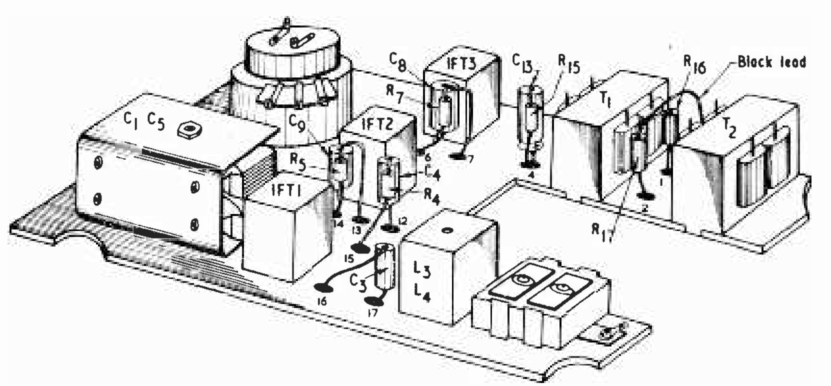


FIG. 7.

G 473

Fig. 7. This diagram illustrates the manner in which some of the smaller components are fitted to the circuit board

and that sleeving is fitted over that lead which connects to eyelet 14. Connect the crystal diode D_1 between eyelet 7 and tag Y of R_9, fitting sleeving over the lead which connects to the eyelet and ensuring that it is the positive end which connects to tag Y. (The positive terminal of an OA70 diode is covered wire, next connect the red tag of T_1 to eyelet 1.

Also connected to eyelet 1 is one end of R_{16} (56Ω). This resistor is fitted such that it is perpendicular to the board and is directly over eyelet 1. The body of R_{16} should not project higher above the board than the laminations of T_1, and its position is shown clearly in Fig. 7. In a similar fashion R_{17} (6.8kΩ) is mounted perpendicular to the board, and is directly over eyelet 2, to which its bottom lead is soldered. Fig. 7 shows this resistor also. The two top leads of R_{16} and R_{17} are next brought over, twisted together, and their junction soldered, cutting off excess wire as necessary.

Fitting sleeving over one of its leads, R_{18} (150Ω) is next soldered in. The sleeved lead from this resistor connects to eyelet 2 and should follow the route illustrated in Fig. 3. The unsleeved lead of R_{18} is connected later. C_{14} (100μF) is connected up in somewhat similar fashion. First fit sleeving over its negative lead-out wire, and then solder this wire to eyelet 1. The positive lead of C_{14} is connected later. In Fig. 3, C_{14} is shown as laying alongside R_{18} but it should, in practice, lay *above* this resistor, taking up the same level, approximately, as the tops of the i.f. transformer cans.

The second transformer, T_2, is next fitted, taking care again to ensure that the colour coded tags assume the orientation shown in Fig. 3. Transformer T_2 is secured by bending its mounting lugs inwards in the same manner as were those of T_1.

Battery clip "A" (the smallest of the three clips) is next secured to the circuit board. This clip should be mounted by a single 8BA nut and screw, a solder tag being fitted under the screw head. Both the clip and the screw head are on the underside of the board and care should be taken to ensure correct orientation of the solder tag and clip, as shown in Fig. 3. The upright section of the clip is adjacent to eyelet 12 and it should be parallel to the long edge of the board. With the aid of a length of p.v.c. covered wire, connect the solder tag just fitted to tag V of the on-off switch.

Further Steps

We now proceed to a further stage in the wiring. In the instructions which follow, reference will be made mainly to Fig. 7.

First, connect the black fly-lead from transformer T_2 to the junction of R_{16} and R_{17}, cutting back to length as required. Two components are next soldered to eyelet 4, these being perpendicular to the circuit board in the same manner as were R_{16} and R_{17}. The first of these components is C_{13} (8μF) and it is its positive lead which connects to eyelet 4. Condenser C_{13} should be positioned directly over eyelet 4. The second component is R_{15} (1kΩ) and its bottom lead (that soldered to eyelet 4) is bent such that it stands alongside C_{13}, as shown in Fig. 7. Ensure that the bottom lead of R_{15} does not touch the metal case of C_{13}. Twist together and solder the free ends of C_{13} and R_{15}, cutting off excess wire as necessary. This junction should not project higher above the board than do the tags of the on-off switch.

In a similar manner, C_8 (0.1μF) and R_7 (47kΩ) are fitted perpendicular to the board, one end of both these components being soldered to eyelet 6. Their free ends are twisted together and soldered, excess wire being cut off as necessary; and a p.v.c. covered wire is taken from their junction to eyelet 5*, where it is soldered. The junction of C_8 and R_7 should not project above the board higher than the on-off switch tags, and the two components should lie between IFT_2 and IFT_3.

(* Not 7 as in Fig. 7)

Observing the same requirement for maximum height above the board, next solder the negative wire of C_9 (8μF), and one end of R_5 (4.7kΩ), to eyelet 14, ensuring that the bottom lead of R_5 does not touch the metal case of C_9. The free ends of R_5 and C_9 are twisted together and soldered, cutting away excess wire as required. Their junction connects with p.v.c. covered wire to eyelet 13. C_9 and R_5 are perpendicular to the board and should lie between IFT_1 and IFT_2.

The next component, which is, again perpendicular to the board, is C_4 (0.01μF), one lead of which is soldered to eyelet 12. R_4 (see note in last month's issue concerning value) is next fitted perpendicular to the board, one lead being soldered to eyelet 15. Twist together and solder the free ends of R_4 and C_4, cutting away excess wire and ensuring that the junction does not protrude above the level of the on-off switch tags. Condenser C_3 (0.01μF) is next similarly fitted, one wire soldering to eyelet 17. The free end of C_3 is bent over and soldered to eyelet 16 as shown in Fig. 7.

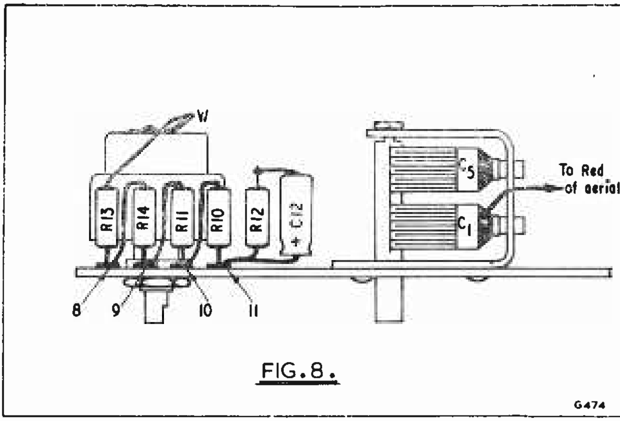
We now proceed to the components illustrated in Fig. 8. All these are fitted perpendicular to the board as shown, and the requirements for maximum height over the board mentioned above have, once more, to be met. The layout shown in Fig. 8 should be adhered to carefully.

First connect one wire of R_{10} (10kΩ), R_{12} (1kΩ) and C_{12} (8μF) to eyelet 11, as illustrated in Fig. 8. It is the positive wire of C_{12} which connects to eyelet 11, and a check should be made after soldering to ensure that this component will not foul the moving vanes of the tuning condenser. The free leads of R_{12} and C_{12} are brought together, twisted and soldered, cutting away excess wire as required. The free end of R_{10} is bent over and soldered to eyelet 10. Also soldered to eyelet 10 is R_{11} (47kΩ), the free end of this resistor being bent over for soldering to eyelet 9. In its turn, eyelet 9 takes, also, one end of R_{14} (3.3kΩ) The free end of R_{14} is brought over to eyelet 8, to which eyelet it is soldered in company with one end of R_{13} (10kΩ). The free end of R_{13} is soldered to tag W of the on-off switch (refer to Fig. 3, if necessary) sleeving being fitted over the lead. The final operation at this stage consists of soldering a one-inch length of p.v.c. wire to the outside solder tag of tuning condenser C_1. The other end of this wire is connected later.

The loudspeaker follows, this being secured to the four speaker-mounting pillars which were fitted last month. The speaker is secured to the pillars with four ⅛in 4BA countersunk screws, and its tags should be on the outside, as shown in Fig. 9.

Next, connect tag T of the loudspeaker to the solder tag at hole G, using bare tinned copper wire. Connect the free ends of C_{14} and R_{18} to tag T of the loudspeaker, ensuring that neither component projects over the edge of the circuit board. For purposes of clarity, C_{14} is not shown in Fig. 9 and it should be remembered, as was mentioned above when it was initially fitted, that it should lay directly over R_{18}. Also connected to tag T of the speaker is the brown tag of the transformer T_2. P.V.C. covered wire should be used for this connection. Similarly using p.v.c. covered wire, connect the mauve tag of T_2 to tag U of the speaker.

Fig. 8. Detail showing layout around the volume control and tuning condenser



Final Steps

The construction of the Mini-7 now approaches completion and we are ready to embark on the final steps in assembly. In the instructions which follow, reference will be made mainly to the layout illustrated in Fig. 9.

The two large battery clips have next to be fitted. These are mounted on holes B2 and B3 (see Fig. 3) with the aid of ⅛in 8BA screws and nuts. An 8BA solder tag is fitted under the screw head at hole B2, and this tag should have the orientation illustrated in Fig. 9. The positions taken up by the battery clips are shown in Fig. 9, and it is important to ensure that their edges are parallel with the short edge of the board. The positive connection from the batteries is taken from battery clip "A" which was fitted earlier; and the positive terminal of the lower battery, when it is later fitted, is intended to pass through the hole in the large battery clip in order to make contact with clip "A." Mounting the large battery clip in the correct manner will ensure that this contact can be made reliably. The batteries must not be fitted yet. The 8BA solder tag at hole B2 is connected by p.v.c. covered wire to the junction of R_{16} and R_{17}.

The remaining transistors are now fitted. In all cases transistor lead-out wires should be covered with sleeving. It is advisable to read all the comments concerning each transistor before commencing its connection into circuit. Transistor TR_6 comes first. Connect the emitter of TR_6 to the brown tag of T_2, the collector of TR_6 to the red tag of T_2, and the base of TR_6 to the yellow tag of T_1. The positioning of TR_6 is discussed below. Follow with transistor TR_7. Connect the emitter of TR_7 to the brown tag of T_2, the collector of TR_7 to the blue tag of T_2, and the base of TR_7 to the green tag of T_1. In Fig. 9, TR_6 and TR_7 are shown projecting sideways from that area of the chassis into which they connect, but in practice they may

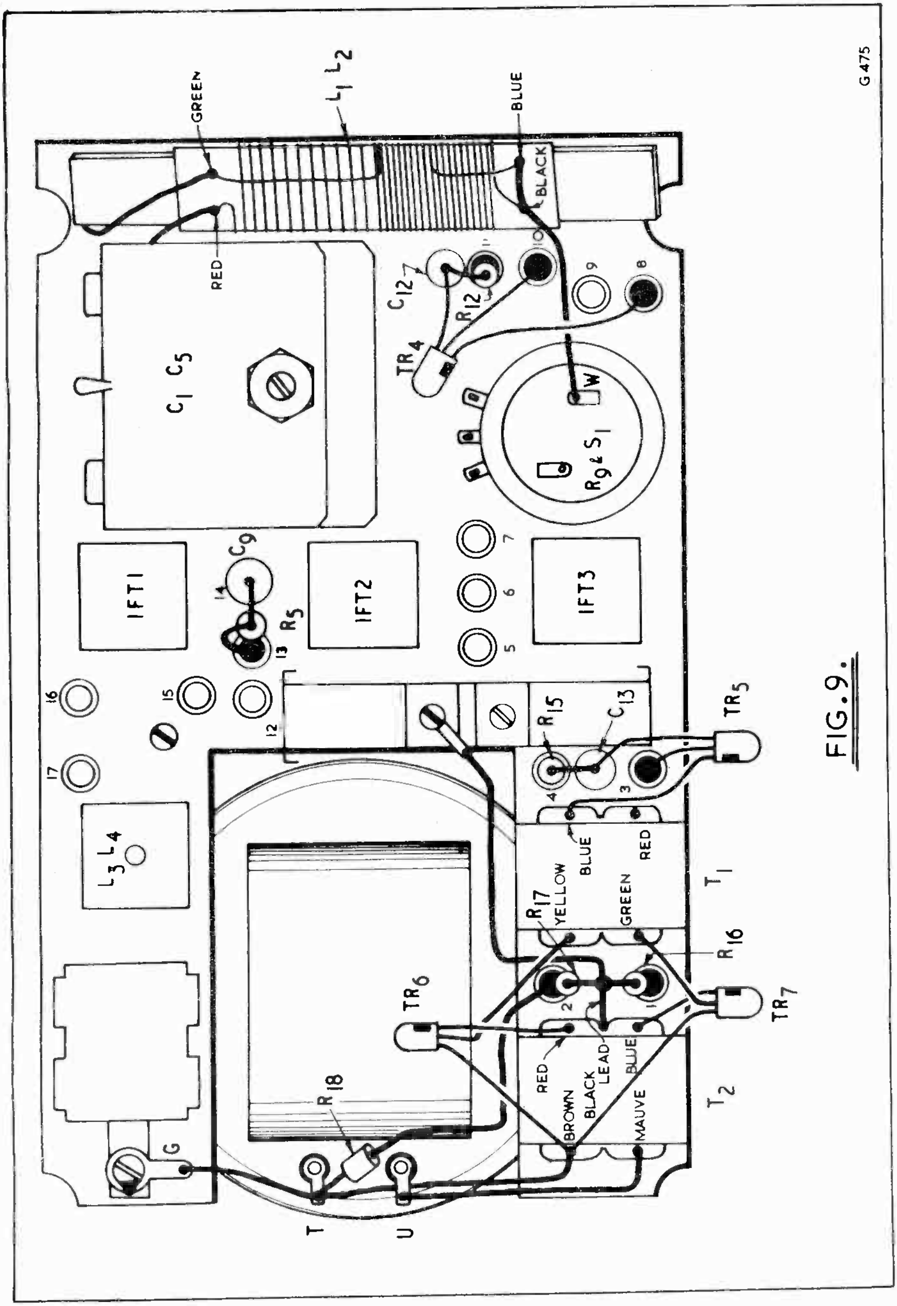


Fig. 9. Final steps in assembly

be made to lie over T_1 and T_2 without protruding over the edges of the board or, upwards, above the level of the battery clips. There is no necessity to cut the leads of TR_6 and TR_7 shorter than an inch or so as these may, if necessary, be folded back on themselves.

Transistor TR_5 is the next to be soldered in. Connect the emitter of TR_5 to the junction of R_{15} and C_{13}, the collector of TR_5 to the blue tag of T_1, and the base of TR_5 to eyelet 3. Although TR_5 is shown projecting sideways in Fig. 9 it should, in practice, be kept within the confines of the circuit board assembly. A convenient layout consists of having the transistor body positioned approximately between eyelet 3 and T_1. Again, there is no necessity to cut lead-out wires shorter than one inch or so.

The final transistor to be fitted is TR_4, and this takes up the position shown in Fig. 9, its body being at approximately the same level as the tags of the volume control switch. Once more there is no necessity to cut the lead-out wires shorter than one inch. (In fact, layout requirements may dictate one or more leads being markedly longer.) Connect the collector of TR_4 to eyelet 8, the base of TR_4 to eyelet 10, and the emitter of TR_4 to the junction of R_{12} and C_{12}.

The ferrite slab aerial L_1, L_2, may now be connected into circuit. This aerial is held in position by the wires which connect to its eyelets, its light weight enabling a reliable and sturdy fitting to be provided in consequence. For purposes of illustration the ferrite slab aerial is shown in Fig. 9 at an angle to the surface of the circuit board but, in practice, its width is perpendicular to the board and it should fit snugly inside its boundaries. The photograph of the underside of the chassis demonstrates the position of the aerial. The two rubber grommets should be removed before the aerial is connected up.

The aerial is soldered into the receiver circuit in the following manner. Connect the p.v.c. covered wire from tuning condenser C_1 (see Fig. 8) to the red eyelet of the aerial. Connect the wire which was passed through hole R (Figs. 2 and 3) to the green eyelet of the aerial, shortening as necessary. Finally, connect together the blue and black eyelets of the aerial and join these with a length of p.v.c. covered wire to tag W of the on-off switch.

All that now remains is to fit the batteries. The receiver should primarily be switched off (volume control spindle fully anti-clockwise). The first battery is inserted such that its positive terminal is towards eyelet 12. The brass cap then makes contact to battery clip A in the manner mentioned above. The second battery is then fitted the other way round, the positive terminal being at the TR_5 end.

The receiver is now completed and is ready to be switched on and aligned.

Alignment

The process of alignment is quite simple and straightforward. The constructor is strongly advised to employ a signal generator, if only to make certain that coil cores and trimmers are set up at the correct frequency. In all cases the signal generator output should be attenuated as necessary in order to allow alignment to proceed at a low signal level.

The signal generator should first of all be set up to 465 kc/s and its output connected across the earth line of the receiver and tag 1 of IFT_2. The core of IFT_3 is then adjusted for maximum output. The signal generator is next connected across pin 1 of IFT_1 and the earth line, whereupon the core of IFT_2 is similarly adjusted for maximum output.

