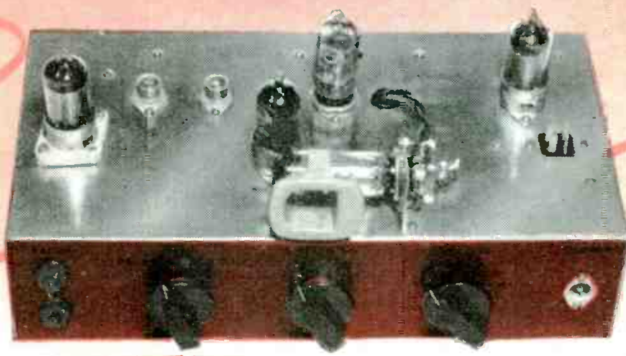
Cooper-Smith "PRODIGY" 6W Amplifier, Part 2

VOLUME 12
NUMBER 4
NOVEMBER
1958

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

The MULLARD Tape Amplifier "Type C"



LATEST VERSION OF THIS POPULAR UNIT WITH PUSH-PULL OUTPUT

Included in this issue

A SENSITIVE TRANSISTOR RECEIVER
FM FACILITATED
REMOTELY SWITCHED TV PRE-AMPS
A VERSATILE AUDIO FREQUENCY OSCILLATOR
UNDERSTANDING TELEVISION, Part 11
POWER UNIT WITH A DIFFERENCE

DATA Publications 1/9

This splendid AVO Instrument has been developed to meet a definite demand for a sturdy pocket-size multi-range test meter at a modest price, suitable for use on modern electronic apparatus as well as for radio and television receivers, motor vehicles, and all kinds of domestic appliances and workshop equipment.

Readings are obtainable quickly and easily on a very open scale, and range selection is by means of a robust clearly marked rotary switch of the characteristic AvoMeter type. Measurements of A.C. and D.C. Voltage, D.C. Current and Resistance are made by means of only two connection sockets.

19 Ranges

D.C. Voltage
0—100mV
0— 2.5V
0— 10V
0— 25V
0— 100V
0— 250V
0—1000V

A.C. Voltage
0— 10V
0— 25V
0— 100V
0— 250V
0—1000V

D.C. Current
0— 100μA
0— 1mA
0— 10mA
0— 100mA
0— 1A

Resistance
0—20,000Ω
0—2MΩ

Sensitivity
10,000 Ω/V on D.C. voltage ranges
1,000 Ω/V on A.C. voltage ranges

Accuracy
3% of full scale value on D.C.
4% of full scale value on A.C.

To meet special requirements, instruments can be supplied to a higher degree of accuracy for a small additional charge.

THE MULTIMINOR

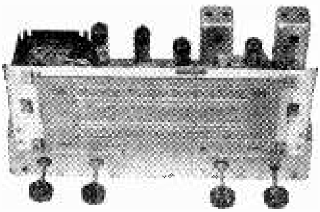
List Price: **£9 : 10s.**
complete with Test Leads and Clips
Leather Case if required **32/6**

Size: 5⅝ x 3⅜ x 1⅞ inches
Weight: 1lb approx.

Write for fully illustrated pamphlet

AVO

AVO Ltd. **AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · SW1**
Telephone VICtoria 3404 (9 lines)



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 2¼". Glass dial 12¼" x 5¾" horizontal or vertical 10" x 4½". 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Immediate delivery.

BRAND NEW £9.10.0 Carr. 4/6

TERMS: Deposit **£5.5.0** and 5 monthly payments of **£1**
MATCHED SPEAKERS: 8" **17/6**, 10" **25/–**, 12" **30/–**

★ GARRARD 4-SPEED SINGLE RECORD PLAYER 4SP ★

£8 — **AUDIO PERFECTION** — **POST FREE**

Designed to play 16, 33, 45, 78 r.p.m. Records, 7", 10", 12". Lightweight Xtal pick-up, GC2 turnover head, two separate sapphire styli. Standard and L.P.

BUILD THIS REPRODUCER BARGAIN

SPECIAL SINGLE PLAYER KIT

COLLARO 4-speed Gram-Pick-up Unit	£4.12.6
Handsome portable case 17½" x 13½" x 7"	£2. 5.0
Ready-built 3 watt amplifier with two valves and 7" elip. speaker, printed circuit	£3.12.6

All available separately

£9.15.0 complete kit post free

I.F. TRANSFORMERS 7/6 pair
465 kc/s slug tuning miniature can 2¼" x 1" x 1". High Q and good band width. By Pye Radio. Data sheet supplied.
Wearite M800 Midget I.F.S. 465 kc/s — 12/6 pair
Wearite 550 Standard I.F.S. 465 kc/s — 12/6 pair

New boxed VALVES 90-day Guarantee

1R5	8/6	6K8	8/6	EA50	1/6	EZ81	11/6
1S5	8/6	6L6	10/6	EABC80	10/6	E1148	1/6
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	6SJ7M	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	7/9	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	12K7	8/6	Sylv.		UBC41	10/6
6H6	3/6	12Q7	8/6	EF80	10/6	UCH42	10/6
6J5	6/6	35L6	9/6	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

C.R.T. ISOLATION TRANSFORMERS
For Cathode Ray Tubes having heater-cathode short circuit and for C.R. Tubes with falling emission. **Type A.** Low leakage windings. **Optional 25%** and **50%** boost on secondary: 2V, or 4V, or 6.3V, or 10.3V, or 13.3V, with mains primaries, **12/6**
Type B. Mains input. Low capacity. Multi-output 2, 4, 6.3, 7.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. **21/–** each
Type C. Low capacity transformer for 2V tubes with falling emission. Mains input. Output 2, 2¼, 2½, 2¾, 3V at 2A, **17/6** each

RESISTORS. Preferred values. 20% 10 ohms to 10 meg, ¼W **4d.**, ½W **4d.**, 1W **6d.**, 1½W **8d.**
HIGH STABILITY. ½W 1%, **2/-**. All preferred values 100Ω–10MΩ. Ditto 5% 100Ω–5MΩ **9d.** each

WIRE-WOUND RESISTORS 25 ohms–10,000 ohms: 5 watt **1/3**; 10 watt **1/6**; 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/–**

3W Lab. Colvern, etc. Standard size Pots, 2¼" Spindle, high grade. All values, 100 ohms to 50k, **5/6**; 100k, **6/6**
W/W EXT. SPEAKER CONTROL 10Ω, **3/–**

MAINS TRANSFORMERS

STANDARD. 250-0-250, 80mA, 6.3V tapped 4V 4A. Rectifier 6.3V 1A tapped 5V 2A and 4V 2A	22/6
Ditto 350-0-350	22/6
MINIATURE. 200V 20mA, 6.3V 1A	10/6
MIDGET. 220V 45mA, 6.3V 2A	15/6
SMALL. 220-0-220, 50mA, 6.3V 3A	17/6
STANDARD. 250-0-250, 65mA, 6.3V 3.5A	17/6
HEATER TRANS. 200/250V, 6.3V 1½A	7/6
Ditto, tapped sec. 2, 4, 6.3V 1½A	8/6
Ditto, sec. 6.3V 3A	10/6
Mullard "510" Mains Transformers	38/6

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 8kΩ, **30/–**
L.F. CHOKES 15/10H 60/65mA, **5/–**; 10H, 85mA, **10/6**; 20/15H, 120/150mA, **12/6**; 5H, 250mA, **15/–**

CRYSTAL MIKE INSERT by Acos, **6/6**
Precision engineered. Size only ⅞" x $\frac{3}{16}$"
ACOS CRYSTAL DESK MIKE 33/2 35/–

ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d.**
0.3" FORMERS 5937/8 and cans TV1/2. ¾" sq. x 2⅜" and ⅝" 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**
LINE CORD. 0.3A 60 ohms per foot, 0.2A 100 ohms per foot, 2-way, **6d.** per foot; 3-way, **7d.** per foot
MIKE TRANSF. 50:1, **3/9**; 100:1, potted, **10/6**
LOUDSPEAKERS. P.M. 3 ohm. 2½" and 5", **17/6**; 6" x 4" Rola, **18/–**; 4" Hi-Fi Tweeter, **25/–**; 8" Plessey, **19/6**; 6½" Goodmans, **18/6**; 10" R.A., **30/–**; 12" Plessey, **30/–**; 10" x 6" R.A., **27/6**; 12" Baker 15W 3 ohm or 15 ohm models, **105/–**; 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. 1⅞" x 1½" x 1¾", **10/–**. 0.0005 standard with trimmers, **9/–**; less trimmers, **8/–**. Midget **7/6**; 50pF single, **2/6**

48-HOUR POSTAL SERVICE

Our written guarantee with every purchase

RADIO COMPON

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**

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 5,000 ohms to 2 Meg.

No Switch	D.P. Switch
3/-	**4/9**

Linear or Log Tracks

80Ω Coaxial Cable

Semi-air spaced Polythene insulated ⅜" dia. stranded core. Ideal Band III **9d.** yd Losses cut 50%

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

Coaxial Plugs 1/- **Double Socket** 1/3
Sockets 1/- **Outlet Boxes** 4/6
Balanced Twin Feeder, per yd **6d.,** 80Ω or 300Ω
Twin Screened Balanced Feeder, 1/6 yd, 80 ohms
Trimmers. Ceramic, 30, 50, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, 750pF, **1/9**. Philips, **1/-** each
BLACK CRACKLE PAINT. Air drying, **3/-** tin
P.V.C. CONN. WIRE, 8 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
Mains Type RM1, 125V 60mA, **5/-**; RM2 100mA, **6/-**; RM3 120mA, **8/-**; RM4 250V 275mA, **16/-**; RM5, **20/-**
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
Teletron. L. & Med. T.F.R. with reaction, **3/6**
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6**
T.R.F. Coils A/HF, **7/-** pair. **H.F. Chokes, 2/6**
Speaker Fret. Gold cloth, 17" x 25", **5/-**; 25" x 35" **10/-**. Expanded metal, silver, 15¾" x 9½", **2/-** each;
Tygan. 4' 6" wide, **10/-** ft; 2' 3" wide, **5/-** ft. Samples

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

Condensers. New stock, **0.001µF** 7kV T.C.C., **5/6** ditto 20kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.01µF, **9d.**; 0.05, 0.1, **1/-**; 0.25, **1/6**; 0.5, **1/9**; 0.1/350V, **9d.**; 0.01/2,000V, **1/9**; 0.1/2,000V, **3/6**
Ceramic Condensers. 500V 0.3pF to 0.01µF, **10d.**
Silver Mica. 10% 5pF to 500pF, **1/-**; 600pF to 3,000pF, **1/3**; close tolerance (plus or minus 1pF), 1.5pF to 47pF, **1/6**; ditto 1% 50pF to 815pF, **1/9**; 1,000pF to 5,000pF, **2/-**

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR		**TUBULAR**		**CAN TYPES**	
1/350V	**2/-**	100/25V	**2/-**	8+16/450V	**5/-**
2/450V	**2/3**	8+8/500V	**6/-**	16+16/450V	**5/6**
4/450V	**2/3**	16+16/500V	**6/-**	6,000µF 6V	**6/6**
8/450V	**2/3**	**CAN TYPES**		32+32/350V	**4/6**
8/500V	**2/9**	**Clips**	**3d.**	32+32/450V	**6/6**
16/450V	**3/6**	16/500V	**4/-**	64+120/275V	**7/6**
16/500V	**4/-**	32/350V	**4/-**	60+100/350V	**11/6**
32/450V	**5/6**	100/275V	**5/6**	100+200/275V	
25/25V	**1/9**	50+50/350V	**7/-**		**10/6**
50/25V	**2/-**	500/12V	**3/-**	1,000+1,000/6V	
50/50V	**2/-**	2,500/3V	**4/-**		**6/6**

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/-**, 7" plastic reel
EMITAPE 7" Long Play 1,800 ft. **45/-**
INSTANT bulk tape eraser, 200/250V a.c., **27/6**

TELETRON MINIATURE

"TRANSIDYNE" Superhet Portable

6 Transistors, T.C.C. Printed Circuit

Ferrite aerial, cabinet and all parts. For medium and long wave reception

Our price

£12.19.6

post free

Size 6" x 4" x 1¾"
Plans and parts list
9d.

6 GENUINE PYE GOLTOP TRANSISTORS ARE INCLUDED WITH THIS KIT, FOR MAXIMUM RESULTS

TRANSISTORS. Pye Goltop Audio V10/15A, **15/-**. R.F. 3 Mc/s, V6/R2, **24/-**. **Sub-miniature Electrolytics** 5µF 12V, 8µF 6V, 16µF 12V, 25µF 6V, **3/-** each

THE HIGH GAIN BAND III TV PRE-AMP
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, **6d.** Band I version available for channels 1 to 5, same prices

Wavechange Switches. 2 p 2-way, 3 p 2-way, short spindle, **2/6**; 5 p 4-way 2 wafer, long spindle, **6/6**; 2 p 6-way, 4 p 2-way, 4 p 3-way, long spindle, **3/6**; 3 p 4-way, 1 p 12-way, long spindle, **3/6**; wave change "MAKITS," 1 wafer, **8/6**; 2 wafer, **12/6**; 3 wafer, **16/-**; 4 wafer, **19/6**; 5 wafer, **23/-**; 6 wafer, **26/6**
Toggle Switches, s.p. **2/-**, d.p. **3/6**, d.p.d.t. **4/-**

JASON FM TUNER COIL SET, 26/-. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s, detector transformer and heater choke. Circuit and component book using four 6AM6, **2/-**. **Complete Jason FM Kit,** with valves and Jason superior calibrated dial, **£6.15.0**, post free
Mullard 3-3. Amplifier ready built, with power socket for tuner, **£7.17.6**

Valveholders. Pax. int. oct., **4d.** EF50, EA50, **6d.** B12A, CRT, **1/3**. Eng. and Amer. 4, 5, 6, 7 and 9 pin, **1/-** MOULDED Mazda and int. oct., **6d.**, B7G, B8A, B8G, B9A, **9d.** B7G with can, **1/6**. VCR97, **2/6**. B9A with can, **2/6**. **Ceramic,** E.F50, B7G, B9A int. oct., **1/-**. B7G with can, **1/9**; B9A with can, **2/9**

HANDY VOLTMETERS. 2" Twin Range 0–25V, 0–250V d.c. with leads and leather case, **9/6** each

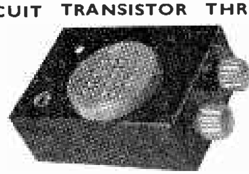
TV Fault Finding. Data Publications **5/-** each
Radio Valve Guide. Books 1, 2 or 3 **5/-** each

TELETRON 'COMPANION'

PRINTED CIRCUIT TRANSISTOR THREE

£5.15.0

WITH 3 PYE GOLTOP TRANSISTORS



Pocket receiver kit, 4½" x 3" x 1½" with plans, cabinet, all parts and batteries. Fitted speaker reproduces strong local stations on Ferrite Aerial. Distant reception with simple aerial or earth

NT SPECIALISTS

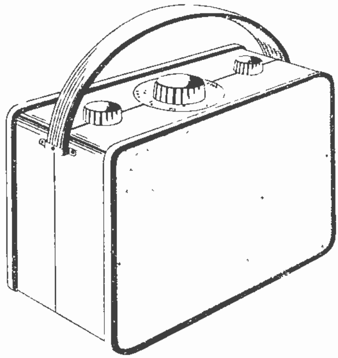
337 WHITEHORSE ROAD WEST CROYDON

Catalogue 6d.

Telephone **THO 1665**

& P. 1/-, over £2 post free. C.O.D. 1/6 (Export C.W.O. post extra, no H.P.)

OPEN ALL DAY (Wed. 1 p.m.)



REPANCO MAJOR-7

ALL TRANSISTOR PORTABLE

A design embodying 7 brand new transistors

★ New Transistors throughout—no surplus.
★ Output: 200 milliwatts.
★ Fully Tunable over Long and Medium Wave.
★ Super sensitive Ferrite Slab Aerial.
★ Eliptical Speaker 7" x 4".
★ Eyeletted chassis for easy wiring.
★ Automatic Volume Control.
★ Negative Feed Back.
★ 465 kc/s Intermediate Frequency.
★ Contemporary Cabinet in Cream and Black.
★ Cabinet Dimensions: 9" x 6½" x 4".
★ Easy to Build—point to point plans.
★ May be used as a combined Car Radio/Portable.

The **MAJOR-7** *may be built for*

(Post Free) **£13 · 19 · 6**

Comprehensive wiring plans and instructions with detailed price list **1/9** *(post free).*

RADIO EXPERIMENTAL PRODUCTS LTD

33 MUCH PARK STREET COVENTRY

POST 21 SELF CONTAINED RANGES COUPON NOW

★

10-1,000 d.c. volts
10-1,000 a.c. volts
100 Microamps to
500 Milliamps d.c.
100 Microamps a.c.
0-1 Megohm
0-10,000 ohms

★

You, too, can be SELF-CONTAINED, or completely equipped to tackle any testing job, by owning one of the well-known M.I.P. Series 100 Multi-Range Test Sets. You can have one sent you almost immediately, simply by sending a deposit of **47/6.** Balance is payable in 6 monthly instalments of **£1.16.** Cash price is **£12.7.6.** Post coupon for full details.

There is also the **SERIES 90 MULTI-RANGE TEST SET** having 19 SELF-CONTAINED ranges: ac/dc volts up to 1,000V dc current up to 500mA ac current up to 200μA Resistance 0–200,000Ω Deposit 35/– and six monthly payments of **28/10** (Cash price **£9.15.0**)

MIP

GD21

MULTI-RANGE TEST SET-SERIES 100

To **MEASURING INSTRUMENTS (Pullin) Ltd.**
Electrin Works, Winchester Street, Acton, W.3
Please send illustrated leaflet of the Series 100 with details of easy payment scheme
Ditto Series 90 ... ...
*Please indicate instrument required

NAME ....

ADDRESS ....

.... F1158

There's nothing so good

AND IT'S BEST IF IT'S A

Jasonkit

When good circuitry and design are presented with straightforward, easily followed instructions, it becomes relatively simple to build technically advanced items of radio, audio and electronic equipment. There are already years of specialised experience in kit design and production behind the new Jasonkit programme. From it, the constructor can choose stereo amplifier and pre-amp designs, first-class f.m. tuners, and soon, a number of items of valuable electronic test equipment. Such is the quality of Jason designs that even to-day, the popularity of the original f.m. tuner, which was the first Jasonkit to be produced, is as great as ever and large numbers continue to be built with complete success.

No special tools or experience are required to build Jasonkits. To the satisfaction of building your own apparatus is added the knowledge that its performance will be the finest possible in its class. Kits are complete, too, down to the last detail, and include chassis and panels punched and drilled to size. Only valves are extra except where otherwise stated.

BRITISH THROUGHOUT

Details of kits in which you are interested gladly sent on request

(SEE US AT STAND 18 RADIO HOBBIES EXHIBITION)

THE JASON MOTOR & ELECTRONIC SALES CO

as building it yourself

FM tuners

am/fm tuners

fm/tv tuners

stereo amplifiers

stereo pre-amplifiers

electronic instruments

AUDIO

STANDARD FM TUNER in chassis form (*less valves*)	**£5.5.0**
Power Pack Kit	**£2.1.9**
ARGONAUT AM/FM TUNER. As tuning unit only (*less valves*)	**£10.10.0**
As complete receiver (*less valves*) ...	**£11.10.0**
MERCURY SWITCHED FM TUNER including front end with 2 valves	**£9.0.0**
STEREO AMPLIFIER (10+10 watts) Power Amplifier with 7 valves	**£17.8.0**
STEREO PRE-AMP J.4-4 with case, but less valves	**£16.10.0**
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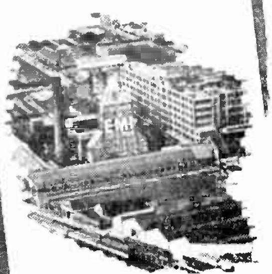

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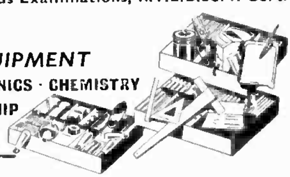

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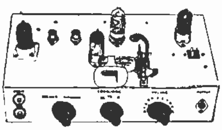

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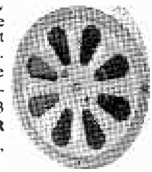

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(Page 135 Sept. issue)

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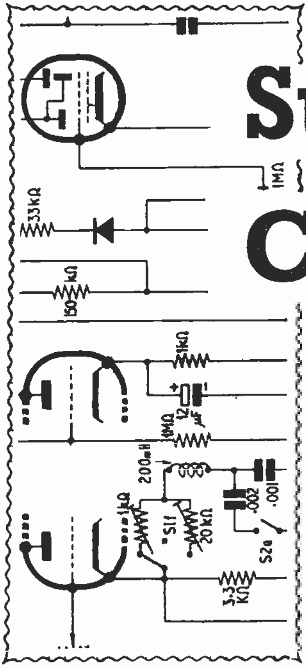


Suggested Circuits

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. 96 Remotely Switched Television Pre-Amplifiers

READERS MAY RECALL THAT, IN *Suggested Circuits* No. 92 and 93,[1] the writer described two remote control systems wherein a large number of operations could be controlled from a remote point with the use of very few interconnecting leads. The circuits employed relays, and the writer made the comment at that time that relay circuits normally reflect considerable reader interest. This comment seems to have been borne out by the correspondence received since the two circuits were published. In this instance, however, readers seem to have been more interested in finding solutions to individual relay problems than they were in the more general theoretical principles involved in the articles themselves.

The writer was intrigued to note that one particular remote control problem was raised by several correspondents, this concerning the operation of television pre-amplifiers fitted close to the aerials with which they were used. Readers raising this matter wished to obviate running long mains leads from receivers to pre-amplifiers, or the necessity of climbing several flights of stairs so that pre-amplifiers could be switched on and off. The writer is a little hesitant at introducing relay circuits so shortly after previous relay articles have appeared, but he feels that the interest exhibited in this particular problem provides a reasonable excuse. In any event, relays are employed in only two of the remote control circuits described here. The third circuit functions on an entirely different principle.

Pre-Amplifier Control

The function of a television pre-amplifier is to amplify, at r.f., the signal picked up by the aerial and to present it to the associated receiver at an enhanced level. Because of this, television pre-amplifiers are normally employed in fringe areas. Provided that they have a low input noise level, television pre-amplifiers also serve the second important purpose of reducing picture noise level if the performance of the associated receiver's front-end circuits is poor in this respect.

To give optimum results, a television pre-amplifier should be mounted as close to the aerial as possible. It then handles a signal which has suffered minimum attenuation in

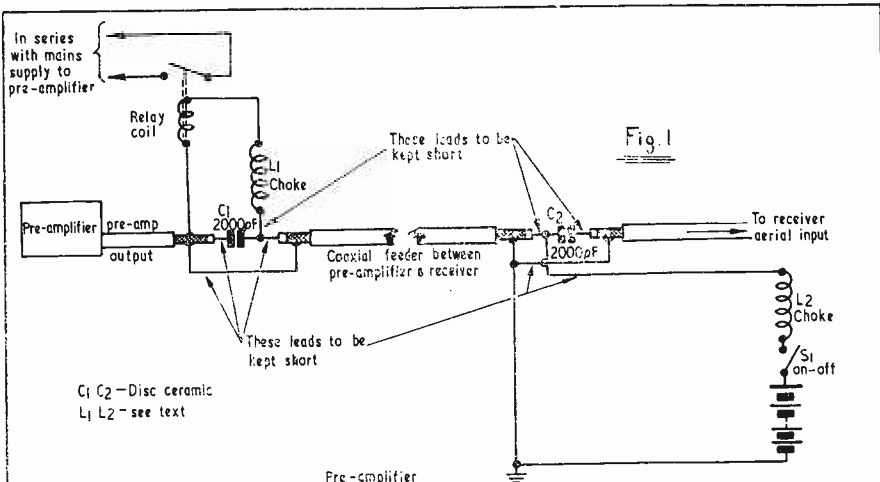
[1] Published in the July and August, 1958, issues.

