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VOLUME 14
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SEPTEMBER
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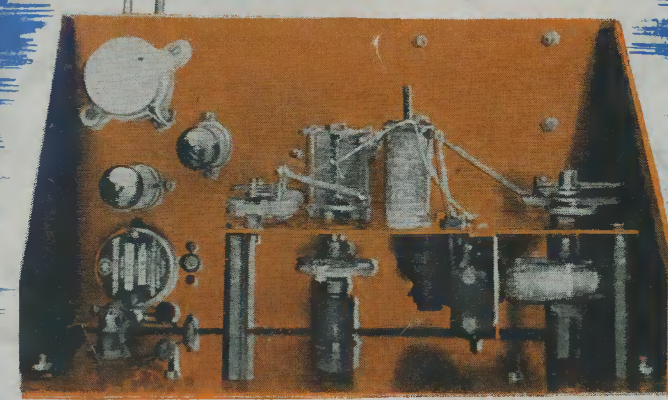

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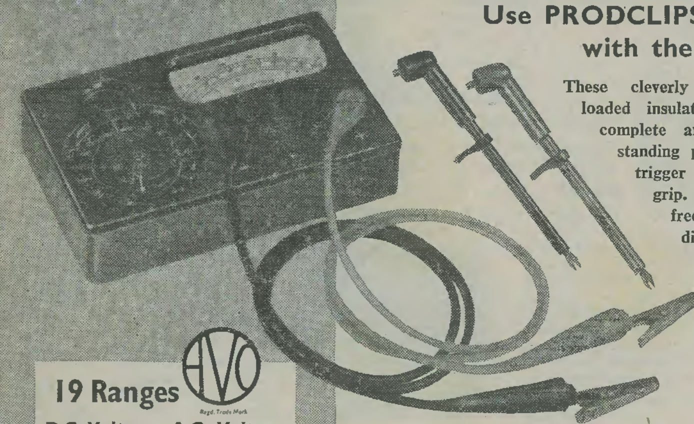

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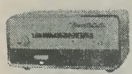

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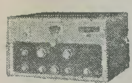

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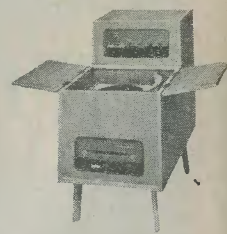

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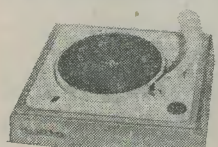

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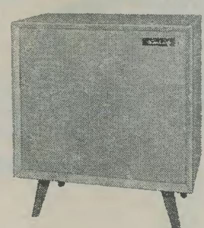

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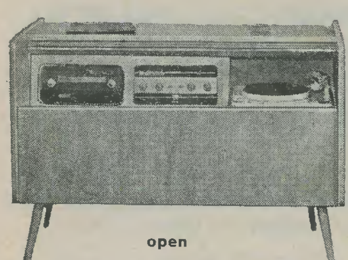

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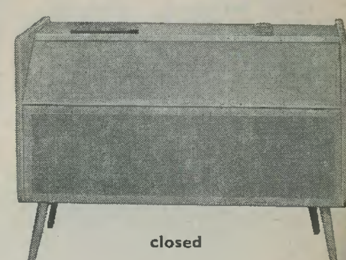

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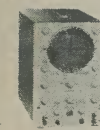
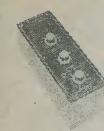


O-12U



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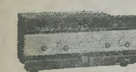

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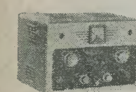
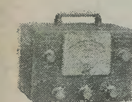
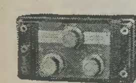


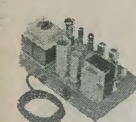
DX-40U



AG-9U



UJR-1



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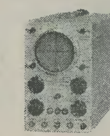
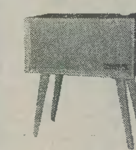


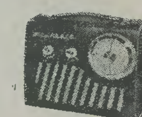
OS-1

V-7A

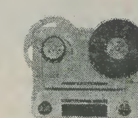
S-88



SSU-1



UXR-1



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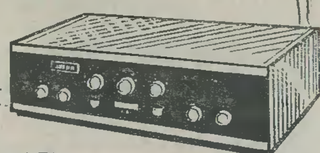

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6SN7GT	8/6	DH77	7/6	EF92	5/6	UY41	8/–
6V6G	7/6	DK91	6/6	EL41	9/–	W76	8/6

Matched Pairs. EL84, **23/–**; EL85, **25/–**; 6V6G, **17/–**; 6BW6, **18/–**; KT33C, **19/6**; 807 **14/6** pair.

SETS OF VALVES

DK96, DF96, DAF96, DL96, "REGENT"	**29/6** per set
DK91, DF91, DAF91, DL92, or DL94	**21/–** per set
1R5, 1T4, 1S5, 3S4, or 3V4	**21/–** per set
6K8, 6K7, 6Q7, 6V6, 5Z4, "G" Types	**27/6** per set
12K8, 12K7, 12Q7, 35L6, 35Z4, GT Types	**35/–** per set
ECH42, EF41, EBC41, EL41, EZ40	**37/6** per set
UCH42, UF41, UBC41, UL41, UY41	**35/–** per set

P.P. Op. Transformers. MR 3–15 ohms for EL84, 6V6, 6BW6, etc., **18/6**; Op. Pen. 50mA, **5/6**; 30mA, **4/6**

★ **Volume Controls.** All values, long spindle. L/S **2/9**, s.p. **3/9**, d.p. 4/3; ext. spkr. control **3/–**

P.M. Speakers. 3 ohms 5″ **16/6**, 6½″ **17/6**, 8″ **21/–**, 10″ **25/–**; 12″ **30/–**; Bakers 12″ 15 ohm 15W, **90/–**.

Coaxial Plugs 1/– each; **Sockets 1/–** each.

C.R.T. Isolation Transformers with nil, 25% and 50% boost, low capacity a.c. mains 200/250V for 2V 4V, 6.3V and 13V tubes. All **10/6** each. P. & P. 1/6

Valveholders. 4, 5, 7 pin English and U.S.A. B7G, 59A, 10, M0, B8G, **9d.** each; B7G, B9A with screening can, **1/6**; B12A, **1/3**; Aladdin formers ¼″ with core, **8d.** each.

Jack Plugs. Miniature standard **3/–**; **Sockets 3/–**

Capacitors. Small mica, 5% 1pF to 100pF, **8d.**; 120pF to 1,000pF, **9d.**; 1,000V wkg. .01, .0015, .0025, .004, .005µF, **1/–** each

Crystal Diodes. G.E.C., **1/6** each

Ceramic Capacitors. Close tol. 500V for V.H.F., **9d.**

Paper Tubular. .001–.1 500V, **9d.**; .25. **1/–**; .5, **1/6**; .01 1,000V, **1/–**

Paper Blocks. 4µF, 1,000 wkg., **3/6**; 4µF 250V, **2/6**

Rectifiers. Contact cooled, 250V 50mA, **7/6**; 85mA, **9/6**

Reaction Condensers. .0001, .0003, .0005µF, **4/6** each

Heater Trans. 200/240V, 6.3V, 1.5A, **7/6**, 3A **10/6**

Resistors. ¼ and ½W, insulated, **4d.** and **6d.**; 1W, **8d.**; 6W W.W., **1/–**; 10W, **2/–**

Electrolytics. Wire ends. 25/25V, **1/6**; 50/50V, **2/–**; 12/50V, **9d.**; 8/450V, **2/–**; 16/450V, **2/9**; 16/500V, **3/6**; 32/450V, **4/–**; 8+8/450V, **4/6**; 8+16/450V, **4/6**; can types: 16/450V, **3/6**; 16+16/500V, **6/–**; 32/500V, **6/6**; 32/450V, **6/6**; 20+20/450V, **4/6**; 64+120/275V, **7/6**

Wavechange Switches. Midget: 1p 12W, 2p 6W, 3p 4W, 4p 3W, 4p 2W, long spindles, **4/6**

Toggle Switches. QMB, s.p.s.t., **2/–**; s.p.d.t., **3/3**; d.p.s.t., **3/6**; d.p.d.t., **4/–**; rotary s.p. ,**3/–**

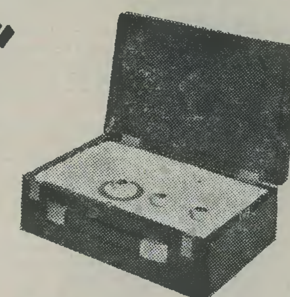
Chokes. 65mA 10H, **5/6**; 80mA 15H, **8/6**; 100mA 10H. **10/6**; 150mA 10H **14/6** ★

P. & P. 6d., over £1 post paid. C.O.D. 2/6

R. COOPER G8BX **32 SOUTH END CROYDON SURREY** CROYDON 9186

RCS "REGENT"
4-Valve Portable Superhet

Plans 9d. or details S.A.E. (as featured in June issue)



- ★ Economy "96" Range Valves
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- ★ Ready-made Mains Unit available. Price **39/6**
- ★ All components identified and of finest quality

Special Reduced Price (*for limited period*) if all components are purchased at one time.

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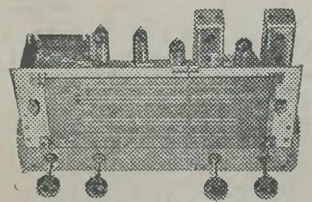
Batteries extra **10/– set**

CHAMPION VHF (FM) TUNER 88 to 96 Mc/s. Factory Built. Ready for use. Features: This is a self-powered 200/250V a.c. VHF (FM) adaptor with 5 Mullard valves and superhet tuning heart. Operating data and a screened lead for connection to pick-up sockets of any radio, radiogram or amplifier. Brand new. In maker's box. 12 months guarantee. List price 16 gns. **Our price £9 10.** carr. 4/6 Maroon and cream cabinet 6″ x 12″ x 6″ 20/– extra. Details S.A.E.

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD WEST CROYDON *Telephone* THO 1665



1960 RADIOGRAM CHASSIS

THREE WAVEBANDS — FIVE VALVES
S.W. 16 m.–50 m. — LATEST MULLARD
M.W. 200 m.–550 m. — ECH81, EF89, EBC81,
L.W. 800 m.–2,000 m. — EL84, EZ80

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, horizontal or vertical, size 10" x 4½". 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Leaflet S.A.E.

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/–.

LATEST "E.M.I." 4 SPEED SINGLE RECORD PLAYER

Acos 73 Hi-Fi Pick-up for LP, 78 and Stereo 7", 10" and 12" records. Silent motor heavy turntable, auto stop.
Special offer **£6.19.6** post free.

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SPECIAL SINGLE PLAYER KIT

COLLARO 4-speed Gram-Pick-up Unit	£3.15.0
Handsome portable case 17½" x 13½" x 7" with room to play 12" records	£2. 5.0
Ready built 3-watt amplifier with two valves and 7" elip. speaker, printed circuit	£3.12.6

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I.F. TRANSFORMERS 7/6 pair
465 kc/s slug tuning miniature can 2½" x 1" x 1". High Q and good band width. By Pye Radio. Data sheet supplied.
Wearite M800 Midget 465 kc/s 1¾" x ¾" sq. **12/6** pair
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New boxed VALVES 90-day Guarantee

1R5	7/6	6K8G	7/6	EA50	1/6	EZ80	7/6
1S5	7/6	6L6G	10/6	EABC80	8/6	E1148	1/6
1T4	6/–	6N7M	6/6	EB91	6/–	HABC80	12/6
2X2	3/6	6Q7G	8/6	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SA7	6/–	EBC41	8/6	MU14	9/–
3V4	7/6	6SJ7M	6/6	EBF80	10/–	P61	3/6
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/–	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/–	12A6	7 6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/–	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/–	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/6	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
6K6GT	6/6	807	5/6	EY51	9/6	UY41	8/–
6K7G	5/–	954	1/6	EZ40	7/6	U22	8/–

DK96, DF96, DAF96, DL96, **8/6** each or **30/–** set

B.B.C. Pocket Transistor. M.W. and L.W. Radio Kit **32/6**. Phones **7/6** or deaf aid earpiece **15/–**.

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C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied. **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. Our Latest Superior Product. Mains Input Type A2. High quality low capacity 10-15pF. Optional boost 25% 50% 75%, 16/6** each. **Type B.** Mains input. Low capacity. Multi output 2, 4, 6.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. **21/–** each.

RESISTORS. Preferred values. 20% 10 ohms to 10 meg, ¼W **4d.**, ½W **4d.**, 1W **6d.**, 1½W **8d.**, 2W **1/–**. **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/–**

WIRE-WOUND POTS Pre-set min. TV type. Knurled slotted knob. All values 25 ohms to 25k, 3/– each, 30k, 50k, 4/–. Ditto ½W Carbon Track 30k to 2 Meg. 3/–.

3W Lab. Colvern, etc. Standard size Pots, 2¼" Spindle, high grade. All values, 100 ohms to 50k, 6/6; 100k, 7/6. W/W EXT. SPEAKER CONTROL 10Ω, 3/–.

MAINS TRANSFORMERS—200/250 AC

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. 220–0–220V 50mA, 6.3V 2A	17/6
STANDARD. 250–0–250 65mA, 6.3V 3.5A	17/6
HEATER TRANS. 6.3V 1½A 7/6. Ditto, sec. 6.3V 3A 10/6. Ditto, tapped sec. 2, 4, 6.3V 1½A, 8/6. **Mullard "510" Osram "912"** 300–0–300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V	38/6
General Purpose Low Voltage. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V at 2A	22/6

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**. Goodmans heavy duty 10/20W 6k or 8k c.t., **30/–**.
L.F. CHOKES 15/10H 60/65mA, **5/–**; 10H, 85mA, **10/6**; 10H 150mA, **14/–**.

CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ⅝" x $\frac{3}{16}$"
ACOS CRYSTAL HAND or DESK MIKE, 27/6

ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d.** **0.3" FORMERS** 5937 or 8 and cans TV1 or 2, ½" sq. x 2¼" or ¾" sq. x 1¼", **2/–** with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3**.
REMPLOY INSTRUMENT IRON, 230V 25W, **17/6**.
MAINS DROPPERS. 3" x 1½". With adj. sliders, 0.3A, 1,000 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 TRANS. 50:1, **3/9**; 100:1, potted, **10/6**.
LOUDSPEAKERS. P.M. 3 ohm. 5" Rola, **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, **90/–**; Stentorian HF1012 10", **95/–**.
CRYSTAL DIODES. G.E.C., **2/–**; GEX34, **4/–**.
40 CIRCUITS FOR GERMANIUM DIODES, 3/–.
H.R. HEADPHONES 4,000 ohms, brand new, **15/–** 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**.
SHORT WAVE Single 75pF, 100pF, 160pF, **7/–** each.
TUNING AND REACTION CONDENSERS. 100pF, 300pF, 500pF, **3/6** each, solid dielectric.
RADIO & TV SERVICE SHEETS 2/6 plus S.A.E.

HIGH GAIN TV PRE-AMPLIFIERS
BAND I B.B.C.
Tuneable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price **29/6** or **49/6** with power pack. Details **6d.** (PCC84 valves if preferred.)
BAND III I.T.A.—Same prices
Tuneable channels 8 to 13. Gain 17dB. ECC84 valve

Volume Controls

Midget size. Long spindles. Guaranteed 1 year. All values 5,000 ohms to 2 Meg.
No Switch 3/– — D.P. Switch 4/6
Linear or Log Tracks

80Ω Coaxial Cable

Post 1d. per yard extra
Semi-air spaced Polythene Ideal Band III **6d. yd.**
Losses cut 50%
FRINGE QUALITY Air spaced Coaxial **1/–yd.**

Coaxial Plugs	1/–	**Lead Socket**	2/–
Panel 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 of stranded, **2d.** yd. Sleeving 1, 2mm, **2d.**; 4mm, **3d.**; 6mm, **5d.** yd.
NEON MAINS TESTER SCREWDRIVERS, 5/–.
SOLDER RADIOGRADE, 4d. yd, ¼lb **2/6.**

Aluminium Chassis. 18 s.w.g. Plain, undrilled, 4 sides, riveted corners, lattice fixing holes, 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**.