The signal generator output is next connected via a series $0.1\mu F$ condenser to eyelet 12 (TR_1 emitter) and the earth line, and the core of IFT_1 adjusted for maximum output. With the signal generator in this position, all three i.f. transformers should be re-checked for correct alignment and any small final adjustments carried out. After this the i.f. transformers require no further attention.

The frequency of the signal generator is next adjusted to 750 kc/s and the tuning dial to 400 metres. Under these conditions the core of L_3, L_4 should be adjusted for maximum output. The signal generator is then set to 1.2 Mc/s and the tuning dial to 250 metres, whereupon trimmer C_6 is adjusted for maximum output.

Next, return the signal generator to 750 kc/s and the tuning dial to 400 metres, and readjust the core of L_3, L_4 for maximum output. Also, at this stage adjust the inductance of L_1, L_2 for maximum output, this process being carried out by sliding the coil along the ferrite slab. Return the signal generator to 1.2 Mc/s and the tuning dial to 250 metres, and readjust C_6 for maximum output. Also adjust C_2 for maximum output.

Since inductance adjustments (padding) and capacity adjustments (trimming) are slightly interdependent it is advisable to repeat the procedure given in the last paragraph until no further improvement is necessary. Unless cores and trimmers were initially considerably out of alignment, a single repetition should normally cover this requirement.

Long Wave Reception

As was mentioned in the first article, it is possible to modify the Mini-7 for reception of a long wave station, should this be desired.

It is assumed that the long wave station required will normally be the Light Programme transmission on 1,500 metres. The circuit modification required is illustrated in Fig. 10, and the extra components needed were listed in the parts list accompanying the previous article.

To make the modification it is necessary to carry out the following steps. The long wave loading coil, L_5, should be fitted to hole S (see Fig. 3) of the component board such that it projects on the underside; i.e. on the same side as the ferrite slab aerial. The wire adjoining the blue and black eyelets of the ferrite slab aerial is next cut and removed. P.V.C. covered wire should be employed for the connections which follow. The blue tag of the slab aerial should be connected to tag W of the on-off switch. Connected also to tag W of the on-off switch (or any other convenient earth point) is one tag of L_5, whilst the other tag of L_5 connects to the black tag of the slab aerial. The black tag of the slab aerial connects, in addition, to the medium wave contact of the wavechange switch. The long wave contact of the wavechange switch is coupled, via the additional 250pF condenser, to tag 4 of L_3, L_4; and its arm is connected to the earth line of the receiver at tag W of the on-off switch, or at any other convenient point.

When the receiver is modified in this manner, throwing the wavechange switch to long waves results in the additional 250pF condenser being connected across the oscillator tuned circuit, causing the resonant frequency of this circuit to be lowered to the requisite range. At the same time, the short circuit across L_5 is removed, allowing additional inductance to be inserted into the aerial circuit. When the wavechange switch is in the medium wave position the receiver circuit reverts to its original state.

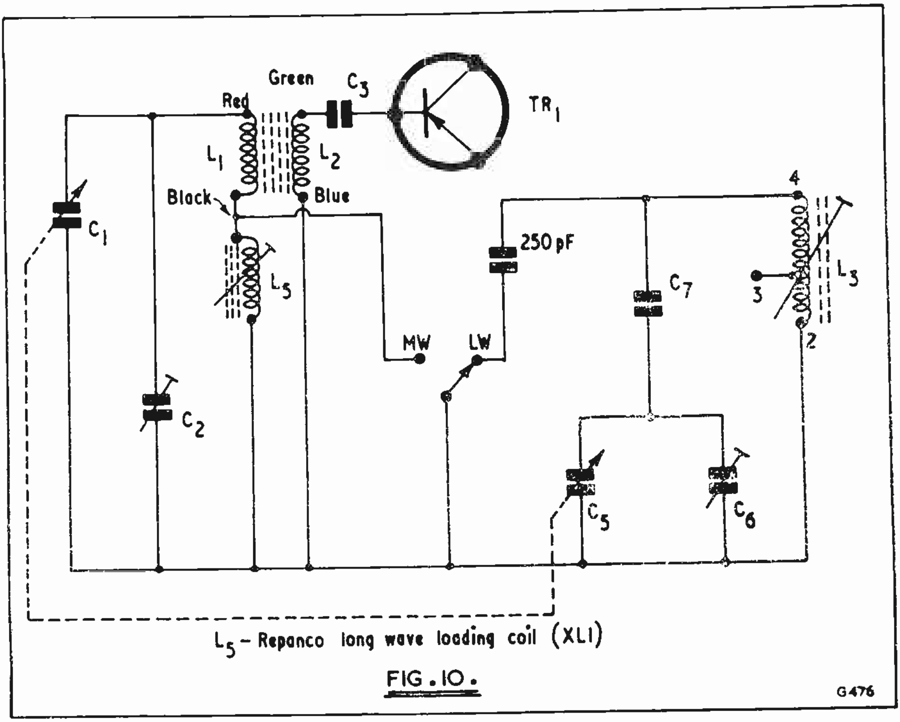


Fig. 10. The circuit employed for the optional modification for two waveband reception

The position taken up by the wavechange switch should not be excessively critical, provided that it is reasonably close to the aerial and oscillator circuits.

After the modification has been completed, it becomes necessary to adjust L_5 for optimum results. This may be done without a signal generator, alignment being carried out with received signals. The tuning condenser is first of all adjusted until the Light Programme transmitter on 1,500 metres is heard at maximum strength. This process ensures that the receiver oscillator is functioning at the frequency required to convert the transmitted signal to the intermediate frequency of 465 kc/s. The core of the loading coil, L_5 is then adjusted for maximum output, whereupon alignment is complete. In areas of high signal strength it might be advisable to rotate the receiver chassis for minimum aerial pick-up in order to ensure that an accurate adjustment of L_5 is finally obtained.

Note: Since Part 1 was published, it has been found that better control of volume is obtained by connecting R_9 with the top end of the track to D_1, C_{10} and R_8, and with the slider to C_{11}—bottom of track to h.t.+ as before. A log law potentiometer, better in this position than a linear type, is not easily obtainable in the value specified—but since low value components R_8 in series with R_5 are already in parallel with R_9, a 250kΩ potentiometer may be used satisfactorily for the latter control, and is available in the miniature range.

TEST EQUIPMENT

A Simple TRANSITRON OSCILLATOR

By J. DALTON, A.M.I.E.E.

THE TRANSITRON OSCILLATOR IS A USEFUL piece of equipment for experimental work. It is easily constructed, and has the ability to set up oscillations in a simple two-terminal circuit which may even be screened and inaccessible. In addition, it will oscillate over a wide range of frequencies and with low values of anode load impedance. As it operates over a portion of the valve characteristic which has only a slight curvature, the output is relatively free from harmonics, and an amplitude of ten to twenty volts is readily obtainable.

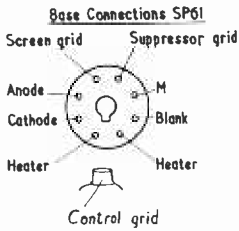
The simplicity of the transitron arises from the fact that no external phase shift is required for oscillation. In a triode valve the grid voltage and the voltage of the anode may be said to be 180 degrees out of phase, for as the control grid voltage goes more negative, the anode current decreases and the voltage of the anode goes more positive. In order, then, to feed back an a.c. voltage which will be in phase with the a.c. voltage at the control grid and so provide oscillations, a further phase shift has to be introduced by mutual inductance between the anode and grid circuits.

In the transitron the screen and suppressor grids take the place of the control grid and anode used in the triode, these latter now acting as auxiliary electrodes only. Conditions for correct feedback are automatically fulfilled by the choice of operating voltages, leading to a simple and easily controllable circuit.

Experimental Data

The valve chosen was the SP61 pentode as it is cheap, easily obtainable and, most important of all, the suppressor grid is not internally connected to the cathode. In order to assess its capabilities, a test circuit was set up as in Fig. 1. With fixed anode and screen voltages R was varied in suitable steps and a table of screen current against suppressor grid voltage constructed. The results are plotted in Fig. 2, where it will be seen that the screen current increases when the suppressor voltage goes more negative. This is because the suppressor voltage controls the division of current between anode and screen. A high negative suppressor voltage prevents electrons from reaching the anode, and they are therefore attracted to the screen because of the positive field existing between suppressor grid and screen grid. The mutual inductance, a.c. resistance and amplification factor between these two electrodes are obtained as indicated on the graph.

The valve is operated as a transitron oscillator by placing a parallel tuned circuit of dynamic resistance $\frac{L}{CR}$ ohms between the screen grid and h.t., the a.c. voltage across



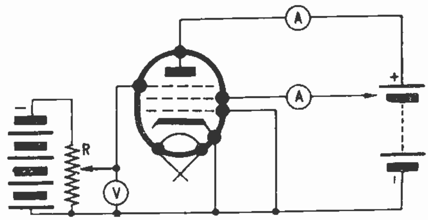


FIG. 1. TEST CIRCUIT.

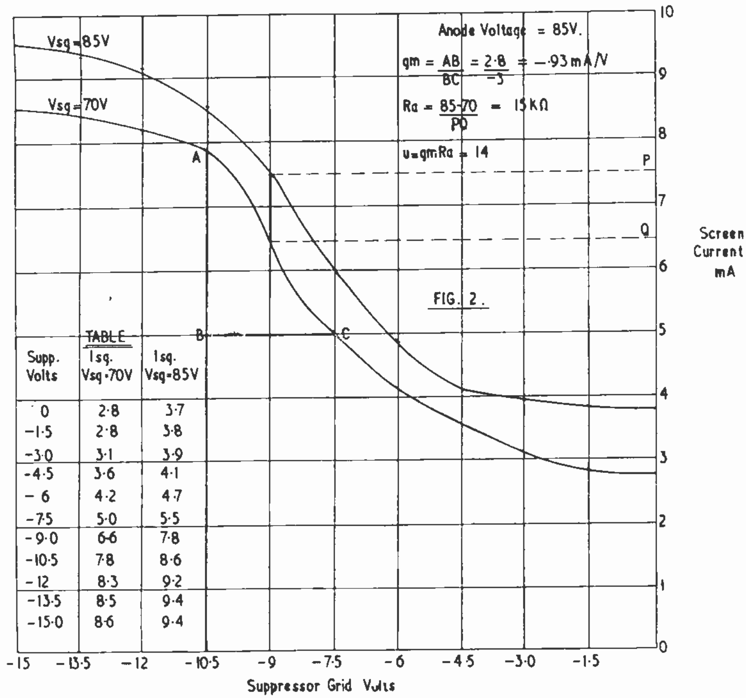


FIG. 2.

TABLE

Supp. Volts	Isg. Vsg·70V	Isg. Vsg=85V
0	2·8	3·7
−1·5	2·8	3·8
−3·0	3·1	3·9
−4·5	3·6	4·1
−6	4·2	4·7
−7·5	5·0	5·5
−9·0	6·6	7·8
−10·5	7·8	8·6
−12	8·3	9·2
−13·5	8·5	9·4
−15·0	8·6	9·4

Components.

R_1 = 47kΩ 1/2w
R_2 = 50kΩ V.C.
R_3 = 5000 Ω 1/2w
C_1 = 0·1μF
Bias = −7·5V
Va = 85V
Vsg = 85V

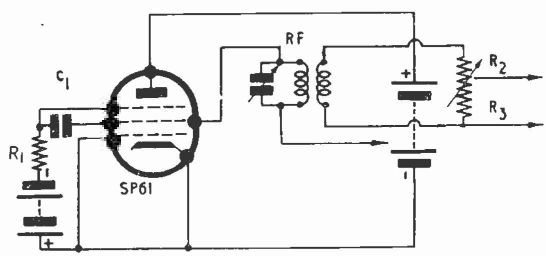


FIG. 3.

the load being coupled back to the suppressor grid by a condenser whose reactance is low at the oscillating frequency.

In an amplifier with a parallel tuned circuit as load, the voltage across the load is given by $\frac{\mu . V_g . R_l}{R_l + R_a}$ where R_l is the dynamic resistance of the tuned circuit. In a transitron oscillator this voltage across the load is also the a.c. voltage at the suppressor grid.

$$\text{Therefore} \frac{\text{Voltage across load}}{V_g} = 1 = \frac{\mu . R_l}{R_a + R_l}$$

$$\text{That is:} \quad R_a + R_l = \mu . R_l$$

$$R_a = R_l \, (\mu - 1)$$

$$\text{and } R_l = \frac{R_a}{\mu - 1}$$

This is the condition for oscillation to take place.

The values of R_a and μ from the graph are approximately 15kΩ and 14 respectively, and substituting these values in the equation shows that R_l is about 1200Ω. This leads to the conclusion that the SP61 when used as a transitron oscillator will operate down to a much lower value of dynamic resistance than is normally obtained, even with poor tuned circuit components.

Practical Details

The circuit used by the author is shown in Fig. 3 together with component values. Coupling to the output was provided by about ten turns wound at the bottom end of the tuned circuit inductance. When measured on a cathode ray oscilloscope, the output was approximately five volts. No noticeable effect on amplitude or frequency was noted with a resistance of 5000Ω as the secondary load.

It was then decided to check whether the oscillator was satisfactory at audio frequencies, and for this purpose the primary of a mains transformer was connected in the anode circuit with a condenser of 0.1μF across it. No difficulty was experienced in obtaining oscillations down to 200 c/s at an output of 10 volts, but harmonic distortion was very high. However, by reducing the suppressor grid resistance to 4000Ω, the waveform was very much improved and would be quite satisfactory for the output of an a.f. oscillator. In practice, a l.f. choke with suitable fixed condensers could provide a number of fixed frequencies.

In conclusion, if a different type of valve than the one used by the author is available, its characteristics should be plotted using the test circuit shown in Fig. 1. This will prevent time being wasted on trial and error methods, avoidance of possible damage to the valve and, perhaps most important of all, a better insight into the operation of a useful type of oscillator.

TRADE NEWS

Tape Position Indicator

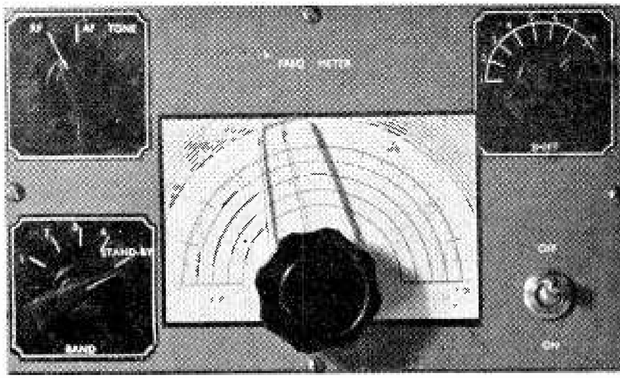
The purpose of the indicator, manufactured by Smiths Industrial Instrument Division, Chronos Works, North Circular Road, London, N.W.2, is to give an indication to length of recording or to the position of any particular passage on a wire or tape recording. It has been introduced to give a more efficient and more ready means of determining a recorded item on a tape.

The indicator is a comparator and has a dial based on the universal clock presentation of two-hand movement. This facilitates easy reading, and when a tape is run at speed the moving hands afford an exact check on position. A pulley is in contact with the spool shaft and operates the hands or pointers through a train of gearing; this mechanism has been designed to ensure that only the minimum of load and friction is imparted to the tape. It is also constant, and thus will not affect the clarity of reproduction. Adjustment of the measuring pointers can be readily accomplished from the front of the indicator dial by a reset knob connected to the centre spindle. The dial, if required, can be illuminated by means of a light source from the back of the plastic bezel.

The complete indicator is encased in a light die-cast alloy body to which is attached the aluminium drive pulley. The unit is safeguarded against ingress of dust, etc., and weighing only sixty-two grammes can be easily fitted to a tape deck. All standard lengths of tape can be accommodated by the tape position indicator, and dial presentation colour of hands and bezel are considered according to individual requirements.

TEST EQUIPMENT

The Mini-Meter



A Frequency Meter for the Beginner

By JAMES S. KENT

Part I

IT WOULD APPEAR, FROM LETTERS RECEIVED, that many of our beginner readers built the "Meteor" receiver described in earlier issues (Sept., Oct. and Nov., 1955), and that many more own receivers constructed from one or other of the designs published in *The Radio Constructor*. From this correspondence emerges the fact that many would like to build a frequency meter by the aid of which they may be able to ascertain the frequency of a particular transmission. It is to this class of reader that the present series is directed.

Design Considerations

For the beginner, the corner stones of design are obvious enough. The instrument must be simple to construct, relatively cheap, stable and efficient in operation. Coupled with this, in order to both match the "Meteor" and be contemporary in design, it should be small physically and include the same range of valves. The more experienced reader will at once ascertain that some of the above considerations are apt to be contradictory—for instance "simple, cheap, stable and efficient" are strange bedfellows in one and the same specification. Nevertheless, the design offered in this series is an attempt to meet, at least in most respects, all of the aspects so far discussed.

A frequency meter is of little use unless an audio modulating stage is incorporated, and this usually entails the addition of a second valve, thus partially destroying the "cheap and simple" proviso at one blow. This has been avoided by using one of the double triodes—virtually two valves for the price of one. The consequent saving of space thus achieved, not to mention the added simplicity of wiring, etc., make this type of valve an obvious choice.