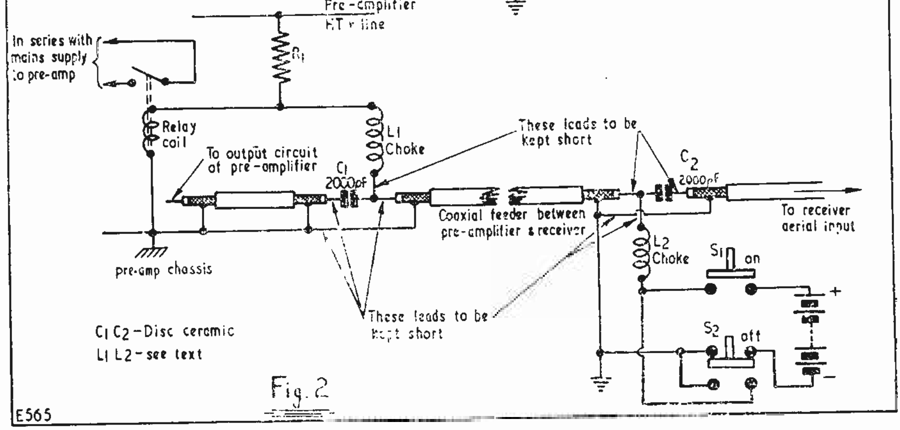
the aerial feeder and it passes an amplified signal to the comparatively long feeder which couples it to the receiver. Under these conditions the incoming signal is more readily capable of over-riding the input noise level given by the pre-amplifier. Also, any interference picked up by the feeder coupling the pre-amplifier to the receiver is reproduced at a lower level than would otherwise have been the case.

In this article several methods of switching the television pre-amplifier on and off are dealt with. In all instances, the only interconnecting link between the pre-amplifier and the receiver is the feeder line itself. In the last method discussed, this feeder carries the power for the pre-amplifier.

Relay Circuits

Fig. 1 illustrates a simple remote control circuit. A relay is employed at the pre-





In practical television installations it is normally fairly easy to mount a pre-amplifier close to its aerial. Usually, this requires the pre-amplifier being fitted at a high point in the house, such places as attics, etc., providing adequate installation facilities. The problem then arises of providing a mains supply for the pre-amplifier and of switching it on and off. It is desirable, as we have just seen, to be able to switch the pre-amplifier from a point near the receiver.

amplifier and this is energised via the interconnecting co-axial cable. It is assumed that a source of mains voltage is available close to the pre-amplifier.

In Fig. 1 the output of the pre-amplifier is applied to the co-axial feeder via the 2,000pF condenser C_1. The impedance of C_1 is low at television signal frequencies, and negligible loss of signal level should result due to its insertion. A similar condenser, C_2, is inserted between the co-axial feeder and the receiver input socket. In consequence, it becomes possible to pass a d.c. control voltage along the interconnecting co-axial cable. In the diagram a suitable control voltage is provided by a battery at the receiver, this being connected across the co-axial feeder by means of switch S_1. When switch S_1 is closed, the battery energises the relay at the pre-amplifier, thereby switching the latter on.

The circuit between the battery and the relay is completed via the two series chokes L_1 and L_2. These chokes should each have an inductance lying between 1.5 and 2.5μH, and they should cause no noticeable attenuation in signal level. Suitable commercially-available components are discussed at the end of this article.

The circuit of Fig. 1 has the advantage of considerable simplicity, but it suffers from the fact that the battery discharges continually during the time that the relay is energised. A more economic version would employ, at the receiver, a small mains power unit having a low-voltage d.c. output. Despite its simplicity, Fig. 1 is still of value, nevertheless, and it helps to demonstrate the arrangements needed for passing control voltages along a co-axial cable which is already carrying a signal voltage.

A more complicated relay circuit is shown in Fig. 2. This arrangement is basically similar to that employed in an earlier Suggested Circuit,[2] a number of component values being altered to fit it for its present purpose.

The relay in Fig. 2 is a component having a coil resistance around 2,000 ohms or more, and should be capable of remaining energised by a "holding-on" current of several milliamps. The battery at the receiver has a voltage which is capable of initially energising the relay. Normally, one or two 9-volt grid bias batteries at the receiver should provide an adequate energising potential. The life of these batteries should be only slightly shorter than their shelf life, as they are required to energise the relay for brief periods only.

When the "On" button of Fig. 2 is depressed, the battery is connected, via the interconnecting co-axial feeder and chokes L_1 and L_2, to the relay coil. The relay energises, switching on the mains supply to the pre-amplifier. As soon as an h.t. voltage becomes available at the pre-amplifier a current flows through resistor R_1 to the relay coil and battery in parallel. The "On" button may then be released, whereupon the current from the pre-amplifier h.t. supply will maintain the relay in the energised position.

When it is desired to switch off the pre-amplifier the "Off" button is depressed. This causes chokes L_1 and L_2, in series, to be connected across the relay coil, effectively shortcircuiting it. The relay, in consequence, de-energises, and breaks the mains supply to the pre-amplifier. When the "Off" button is released the relay remains in the de-energised position as there is now no energising voltage available from the pre-amplifier h.t. line.

The period of time during which the "On" button of Fig. 2 has to be depressed depends upon the type of h.t. rectifier employed at the pre-amplifier. If, as is most probable, a metal rectifier is employed, h.t. will appear almost immediately, whereupon the button need only be depressed for a second or so. If a valve rectifier is used it will be necessary to keep the button depressed for a longer time. With directly heated rectifiers the button would need to be depressed for some five to ten seconds, which is not, perhaps, too excessive. Indirectly heated rectifiers would incur a longer delay and it would be preferable to replace such rectifiers with directly heated, or metal, types.

In the interests of h.t. current economy, the resistor R_1 should have a value which just comfortably enables the relay to remain in the energised position. The current needed for this condition will be lower than that needed to initially cause the relay to operate, this latter being provided by the battery. It should be noted that the battery should be connected into circuit with correct polarity, so that the energising current it provides flows through the relay coil in the same direction as does that from the h.t. supply. The circuit is economic in operation because the battery provides current only during the time that the "On" button is depressed. It will be seen that the "Off" button has a pair of contacts which are made when it is in the released position. The purpose of these contacts is to ensure that the battery is not short-circuited if both buttons are accidentally depressed at the same time. The circuitry around the "Off" button is arranged such that a simple s.p.d.t. arrangement is required here.

The point has to be made that the circuit of Fig. 2 cannot be used if the additional current drawn by the relay coil overloads the pre-amplifier h.t. supply. Normally this should not occur, but it is advisable to check before using the circuit. Fig. 2 assumes also that the pre-amplifier chassis is isolated from the mains supply. The circuit must *not* be used if the pre-amplifier chassis (or its h.t. negative line) is connected to one side of the mains.

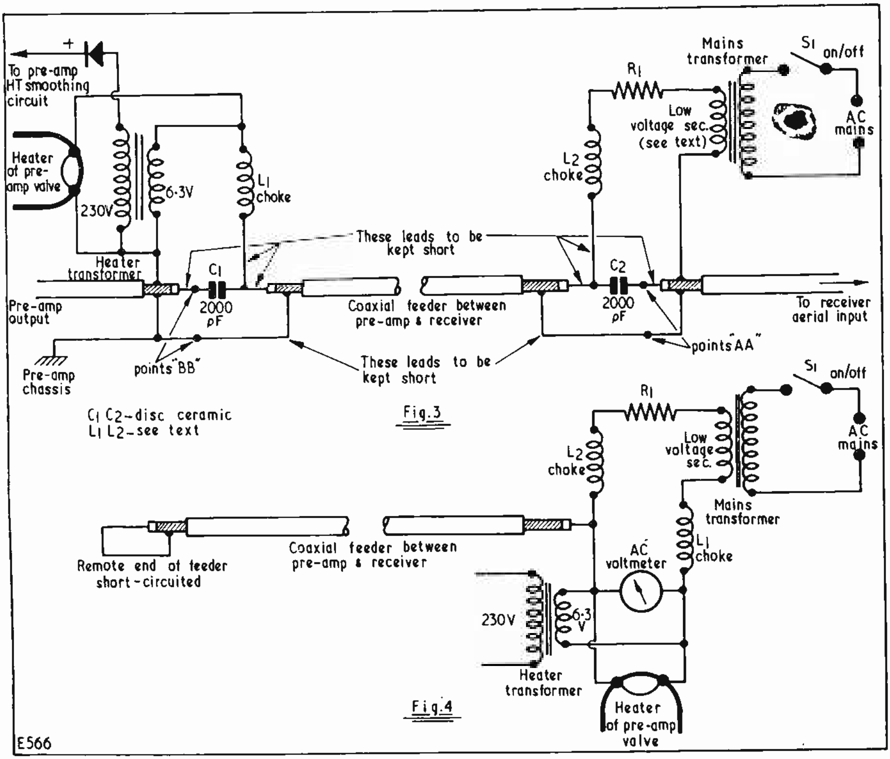
In both Fig. 1 and Fig. 2, care has to be taken to ensure that the blocking condensers C_1 and C_2 are reliable ceramic components and that they are connected into circuit via

[2] *Suggested Circuits No.* 76—A Simple Remote Control Device Employing Existing Speaker Leads; *The Radio Constructor*, March 1957.

very short leads. Chokes L_1 and L_2 should be positioned very close to the co-axial centre conductors to which they connect. Many television receivers will have input circuits consisting of isolating condensers which are bridged by high value resistors. If this is the case C_2 is not required, the co-axial centre conductors connecting together directly at this point. A final fact is that care has to be taken with the relays employed for switching the mains supply at the pre-amplifier. It is most important to ensure that the insulation between the contacts and coil of whatever relay is employed is adequate to withstand mains potentials, in order to prevent shock or accident.[3] It is also advisable to earth the outer braiding of the co-axial cable to a reliable electrical earth, as shown in the diagram.

feeder itself. It must be emphasised that the circuit of Fig. 3 may be a little more difficult to get into working order than are those of Figs. 1 and 2, as it is necessary for a certain amount of experimental work to be carried out. Also, the mains transformer needed at the receiver may not be directly available, it being necessary to employ modified connections to a standard component. Further, alterations to the pre-amplifier power supply circuits are needed. The writer would recommend that this circuit arrangement be tackled by the more experienced constructor only.

The circuit of Fig. 3 functions under the principle that power at a low voltage is fed along the co-axial feeder between the pre-amplifier and the receiver, this being applied directly to the heater of the pre-amplifier



Remote Power Circuit

Fig. 3 shows an entirely different approach to the problem. In this circuit there is no relay and there is no necessity to have a mains point near the pre-amplifier because the power for this is passed along the co-axial valve and to a step-up transformer which provides a suitable high voltage for h.t. rectification. It is assumed in the diagram that the pre-amplifier valve has a 6.3 volt heater, whereupon a conventional heater transformer can be connected "back-to-front" in order to provide h.t. A metal h.t. rectifier at the pre-amplifier is almost essen-

[3] This assumes that the metalwork of the relay is isolated from chassis.

tial, as a valve rectifier would consume an undesirably high heater current with consequently increased volts drop in the interconnecting feeder. As may be seen, the use of the Fig. 3 circuit incurs modification to whatever power supply circuits are already fitted to the pre-amplifier. Care should be taken to ensure that the h.t. voltage provided by the "back-to-front" heater transformer is similar to that given previously. At the receiver end of the co-axial feeder, all that is required are the isolating components C_2 and L_2, a mains transformer, a series resistor R_1, and an on-off switch.

The presence of the series resistor R_1 is due to the fact that a marked volts drop will occur in chokes L_1 and L_2, and in the co-axial feeder coupling the receiver to the pre-amplifier. It thereupon becomes necessary to use a mains transformer at the receiver end whose secondary voltage is equal to, or greater than, that required to overcome this volts drop; the series resistor being adjusted to the value which ensures that the correct voltage appears at the pre-amplifier end of the cable. In order to reduce the a.c. voltage appearing across the feeder the series resistor is fitted at the receiver end, even though this complicates the procedure of initially finding the value it requires.

To determine the requisite value for R_1, and the required secondary voltage of the mains transformer at the receiver end, it is first of all necessary to roughly determine the current requirements of the pre-amplifier, together with the resistance inserted by the chokes and the feeder. To take an example, a pre-amplifier employing a single ECC84 would require a heater current of 0.34A, plus a primary current, for the "back-to-front" heater transformer at the pre-amplifier, of some three-quarters of an amp; these totalling approximately 1.1 amps. The resistance of the co-axial feeder should next be measured, this being carried out by short-circuiting it at one end and measuring the resistance across the other end. With normal feeder a resistance of some 5 ohms per 100 feet is the sort of thing to expect. In the case we have just considered, the 1.1 amp current required by the pre-amplifier would result in a drop of some 5.5 volts for every 100 feet of interconnecting feeder. These initial resistance measurements assist in determining what secondary voltage approximately is required of the mains transformer at the receiver end.

After the pre-amplifier power circuits have been modified to those shown in Fig. 3 it may be connected up temporarily in the manner illustrated in Fig. 4, the resistance of the interconnecting feeder being inserted in series with the input to the pre-amplifier by short-circuiting it at the remote end. The series resistor, R_1, is now adjusted in value until 6.3 volts a.c. is indicated by the voltmeter connected across the pre-amplifier valve heater and step-up transformer primary.

We have mentioned the fact that the secondary voltage required of the mains transformer at the receiver end is almost certain to be of a non-standard nature, and it may be necessary to use such devices as connecting in series the 6.3 and 5 volt windings of a conventional mains transformer to provide the voltage required. The secondary of the mains transformer should be capable of supplying the current needed by the pre-amplifier. In some instances it may be found that the secondary provides a voltage sufficiently close to what is required for R_1 to be dispensed with.

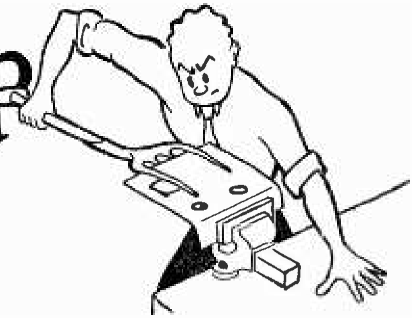
After the correct value for R_1 has been determined by the set-up of Fig. 4 the pre-amplifier may be connected up permanently as illustrated in Fig. 3, whereupon no further adjustments should be required. There is, however, a slight risk of cross-modulation between the mains voltage appearing across the co-axial feeder and the input signal. If this should occur it may be cleared by connecting a 470 ohm resistor across the points marked AA in Fig. 3. In very severe cases it may be necessary to fit a further 1.5 to 2.5μH choke across these two points instead of the resistor. On the other hand, if there is no evidence of cross-modulation, and if the receiver employs an input isolation circuit consisting of condensers bridged by high value resistors, condenser C_2 may be deleted, as occurred with Fig. 1 and 2. The possibility of cross-modulation occurring in the pre-amplifier is very remote, as the output circuit of this unit will consist almost always of a coupling coil having a low impedance to 50 c/s a.c. In the event that an alternative output circuit is employed any possible cross-modulation can be cleared by connecting a 470 ohm resistor (or, in severe cases, a 1.5 to 2.5μH choke) across the points marked BB in Fig. 3.

The requirements for short connecting leads in the co-axial circuits is of equal importance in Fig. 3 as it was in the circuits of Figs. 1 and 2.

Isolating Chokes

Apart from the mains transformer at the receiver end, the components required in the circuits described this month are easily obtainable. So far as isolating chokes are concerned, a suitable component would be the Teletron coil type 22. This coil has an inductance of approximately 2μH, and is capable of passing a continuous current of 3 amps.

IN YOUR WORKSHOP



This month Serviceman Smithy's able assistant, Dick, finds that things in the Workshop are not quite what he expected

THE GREENWICH TIME SIGNAL CONSISTS OF six pulses, or "pips," of an audio tone and, apart from other times, it is radiated every weekday morning at nine o'clock. It is the sixth pip which indicates the instant of nine o'clock.

Smithy, who had entered the Workshop a little early, had switched on a radio he had repaired the evening before, and was now waiting for the Time Signal. He frowned as he looked first at his watch then at the Workshop clock, which was belatedly indicating ten to nine. Smithy was trying to remember if he had wound it before leaving the previous day.

As the first pip of the Time Signal sounded the door of the Workshop burst open to admit the hurtling figure of Smithy's assistant, Dick. Just as the sixth pip ended, not only were Dick's mackintosh and jacket hung on their hooks but he himself was stationed at his bench, soldering iron raised, white overall buttoned up, and ready for work.

"Morning, Smithy," he grinned after the echoes of his entry had died down.

"You only just made it," grunted the Serviceman by way of greeting.

"Perhaps so," said Dick pompously, "but you cannot deny that I have succeeded in achieving my correct position in the Terrestial time-space continuum. My co-ordinates are nine of the clock, plus some seconds, and my locality the Workshop."

Smithy, who recognised the signs, groaned outwardly, but grinned inwardly.

"I see that your space-opera magazine arrived last night," he remarked unkindly. He wandered over to the clock to correct it.

"S.F."* replied Dick, indignantly, "is not space-opera. My regular copy of *Astral Bodies* did arrive last night, if you must know, and I was up till two in the morning reading it. Hence the rush."

With mock horror he watched the Serviceman approach the clock.

"Smithy," he called out urgently. "Don't, for goodness sake, alter that clock. Who knows but that, by merely moving the hands, you might transport us into a different cosmos! In fact," continued Dick, warming to his theme, "one of the stories I read last night was about someone who deliberately set a clock wrong. After that everything went topsy-turvy. For instance, all the printing in books went from right to left instead of from left to right, and all positive quantities became negative. Very disturbing for those concerned."

"I think I'll risk it," said the Serviceman.

To Dick's astonishment, Smithy first of all advanced the Workshop clock to the correct time—a minute past nine—then deliberately advanced it a further five minutes.

Dick's next protest sounded almost genuine.

"Take it easy, Smithy. You never know whether there mightn't be something in these fantasy stories after all. Why, what you've just done may have conveyed us to a sphere where, instead of repairing television sets, people pay us to *stop* them from working.

"That mightn't be a bad idea at that," replied the Serviceman mysteriously. "Anyway, it somehow seems homely to work under a clock which is five minutes fast."

* Science Fiction—ED.

The Ohm and The Mho

The Serviceman's action seemed to produce no immediate harmful effects, and he and his assistant soon settled down to their respective jobs; with the result that the Workshop became relatively peaceful. But Dick was not one to allow this state of affairs to continue for long.

"Hey, Smithy," he called out, breaking the silence after some ten minutes. "What on earth is a micromho?"

"A micromho," replied Smithy equably over his shoulder, "is one millionth part of a mho."

There was silence for a moment.

"Well, what's a mho?" persisted Dick.

Smithy left his work and walked over to his assistant's bench. Dick was gazing with a puzzled expression at a table of valve characteristics.

"Here's what I mean, Smithy," said Dick, pointing to a particular entry. "A valve type 6C4 is quoted here as having a transconductance of 2,200 micromhos. I don't get it."

"Transconductance," replied Smithy, "is just another word for mutual conductance. You don't see the word transconductance in English technical literature very often, but it pops up now and again. Mutual conductance, quoted in micromhos, appears rather more frequently."

"Yes, but what *are* micromhos?" asked Dick impatiently.

"I'll tell you," replied Smithy, drawing up a chair. "But first of all I will have to remind you of some of your very basic theory concerning resistance. Now, you yourself are pretty familiar with resistance because, being in the servicing game, you're bumping into it all the time. Also, you can express resistance in terms of voltage and current. Correct?"

"Resistance, in ohms," declaimed Dick, obligingly, "is equal to volts divided by amps."

"Right," said Smithy, "and the units of resistance—ohms, together with kilohms and megohms—are what people like ourselves deal with because they fit in with the sort of equipment which we handle. But engineers in other spheres of electrics find it much easier to work in terms of conductance rather than in terms of resistance. Conductance being the exact opposite of resistance, and being measured in mhos."

"That's funny," interrupted Dick, thoughtfully, "I've just noticed that the word mho is ohm spelt backwards. Just like what happened in that story last night."

"That's right," said Smithy blandly. "Also, I have to tell you that a mho is the reciprocal of an ohm."

"I see," replied Dick. "In other words, ohms are equal to one over mhos. And vice versa, I suppose."

"You've got it," said Smithy. A resistance of 10 ohms is the same as a conductance of 1/10 mhos. Conversely, a conductance of, say, 100 mhos is the same as a resistance of 1/100 ohms."

"And two ohms," interrupted Dick quickly, "is equal to half a mho."

The Serviceman sighed.

"I *knew* you were going to make that crack," he remarked dolefully. "I have never yet been able to explain conductance to *anyone* without that half a mho gag coming up.

"Anyway, let's carry on to the business we started off with: the mutual conductance of valves. Now, we know that one method of evaluating the performance of a valve consists of quoting a figure for the change in anode current which is caused by a change in grid voltage, the anode voltage remaining constant. This is the mutual conductance, or gm, of the valve and we normally refer to it as so many milliamps per volt. Thus if, under a given set of conditions, we find that changing the grid potential of a valve by 1 volt causes a change in anode current of 4 milliamps, we say that the valve has a mutual conductance of 4 milliamps per volt under those conditions."

"I can understand that easily enough," said Dick, "but is it entirely necessary to change the grid potential by exactly one volt to obtain a figure for mutual conductance?"

"You've made a very good point there," said Smithy. "Sometimes it is desirable to measure the mutual conductance of a valve for a change in grid voltage which is much less than a volt. This is partly due to the fact that the mutual conductance itself may change whilst you are changing the grid voltage. For instance, if you want to work a valve with a very low input signal under conditions which could cause marked changes of mutual conductance for a change in grid voltage of one volt, you might get a false answer by taking measurements with such a big change. I'll give you an example. Here's the anode current—grid voltage curve (Fig. 1) of a valve which is working under special conditions. For certain reasons I want to bias this valve at -3 volts. Also, I am going to apply a very small signal input to it, something of the order of a few millivolts. That means that I want to know the mutual conductance of the valve under very small input conditions with -3 volts bias on the grid. This bias corresponds to point A on the curve I've just drawn.

"Now, one way of finding the mutual conductance from the curve *could* consist of moving the grid voltage either side of -3 volts by half a volt, thereby giving me an overall change in grid potential of one volt. If I try this on the curve I've drawn I get points B and C. Point B corresponds to 0.8 milliamps anode current and point C to 4.4 milliamps anode current. So my change in anode current for one volt change in grid potential is 3.6 milliamps, this being also the figure, in milliamps per volt, for its mutual conductance.

"However, the result we've just obtained will not help us a great deal in this particular instance, where we only intend applying a small input signal. Let's check what happens, therefore, if we see what change of anode current we get for a much smaller change in grid potential. This could be, say, one tenth of a volt. Our process of finding mutual conductance from the curve now results in our moving the grid potential by one-twentieth of a volt on either side of −3 volts, and seeing what change in anode current we get. That is, we work at points D and E on the curve. The two anode currents we now get are (so far as we can read them, because they are very close together on the curve) 1.25 milliamps and 1.55 milliamps respectively; this giving us a change in anode current of 0.3 milliamps. But 0.3 milliamps is the anode current change given by a grid change of only one-tenth of a volt, so, if we want to express it in milliamps per volt we have to multiply it by ten. The mutual conductance figure then becomes 3 milliamps per volt. Which is somewhat different from the previous figure of 3.6 milliamps per volt.

"Just for fun, I'll draw straight lines between points B and C and points D and E and continue the latter out a little so that you can compare them. As you can see, the two lines represent quite different states of affairs."

"This is rather interesting," said Dick. "I don't know whether you're keeping something up your sleeve, Smithy, but there's something I've spotted straight away. In practice, first of all, we are already assuming the obvious fact that if you were designing a piece of gear using the valve in question you wouldn't go through the business of actually measuring mutual conductance with meters and things. Instead, you'd work with the curves given by the manufacturer, as you've just done. Secondly, if you wanted to work a valve under the conditions you've just mentioned you wouldn't normally try to read from the curve the difference given by tiny variations in grid voltage because it would be difficult to read the resulting small changes in anode current without error. So, in this particular instance, you could employ another method of attack. This would consist of drawing a straight line such that it only touched the curve at point A. In other words, nothing more nor less than a tangent."

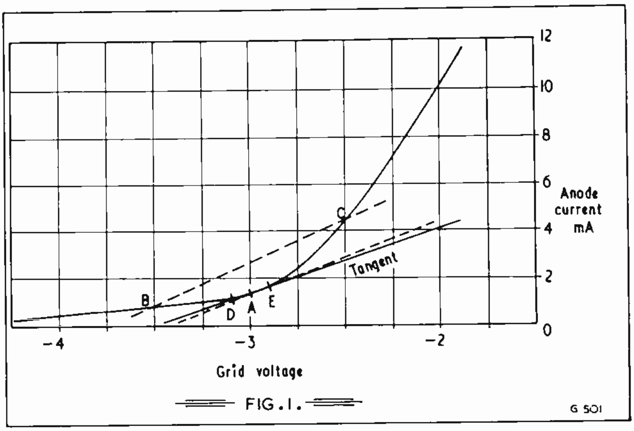


Fig. 1. Several methods of finding mutual conductance from an anode current-grid voltage curve. The solid line represents a tangent drawn to the curve

Whereupon Dick drew a tangent on Smithy's curve.