Miniature Contact Cooled Rectifiers. 250V 50mA, **7/6**; 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 D.W.R. L. & Med. T.R.F. with reaction, **3/6**.
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6**.
Ferrite Rods 8" x ⅜", **2/6**
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/–**. **Tygan,** 4' 6" wide, **10/–**; 2' 3" wide, **5/–** ft. Samples, S.A.E.
Condensers. 0.001µF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 0.1µF 7kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.05, **9d.**; 0.1, **1/–**; 0.25, **1/6**; 0.1/350V, **9d.**; 0.5/250V, **1/9**; 0.01/2,000V, **1/9**; 0.1/2,000V, **3/6**.
Ceramic Condensers. 500V 0.3pF to 0.01µF, **9d.**
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/–**.

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TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/–	50/350V	5/6	8/600V	9/–
2/350V	2/3	100/25V	3/–	32/350V	4/–
4/450V	2/3	250/25V	3/–	100/270V	5/6
8/450V	2/3	500/12V	3/–	2,500/3V	4/–
8/500V	2/9	8+8/450V	3/6	5,000/6V	5/–
16/450V	3/–	8+8/500V	5/–	32+32/350V	5/–
16/500V	4/–	8+16/450V	3/9	32+32/450V	6/–
32/450V	3/9	8+16/500V	5/6	32+32+32/350V	7/–
25/25V	1/9	16+16/450V	4/3	50+50/350V	7/–
50/25V	2/–	16+16/500V	6/–	64+120/350V	11/6
50/50V	2/–	32+32/350V	4/6	100+200/275V	12/6

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**.

P.V.C. PLASTIC RECORDING TAPE

Long Play		Standard Play—	
7" reel, 1,700ft	32/6		
5¾" reel, 1,200ft	22/6	7" reel, 1,200ft	21/–
5" reel, 850ft	19/6	5¾" reel 850ft	17/6
3" reel, 225ft	7/6	5" reel, 600ft	15/–

Spare Plastic Reels all sizes 3/–. Metal Reels 7" only 2/–. "Instant" Bulk Tape Eraser and Head Defluxer, 200/250V A.C., 27/6. Leaflet, S.A.E.

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Model UA8
OUR PRICE
£6.15.0

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UA8 £7.19.6
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★ **COLLARO** ★
HI-FI AUTOCHANGER £7.19.6
4 SPEEDS—10 RECORDS
or with Cabinet, Amplifier and Speaker
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★ **GARRARD 4-SPEED RECORD CHANGERS MODEL 210** ★
With Plug-in Head for Monaural Stereo Heads £2 extra **£10.10.0**

AUTOCHANGER ACCESSORIES

Suitable player cabinets (uncut boards)	49/6
Amplifier player cabinets with cut boards	63/–
2-valve amplifier and 6½" speaker for above	79/6
3-valve amplifier and 6½" speaker for above	95/–

Wired and tested ready for use

★ **GARRARD 4-SPEED SINGLE RECORD PLAYER TA MK. II** ★
£8.8.0 — **AUDIO PERFECTION** — Stereo wired
with plug-in GC8 Normal Heads — Stereo Heads £2 extra
MODEL 4 HF £18

Wavechange Switches. 2 p. 2-way, 3 p. 2-way, short spindle, **2/6**; 5 p. 4-way 2 wafer, long spondle, **6/6**; 2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle, **3/6**; 3 p. 4-way, 1 p. 2-way, long spindle, **3/6**; wavechange "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, 29/–. 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, **2/6**. **Complete Jason FMT.1 Kit,** and Jason chassis with calibrated dial, **5 gns.** 4 valves **20/–**

Valveholders. Pax. int. oct., **4d.** EA50, EF50, **6d.** B12A, CRT, **1/3**. Eng. and Amer. 4, 5, 6 and 7 pin, **1/–**. MOULDED Mazda and int. oct., **6d.**, B7G, B8A, B8G, B9A, **9d.** B7G with can, **1/6**. B9A with can, **1/9**. **Ceramic,** EF50, B7G, B9A, int. oct., **1/–**. B7G, B9A cans, **1/–** each. **Valve and TV Tube** equivalents, **9/6**. **TV Fault Finding, 5/–. Quality Amplifiers, 4/6. Radio Valve Guide.** Books 1, 2 or 3, **5/–** each.
TRANSISTORS. Ediswan Audio XB112, **10/–**, R.F. 2 Mc/s XA103, **15/–**; R.F. 4 Mc/s XA104, **18/–**. Red Spot **5/–**; White Spot **7/6**.
Sub-miniature Electrolytics (15V) 1µF, 2µF, 4µF, 5µF, 8µF, 25µF, 50µF, 100µF, **3/–**.

TELETRON POCKET RADIO KIT
Transidyne Superhet Six 6" x 4" x 1¼"
T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker push-pull output. All parts, cabinet, 6 Ediswan transistors, GEX34 diode, **£9.9.0** Details **9d.**

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

Post and packing charge 1/–, over £2 post free. C.O.D. 1/6 (Export welcome. Send remittance and extra postage)

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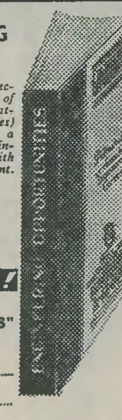

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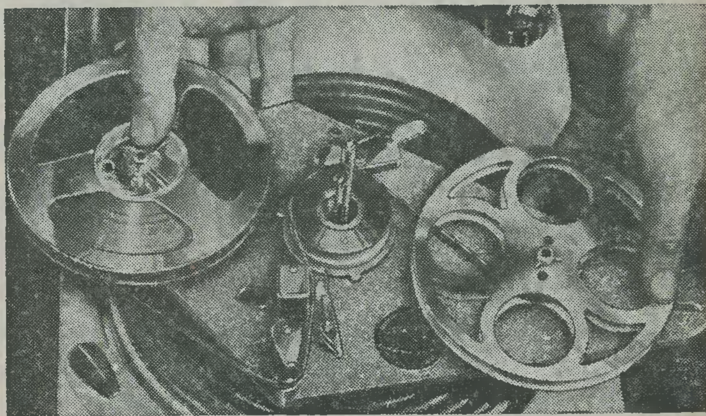

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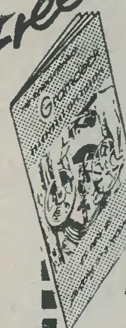

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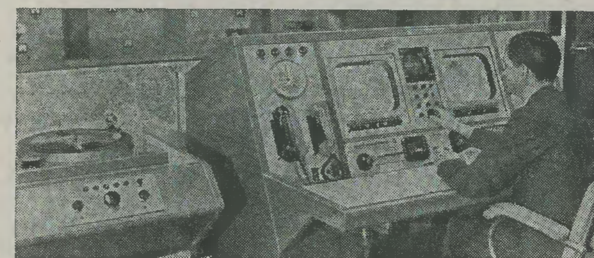

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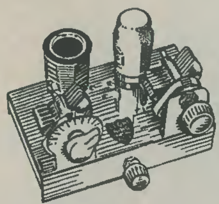

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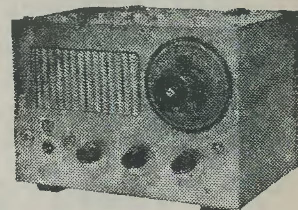

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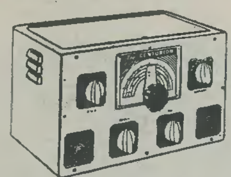

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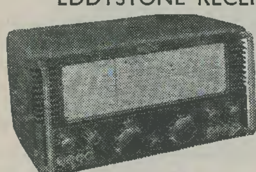

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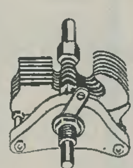

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suggested circuits

No 118. A Single Transistor Phase-Shift Oscillator

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

An a.f. oscillator is always a useful item of equipment to have available, whether it be employed for experimental or service work or, even, for such commonplace applications as Morse practice and the like. It is extremely desirable that such an oscillator should be capable of providing a high level output into circuits of varying impedance, that its waveform should be good, and that it should be self-contained and portable.

The oscillator which forms the subject of this month's article meets all these requirements, and it has the further advantage of being relatively inexpensive. It employs a single transistor in a phase-shift circuit and the output waveform shows little distortion. It offers a high level output and is capable of feeding into a very wide range of impedances. Indeed, it may be coupled directly to a loudspeaker, whereupon it gives an audible tone at reasonably comfortable level. This fact alone makes the oscillator capable of a.f. signal tracing back from the loudspeaker, apart from any of the many other uses to which it may be applied. If the oscillator is coupled to headphones, the volume available is in excess of comfortable level.

Considering the simplicity of the circuit, frequency stability is quite reasonable, a shift in frequency of less than 5% from its nominal 1,000 c/s occurring when the impedance of the circuit to which the output terminals are connected changes from 1MΩ to 100Ω. If desired, this stability may be markedly improved by making slight changes to the circuit. The transistor employed is stabilised against thermal runaway. Finally, the circuit can be made into a small, compact and completely self-contained unit, power being obtained from a 9 volt battery with a current drain of slightly less than 5mA.

The Circuit

As may be seen from the accompanying circuit, a fairly conventional phase-shift oscillator arrangement is employed. The collector of the transistor, an OC72, couples into the phase-shift network C_4, C_1, C_2, C_3 and their associated resistors, these feeding back into the transistor base. Thus, the requirements of a phase-shift oscillator are set up. The values in the phase-shift network are experimentally determined to provide oscillation at a nominal frequency of 1,000 c/s. The output of the oscillator is taken directly from the collector of the transistor via the 0.01µF condenser C_6.

The resistors R_4, R_5 and R_7 provide a stabilising circuit. The electrolytic condenser C_5 bypasses the emitter resistor R_7. The resistor R_4 brings the transistor to its correct operating point, and its value is discussed later.

Design Features

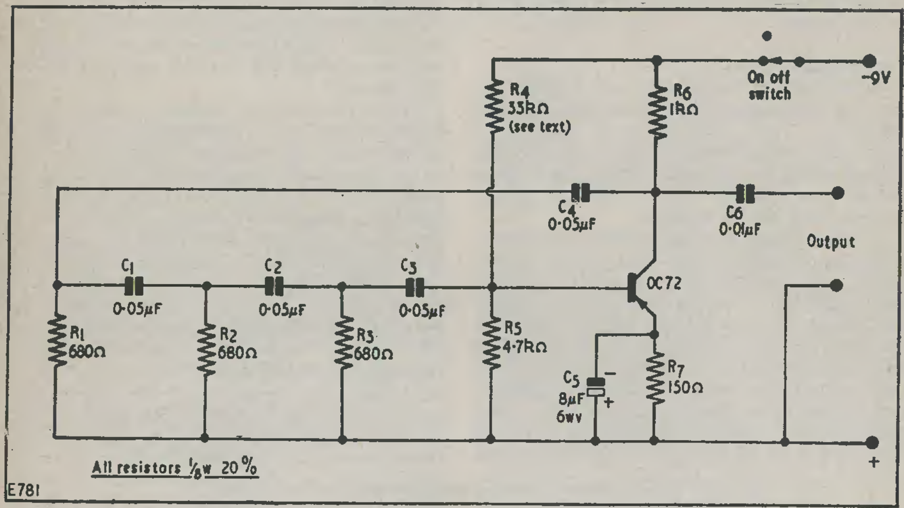
Several features of the design require to be discussed at this stage.

The fact that the output connection is taken direct from the collector of the OC72 results in the small sacrifice of frequency stability referred to above. Considerably higher frequency stability would be provided by making R_6 a potential divider and tapping the output connection into a point approximately one-tenth down from the h.t. negative rail. This method of connection would, however, cause a heavy loss in output voltage, and it was felt that the advantage of the high level output which is given by coupling direct to the collector more than outweighs the small loss in frequency stability sustained thereby. Constructors who desire a high level of stability at a lower output level can, of course, modify the output coupling in the manner just described.

An improvement in long-term frequency stability may be achieved by connecting an electrolytic condenser of some 25µF or so across the h.t. positive and negative rails. This condenser will then prevent shifts in frequency caused by increasing internal resistance in the 9 volt supply battery as it ages. As the result of checks carried out on the prototype the writer felt, however, that such alterations in frequency were not of a sufficiently high order to warrant the cost of the additional component. Nevertheless, the individual constructor who desires a high level of frequency stability may, here again, carry out the simple modification required. The writer found that there was no noticeable change in output frequency for varying supply voltage.

In the circuit the OC72 passes a collector current of slightly under 5mA at an applied h.t. voltage of 9, and it was considered that these figures justified the inclusion of stabilising components.

It will be noted that all resistors are given a tolerance of 20% and that no tolerance is quoted for condensers, (whereupon it may be assumed that the latter will have the commercial tolerance, for paper condensers, of 20 or 25%, according to make and value). It is possible, in consequence, that some oscillators constructed to the circuit may run at frequencies removed from the nominal 1,000 c/s. When this occurs the frequency may be brought back to 1,000 c/s by the simple procedure of adjusting the value of one of the resistors in the phase-shift network; and the writer considered that such a process was much preferable to that of commencing with close tolerance resistors and condensers which would be both expensive and difficult to obtain.



Setting Up the Oscillator

When the oscillator has been wired up it is necessary to ensure that R_4 has a value which causes optimum output to be given.

R_4 brings the transistor on to its most efficient operating point. Its value is not very critical, but it may vary for different transistors and for variations in value (within the tolerance stated) of components immediately connected to the transistor. It was found, with the prototype, that oscillation occurred reliably when R_4 lay between the limits 20kΩ and 45kΩ, optimum results being given at 33kΩ.

To find the best value of R_4 in a particular oscillator, this resistor should be temporarily replaced by a 50kΩ potentiometer in series with a 15kΩ limiting resistor. The potentiometer should be initially set such that it inserts all its resistance into circuit. The output of the oscillator is next connected to an a.f. amplifier or to high resistance (2,000Ω) headphones and a 9 volt supply applied. The temporary 50kΩ potentiometer is then adjusted slowly. As the resistance inserted by the potentiometer decreases, oscillation should commence and pass through a fairly flat peak in amplitude. The value of the potentiometer and 15kΩ resistor in series should be measured for the peak setting; and the two replaced by a single fixed resistor of the same value plus or minus some 5kΩ.

After R_4 has been set up all that remains is to adjust the frequency of the oscillator, should this be removed from 1,000 c/s. It should be possible to adjust the frequency by varying the value of one of the phase-shift resistors only, say R_1. Increasing its value will lower the frequency of oscillation, and reducing its value will increase the frequency of oscillation.

Performance Tests

Several performance tests were carried out on the prototype, and these are detailed below.

It was mentioned above that current consumption is slightly less than 5mA for a supply potential of 9 volts. The prototype drew 4.5mA at this voltage.