The availability of components from well-known advertisers, where these parts are not obtainable locally, is also a prime factor to be considered. It is of little help to specify items of equipment that have long since been out of production and are therefore not only obsolete but also completely unobtainable.

A self-contained power unit, in the writer's opinion, is another factor to be favourably considered. By its inclusion within the physical limits of the cabinet itself, it not only reduces the cost by excluding a further chassis and cabinet, but also results in the unit as a whole becoming semi-portable, i.e. being capable of transportation as a single entity, between places where a.c. mains are available.

As few components as possible, compatible with efficiency in general, should be included. To ignore this factor would only result in added confusion when wiring the circuit—and, in addition, result in increased cost, thus destroying the "simple and cheap" consideration.

All in all, in the design about to be discussed, the foregoing merits have been incorporated. Furthermore, a symmetrical layout of the front panel, together with "eye appeal" and ease of operation, have also been achieved.

Circuit Description

A study of Fig. 1 will show that one-half of the double triode valve, a Mullard ECC40 and one of the B8A range, is used as the r.f. oscillator, the remaining portion being utilised as the audio modulator. This valve, as may be seen, consists of two entirely separate triodes. The heaters of each are

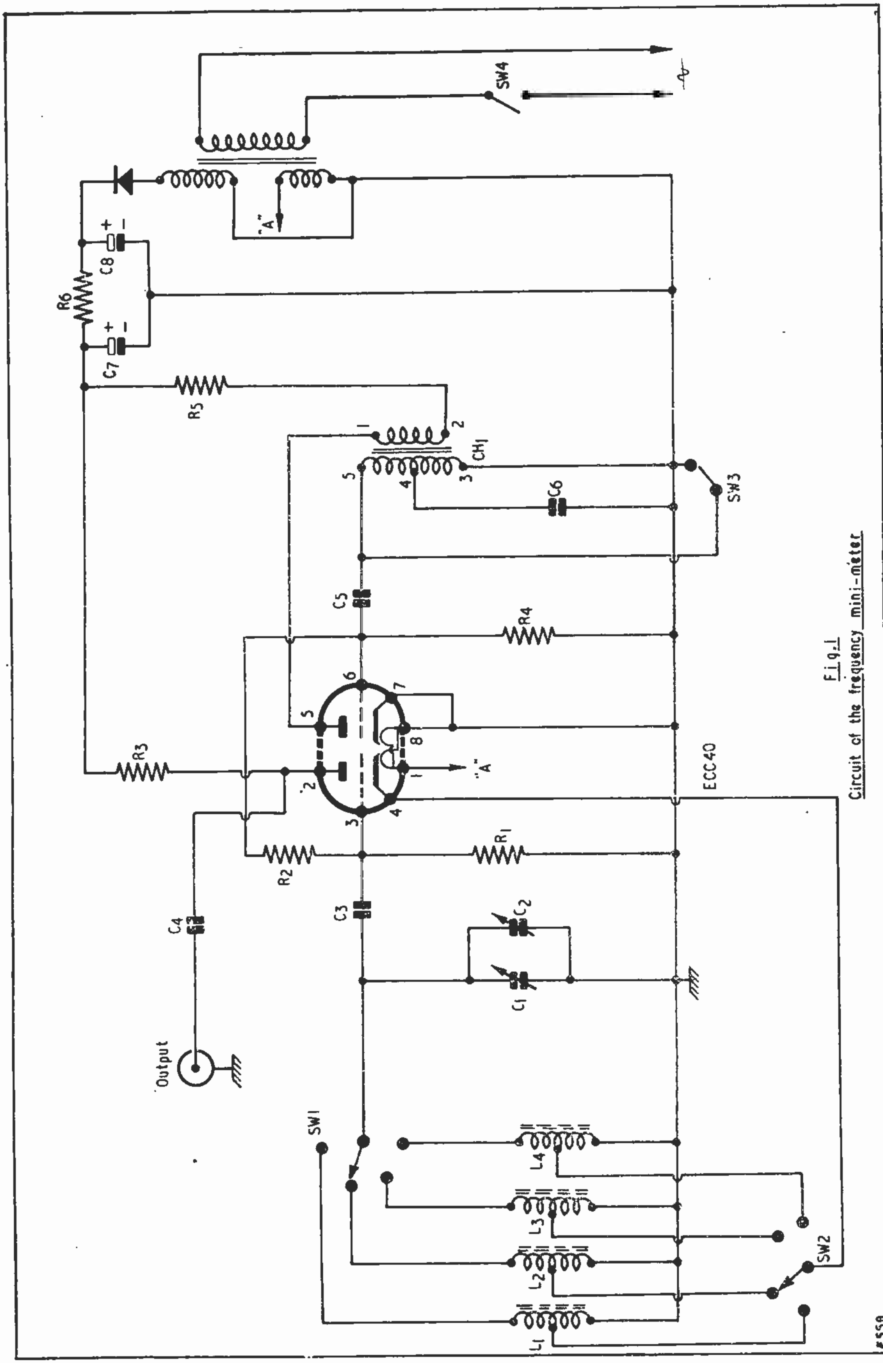


Fig. 1 Circuit of the frequency mini-meter

connected in parallel and, as each heater current is 0.3A, the total is 0.6A. Each section of the ECC40 has a gain factor of 32 and it is normally used as a cascade audio amplifier preceding an output valve. Nevertheless, it will provide reasonable gain and, at the same time, function efficiently as an r.f. oscillator. It is for this reason, among others, that it has been selected for this design.

The oscillator itself is of the E.C.O. (electron coupled oscillator) type. It is so termed by reason of the fact that the output (anode) is coupled to the oscillator (grid and cathode), only through the electron stream. Electron coupled oscillators are very widely used as frequency converter stages in superheterodyne receivers and as oscillators of transmitters operating over a wide frequency range.

Four ranges are provided, SW_1 and SW_2 being ganged and used as the wavechange and standby control. These ranges are: (1) 15 to 63 metres (20–4.762 Mc/s); (2) 60 to 230 metres (5–1.3 Mc/s); (3) 200 to 750 metres (1,500–400 kc/s); (4) 750 to 3,000 metres (400–100 kc/s). The coils are types EO1, 2, 3 and 4, these being tapped and made specially for this design by the Teletron Co. Ltd. (see advert.). The selected coil is tuned by the variable condenser combination C_1/C_2, the latter being used either as the zero set or as a bandspread control. R_1 and C_3 are the grid condenser and leak respectively. The cathode of the valve is connected, via SW_2, to the centre tap of the coil.

The resistor R_3 forms the anode load of the oscillator and C_4 is the output condenser. So much for the r.f. oscillator.

The other half of the valve is wired as an audio modulator. The primary winding of a small inter-valve transformer is used as a feedback winding for the audio oscillator. The audio tone of the oscillator may be varied by experimenting with the values of C_6, the normal choice of tone being 400 c/s. Individual tastes, however, vary with respect to the audio tone, but those wishing to obtain an approximation to the 400 c/s note may gain a rough idea of this audio frequency by listening to either MSF or WWV. These frequency standard transmissions are radiated on 2,500, 5,000 and 10,000 kc/s from both stations, MSF being situated at Rugby and WWV at Washington D.C., U.S.A. The latter station also transmits on the additional frequencies of 15,000, 20,000, 25,000, 30,000 and 35,000 kc/s.

Injection of the resultant audio tone into the r.f. oscillator is effected via R_2 connected between the two grids. The degree of injection may, of course, be varied by changing the value of this resistor. Switch SW_3 is the a.f. tone on/off control. When in the earthed position, it causes the oscillations to cease by grounding the grid, via C_5, to chassis. In the open position, the oscillator is allowed to function and inject the note into the grid of the r.f. oscillator. Both oscillations are mixed and appear at the anode where they are taken, via C_4, to the output socket. This method of switching the audio modulator is much to be preferred to the more usual method of switching the h.t.+ to the anode. With the system adopted, no sudden drain is imposed upon the h.t.+ output which would cause the r.f. oscillator to violently shift frequency.

The power unit is a simple half-wave rectifier consisting of the mains transformer and a metal rectifier, the Brimar RMO. The resultant output is smoothed by the combination of R_6, C_7 and C_8. A 6.3V heater winding is provided on the transformer.

to be continued

Component List

Valve
ECC40 Mullard

Resistors

R_1	33kΩ ½ watt ±10%
R_2	100kΩ ½ watt ±10%
R_3	5kΩ ½ watt ±10%
R_4	100kΩ ½ watt ±10%
R_5	33kΩ ½ watt ±10%
R_6	1kΩ ½ watt ±10%

Inter-Valve Transformer
Elstone type LF36

Switches

SW_1, SW_2	2-pole, 6-way Yaxley
SW_3	1-pole, 2-way Yaxley
SW_4	1-pole 1-way toggle switch

Other Items
B8A valveholder; nuts and screws; p.v.c. wire; short length of coax (6in); output socket and connector (t.v. type); length of mains flex; rubber grommet, small; small piece of Perspex sheet to cover tuning scale

Coils
Type EO1, 2, 3 and 4, The Teletron Co.

Condensers

C_1	500pF variable, midget, Polar or J.B.*
C_2	15pF variable
C_3	100pF ceramic
C_4	0.05μF tubular, T.C.C., type CP35N
C_5	0.005μF mica
C_6	0.01μF tubular
C_7	16μF electrolytic, 150V wkg
C_8	16μF electrolytic, 150V wkg

*C_1 is a two-ganged type, only one-half of which is used. C_2, C_7 and C_8, if not obtainable locally, are available from cabinet supplier (see under).

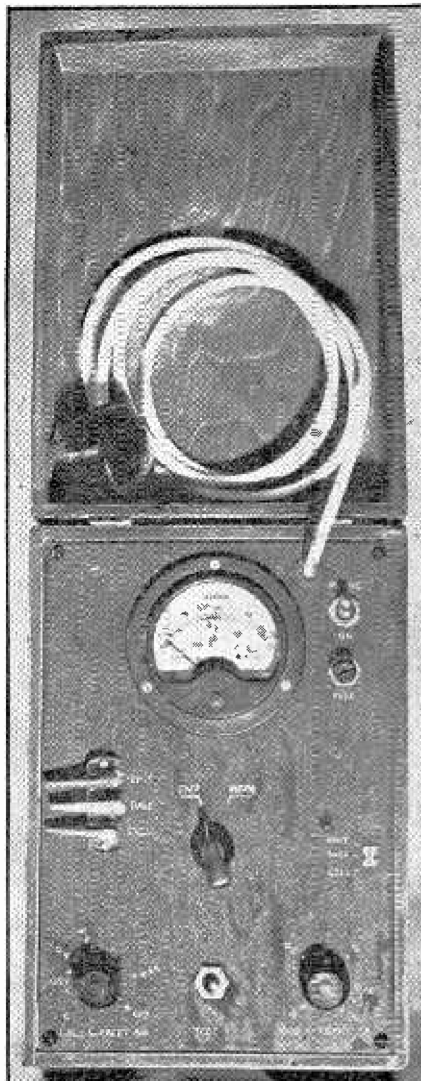
Cabinet, etc.
Cabinet, panel and chassis, mains transformer, metal rectifier, C_2, C_7 and C_8. R.C.S. Products (Radio) Ltd.

Panel Signs
Sets Nos. 1 and 2

A Self-Calibrating
TRANSISTOR TESTER

Part 2

By JOHN K. OWEN



Construction

The general construction can be seen from the photograph, Fig. 5. There is no chassis—all the components are mounted on the underside of the aluminium panel, which is finished in black crackle paint. There are four holes in the corners—clearance for the No. 6 round-head black japanned wood-screws which hold the instrument in the case.

The prototype model was housed in a wooden case because a suitable one was to hand. If carpentry presents a problem, an alternative is an aluminium case : a ready-made version of this is to be had in the shape of a standard chassis, which is readily obtainable with corner reinforcing brackets. This can be used inverted, with the panel secured to the corner brackets by self-tapping screws.

The panel measures 9in. by 6in., so that if the inverted chassis arrangement is used, a standard 9in. by 6in. by 2½in. deep model is just the right size.

The general layout of the panel can be seen from the photograph shown on the title page. The meter is a 2½in. dia. flush mounting type, though there is sufficient room for a larger one, if necessary.

The transistor being tested is connected by one of two alternative methods. On the right of the panel can be seen a miniature socket into which the specimen can be plugged, while on the left are three " crocodile " clips. This apparent duplication may seem an unnecessary complication : those who have tried to hold the thin, straight connecting wire of an unused transistor in a crocodile clip will agree it is not. It is far more difficult that it would seem to make reliable contact with even one wire—when it comes to three the operation can be irritating in the extreme.

On the other hand, when the transistor has been in use, the wires are usually formed into loops at the ends, where they have been

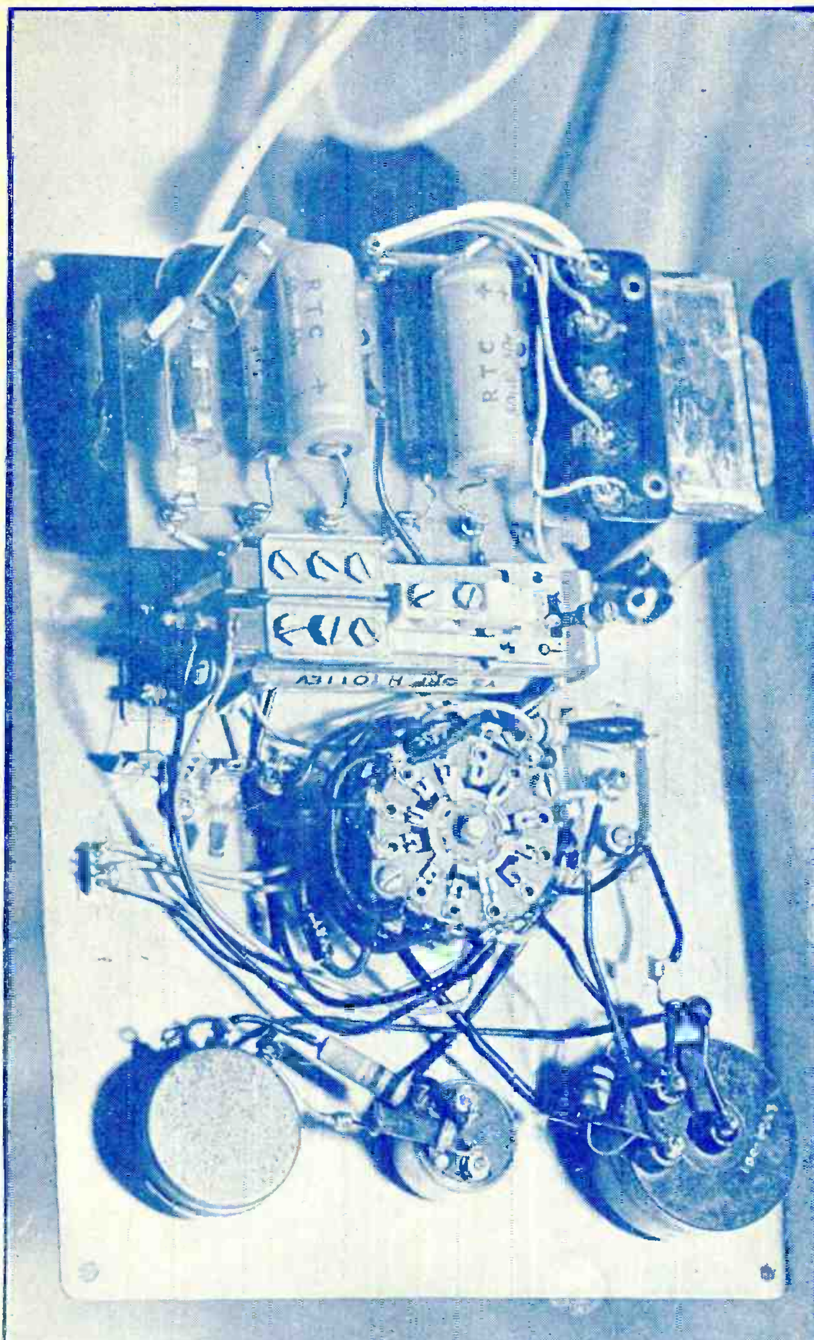


Fig. 5. Underneath (back of panel) view of the self-calibrating transistor tester, showing the general arrangement of components

connected into the circuit. While they will not then plug into the socket, the formed ends make for easy gripping by the crocodile clips.

To prevent the clips shorting together, they are mounted on a saddle made of perspex, details of which are shown in Fig. 6.

Transformer

The mains transformer, as mentioned earlier, is a 6.3 volt 1.0 or 2.0 amp heater transformer, with the secondary re-wound. A transformer of this rating will usually be found to have a " turns-per-volt " figure of around 12, so that the 11 volt and 8 volt secondaries will then require 132 turns and 96 turns respectively. The " turns-per-volt " of the particular transformer being used should, of course, be checked, by counting the number of turns on the secondary during stripping, and dividing by the rated voltage. Both the new secondaries can be wound with 32 s.w.g. enamelled wire, care being taken to ensure that they are well insulated from each other and from the primary. If the voltage across R_1 and R_2 is not exactly 12, it is an advantage for it to be higher, rather than lower, as it can then be adjusted by the insertion of a suitable resistor at X (Fig. 4), bearing in mind that approximately 20Ω is required for each volt to be dropped.