"There you are," said Dick. "I can now read very easily, from my tangent, the mutual conductance existing at point A, because my tangent has the same slope as the curve has at this point. If, using the tangent, I check the anode currents for, say, −3 and −2 volts at the grid, I get an anode current change of 2.6 milliamps. So the mutual conductance at point A is 2.6 milliamps per volt, this figure having been obtained quickly and easily. Also, it is more accurate than that given by your own line DE."

"Dick," beamed Smithy, "I'm proud of you. Never again shall I doubt your ability to pick things up quickly. Or not very often, anyway.

"Right. Now the conditions we have been discussing apply to the case where we are applying a very small input voltage to the valve, the grid bias being such that the anode current-grid voltage curve is quite curved at the point where we wish to operate. It frequently happens that we want to work a valve at a point where the anode current-grid voltage curve is almost straight, and it is quite possible that we may also want to apply a hefty input signal."

each case. However, at the accuracy we're working to here, they all come out to the same value."

"You're leading up to something here," said Dick suspiciously. "I said you had something up your sleeve."

"And so I have," chuckled the Serviceman. "Because, whatever grid voltage change I have made I have always had to find the mutual conductance in milliamps per volt by dividing the change in anode current by the change in grid voltage. Thus when, just now, I made a grid current change of 2 volts the

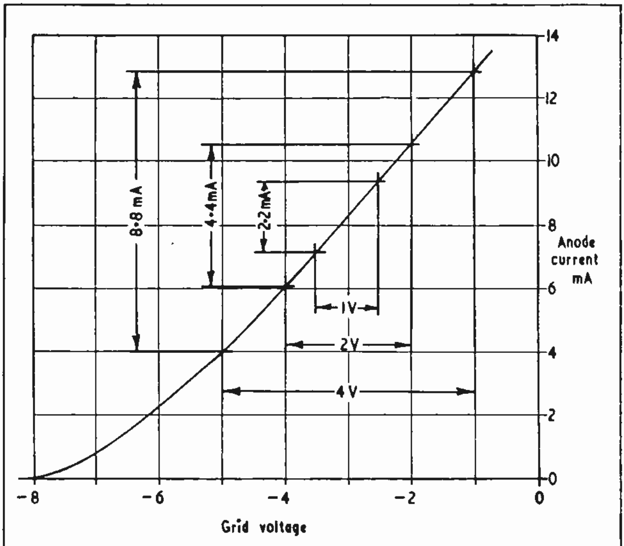


FIG. 2.

Fig. 2. If the anode current-grid voltage curve is relatively straight, mutual conductance readings will be similar for varying changes in grid voltage

Smithy drew a second curve (Fig. 2).

"In this case our curve is so straight," the Serviceman continued, "that we can find our mutual conductance by checking anode current change for one volt, two volts, or even four volts change. For one volt change we get an anode current change of 2.2 milliamps, so the mutual conductance is 2.2 milliamps per volt. With a two volt change the anode current changes by 4.4 milliamps, so that the mutual conductance is 4.4/2 milliamps per volt, which is equal to 2.2 milliamps per volt. For four volts change we get a mutual conductance of 8.8/4 milliamps per volt, which brings us back once more to our initial figure of 2.2 milliamps per volt. If we had measured our changes in anode current to more than two significant figures we might have found small discrepancies between the mutual conductance figures in

mutual conductance was 4.4/2 milliamps per volt. Earlier on, when I made a grid voltage change of one-tenth of a volt, the mutual conductance was $\frac{0.3}{\frac{1}{10}}$ milliamps per volt, which is, of course, equal to 0.3 x 10, or 3 milliamps per volt."

"I see," said Dick, frowning, as he concentrated. "What you mean is that the mutual conductance of the valve is actually I/E, where I is the change in anode current and E the change in grid voltage."

"Exactly," said Smithy. "Now what's a mho in terms of I and E?"

"Well," said Dick slowly, "to start off with an ohm is E/I, as we said earlier. A mho is a reciprocal of an ohm so a mho, therefore, must be equal to I/E. Am I right?"

Smithy nodded.

"Fair enough," continued Dick. "Now

we have also got round to the point that the mutual conductance of a valve is, similarly, I/E."

"Keep going," said Smithy. "You might find things easier if you next bring all your currents up to amps."

"Righto," said Dick. "I would also like to carry on with an actual example because I find it easier that way. Let's assume that a valve has a mutual conductance of 4 milliamps per volt. Now, substituting figures for I and E, and bringing the milliamps to amps I can next say that the mutual conductance of this valve is 0.004/1 amps per volt. Right?"

"Right."

"But," carried on Dick, "I/E where I is in amps and E is in volts, is also the formula for mhos. So, can I now say that the mutual conductance of my valve is 0.004/1 or, simply, 0.004 *mhos*?"

"You can."

"Ah," said Dick a little excitedly, "I see it all now. Carrying on back to the 'millis' and 'micros,' then, my mutual conductance of 0.004 mhos is equal to 4 millimhos and is equal to—let me think—4,000 micromhos."

"Precisely," commented Smithy. "Now how about tackling your original mutual conductance of 2,200 micromhos?"

"Well," said Dick, "if 4,000 micromhos is the same as 4 milliamps per volt, then 2,200 micromhos must be the same as 2.2 milliamps per volt. In other words, divide mutual conductance in micromhos by 1,000 and you get the answer in milliamps per volt."

"You've got it," said the Serviceman.

Negative Resistance

He glanced at the Workshop clock, which now indicated half-past nine. Dick followed the movement of his eyes.

"I wish," Dick remarked, a little worriedly, "I could get that silly story I read last night out of my mind. I mean to say, you didn't have to set the clock wrongly this morning, but you did. Nor did I have to read words like ohm spelt backwards, but I did. You know, I'm beginning to feel that this is going to be rather a *weird* morning."

"You're letting your imagination run away with you," chuckled Smithy. "That's what comes of reading fantasy in the early hours. Anyway, whilst we're talking about resistance, I think I ought to pass on some more information on this subject."

"What sort of resistance do you want to talk about?" asked Dick.

"*Negative* resistance," intoned Smithy.

"Ye gods," muttered his assistant.

"Yes," continued Smithy firmly, "negative resistance. Which occurs not when R equals E/I but when R equals *minus* E/I."

He glanced enquiringly at his assistant, but Dick had given himself up to a troubled silence.

"Another way of putting it," Smithy carried on, "is to say that negative resistance appears when an increase in current results in a *decrease* in voltage. In some instances, if you connect a tuned circuit up to something having negative resistance it starts oscillating straight away."

"That sounds intriguing," said Dick, forgetting his worries for a moment.

"A typical example of this happening," said Smithy, "is in the dynatron. A dynatron uses a circuit like this."

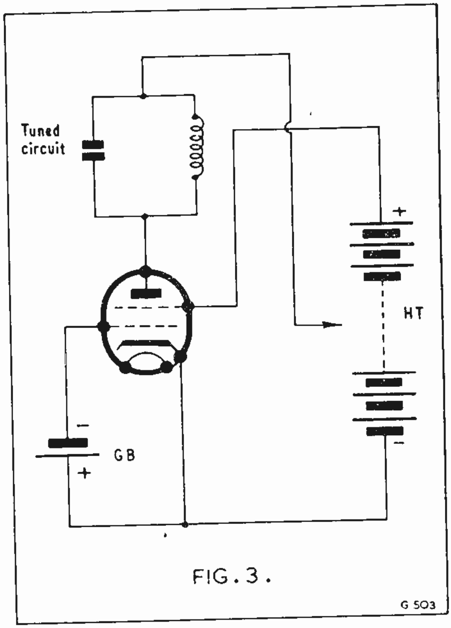


Fig. 3. *The dynatron*

Smithy scribbled on the paper in front of (Fig. 3).

"Now you will see that, in this circuit, I have shown the h.t. supply as a battery," he stated. "The reason being that I want to emphasise the fact that the screen grid of the valve connects to an h.t. supply whose potential is higher than that to which the anode is connected.

"Before proceeding further I think we should take a very quick look at the anode voltage—anode current curve given by a normally-connected valve. The curve you get is usually something like this. (Fig. 4 (*a*).) There's nothing at all out of the way in this curve; all it tells us is that as the anode voltage increases the anode current increases also. Which is what you would expect.

"However, with the dynatron circuit you get a curve like this. (Fig. 4 (*b*).) To understand why the queer kink occurs in this curve it is best to start off by considering what happens at a low anode voltage, such as occurs at point P. At point P the anode voltage is considerably less than the screen grid voltage, but this still does not prevent a quantity of electrons from the cathode reaching the anode and causing an anode current to flow. As we increase anode voltage, proceeding along towards point Q on the curve, the anode current similarly increases. Which is, again, just what you would expect.

electrons to be knocked out, whereupon these may leave the body. It is quite possible for a single electron to cause many secondary electrons to leave the body. Also, all else being equal, the number of secondary electrons knocked out by a single primary electron increases when the speed with which the latter strikes the body increases.

"As we approach point Q on our dynatron curve, we are both increasing the velocity of the electrons striking the anode, and their quantity. Quite a number of the secondary electrons are attracted towards the positively charged screen grid, whereupon they become lost by the anode.

"When we reach point Q the curve ceases to climb. At this point the number of extra electrons which would flow through the anode-cathode circuit if a very small increase in anode voltage were to occur is equalled by the number of extra secondary electrons which would flow in the reverse direction,

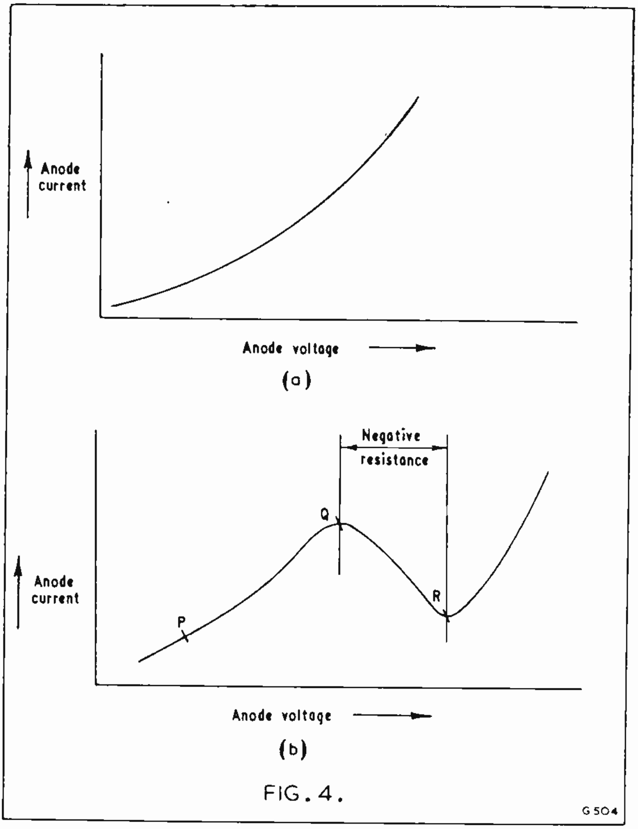


FIG. 4.

Fig. 4 (a) Anode current-anode voltage curve of a normally connected valve. Fig. 4 (b) The anode-current-anode voltage curve of a dynatron

"Now, whilst the anode voltage is increasing, a second effect becomes prominent. As you should know, when an electron strikes a body such as an anode it causes secondary through the anode-screen grid circuit. As we further increase the anode voltage, going past point Q towards point R, the increase in the secondary electron current now becomes greater than that in the anode-cathode circuit, and the overall anode current descends. The curve continues to descend until the anode voltage reaches point R. At R the anode potential is such that the screen grid offers less attraction to the secondary electrons, whereupon more of these return to the anode. After point R the increase in secondary electron current for a small change in anode voltage is less than the increase in the current which flows in the anode-cathode circuit, and the total anode current behaves in normal fashion."

"Phew," remarked Dick. "I hadn't realised that things like that could happen in simple circuits like the one you've just drawn. It seems almost like necromancy to take an ordinary bottle, apply nothing to it other than potentials, and yet get it to exhibit negative resistance like that. The bit that I find most fascinating is that you simply pop a tuned circuit in series with the valve, using no feedback circuits at all, and it just oscillates!"

"Provided you apply the right potentials," qualified Smithy. "Whereupon it oscillates quite well and reliably. You will note that I used a screen grid valve in my circuit. In a pentode, the suppressor grid between the anode and screen grid is inserted purposely to prevent the secondary electrons from the anode reaching the screen grid. And the negative resistance effect disappears."

"Well, that's something of a relief," stated Dick. "I might have a few back-to-front micromhos wandering around in the sets I service but at least I don't have any upside-down negative resistances to handle."

"Oh, but you do," remarked the Serviceman. "One of the most obvious examples being the thermistor in series with most heater lines. The greater the current which flows through a thermistor the less the voltage developed across it. And if that isn't an example of negative resistance I don't know what is."

Time Factor

"Is that all you have to say about negative resistance?" asked Dick.

"It is," replied Smithy gravely.

"Then thank goodness for that," said Dick with relief. "I'm now going to get back to some good old practical servicing."

"But aren't you going to boil the kettle for tea?" asked the Serviceman seriously. "It's gone eleven o'clock."

Dick looked wildly at the Workshop clock, now indicating 9.32, and at the watch Smithy showed him, which indicated five past eleven.

"This is the end," he gulped wildly. "O.K., Smithy, I'll make the tea if that's what you want me to do. But I'm going to say right now that there's something seriously *wrong* with things this morning. If this is what happens when the Workshop and science fiction become muddled together, then from now on I'm going to drop science fiction. Or the Workshop!"

Which only goes to show what confusion can be caused when a run-down Workshop clock has stopped for some time at 9.32, and a far from guileless Serviceman surreptitiously advances his watch by an hour or so (even if it does mean having tea a little earlier than usual).

And, of course, Smithy would never have confessed that he, also, had received his own copy of *Astral Bodies* the night before!

Sorry, No More Room!

Grafton Radio Society (G3AFT) announce that with over seventy applicants for their well-known R.A.E. and Morse classes, they regret no more applications can be considered. The club meetings, held on Friday evenings at Montem School, Hornsey Road, Holloway, London, N.7 (just off Seven Sisters Road) with slow Morse at 7 p.m., the usual club lecture, talk, discussion, quiz, junk sale, etc., at 8 p.m. until 10 p.m., are open to new members and to visitors. In addition, the club operates two transmitters covering all bands from 160m to 10m. Hon. Sec.: A. W. H. Wennell, G2CJN, 145 Uxendon Hill, Wembley Park, Middlesex.

Nottingham Hi-Fi and Tape Club

A new club has been formed at Nottingham for hi-fi enthusiasts and tape recording fans.

Meetings are held at 7.30 p.m. every Wednesday at Woodthorpe House, Mansfield Road, Nottingham.

Activities will include discussions, talks, and demonstrations of audio equipment, as well as practical work involving the use of tape recorders, record players, etc. If there is sufficient demand, lectures and talks of a technical nature will be organised. It is also intended to lay on visits to places of interest to audio fans, exhibitions, etc.

Enquiries should be made to N. D. Littlewood, c/o the above address or at 129 Standhill Road, Nottingham.

UNDERSTANDING TELEVISION

PART 11

By W. G. MORLEY

The eleventh 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 r.f. amplifier, as employed in modern television tuners. We discussed the cascode circuit arrangement and showed how this is employed with aerial coils of the double-winding transformer type. We shall now carry on to the more recently introduced single winding aerial input circuits.

Owing to space limitations, part of last month's article has been carried forward to form the commencement of this month's contribution. In consequence, it will be found that reference is made occasionally to diagrams which were published in the previous issue.

Single Winding Aerial Circuits

In the United States it has been conventional practice for the last few years to employ a single winding aerial coil instead of the double-winding r.f. transformer shown in Fig. 57. Single winding aerial coils are to be seen, also, in some British tuners.

Single winding aerial coils are used in a circuit of the type shown in Fig. 60 (*a*). In this diagram the coil operates in a simple pi circuit, the tuning capacities consisting of the condenser C_1 and the capacity to chassis given by the first triode. The input condenser normally has a value (according to tuner design) lying between 20 and 40pF, whilst the input capacity of the valve is of the order of 2–3pF. In consequence the circuit functions in the same manner as would occur if there were an "earthy" tap near that end of the coil which is remote from the grid. The result is that a voltage step-up effect takes place. By suitable choice of input condenser value it is, therefore, possible to match the impedance of the aerial feeder to the input impedance of the valve.

It is usual to employ neutralising in practical cascode circuits, and this process is carried out in single winding input circuits by fitting a condenser between the anode of the first triode and that end of the aerial coil which is remote from the grid. See Fig. 60 (*b*). This condenser then provides neutralisation in the same manner as did C_1 in Fig. 57. In cases where it is intended to apply an automatic gain control voltage to the cascode, this may be applied via a grid leak, as in Fig. 60 (*c*). In such an instance it becomes necessary to insert a d.c. blocking condenser at some point between the input condenser C_1 and the grid of the valve. So far as its d.c. blocking effect is concerned, this condenser may be fitted at either side of the coil. In Fig. 60 (*c*) it is inserted in the grid side of the coil.

A disadvantage with the pi-type input circuit is that it does not offer as great a degree of rejection to frequencies other than the signal frequency as does the r.f. transformer input circuit. Any signals picked up by the aerial which fall close to, or within,

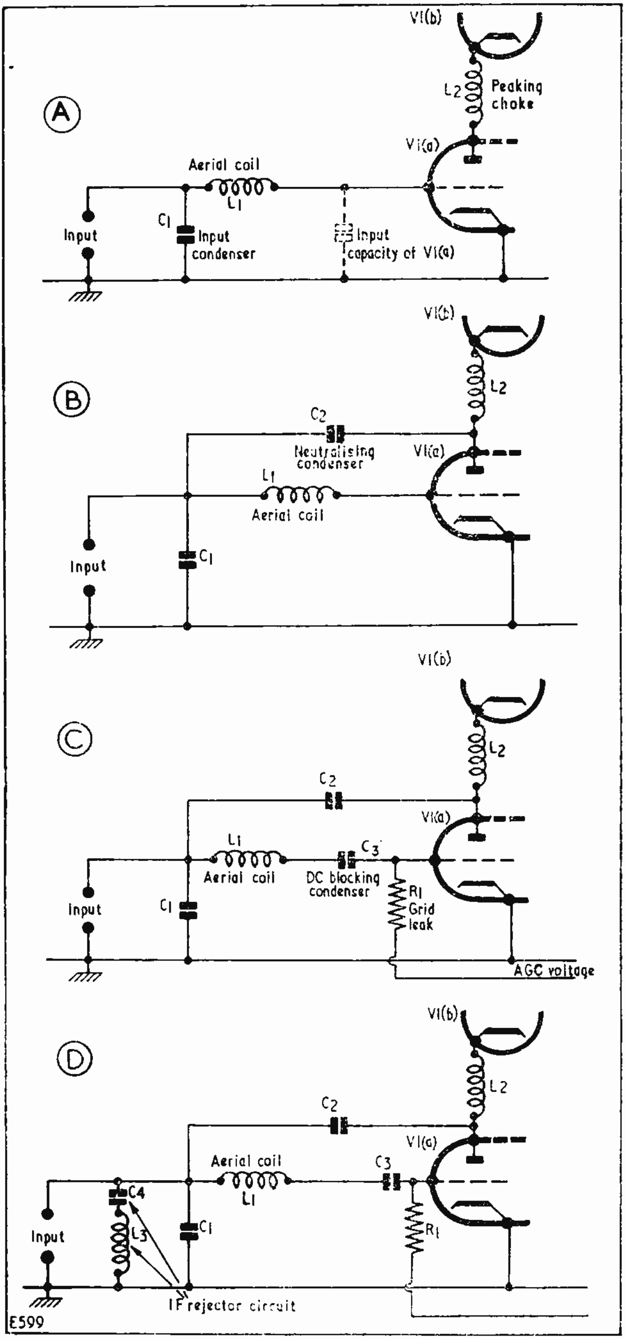


Fig. 60 (a) The basic circuit around a single winding aerial coil. C_1 and the input capacity of the valve tune the coil in a conventional pi arrangement. (b) Neutralising may be obtained by adding C_2. (c) A grid leak and d.c. blocking condenser are fitted, thereby enabling an a.g.c. voltage to be applied to $V_{1(a)}$. (d) Finally, to overcome the relatively poor rejection of a pi tuned circuit to frequencies other than the resonant frequency, a simple absorption i.f. rejection circuit is added the intermediate frequencies of the television receiver are particularly liable to cause interference, especially when the tuner is switched to a low channel (whose frequency would be close to the intermediate frequency). In consequence, when a single winding aerial circuit is employed it is customary for an i.f. rejection circuit to be fitted as well. Such a circuit is illustrated in Fig. 60 (*d*) and, as may be seen, it consists quite simply of a series tuned circuit made up by a coil and condenser connected across the input condenser. Normally, the coil is adjusted by means of a core until the rejection circuit resonates at the desired frequency. The circuit then absorbs energy at the frequency to which it is tuned, thereby reducing the amount of interfering signal at this frequency, which is passed on to the grid of the cascode.

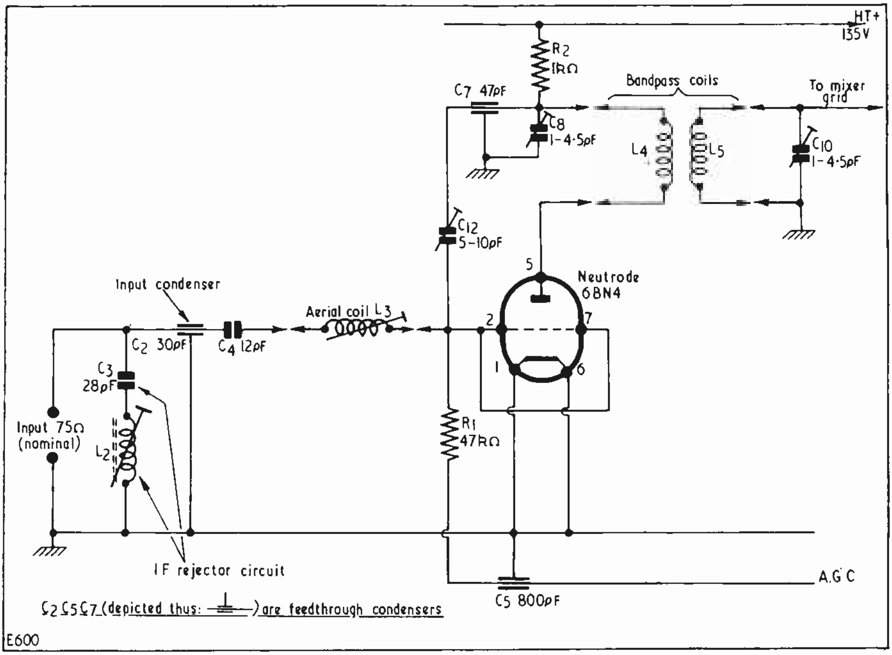


Fig. 61. The circuit employed around the Neutrode in the Standard Coil Products ND 4000 series of turret tuners. A balun and an extra i.f. rejector circuit (needed due to the small amount of spacing between the standard American i.f. and lowest channel signal frequency) are employed between the aerial input and the 75 ohm input terminals shown here. The component number suffixes are those employed in the full Standard Coil Circuit. The connection to the mixer grid is made via a 47pF condenser

We have just noted that the single winding aerial circuit suffers from the disadvantage of requiring an additional i.f. rejector circuit. At the same time, however, it offers a considerable number of advantages, and these are of sufficient importance to make its use extremely attractive. One of these advantages is that only two connections are needed to the coil itself. In practical turret designs this results in a valuable reduction in the number of contacts required for connection between the chassis assembly and the aerial coils, with a consequent reduction in space requirements, mechanical design problems, and cost. A further advantage is that, since there are now no coupling windings, the single winding coils may be made self-supporting, thereby obviating the necessity for coil formers and cores. In its self-supporting form the inductance of the aerial coil can be adjusted by opening or closing its turns, the wire of the coil being sufficiently rigid for these to remain in position after this operation has been carried out.

The Neutrode

In a number of current American tuners,

a cascode is not employed as r.f. amplifier. Instead, a valve described as a *neutrode* is used. The Neutrode is a single triode having a low anode-grid capacity which has been specifically developed for television tuner applications. In order to keep lead inductances low, both grid and cathode of the Neutrode have double lead-out wires. The Neutrode appears as type 6BN4—for 6.3 volt heater operation—or as types 2BN4 and 3BN4 when series heater lines are employed.[1]

Despite its low anode-grid capacity, the Neutrode still requires neutralisation. In this case neutralising is too critical for fixed components to be employed, and a means of adjustment is essential. A typical neutralising circuit is illustrated in Fig. 61, this being the arrangement employed in the ND-4000 series of Neutrode tuners manufactured by Standard Coil Products Co. Inc.