A further test was concerned with supply potential and the speed with which oscillations commenced when the supply voltage was applied. The recommended supply voltage is 9, and it was found that the oscillator gave a reliably high output when this was reduced to 7 volts. Below 7 volts oscillation amplitude noticeably dropped, and oscillations ceased at 5 volts. The recommended supply voltage may therefore be stated to lie between 7 volts minimum and 9 volts maximum.[1] It was found that, for all supply voltages between 7 and 9, oscillation commenced instantly on application of the supply voltage. (This test was not carried out for supply voltages below 7.) If it were decided to key the oscillator, the key could, therefore, be inserted in either supply lead.

Tests were also carried out on the oscillator whilst its output terminals were connected to the input terminals of an a.f. amplifier. The input resistance of the amplifier was 1MΩ. Fixed resistances were then connected across the output terminals of the oscillator. For fixed resistors down to 15kΩ there was negligible change in output voltage or frequency. As would be expected, below 15kΩ output voltage commenced to drop as the value of the parallel resistor decreased in value, the reduction being particularly evident for resistors below 1kΩ. Nevertheless, the circuit did not cease to oscillate even when a parallel resistor having a value as low as 100Ω was connected across the output terminals. Slight changes in output frequency became evident for parallel resistors below 2kΩ or so.

When the oscillator output terminals were connected to a 3Ω loudspeaker via a 50:1 transformer, the resulting tone was audible at a reasonably comfortable level. It is probable that a more careful choice of loudspeaker transformer ratio would have resulted in a louder tone from the speaker, but the writer did not proceed further with this particular test. Finally, a pair of low resistance (30Ω) headphones were connected across the output terminals. In this case the tone was reproduced at a volume which was in excess of comfortable level.

[1] The supply potential should not exceed 9 volts, as this figure approaches the maximum limiting collector voltage specified by Mullard for the external base resistance used in this particular circuit.

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The venue for the above classes is: The Ilford Literary Institute, High School for Girls, Cranbrook Road, Ilford, Essex (adjacent to Gants Hill Station on the Central London Tube, and buses pass the door).

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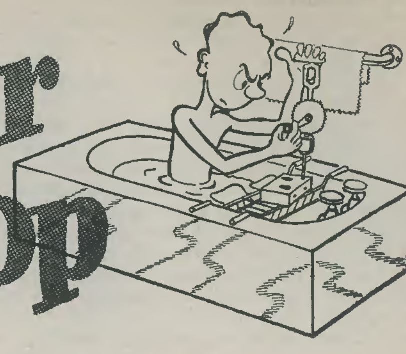
In your Workshop



This month Smithy the Serviceman attempts, completely unsuccessfully, to retire to the seaside and Get Away From It All.

"AH," murmured Smithy blissfully to himself, as he basked in the late August sunshine, "this is the life!"

He smiled benignly at a puppy which had wandered up and was sniffing at his thinning hair. The puppy settled down alongside and quietly wagged his tail, evidently approving of Smithy's fragrance. Smithy turned over and sleepily reflected. "How pleasant it is to get away from work for a fortnight and forget altogether about condensers, resistors and intermittent faults!"

Raising himself on one arm he regarded his torso. The first fiery redness had now cleared almost completely, and his skin was taking on a very satisfactory light brown tan. The Serviceman then looked around and, spotting a little man close by with paper white skin, experienced a warm sensation of superiority. It was the first Saturday of his holiday—taken late this year because of pressure of servicing work—and he still had another week in which to deepen the shade of his tan. He wondered vaguely how his assistant Dick, left behind in the Workshop to carry on by himself, was progressing; then dismissed the thought from his mind.

Smithy next glanced at the laughing crowd swimming and splashing in the sun flecked sea. Ah well, he thought, I'll pop in for a swim myself shortly! And he congratulated himself once more on his complete freedom from all the cares and annoyances that radio and t.v. servicing brings in its train.

In the meantime the puppy had come to the conclusion that treasure of immense value lay hidden several feet below the surface of the sand and was carrying out vigorous excavation work, holding up operations every now and again to insert a briskly enquiring explorative nose. Smithy watched and dozed.

It Could Only Happen To Smithy

The Serviceman was suddenly awakened from his daydreams by the barking of the puppy. Smithy felt too lazy to do more than look around him horizontally, and he saw a pair of red and yellow plimsolls, surmounted by mauve cavalry twill trousers approach him. The dog was evidently on very friendly terms with the person to whom these colourful accoutrements belonged, and he rushed excitedly towards him, eager to demonstrate the extent and capacity of the hole he had been digging. The mauve legs came closer and closer; and there was something about them which caused an abrupt unease in Smithy's mind. Unbelievably, he looked up. At the same time, the person, unbelievingly, looked down.

"Oh, *no!*" they exclaimed in chorus.

There was a deathly hush.

"Dash it all," remarked Smithy aggrievedly. "I purposely didn't even *tell* you where I was going for my holiday!"

"I know you didn't," said Dick, equally aggrievedly. "I'm on a coach trip with my girl friend for the day, and we just *happened* to pick this place."

A further moment passed as they adjusted themselves to the situation.

"Well, I suppose it can't be helped," said Smithy, eventually.

"I suppose not."

"I didn't know you had a dog."

"It's not mine, it's hers," replied Dick. "She's gone shopping for half-an-hour."

"On her own?"

"Of course. Only mugs go shopping with women."

With which sage observation Dick dropped the junior kitbag strung over his shoulder on to the sand, and squatted down beside Smithy. They remained moodily quiet, and watched the puppy as he chose a new stretch of sand in which to prospect. Smithy moved a little to one side to avoid the avalanche of sand which suddenly emanated from between the puppy's hind legs. Somehow, the sea seemed far away.

Dick was the first to break the silence.

e.h.t. regulation. As the brightness of the picture increased so also did the e.h.t. current, with the result that, due to poor regulation, e.h.t. voltage dropped."

Despite himself, Smithy could not help but relapse into his Workshop manner.

"And why does lowered e.h.t. voltage increase picture size?"

"Because", said Dick promptly, "it means that the electrons pass through the deflection field more slowly, and suffer more deflection thereby."

"Fair enough," approved Smithy.

"I found the fault very quickly in this case," said Dick, "because, as soon as I touched the outside graphite coating of the tube, I got a real dickens of a belt!"

Smithy chuckled.

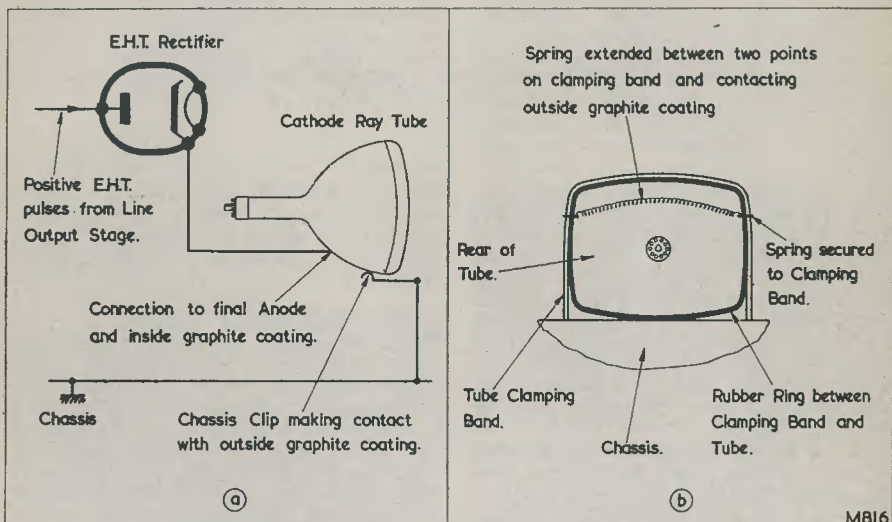


Fig. 1 (a) If the chassis clip connecting to the outside graphite coating of the cathode ray tube fails to make contact, the e.h.t. rectifier circuit loses its reservoir capacity and e.h.t. regulation suffers

Fig. 1 (b) A very reliable method of earthing the outside graphite coating. This diagram, giving a rear view of the tube fitted in a chassis, illustrates how a spring is extended across its bulb, thereby contacting the outside graphite at a large number of points

"Things are going pretty well in the Workshop," he remarked brightly.

"Oh yes," said Smithy non-committally.

"I cleared up that set I had in just before you started your holiday. You know, the one with the blooming picture!"

"By 'blooming'," said Smithy, collecting his thoughts, "I suppose you mean that the picture expanded in size as it got brighter."

"That's right," confirmed Dick. "I surmised that this was a classic symptom of poor

"There's no need to say any more," he laughed. "The only thing that can have happened was that the chassis contact to the outside graphite had gone open (Fig. 1 (*a*)) and so the e.h.t. rectifier had practically no reservoir capacity to work into. Also, the outside graphite, being unearthed, would soon pick up a charge which would be quite big enough to let you know all about it if you happened to touch it. Indeed, the shock, or the involuntary action following it, could

well, in such circumstances, be dangerous."

"That's just about the size of things," agreed Dick. "This set had phosphor-bronze leaf springs which were supposed to contact the outside graphite. However, I had to take the tube out, bend the springs up, and pop it back again before I could get reliable contact. After that, everything went fine."

"Your adventure," said Smithy, "highlights a silly little snag which often occurs with t.v. sets. You may sometimes find, for instance, that the earthing springs are so positioned on the chassis that they only just manage to touch the edge of the outside graphite coating of the tube. If you get a tube whose outside coating has been skimped a little you find your earthing contacts pressing against glass only! It's a thing to watch out for. Some manufacturers have a much better earthing idea, this consisting of what looks like spring curtain rod stretched out over the bulb of the tube. (Fig. 1 (*b*).) There's little risk of losing contact with this scheme. Even here, though, it is occasionally possible that with 21 inch tubes, which have a proportionately small area of outside graphite coating, there is a slight risk of the spring being accidentally shifted off the graphite."

No Vision

This seemed to exhaust the present subject, and Dick and Smithy fell silent once more. The sound of the bathers in the water reached Smithy's ears again, and he shifted uncomfortably.

"The next set I had a go at", Dick offered, "had what I thought at first to be a really queer sort of fault. It was an oldish model with a separate Band III converter, and it gave perfect sound with not a trace of vision whatsoever. I checked all the bottles and the voltages in the vision amplifier and i.f. strip, but everything seemed perfect. And yet there wasn't a trace of picture on the tube at all."

Smithy brought his thoughts back to the conversation.

"Did the set have vision a.g.c.?"

"If it had, it was a pretty elementary sort of a.g.c. There was a front panel contrast control, and a gain pot at the back; the latter giving a very fierce control."

"Your fault was the vision detector broken down," said Smithy laconically.

Dick looked disappointed.

"You've spoilt my story now," he complained. "I was just about to tell you how I located it. How do you *know* it was the vision detector?"

"I was making a slightly inspired guess," confessed Smithy, "based on my own experience. These earlier t.v's were usually designed to work on one channel only, whereupon there wasn't much point in fitting comprehensive a.g.c. circuits. All you had to do was to set up the pre-set gain control at the back to give you acceptable contrast with the front panel control at the middle of its range. At that setting held good because there was only one station to receive anyway! These sets also tended to employ rather earlyish germanium diode vision detectors, such diodes having low turnover voltage figures. When receivers of this type are used in areas of high signal strength, excessively high settings of the gain control can cause the video signal passed to the detector to exceed turnover voltage; whereupon the latter goes pop!"

"That's what must have happened in this case," said Dick, "because the diode had completely broken down. Incidentally, if the video diode in this particular set was liable to break down fairly readily, I can't understand why the manufacturers went to so much

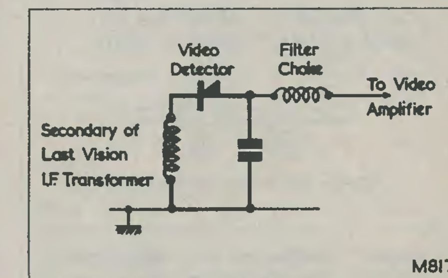


Fig. 2. Signals at the video detector are rectified at relatively low impedance. In consequence, radiation at i.f. harmonics can occur if the components and wiring immediately associated with the detector (shown here in heavy line) are not screened

trouble to hide it away. I had to take the vision detector coil assembly right out of the chassis before I could get at the diode!"

"The detector and its immediate circuit has to be well screened," explained Smithy. "That's why it was inside the coil can in your set. You'll usually find that the sound detector is similarly well screened. Both these detectors handle fairly high signal voltages at low impedance, with the result that you get almost a square wave in the circuit immediately around them. (Fig. 2.) Such a square wave is going to be rich in harmonics of the i.f., and these harmonics are liable to be radiated and picked up by earlier stages in the receiver if you don't screen the detector."

"What trouble would that cause?"

"If", replied Smithy, "an i.f. harmonic was close to, or fell inside, a channel you were receiving, you would get patterning on the screen or whistles on sound. This effect could be especially noticeable if you happened to use an indoor aerial very close to the receiver, because such an aerial would be

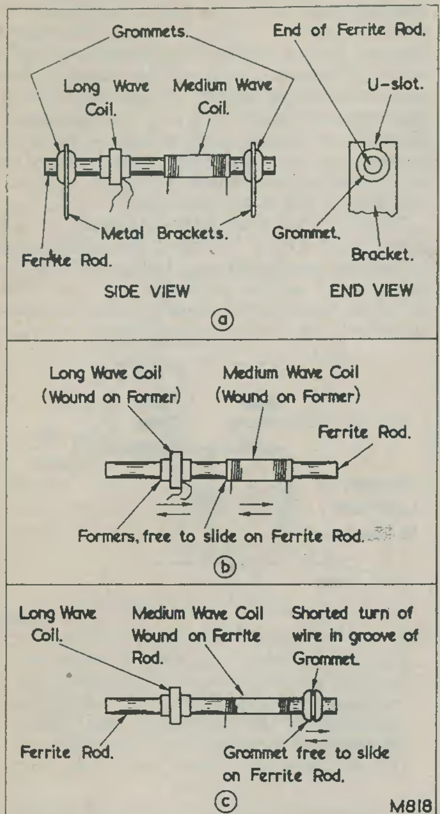


Fig. 3 (a) Typical ferrite rod aerial mounting brackets. When the brackets are made of metal the ferrite rod is held in U-slots in order that it may not be completely encircled by the metal

(b) When the Medium and Long wave coils are wound on formers, their inductance may be varied by sliding them along the ferrite rod

(c) Sometimes the Medium wave coil is fixed to the rod (or is wound directly on to it) whereupon adjustment of its inductance may be achieved by sliding an adjacent shortened turn along the rod

particularly liable to pick up any harmonics 'sprayed out' from the detector stages."

"So you wouldn't advise anyone having, say, one of those indoor V-aerials to place it on top of the cabinet?"

"I wouldn't advise them *not* to do so," replied Smithy, "but I would also say that, *if* putting the aerial on top of the cabinet caused patterning on picture or heterodynes on sound, they would be very sensible if they moved it some five to ten feet away."

Ferrite Rod Aerial

"My next job", commenced Dick (whilst Smithy groaned inwardly), "was concerned with a little transistor portable. I couldn't cure this one so I'm leaving it for you when you come back."

Smithy groaned again, audibly this time.

"Tell me the worst."

"The set wasn't working when it came in." replied Dick, "and on looking inside I found that the moulding which held the ferrite rod aerial in the middle had broken away. The ferrite rod had, in consequence, been clanging around inside the cabinet, and two of its connections had broken off. I re-made these connections and tied the rod back to what was left of the moulding, but I found that the set gave a very weak performance indeed. I tried the trimmers, but I couldn't get a maximum signal strength setting on either of the trimmers which tuned the ferrite rod aerial, so I presumed that the coils on this aerial had been damaged also. I thought it would be a nice job for you to start work with after your holiday!" concluded Dick brightly.

Smithy sighed.