Rectifiers

The rectifiers MR_1 and MR_2 have to handle some 50mA, so that, as explained previously, the small germanium point contact types are unsuitable.

There is a Westinghouse instrument rectifier, type M-3, which with a very small modification, is eminently suitable. Its current rating is 50mA, and its small size (¾in. dia. by 27/32in. long) fits in well with the general layout. As supplied, the M-3 is bridge connected. There are four connecting leads, as indicated in Fig. 7. The two outside lugs are joined together, and a lead joined to one of them. This is the positive lead. The lead connected to the centre lug is the negative one, while the two intermediate leads form the " a.c." connections. The modification consists simply of joining these two " a.c." leads together, thus forming the centre tap of the rectifiers MR_1 and MR_2.

Should the M-3 prove difficult to obtain, the alternative of stripping and re-building a selenium rectifier can be adopted. Almost any dealer handling " surplus " or ex-service equipment can supply a suitable unit. The one used in the prototype was rated at 150 volts, 60mA. Since the a.c. input is only 11 volts, a single plate is sufficient for each rectifier and, provided a little care is exercised, there should be no difficulty in re-assembling them.

Fig. 8 shows an " exploded " section of two plates, as stripped from the complete unit. The rectifier is formed by the junction of the copper and selenium, with the copper disc serving as cathode and also as a heat dissipating fin. The lead washer which is fused to the reverse side of the copper disc is to make contact with the selenium on the adjacent plate, and *only* with the selenium. If the lead washer was omitted, the full area of the copper disc would contact the selenium and, as this is only a very thin layer, there would be the possibility, if there was any distortion in either disc, of the copper of one disc contacting the copper of the next, so shorting the rectifying element. This is the point which has to be watched in assembly.

Fig. 9 shows the complete assembly. A connection has to be made to the junction of the two plates, to provide the necessary centre-tap. This connection is made by interposing a lug, as shown, between the two elements. However, to prevent this lug shorting to the copper, where it should be contacting only the selenium, a further washer must be inserted ; the outside diameter must be slightly less than the diameter of the selenium layer, while the central insulating tube must be slightly larger than the "hole" in the selenium. Since this washer will " float " on the central insulating tube, it must be carefully centralised just prior to finally tightening the complete assembly. A suitable washer can usually be found in the rectifier assembly itself. The lug, however, will probably have to be made, since there will only be two in the original unit. This should not present undue difficulty ; using one of the existing lugs, a duplicate can be cut from a piece of tin-plate (such as a cocoa tin, for instance, if no better material is available).

MR_3 and MR_4 are straightforward. Since the current is only of the order of 5.0mA, almost any type of germanium diode is suitable. The only point to watch here is the polarity—if this is reversed, the control transistor is likely to be damaged. Most germanium diodes are colour-coded—the majority red—the colour invariably being adjacent to the cathode, or " positive " wire.

A feature of the circuit which was not mentioned earlier is the " range multiplier," consisting of R_8 and S_3. With S_3 "open ", R_8 is introduced into the bias circuit in series with R_7, reducing the bias current from 10 to 5μA, and thereby doubling the full scale reading of the meter. After the prototype had been completed, a number of transistors came to hand with gains considerably in excess of 100, so it was felt to be a desirable feature to be able to increase the range to 200. The switch can be fitted in any convenient place on the panel, and is marked

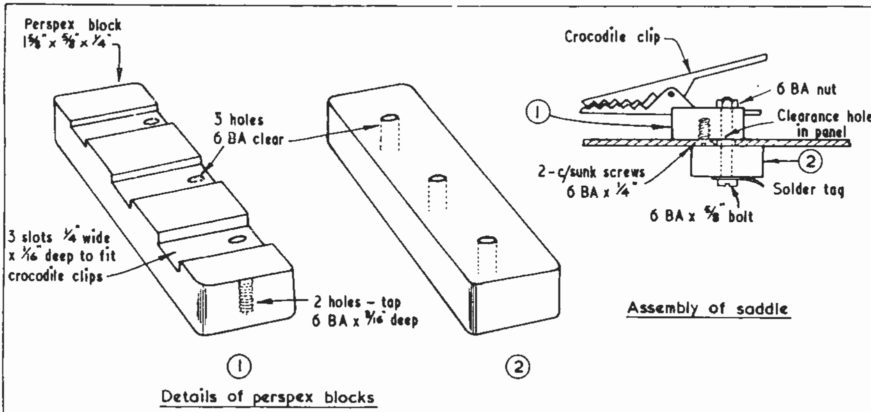


FIG.6. PARTICULARS OF MOUNTING SADDLE FOR CROCODILE CLIPS

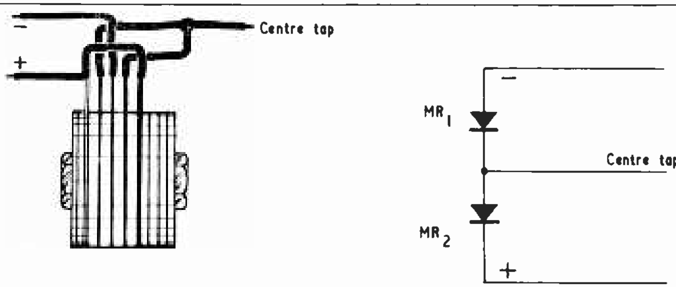
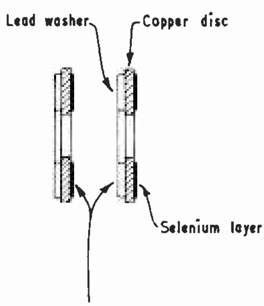
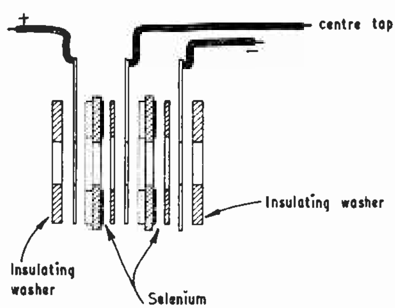


FIG.7. METHOD OF CONNECTING WESTINGHOUSE M-3 RECTIFIER



Lead washer must contact selenium only and not copper of adjacent disc

FIG. 8.



Central insulating tube must be cut approx 1/32" shorter than the complete assembly above to ensure proper 'nip'

FIG. 9.

G454

"X1" in the "closed" position, and "X2" in the "open" position.

To calibrate the "backing-off" control R_3, connect a 5.0mA meter, in series with a fixed resistor of 2kΩ and a variable of about 50kΩ to the collector and emitter clips. Start with the variable at maximum resistance, and adjust it to give a current of 0.2mA. Back this current off to zero in the 1mA meter by means of R_3 and put an appropriate mark on the dial. Increase the current in steps of 0.2mA, backing off each increase to zero until the limit of R_3 is reached, around 1.5mA.

If a suitable micro-ammeter is available, the bias control can be similarly calibrated. The micro-ammeter is connected in this case to the base and emitter clips, whereupon adjustment of R_5 will vary the current between about 4μA and 20μA.

To use the tester, a transistor is connected to either the holder or the clips, S_2 is set to the correct position—either p.n.p. or n.p.n. —and initially S_3 is set to the "X2" range. The backing-off and bias controls are both set to zero, and the tester switched on. The resulting collector current is backed-off to zero, and the gain read by pressing the push-button.

If the reading is half-scale or less, the range switch can be set to "X1" when a more accurate reading can be taken.

The effect of increasing the bias current can then be observed, remembering to back-off the increased collector current by suitable re-adjustment of R_3.

UNDERSTANDING TELEVISION

continued from page 797

direction of the lines of force here being such as to cause it to be deflected to an outward-going path. However, due to the acceleration provided by the final anode, the electron passes through the field around electrode Q in a shorter space of time than it did through the field around electrode P. In consequence, and although electrode Q causes the electron to be deflected in an outward-going manner, the degree of deflection here is less than that around electrode P. The result is that the electron follows the path CD.

An electron leaving the point source in the direction AE suffers a similar type of deflection, this causing it to follow the path AEFD. Other electrons leaving the point source are similarly deflected, the degree of deflection becoming less as the electron travels closer to the centres of the apertures. An electron leaving the cathode along the line AGHD and passing through the exact centres of both electrodes would travel in a perfectly straight line.

All the electrons shown in Fig. 32 begin to converge after leaving the electrostatic lens and they meet at point D. If this point is on the surface of the cathode ray tube screen the electrons will cause a small spot to appear at this point. In other words the electrons will be focused on to the screen. The size of the spot given at the screen will, of course, depend upon the accuracy with which the electrons converge at the crossover point D, and this is a function of the efficiency of the design and manufacture of the electrostatic lens. A control of focus is possible by adjusting the positive potential on one of the two electrodes in the lens, this varying the strength of the curved field and, in consequence, the point at which crossover occurs.

The two basic factors of the electrostatic lens of Fig. 32 are as follows. Firstly, electrons leaving the point source travel through curved lines of force which result in their being deflected first inwards and then outwards. Secondly, by causing electrons to become accelerated whilst passing through the field, the time they spend in its second part is less and they suffer less outward deflection thereby.

The two cylindrical electrodes of Fig. 32 are meant to be typical only of the make-up of an electrostatic lens, and practical electrode shapes may vary widely from those shown. A frequently met variant is shown in Fig. 33. In this diagram we once more have the point source of electrons, this being followed by the first anode and the final anode of a "tetrode" cathode ray tube. The first anode has a lower positive potential than the final anode, with the consequence that we once again have curved lines of force between these two electrodes. These curved lines of force act in just the same manner as did those of Fig. 32, and electrons are similarly focused at a crossover point which should occur at the surface of the cathode ray tube screen. Control of focus is obtained by varying the potential of the first anode.

Next Month

In this article we have confined ourselves to the manner in which the electron stream inside a cathode ray tube may be deflected and focused by electrostatic means. In next month's issue we shall carry on to magnetic deflection and focusing.

AUDIO

Introduction to

The JUPITER

Stereo Pre-Amplifier and Main Amplifier

A Jason Design, by G. Blundell

IN THIS SERIES OF ARTICLES THE DESIGN OF a stereo pre-amplifier and a main amplifier will be described. The two units will be shown as cabinet mounting models, but cases are available so that both may be free-standing. The two units may both be built as single-channel amplifiers—thus saving some initial cost—and the second channel may be added later.

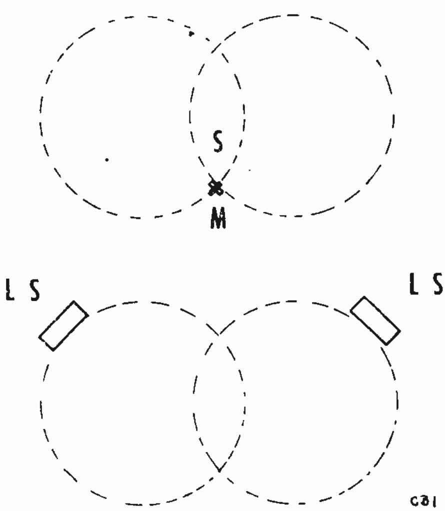


Fig. 1. The fields of the microphone M and the speaker LS. Why stereo works best when the listener is roughly midway between, although the stereo effect is not completely lost when the listener is right over on one side. A soloist near the microphone at point S would cause large changes in the relative output of the channels and thus apparent position just by turning his head.

First, what is "stereo"? True stereophonic reproduction is only possible by reproducing at each ear exactly what a person would have heard if standing in the same position as the microphone. This involves wearing headphones. This perfect reproduction is lost immediately the listener moves his head, and to see the reason for this an explanation of how direction is normally judged is required. Firstly, there is simply the volume difference between the sounds heard in each ear; secondly, the phase difference of the sounds heard in each ear.

The Difference in Level

Difference in level is very much more difficult to judge if one keeps one's head still. Try listening to sounds and see how difficult it is to judge the direction if one does this. A small head movement causes a louder signal in one ear and a lesser one in the other ear, and the source of the sound is quickly located.

The Difference in Phase

Less is known about how we judge direction by difference in phase; certainly direction of low notes can be estimated, though less accurately than high notes, and as measurements show that at low frequencies the sound levels arriving in each ear are approximately the same, it seems unlikely that the direction can be judged by difference in level. It is also likely that turning the head again gives a difference signal which allows more accurate judgment of direction. Under this heading of difference in phase (or time) may be included the fact that a sharp noise produces high frequency sound which arrives at the nearer ear first, and this also helps to give an immediate indication of direction.

Stereophony with Headphones

From the explanations in the previous paragraphs about how one judges direction by moving one's head, it can be seen that perfect stereophonic reproduction cannot be reproduced with headphones, contrary to many claims. The effect of turning one's head when listening via phones is to imagine that the whole sound source is moving around one rapidly. It is the aural equivalent to the room spinning round, which one knows is a very unpleasant effect. A sensitive person might have equally bad effects listening to stereo via headphones. At least a bad headache would probably result, due to the effort of the brain to interpret sounds which are not following the usual course of events which have been learned.

effect of a sound in the middle, and the illusion of stereophonic reproduction is complete.

This picture is quite adequate when applied to a large signal source spaced some distance from the microphone as shown in Fig. 1, and remarkably good effects can be obtained. It is possible, for example, by listening to a good recording, to make a complete drawing of the orchestra seating arrangements, and to throw in for good measure the positions of the microphones as well!

Unfortunately, the system does not work nearly so well for solo voices or instruments

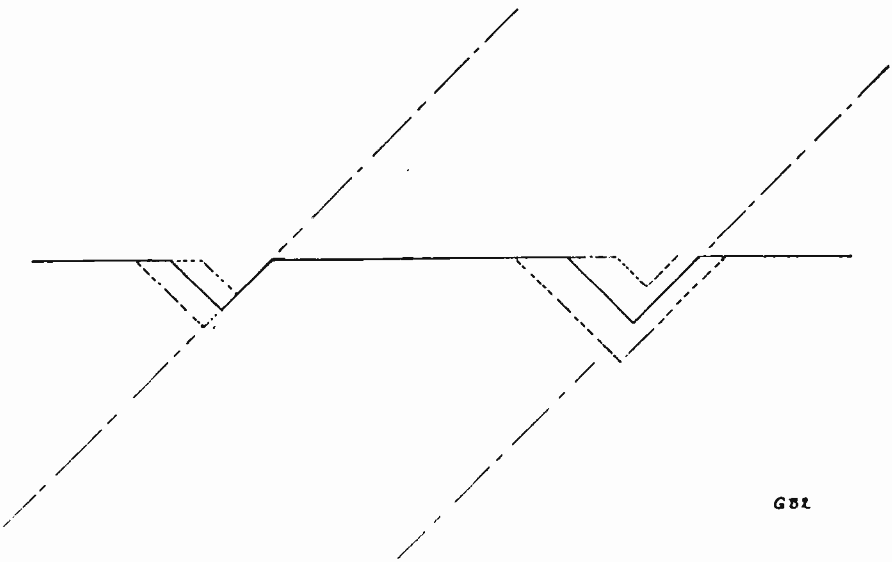


Fig. 2. The left-hand wall of the groove is being modulated. If the dotted line was the surface of the record, this would be equivalent to normal lateral modulation. Fig. 3. The left-hand wall is being modulated with a signal and the right-hand wall with a smaller one. If the dotted line was the surface of the record, there would be both lateral and hill-and-dale modulation.

Stereo by means of Two Separate Channels

Many listeners may have noticed that if two speakers are connected to an amplifier and are arranged a few feet apart, the sound appears to come from the middle point between them. This fact shows how stereophonic reproduction is possible with two channels. Two microphones reproduce two signals through two amplifiers and loudspeakers. A sound on one side comes obviously from one channel, while equal sound from each loudspeaker produces an near to the microphone. It can be seen from Fig. 1 that a small movement of the soloist near the microphone or change of direction of the soloist's head would cause a considerable change of level in each channel. The effect on the listener would be of the soloist appearing to be moving about rapidly in the middle of the stage. One solution to this problem would be to have the soloist on one side of the stage, but this is contrary to normal practice. The better way, probably, is to record the accompaniment stereophonically, but to record the soloist using present-day close microphone techniques, monaurally, and to record this monaural signal equally on each channel. The effect then would be that the soloist would appear to come from the middle of the stage, and the unnatural positioning effects would not be present.

Some discussion on these problems is important because for most purposes two-channel reproduction is the only one possible. However, present results show that with improvement of microphone technique all present problems of stereophonic reproduction can be solved. What appears to be happening between the speakers shows up the weaknesses of the system. Another fault of microphone technique makes it appear that sounds are coming from either right or left of the stage but nothing from the middle. These, however, appear to be minor faults easily cured by good microphone techniques.

The "hole-in-the-middle" effect can be solved with another channel, but this of course increases the cost of the system considerably. However, recent American "spectacular" films are using as many as six separate channels!

The controlling factors for the reproduction in the home are cost and the gramophone disc itself, which means that two channels are the maximum which will be used. The point about the disc being limited to two channels will be explained later, but meanwhile it is an interesting possibility that three-track tape recordings can easily be made, and it is possible in a year or two that three-track recordings will be available.