In Fig. 61 the circuit before the grid of the Neutrode employs a single winding aerial coil, similar to that of Fig. 60 (*d*). The anode of the Neutrode connects into the first of two coils which are coupled together to form a bandpass tuned circuit, as in the block schematic diagram of Fig. 51. The second of these coils couples into the mixer input circuit. (We shall be dealing with the bandpass coil section of the tuner in next month's article). The two condensers C_8 and C_{10} are low-value trimmers whose purpose is that of ensuring that all production chassis present the same tuning capacity to the coils.

An interesting feature of the circuit of Fig. 61 is that the necessary 180 degree phase reversal of anode voltage needed for neutralisation purposes is provided, not by the aerial coil as in Figs. 57 and 60 (*b*), but by the coil in the anode circuit. This coil, L_4 of Fig. 61, is decoupled to earth via C_7. However, the value of C_7 is made sufficiently low for a small proportion of the signal frequency voltage to appear across it. This signal frequency voltage is then applied to the grid of the Neutrode via the trimmer C_{12}, this latter being the component which is adjusted for optimum neutralising.

The main advantages offered by the Neutrode when compared with the cascode r.f. amplifier are that it requires fewer components, that it can work with a lower h.t. voltage, and that it dissipates less power. The fact that a lower h.t. voltage is required is of value in American receivers of the a.c./d.c. transformerless type as, unless a voltage doubling rectifier arrangement is used, the rectified h.t. voltage available is limited to some 135 volts because of the standard a.c. mains voltage of 117 volts.

[1] New Circuits in TV Tuners, by E. D. Lucas. Jnr.. *Radio-Electronics*, August, 1958. Details for the circuit given in Fig. 61 have also been taken from this reference.

The Neutrode is designed to operate from an h.t. supply of 135 volts. The feature of less dissipation of power is valuable not only because it is, in any event, always desirable to keep down h.t. current in a television receiver, but also because less power dissipation results in the generation of less heat, an important factor when miniaturised layouts are employed. The r.f. gain provided by the Neutrode is lower than that given by the cascode. (It is stated that the Neutrode offers better a.g.c. characteristics than does the cascode.)

300 Ohm Inputs

In our discussion of tuner aerial circuits in this and the preceding article we have seen examples wherein the input from the aerial was provided via 75 ohm coaxial feeder. As one conductor of 75 ohm coaxial feeder is connected to chassis at the receiver (and thence to earth) this type of feeder is referred to as "unbalanced."

Fig. 62 (*a*) illustrates the method by means of which 75 ohm coaxial feeder couples to the input tuned circuit of the television tuner where an r.f. transformer type of aerial coil is employed. Although 75 ohm feeder is very common in British installations it is rarely employed for such purposes outside the U.K. Instead, 300 ohm feeder is used.

A typical input circuit for 300 ohm feeder is shown in Fig. 62 (*b*). It will be seen that in this case the input coil has a centre tap which connects to chassis, and that the two conductors of the feeder connect to the outside ends of the coupling coil. Since the two conductors of the feeder are now balanced about chassis (and, thence, about earth) this type of feeder is referred to as "balanced."

Due to the fact that, for impedance matching purposes, the turns ratio of a transformer is equal to the square root of the impedance ratio it matches, the 300 ohm coupling winding of Fig. 62 (*b*) has twice the number of turns as has the 75 ohm winding of Fig. 62 (*a*). (The square root of the impedance ratio 300:75—which is equal to 4:1—is 2:1.) This assumes, of course, that the secondary windings and circuits of Figs. 62 (*a*) and (*b*) are similar. Because of this simple 2:1 turns relationship between coupling windings intended for 300 and 75 ohm inputs, it is quite possible for the coupling winding of Fig. 62 (*b*) to accept a 75 ohm coaxial input, this being connected either across points A and B, or across points B and C. In either case, the outer conductor of the coaxial input would be connected to point B.

When single winding pi-tuned circuit inputs are used in the aerial stage, a different technique has to be employed if a 300-ohm-

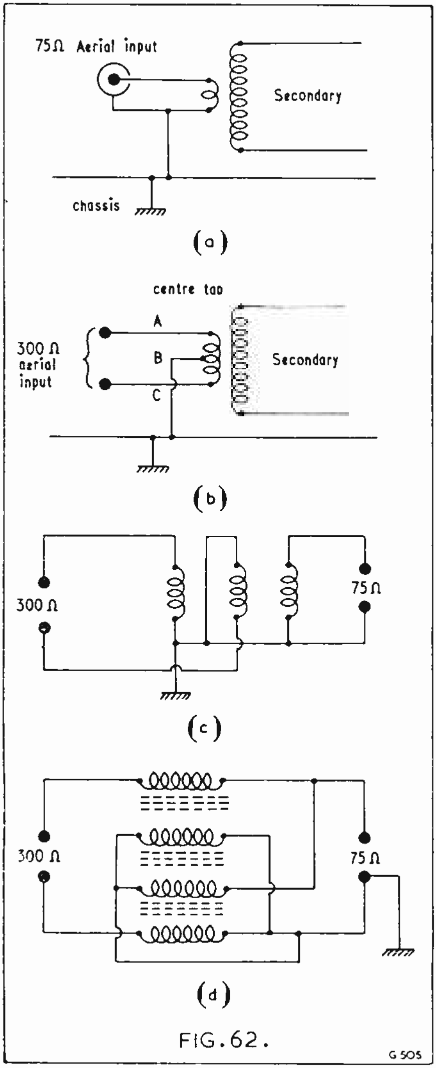


Fig. 62 (*a*) A 75 *ohm input circuit.* (*b*) *A centre-tapped input winding is employed for* 300 *ohm input feeders.* (*c*) *A simple* 300-*ohm-balanced to* 75-*ohm-unbalanced balun. The three windings have the same number of turns and are tightly coupled together.* (*d*) *A more complex balun of the type employed in current tuners*

balanced input is intended. The difficulty here is that one side of the input to the single winding circuit must be at chassis potential, whereupon a direct connection to the balanced feeder becomes impossible. The solution to this problem consists of employing a balun.[2] A simple 300-ohm-balanced to 75-ohm-unbalanced balun is depicted in Fig. 62 (*c*). This balun could be inserted between a 300-ohm-balanced aerial-feeder and a single winding aerial circuit having an input impedance of 75 ohm. For good operation the three windings of the balun of Fig. 62 (*c*) must be coupled together very tightly indeed. In practice, baluns of the type employed in television tuner units have slightly more complex circuits, an example being shown in Fig. 62 (*d*). Arrangements of this type ensure optimum mutual coupling between the various parts of the winding whilst still retaining the necessary 2:1 turns ratio. These baluns usually employ only a few turns of wire and are wound on special low-loss ferrite cores.

Aerial Isolation

When, as is common practice, television receivers work from transformerless power supplies, care has to be taken to ensure that the aerial connections are adequately isolated from their consequently "live" chassis in order to prevent accidental shock. The conventional method of obtaining isolation consists of connecting condensers in series with both input leads. As it is possible for an aerial to acquire high potential static charges, it is also necessary to provide a leakage path between the input feeder connections and the chassis of the receiver. Such a leakage path may be given by connecting one or more high value resistors between the aerial feeder and the receiver chassis.

Typical aerial isolating circuits are illustrated in Figs. 63 (*a*) and (*b*). That of Fig. 63 (*a*) would be employed for 300 ohm and 75 ohm inputs, although many 75 ohm inputs nowadays use the arrangement of Fig. 63 (*b*).

In Britain, special requirements for aerial isolation are laid down in British Standard 415:1957.[3] One of these requirements is that the maximum leakage current which can be allowed to flow to earth from the aerial terminal, or group of terminals, is 0.3mA. In order to meet this requirement many of the more recently manufactured British television receivers employ the isolation circuit of Fig. 63 (*b*), the resistor R_2 having a value of 2MΩ, and the series condensers values of 470pF. The resistor R_1 may have a value of 1 or 2MΩ.

[2] A balun is a transformer whose function it is to match a balanced input to an unbalanced output or vice versa. The term is derived from the phrase: *bal*ance to *un*balance.

[3] British Standard 415 : 1957. *Safety Requirements for Radio or other Electronic Apparatus for Accoustical or Visual Reproduction* (*Electric-mains-supplied*).

The Bandpass Circuit

A very important part of the television tuner is the bandpass circuit which couples the r.f. amplifier to the grid of the mixer valve. In company with the aerial tuned circuit it is the function of the bandpass circuit to provide a response which ensures that the desired vision and sound signals are received without undue attenuation of any part, and that adequate selectivity against interference from transmissions on adjacent channels is provided. Without going into too much detail at this stage it would be interesting to quickly examine the response of practical bandpass tuned circuits, and to see how they fit into the overall response of the tuner. To give an instance of what is required of television tuners, let us consider the ideal transmitter characteristic on any channel in the British 405 line system. Fig. 64 illustrates this characteristic.[4] As may be seen, if both the vision and sound signals are to be correctly presented to the i.f. stages of the associated televisor, the

[4] The information given in Fig. 64 is taken from Fig. 20 and Table 2 of *Understanding Television*, part 4, published in the April 1958 issue.

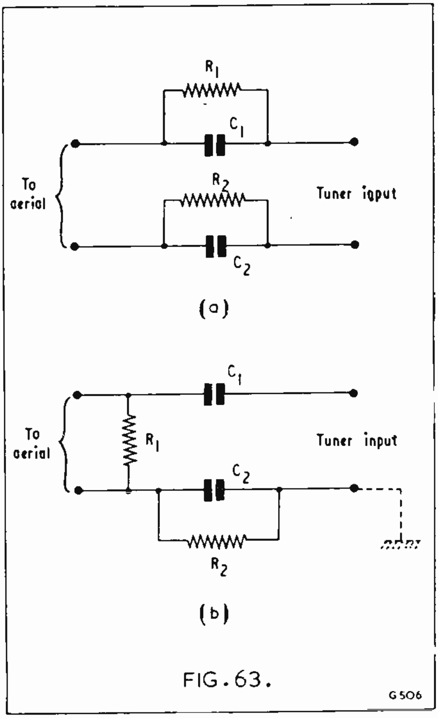


FIG. 63.

Fig. 63 (a) A simple aerial isolation circuit, used when the associated receiver has a transformerless power supply. (b) An alternative isolation circuit, frequently employed for 75 ohm inputs

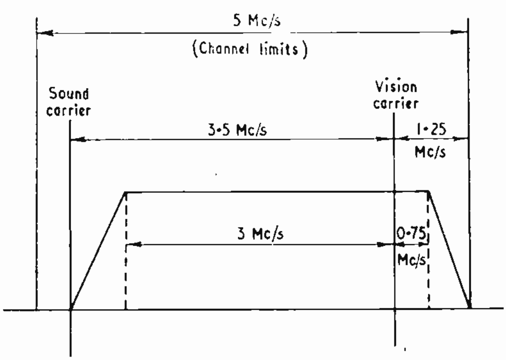


FIG. 64.

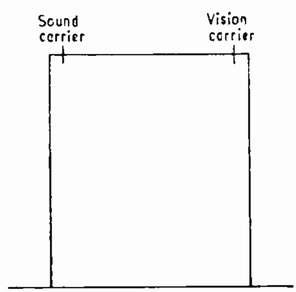


FIG. 65.

Fig. 64. The ideal transmitter characteristic for any channel in the British 405 line system. Fig. 65. An ideal tuner response would have an appearance similar to that shown here

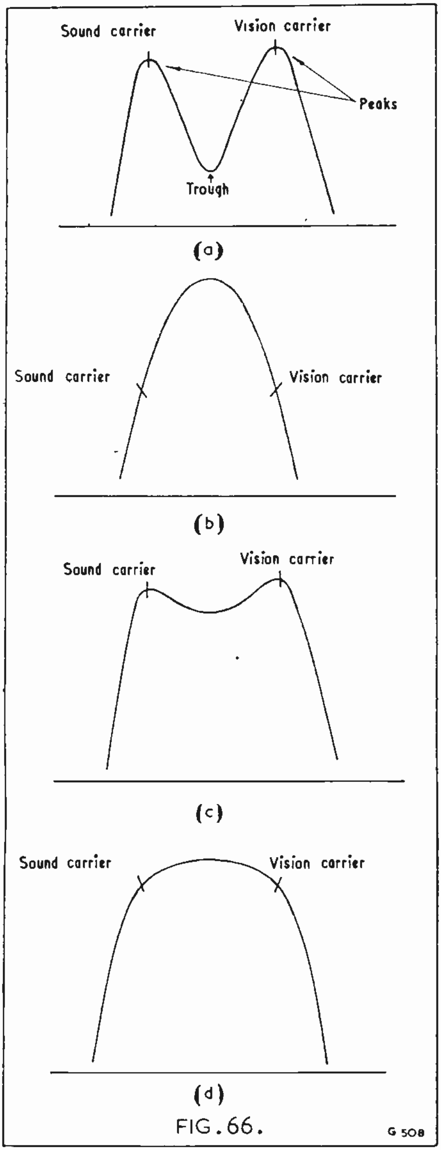


FIG. 66.

G 508

Fig. 66 (a) An example of the response given by the bandpass coils of a television tuner. (b) The response given by the aerial tuned circuit. (c) The overall response of a tuner unit is a combination of the bandpass and aerial responses. (d) The aerial tuned circuit response may sometimes cause the overall response to take up the form shown here

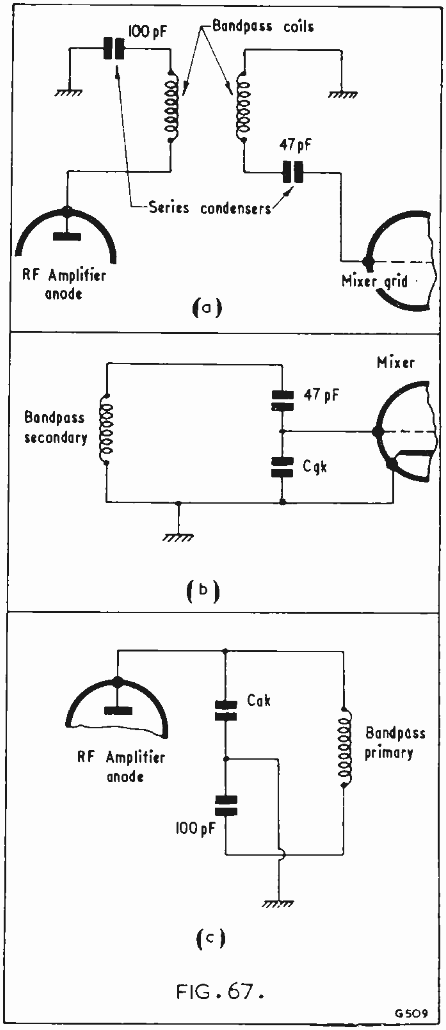


FIG. 67.

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Fig. 67 (a) A bandpass circuit illustrating the relatively low value condensers which are inserted in the primary and secondary tuned circuits. The values given are typical of current tuners. (b) Due to the presence of the 47pF condenser in the secondary tuned circuit, the grid of the mixer valve taps into the capacitive section of the tuned circuit. (c) In similar fashion, the 100pF condenser in the primary circuit causes the anode-chassis output of the r.f. amplifier to tap into the capacitive half of the primary tuned circuit tuner has to have a response which passes, without undue attenuation of any part, a range of frequencies lying between the sound and vision carriers. An ideal tuner response would take up a form something like that shown in Fig. 65.

The response given by the bandpass coils of most television tuners usually assumes an appearance like that of Fig. 66 (*a*). This response has the familiar double-peak form peculiar to bandpass tuned circuits, and the highest points on the two peaks are intended to lie close to the vision and sound carriers.[5] A typical response for the aerial tuned circuit of a tuner is shown in Fig. 66 (*b*). Since the aerial input circuit employs only one tuned circuit, a single peak occurs.

The overall response of the tuner is that given by both the aerial and bandpass tuned circuits, and it is normally similar to that of Fig. 66 (*c*). This is a combination of the responses of Figs. 66 (*a*) and (*b*), and it will be noted that the single peak of Fig. 66 (*b*) causes the trough between the peaks of Fig. 66 (*a*) to be raised by quite an appreciable amount. As may be seen, the overall response begins to approach the ideal curve of Fig. 65. In some cases (or on some channels in a particular tuner) the effect of the aerial tuned circuit is greater than occurs in Fig. 66 (*c*). When this happens the centre of the bandpass response is raised so much by the aerial response that the final response assumes the shape shown in Fig. 66 (*d*). Such a response is quite satisfactory, provided that the points at which the vision and sound carriers appear are not too low when compared with the highest part.

[5] According to the design of the tuner, the peaks may be positioned either slightly inside or outside the carriers.

The above paragraphs are intended only to introduce the effect that the bandpass tuned circuit has on the overall tuner response. We shall examine the subject of overall response in more detail later, after we have discussed the mixer stage and its test points.

Before concluding on the subject of bandpass coils it should be mentioned that these are normally coupled to their appropriate valves via condensers having values which are lower than those normally chosen for decoupling purposes. A typical example is given in Fig. 67 (*a*), wherein a 47pF condenser is connected between the secondary coil and the grid of the mixer valve, and a 100pF condenser is connected in series with the primary coil and chassis. The purpose of these condensers is that of ensuring that the input impedance of the mixer and the output impedance of the r.f. amplifier do not cause excessive damping of the tuned circuits. The condensers ensure that the grid of the mixer and the anode of the r.f. amplifier connect to taps in the capacitive parts of the tuned circuits, the positions of these taps being governed by the values of the series condensers. Fig. 67 (*b*) and (*c*) may help to illustrate the effect more clearly. The values chosen for the bandpass series condensers in practical tuners are those which offer the best compromise between minimum damping of the bandpass coils and maximum transference of signal frequency voltage from the anode of the r.f. amplifier to the grid of the mixer valve.

Next Month

In next month's contribution we shall carry on to the mixer and oscillator sections.

Can Anyone Help?

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

R,1426 Receiver (Modified 1355).—M. Ivings, 359 Rocky Lane, Great Barr, Birmingham 22A, wishes to obtain any possible information, particularly connections to the 12-pin Jones plug, and is willing to purchase manual or circuit diagram.

R.107 Receiver.—V. A. Davies, 154 Frampton Road, Penyrheol, Gorseinon, Swansea, would like to buy or borrow the service manual or any data.

Amplion Six Receiver.—J. Roberts, 15 Sambrook Road, Fallings Park, Wolverhampton, Staffs, wishes to buy or borrow details of this 6-valve a.c. mains receiver, and will promptly acknowledge all letters.

Marconi Communications Marine Receiver 352 (A).—W. Stephenson, 5 Clifton Road, Birkenhead, Cheshire, appeals for any data and the circuit diagram, and will gladly defray any expenses.

Transmitter/Receiver Sets 18 Mk. 3 and 17 Mk. 2.—P. Dawson, 411 Oxford Street, London, W.1, would like to purchase or to borrow the circuit diagram and details.

34–38 Mc/s Discriminator.—J. W. Fuzzard, Athelstan, Chapel Enlefrith, Stockport, Cheshire, has a home-built radio/t.v. receiver using a Cyldon turret tuner for 34–38 Mc/s i.f. Can any reader suggest a source of supply for a 34–38 Mc/s Discriminator, since he wishes to add f.m.?

MCR.1 Miniature Communications Receiver.—G. Clarke, c/o Harmony Productions Pty. Ltd., 123 Blagowlah Road, Fairlight, Sydney, New South Wales, Australia, asks if any reader can supply him with the circuit of the MCR.1 and its a.c./d.c. power supply unit.

Philco Signal Generator Model 778.—P. J. G. McAvera, Ballymacnamee, Portaferry, Co. Down, N. Ireland, wishes to obtain on sale or loan any literature, data or service manual. Manufactured in 1934, the makers can no longer supply details.

Ferguson Model 951T. T.V. Receiver.—H. F. Walker, 8 Gladstone Road, Dorridge, Solihull, Warwickshire, wishes to buy or borrow a service sheet for this 9in model which has a fault in the picture circuit.

radio miscellany

THIS MONTH I STILL FIND MYSELF HAVING to write from a hospital bed, but there's every hope I shall be back to normal shortly. Once again there are a number of nice letters from readers, so I am hardly at a loss for topics. Indeed, the difficulty may be covering them all. First our old friends, the Bedfast amateurs. Their September *Radial* mentions that one of their Leeds members, Mick Drury, logged the bleep-bleep from Sputnik No. 1 for three days and sent a detailed report of reception to Moscow at the invitation of a Russian radio magazine. He has now received a colourful acknowledgment card depicting a Sputnik encircling the globe—and the inevitable large Red Star. Incidentally, he also made a tape recording of the bleeps.

recipients, although many amateurs do patiently send cards to listeners who they feel are trying to be helpful despite their lack of usefulness.

Keen "ether" searchers who report intelligently will invariably get a high percentage of verifications, many of them, like the Sputnik card, of considerable interest.

Fireside Listening

Recently I wrote of matchbox receivers, and some interesting correspondence with readers has ensued. An outstanding application of the idea comes from Mr. O. G. Kerslake who builds miniature receivers into tiny radiograms which form a part of 3-D stage sets which are surrounded by a gilt picture frame for hanging on walls. The photograph gives an idea of the finished result.

The scene can be built up with dolls house furniture or specially made pieces in contemporary style. In the scene illustrated the radio really works and can be heard clearly at the far end of the room. The clock which tells the correct time is the dial and movement from a small wrist watch; the mirror forming the overmantel is one of the type used in birdcages. A small glass cat sits beside the fire. The figure sitting in the scene is a cut-out of your wife or girl friend—failing possession of either of these you will have to fall back on a pin-up personality.

The usual plaques or model scenes are dead and of little interest, but here is a working model which might well be based on real life or be an actual scene from your own drawing room, complete with carpet and rug. Other working parts might well be included by imaginative readers. For instance, in the

Centre Tap talks about items of general interest

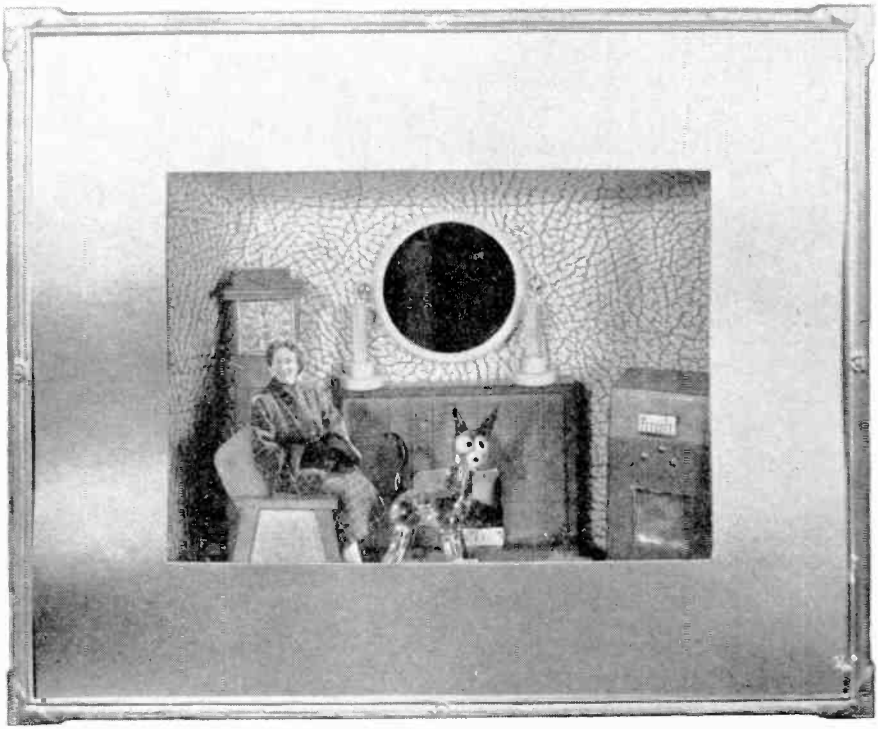
The pastime of short-wave listener QSL collecting has greatly declined in recent years. During the thirties, and even the early post-war years, it was quite a thing. In the early days of short-wave broadcasting many stations were eager for reception reports and gladly acknowledged with a colourful card. Amateur stations, too, were often pleased to have detailed listener reports which they QSL'd conscientiously. Unfortunately a large number of listeners began to send off slap-dash reports to any and every station they heard. This obsession with card collecting (with utterly useless "reports") merely served to exasperate amateurs, and DX broadcasters who knew perfectly well that consistently good reception was possible in that particular area, didn't want reports, let alone the bother of verifying them. As a result listener reporting rather fell into bad favour and even useful and helpful reporters suffered at the lack of response shown by scene illustrated I would suggest that a "live" fire could be simulated by a peanut bulb behind red celluloid set inside the grate. A small piece of suspended foil would rotate automatically by the heat, giving apparent life and movement to the fire. The purist might even add a little Eureka wire element so}heat comes off as well!