"What did you tie the rod to the moulding with?" he asked, resignedly.

"Wire, of course."

"Bare wire?"

"Bare tinned copper. 22 s.w.g."

"And did you twist the ends together?"

"Not only did I twist them", said Dick proudly, "but I soldered over the twisted bits as well, for maximum security."

"You *muggins!*" exploded the Serviceman wrathfully. "Don't you realise that you have put the father and mother of all shorted turns right slap-bang in the middle of that poor little ferrite rod!"

Dick looked perplexed.

"Apart from the fact", continued Smithy censoriously, "that you should never have tied up a thing as brittle as a ferrite rod with wire anyway, your attempts at repair have not only caused it to lose most of its sensitivity, but have also caused the inductance of its coils to be thrown completely haywire. If you look at the mountings used for ferrite rods in commercial receivers you will have seen that, when these are made of metal, the ferrite rod goes into a U-slot. (Fig. 3 (*a*).) The U-slot doesn't allow the metal to completely encircle the rod and form a shorted turn and so you get no loss of efficiency."

Smithy stopped. The puppy had altered his digging position, and a shower of sand was suddenly projected against the Serviceman's face.

"Mind you," continued Smithy, his speech punctuated by expectorations of sand. "Shorted turns are sometimes added purposely to ferrite rods. In most cases you . . . Can't you control that sand-happy monster of yours?"

"Elvis," called out Dick in a commendably level tone.

The puppy obligingly stopped and directed an enquiring glance at Smithy's assistant.

"Find another hole!"

The puppy walked over, licked Dick's hand and flopped down on the sand beside him.

"Elvis?" queried Smithy. "That's a funny name for a dog, isn't it?"

"My girl friend chose it," replied Dick dispassionately. "It's her dog," he added, emphasising his lack of responsibility in the matter.

"Of course," said Smithy. "Where was I?"

"You said that shorted turns are sometimes added purposely to ferrite rod aerials."

"Oh yes, so I did! Now, in most cases you vary the inductance of a coil on a ferrite rod aerial by sliding it along the rod. (Fig. 3 (*b*).) The closer the coil goes to the centre of the rod, the greater its inductance. You treat this adjustment as a 'padding' operation during alignment. Sometimes, the medium wave coil is fixed to the rod, or may even be wound directly on it, whereupon adjustment of Medium wave inductance may be carried out by sliding along a shorted turn near the end of the rod at the Medium wave end. (Fig. 3 (*c*).) The shorted turn consists of a circle of wire fitted in the groove of a grommet and, since it is very close to the end of the rod, it does not, apparently, cause any loss of sensitivity."

Smithy stretched himself luxuriously.

"There won't", he said, smugly, "be any need for me to repair *that* set when I get back from my holiday! I would suggest that, first thing on Monday, *you* take off the wire fastening the ferrite rod, and tie the rod to the moulding, instead, with a strong twine such as dial cord. Slap some dope on the twine afterwards, and it'll be as firm as anyone could want. Also, the set will then work properly again, with the ferrite rod trimmers giving maximum sensitivity within their range."

"Fair enough," said Dick, equably. "That's one little job I'll save you from, anyway."

Picture Distortion

Smithy raised a suspicious eyebrow.

"I have no doubt", he said drily, "there are quite a few more."

"Bound to be," replied Dick cheerfully. "There's only me in the Workshop where previously there were two of us."

"I suppose that's a reasonable way of looking at things," conceded Smithy. He reflected that it would soon be time for him to have his swim. "How long did you say your girl friend would be away shopping?" he added pointedly.

"Half-an-hour," said Dick artlessly. "Now the next set that gave me trouble was a new 110 degree t.v. with a shocking trap."

"With a *what*?"

"Shocking trap. It was the worst case of trapezium distortion I've ever seen. The right hand side of the picture was only half the height of the left hand side."

"Ah," said Smithy, dismissing all thoughts of swimming from his mind, "now, if it had been very slight picture shape distortion I'd have suggested that you tried moving the pincushion correction magnets around to see if you could clear it. But the very severe case you mention is beyond the range of adjustment of such magnets. I presume that the trapezium wasn't the result of activities on *your* part?"

"Of course not." Dick was suitably shocked.

"Fair enough, then" said Smithy. "It's almost certain that we'll need a new deflector yoke for that receiver. When you get back, whip the existing one off and have a quick look round for an obvious fault in the frame windings and in the connections to them. The frame windings can be easily identified because they will almost certainly be wound on to the ring of ferrite material. Look for a really *obvious* snag, such as a wire broken away from its tag or a short circuit. If you can find such a snag, all well and good. If not, order up a new yoke straightaway, as the repair of the existing one will be beyond our capabilities."

"O.K., Smithy," said Dick absentmindedly. His voice betrayed the fact that his thoughts were elsewhere.

"What's up?" enquired Smithy.

"I'm just thinking about what you said concerning pincushion correction magnets. Are they fitted to all 110 degree deflector yokes?"

"So far as I know, yes," replied Smithy, "but they aren't always capable of being adjusted. In some instances they're fixed by the manufacturer to the polythene moulding which houses the line coils, and shouldn't really be touched by the likes of us. Usually, though, they're stuck on the ends of small brass brackets (Fig. 4), whereupon you bend the brackets around until you get the correction you want."

"Well, now," said Dick thoughtfully.

"That explains *another* snag I was putting on one side for you!"

"Go ahead."

"This other set also suffered from picture shape distortion, but it was infinitely less severe than the trap case I've just mentioned. In fact most viewers would probably not have noticed it. I rather tended to put the set on one side as having a fault which lay more in your country than in mine, but I did notice that there was a bracket on either side of the yoke assembly, and that one held a magnet and the other didn't."

"There is little doubt that one of the magnets had fallen out of its holder," said Smithy. "That one's an oldie!"

"What I'll have to do then," replied Dick,

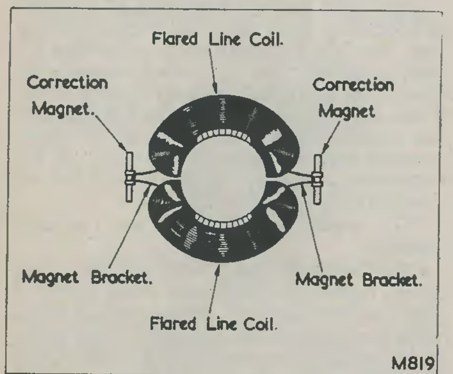


Fig. 4. On many 110° deflection yokes, picture shape correcting magnets are fitted to brackets positioned at the points where the line coils meet. The brackets are made of thin brass and are capable of being bent to any desired shape, thereby allowing the position of the magnets to be readily adjusted. The magnets themselves are in the form of small rods having diameters and lengths of the order of ¼ and 1 inch respectively

"is to find the old magnet and stick it back into the clamp again. After which the slight picture shape distortion should clear. Or, at least, it should clear after I've waggled the bracket round a bit."

"That would seem to be the drill," said Smithy, just a little acrimoniously. "If you're lucky you'll probably find the missing magnet lying around in the chassis, bridging h.t. positive down to chassis or something like that. It's own magnetism will, actually, make it liable to stick to ferrous metals such as transformer cores or the chassis. On the other hand, it could have slipped through the bottom of the cabinet, in which case it may well be lost." (Dick's face fell.) "However," continued Smithy, "we have a small graveyard of 110 degree yokes in the Workshop. You should be able to sort out a defunct one that looks the same as the one in your set and pinch a magnet off that." (Dick's expression brightened again.) "Don't forget that the magnet has got to go back right way round."

"Which way round will that be?"

"The one that clears the distortion," said the Serviceman shortly.

Printed Circuit Fault

Discussion of deflector yokes was now obviously at an end, and even the rhinoceros-hided Dick realised that there was a reluctance on Smithy's part to talk about technicalities. Dick mustered all his tact in an attempt to change the conversation.

"You're peeling an awful lot, aren't you?"

"Nothing of the sort," replied Smithy indignantly. "I'm acquiring a deep healthy tan."

"Your knees don't look very brown," commented Dick, examining the Serviceman critically.

"If", said Smithy heatedly, "you're going to look at me as though I were a specimen in a glass case I would prefer that we spent the few remaining minutes of our conversation discussing radio."

"Okeydoke," said Dick serenely. After all, he'd done his best. "Now I had a real stinker of a fault on a printed circuit receiver only a day or two ago; and so . . ."

"And so", interrupted Smithy, "you left it for me."

"Why, yes I did, actually," confessed Dick. "It was a little four valve battery portable and it came in suffering from weak reception. Armed with my trusty signal genny I soon discovered that one of the i.f. slugs wasn't tuning and so I whipped off the transformer can."

"The condenser across the tuned winding which didn't tune was a silver-mica which had gone open-circuit?"

Dick looked startled.

"How on earth did you know that?"

Smithy could not help but laugh at his assistant's surprised expression.

"It's the first thing I'd have looked for," he chuckled. "Carry on."

"Well, I popped in another condenser", resumed Dick, "and replaced the transformer can. I switched on and found that, whereas all the valves had lit up O.K. previously, only two of them lit up now! I checked the remaining two on the valve tester and they were perfect, yet when I replaced them in their sockets on the printed circuit board they still refused to light up."

Smithy grinned surreptitiously.

"I'm pretty certain what had happened," he said, "but I'm always interested in the processes of your mind. What did you do next?"

"Well, I checked for filament voltage on the pins of the two valveholders and there just wasn't any. And then I had a bright idea. I traced out the copper pattern on the board itself. Do you know, Smithy, there was no circuit on that board whatsoever which would supply l.t. negative to those two valves!"

Smithy raised a politely incredulous eyebrow.

"Honestly, Smithy," continued Dick, "there was just a little island of copper going to those two valveholder pins, and to a few odd condensers and resistors, but it didn't couple to the l.t. negative supply in any way whatsoever."

"Was one of your i.f. can mounting lugs soldered over to your 'island of copper'?"

Dick paused.

"Why, yes, I believe it was."

Smithy watched Dick's expressive face as it registered first puzzlement, then sudden understanding, and finally self-vexation.

The puppy suddenly gave a loud bark of recognition and rushed off across the sand.

"Don't you worry about that set," said Dick hastily, rising confusedly to his feet. "I'll clear it up when I get back! My girl friend's coming and I'll have to be on my way."

"Without even telling me how you're going to clear the fault?"

"O.K. Smithy," laughed Dick, getting ready to leave. "You win! When I put the i.f. can back I only soldered one of its two mounting plugs, because I thought that this would be good enough for testing purposes. I've just realised that the l.t. negative connection to the two valves which didn't light up was made via the can itself. If I'd soldered *both* lugs to the copper pattern on the board, everything would have been O.K."

Peace At Last

With which sentence, and with a final "Cheerio" over his shoulder, Dick rushed off to meet his companion. Smithy watched them as they walked away together across the sand. He realised that it might, perhaps, have been more sociable of Dick had he introduced his friend to Smithy, but previous meetings of this sort had tended to be catastrophically unsuccessful due to confusion in Smithy's mind over the names of Dick's current and previous flames.

Smithy brushed away the remaining sand from his hair and lay back happily. Thoughts of servicing and the Workshop faded gradually away. Peace at last!

"Excuse me."

Smithy opened one eye and saw that the little man with the paper white skin was sitting beside him.

"Yes?"

"I couldn't help hear you talking," said the little man, "about radio and television just now, and I was rather interested."

"Oh, yes," said Smithy non-committally. "Are you in the trade?"

"Dear me, no," replied the little man. "I'm a greengrocer."

"Perhaps you're an amateur then?"

"Gracious me, no," said the little man. "I don't know the first thing about radio. What has happened is that I've got a little portable on the beach with me and I can't get a sound out of it at all. I've just brought it over and I wondered if you could have a look . . ."

CAN ANYONE HELP?

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

H.M.V. Radiogram Model 580.—A. G. Stuart, 43 Castle Street, Aberdeen, wishes to obtain the circuit or service manual.

* * *

Tx Type 82 (40R/81).—T. Hannen, Sarden Cottage, Great Maytham, Rolvenden, Kent, would like to obtain a circuit diagram of this equipment. Also required is information regarding the h.t. voltage to supply and tapping points for operation of in-pulses.

* * *

Model 8 "True-Vue" Portable TV A33.—P. L. Grieveson, 46 Clarence Crescent, Sidcup, Kent, believes this receiver was a "direct-to-customer" supply by Jack Buchanan Enterprises. The service sheet or manual for this t.v. receiver is urgently required and any information on this early receiver would be greatly appreciated.

Transistorised Converter.—J. B. Wheatcroft, "Clevedon", 4 Littlemoor, Newbold, Chesterfield, would like to receive a circuit for a transistorised converter which would convert a low d.c. voltage (4–12V) to 270V d.c. for charging an electrolytic condenser which operates an electronic flash.

* * *

German Army Transmitter/Receiver Type 15WSEB.—J. R. Hardcastle, Rigton Grange, East Keswick, Nr. Leeds, requires the circuit and information on this equipment. Particularly required is information *re* input socket connections and voltages. Also required are details for converting the RF26 unit for use on the 10, 15 and 20 metre amateur bands.

* * *

Indicator Units Conversion Data.—W. O'Brien, 33 Horace Road, Barton, Torquay, requires conversion data for indicator units to oscilloscopes suitable for radio and t.v.

UNDERSTANDING TELEVISION

PART 32

By **W. G. MORLEY**

The thirty-second in a series of articles which, starting from first principles, describes the basic theory and practice of television

In last month's contribution to this series we introduced the subject of the sync separator. We saw how the synchronising signals are clipped from the transmitted waveform and, also, how differentiated sync pulses were passed to the line sawtooth generator in order that the latter may remain in synchronism during the frame sync pulses. We shall now carry on to synchronising the frame sawtooth generator; and this will necessitate further reference to the synchronising waveform of the 405 line system which was published in last month's issue. (See Fig. 13, page 26.—Ed.)

Integration

In order that the frame sawtooth generator may be kept in synchronism, it is necessary that it should receive synchronising information from the transmitted waveform. As was shown in Fig. 13, which illustrated the synchronising waveform for the 405 line system, eight broad frame synchronising pulses are transmitted at the end of each frame. In the manner in which they are transmitted such pulses cannot be applied directly to the frame sawtooth generator. In consequence synchronising information has to be obtained by some form of processing. We shall now examine how such processing may be carried out.

Fig. 193 (*a*) illustrates an *integrating circuit*. This consists of a series resistor followed by a condenser. In Fig. 193 (*b*) we apply a series of positive-going line sync pulses to the integrating circuit, the integrated signal at the output terminals being shown below the pulses which are applied to the input.

At point "A" of Fig. 193 (*b*) we have the leading edge of the first positive-going pulse. Immediately after point "A" the condenser commences to charge to the new potential applied to the input terminals, its rate of charge being slow because of the series resistor. In consequence, there is a gradual rise in potential across the condenser. At point "B" the positive-going pulse ceases, whereupon the condenser commences to discharge, again slowly. At point "C" we have the leading edge of the next sync pulse and, at point "D", the end of that pulse. The voltage across the condenser commences, once more, to rise slowly at point "C", and to fall, slowly, at point "D". The process is repeated for each successive pulse applied to the input terminals.