Listening Sources

The three important possibilities are tape, disc, and radio. Stereo tape recordings have been available for a year or two in both England and America. Disc recordings are now being released, and the B.B.C. are making experiments with stereo broadcasts.

Stereo on Tape

This consists of two separate recordings on standard ¼in wide tape. The two tracks are quite independent and are reproduced separately by two heads mounted directly one above the other. These two reproducing heads must be exactly in alignment or the stereophonic effect will be lost. An older American system uses heads following one after the other, one recording of course being delayed by an equal amount. To achieve good results the head spacing and tape speed have to be very accurate. No tapes have been released in England using this system.

Stereo on Disc

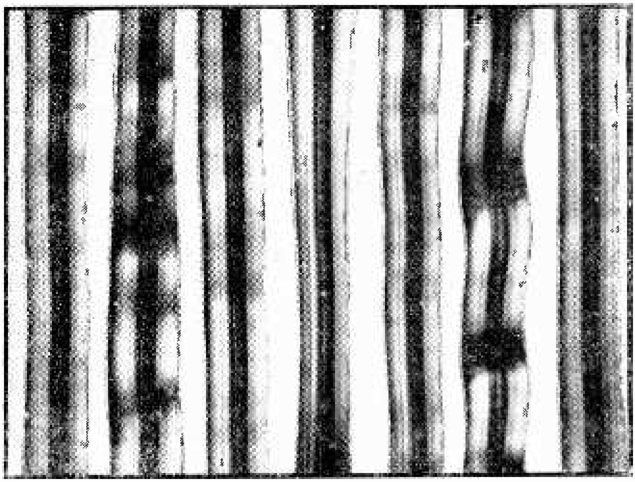
Contrary to many recent statements, recording of two channels in one groove is a British invention first patented by A. D. Blumlein of H.M.V. before the war. There are two possible variations in the method of doing this, and it is to the credit of the gramophone record industry that complete agreement has been reached to standardise on one of them. Briefly, one method uses the normal lateral method of modulating the groove for one channel whilst the other channel is modulated in depth on the same groove using the hill and dale system. One needle of course reproduces both channels, vertical movement generating one voltage and lateral movements another voltage which are fed to the two amplifiers. This system was demonstrated in England by A. R. Sugden (Connoisseur) and Decca, and very good results were demonstrated. In America development took place by Westrex of the 45/45 system. A short explanation of this will be given, although briefly it is the same as the above system except that the plane of the record has been tilted through 45°. The advantages are considerable. Both channels are now identical, carrying the same amount and type of distortion, the same recording response curves may be used, external defects such as motor rumble affect each channel identically. This balance between the systems is important if good stereophony is to be obtained. Fig. 2*a* shows the way in which the groove is modulated, the dotted line showing one channel varying. In Fig. 2*b* the dotted line shows the depth of the groove in the presence of signal, while the full line shows the unmodulated groove. On each drawing is shown a further dotted line representing the plane in which the record surface would be if the drawings referred to hill and dale/lateral systems instead of 45/45. Basically, the systems are the same and the present standard 45/45 system was referred to by Blumlein. It may safely be claimed that though we have adopted an American development, the original system and variants were British inventions.

Stereo on Radio

As stereo radio is in its infancy here, it will be more helpful to describe American developments. American radio stations on the whole serve small areas of population and operate independently. They may take network programmes of major interest, but there is spare radio time available for unusual broadcasts. A number of stations operate both a.m. and f.m. transmitters, and these are sometimes used for stereo broadcasts—one channel being broadcast on each wavelength. This, of course, reduces the quality of the broadcast to that obtainable from the a.m. station; but as, usually, smaller areas are served, good quality is obtainable by the majority who live near the station.

Another possibility also being explored in America is a method known as multiplexing or sending out two programmes on the same f.m. wavelength. The bandwidth required prevents this being done on a.m. The f.m. carrier is modulated both with one channel and also an inaudible carrier frequency of 40 kc/s. This second carrier is modulated with the second channel, and complete separation between the channels is easily obtained. A normal tuner receives the first channel, to which a second unit must be connected to demodulate the 40 kc/s carrier. This unit must be connected before the de-emphasis circuit which would otherwise attenuate the second carrier completely. Slightly worse signal-to-noise ratio results since only the same bandwidth can be used, but this is more than balanced by the improvement in realism. The same remark is, of course, true of disc.

A difficulty arises, though, with radio which does not arise with discs. Anyone wanting to listen to stereo buys the appropriate disc, and it is not necessary for this to work with normal pick-ups and single channel equipment. The opposite is not true of radio. One channel of the radio must be "compatible," must carry all the information. One channel of stereo usually sounds rather weak and indistinct due to some of the sounds originating farther from the microphone being blurred with echoes. The balance of an orchestra is completely lost. Therefore, a new system has been proposed which works algebraically. The main programme carries both channels added together (A+B); the second channel or sub-carrier carries a difference signal (A−B). Appropriate electrical circuits add these signals or subtract them by reversing the phase on one, giving the following results: (A+B) + (A−B)=2A, secondly (A+B)−(A−B)=2B and—hey presto—our two original channels are recovered for feeding to our two amplifiers, and yet our first programme is compatible, carrying both signals A and B.



Actual photograph of a stereo groove

Photograph by courtesy of E.M.I. International Ltd.

To CHASSIS BASHERS!

The Osmor people announce a FREE LOAN SERVICE for any of their chassis-cutters and "Jiffy" punches. These tools will be sent on application to Osmor Radio Products Ltd., 418 Brighton Road, South Croydon, Surrey, enclosing the retail price of the tools required. The total cost (less postage) will be refunded in full when the tools are returned undamaged. The loan period is for a full 14 days, and the tools must be returned within 17 days,

Radio Miscellany

FREQUENTLY DURING THE LAST FEW months I have felt it only courteous to apologise to readers, where it has not been possible to deal with their points in print, for my apparent tardiness in replying to letters. Yet in doing so I have been rather uneasy for fear of irritating those readers who never write, with seemingly weak excuses—although as fellow enthusiasts they no doubt feel they haven't got enough spare time either! However, I really do try. As one who has for so long emphasised to newcomers our hobby's strongly established tradition of good fellowship, I should be ashamed to do otherwise. Imagine my surprise, therefore, to have a request for the address of a regular contributor to another periodical. Apparently two letters addressed to him failed to evince a reply. Could I supply his private address?

It jolted me into a desperate effort to get up to date with my correspondence and also to give over much of this month's space to "sequels" of points raised by readers. Please don't take this to mean a reply will be forthcoming by return of post. Unfortunately, I am still in hospital where my only pursuit of the hobby is to read and think about it and where, incidentally, I have just nearly injured myself through laughing. It happened this way. The chap in the next bed is nearly better and the Ward Sister thought he could well attend some sort of non-denominational thanksgiving service to be held in the chapel. He pleaded an improbable sort of excuse, intending to remain in bed and listen to his favourite funny man on the Light Programme. Thus he was lying with the earphones on while I was writing. Suddenly, he tore them off and they fell to the floor with a startling clatter. I thought he must have had a shock. In the early days before output transformers were in general use, headphones used to be wired direct in the anode circuit. Old boys with bald heads often used to get a mild shock when listening on their one-and two-valvers. However, it wasn't that sort of shock he received. They cut off the Light Programme and began to relay the chapel service instead, for the especial benefit of the bedridden! I don't know which made me laugh most. The poetic justice of it or the look on his face. If it amuses you, too, it must be the former.

I-Spy

A few weeks ago I heard from a Scottish reader who had never been to London before. At last the occasion was to arise and he would be spending a few days in the Big City. Would I suggest a comprehensive tour of the radio (and junk) shops?

I sent him a brief itinerary of places of interest in the Central London area. Not a very imaginative tour, I'm afraid, but it included the Lisle Street, Tottenham Court Road, Fleet Street, Edgware Road and Praed Street areas. Now he has written to thank me and says he enjoyed it. No special bargains mentioned! On his own initiative he added Broadcasting House, and while he stood admiring that magnificent edifice he noticed a parked car bearing simply the word "Radio." On closer inspection to see whose radio it was, he found it was the registration number RAD 10. Whilst contemplating this remarkable coincidence, a delivery van drove by. This bore the registration number 1 AMP. When he tells folks back home they allege he had either (*a*) been drinking, or (*b*) showing early symptoms of radio-mania. The only thing I can suggest is that the next time he comes to London he brings his camera with him—in an ever-ready case.

Test Record

Those who have followed the discussion on test records will be interested to know that a new hi-fi test disc was introduced last month at the Audio Fair. Its release to the record shops was held back until after this event. It was originally released under the U.S.A. "Popular Science" label in a 12in. double-sided 33⅓ r.p.m. disc, and is said to have sold over 50,000 copies there. While it doesn't quite meet the requirements of our original Aberdonian enquirer (who asked for a 45 r.p.m. record), it will find a very wide welcome among hi-fi fans. Such a record makes for easy tuning of reflex speaker enclosures, detection of resonance points and vibration occurring in certain frequency ranges, checking turntable speed steadiness, testing amplifier equalisation, and in matching tweeters to existing speaker systems.

This record, by the way, also contains a sound effects quiz game, suitable for parties. If everybody gets them *all* right you can feel very satisfied with your equipment! Also included is a recording of five music-box selections.

Such a disc has an obvious appeal to the constructor experimenting in search of perfection in reproduction, but equally important is what it will reveal to the non-technical. The term hi-fi has only too often been exploited as a sales booster of equipment ill-deserving such a description. It should prove an effective means of protection against inferior amplifiers and accessories.

Still Coming

Last month I mentioned the availability of 16 r.p.m. records in the United States. I now hear that 16 r.p.m. records are on general sale in France in both 7 and 10in sizes. They play for 15 and 30 minutes per side respectively and a normal 33⅓ r.p.m. stylus can be used without difficulty.

I have had no opportunity of hearing any of the few specimens imported for test purposes, but a hard-to-please friend assures me they are "quite acceptable," although he said there was a very slight trace of wow on the outer circumference of the larger size. They are not normally available in the U.K. and as far as I can trace (from the remoteness of a hospital bed) nor are any other 16 r.p.m. discs—yet.

Rust Inhibition

As a result of my request for suggestions (on behalf of readers handicapped by garden shed, outhouse, or other damp workshops), details of a modern vapour phase inhibitor have come to hand. It is marketed under the name Rustfoe and comes in the form of a coated paper. Three grades are available, unwaxed neutral kraft, waxed neutral kraft and pure union kraft (bitumen centre). A vapour is slowly given off by the coating, which it is claimed will render water non-corrosive to steel.

Samples have come to hand from the manufacturers who kindly offer to advise readers on their particular problems. I have had no opportunity to try out the samples they have sent me—obviously delayed until I am again on the active list—but I am told it is becoming widely used throughout the electrical trade. Uses which readily come to mind are for lining tool boxes, drawers, and shrouding small lathes and other tools.

Rustfoe paper should be used as an inner lining to prolong its protective life by retaining the non-corrosive vapour. When stored it should be kept in an envelope until required for use. It is supplied in either rolls or sheets to order and a popular handyman pack is available containing eight sheets 15in × 20in at a cost of 5s. The coated side of the paper (the white side) must, of course, face towards the metal to be protected. Readers unable to obtain supplies through their usual retailers should write to Williams-Cook Ltd., 43-45 Brunel Road, W.3.

Centre Tap talks about Items of General Interest

More of Yore

Several more letters from Old Timers this month, for which many thanks. They still outnumber correspondents on other matters. Perhaps they remember the stuff I wrote "way back" and look on me as an old friend. At least, it is nice to think so, especially as I am still numbered among the Bedfast. By the way, thanks fellow invalids for the regular copies of *Radial* and for the good wishes for my recovery. I found your current Newsletter cheerfully chatty and it made me less impatient with my infirmity.

Old Timer W.H.S., of Swindon, relates how he deserted our ranks for a spell, but like a great many others recently made a come-back. He celebrated his reunion with the hobby by building a battery portable. I gather it was the Petite, recently described in

continued on page 825

Technical Forum

The Remote Control of TV Sets

When visiting exhibitions one is often surprised at the number of sales gimmicks which are added to standard pieces of equipment in an effort to enhance their sales value. Frequently it would seem that the addition has little more than a sales or novelty value, and may prove of little use to the final owner. Whether or not a gimmick is found to have a value to the user can often be assessed by noting whether it is retained for more than one season. Many will appear on one model only and will have been discarded by the time the next design is introduced. Others will survive much longer, in which case they will move out of the gimmick category into one of usefulness. We feel that the provision of a remote control system for a television receiver falls into the latter class, particularly if the receiver is used by an invalid where the need for readjustment can be a serious inconvenience.

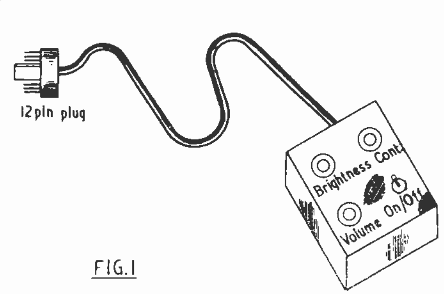


FIG. 1

Most readers who are interested in adding a refinement of this type to a receiver will no doubt wish to do so with the very minimum of modification to the set itself, and it is particularly with this in mind that the following recommendations have been worked out.

The receiver controls which are most usefully and easily extended for remote operation are:

Contrast, brightness, volume, and the on/off switch.

There will be some cases where it would be considered an advantage to be able to remotely control the station selector. This is largely a mechanical problem which will vary in its complexity according to the type of station tuner which is employed, and it is therefore considered to be outside the scope of the present article. A general impression of the remote control unit will be obtained from Fig. 1, and it will be seen that the multi-way cable is terminated by a 12-way duodecal type plug. This plug fits a 12-way socket which is added on the back panel of the receiver, and enables the set to be used either with or without the extension unit. When the unit is in use its controls are in circuit and those on the receiver are inoperative. When not required, the unit is unplugged from the receiver and a dummy plug inserted in the socket; the set then functions normally. The dummy plug is necessary to complete the circuit of the main controls. With the exception of the volume control the leads to the extension unit carry no r.f. or a.f. signal, so there is no serious chance of interaction causing instability. The volume control has been included in a low impedance part of the circuit, so that here again there is no possibility of interaction, thus it is permissible to employ any reasonable length of cable between control unit and receiver. The various receiver manufacturers use circuits which vary quite widely in their method of achieving similar results, so that it is impossible to give full details of how the remote control unit is added to every class of set. The ensuing description, however, covers a unit which will be satisfactory for use with three-quarters of all receivers at present in use, and the reader should have no difficulty in adapting the system to cover the others.

The Circuit

When the unit is plugged into the receiver, the set controls are cut out of circuit and only those on the unit itself are operative. This is achieved by the use of shorting contacts on the 12-way socket at the receiver end. The circuit diagram (Fig. 2) indicates the way in which these shorting links are made to function. The brightness control in the set is R_1 and on the unit R_2. R_2 is a linear potentiometer, and it is essential that it should have the same value as R_1. In order than R_1 can be cut out of circuit, the leads to its slider and most positive end are broken and connected up to the 12-way socket added on the back panel of the set. When the remote unit is in use, leads to it are simply taken from contacts 1 and 4 together with the common earth line 5. This leaves R_1 out of circuit and completely replaced by R_2. In some receivers an additional resistor may be found between R_1 and chassis, and in such cases a similar resistor must be employed between R_2 and pin 5 so that the two control circuits are identical. Should the extension unit not be required, it is unplugged from the back of the receiver and the dummy plug replaced in the socket. Shorting links in the plug bridge pins 1 and 2 and also pins 3 and 4, thereby enabling the brightness control in the receiver to function normally.

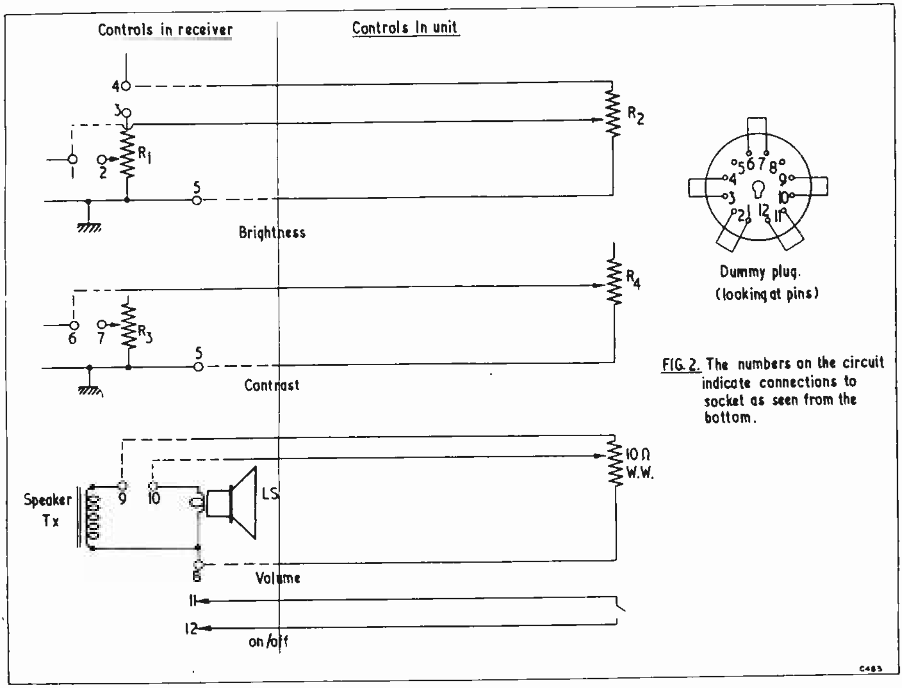


FIG. 2. The numbers on the circuit indicate connections to socket as seen from the bottom.