The great thing, of course, is to keep everything in the correct proportion to ensure naturalness and reality.

could shave in the mirror while listening for the time-signal and weather report. This column would welcome details (with photograph) of any models made up by readers, especially of the equipment used for the radio.

Mr. Kerslake is willing to supply working models to trade distributors, etc. His address is 18 Wickham Avenue, Bexhill-on-Sea, Sussex.

As a final suggestion for those who have no particular scene in mind, why not build up a miniature broadcast studio scene with the sound coming from one of the monitor loudspeakers?



Reader O. G. Kerslake's Picture Frame Receiver

As far as the radio side is concerned, a moving coil headphone earpiece (or even an old m/c microphone) will serve as the loudspeaker, and with the advent of transistors and deaf-aid components a set which would really fit into the "radiogram" cabinet might well be designed. Alternatively, a little judicious cheating is permissible with the larger components hidden behind the breast of the fireplace or even at the back of the scene. There is still time to get one ready as a Christmas present for a special friend. A small ceiling light could be fitted. Thus one

Variety

Of the many readers who wrote on the type of articles they like in *R.C.* and its general policy, all praised its wide range of subjects and many say they would like to see an even wider field. A South Australian reader, Mr. E. M. P. Wells of 59 Scottish Avenue, Clovelly Park, suggests we might emulate the Australian *Radio and Hobbies* magazine. For British readers unfamiliar with this magazine, I might mention that up to half its contents are given over to articles of scientific interest. Occasionally such subjects as astronomy are covered, but in these days of radio-equipped sputniks perhaps the latter is not really so remote from our hobby after all.

He would like to hear of readers' experiences on the efficient frequency range of transistors and also their employment in hi-fidelity circuits. He does not like ultra-miniaturisation (matchbox sets, etc.) but readily appreciates that other readers do. One of the chief reasons for his interest in transistors is on account of the exorbitant cost of batteries "down under." Readers who do see copies of Australian magazines are invariably horrified at the prices of all radio gear, many items costing more than double the list price in U.K. and then gaily advertised as bargains. If you are thinking of emigrating to Australia, take as much gear as you can carry.

He also asks about projection t.v. Am afraid, OM, interest over here has largely languished chiefly on account of cost, and with many others I personally feel that the "eventual" t.v. receiver will be in the form of a flat picture to be hung on the wall or stood on the mantelshelf.

Reely!

To get round to other correspondents. From P.M. (Gainsborough) comes a complaint. He writes: "Recently you said you were open to receive readers' criticisms. Here is one, and an important one, I think. Insist that all set designers stick to coils of well-known and easily obtainable makes. This business of so many turns of 32 s.w.g. enamelled on a ½in former is both irritating and expensive. It is almost impossible nowadays to buy either the wire or a former without a lot of trouble. In any case you have to buy far more wire than you need and the rest of it is usually waste. Even if the gauge happens to be right for the next winding job, the specification is sure to call for either silk or cotton-covered. Because of this silly practice I have already collected half-a-dozen reels which, as far as I can foresee, are useless. In any case the ready-made coils are cheaper than buying the wire. Otherwise the magazine is all right but more articles on refinements such as magic eyes, tuning meters, remote control, noise suppression, etc. would further improve it."

In Brief

Further opinions on the question of club gramophone records serve to confirm those summarised last month. I gratefully acknowledge views and opinions from E.J.N. (Clayton, Newcastle, Staffs.), D.L.A. (Essex Road, Gravesend), E.A.S. (Branksome Park, Bournemouth), R.A.N. (Sidcup), T.H.S. (Slough) and regret my inability to reply to them in detail.

My recent comments on that happy outcome of our hobby, a very real international fraternal spirit, brings further news from our good friend, G. A. Partridge (G3CED) of the widening activities and world-wide expansion of the International Ham Hop Club of which he is the hon. secretary. Through the medium of the club many pleasant individual international friendships have been formed, mutual holidays planned and exchange hospitality arranged.

A more recent introduction is the Friendship Link which is now in operation to enable local clubs to form a link with a similar club overseas. Group membership of the H.H.C. is not essential. I know that the ideas both of individual and club schemes will commend themselves to home and overseas readers, and would remind those interested that G3CED's address is 17 Ethel Road, Broadstairs, Kent. He will be pleased to supply full details.

What's My Line?

A.G. of Ewell asks, in a cheery letter: "I have often been amused by some of the sub-headings you use. They remind me of the sub-titles used for the small news items on the front page of the London *Evening News*. You wouldn't happen to be the same chap, would you?" The answer, I am afraid, is no, but on A.G.'s recommendation I am considering applying for the job when it falls vacant.

Finally R.M., of Dorking, another of the Old Timer school, writes: "How thankful I am that I kept up my interest in the technical side of radio. The t.v. programmes are so dull (except for sport and outside broadcasts) that I should be bored to death if I couldn't get some fun out of constructing, adjusting and experimenting, which is more than most licence-holders get. As for the plays—most of them are feeble, especially those written 'specially for t.v.'—a phrase I've learned to dread. Produced for any form of entertainment for which an admission fee is charged, the customers would want their money back—and if they didn't get it they would be justified in wrecking the theatre."

FM facilitated

BY A. S. CARPENTER

A suitable and economically-made amplifier for use with a modified RF27 unit

THE V.H.F. SERVICE DOES MAKE QUALITY listening possible—provided well-set-up apparatus is used at the receiving end—and many and varied are the tuners available either ready made or in kit form. FM equipment must, however, comprise something more than merely a tuner, and the overall expense entailed is not negligible.

To the unwealthy would-be listener the RF27 unit can be highly recommended as a "front end," only small modifications being required; and as the unit is a powerful one it is well suited to use in fringe areas. An article giving the necessary alterations appeared in an earlier issue of this journal[1], but although no actual details were given regarding the i.f. strip this may well conform to a standard design and, provided B7G-based valves and miniature i.f. transformers are used, ample erection space exists on the side flange of the unit. A suitable i.f. strip is illustrated in Fig. 4 (which has been approved by Denco (Clacton) Ltd.) and no problems should arise regarding its construction. It is interesting to learn that the ratio discriminator transformer specified is now obtainable in a can 1in square as opposed to the original size of 1⅜in. FM alignment has been adequately dealt with in previous issues[2] and will not be repeated here.

When this has been done—and provided some means of powering the apparatus has been found—one may then feed the output into the gram. sockets of a broadcast receiver, but as this is not always convenient, or desirable, some other method must be adopted.

Unfortunately, not everyone can afford a push-pull amplifier; and assuming that none such is available—or likely to be due to the

[1] "The Radio Constructor", January 1957.

[2] "The Radio Constructor", June 1955; August 1956.

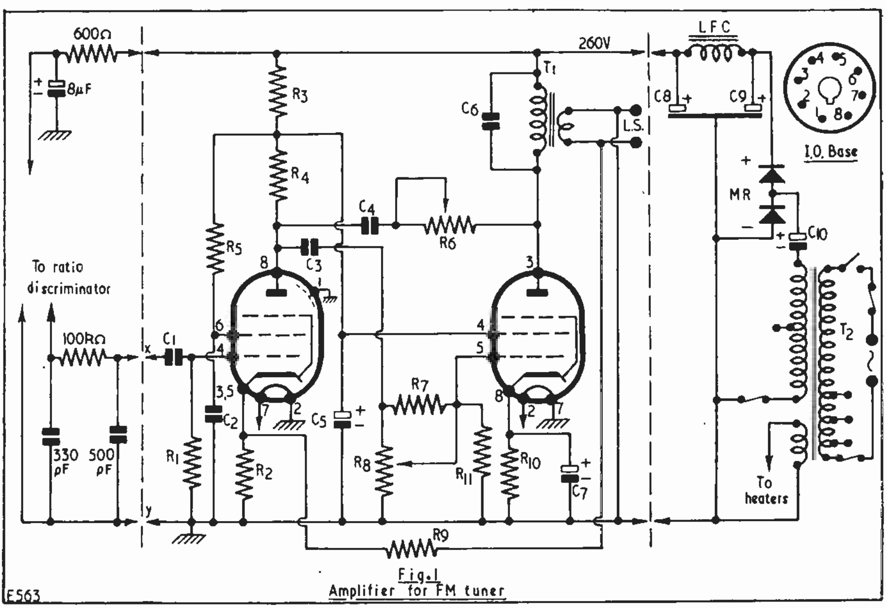


Fig. 1
Amplifier for FM tuner

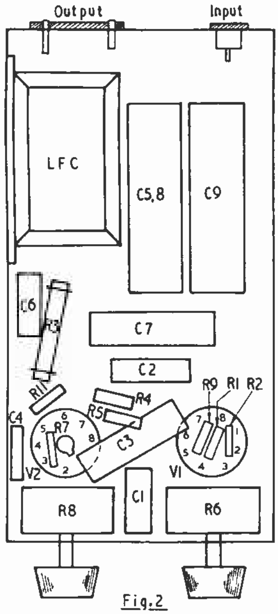


Fig.2
Amplifier layout below chassis

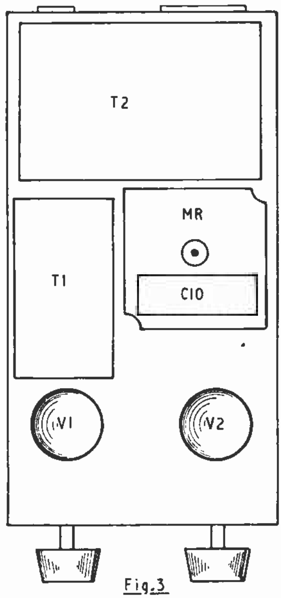


Fig.3
Amplifier layout above chassis

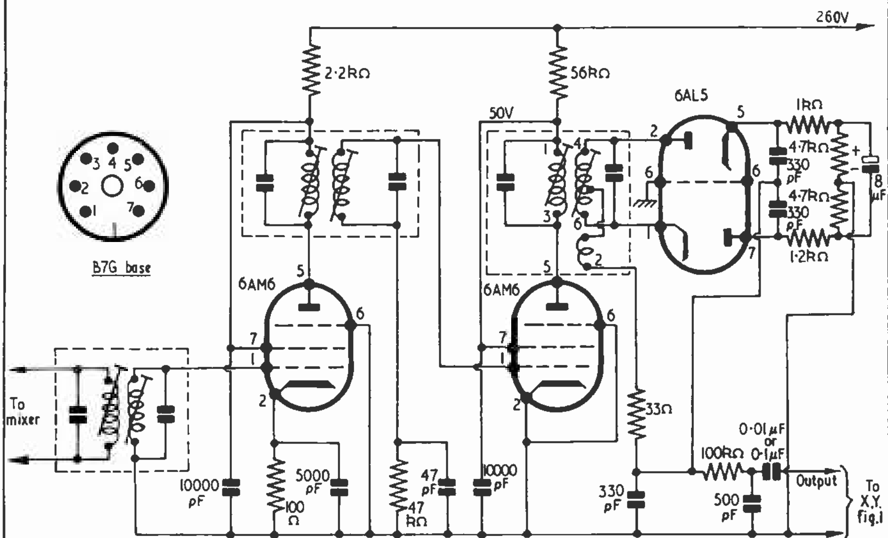


Fig.4
A suitable I.F./discriminator strip for use with the equipment

E564

expense already entailed—one could do worse than use something like that depicted in Fig. 1, which, please note, will stand most conveniently beside the RF unit due to both chassis being the same size—or the two may be bolted together and panelled.

The output from this comparatively inexpensive amplifier is considerably more than that generally required—even when the tone control is turned full travel—and sufficient space exists on the same chassis for a power supply so that the whole equipment becomes compact and self-contained. Quality is excellent, and will be found superior to that obtainable from the average domestic receiver.

The amplifier proper—contained between the two vertical broken lines in the diagram —has its actual input points marked "X" and "Y"; but the preceding de-emphasis network is shown as component values are chosen to permit the amount of "top" required. It has also been found beneficial, in this case, to place the volume control in the grid circuit of V_2. Since a small, self-contained speaker is inadequate, provision is made for an external unit, that used by the author being a 10in model, baffle mounted.

The power supply section is shown merely for interest since a voltage multiplying circuit is used in conjunction with a centre tapped rectifier and a surplus mains transformer that failed to supply sufficient "push" in any other way except auto-connected: as the latter method meant a live chassis the idea was discarded. As it stands, 290 volts are available at C_9, of which 30 volts are dropped across the choke leaving sufficient to maintain the current of 100mA demanded by the complete equipment. Anyone wishing to duplicate the supply arrangements should ensure that the mains transformer secondary can cope without overheating, and adequate fuses should be incorporated. The value of C_{10} (which must not be a canned type) should be chosen in relation to that of C_9 and although complete doubling is not possible with this configuration, the voltage made available does tend to increase as the value of C_{10} approaches that of C_9.

Component values specified for the amplifier section should be closely adhered to, and provided the h.t. rail is maintained at the voltage shown the overall response will be found remarkably good, low distortion resulting from the use of proportioned negative feedback.

Layout diagrams for the amplifier are illustrated in Figs. 2 and 3.

List of Components for the Amplifier

(Component values for the i.f. strip are shown in Fig. 4).

Capacitors

$C_{1, 2, 3}$	0.1μF
$C_{4, 6}$	2,000pF
$C_{5, 8}$	12+12μF electrolytic 500V
C_7	50μF electrolytic 50V
C_9	32μF electrolytic 500V
C_{10}	8μF electrolytic 500V

Resistors

R_1	4.7MΩ
R_2	100Ω
R_3	4.7kΩ, 1 watt
R_4	100kΩ
R_5	470kΩ
R_6	2MΩ pot
R_7	10kΩ
R_8	2MΩ pot with switch
R_9	4.7kΩ
R_{10}	470Ω, 1 watt

Transformers

T_1	Output transformer to match 6V6 to required speech coil.
T_2	See text, or input: 230V; output: 275–0–275V at 100mA, 6.3V at 3 amps

M.R.—See text, or 6X5 valve rectifier

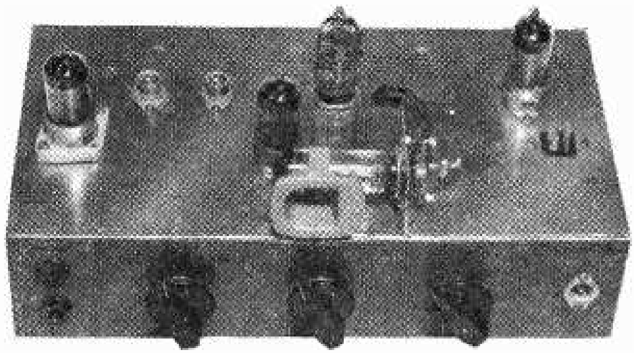
Valves

V_1	6SH7
V_2	6V6

Miscellaneous

LFC—Miniature choke: 10 henry, 100mA
I.O. valve bases (2)
Coaxial plug and socket, Belling-Lee
Control knobs (2)
Fuses, wire, nuts, screws, etc.
Chassis—8in x 4¼in x 1¾in

The MULLARD TAPE AMPLIFIER "Type C"



PART 1

Described by R. H. WEBB

There is no doubt that there is considerable attraction in being able to make one's own recordings of events, whether they be personal ones or those of general public interest. The tape recorder with its associated recording and play-back amplifier makes it possible for the home constructor, with a moderate amount of knowledge and skill, to take advantage of this particular form of entertainment which can be used for simple pleasure purposes or for more serious occasions. Amateur cine operators have a use for a tape recorder for adding their own comments to home movies. Again, radio broadcasts can be transcribed into a tape recording and replayed indefinitely, whilst the possibilities of borrowing good records for an evening in order to make your own permanent recording for future replaying must not be overlooked. For business use, of course, the usefulness of the tape recorder is only too well known, use being made of the fact that messages and instructions can be left "on tap" for action to be taken in the principal's absence. A very good range of pre-recorded tapes can also be obtained covering a field which will adequately cover the needs of high and low brow alike.

Considering the above and many other uses of a tape recorder, it will be realised that certain of these functions can best be catered for by specially designed equipment. For example, for the sake of portability one would be prepared to accept a few less features such as lower output and, to a certain extent, quality of reproduction. In this connection it is only fair to state that some portable recorders achieve a sufficiently high standard of reproduction to satisfy most listeners, but there is always a case for getting the very best out of the recording, and it is here that a combination of high quality tape pre-amplifier and main amplifier can be used to obtain a really full frequency range of reproduction. Before embarking on a programme of building equipment, consider first the prime requirement, which is to be sure that the loudspeaker you use is capable of satisfactorily reproducing the full range of frequencies that the amplifier and recording apparatus pass to it. At the upper frequencies you may be content if the speaker manufacturers quote a limit of 16,000 cycles per sec. which will ensure that your keenest listeners will hear the 14,000 c/s you might expect them to claim as being their upper limit. At the lower end be satisfied with 40 cycles per sec. otherwise you will find yourself spending considerable time trying to eliminate various very low frequency noises between 20 and 40 c/s. which need not bother you when seeking normally good full frequency reproduction.

For such a "hi-fi" recorder and amplifier as that about to be described, a further requirement is a good high quality main amplifier, and the amplifier for which the

"Type C" was intended is the well-known Mullard "5-10," although other main amplifiers may be used provided they are accepted as reproducing the correct degree of high quality.

Power supplies for the main amplifier are, for the purposes of this article, taken as being available whilst supplies for our tape pre-amplifier will be described as a separate unit, a note being included regarding the requirements of certain tape decks.

to the existing gramophone pick-up and/or radio input sockets. A standard "5-10" with single input facilities only can most conveniently be converted for general use by re-building the front end to incorporate the "Versatile 2-Valve Audio Pre-Amplifier" described in the March 1958 *Radio Constructor*, and which is now obtainable as a booklet, reference RR7 (price 1s., postage 2d.) from the publishers of this journal. Various other forms of pre-amp. for the "5-10" are available, some of which include a "Tape" input position and most of which would be suitable to link the facilities shown in the block schematic diagram, Fig. 1.

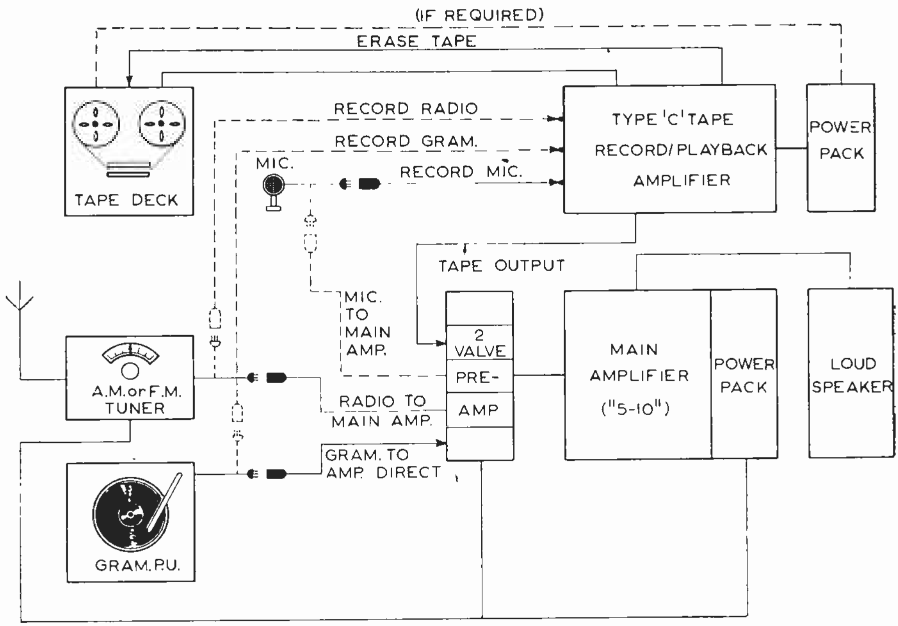


FIG. 1

Block schematic diagram of all facilities available with equipment described. (Note: Dotted lines indicate alternative connections.)

Various tape decks will be mentioned, there being no particular preference indicated, the choice being left entirely to the reader to suit his pocket and his own equipment housing requirements. This should present little individual difficulty as the specification of the "Type C" amplifier includes all the necessary switching arrangements in respect of tape speed and the accompanying equalisation.

On the assumption that the reader already possesses a main amplifier in the form of a Mullard "5-10," provision for a tape input is required on the main amplifier in addition

A 3-valve pre-amp. will be described later which embodies a "Programme Recording Outlet" in addition to the normal pre-amp. output socket. This will enable the input signal which is being recorded to be fed into the appropriate pre-amp. channel and then via the "Programme Recording Outlet" on the pre-amp. to the tape amplifier input circuit, thereby providing a monitoring facility which is very often desirable if only

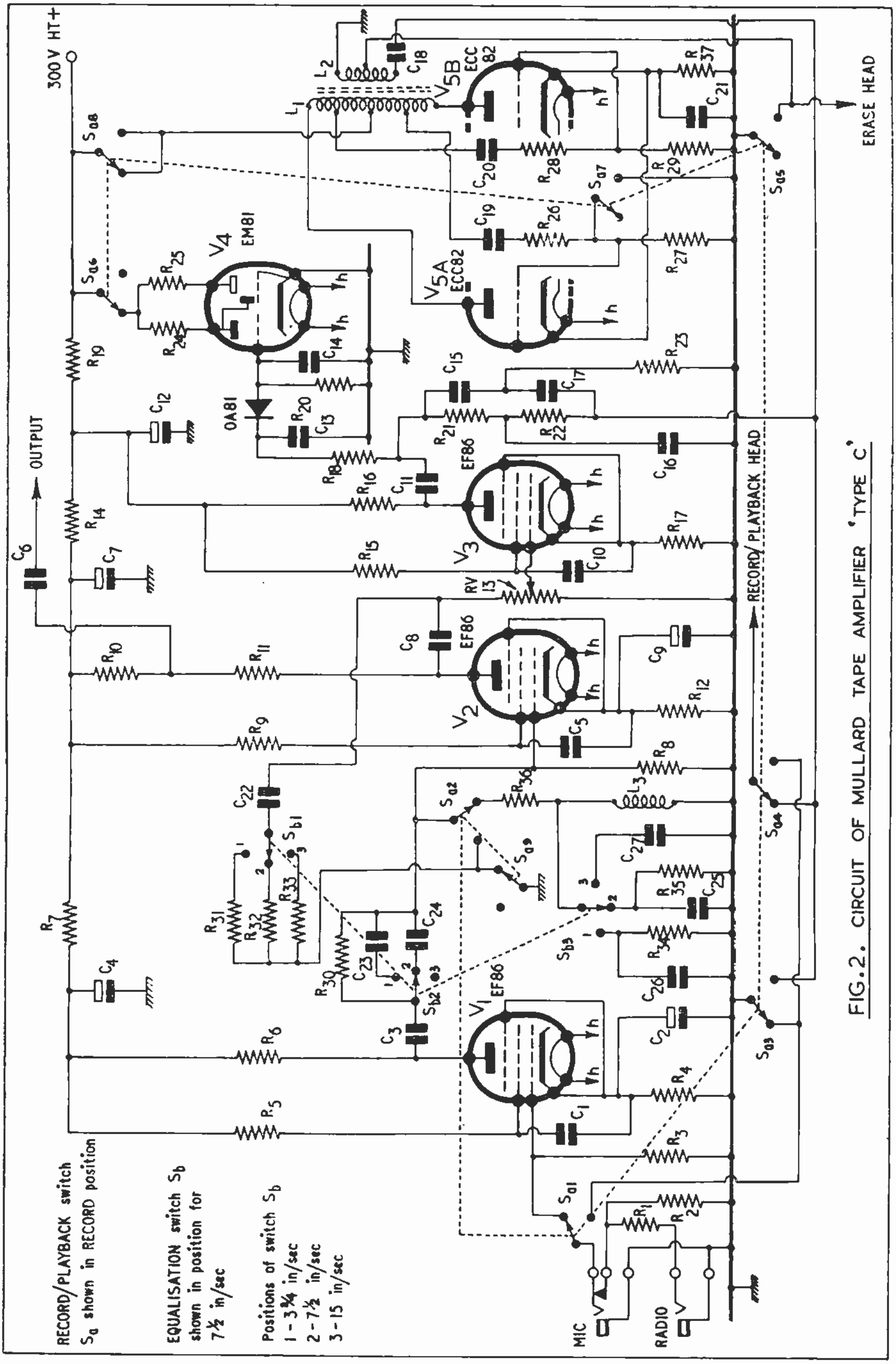


FIG. 2. CIRCUIT OF MULLARD TAPE AMPLIFIER 'TYPE C'