In Fig. 193 (*c*) we apply both line and frame synchronising pulses to the integrating circuit. The input pulses shown are those given by clipping the even frame waveform of Fig. 13, and both line and frame pulses are positive-going. Up to point "P" in the diagram the output of the integrating circuit is similar to that shown in Fig. 193 (*b*), wherein line sync pulses only were integrated. Point "P" marks the leading edge of the first broad frame pulse and, once again, it defines the point where the condenser in the integrating circuit commences to charge. However, in this instance the length, in time, of the applied pulse is considerably longer than that of the previous line sync pulses, with the result that the condenser is able to charge to a much higher potential than it did during the length of a line pulse. At point "Q" the first frame pulse comes to an end, and the condenser commences to discharge slowly. Very shortly afterwards, at point "R", we have the leading edge of the next frame pulse, and the condenser ceases to discharge and commences to charge once more. At points "S" and "T", the process is repeated, the condenser discharging over a relatively short time and charging over a relatively long time. The process continues until, at point "U", the trailing edge of the last frame pulse appears. After point "U" normal line sync pulses reappear, and the potential across the condenser falls during the next few pulses to the average potential it held before point "P".

It will at once be seen that, due to the integrating circuit, the frame synchronising pulses have been made to produce a single jagged pulse having an amplitude considerably greater than that of the integrated line sync pulses. The single integrated frame pulse does not have the sharp leading edge we have, up to now, associated with synchronising pulses, but it is still, nevertheless, quite suitable for application to a frame sawtooth generator for the purpose of initiating its flyback period.

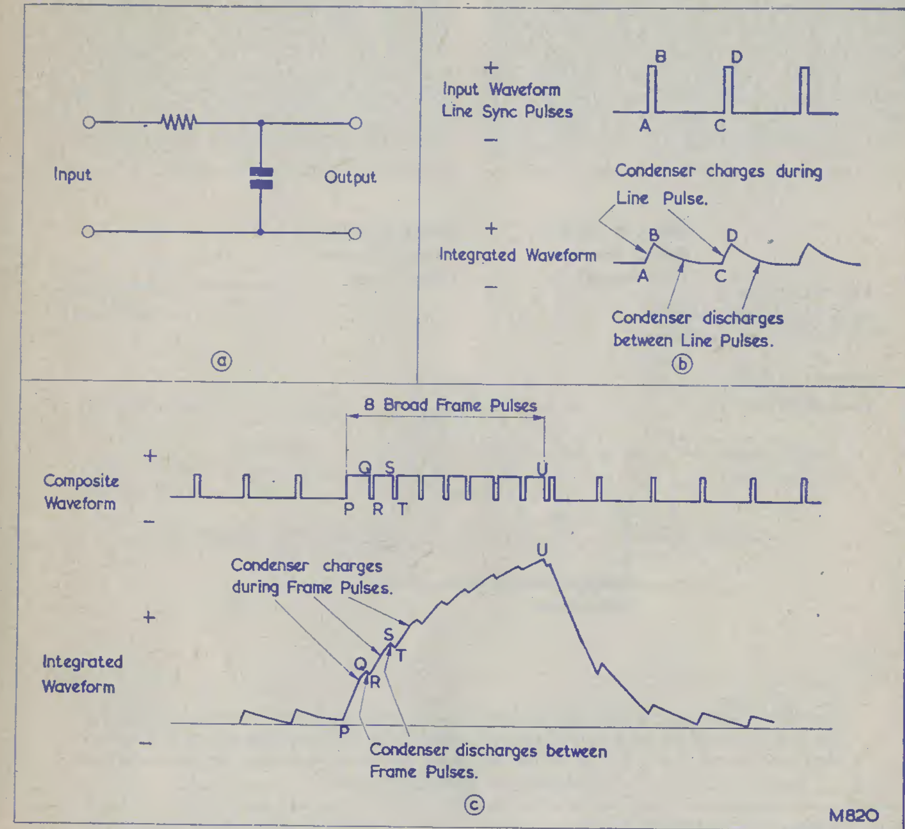


Fig. 193 (a) An integrating circuit

(b) The waveform appearing at the output terminals of the integrating circuit when line sync pulses are applied to its input

(c) If the composite synchronising waveform for the 405 line system (even frames) is applied to the integrating circuit, the broad frame pulses cause a single large integrated pulse to appear at its output

3A

Integrating Even and Odd Frames in the 405 Line System

An examination of Fig. 13 shows that the frame synchronising pulses for even and odd frames have the same number and shape. At the same time, the line sync pulses immediately preceding the frame pulses differ in timing for even and odd frames. On even frames the leading edge of the last line sync pulse is spaced by a period equal to one line away from the leading edge of the first broad frame pulse; whilst, on odd frames, the leading edge of the last line sync pulse is spaced by a period equal to half a line only from the leading edge of the first frame potential starting point than does that for even frames. This higher potential is retained throughout the leading edge of the integrated pulse, and the result is shown in the diagram. If the integrated waveforms of Fig. 194 were applied directly to the frame sawtooth generator initiation of frame flyback would occur at a single potential, such as that at line "XY". It will be seen that the two waveforms of Fig. 194 do not cut the line "XY" at the same instant in time (relative to the leading edge of the first frame sync pulse). In consequence, direct application of the integrated pulses to the frame sawtooth generator must always result in a

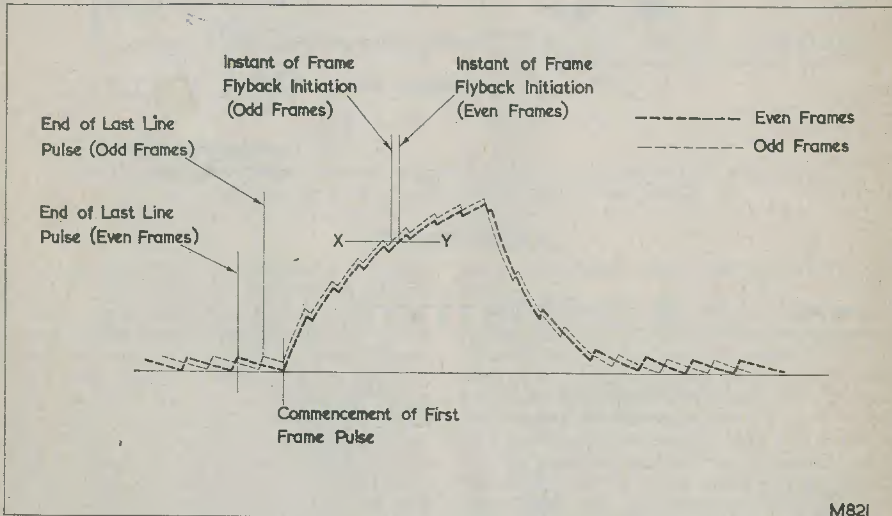


Fig. 194. Since, in the 405 line system, the last line sync pulse is spaced away from the first frame pulse by a period equal to a line of a half-line (according to whether the frame be even or odd) the integrated frame pulses do not have the same starting potential on alternate frames

pulse. This dissimilarity causes slight differences between the integrated frame pulses for even and odd frames.

Fig. 194 illustrates the integrated frame pulses given by even frames and odd frames superimposed upon each other. The waveform for even frames is shown in dashed line and that for odd frames in dotted line. The dashed line waveform is similar to that of Fig. 193 (*c*).

At the point when the leading edge of the first frame pulse appears it will be seen that the condenser in the integrating circuit has a higher charge for odd frames than it has for even frames, this being due to the fact that it has had less time to discharge since the last line pulse. Thus, the integrated frame pulse for odd frames commences at a higher slight dissimilarity in time (relative to the leading edge of the first frame sync pulse) between frame flyback initiation on even frames and frame flyback initiation on odd frames.

The dissimilarity in time between the two integrated frame pulses, although small, is capable of seriously upsetting the goodness of the interlace given in the reproduced picture. Perfect interlace occurs when the lines of one frame lie exactly centrally between the lines of the other frame. The dissimilarity in time, evident in Fig. 194, would cause the lines in the frame following the integrated odd frame pulse to take up a position lower than the exactly central condition, because the frame flyback period immediately preceding them was initiated at

a relatively earlier time. In practical instances it is possible for the interlace under these conditions to be so poor that visible "pairing" takes place.[1] Examination of Fig. 194 will show that the dissimilarity in time between the odd and even integrated pulses varies for different heights of the line "XY". This effect was sometimes taken advantage of in early 405 line receivers wherein integrated frame pulses were applied directly to the frame sawtooth generator; setting-up instructions for such sets stating that the frame hold control should be adjusted to a position which gave best interlace. (Adjusting the frame hold control over the range in which frame synchronisation employed, in one form or another, in all modern receivers. They are normally given such names as "pulse shaper", "interlace filter", and so on.

A typical and frequently employed circuit technique is illustrated in Fig. 195. In this diagram the presence of R_1 causes integrated pulses to appear across C_1, these being applied, via a diode, to condenser C_2 in parallel with resistor R_2. The time constant of C_2 and R_2 is normally considerably longer than that of the integrating circuit given by R_1 and C_1. Also, C_2 normally has a larger value than C_1. The sync pulses applied to R_1 and C_1 are negative-going (as would occur at the anode of a sync clipper following a

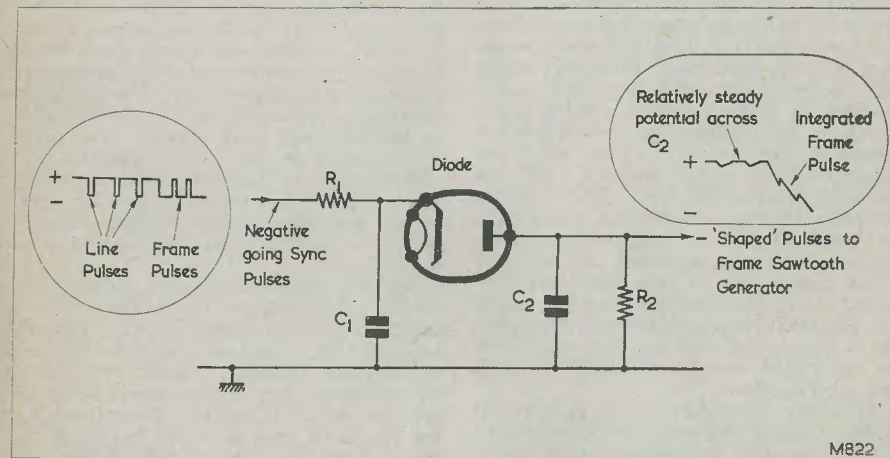


Fig. 195. A circuit which reduces the dissimilarity in time (relative to the leading edge of the first frame pulse) between alternate integrated frame pulses in the 405 line system

occurs has the effect of varying the height of line "XY" in Fig. 194. This is because it varies the negative voltage on the appropriate grid of the frame sawtooth generator at the moment when the integrated sync pulse is applied to it.)

Improving Interlace with the 405 Line System

A number of different circuit devices have been developed to overcome the dissimilarity in time between the integrated frame pulses for even and odd frames which occurs with the 405 line system. Such devices are

[1] "Pairing" is a loose term which usually describes the condition where interlace is sufficiently poor for adjacent pairs of lines in alternate frames to merge together, producing a picture having, apparently, only half the lines offered by the system. Sometimes, the term is used to describe obviously poor interlace without actual merging of adjacent lines.

cathode-modulated cathode ray tube). The small negative-going integrated line sync pulses between frame sync pulses cause C_2 to charge, via the diode, to a potential which is very nearly equal to their peak value. In consequence, the diode only conducts during integrated line sync pulse peaks, and the potential across C_2 is relatively steady. On the arrival of the frame sync pulses, an integrated pulse much larger than the line sync pulses appears across C_1. The diode conducts during the leading edge of this large integrated pulse, causing C_2 to charge to a much higher potential than it held during the line sync pulses. The leading edge of an integrated pulse appears, therefore, across the plates of C_2 also. On the cessation of frame sync pulses both C_1 and C_2 discharge. Because of the longer time constant in C_2

and R_2, C_2 discharges more slowly than C_1 and, for a period, the diode is non-conductive. When the potential across C_2 falls to the peak value of the integrated line sync pulses the diode conducts on their peaks, and the circuit reverts to the condition it held before the arrival of the frame sync pulses.

If the foregoing is considered a little more fully, it may be noted that between frame sync pulses—where the diode is non-conductive almost all of the time—the integrating circuit is formed by R_1 and C_1. On the arrival of the frame sync pulses the diode becomes conductive, with the result that the integrating circuit is provided by R_1 and by C_1 *in parallel with* C_2.

The integrated frame pulse across C_2 will, due to the additional capacity brought into circuit by the diode, have a lower amplitude and a less steep front than that which would be given by C_1 on its own. Provided that the pulse across C_2 is large enough to synchronise the frame sawtooth generator, this represents no disadvantage. The important feature of the circuit is that, since the integrated frame pulses across C_2 for odd and even frames both have almost exactly the same *starting potential* (i.e. a potential very nearly equal to the peak potential of the integrated line sync pulses held, as a relatively steady charge, in C_2) then both will have almost exactly the same shape and amplitude. The dissimilarity in time between the pulses shown in Fig. 194 does not then occur, and the controlled sawtooth generator should give good interlace.

A further, secondary, point is that the trailing edge of the pulse appearing across C_2 is the same for both odd and even frames because it is formed entirely by the discharge of C_2 into R_2, the diode at this time being non-conductive. As a result, it may be stated that the circuit of Fig. 195 provides integrated frame pulses on odd and even frames whose leading *and* trailing edges are very nearly identical.

Most conventional frame "pulse shaping" circuits following integrating circuits in practical receivers employ the basicprinciple illustrated in Fig. 195, integrated frame pulses for odd and even frames being allowed to commence at very nearly the same starting potential. Indeed, many practical arrangements are almost identical to the simple circuit of Fig. 195, the main difference being that, since the integrating circuit is normally connected to the sync clipper anode, R_2 is returned to a fixed positive potential instead of to chassis. Alternatively, a large value d.c. blocking condenser may be inserted between the integrating circuit and the diode to enable R_2 to be returned to chassis.[2] Also, in practical circuits, it is usual to replace the thermionic diode of Fig. 195 by a germanium diode or a Westector.[3]

Differentiating the Frame Sync Pulses in the 405 Line System

An alternative solution to the interlace difficulties associated with the 405 line system is given by obviating the integration process altogether. The frame synchronising information is, instead, extracted from the composite waveform by differentiation.

Fig. 196 (*a*) illustrates a synchronising waveform, applicable to an even frame in the 405 line system and having negative-going pulses, applied to a differentiating circuit. The latter has a longer time constant than would occur in a differentiating circuit intended to pass spike shaped pulses to the line sawtooth generator. Before point "A" in Fig. 196 (*a*) the leading edge of each successive line sync pulse causes the potential on the output terminals of the differentiating circuit to go rapidly negative. The condenser then discharges slightly until the trailing edge of the line sync pulse appears, whereupon the potential on the output terminals goes rapidly positive. Between line sync pulses, the condenser discharges slowly, causing the output potential to go slightly negative before the leading edge of the next line sync pulse.

The first broad frame sync pulse arrives at "A", whereupon the output of the differentiating circuit goes rapidly negative, to point "B", in the same manner as did it with the leading edges of the line sync pulses. The condenser then commences to discharge until point "C" is reached. Since, however, the length of time occupied by the broad frame sync pulse is much greater than that occupied by a line sync pulse, the condenser discharges by a larger amount between points "B" and "C" than it did during the line sync pulses. At point "C", therefore, the output potential of the differentiating circuit is more positive than it is at the end of a line sync pulse. Immediately after point "C" the first broad frame pulse ceases, and its trailing edge causes the output potential to go rapidly positive, reaching point "D". After point "D" subsequent broad frame pulses cause the output potential to go more and more positive, as shown in the diagram.

It will be seen that point "D" in Fig. 196 (*a*) is significantly more positive than any previous point in the waveform, and it is possible to synchronise a frame sawtooth generator with the section of "CD" which lies between lines "WX" and "YZ". In practical arrangements it is desirable to clip the remainder of the differentiated waveform so that no point of it is more positive than point "D". The frame sawtooth generator can then have its flyback initiated only by the upper section of the sharp pulse-face "CD".