The contrast is normally varied by means of the cathode bias on valves in the r.f. and i.f. stages, and this is often achieved by a common adjustable resistor in the cathode circuits; such a resistor is shown as R_3. With such an arrangement it is only necessary to break the lead to the slider and connect up to pins 6 and 7 on the socket. The remote control is then R_4, having the same value as R_3 and joined between leads 6 and 5.

To eliminate the need for screened cable to the volume control, it has been joined in the secondary circuit of the speaker transformer. The impedance here is in the region of a few ohms only so there is no possibility of hum occurring due to stray pick-up. One lead to the speech coil is broken and connected up to pins 9 and 10 on the socket, whilst pin 8 is taken to the other side of the speech coil. Volume is adjusted by means of a 10 ohm wire-wound potentiometer as shown on the diagram.

This leaves two spare positions on the 12-way socket for the single pole on/off switch, which is joined in the positive mains lead, and is in series with the switch in the receiver. Thus the receiver switch has to be closed before the remote unit is put into service.

Construction

These recommendations are equally applicable to both a.c.-only and the live chassis type of a.c./d.c. receiver, but it is essential to make sure that the user cannot make contact with any of the live parts. This includes the chassis lead to pin 5 in the case of the universal type of set. The best form of housing for the remote controls is a box made in either paxolin, Perspex, or one of the other plastic materials. The lead may be a multi-way type having at least nine cores each of which can be identical, as none has to be screened.

Can Anyone Help?

Requests for information are inserted in this section free of charge, subject to space being available

P. H. Byles, 57 Devonshire Road, London, S.E.23, wishes to obtain a circuit of the MCR.1 Receiver, and would also like suggestions as to where he could obtain an output transformer for this set.

* * *

P. Jackson, 60 Southwold Road, London, E.5, would like to buy or borrow a service sheet, manual, etc., for the Eddystone 358X Receiver.

* * *

E. M. E. Decottignies, 58 Leighcliff Road, Leigh-on-Sea, Essex, wonders if any reader can help identify a valve. This is all-glass, IO based, with top cap, and is marked ↑ EF—CV1501—KB/K. It appears to be a pentode, with anode connected to top cap. Heaters are as normal in IO valves.

* * *

P. L. Grieveson, 40 Clarence Crescent, Sidcup, Kent, has been trying, without success, to get a copy of the service sheet for the Ferguson 9in 841T televisor. Can anyone help?

* * *

J. P. Hupfield, 51 Wotton Road, Cricklewood, London, N.W.2, wishes to purchase, borrow or otherwise obtain a circuit diagram or manual for the New Zealand Transceiver Z.C.1 or Z.C.2.

* * *

P. G. Martin, 4 Beech Road, Princes Risborough, Aylesbury, Bucks, asks if anyone has a copy of *Wireless and Electrical Trader* which he can spare.

G. Worrall, 2 Cecil Avenue, Dronfield, Derbyshire, would like to hear from anyone who has successfully built the Premier "Mayfair" televisor.

* * *

H. Lane, 21 Barrack Hill, Newport, Monmouth, wishes to buy or borrow the circuit of the Test Set 74 (VCR139A tube, SP61 valves, internal power pack) and would like to hear from anyone who has modified this unit for use as a 'scope. Any expenses involved will be covered.

* * *

F. W. Hattemore, 20 Baroness Place, Penarth, Glamorgan, would welcome information leading to a source of supply of a cabinet and baseplate for the CR.100 receiver. He offers any information required by any reader on the following equipments, providing an S.A.E. is enclosed: 358X Receiver, HRO, CR.100 or R.1155 Receivers.

* * *

W. Wren, 36 Curzon Street, Gateshead 8, Co. Durham, wishes to buy or borrow the handbook or any data on the ex-Admiralty Tuner-Amplifier, Marconi B.21.B.

* * *

T. G. Whitehead, 86 Seymour Road, Trowbridge, Wilts, would like to buy or borrow the service manual or any data on the Collins TCS.13 Receiver.

* * *

J. Longley, 7 Chapelfields, Marple, Cheshire, would like to buy or borrow any information or service manual on the American Du Mont Oscilloscope type 208.

The London Audio Fair 1958

It was heard suggested that if all the power dissipated at the Audio Fair as sound output were released as one gigantic signal, it would probably be no more than a tiny fraction of a peal of thunder.

If one adopts a less cynical view, however, there can be no doubt that the third London Audio Fair, held once again at the Waldorf Hotel from the 18th to the 21st April inclusive, was an outstanding success. The visitor's first reaction was to notice the increase in the size and scale of the Fair—a second exhibition hall has had to be brought into service to accommodate the total number of exhibitors, given in the programme as sixty-five. This did, in fact, result in a layout that lent itself to an easier flow through the exhibition halls. The organisers are to be congratulated, not for the first time, on the way in which their arrangements stood up to the severe test of the large number of visitors. As in previous years, the majority of the firms exhibiting were demonstrating their equipment in rooms on either the first, second or third floors of the hotel.

Strictly speaking, one of the objects of a report of this nature should be to highlight the new equipment that was presented. This is always possible when two or three items only are noticed, but in view of the fact that this year marked the first real onslaught on the public of stereophonic reproduction, it will be appreciated that no space is available for individual mention, in fairness to those that would have to be omitted. A short while ago it would have been assumed that the natural sphere for stereophonic recording and reproduction was tape. Quite obviously the record manufacturers are determined that this shall not be the case, and several convincing demonstrations of stereophonic reproduction from disc were given. The method employed now seems to be universally according to the 45/45 standard, and pick-up cartridges for this type of record are now becoming available from several manufacturers.

Your correspondent was informed by the organisers that some 50,000 people attended the Audio Fair during the four days that it was open. Conversation with a number of manufacturers showed that amongst these visitors were a useful number of overseas buyers who showed considerable interest in the products available.

Radio Miscellany

continued from page 821

our pages. He is tremendously enthusiastic and says in past years he has built dozens of designs, most of which were highly successful, but never before has he built a set so completely perfect!

He doesn't mention the date when he built his last portable. I suspect it must have been a few years back when it took a couple of able-bodied men to carry a portable equipped with batteries. The half a dozen full-sized valves, numerous large components and frame aerial-cum-tuning coil needed a fair-sized suitcase for a start! Even so the output level was little more than a good crystal set, with the most alarming instability. One had to tread gently whenever within six feet of it. I hope he is not judging the Petite by comparison with one of these. True it is a very well designed little set, but such lavish praise might give beginners (who would judge it by 1958 standards) a wrong impression.

Lt.-Col. F. C. Booty (Secretary of the Norfolk Broads Yacht Club) also writes of the good old days, *circa* 1925, in India. He recalls the early wireless periodicals, especially the advice solemnly given to constructors: "When wiring up to terminal posts, never make a complete loop of the wire. Always leave a small gap and so avoid capacity." About 1929 he started on short waves, and although sited at 3,000 ft A.S.L. he was weeks before getting a signal. Then one day he heard a voice speaking in Urdu. When it said: "Ajaib Singh isn't here. He's gone to the latrines," he realised it was a harmonic from the regimental signallers in the next tent. At last he did resolve a signal and heard the strains of the Soldiers' Chorus—their regimental march! The signal came in and out for hours, but he was never able to confirm the call-sign. By all the rules it should have been KDKA—and what memories that revives!

By the way, he discovered something which would have been of vital interest to readers of those days. Dry wood was found to make much better panels than much of the expensive ebonite. Most old timers still harbour bitter thoughts of much of the ebonite of those days. Like the Greeks, they had a word for it. They called it muckite!

RADIO

A 3-Valve MAINS T.R.F. RECEIVER

By **W. HARRIS***

THE RECEIVER ABOUT TO BE DESCRIBED offers an opportunity to constructors who have so far limited their efforts to battery driven sets. The advantages are many, including cheaper running costs and better overall reception.

The receiver is built around modern slug-tuned coils, thus providing increased sensitivity and selectivity. Lining-up of the tuned circuits entails only the setting of the cores—once set, they can be forgotten.

For the original receiver an Eddystone cabinet fitted with a chassis measuring 9in × 6in × 2½in deep was used. Any alternative cabinet and chassis of suitable size may be used, provided that the front panel is a rigid structure—it may be stiffened, if necessary, by fitting an angle bracket at each end above the chassis top. The power pack, being a separate unit, can be employed for other experimental work, within the limits of its output, when not being used to drive the receiver.

The anode feedback condenser C_9 is a variable instead of the more usual fixed type, this enabling a setting to be determined for each detector coil to ensure stability and smooth regeneration control on all bands. The actual regeneration control is, of course, R_9.

Electrical bandspread is incorporated which is effective on all bands; however, on MW and Top Band its effect is relatively small, but it is still useful for the purpose of setting the tuning to the dial calibration.

For the reception of c.w., or telegraphy, R_9 should be adjusted so that the receiver is just in oscillation. No radiation occurs via the aerial as the detector stage is isolated by the r.f. stage.

Construction

This does not entail any great difficulty. If the components are arranged as shown in the layout diagrams no inter-stage screens will be found necessary.

The Denco coil bases require a hole ⅝in diam., the bases being 9-pin noval. The octal based valves need the usual 1⅛in diam. hole and i.o. holders. Before drilling the holes used for the fixing screws make sure that the holders are oriented correctly for the obtaining of short wiring.

A 4-pin valveholder and plug will be needed for connecting the power supplies, and the hole for this is cut on the rear wall of the chassis.

The 375pF 2-gang bandset tuning condenser is placed so that the spindle is on the centre line of the chassis, and set back so that a flexible coupler and short extension spindle may be employed. The same applies to the 15pF 2-gang bandspread tuning condenser, which is fitted under the chassis.

If a metal cabinet is used, the holes cut for the spindles of the various controls must be positioned to correspond exactly with those controls which are mounted on the chassis. An extra nut on the r.f. gain and reaction

* Radio Amateur Bedfast Club

Component List

Condensers	
C_a	50pF variable
C_1–C_3	375pF 2-gang J.B.
C_2–C_4	15pF 2-gang
C_5, C_6, C_7, C_{12}, C_{14}	0.01µF
C_8	0.005µF
C_9	100pF variable
C_{10}	100pF mica
C_{11}, C_{15}	2µF electrolytic
C_{13}	0.5µF paper
C_{16}	25µF 25V electrolytic
C_{17}	0.1µF paper
Ct_1	3–30pF concentric trimmer
Resistors	
R_1	330Ω ¼W
R_2	10kΩ potentiometer
R_3	56kΩ ½W
R_4	10kΩ ½W
R_5	2MΩ ¼W
R_6, R_7	100kΩ ½W
R_8, R_{11}	22kΩ ½W
R_9	50kΩ potentiometer
R_{10}	1MΩ ¼W
R_{12}, R_{14}	47kΩ ½W
R_{13}	600Ω ½W
Valves	
V_1, V_2	EF39 or equivalent
V_3	L63 or equivalent
Coils	
L_1, L_2, L_3, L_4, L_5	Denco miniature Noval based "Maxi-Q" to suit ranges required
RFC_1	All-wave choke

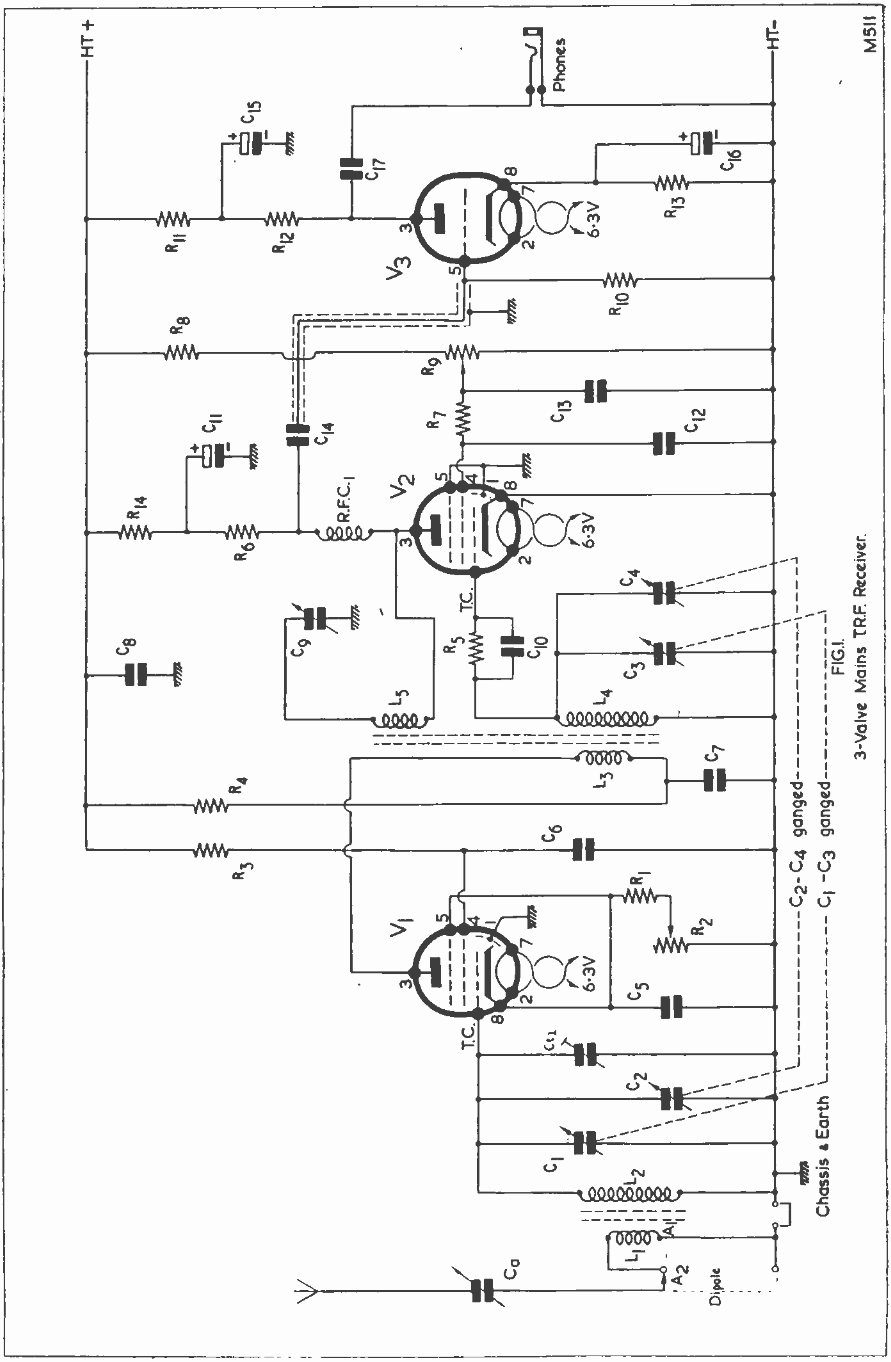


FIG.1.
3-Valve Mains T.R.F. Receiver.

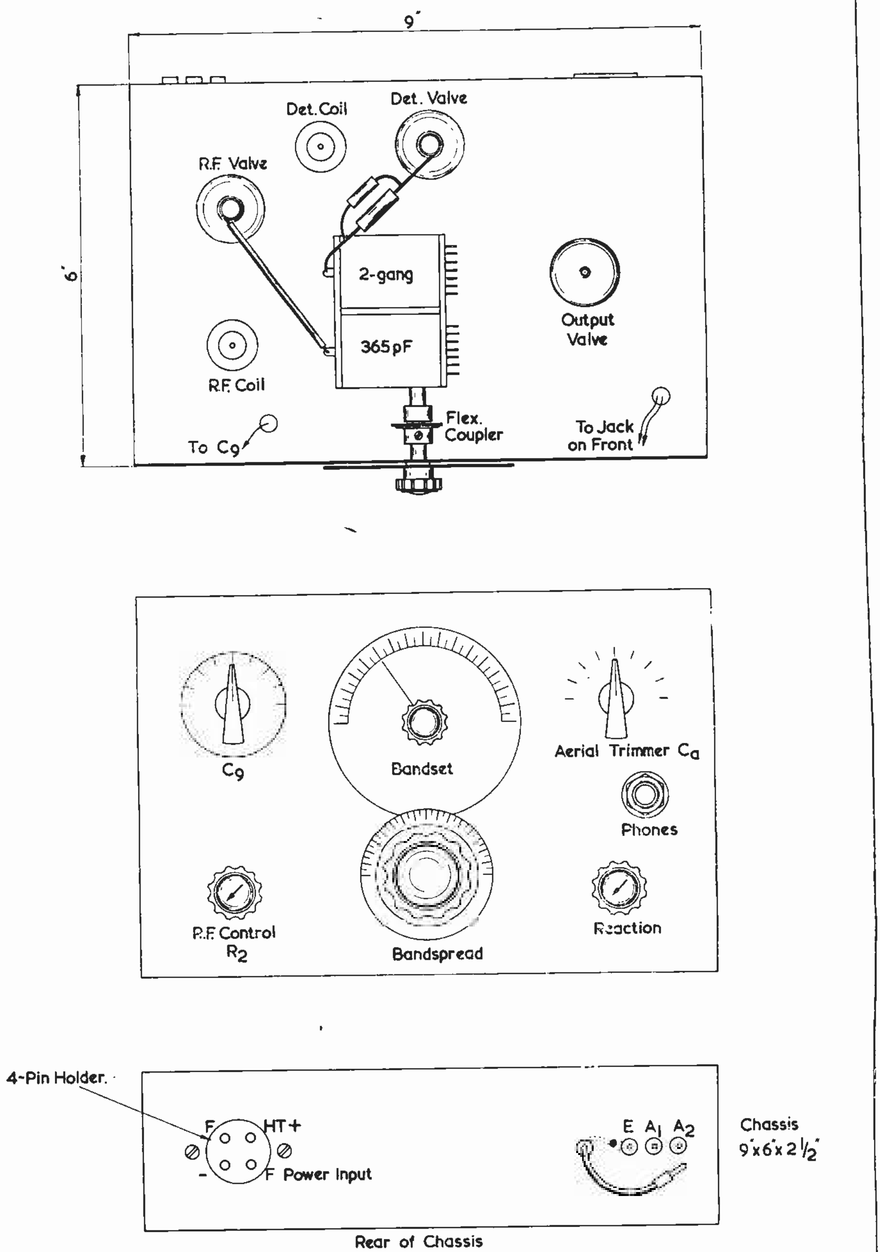


FIG. 2
Suggested Layout.

controls will lock the chassis to the front panel. A panel bush will be required for both the extension spindles of the tuning controls. These short extension spindles are cut to a length suited to the knobs and slow-motion drives employed. Any minor inaccuracy of these spindles with the bushes is taken care of by the flexible couplers.