List of Component Values for Type C Amplifier

Resistors

R_1 680kΩ ±10% $\frac{1}{4}$W
R_2 5.6kΩ ±10% $\frac{1}{4}$W
R_3 2.2MΩ ±10% $\frac{1}{4}$W
[1]R_4 2.2kΩ ±5% $\frac{1}{2}$W
[1]R_5 1MΩ ±5% $\frac{1}{2}$W
[1]R_6 220kΩ ±5% $\frac{1}{2}$W
R_7 33kΩ ±10% $\frac{1}{4}$W
R_8 1MΩ ±10% $\frac{1}{4}$W
R_9 390kΩ ±10% $\frac{1}{4}$W
[2]R_{10} 18kΩ ±10% $\frac{1}{2}$W
[2]R_{11} 82kΩ ±10% $\frac{1}{4}$W
R_{12} 1kΩ ±10% $\frac{1}{4}$W
RV_{13} 500kΩ logarithmic 10% law; carbon potentiometer
R_{14} 27kΩ ±10% $\frac{1}{4}$W
R_{15} 220kΩ ±10% $\frac{1}{4}$W
R_{16} 68kΩ ±10% $\frac{1}{4}$W
R_{17} 1kΩ ±10% $\frac{1}{4}$W
R_{18} 470kΩ ±10% $\frac{1}{4}$W
R_{19} 10kΩ ±10% $\frac{1}{4}$W
R_{20} 1MΩ ±10% $\frac{1}{4}$W
R_{21} 56kΩ ±10% $\frac{1}{4}$W
R_{22} 56kΩ ±10% $\frac{1}{4}$W
R_{23} 27kΩ ±10% $\frac{1}{4}$W
R_{24} 560kΩ ±10% $\frac{1}{4}$W
R_{25} 150kΩ ±10% $\frac{1}{4}$W
R_{26} 4.7kΩ ±10% $\frac{1}{4}$W
R_{27} 22kΩ ±10% $\frac{1}{4}$W
R_{28} 4.7kΩ ±10% $\frac{1}{4}$W
R_{29} 22kΩ ±10% $\frac{1}{4}$W
R_{30} 390kΩ ±10% $\frac{1}{4}$W
R_{31} 2.7MΩ ±10% $\frac{1}{4}$W
R_{32} 1.2MΩ ±10% $\frac{1}{4}$W
R_{33} 680kΩ ±10% $\frac{1}{4}$W
R_{34} 150kΩ ±10% $\frac{1}{4}$W
R_{35} 470kΩ ±10% $\frac{1}{4}$W
R_{36} 27kΩ ±10% $\frac{1}{4}$W
R_{37} 680Ω ±10% 1W

[1] *High stability.*

[2] *Values may be adjusted to vary output impedance.*

Capacitors

C_1 0.5μF, paper, 350V
C_2 50μF, electrolytic, 12V
C_3 0.1μF, paper, 350V
C_4 8μF, electrolytic, 350V
C_5 0.1μF, paper, 350V
C_6 0.1μF, paper, 350V
C_7 8μF, electrolytic, 350V
C_8 0.1μF, paper, 350V
C_9 50μF, electrolytic, 12V
C_{10} 0.5μF, paper, 350V
C_{11} 0.1μF, paper, 350V
C_{12} 16μF, electrolytic, 350V
C_{13} 18pF, silvered mica
C_{14} 0.05μF, paper, 150V (Min.)
C_{15} 47pF, silvered mica
C_{16} 100pF, silvered mica
C_{17} 47pF, silvered mica
C_{18} 56pF, silvered mica, 350V
C_{19} 0.005μF, paper, 350V
C_{20} 0.005μF, paper, 350V
C_{21} 0.1μF, paper
C_{22} 82pF, silvered mica
C_{23} 180pF, silvered mica
C_{24} 82pF, silvered mica
C_{25} 390pF, silvered mica
C_{26} 2,200pF, silvered mica
C_{27} 100pF, silvered mica

Inductor

L_3 Mullard Ferroxcube wound pot core type WF816

Oscillator Coil

L_1, L_2 Mullard Type WF1388

Valves and Germanium Diode

V_1 Low noise pentode, Mullard type EF86
V_2 Low noise pentode, Mullard type EF86
V_3 Low noise pentode, Mullard type EF86
V_4 Tuning indicator, Mullard type EM81
V_5 Output triode, Mullard type ECC82
MR Germanium diode, Mullard type OA81

Miscellaneous

Recessed coaxial output socket. Belling Lee L/734/S
Record/playback head coaxial socket. Belling Lee L/604/S
Erase head coaxial socket. Belling Lee L/604/S
Supply input socket. Elcom PO4
Input jack (radio). Igranic P71
Input jack (microphone). Igranic P72
B9A valveholder (two). McMurdo BM9/U
B9A nylon-loaded valveholder with screening skirt (two). McMurdo XM9/UC1, skirt 811
B9A nylon-loaded valveholder with screening skirt and flexible mounting. McMurdo XM9/UG1
Record/playback switch SA
Shirley Laboratories Ltd., 16370/B3
Specialist Switches, SS/567/A
Equaliser switch SB, 3-pole, 3-way
Specialist Switches, SS/567/D
Five-way tagboard (one). Bulgin C120
Ten-way tagboard (three). Bulgin C125
Ceramic stand-off insulator (three). Must be capable of withstanding 350V

for editing purposes. In this event the main amplifier is utilised with the input to it at recording level.

The tape amplifier about to be described first appeared in the Mullard booklet "Circuits for Tape Recorders" (issued in 1956), and was called the "Type B" amplifier. A second version appeared in August 1957 called the "Type C," and whereas treble equalisation in the "Type B" was obtained by twin-T networks in the negative feedback loop using a series of plug-in units for the components, the "Type C" uses a passive attenuator comprising a non-adjustable Ferroxcube pot core inductor in a resonant circuit, adjustment for different tape speeds being effected by switching in the values of capacitance in the resonant circuit. The greater flexibility of the treble boost in the "Type C" amplifier allows better control of the complete frequency response and the reproduction of slightly higher frequencies. An EL84 valve was used as an H.F. oscillator to provide bias and erase current in both the "Type B" and first "Type C" amplifiers. In the present version, here described, this function is performed by an ECC82 double triode, the new circuit being arranged to work in push-pull using a Ferroxcube cored oscillator transformer which it is intended shall be universally suitable for a number of tape deck playing and recording heads.

Description

The tape recording amplifier here described is intended to be used in conjunction with a high-quality pre-amplifier and power amplifier. The unit combines the function of both recording and playback amplification, although, in the playback operation, it acts only as an equalising stage, giving sufficient output to drive the high-quality system.

The general principle of the design has been to preserve simplicity as far as is compatible with high-quality performance. The distortion introduced in the recording channel has been reduced to such an extent that it is probable that the quality of performance will be limited only by the magnetic tape itself, provided, of course, that the tape deck used is of satisfactory performance. The level of total harmonic distortion in the recording process should not be greater than 0.5% with a recording current of 150μA through the head.

Equalisation to correct for head and tape characteristics is provided for each of the tape speeds: 3¾, 7½, and 15 inches per second. The high-frequency equalisation is applied during the recording process and the low-frequency during playback.

Treble equalisation is achieved by using a Ferroxcube pot core inductor in a resonant circuit between the first and second stages of the amplifier. The frequency at which maximum treble boost occurs is determined by the tuning capacitance which can be adjusted by the switch SB_3. The value of resistance in the feedback network to give bass equalisation during playback is selected for each tape speed by the switch SB_1.

There is no provision for tone control in the Type C amplifier. It is anticipated that such control will be available with the associated amplifier.

PERFORMANCE CHARACTERISTICS

Frequency Response

The overall response of the recorder depends on the type of head used, the magnitude of the bias current, and, to some extent, on the tape employed. The low-frequency response depends on the amplifier used rather than on the type of head, and in this design, it will not be more than 3dB down at 50 c/s. The high-frequency response depends on the tape speed and the gap width of the head. With heads having a gap width of 0.005in, the following performance can be obtained:

15in/sec	±3dB (relative to the level at 1 kc/s) from 50 c/s to 17 kc/s
7½in/sec	±3dB (relative to the level at 1 kc/s) from 50 c/s to 12 kc/s
3¾in/sec	±3bB (relative to the level at 1 kc/s) from 50 c/s to 5 kc/s

Greater flexibility is achieved in the treble boost circuits of the Type C amplifier compared with those of the original Type B unit. Consequently, better control of the complete response of the amplifier is possible, and equalisation to slightly higher frequencies is practicable. However, these improvements depend on the individual adjustment of component values to suit the head and tape being used. The component values given in this article apply only to the amplifier when it is used with E.M.I. recording tape and a Collaro tape transcriptor.

Ferroxcube pot cores are adequately screened to prevent excessive hum or stray bias being picked up, and they do not appear to cause more circuit-ringing than R-C networks which will produce the same treble boost.

The playback characteristic of the amplifier conforms to the specification of the International Radio Consultative Committee (C.C.I.R.), thus permitting excellent reproduction of pre-recorded tapes. The recording characteristic is arranged to give a flat frequency response in conjunction with this playback characteristic. Additional head losses occurring during playback will normally be capable of correction by the tone controls situated in the associated amplifying systems.

Sensitivity

The sensitivity of the recording process is measured with the control RV_{13} set for maximum gain. This, of course, does not apply to the playback sensitivity because the gain control is not operative at the point from which the output is taken for the associated equipment.

Recording Sensitivity

(measured at 1 kc/s, with recording-head audio current of 150μA)

(*a*) Microphone input: (impedance=2MΩ)	0.5mV for peak recording level
(*b*) Radio input: (impedance=700kΩ)	65mV for peak recording level

Playback Sensitivity

(measured at 5 kc/s for each tape speed for output of 300mV)

(*a*) 15 in/sec: 5.5mV
(*b*) 7½in/sec: 2.4mV
(*c*) 3¾in/sec: 1.0mV

CIRCUIT DESCRIPTION

The circuit diagram of the combined record/playback amplifier is given in Fig. 2. The record/playback switch SA is shown in the "record" position and the equaliser switch SB is in the position for equalisation at a tape speed of 7½ inches per second. The output during playback is taken from the anode of the second EF86, and the remaining stages are used only for the recording operation.

Controls

Two switch banks are used in the amplifier. Switch SA provides the change from the recording to the playback process, and switch SB provides equalisation appropriate to one of the tape speeds: 3¾, 7½ and 15 inches per second.

The gain control RV_{13} is the only other control in the amplifier.

Valve Complement

The complete amplifier uses five Mullard valves and one Mullard germanium diode. These are:

(*a*) Type EF86, low noise pentode, used in the input stage.
(*b*) Type EF86, used in the second stage.
(*c*) Type EF86, used in the output stage for recording.
(*d*) Type ECC82 (double triode), used as an oscillator for the bias and erase currents.
(*e*) Type EM81, tuning indicator, used in the recording level stage.
(*f*) Type OA81 germanium diode, used as the indicator-circuit rectifier.

Input Stage

The pentode, type EF86, acts as a voltage amplifier for both recording and playback processes. It is possible to record from either microphone or radio sources, the radio input also being convenient for recording from crystal pick-ups. Both inputs are fed to the grid of the valve, the radio input being attenuated to the level of the microphone input. The switching is achieved by inserting the jacks: thus only one input may be used at a time.

Equaliser Stage

As was stated above, no tone control is incorporated in this stage. The output is taken during playback from across part (R_{10}) of the anode load of the EF86. The output supplied is 300mV at a source impedance of 20kΩ. A rearrangement of the anode load resistance (that is, R_{10} and R_{11}) can be made, if required, to give an output of, for instance, 1V at a source impedance of 60kΩ.

The output of the second stage of the amplifier is fed during the recording process from the anode of the EF86 by way of the gain control of RV_{13} to the grid of the following EF86.

As previously explained, a resonant-circuit containing a Ferroxcube pot core inductor L_3 is used to provide treble equalisation. The value of tuning capacitance in the resonant circuit is selected by the switch SB_3 to give the maximum treble boost at frequencies appropriate to the tape speed used. The extent of treble boost is controlled by the resistor R_{30} and the damping resistors R_{34} and R_{35} connected in parallel with the capacitors C_{26} and C_{25}. The steep rise in boost which occurs below the resonant frequency is modified by damping the inductance, and by partially shunting the resistor R_{30} at the appropriate frequency.

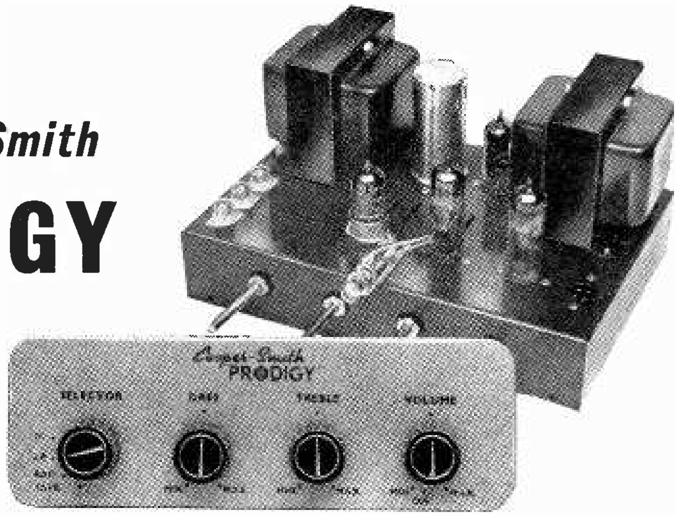
The values of the resistors R_{31}, R_{32} and R_{33} arranged on switch SB_1 have been chosen to give appropriate feedback for bass equalisation during playback.

Recording Output Stage

The third stage of the unit, operative only during the recording process, uses another EF86, the grid of which is fed from the gain control RV_{13}. The stage is designed to give low harmonic distortion at peak levels of recording current, and the distortion should not exceed 0.5% for a recording current of 150μA.

The recording current is fed to the recording head by way of a parallel-T network, which acts primarily as a bias-voltage rejector circuit. The series resistance of the network is needed in this stage to ensure a constant current drive to the head, and its inclusion is also desirable to preserve a satisfactory a.c./d.c. load ratio for the EF86 of the third stage. *continued on page* 297

The Cooper-Smith PRODIGY 6-watt high fidelity AMPLIFIER



PART 2

Described by J. COOPER

Construction

Building the amplifier should be done in stages as detailed below. Although this makes the drawings very easy to follow, experience shows that most failures are due to errors and omissions in wiring, and it is strongly recommended that the point-to-point checks be used as each stage is completed.

For soldering use a small iron and resin-cored solder. Do *not* use liquid flux such as Baker's Fluid. After soldering each joint, give the wire a tug to ensure that a proper electrical connection has been made.

Where several wires are taken to the same solder tag, it is usually advisable to delay the actual soldering until they are all in position rather than to solder each wire separately. Make sure, however, that all the wires *are* soldered. Keep all wires and components clear of each other.

Stage 1.—Mount all components shown on drawing, starting with T_1 and T_2.

NOTE.—All valveholders must be fitted with the blank position towards the left of the chassis (marked L on drawing). V_1 is fitted on top of the chassis, the others underneath. Do not pull tags out of alignment (a good idea is to insert an old valve while wiring). It is advisable to solder about an inch of the 16 gauge wire provided for the busbar to the spigot of each holder before fitting. The busbar can then be soldered to the ends of these when wiring up.

Position the transformers in relation to the colours of the leads. Use long screws where shown when fitting. Fit solder (earthing) tag on T_2 and radio input socket retaining screws where indicated.

Smoothing Capacitor (50–50μF) fixing plate should be underneath chassis. The red dot must be nearest right of chassis. Twist lugs to secure.

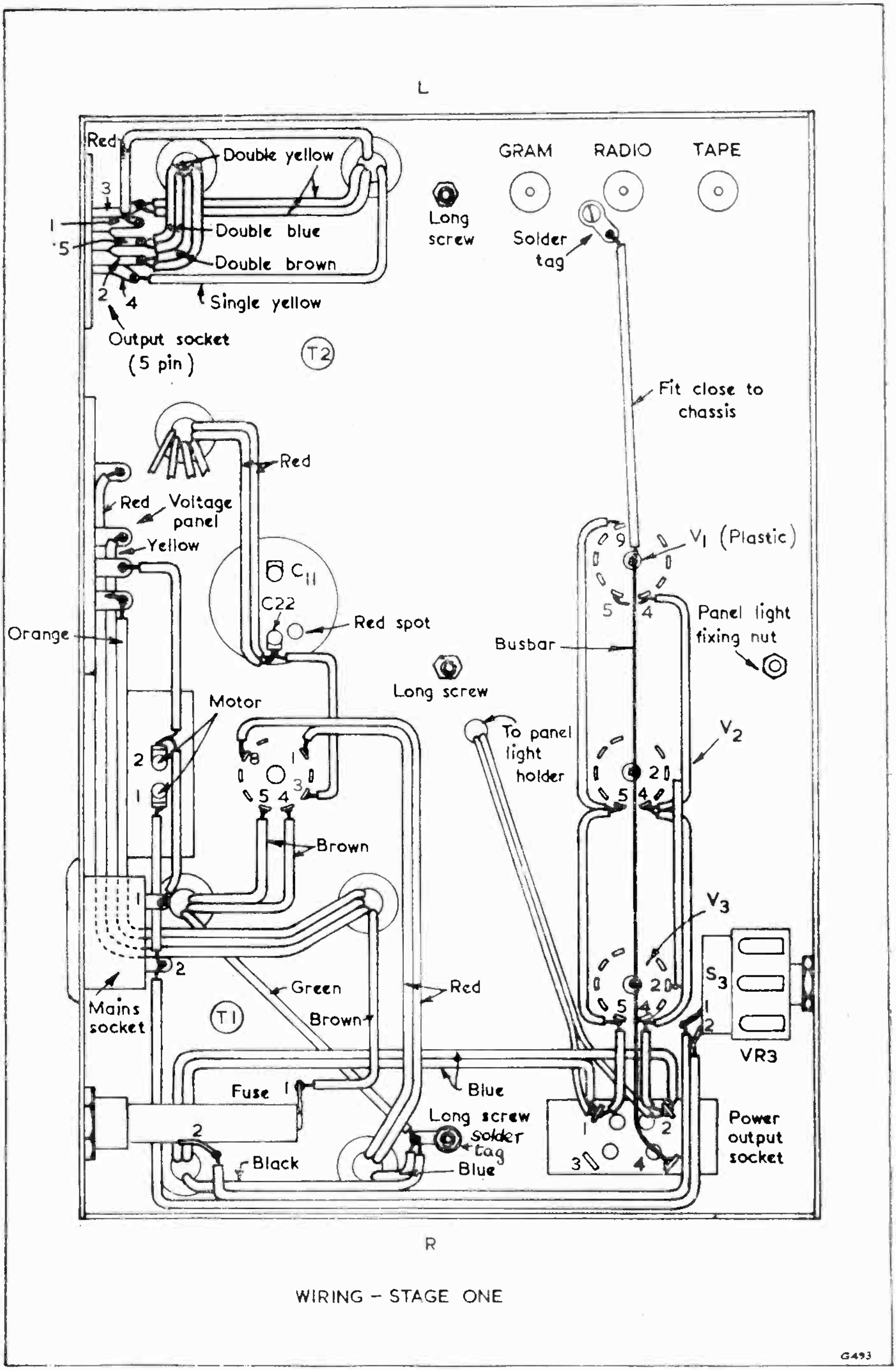
The Voltage Selector panel should have the larger solder tags furthest from top of chassis.

Bend tag 1 of fuse holder at 90°.

When fitting potentiometers allow only just sufficient thread to protrude through chassis so as to provide maximum clearance between potentiometers and chassis. *Only the two solder tags shown on the drawing on S_3 are used. (VR_3).

The output socket should be fitted so that the wider spaced pins are nearest to the top of chassis.

Wire up as shown, using sleeving where indicated. Make sure that all enamel is removed from transformer leads and that each wire is properly



WIRING – STAGE ONE

tinned. Leads are shown parallel in the drawing for the sake of clarity but they may, of course, be twisted together if desired.

Input sockets. Care must be taken that the iron is not left too long on these components as this will soften the plastic. (Insert plug before soldering.)

Green lead (electrostatic shield)—solder (earth) tag.

T_1 Secondary:

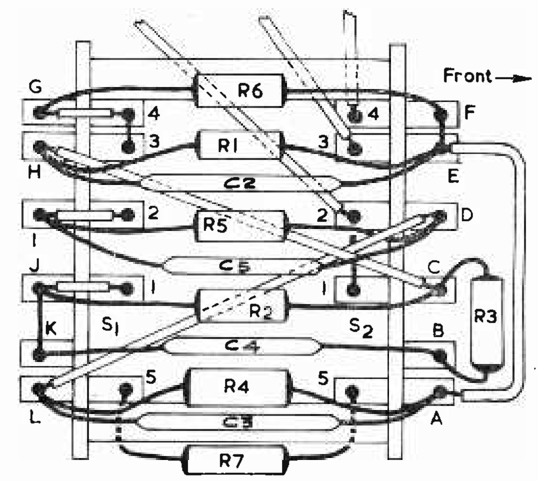
Twin brown leads—4 and 5 on V_4

Twin red leads—1 and 8 on V_4

Black lead—solder tag

Blue lead—solder tag

Twin blue leads—1 and 2 on power output socket.



WIRING - STAGE TWO (SWITCH)

G494

Valveholders:

9 on V_1—5 on V_2 and V_3—1 on power output socket

4 and 5 on V_1—4 on V_2 and V_3—2 on power output socket

3 on V_4—C_{22}

Mains input:

1 on mains socket—1 on motor socket

2 on mains socket—2 on motor socket

1 on mains socket—2 on S_3

2 on motor socket—Common on selector panel

2 on fuse holder—1 on S_3

Solder tag on RADIO input socket—spigots on V_1, V_2, V_3—4 on power output socket

Twin flex from 1 and 2 on power output socket—Panel lamp holder.

POINT-TO-POINT CHECK

Stage 1

T_2 Secondary:

Double yellow lead—3 on output socket (wide spacing, L)

Single yellow lead—4 on output socket (wide spacing, R)

Red lead—1 on output socket (narrow spacing, L)

Double brown lead—2 on output socket (narrow spacing R)

Double blue lead—5 on output socket (centre)

T_2 Primary:

Twin red leads—C_{22} (red spot)

T_1 Primary:

Red lead—240V on selector panel

Yellow lead—220V on selector panel

Orange lead—200V on selector panel

Brown lead—1 on fuse holder

Stage 2.—Wire up the selector switch, including wires to input sockets.

NOTE.—Only the inner tags are part of the switch, the outer ones being merely anchor points for the components.

POINT-TO-POINT CHECK

Stage 2

3–4 on S_1—G

2 on S_1—I

1 on S_1—J—K

H—C

L—D

F—E—A

1—2 on S_2

5 on S_1—R_7—5 on S_2

L—C_3 and R_4 —A

K—C_4—B

J—R_2—C

I—C_5 and R_5—D

H—C_2 and R_1—E

G—R_6—F
C—R_3—B

Stage 3.—Mount the rest of the components.

NOTE.—The solder tags on the selector switch are nearest the chassis and care must be taken that these do not touch the latter.

Wire up as shown. Make the connection from pin 7 on V_1 first, taking it close to the chassis then up to tag 5 on S_1. Next in order should be all capacitors.

POINT-TO-POINT CHECK

Stage 3

2 on S_2—GRAM
3 on S_2—RADIO
4 on S_2—TAPE
5 on S_1—7 on V_1
A on selector switch—C_9—3 on VR_1
A on selector switch—R_{16}—3 on VR_2
1 on VR_2—C_{14}—2 on VR_2
2 on VR_2—C_{13}—3 on VR_2
2 on VR_2—R_{15}—2 on VR_1
2 on V_1—2 on VR_1
1 on V_1—C_{12}—3 on VR_3
1 on VR_3—R_{19}—2 on VR_3
1 on VR_1—C_{10}—1 on VR_3
5 on S_1—R_8—busbar
1 on VR_2—R_{17}—busbar
1 on V_3—2 on VR_3
1 on VR_3—busbar

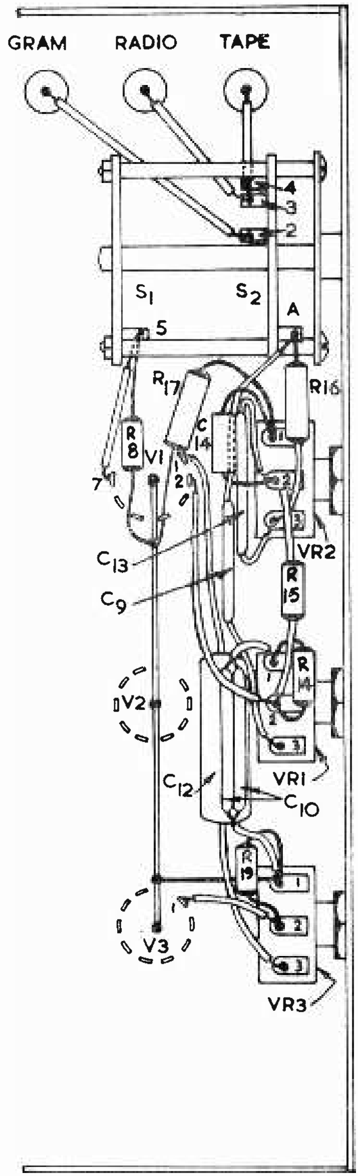
Stage 4.—Insert capacitors and resistors through rivets on group board (also straps on 21 and 24) as shown, and bend wire outwards (1). Turn group board over (making sure it is the right way round) and wire up as shown (2). Group board may be marked A and B, 1–26 to facilitate wiring.