[2] In the latter case the junction of the large value condenser and the diode would be held at a fixed average potential by a potentiometer between chassis and the h.t. positive rail.

[3] "Westector" is a brand name applied to small metal-oxide rectifiers manufactured by Westinghouse Brake and Signal Co. Ltd.

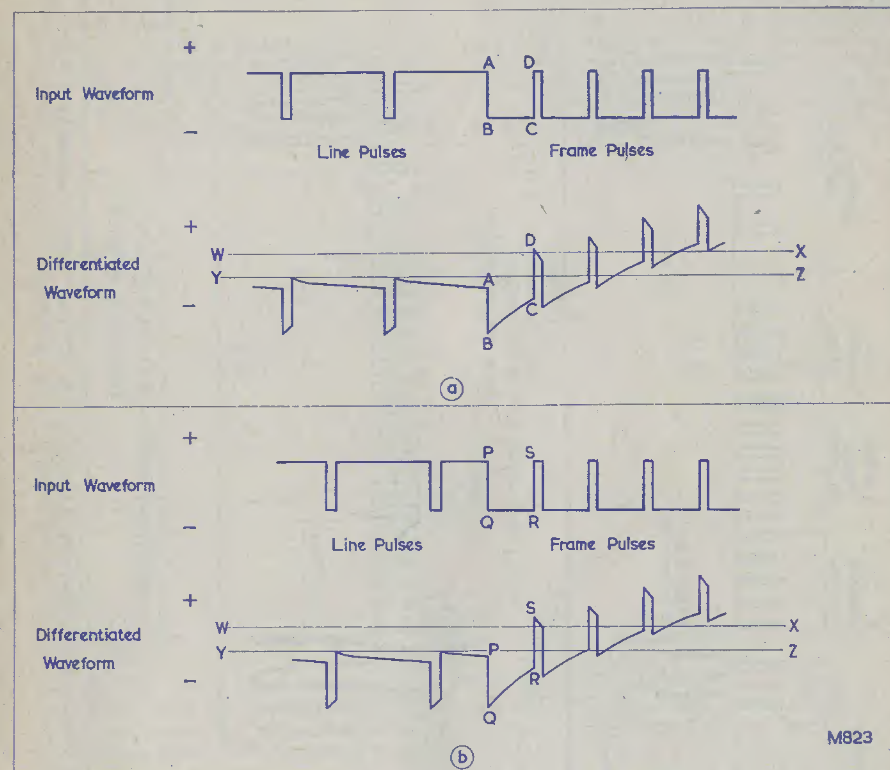


Fig. 196 (a) Obtaining a frame sync pulse in the 405 line system by differentiation. In this diagram the even frame waveform is differentiated

(b) Differentiating the old frame waveform

the trailing edge of the pulse. The output potential now goes rapidly positive, causing the sharp pulse-face "RS" to appear at the output of the differentiating circuit. A frame sawtooth generator capable, as in Fig. 196 (*a*), of being synchronised by potentials between lines "WX" and "YZ" would then have its flyback initiated by the sharp pulse-face "RS". Since the starting point of the first differentiated frame pulse, at "P", is slightly higher than point "A" in Fig. 196 (*a*), all subsequent parts of the differentiated waveform will also be slightly higher. Thus, the upper line "WX" cuts pulse-face "RS" at a relatively lower level than it cuts pulse-face "CD". This is of no importance, the entire point of the circuit being that between the limits "WX" and "YZ" frame synchronisation on both odd and even frames occurs at the same point relative to the leading edge of the first frame pulse, with the

Fig. 196 (*b*) illustrates the results given by differentiating the composite waveform for odd frames. In this diagram the first broad frame pulse appears at point "P". Since the last line pulse is spaced away from point "P" by a half-line period only, the condenser in the differentiating circuit discharges less than it did before point "A" of Fig. 196 (*a*). In consequence, point "P" is slightly more positive than point "A". The leading edge of the first frame pulse causes the output potential to go rapidly negative, to point "Q", this being followed, at point "R", by

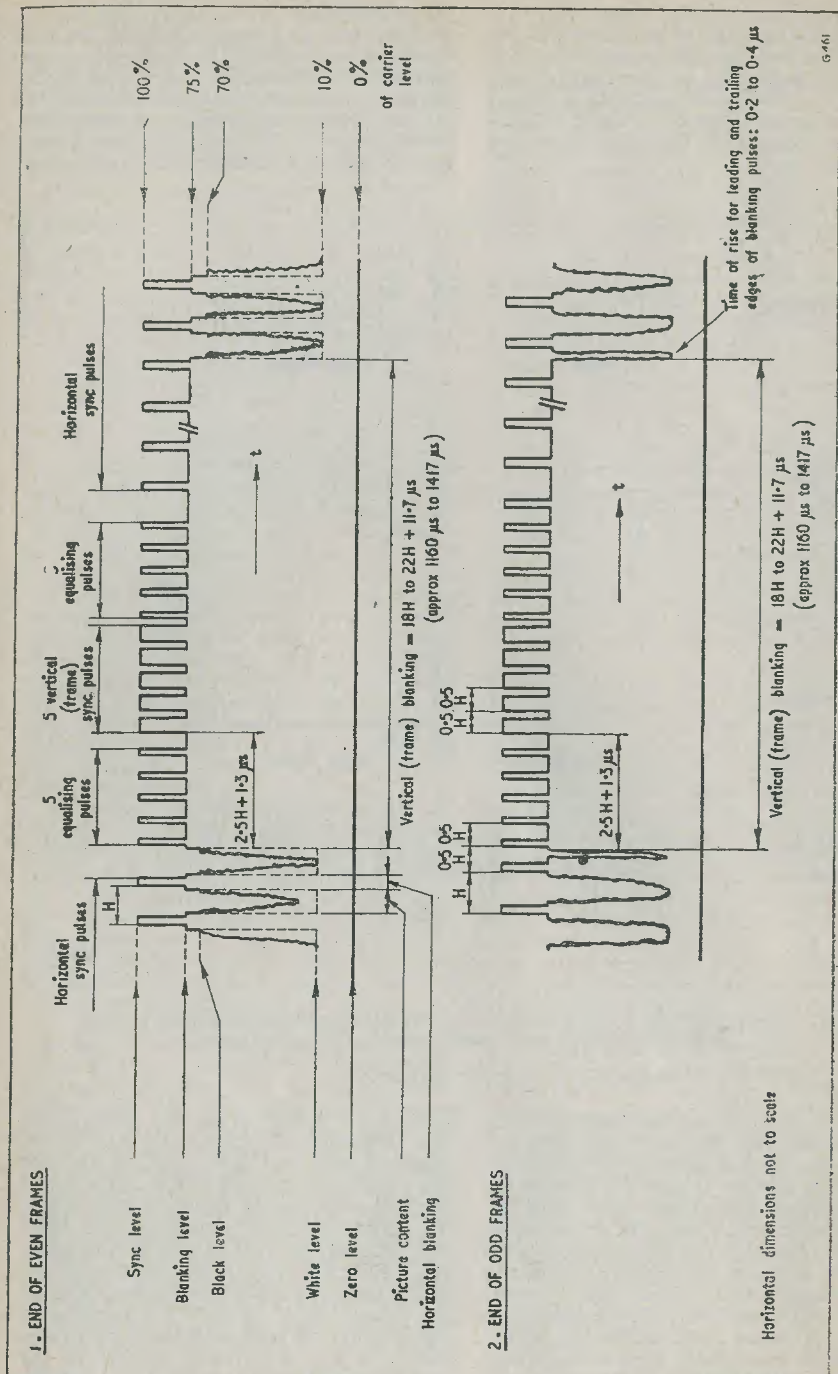


Fig. 18 (a) Synchronising waveform of the "C.C.I.R. 625 line" system. (Actually "625 line system for 7 Mc/s channel width.") The dimension H refers to the duration of 1 line

result that good interlace is possible. (In practice, the top sections of both "CD" and "RS" would, in any case, probably be clipped to the same level in the subsequent circuit which clipped the remainder of the differentiated frame pulse waveform.) It should be noted that both pulse-faces "CD" and "RS" correspond to the *trailing* edge of the first broad frame pulse.

Equalising Pulses

There is no necessity to employ circuit techniques of the type we have just considered ("pulse shaping" circuits or differentiating circuits followed by clippers) in receivers working on the C.C.I.R. 625 line or American 525 line systems. This is because, in these systems, *equalising pulses* are inserted into the signal to make the integrated frame pulses closely identical. Equalising pulses appear between the last line carrying picture information and the first broad frame pulse, and immediately after the last broad frame pulse.[4] To understand the function of these pulses it will be sufficient to consider the C.C.I.R. 625 line synchronising waveform, this being very similar to the American 525 line synchronising waveform.

Fig. 18 (*a*)[5] shows the sync pulse waveforms given at the end of even frames and at the end of odd frames. Commencing with the waveform for the end of even frames it will be seen that we have several positive-going line sync pulses[6] before we reach the end of picture information. Immediately after the last line of picture information we have five equalising pulses. These pulses are half as wide as the line sync pulses and they are spaced out so that their leading edges are at half line intervals. After the last equalising pulse we have the first of five broad frame pulses, these being followed by a further five equalising pulses. After the last equalising pulse normal line sinc pulses, spaced at intervals of one line, reappear on the waveform.

In the waveform for the end of odd frames the picture information ends with a half line. We then have the first of five equalising pulses, to be followed by the five broad frame pulses. These are followed by a further five equalising pulses, after which normal line sync pulses appear once more. The leading edge of the first line sync pulse is spaced away from that of the last equalising pulse by a half line period.

In order to distinguish between the two sets of equalising pulses, those which appear

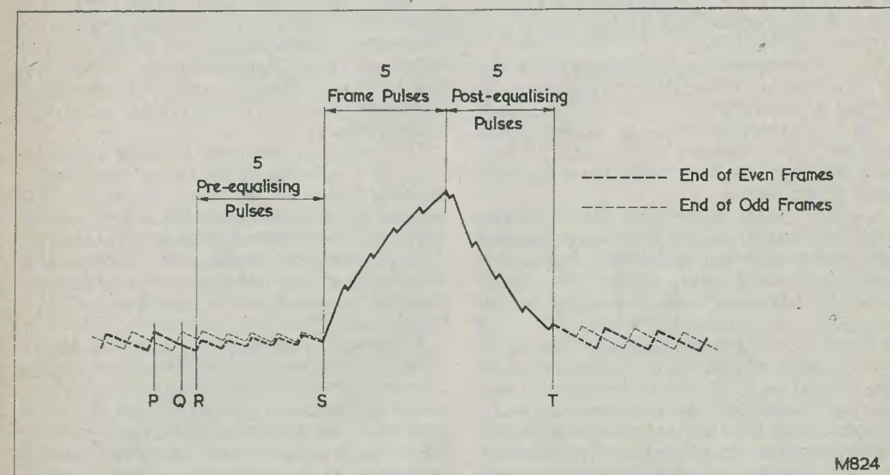


Fig. 197. With the American 525 and C.C.I.R. 625 line systems, the pre-equalising pulses cause the starting potentials for alternate integrated frame pulses to be very nearly equal. Also, the post-equalising pulses cause the formation of similar trailing edges. In consequence, alternate integrated frame pulses are nearly identical

[4] Complete information on the synchronising waveforms for the C.C.I.R. 625 line and American 525 line systems was given in "Understanding Television" Part 4, April 1958 issue.

[5] Reproduced from the April 1958 issue.

[6] Designated "horizontal sync pulses" in Fig. 18 (*a*).

before the frame pulses are called the *pre-equalising pulses* and those which appear after the frame pulses the *post-equalising pulses*.

Fig. 197 illustrates the result of integrating the two waveforms of Fig. 18 (*a*). The integrated waveform for the end of even frames is illustrated in dashed line, and that for the end of odd frames in dotted line.

Commencing with the end of even frames, and following the dashed line, we have, at "P", the commencement of the last line of picture information. This last line ends at "R", whereupon we have the first equalising pulse. Since the duration of this pulse is only half that of a normal line sync pulse, it causes the integrating condenser to charge to a lower value. Successive equalising pulses then produce the dashed waveform between "R" and "S".

At "Q" we have the commencement of the last half line of picture information given at the end of odd frames. This half line ends at "R". Following, now, the dotted waveform we have, between "R" and "S", the waveform given by integrating the equalising pulses which follow.

At "S" both waveforms have almost exactly the same potential. This is because identical waveforms—both consisting of five equalising pulses and having the same average voltage—have been applied to the integrating circuit between "R" and "S", and the condenser in the integrating circuit tends to take up a charge equal to the average voltage. After "S" the first broad frame pulse commences and is integrated in normal fashion. Since the starting potentials for the integrated pulses are almost exactly the same for both waveforms, both integrated pulses have almost identical leading edges. The integrated frame pulses continue to remain near identical during the post-equalising pulse period. When, at "T", the post-equalising pulses cease, the two waveforms become separate again, settling down after a few further lines to integrated line pulses of equal amplitude.

Since the integrated pulses in Fig. 197 are the same, or very nearly the same, for both the end of even and the end of odd frames, it follows that a frame sawtooth generator may be directly synchronised by them, and that good interlace will result.

The equalising pulses added to the composite waveform do not prevent the line sawtooth generator from remaining synchronised during the frame blanking period. We saw in Fig. 191[7] that, in the 405 line system, the line sawtooth generator has its flyback initiated by alternate differentiated pulses spaced at half line intervals during the frame synchronising period. Differentiating the C.C.I.R. 625 line system waveform causes pulses to appear at half line intervals not only during the frame pulse period, but also during the pre-equalising and post-equalising periods. As in the 405 line instance the line sawtooth generator has its flyback initiated by alternate half line pulses until the first normal line sync pulse appears once more, these half line pulses now appearing in the equalising periods as well as in the frame pulse period.

Frame Sync Pulse Amplitude

After the frame sync pulse has been separated from the transmitted signal and, if necessary, processed by any of the methods discussed above ("pulse shaping" circuits and the like) it is finally applied to the frame sawtooth generator, whereupon it initiates frame flyback.

It is a fairly common practice to ensure that the amplitude of the frame sync pulse is relatively low at the point at which it is applied to the sawtooth generator, and it may even be attenuated after processing to achieve this low amplitude.[8] The result is that frame synchronisation in many receivers tends to occur over only a small range of the frame hold control.

The reason for employing a low amplitude synchronising pulse is that such a pulse corresponds to a similarly low degree of coupling between the input to the sync separator and the sync application point of the frame sawtooth generator. The sawtooth generator is, in consequence, less liable to have its flyback initiated by random bursts of impulsive interference.

Next Month

In next month's contribution we shall carry on to flywheel sync circuits.

Reference

The information given in Fig. 18 (*a*) is taken from Report No. 83, Television systems; Extract from the documents of the C.C.I.R. VIIIth Plenary Assembly, Warsaw, 1956. The term "field", where it appears in extracts from the report, has been changed to "frame".

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[7] Published in last month's issue.

[8] Such attenuation may be provided by inserting a fixed resistor in series with the point of application to the sawtooth generator.

BOUND VOLUMES—"The Radio Constructor"

Bound volumes of the magazine (Vol. 13, August 1959 to July 1960 inclusive) will be available early in October. See advertisement inside front cover of this issue.