Wiring

Covered wiring of 22 s.w.g. is recommended. Work should commence with the heater wiring, this being twisted together between connections and allowed to run along the bottom (that is, the underneath of the top) of the chassis. Start from the power supply socket at the rear of the chassis, using the two filament or heater pins. (The "grid" pin is used for h.t.– and is connected to a tag nearby on the chassis. The "anode" pin is used for h.t.+ wiring.) Solder tags under the nuts holding down the valve and coil holders should be used to obtain short, direct earth connections. 2 or 3-way tag-strips should be employed where necessary to prevent undue movement of small components.

Having finished the heater wiring, a start can be made on the coil and valveholders, beginning with the r.f. stage. All wiring should be kept as short and direct as is possible. When using cored solder bring the iron point and solder together and make the connection with a minimum of solder—large blobs are liable to cause shorting where pins are close together.

Wiring above the chassis can be left until the under-chassis work is completed. Make certain that each joint is a sound one—"dry" joints cause much trouble and are often difficult to locate after the receiver is completed.

Power Pack

The power pack is fairly straightforward and should present no difficulties. The mains transformer, smoothing choke and electrolytic condensers are all standard items. The 4-pin plug should be connected to the end of the output cable taking care that the connections correspond with those on the socket at the receiver end. A chassis size 8in × 6in × 2½in is suitable.

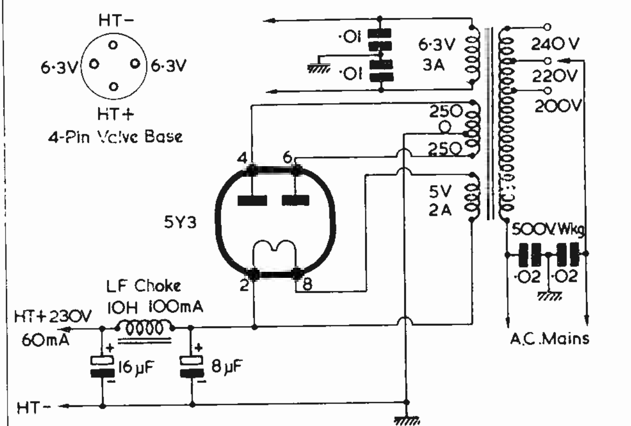


FIG. 3.
Circuit of Power Supply

M513

Operating the Receiver

After connecting the aerial, earth, power pack and 'phones, set the r.f. gain control halfway, anode feedback condenser vanes about one-third "in," and switch on.

Assuming the 80m coils are being used, set the bandset tuning condenser at about one-quarter "in," tune in a signal and bring it "up" with the regeneration or reaction control, then adjust the coil cores until the circuits are in line.

Adjustment of the aerial trimmer C_a will often be found beneficial in improving selectivity or, alternatively, in increasing the strength of a weak signal. In cases where a dipole aerial is to be used, provision has been made for isolating the bottom end of the primary winding from chassis for this purpose, and for omitting C_a likewise. A switch could be arranged to do both functions where different types of aerial are to be tried.

Tuning is normally carried out by first setting the bandset condenser to any required frequency, such as the l.f. end of an amateur band, with the bandspread condenser vanes fully engaged. Rotation of the bandspread condenser in the direction of minimum capacity will then tune a range on the high frequency side of that frequency to which the bandset condenser was tuned. Although it may seem to the beginner that there is a complexity of controls, he will, after a little practice in the handling of the receiver, realise the benefits of the flexibility which these controls confer.

Using Surplus Meters

By R. H. WRIGHT, G3IBX

PERIODICALLY, SUPPLIES OF METERS, VOLTmeters, milliammeters and ammeters appear to be released on to the surplus market and are advertised at reasonable prices in the magazine. Some of them have ranges which are extremely useful to the experimenter; but others have ranges which, except in odd cases, have little apparent practical use.

One of the more useful types is the meter having a full scale deflection current of 1mA with a meter resistance of 100 ohms. Such a movement may be used in conjunction with suitable shunt and multiplier resistors to build up a useful multi-range meter which, in addition to resistance measurements, has the following d.c. ranges:

Volts	*Current (mA)*
0–1	0–1
0–10	0–10
0–100	0–100
0–500	0–500

Suitable values of shunt and multipliers may be easily made up. Fig. 1 shows a suggested layout for such a meter.

The scale of the meter will, of course, be marked 0–1mA; therefore the scale reading will have to be multiplied by the appropriate factor when using the meter for higher current and voltage readings.

Range	*Multiply scale reading by*
0–1	—
0–10	10
0–100	100
0–500	500

For resistance measurements first connect the test terminals together and adjust R_2 for full scale deflection on the meter. In calibrating the meter for resistance measurement, the actual pointer position on the scale for different values of resistance may be calculated or, alternatively, a number of known value resistors may be measured and the scale calibrated accordingly.

Components Required

M 0–1mA, 100 ohm moving coil meter
R_1 3.3kΩ ½ watt, 20% tolerance
R_2 2kΩ wire-wound variable resistor

Shunts

R_3, R_4, R_5 11.11Ω, tapped at 1.01 and 0.2004Ω

Multipliers

R_6 400kΩ, R_7 100kΩ, R_8 9.9kΩ, R_9 900Ω — Close tolerance resistors
SW_1 2-pole, 9-way switch (Bulgin, type S.206)
B 4.5 volt battery

The Planet Instrument Co., 25 Dominion Avenue, Leeds, can supply a made-up shunt resistor and also the close tolerance multiplier resistors. The arrangement shown in Fig. 1 will permit the shunt connections and the multiplier resistors to be wired directly on to the tags of the switch.

Previous reference was made to those meters which would appear to have little practical use to the experimenter. However, many of the more "awkward" range meters can be adapted for other uses by the simple application of Ohm's Law. In general terms this law states that the current in a circuit is directly proportional to the applied voltage and inversely proportional to the resistance of the circuit. Symbolically, this may be shown as $I=\frac{E}{R}$, where I is the current, measured in amperes, E is the applied voltage and R is the resistance, measured in ohms. Mathematically, this formula may be altered to $R=\frac{E}{I}$, and $E=I\times R$, and it is from here that one may set about altering the ranges of both voltmeters and ammeters.

With the exception of electrostatic, moving-iron and hot-wire type meters, those advertised are moving coil instruments having a basic full scale deflection current of, perhaps, one or two milliamps and a coil resistance varying between a few ohms and a hundred or so. If this basic movement is being used to measure a higher value of current, the current in excess of that required to give full scale deflection on the meter is shunted through a parallel resistor, as in Fig. 2 (*a*). Thus with a suitable shunt value, a meter may be adapted to read any value of current. The same type of meter may also be used to read voltages if a suitable current limiting resistor is connected in series with it, as in Fig. 2 (*b*).

The correct values of shunt and/or multiplier resistors necessary to extend the range of any meter may easily be determined if the full scale deflection current and coil resistance of the meter are known.

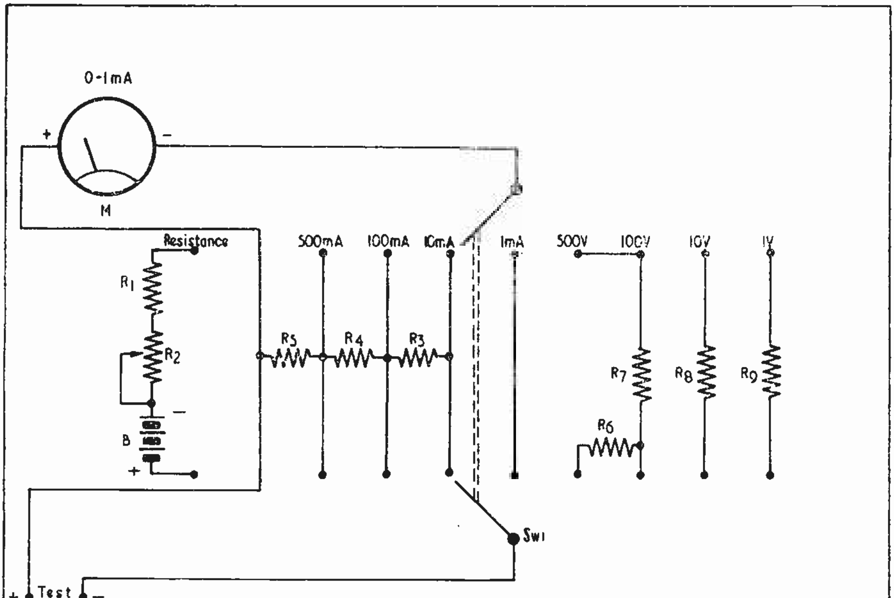


Fig. 1
Multirange instrument

To Calculate Shunt/Multiplier Values

Shunt Resistors

Since the meter and shunt are to be connected in parallel, the product of the current through the meter (I_m) and the resistance of the meter (R_m) must equal the product of the current through the shunt (I_s) and the resistance of the shunt (R_s) . . . . $I_s \times R_s = I_m \times R_m$

hence, $$R_s = \frac{I_m \times R_m}{I_s}$$

Example: What value of shunt will be required to enable a meter having a full scale deflection (f.s.d.) of 1mA and resistance of 100Ω to read 0–10mA?

Since the meter required only 1mA for f.s.d., 9mA must pass through the shunt,

$$\text{Shunt resistance } (R_s) = \frac{(1\times10^{-3})\times100}{9\times10^{-3}}$$

$$= 11.11 \text{ ohms}$$

Multiplier resistors

Suppose the meter of the previous example is now required to measure up to 10 volts. The f.s.d. of the meter is 1mA and so, when measuring 10 volts, the current through the meter must not exceed this value The total value of the resistance required to limit the current to the required value can be found by application of Ohm's Law—($R = \frac{E}{I}$)

$$\text{therefore, } R = \frac{10}{1 \times 10^{-3}} = 10{,}000\,\Omega$$

But the meter has a resistance of 100Ω, therefore an additional series resistor of 10,000−100=9,900Ω will be required.

In both examples, the actual meter reading will, of course, have to be multiplied by 10.

A multi-range meter, similar to that described previously can be made up quite easily with a basic moving coil movement and a suitable selection of shunts and multipliers.

The meter may also be used to measure resistance in addition to current and voltage by the inclusion—in series—of a battery of, say, 4½ volts and a current limiting resistor. For example, suppose we connect such a battery in series with the meter used in the above example, together with a fixed resistance of 3.3kΩ and a variable resistor of 2kΩ, as in Fig. 2 (*c*). If T_1 and T_2 are joined, R_2 should be adjusted so that the meter shows f.s.d. If now a resistor of unknown value is connected in series between T_1 and T_2, a reduced current will flow through the meter. A number of known value resistors may be used and the scale calibrated accordingly.

resistor of about 50kΩ set to full resistance, and a small cell of about 1½ volts—as in Fig. 3 (*a*)—and gradually reduce the resistor value until the unknown meter is reading f.s.d. The value of current flowing may now be read off the calibrated meter. To measure the resistance of the unknown coil, disconnect

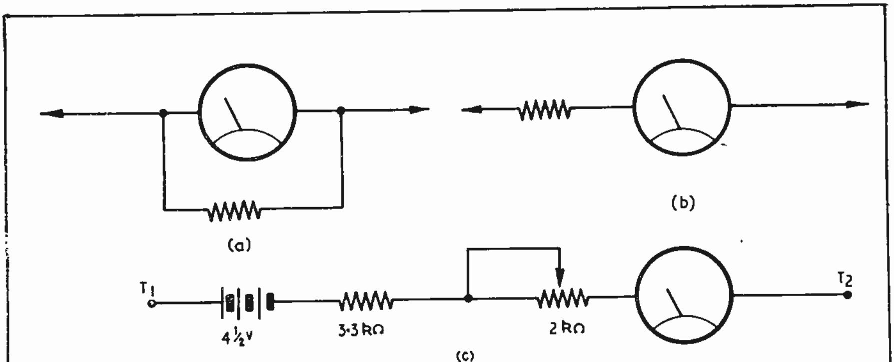


Fig.2

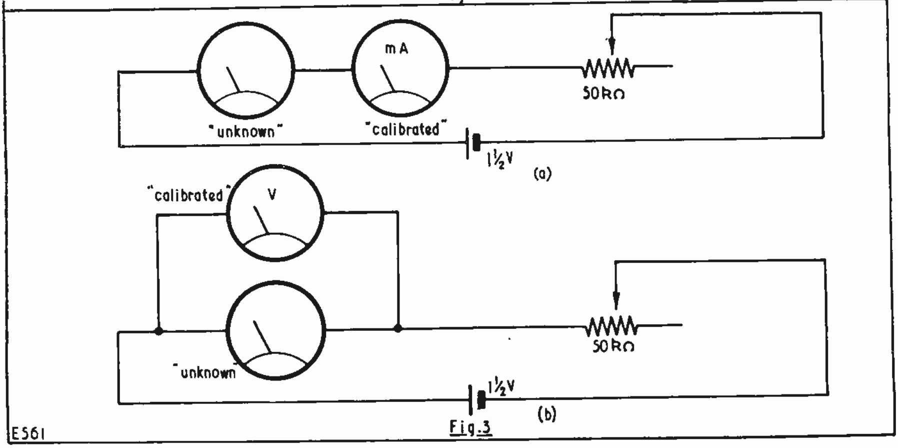


Fig.3

Meters previously used for measuring high voltage or current values may be used in multi-range instruments provided that they are dismantled and the internal shunt or multiplier resistance removed. Great care should be exercised when carrying out this operation since the coil, bearings and pointer are very easily damaged. In many cases the meter full scale deflection current and resistance are marked on the scale towards the bottom. If this information is not given, however, both values may be calculated if an accurately calibrated milliammeter and voltmeter can be borrowed. First connect the unknown meter together with the borrowed milliammeter in series with a variable

the calibrated meter, reconnect the unknown meter in the circuit without altering the resistor setting, and measure the voltage drop across the coil (Fig. 3 (*b*)). If this voltage drop is divided by the current, the resistance of the coil will be known.

Thermo-coupled ammeters may be used for multi-range meters or other purposes if the thermo-couple is carefully removed from inside the meter. Access may be obtained to the meter movement by removing—usually—three small screws located at the front or rear of the meter casing. Very often these thermo-coupled meters have a basic f.s.d. of about 2.5mA and a coil resistance of 6 to 10 ohms.