NOTE.—Keep R_{24} clear of group board and other components.

POINT-TO-POINT CHECK

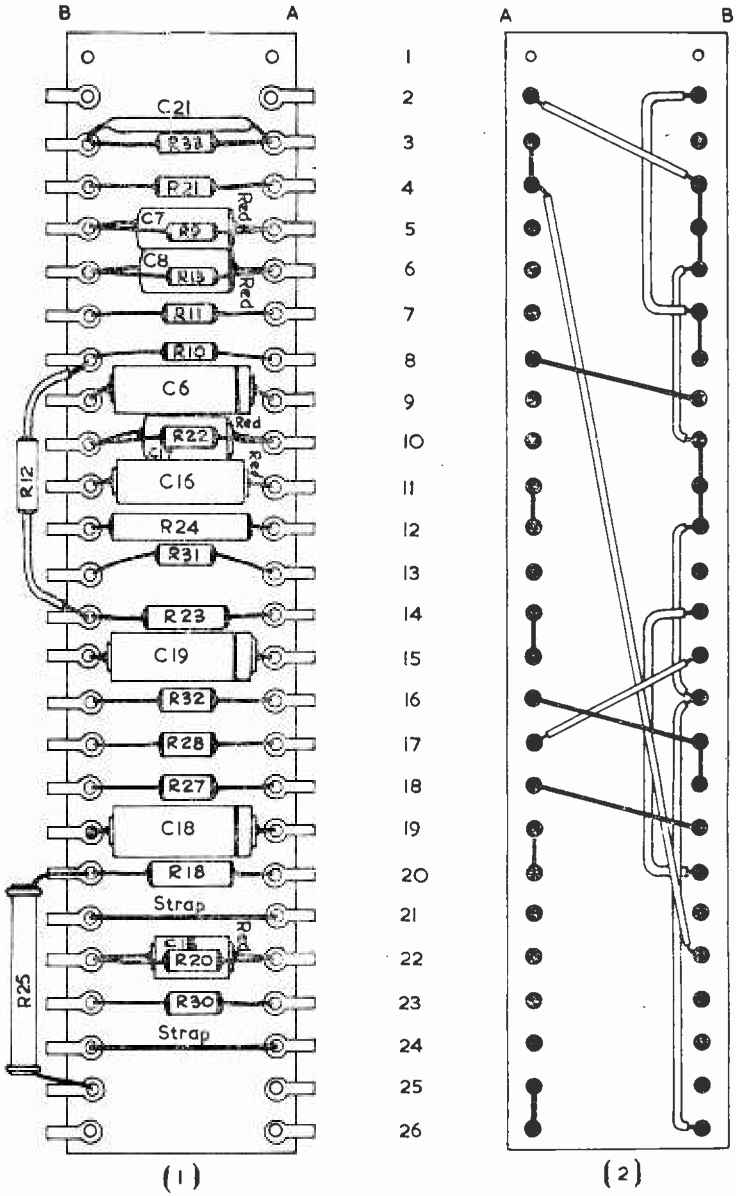
Stage 4 (1)

B3—C_{21} and R_{33}—A3
B4—R_{21}—A4
B5—neg. C_7 and R_9—A5
B6—neg. C_8 and R_{13}—A6
B7—R_{11}—A7
B8—R_{10}—A8
B9—C_6—A9
B10—neg. C_{17} and R_{22}—A10
B11—neg. C_{16}—A11
B12—R_{24}—A12
B13—R_{31}—A13
B14—R_{23}—A14
B15—C_{19}—A15
B16—R_{32}—A16
B17—R_{28}—A17
B18—R_{27}—A18
B19—C_{18}—A19
B20—R_{18}—A20
B21—A21
B22—neg. C_{15} and R_{20}—A22



WIRING – STAGE THREE

a495



WIRING – STAGE FOUR

G496

B23—R_{30}—A23
B24—A24
B8—R_{12}—B14
B20—R_{25}—B25

Stage 4 (2)

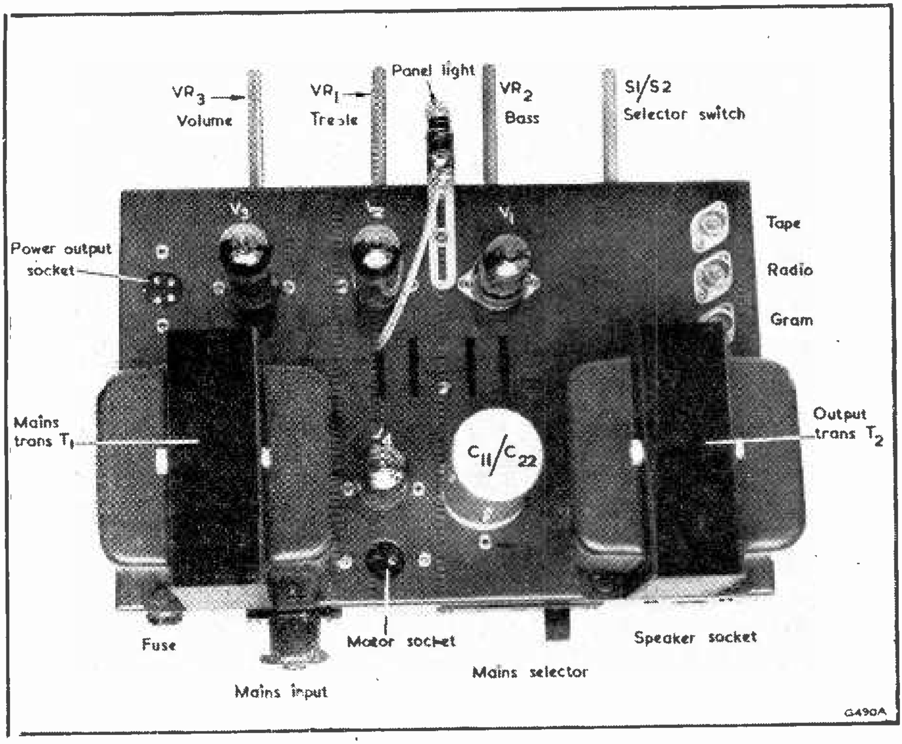
A2—B4—B5—B6—B10—B11—B12—B16—B26
A3—A4—B22
A8—B9
A11—A12
A14—A15
A16—B17—B18
A17—B15
A18—B19
A19—A20
A25—A26
B2—B7—B8
B14—B20

B5, B6, B7, B8 (keep these clear of connection from pin 7, V_1), B9, B10, B12, B13, B14, B16, B21, B17, B18, B20, B22, B23, B24.

POINT-TO-POINT CHECK

Stage 5

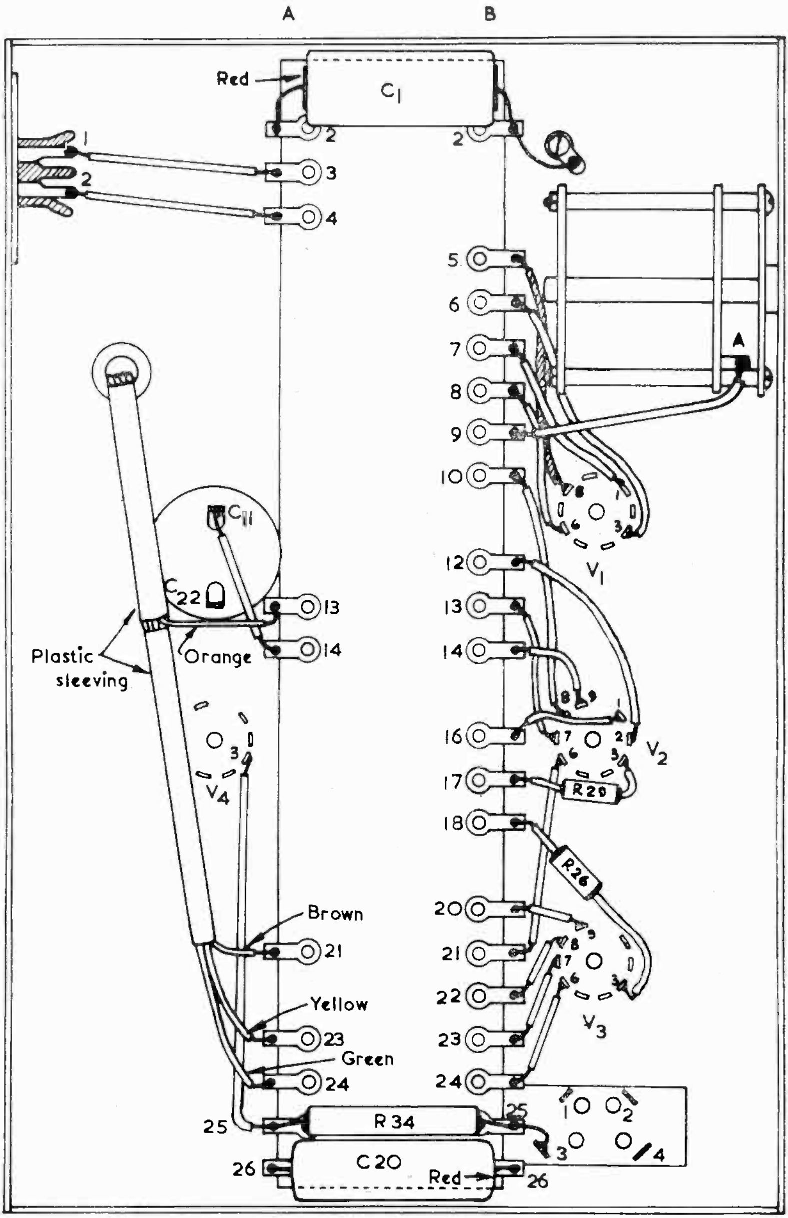
B2—pos. C_1—A2—Solder tag
B3—1 on output socket
B4—2 on output socket
B13—orange lead from T_2
B14—C11
B21—brown lead from T_2
B23—yellow lead from T_2
B24—green lead from T_2
B25—3 on V_4
B25—R_{34}—A25—3 on power output socket
B26—neg. C_{20}—A26



Cooper-Smith "Prodigy", layout above chassis

Stage 5.—Put a nut on each of the three long screws about ¼in down the thread, fit group board and wire up as shown, adding C_1, C_{20} and R_{34}. The best sequence for wiring up to the valveholders is as follows:—

A5—8 on V_1
A6—3 on V_1
A7—1 on V_1
A8—6 on V_1
A9—A on selector switch



WIRING – STAGE FIVE

A10—8 on V_2
A12—2 on V_2
A13—7 on V_2
A14—9 on V_2
A16—1 on V_2
A17—R_{29}—3 on V_2
A18—R_{26}—3 on V_3
A20—9 on V_3
A21—6 on V_2
A22—8 on V_3
A23—7 on V_3
A24—6 on V_3

The Power Output Socket

The Power Output Socket is incorporated in the amplifier to enable the user to obtain readily h.t. and l.t. for supplying ancillary apparatus such as a radio tuner or tape pre-amplifier. As these rarely need as much as 250V h.t., provision is made on the group board for a dropping resistor (R_{34}), which cannot be included in a kit or built-up amplifier as its value will depend on the voltage and current required. This may easily be calculated by Ohm's Law, for example:

It is desired to use a tuner requiring 200V at 35mA, so the voltage to be dropped is 50.

The formula is

$$\frac{\text{Voltage to be dropped}}{\text{Current in mA}} \times 1{,}000 = \text{Ohms}$$

$$\frac{50}{35} \times 1{,}000 = 1{,}430\Omega$$

The nearest stock value being 1,500Ω, this would be the resistor to be asked for when ordering.

Decoupling is already provided by C_{20}. Connections to the plug should be made to the pins which correspond to the numbers on the socket, as follows: Pin 3, h.t.+. Pin 4, h.t.−. Pins 1 and 2, l.t.

The output transformer secondary is wound in three separate sections, correct speaker matching being achieved by a series/parallel arrangement. The three speaker impedances are matched to the amplifier by wiring the speaker plug in accordance with the diagram shown on page 197 of the October issue. This minimises the amount of re-wiring inside the amplifier. However, each loudspeaker impedance calls for different values of feedback resistor and capacitor.

For 15Ω R_{33}=680Ω, C_{21}=3,000pF.
For 7.5Ω R_{33}=560Ω, C_{21}=3,500pF.
For 3.75Ω R_{33}=470Ω, C_{21}=4,000pF.

Before switching on the amplifier, thoroughly check the wiring and, if a continuity meter is available, connect between the positive side of C_{22} and earth. If all is well, the needle will kick and then return slowly to zero. If the needle remains at full scale, a short circuit is indicated and the amplifier must not be connected to the mains until the fault has been rectified. Of all the faults which may exist, this is the most important as it will cause damage to components and rectifier valve if not put right.

Do not switch on the amplifier without first connecting the loudspeaker.

With the specified components, and careful work on your part, all should be well. Should any difficulty arise, however, contact Jack Cooper of H. L. Smith & Co. Ltd.

Transformer Specifications

Mains Transformer: Primary 0–200–220–240V. Secondaries 250–0–250V at 100mA, 3.15–0–3.15V at 4A, 6.3V at 2A.

Output Transformer: Primary 10kΩ anode-to-anode, ultra-linear taps 43%. Secondary wound in 3 separate sections. Speaker matching achieved by series/parallel arrangement. 15Ω 7.5Ω 3.75Ω. Primary inductance 58H at 30V 50 c/s. Leakage inductance 0.5mH at 1V, 1,000 c/s.

MODELS FOR RADIO CONTROL

THE "WAVEMASTER" KIT

Part 4

by Raymond F. Stock

Electric Drive

When a reduced performance can be accepted, electric drive may be indicated and will, of course, simplify control. Installation then becomes very simple. Several types of surplus low voltage motors can be used and will, in general, be held down by metal straps screwed to a block glued down to the bottom of the hull. Circular-section motors may rest in a shaped saddle of wood.

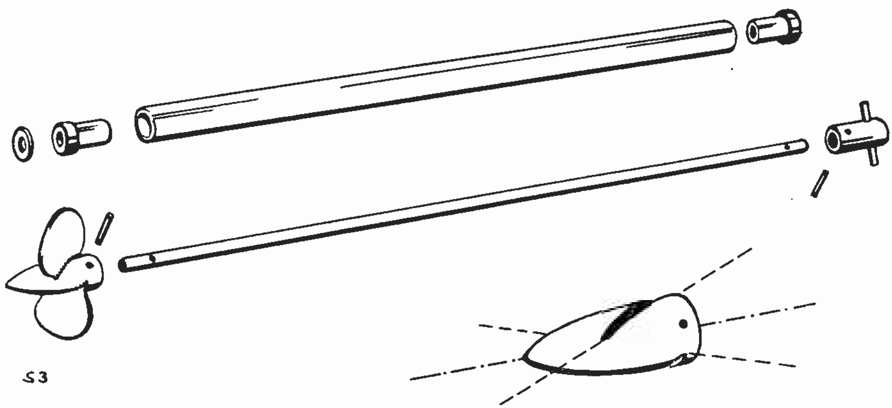


Fig. 3. Simply made components for a propeller, shaft, coupling and shaft tube. The bushes are soldered into the tube. The larger view of the hub shows how the slots are made by angled saw cuts

The *Wavemaster* is provided with a partly cut slot through the keel which is opened out during building to take a propeller shaft and tube. The complete unit may be purchased from model shops, a suitable size being selected, or the components may be made at home.

The general form of construction suited to hand tools is shown in Fig. 3. An outer tube may be cut from a length of thin-walled seamless steel tube, and certain surplus whip aerial sections can be used here; alternatively, brass tube can be employed. In each end is inserted a short bearing of brass or, preferably, a bronze bearing material, soft-soldered into place.

The shaft should be of silver steel rod, or, if obtainable, rustless ground bar. For a boat of this size $\frac{1}{8}$in diameter should be regarded as the minimum (for electric drive) or up to $\frac{3}{16}$in when a powerful I.C. engine is fitted. The inboard end should terminate in a half coupling to mate with that on the motor, and some form of flexible drive using a rubber component is useful in promoting quiet running.

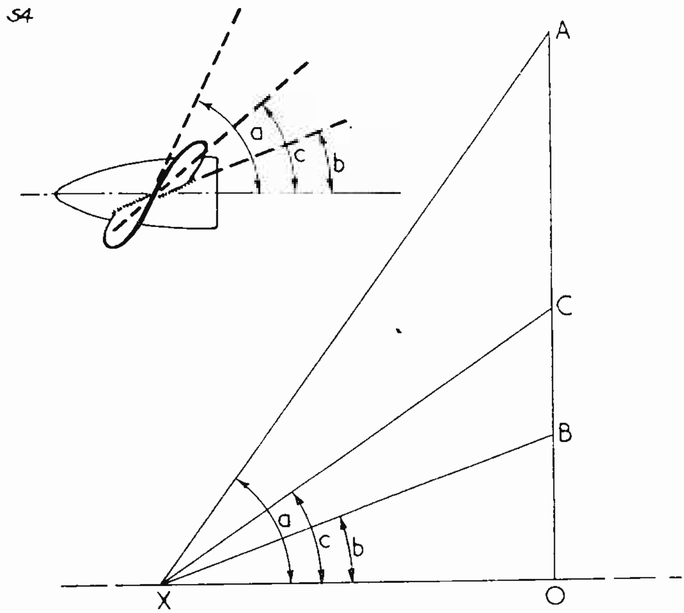


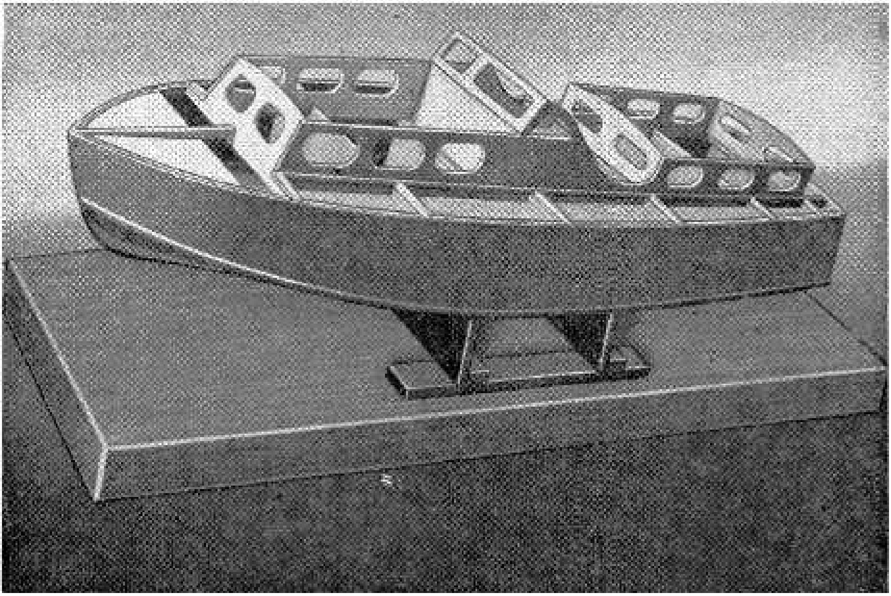
Fig. 4. X-O=Pitch. A-O=Circumference at tip

Propellers

A small volume could be devoted to propeller design, and it is impossible to quote exact sizes. The biggest mistake usually made is to fit too large a propeller (in either diameter or pitch), as this slows down the motor to an inefficient speed; this applies both to I.C. and to electric drive. A "cut and try" method is usually best, simple soft-soldered screws being used until the optimum size is found, after which a more elaborate model can be made. There is no justification for using more than two blades, and these may be cut from 16 s.w.g. brass sheet, hard-soldered (for a finalised component) into saw cuts in a circular brass hub. The latter can be "turned" to shape with a file if mounted in an electric drill chuck. It should be attached to the shaft by cross-pinning with a $\frac{1}{16}$in steel pin.

The blades should be of a rounded form (this is not a critical factor) and, if made deliberately oversize, trimmed down with cutters and a file *in situ* to achieve the best performance. The angle of the blades is most important and is quoted (indirectly) as the *pitch* of the propeller. This may be calculated from the estimated speed of the complete model, though unfortunately a good deal of experience is required to assess the latter. Ideally, one assumes a certain speed —say, two knots plus (for an electric model). This equals 6,000 x 2 feet per hour= 200ft/min. If the motor is intended to run at 1,000 r.p.m. each revolution must advance the boat $\frac{200}{1,000}$ ft or 0.2ft. Allowing a 25% slip (since the screw is not working in a solid medium), the screw should have a pitch of 1.25 x 0.2ft=3in.

Fig. 4 shows a graphical method of determining blade angle. The base is made 3in long (X-O) while the vertical height of the triangle is made equal to the circumference of the propeller (A-O). Drawing a diagonal line (A-X) then represents the angle of the blade tip relative to the shaft, at (a). Similarly, (B-X) is drawn to the point representing the circumference of the hub and (b) represents the angle of the blade root (and the saw cut in the hub). (C-X) and (c) refer to a station at half the blade height; these three angles should be checked on each blade as it is twisted. The blades are, of course, inserted and soldered into the hub whilst in



Fixing the superstructure

the flat, and something like a correct twist should result if each blade tip is gripped by a pair of flat nose pliers and turned.

Soft soldering is *not* adequate for retaining the blades on a model powered by a large electric motor or by an I.C. engine. Silver solder *must* be used, a neat fillet being left and filed smoothly into the contour of both hub and blade. A steel washer should be trapped between the boss and the after-tube bearing to absorb propeller thrust. In use, the tube should be packed with light grease or thick oil.

Radio *HOBBIES* Exhibition

EXHIBITORS AS AT 6th OCTOBER 1958

	Stand No.
British Amateur Television Club	34
British National Radio School	5
Clyne Radio Ltd.	28
Cossor Instruments Ltd.	—
Data Publications Ltd., *Radio Constructor*	29
Daystrom Ltd. (Heathkits)	—
Enthoven Solders Ltd.	23
Home Radio (Mitcham) Ltd.	20
Iliffe Press Ltd., *Wireless World, Electronic and Radio Engineer*	22
Jason Motor & Electronic Co.	18
K.W. Electronics Ltd.	8
London Electric Wire Co. & Smith's Ltd.	27
London U.H.F. Group	3
The Minimitter Co.	13
Mullard Limited	26
E. J. Philpott's Metalworks Ltd.	15
Premier Radio	16
Racal Engineering Ltd.	24
Radio Society of Great Britain	1
Relda Radio Ltd.	9
Royal Air Force	4
Royal Navy	25
Army	33
Short Wave Magazine	14
Standard Telephones & Cables Ltd.	17
Taylor Electrical Instruments Ltd.	6
Teletron Ltd.	31
Whiteley Electrical Radio Co. Ltd.	35
Colour Television G3ILI/T	35

Visit to Siemens Edison Swan

Sunderland TV Tube Factory

The writer recently formed one of a party of radio and engineering journalists who flew north in a Viking aircraft, at the invitation of Siemens Edison Swan Ltd., to their model t.v. tube factory at Sunderland. The flight from Blackbushe to Newcastle airport took a little over an hour and a quarter, a speed of 230 m.p.h. at a height of 8,000 feet being set most of the journey.

From the latter air terminal, a coach was provided for the run to the factory situated in ideal surroundings on the outskirts of Sunderland. After an excellent lunch, the writer was admirably conducted around the factory by Mr. Potts of the Engineering Division.

Mass production of t.v. tubes at this factory is currently running at 12,000 a week, and the use of automatic methods enables the entire manufacture to be carried out by a minimum of operators. The factory runs continuously through 15 shifts from Monday morning to Saturday morning inclusive. The total number of employees at the factory is around 660.

The Manufacturing Processes

The making of Ediswan-Mazda t.v. tubes is carried out by a series of automatic processes linked by nearly two miles of overhead conveyors. The equipment is estimated to be worth £1¼ million. It has been designed, much of it to the company's own specification, for the single purpose of making cathode ray tubes.