Beginners' Short Wave Receiver

Building the "GLOBE-KING" 100A RECEIVER

by JAMES S. KENT

In which our contributor describes, step-by-step, the construction of a simple receiver for Short wave operation. Presented specifically for the beginner, this article should be of great assistance to those about to embark on that never-to-be-forgotten venture—constructing the very first receiver

THE ABOVE HEADING HAS CAUGHT YOUR eye! You are a beginner who has acquired an interest in radio and you have ventured into this vast and strange new world for the first time. Having purchased this magazine, possibly for the first time, the designs, circuits and terms puzzle you immensely. You would like to build a simple radio set that would really work. There is no one to help or give you advice and you live, possibly, far from a radio shopping centre. All very bewildering and difficult, isn't it?

Nevertheless, the above heading has caught your eye! In time, and with the help of other articles and books, you will learn about the circuits and terms but here, and now, is something you can really "get your teeth" into and get down to as a practical start.

Firstly the tools required. All that you need for building a simple receiver, such as the one described here, are the following: pencil-bit type electric soldering iron, small pair of sidecutting pliers, a small screwdriver and penknife. The soldering iron, although possibly a little on the expensive side initially for the younger beginner, will prove to be cheap over the long period of its life.

Soldering

Before commencing operations it must be pointed out that good soldered joints should be made throughout the construction of the receiver—the additional resistance introduced by even one single poorly soldered connection will easily ruin the performance of an otherwise perfect set. Using a non-corrosive solder and flux, "Multicore" radio/t.v. quality three-cored solder is recommended, carefully prepare each joint just prior to the actual soldering by cleaning the component wire ends and tags, etc. Using the blade tip of an ordinary pocket-knife, scrape clean and brighten all such wire ends, tags, etc. Having done this, apply to the joint, at the same time, both the solder and the iron—having first, of course, allowed the iron to reach its working temperature. Never carry the solder on the iron to the joint or "dwell" on the latter too long with the hot iron—both cause the solder to lose its tin content. Soldering is an acquired knack and one where practice makes perfect. For more information on this subject, together with an excellent introduction to the short waves, the beginner is recommended to purchase a copy of *Short Wave Receivers for the Beginner* (Data Publications Ltd.).

Preliminaries

Five easy-to-follow diagrams, together with illustrations of the completed receiver and the circuit diagram, are presented here in order to make the construction of this receiver as easy as possible. This is a practical article and those wishing to obtain knowledge of radio theory and circuit applications should obtain reasonably inexpensive books dealing with such subjects.[1]

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[1] Recommended books for the beginner, inexpensive, lucidly and clearly written, are: *Foundations of Wireless, 7th Edition*, by M. G. Scroggie, B.SC., M.I.E.E., at 15s. net; *A Beginner's Guide to Radio*, by F. J. Camm, at 7s. 6d. net—both available from the Modern Book Co., 19 Praed Street, London, W.2.

Assembly and Wiring

Having obtained all the components, place a newspaper on the table or bench—this will avoid scratching the transfer already affixed to the front of the receiver. Using the nuts, screws and washers provided, mount into position both the valve and coil holders, as shown in Fig. 1, noting that the flanges of these are positioned under the chassis. Also note that three chassis solder tags must be mounted into position exactly as shown, one of these being a double tag. Fit these tags between the washers and the nuts. The nuts should be tightened down really firm, any tendency to movement will result in an intermittent fault later.

Stage 1

Following the large numerals in Fig. 1, commence wiring using plain tinned copper wire. Cut three lengths approximately 1½in each and use as follows:

(1) Solder chassis tag to valveholder tag 1.
(2) Solder chassis tag to valveholder tag 5.
(3) Solder chassis tag to coilholder tag 2.
(4) Solder chassis tag to black lead (thread this lead through grommet and prepare for soldering by cutting back approximately ¼in of rubber insulation, then insert the wire end into the tag hole and solder at this point).

Stage 2

(5) Thread the red lead (see Fig. 2) through the rubber grommet and solder one end of the filament resistor R_3, suitably shortened, to this lead after the latter has been bared. Next, solder the free end, suitably shortened, of R_3, together with one wire end, suitably shortened, of the grid resistor R_1 to tag 3 of the valveholder.

(6) Solder the remaining end of R_1 and one end of C_5, again having suitably shortened the wire ends, to tag 4 of the valveholder.

(7) Thread the free end of the yellow lead through the rubber grommet (one end of the aerial condenser C_1 is already connected to this as supplied). Take the wire ends, suitably shortened, of both the grid and the aerial condenser (C_5 and C_1 respectively) to tag 1 of the coilholder, and leave unsoldered for the present, two further connections being made later to this point. (See Stage 3, step 9.)

Stage 3

(8) Obtain a length of insulated sleeving, about 1⅞in in length, threading this over a length of plain tinned copper wire so that each end of the wire protrudes about ¼in at each end of the sleeving. Solder this from tag 2 of the valveholder to tag 4 of the coilholder (see Fig. 3).

Obtain the bandspread variable condenser C_3 and secure to the front of the chassis in the aperture provided. Note that the fixed vanes (stator) shaft tip is the soldering point —as shown in Fig. 3. The two condenser mounting brackets can now be mounted (see Fig. 4), using nuts, screws and washers. Fit to these brackets the two remaining variable condensers—these are identical components and each can be fitted in either position. Secure into position the dial scale with the bandset condenser C_2. (See Fig. 4.) Note that only the first nut is removed from these two condensers when mounting into position on the brackets. Under no circumstances should be second nut be removed or even unscrewed.

(9) (See Fig. 3). Cut two lengths of sleeving, one 1¼in in length and the other ½in in length, and two wire lengths about ½in longer. Thread these wires through the sleeving so that approximately ¼in protrudes at each end. Solder two ends to tag 1 of the coilholder together with the ends of the aerial and grid condenser wires previously left unsoldered. (Stage 2, step 7.) The best method of connecting the four wire ends is to first take a single wire and thread this through the tag hole, wedging the three remaining wires under this to secure them all into position, soldering only when this has been done. Solder the free end of the short wires to the bandspread condenser C_3. The remaining sleeved wire should now be fed through the hole in the chassis (12), whereupon its other end is connected to the bandset condenser C_2, soldering to the fixed vanes tag.

(10) Obtain the green lead and solder it to one end of the suitably shortened wire of the anode resistor R_2. Thread the free end of this lead through the rubber grommet. (See Fig. 3.) Shorten the other wire end of R_2 and place through the coilholder tag 3 but do not solder as yet. Obtain a length of sleeving, some 2⅞in in length and a wire about 3¼in long. Thread the wire through the sleeving and solder one end, together with the wire end of R_2, to tag 3 of the coilholder. Feed the sleeved wire through the chassis at point (11), connecting its other end to the fixed vanes tag of the reaction condenser (C_4).

Stage 4

(11) Fit the control knobs to the various spindles, the smallest being fitted to the spindle of the bandspread control and the pointer knob to the bandset spindle. Fit the latter knob in such a manner that the pointer indicates zero when the condenser moving vanes (rotor) are completely out of mesh. At the other end of the scale, if this knob is correctly fitted, the indicator should be at

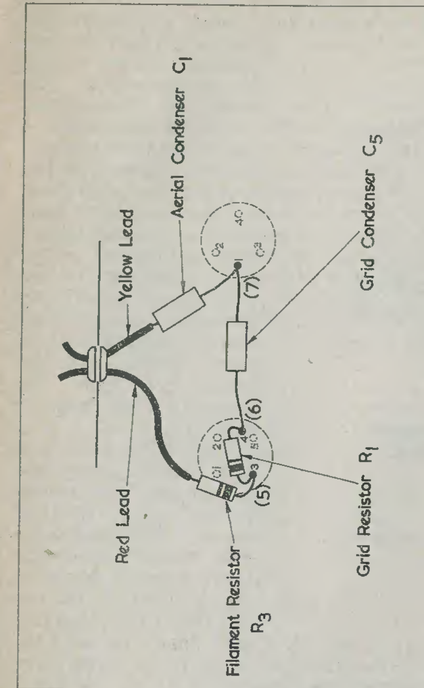


FIG.2.

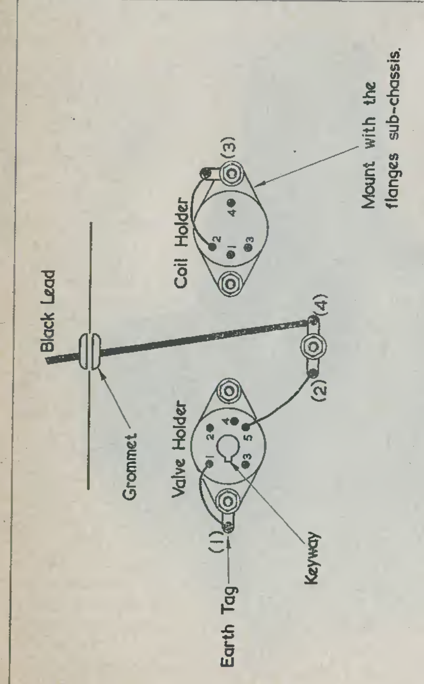


FIG.1.

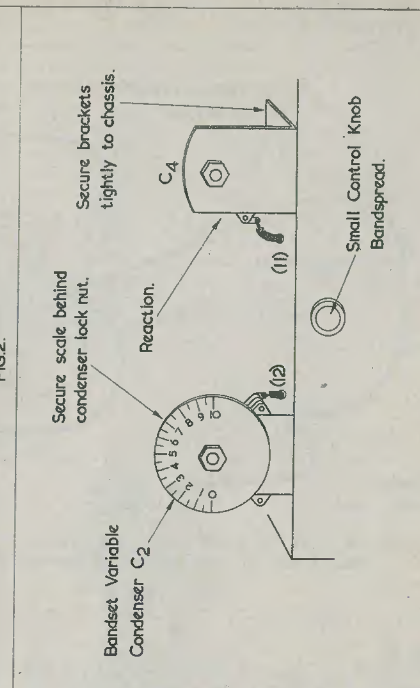


FIG.4.

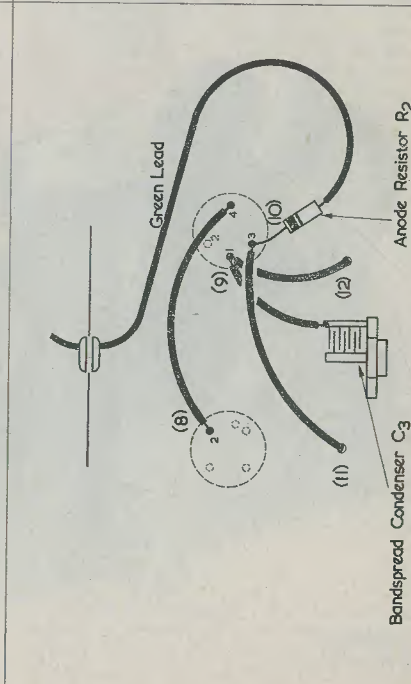
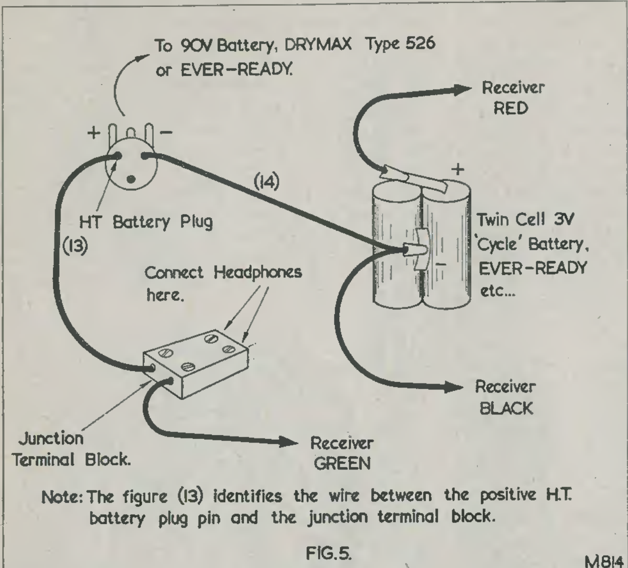


FIG.3.

point 10 with the moving vanes in full mesh —or maximum capacity.



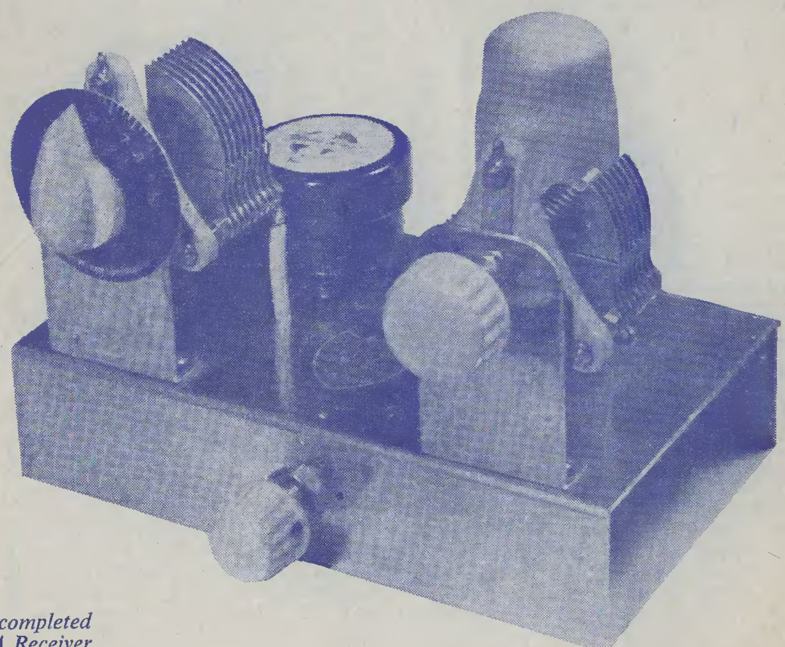
Note: The figure (13) identifies the wire between the positive H.T. battery plug pin and the junction terminal block.

FIG.5.

Stage 5

(12) The h.t. battery plug should now be connected into circuit as shown in Fig. 5. A lead (13) should be cut to a suitable length and have both ends bared, whereupon one end is soldered to the positive (+) pin of the h.t. battery plug. The other end of this lead should be connected to the junction terminal block as shown. The negative lead (14) from the battery plug, similarly cut and bared, should next be soldered to the appropriate pin of the plug, the other end being soldered to the 3-volt battery negative (−) clip together with the black lead from the receiver. (See Stage 1, step 4.)

The receiver green lead (see Stage 3, step 10) should next be connected to the junction terminal block. The headphone leads may now be secured to the terminal block as shown in Fig. 5. The red lead from the receiver (see Stage 2, step 5), should finally be soldered to the 3-volt battery positive (+) clip. This completes the construction of the receiver.



The completed 100/A Receiver

Testing and Operating the Receiver

Connect the aerial and earth to the receiver, the former being connected to the receiver yellow lead. The aerial required with this receiver is not critical, and any length from 100 feet down to a few feet strung around the room will suffice. A short outdoor vertical aerial, some six to ten feet in length, would be ideal for testing purposes. The earth connection should preferably be made to a copper rod buried in moist earth and kept in a damp condition. An alternative earth connection may be provided by connection to a lead cold water pipe carrying the main water supply. Make the earth connection, at the receiver end, to any part of the metal chassis or the l.t. negative (−) connection of the 3-volt battery with the aid of a crocodile clip.

Fit the negative (−) battery clip to the 3-volt battery. Do not fit the positive (+) battery clip yet. Insert the h.t. battery plug into the 90-volt h.t. battery. Insert the valve into the valveholder and coil No. 2 into the coilholder for the initial test.