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4D1	6/9	12Y4	8/9	EF50	2/9	SP41	4/9
5Y3	8/9	35Z4	8/9	EF50 red	5/9	SP61	6/9
6AM5	3/9	35L6	8/9	EF80	8/9	T41	10/9
6AM6	7/9	63SPT	2/9	EF85	8/9	U22	10/9
6B7	1/9	77	3/9	EF91	7/9	UF41	8/9
6B8G	3/9	21OVPT	5/9	EF92	3/9	UU6	7/9
6F12	7/9	7193	3/9	EL84	10/9	U52	8/9
6F14	8/9	AR6(2V)	1/9	EL91	3/9	VR65	6/9
6H6M	1/9	ARP35	3/9	EZ40	8/9	VT52	6/9
6J5M	2/9	CV1083	3/9	EZ80	8/9	VT501	6/9
6K7M	3/9	CV188	3/9	FW4/500		VW48	9d.
6SJ7M	8/9	D1	1/9		10/9	TT11	6/9
6V6M	8/9	DH76	8/9	KTW61	5/9	W76	8/9
6P28	12/6	DK96	8/9	L410	1/9	W81	3/9
6SA7M	3/9	DF66	5/9	NR41	3/9	Z77	7/9
6SG7	3/9	EA50	1/9	PEN45	6/9		
6SG7M	2/9	EABC80	9/6	PEN46	6/9	**UX Types**	
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8D3	7/9	EB34	1/9	PEN220A	3/9	42	3/9
8D7	8/9	EBC33	6/9	PL82	8/9	78	3/9
9D2	6/9	ECC81	8/9	PL83	8/9	25RE	3/9
12A6	8/9	ECH42	8/9	PP225	3/9		
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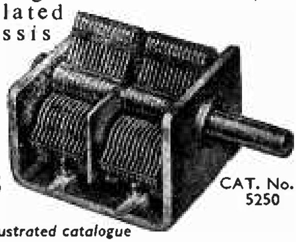

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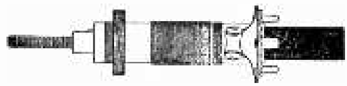

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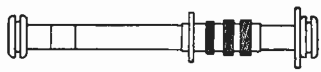

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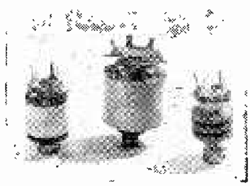

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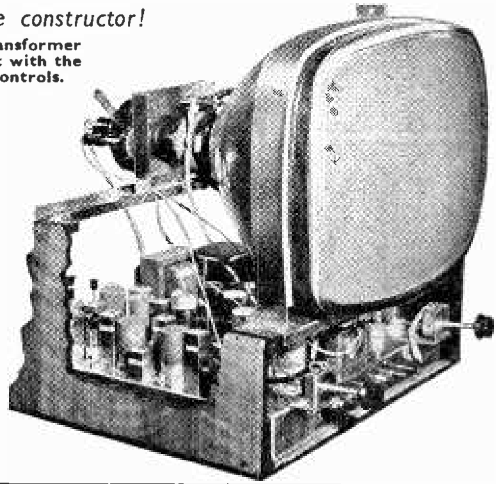

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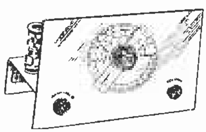

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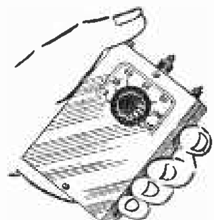
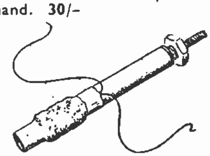


Transistor Pocket Radio, low cost and ideal for the beginner. Using the Variloopstick aerial (see below) and miniature condenser, the whole Medium Wave is covered. Fits the palm of the hand. 30/-



Variloopstick, specially designed for maximum transistor receiver performance, high 'Q' 4/6

Postage: Under 10/-, 9d. Under 40/-, 1/6. Over 40/-, post free

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or **£10.6.6** *Medium and Long wave*

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HIGH SENSITIVITY
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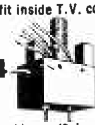
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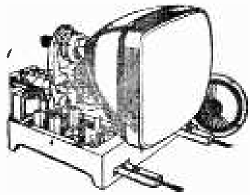

Latest improved circuits. Higher E.H.T. (brilliant picture), improved sensitivity (for greater range). Chassis easily fitted into any cabinet. 17" rectangular tube on adapted chassis. Less valves. 12 months guarantee on tube, 3 months guarantee on valves and chassis. With valves **£25.19.6.** Valve line-up: 6SN7G, 6V6, EY51, 6D2's, EL38, EL41 and 7-6F1's. Turret tuner **50/–** extra. State B.B.C. and I.T.A. channel required. Extra channel supplied at **7/6** each. Ins. carr. (inc. tube) 25/–

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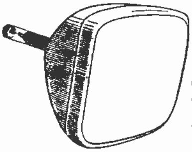
As above with 14" round tube. Less valves. 3 months guarantee. With valves **£19.19.6.** Turret tuner **50/–** extra. Ins. carr. 25/–



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17" £7.10.0 **12 Months Guarantee** **14" £5.10.0**

6 months full replacement, 6 months progressive. Made possible by the high quality of our tubes. Ins. carr. 15/6. Convert your 9", 10", 12" tubes to 14", 15", 16" (round tubes). Our special offer of these sizes **£5.** Full instructions in our FREE CATALOGUE. 12" **TV Tubes £6.** 3 months guarantee on round tubes. Ins. carr. 15/6 on all tubes

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(REDUCED TO CLEAR)

BOXED **VALVES** 3 MONTHS GUARANTEE

4D1	2/9	15D2	6/9	ECC81	8/9	EF92	3/9
6B8	3/9	45-1U	10/9	ECH42	8/9	EL91	3/9
6F12	5/9	77	1/9	EF37	4/9	KTW61	5/9
6H6M	1/9	2C22	2/9	EF39	3/9	PEN45	6/9
6P28	10/9	CV188	1/9	EF36	5/9	RL37	1/9
6SG7	3/9	6J5	2/9	EF50	2/9	SP61	2/9
8D2	3/9	DF66	5/9	EF91	7/9	T41	8/9
12BE6	6/9	EB34	1/9	Z77	7/9	TT11	4/9

American types UX All at 1/9 each
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MAINS POWER TRANS. 350-0-350V, 9/9. 250mA, 6V heater at 5A, 4V at 5A, 4V centre tapped. Drop through type. Primary 200-250V (4½" x 5" x 5"). Post 3/9

MAINS TRANS. 3/9. 350-0-350V, 80mA, 4V. 4V heaters. 200-250V prim. Post 2/3

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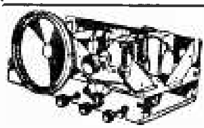
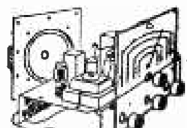
O.P. TRANS. 1/3. Std. size. 2-5 ohms. Post 1/–. 20 for £1. Post 5/6



POPULAR RADIO OR RADIOGRAM CHASSIS — 39/9

A.C. or a.c./d.c. 3 w/band and gram. 5 valve superhet. International octal. Ideal table gram, but still giving high quality output. 4 knob control. 8" p.m. speaker 7/9 extra. Set of knobs 2/– extra. Chassis size 15½" x 7½" x 8¼". Less valves. Ins. carr. 4/6

SUPER CHASSIS — 99/6



5 valve superhet chassis, including 8" p.m. speaker and valves. Four control knobs (tone, volume, tuning, w/change switch). Four w/band with position for gram. p.u. and extension speaker. A.C. Ins. carr. 5/6

8" P.M. SPEAKER — 8/9

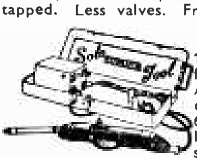
Ideal for kitchen and bedroom extension. Let the lady of the house enjoy that radio or TV programme. Complete with o/p trans. 10/–. P. & p 2/9

SOUND AND VISION STRIP 10/6. Superhet. Complete vision strip. Less valves. Drawings free. Post and packing 2/6 (not tested)

TIMEBASE 4/9. Complete including scanning coil, focus unit, etc. Less valves. Post and packing 2/6

POWER PACK AND AMPLIFIER 19/6. Output stage 6V6 with o.p. trans. Smoothed h.t. 350V 250mA, 6.3V at 5A, 22V at 3A, 6.3V at 4A centre tapped. Less valves. Free drawings. Carriage 5/6

SOLO SOLDERING TOOL 19/6



110V or 6V (special adaptor for 200/240V 10/– extra). Automatic solder feed. Includes a 20ft reel of ERSIN 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 2/9

CHASSIS 1/– each. 6 or 8 valve. Latest type midget valve design for a.m. or f.m. Brand new cadmium plated. Size: 12¼" x 7¼" x 2¾". Post 1/9; 4 for **4/–**, post 3/–; 12 for **10/–**, carr. 5/–

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TV MASKS 3/9. 12" new, white rubber. Postage 1/9

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RED-SPOT 800 kc/s Audio Frequency ...	**7/6**
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RED/YELLOW 1.5–8 Mc/s, R.F. and I.F. ...	**21/–**
XC101 matched pairs **60**/– pr., **XB102** audio. amp. **21**/–, **XA102** 8 Mc/s osc/mixer ...	**40/–**

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AC/DC Volts 12/60/300/600/1200/6000

Milliamps 1.2/12/60/600

Ohms 0–5,000/5 meg.

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Including Batteries

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2-TRANSISTOR MINIATURE POCKET RADIO The smallest transistor set offered on the market. Variable tuning. Drilled chassis, plastic case size 3" x 2" x ¾", miniature hearing aid, 2 transistors and all components including 1½ volt battery, circuits and full practical layout diagrams.

Total cost **47/6** complete

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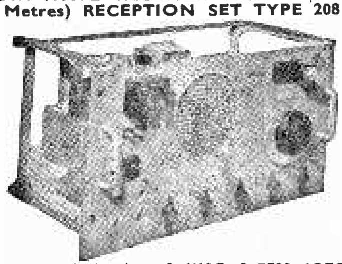
SHORT-WAVE RECEIVER 10-60 MC/S (5-30 Metres) RECEPTION SET TYPE 208



Complete with 6 valves, 2 6K8G, 2 EF39, 6Q7G and 6V6G. Internal mains power pack and 6V vibrator pack. Built-in 6½" speaker. Muirhead slow-motion drive. B.F.O. and R.F. stage. I.F. freq. 2 Mc/s. Provision for phones and muting and 600 ohms. **Input 110/250V a.c.** 6V vibra pack included for battery operation. All sets in new condition and air tested.

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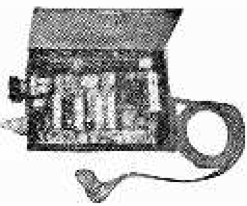

Medium wave, Variable tuning. Total cost, as specified, including Transistors, Transformers, Coils, Condensers and Battery, etc., with circuit and plastic case. All items sold separately **70**/– POST FREE. With single 'phone **73/6**. With Acos Mike, **82/6**. With Min. Hearing Aid, **86/–**

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The above may be used with any of our miniature transistor portables

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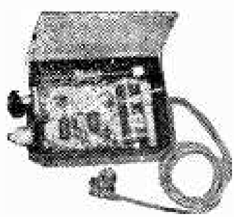
Complete Kit with 2 Transistors, components, phones, with circuit and plastic case **37/6**



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Variable tuning. We can supply all components, including two transistors, diode, resistors, condensers and miniature hearing aid and plastic case, size 4¼" x 2⅞" x 1⅜" and 3V battery for Practical layout **50/–**

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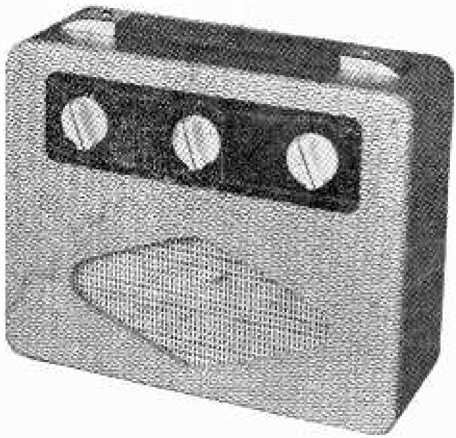
As above, but with extra transistor stage, increasing output, complete with 3 transistors, etc. **58/6**

The "TRANSISTOR - 8"

Push-Pull Portable Superhet



COMBINED CAR RADIO & PORTABLE

TWO SETS FOR PRICE OF ONE

TEN STAR FEATURES

★ 8 specially selected Transistors
★ 250 Milliwatts output push-pull
★ Medium and Long Waves
★ Internal Ferrite Rod Aerial
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★ Attractive lightweight contemporary case

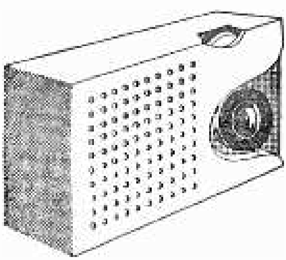
Send stamps for Instruction Booklet

This Portable 8-Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

All components as specified can be supplied at an inclusive price of **£11.10.0** p.p. 2/6
Car radio conversion components **8/-** extra

N.B.—Pair of XC101's for larger output supplied at additional cost of 40/- Call and hear demonstration model

MINI-7 POCKET TRANSISTOR PORTABLE



Size $5\frac{1}{8}$" x $3\frac{1}{8}$" x $1\frac{1}{16}$"

SPECIAL FEATURES

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★ Internal ferrite aerial
★ Operates from 6V battery
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ECONOMICAL!
HIGHLY SELECTIVE!

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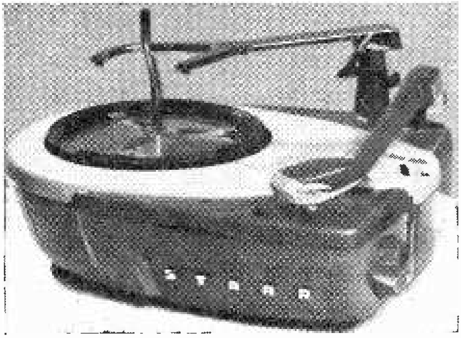

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Consisting of Galaxy 4-speed changer in quality two-tone case excellent 3 valve amplifier, 7" spkr., beautiful reproduction (worth £20)

13 GUINEAS

4 SPEED STAAR GALAXY

RECORD PLAYERS as illustrated. Acos GP65 sapphire turnover pick-ups Plays 10 records of any size or speed through your radio. 200/250 volts a.c **£5.15.0** (Post 4/–)

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AMPLIFIERS. Parmeko 200/250V a.c. mains, 10/20W complete EF36, ECC31, 2 EL35, 524, untested, **£3.15.0.** Quality 5 watt amplifiers 6J5, 6J7, 6V6, 5Z4, Parmeko mains and output trans., **£2.19.0.** Ardente 12V street broadcast 10/20W compact, 2 ECC31, 2 6L6, rotary convertor, **£4.10.0.** Ditto 24 volt **£3.15.0.**

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POWER PACKS. 230V a.c. in., 2 separate double smoothed outputs of 375, 550 or 620V at 200/250mA, also 6.3V 5A. Sealed transit cases, 4 5U4G valves, **£7.10.0.** Less valves, **£6.10.0**

MAINS TRANSFORMERS, 230V in., 525–0–525V 150mA, 6.3V 5A, 5V 3A, **25/–.** Chokes to match, 150mA **6/–.**

L.F. CHOKES. 10H, 80mA, **5/–**; 5H 250mA, **4/6**; 7H 250mA, **6/–**

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FOCUS MAGNETS, wide angle, with centreing and mounting, **9/6.** Ditto double magnet **12/6**

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COSSOR WOBBULATORS, all wave, **£9.10.0**

13 CHANNEL CONVERTORS. For T.R.F. or superhet receivers. Famous make. 3-position switch, fine tuner and 9 quick-set trimmers. Give any 3 channels, T.R.F. Band I, superhet Band III. Output direct to aerial socket. Beautiful bakelite case with PCC84, PCF80, **£3.15.0**

12 VOLT 3-4 AMP RECTIFIERS, 9/6 to **£5** doz.

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GERMANIUM CRYSTAL DIODES, famous make. tested, **9d.,** p. and p. 3d., **8/–** doz.

TRANSISTORS. Red Spot (up to 800 kc/s), guaranteed, **7/–**; White Spot (up to 2.5 Mc/s) guaranteed, **14/–**

GUARANTEED RADIO VALVES, BOXED,
24 HOUR SERVICE

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6AC7	**5/–**	6V6G	**6/–**	ECC31	**9/6**	HVR2A	**5/–**
6A8	**9/–**	6V6GT	**6/6**	ECC32	**9/–**	KTW63	**6/–**
6AL5	**5/6**	6V6M	**7/–**	ECC81	**8/–**	MU14	**9/–**
6AM6	**7/–**	6X4	**6/–**	ECC82	**6/6**	P61	**2/6**
6BA6	**6/6**	6X5GT	**5/6**	ECC83	**8/6**	PCC84	**9/–**
6BE6	**6/6**	7B7	**7/6**	ECC84	**10/6**	PCC85	**11/6**
6C4	**4/9**	7C6	**7/6**	ECC85	**9/–**	PCF80	**12/6**
6C6	**4/6**	12A7M	**8/6**	ECF80	**12/–**	PCF82	**11/–**
6D6	**4/6**	12AT7	**8/–**	ECF82	**11/–**	PEN25	**5/–**
6H6	**2/–**	12AU7	**6/6**	ECH42	**9/6**	PL81	**13/6**
6J5M	**5/–**	12AX7	**8/6**	ECL80	**13/6**	PL82	**9/–**
6J5GT	**4/6**	12K7GT	**6/6**	EF36	**4/–**	PL83	**10/–**
6J5G	**3/–**	12Q7GT	**7/6**	EF37	**7/–**	PY80	**8/6**
6J7G	**5/–**	25L6GT	**8/6**	EF37A	**8/–**	PY81	**8/6**
6K7G	**4/6**	35Z4GT	**7/6**	EF39	**5/–**	PY82	**8/6**
6K7GT	**5/6**	80	**7/6**	EF50(B)	**3/6**	PY83	**9/6**
6K7M	**6/–**	83	**7/6**	EF50(A)	**4/9**	SP4B	**9/6**
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