The glasswork consisting of face, back and neck is first placed in pre-heating ovens and brought slowly to an appropriate temperature. The backs are then joined to the necks and transferred to a circular machine which makes the anode hole and drops in the anode button. After annealing they are inspected and the completed backs are then joined to the pre-heated faces by the electrical face sealing technique. The finished bulbs enter a lehr which gradually cools them after holding them for a certain period at a high temperature, in order to allow the glass to "settle," after which they are again inspected.

In the bulb-washing section, where surface contamination is removed, the bulbs pass various jets of chemicals and demineralised water rinses. There is also a similar process for reclaimed bulb-washing using different proportions of chemicals.

Screening the Faces

Screening of the faces now follows on a giant conveyor. Barium acetate and water are poured into the upturned bulbs in quantities according to tube size, phosphor powder and silicate are added, and the mixture allowed to settle for 20 minutes. With the screen now formed, the tube reaches the end of the conveyor where decantation of the liquids takes place, the tube returning on the underside of the conveyor to the take-off point. Inspection of the screen under a fluorescent light now takes place. The screen is next coated with a bedacryl and tolurine solution which provides a plasticiser to protect the coating at the subsequent aluminising operation.

Tubes are now placed on a conveyor to dry out by means of hot air pokers. Aquadag, a graphite solution, is now applied inside the neck to give contact between the anode button and the gun, which latter is subsequently inserted.

The aluminising process, which is fully automatic, comprises several stages of evacuation. After vacuum check the aluminium is volatilised, thus forming a mirror behind the screen. There is a further inspection at this stage.

Aluminised tubes are now fed into a 120ft long bake lehr, and receive a four-hour treatment. A rigid inspection with the aid of ultra-violet light now takes place, only those screens without any trace of blemish being allowed to go forward.

Inserting the Guns

The guns, comprising anodes, grid, cathode and heater are now inserted into the necks. These "mount assemblies" arrive complete from another Siemens Edison Swan factory in Sunderland. The marrying of gun to neck is an extremely fine operation with little permissible tolerance, as it is at this point that the distance from gun to screen is set.

Evacuation of the tube follows on in-line exhaust machines. These embody conveyors carrying 159 exhaust cubicles each. Every cubicle is an exhaust machine in its own right. The cubicles move round one station at regular intervals between 30 and 60 seconds. Different size tubes can be evacuated simultaneously on the in-line machine as each cubicle may be separately adjusted. During this process, not only is it necessary to remove the air, but also to heat all parts inside and outside to various temperatures by means of radio frequency heating and external baking of the bulb. Cubicles are withdrawable in event of a fault arising. The cap base is now added, after which r.f. heating of the barium getter is carried out. This removes from the tube any final traces of residual gas.

continued on page 301

Mullard Tape Amplifier "Type C"

continued from page 285

H.F. Oscillator Stage

This stage is designed to work with the two triode halves of an ECC82 valve working in push-pull into a Ferroxcube cored oscillator coil, L_1, L_2. During playback, when it is inoperative, the circuit draws approximately the same current as during the oscillatory condition for recording. With little or no change of current for the two conditions, the design of the power supply is simplified. The push-pull circuit effects a current saving over the earlier version and enables a lower distortion figure to be achieved. The erase current is obtained off a tap on the secondary winding. Switch wafers SA_5, SA_7 and SA_8 of the record/playback switch are used to switch the output, earth the circuit on playback and switch h.t. respectively as required.

Recording Level Indicator

The tuning indicator, type EM81, used in this stage is fed from the anode of the recording stage through a large series resistance R_{18} to minimise the loading of the recording stage.

Assembly and Wiring

The list of components required will enable intending constructors to start collecting or to place orders for the complete kit as advertised in this issue. Next month full wiring details will be given.

A Sensitive Transistor Receiver

By J. C. BAKER

DETAILS OF TRANSISTOR RECEIVERS HITHERto published appear to fall into two classes: the very simple circuits consisting of one or two transistors and very little else, and elaborate superhets. The former, although they give the beginner some insight into basic circuits, are of little actual value; while the latter are far too difficult to build and expensive for many home constructors.

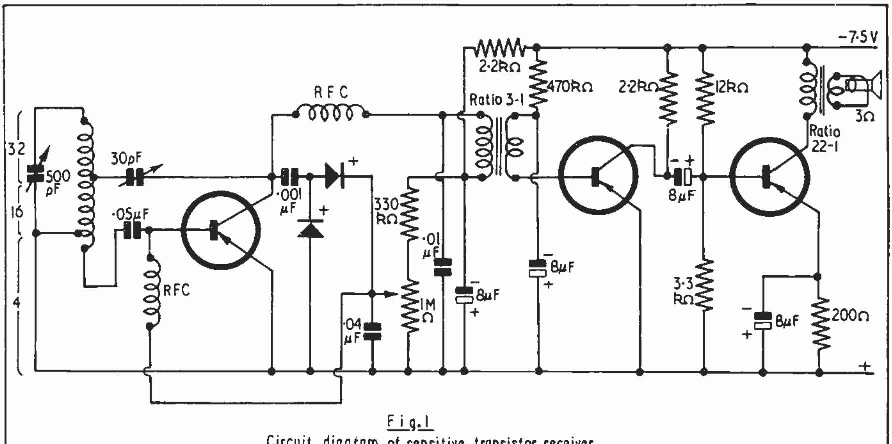


Fig. 1
Circuit diagram of sensitive transistor receiver

In the present article it is intended to describe a circuit which can be regarded as midway between these extremes. Assessing the performance of any set without extensive laboratory tests is difficult. It could be mentioned as a rough guide that in the London area Home, Light, Third and Hilversum can be received at full loudspeaker strength; and with careful adjustment of reaction several French and German stations can be received. The selectivity is good, being comparable to that of many superhets.

Incidentally, the writer claims no originality for the idea, which is a modification of a Japanese pocket receiver described in an American magazine.

Referring to Fig. 1, the winding on the ferrite rod aerial is tuned by a 500pF variable condenser in the usual way and an extension of this winding forms the secondary of a step-down transformer, the output of which is fed to the base and emitter of the first transistor. A small part of the resulting collector current is fed back to the aerial through the 30pF preset reaction condenser, while the remainder is fed to the two germanium diodes arranged as a voltage doubler detector. The a.f. current so obtained is fed back via RFC_1 to the base and emitter of the r.f. transistor. This principle of using the same device for r.f. and a.f. amplification simultaneously is known as reflex working and was popular in the early days of broadcast receivers. The collector a.f. output is fed via RFC_2 to the primary of the interstage transformer and the remainder of the circuit follows accepted practice.

Although the dimensions and layout of the receiver can be arranged to suit individual requirements, for maximum performance the ferrite rods should be eight or nine inches in length. Also, the speaker should be as large as circumstances permit. Assuming the cabinet will be of such dimensions as to accommodate a 7in or 8in ferrite rod, it is suggested that a 7in x 4in elliptical speaker be used. This is a standard size of which there are many makes available. The "Elac" is a good example; it is inexpensive and has an excellent frequency response. All small components should be mounted on a tag-board secured to any convenient part of the cabinet, a metal chassis being quite unnecessary. The general layout should be such that there is some vacant space near the top of the cabinet in order that the ferrite rod can be fastened horizontally and not be near to any large metal objects, such as the speaker chassis.

As the aerial assembly is an important item, its construction will be considered in some detail (see Figs. 2 and 3). Two ferrite rods 8in x $\frac{3}{8}$in dia. are mounted side by side and the coil is wound (on a paper tube) round the rods. This coil assembly should be capable of being moved along the rods in order to find the most sensitive position. This will not be the centre of the rods, but roughly one-third of the length. Although reasonably good results can be obtained with almost any sort of wire, for maximum efficiency "Litz" wire should be used. When the winding is put on, it exerts considerable inward (crushing) pressure and unless the right method is adopted it will be found that the coil former is pressed so firmly to the rods that it will be impossible to move it. To obviate this, proceed as follows: first, fit two paper tubes round the rods. That is, one paper tube about three inches in length round each rod. Two turns of paper should be sufficient. Secure with "Durafix," but try to avoid sticking the tubes to the rods. Bind the tubes with string or wire until dry. When dry, remove the lashings and place the two rods beside one another so that the paper tubes are level. Now wind three turns of stiff paper over this assembly to form a sort of oval tube; glue and bind as before. When the binding has been removed, the coil is wound on this tube, making tappings at the appropriate points. When complete, it will be found that the coil assembly cannot be moved along the rods. Mount one ferrite rod vertically in a vice—first covering the jaws with felt. If the other rod is gently tapped with a piece of wood it can be driven gradually out. The paper tubes are now removed from the rods and upon re-assembling it will be found that there is now sufficient clearance to permit free movement of the coil.

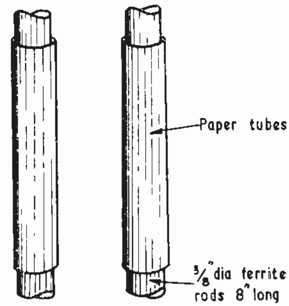
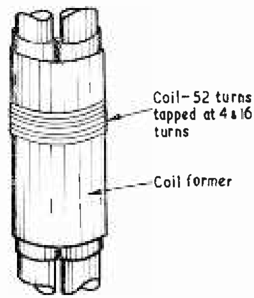


Fig.2



E562

Fig.3

The only other point requiring comment is the choice of transistors. The first (r.f.) transistor should be of known make and characteristics. In the second stage, much greater latitude is permissible; in fact almost any transistor can be used. It should, however, be reasonably free from background noise. The Mullard OC72 is excellent for the output stage.

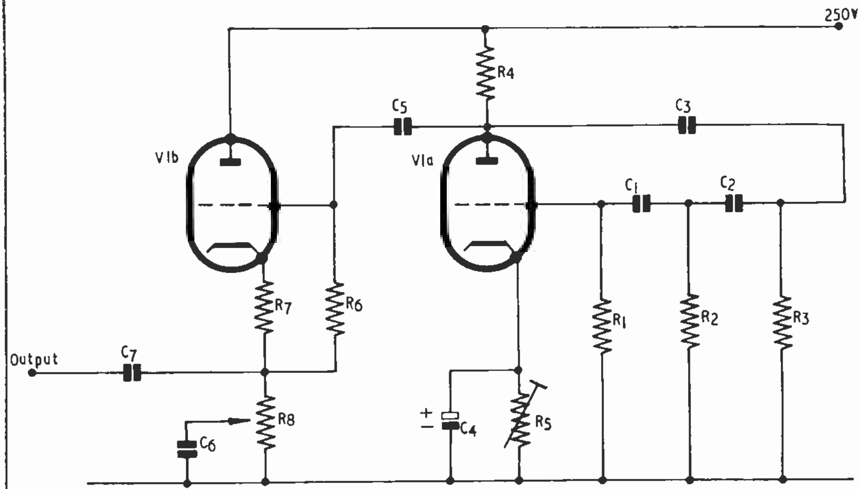


Fig. 1

Component list

R1·R2·R3—180kΩ ¼ watt	C1·C2·C3—1000pF ceramic
R4 —— 47kΩ ½ watt	C4 —— 50μF 12V electrolytic
R5 —— 10kΩ preset pot	C5·C7 —— 0·05μF 350VW
R6 —— 470kΩ ¼ watt	C6 —— 8μF 150VW
R7 —— 390ohms ¼ watt	V1a·V1b —— 12AT7, ECC81 etc
R8 —— 10kΩ ww pot	

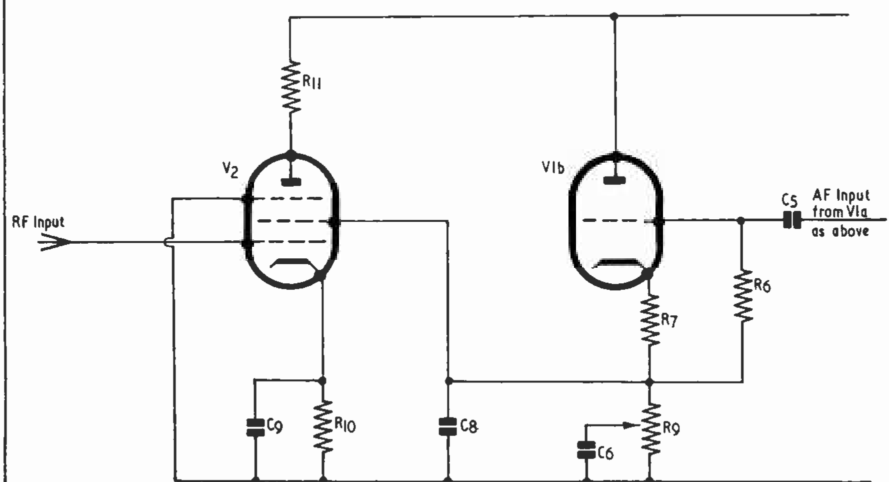


Fig. 2

Additional components list

R9—20kΩ ww pot	C8—100pF sm
R10—150 ohms ¼ watt	C9—0·01μF 150VW
R11—4·7kΩ ½ watt	V2—EF80, EF91 etc

E599

A VERSATILE Audio Frequency Oscillator

By D. E. VAUGHAN

THE PURPOSE FOR WHICH THIS CIRCUIT was originally devised required a compact source of audio frequency possessing good waveform, reasonably constant frequency and variable amplitude. The writer thinks that a simple circuit with such characteristics might be of general interest.

As compactness and low weight were of primary importance, the use of transformers or chokes was out of the question; so it was necessary to investigate the so-called R-C oscillators. The circuit which was finally chosen is shown in Fig. 1. It consists of a phase shift oscillator feeding into a cathode follower, the whole circuit being constructed around an easily obtainable double triode. If, as is usual with this circuit, $C_1 = C_2 = C_3$ and $R_1 = R_2 = R_3$, then the approximate frequency of oscillation is given by

$$f = \frac{1}{2\pi\, C_1\, R_1 \sqrt{6}}$$

Variation of frequency over a limited range is best obtained by making R_2 variable, although this is not provided for in the circuit given. The component values listed give a frequency of about 400 c/s, which is a standard test frequency. Other frequencies can be obtained with component values calculated from the formula given above.

No constructional details are given since the layout is not critical. This means that the unit can be built into any convenient space, with most of the components attached to the valveholder tags.

The only adjustment required to set up the instrument is to the value of R_5. It will be found that oscillation occurs only between narrow limits, and the control should be adjusted to the midpoint of this range.

The current requirements of the circuit are extremely modest, about 3mA for the oscillator and about 5mA for the cathode follower with an h.t. line of 250V.

Because of its good waveform, this oscillator is particularly suitable for use as a source of modulation for a signal generator. It is not always appreciated that good waveform is necessary for this purpose, but the presence of high order harmonics of the modulating frequency will produce sidebands, well spaced from the carrier, which can be very troublesome in alignment work.

A particularly satisfactory modulator, based on the audio oscillator just described, is shown in Fig. 2. It is a screen modulated pentode fed from the oscillator through a cathode follower, directly coupled to the screen. Through using an additional valve it has the advantage over the usual system of eliminating interaction between the audio frequency and radio frequency oscillators. This means that modulation depths approaching 100% can be obtained without affecting the carrier frequency. Suitable valves for the modulator are EF80 or EF91, but it is possible to use the pentode section of an ECF82 as the modulator and to use the triode section as the radio frequency oscillator.

In addition to its use as a modulator as described above, the oscillator can be used for energising an a.c. bridge, and applied to the general testing of audio frequency equipment. Other experiments will doubtless find still further uses.

Visit to Siemens Edison Swan Sunderland TV Tube Factory

continued from page 297

Running-in the Tubes

Electrical ageing or "running-in" of the tube follows, the object being to stabilise tubes which are in various stages of activation. Ordinary ageing is followed by high voltage ageing which entails bombarding of emissive spots to obviate spurious emission. Complete electrical and picture tests are now made. Before dimensional inspection, the conical section of the bulb is externally coated with aquadag to a specified thickness. This provides the t.v. setmaker with a ready-made capacitance between the internal aluminium film and the external aquadag.

At the packing station, the tube undergoes a final inspection. Finished tubes are then packed and despatched either in single boxes or in the more economical multi-packs which take 6, 12 or 15, according to type of tube.

This month, the Sunderland factory completed its one millionth t.v. tube since manufacture began three years ago.

a power-unit

THE POWER-UNIT ABOUT TO BE DESCRIBED was constructed by the author, a few months ago, to fulfil two main purposes. They were: (1) To find a use for a homeless mains transformer which had been moved from shelf to shelf in the workshop over the past three years; (2) To provide a continuously variable h.t. power supply for test and experimental purposes.

The results in both cases were found to be quite satisfactory.

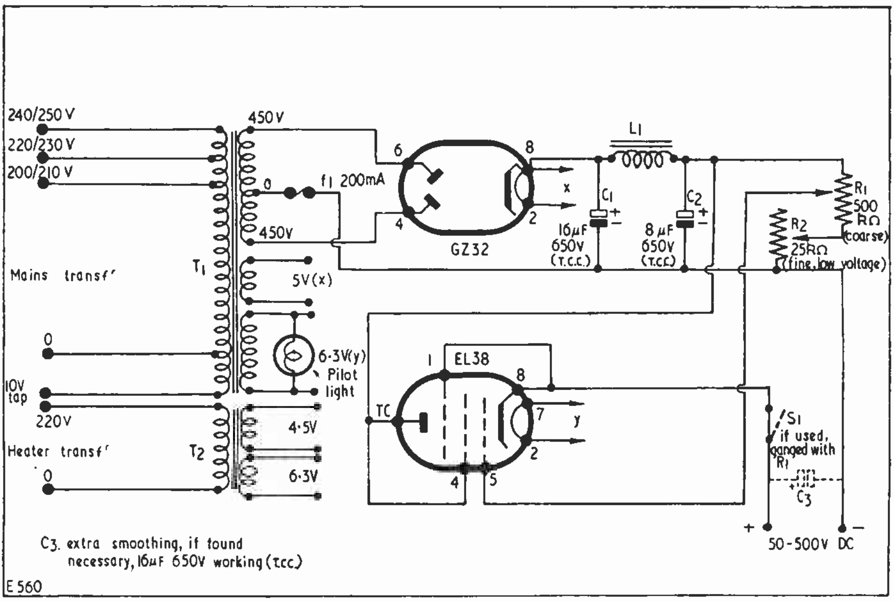
The total expenditure was the cost of the solder used to hold the job together; and, using the basic principle of the circuit, most readers will no doubt find that they too can provide a use for a few oddments cluttering up the shack.

It will be seen that the EL38 is simply placed in series with the h.t. positive side of the output from the rectifier, and that the bias applied to the control grid, g_1, is used to control the current through the valve. Hence the voltage drop across it is controllable—resulting in a continuously-variable output.

It will be seen that the bias supply is derived from a potentiometer across the output from the rectifier.

It could be obtained by putting the potentiometer across the actual output (which is probably the safer method) but then a certain amount of control would be lost as the bias available becomes dependent on the h.t. output.

The former method is by far the most satisfactory, and although under certain conditions the potential between g_1 and cathode may become quite high, it is found in practice that the EL38 can take the strain without any shadow of complaint.



Circuit

A quick glance at the circuit will show that the most fundamental characteristic of a Multi-grid Valve is being put to good purpose.

—with a difference

By R. S. SQUIRES

As a test, the unit constructed by the author was run continuously for a period of approx. 75 hours at a voltage of 45 volts and a load of 100mA. The EL38 did not even become as warm as it does when employed in more conventional circuits.

The h.t. output should be isolated from the container, and offered only at the h.t. output terminals. There will then be little chance of an accident if the unit is adjusted whilst connected to any external apparatus.

It will be noticed that a heater-transformer is included in the circuit to provide l.t. for test purposes. This is, of course, quite optional—but *very* useful.

The unit can be constructed in any box of convenient size, either wood or metal. The layout is not in the least important apart from one small consideration; the lead from the potentiometer "wiper" to g_1 of the EL38 should be kept short in order to prevent any hum being picked up and applied to the grid.

All the controls, pilot light, mains switch and output terminals should be mounted on what is to be the front panel of the unit. But this is more for the sake of convenience rather than from a technical standpoint.

The author's unit was constructed in a metal box measuring 10½in x 6in x 3in. Things were a little cramped in this case, but the actual size of the container chosen will depend to a large extent on the contents of the constructor's "junk box."

There are several variations from the suggested circuit. The chief requirement of the valve used as a "dropper" is that the dissipation of the EL38 is given as:

Anode 25 watts
Screen 8 watts

This is adequate for our purpose and any valve with similar characteristics could be used.

It was mentioned earlier that a *separate* heater-transformer was included in the unit for l.t. output. Some readers may wonder why the two heater supplies available for the GZ32 and EL38 are not utilised. The main reason for this is, of course, that if, for instance, the EL38 heater were to be used also as the heater supply for a radio under test, then the potential which exists between heather and cathode of the EL38 would also exist between heater and cathode of most of the other valves in the set. And they may *not* be able to survive.

Finally, the author would welcome any suggestions for improvements to the unit; especially if a small modification could provide 0 to 500V instead of 50 to 500V.

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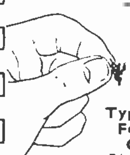

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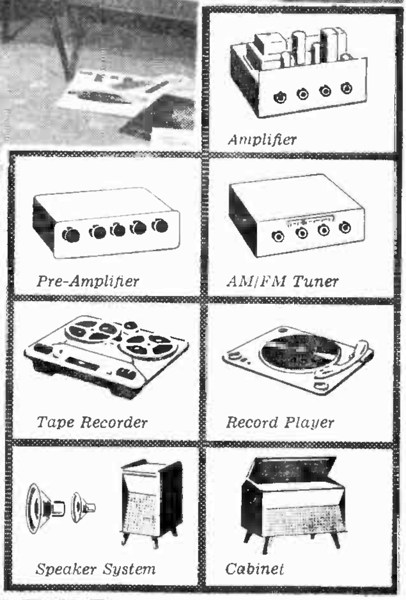

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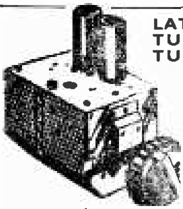

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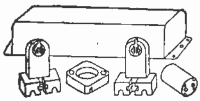

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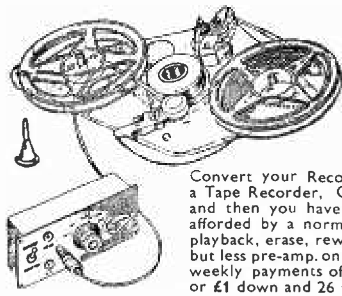

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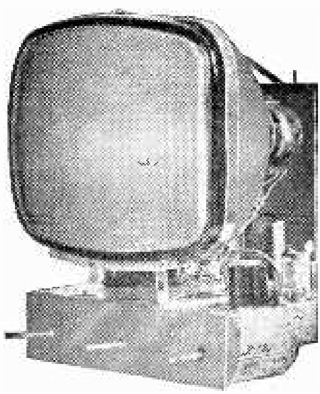

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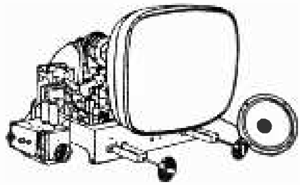

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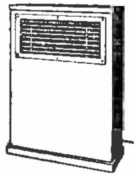

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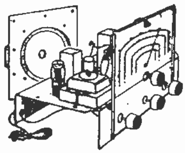

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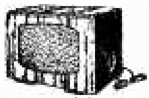

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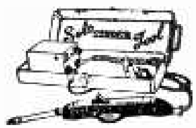

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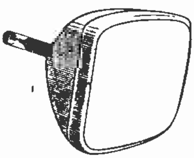

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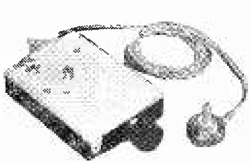

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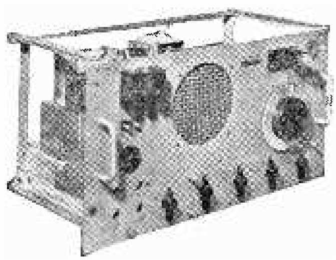

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Push-Pull Portable Superhet

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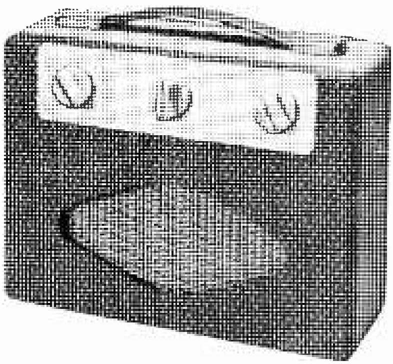

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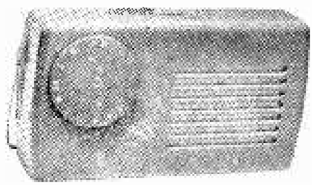

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continued on page 319

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continued from page 317

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continued on page 320

SMALL ADVERTISEMENTS

continued from page 319

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