Rotate the reaction control so that all the rotor vanes are out of mesh and set the bandset dial to read between 4 and 5 degrees. Next, connect the positive (+) clip to the 3-volt battery—the receiver is now switched on. (**NOTE:** The positive clip must be removed when the receiver is not in use —otherwise the batteries will very soon require renewing!)

Rotate the reaction control clockwise until a "click" is heard in the headphones. Now, bring this control back in an anti-clockwise direction until it is just slightly inside the "click" position. (In this latter position the receiver is, in fact, oscillating.) Next, slowly rotate the bandset control throughout points 3 to 6, whereupon signals—either speech, music or morse—should be heard. To adjust for maximum gain on the signal required rotate the bandspread control slowly until the peak signal position is attained. This can now be further boosted by carefully adjusting the reaction control just off the point of oscillation. A little practice here will soon make the beginner conversant with the technique of Short wave tuning. To receive morse signals, the receiver should be slightly advanced into oscillation.

The various coils should now be inserted into the coilholder and the various bands explored. Generally speaking, it will be found that daylight periods are the best times for operating over the higher frequencies whilst darkness favours the lower frequencies. Morse signals can be tuned to the desired pitch for maximum readability by setting the reaction condenser in the oscillating position and then rotating the bandspread condenser until the required pitch is obtained.

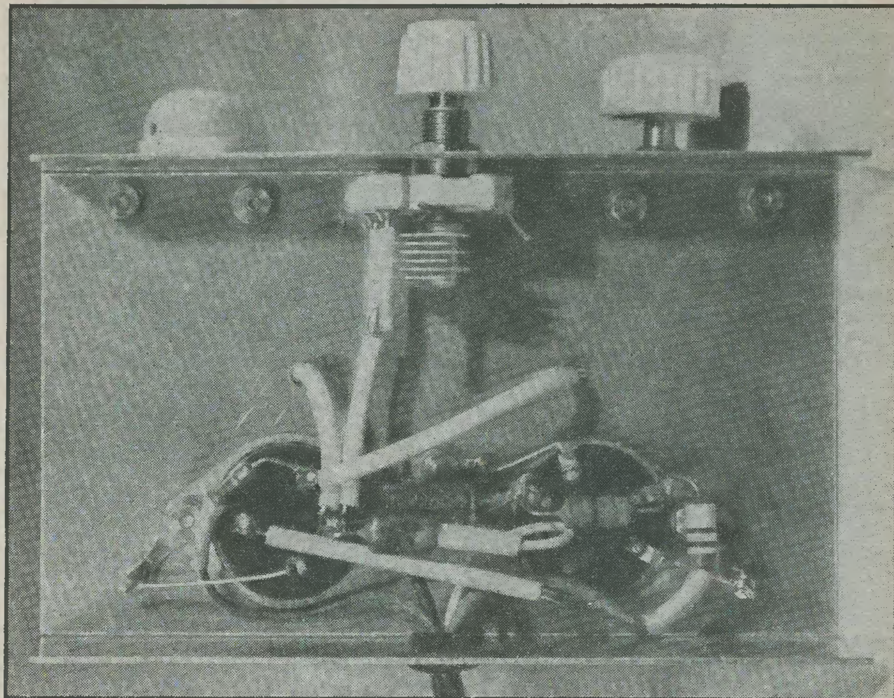
Table I

Frequency Mc/s	Bandset	Band	Metres
Coil No. 1			
30–28	0 to 0.5	Amateur	10
25.5–26	2	Broadcast	11
21.75	5.5	Broadcast	13
21.5	6	Amateur	15
17.5	10	Broadcast	16
Coil No. 2			
15	0 to 1	Broadcast	19
14	1 to 1.5	Amateur	20
12	3	Broadcast	25
9.5	5.5	Broadcast	31
7.5	10	Broadcast	40
Coil No. 3			
7.3–7	0 to 1	Broadcast/Amateur	40
6.2–5.95	2	Broadcast	49
5.05–4.75	4	Broadcast	60
4–3.5	8	Amateur	80
3	10	Broadcast/Commercial	100

This little receiver will be found ideal for those who aspire to the ownership of their very own first Short wave set—built entirely by their own hands.

Circuit

This is shown in Fig. 6 and it will be seen that it represents an extremely simple design ideally suited to the beginner. The minimum components are used consistent with a



Under chassis view of the 100/A Receiver clearly showing the component layout

satisfactory performance over the Short wave ranges covered by the three coils, a further advantage being, of course, that the receiver is comparatively inexpensive.

The coil and valveholder tags are numbered, these being referred to in the text. It is unusual to present a circuit diagram at the end of a technical article and it has been done, in this instance, so that beginners can —with the aid of the preceding practical diagrams—construct the receiver without worrying about the theoretical circuit.

For those who care to do so, the theoretical symbols and wiring may be "filled in" as the wiring and soldering operations, in conformity with the textual instructions, proceed —using a ball-point pen for the purpose. In this manner, the beginner will learn the relationship between circuit representation and actual practical construction.

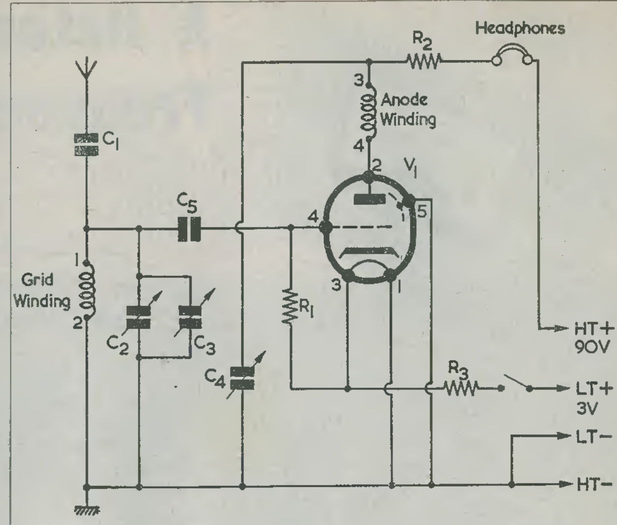
The circuit is designed around the Mazda HL23 valve used as a high gain detector. This valve has a 2 volt filament and offers many advantages in such a circuit. With a low filament drain, some 50mA (milliamps), it allows the choice of either 3-volt dry battery or 2-volt accumulator operation. The 3-volt dry battery is both cheap and easily obtainable, giving a considerable length of service without the need to replace.

It should be noted that the 20Ω filament resistor R_3 should always be in circuit when operating the receiver from a 3-volt dry battery. If operation from a 2-volt accumulator is temporarily required, R_3 should be short-circuited, i.e. the resistor should be "bridged" or bypassed with a short length of p.v.c. covered wire. Where, of course, permanent operation from a 2-volt accumulator is envisaged, R_3 should be omitted from the circuit.

As was mentioned above, the receiver is switched off by removing the positive battery clip. When this clip is removed, the filament of the valve does not emit electrons and there is no current drain from the h.t. battery. The latter may, therefore, remain permanently connected.

The circuit is that of a simple leaky grid detector incorporating three plug-in type coils. The aerial is fed to the grid winding of whichever coil happens to be plugged into

circuit via the condenser C_1, the variable condensers C_2 and C_3 being the bandset and bandspread tuning controls respectively. The grid condenser C_5 and the grid resistor R_1 have values chosen to provide a time constant which will, together with the other circuit values, produce reaction which is free from backlash. This is of great importance if maximum sensitivity is to be obtained from the receiver. Reaction is obtained by positive feedback, energy being fed back, via the anode winding, to the grid winding of the coil. The amount of feedback is controlled by the reaction condenser C_4. R_2 prevents the radio frequencies at the anode from reaching the headphones.



Valve pin numbering corresponds to that employed in Figures 1,2 and 3.

FIG.6.
Circuit of the 'Globe-King' 100/A Receiver.

M815

Components List

Resistors
- R_1 3.3MΩ ¼ watt
- R_2 1kΩ ¼ watt
- R_3 20Ω ¼ watt

Valve
- V_1 Mazda HL23

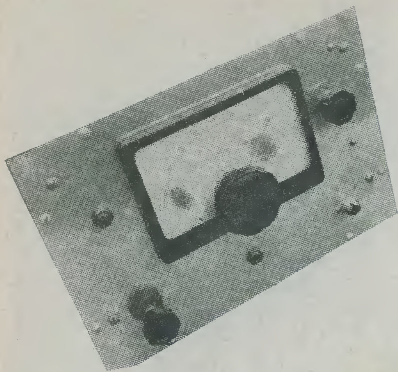
Coils
- Set of 3 (Johnsons Radio) 10–100 metres. Additional coil 80–180 metres also available.

Condensers
- C_1 5pF silver mica
- C_2 140pF variable (Johnsons Radio)
- C_3 10pF variable (Johnsons Radio)
- C_4 140pF variable (Johnsons Radio)
- C_5 0.0002μF mica

Miscellaneous
- Panel, chassis, mounting brackets, knobs, etc. (Johnsons Radio)

RADIO AMATEURS EXAMINATION AND MORSE CLASSES

Grafton Radio Society announce that they have again made arrangements with Holloway L.C.C. Evening Institutes for official courses in the Radio Amateurs Examination and Morse (both for beginners) to be held this winter at the Montem School, Hornsey Road, Holloway, London, N 7. The classes will meet on Mondays, with repeat lectures on Tuesdays and Wednesdays, commencing Monday, 26th September, for the R.A.E. course at 7.0–9.0 p.m. (Instructors: S. H. Iles (G3BWQ) and P. F. Bernal (G3KQZ), followed by the Morse at 9.0–10.0 p.m. Instructors: L. Barber and A. Ralph). The fee for either course is 20s., or 22s. 6d. for the two. Enrolment will be at the school any evening (7.30–9.0 p.m.) Monday to Friday during the week 19th–23rd September, but application in the first instance should be made to the Hon. Secretary of the Grafton Radio Society: A. W. H. Wennell (G2CJN), 145 Uxendon Hill, Wembley Park, Middlesex, so that a place may be assured.



A Heterodyne Frequency Meter

By DAVID NOBLE, G3MAW and DAVID M. PRATT, G3KEP

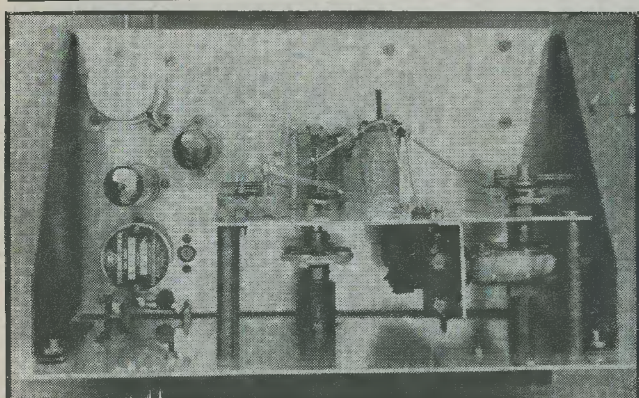
It is often desirable to be able to measure the frequency of a receiver accurately, and radio amateurs are required, by the terms of their licence, to be able to measure the frequency upon which they are operating. For accurate measurement of frequency, a simple interpolation frequency meter will give results to a very close tolerance provided that the crystal used in the unit is of sufficient accuracy. This type of frequency meter is used in conjunction with a receiver, and if it is required to measure the frequency of a transmitter, then the transmission is monitored on the receiver, and the receiver frequency measured.

A 100 kc/s crystal will produce harmonics every 100 kc/s, and these can be used to measure frequencies up to and over 30 Mc/s. However, this will not give intermediate frequencies, nor, for amateur purposes, an accurate measurement of the band edges of the 40, 20 and 15 metre bands (7.15, 14.35, 21.45 Mc/s). While all the band edges could be provided by a following multivibrator on 10 kc/s, this does not give a continuous frequency range, and by the expense of a little more with respect to valves—two pentodes instead of a twin-triode—a continuous coverage interpolation type of frequency meter can be provided.

Circuit

The first valve (V_1) operates as a Pierce crystal oscillator. The condenser C_1 (40pF) is used to adjust the crystal to exactly 100 kc/s. This may be checked by listening to the Light Programme on 200 kc/s, and tuning the condenser for exactly zero beat. An "S-meter" or "magic eye" are useful if the receiver is so fitted, a beat period of several seconds can then be observed.

V_3 is the variable interpolation oscillator. The main tuning condenser is C_{15} which is arranged to tune over a range of 100 kc/s.



Plan view of the frequency meter showing the constructional method adopted with the variable oscillator section. Note the vertical panel mounted to the front panel by means of the four brass pillars. The crystal oscillator section is shown to the left of the vertical sub-chassis

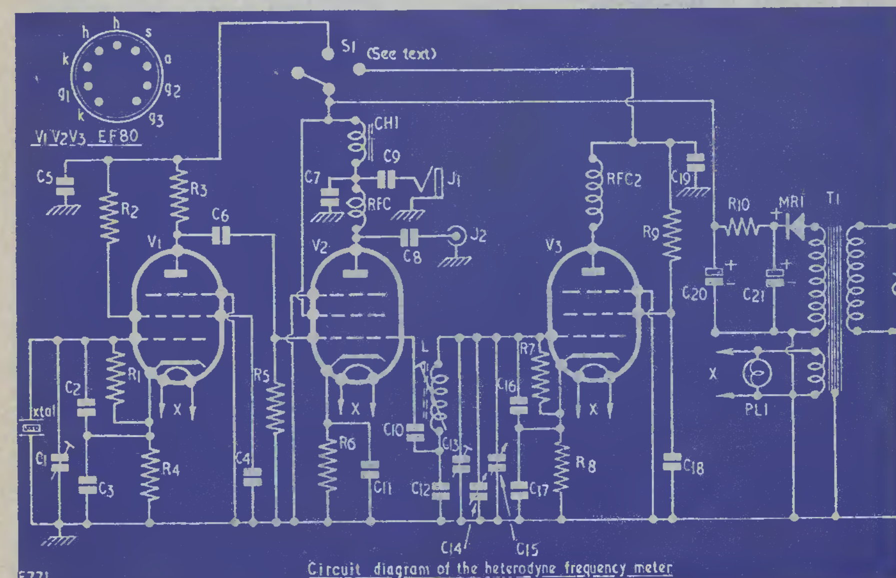
The actual frequency of operation of the oscillator is not critical. In the prototype, with the coil data given, the oscillator operated from 3.9 to 4 Mc/s. C_{13} is a fine trimmer for initially setting up the oscillator, and C_{14} is a variable condenser of very low capacity. This condenser has its spindle protruding through the front panel, its purpose being to set up the oscillator before use.

The two outputs from the oscillators are fed through 20pF condensers to the grid of V_2. The valve operates as a mixer, and r.f. output is fed to the coaxial socket via an isolating condenser, C_8. This provides an output of high harmonic content, and is coupled to the receiver with which the frequency meter is to be operated.*

Setting Up

A headphone jack is provided for setting up the equipment. As the dial is calibrated 0 to 100 kc/s, it will be necessary to ensure

* It should be noted that, at frequencies above 4 Mc/s, advancing the interpolating oscillator tuning condenser causes both a rising frequency and following frequency to appear within the 100 kc/s range under consideration. This should cause little difficulty in practice since it is almost invariably possible to use common sense and knowledge of tuning condenser direction against capacity to differentiate between the two signals.—Editor.



Circuit diagram of the heterodyne frequency meter

Components List

Resistors

- R_1 470kΩ ½W
- R_2 100kΩ ½W
- R_3 22kΩ ½W
- R_4 10kΩ ½W
- R_5, R_7 68kΩ ½W
- R_6 220Ω ½W
- R_8 8.2kΩ ½W
- R_9 33kΩ ½W
- R_{10} 1kΩ 10W wire-wound

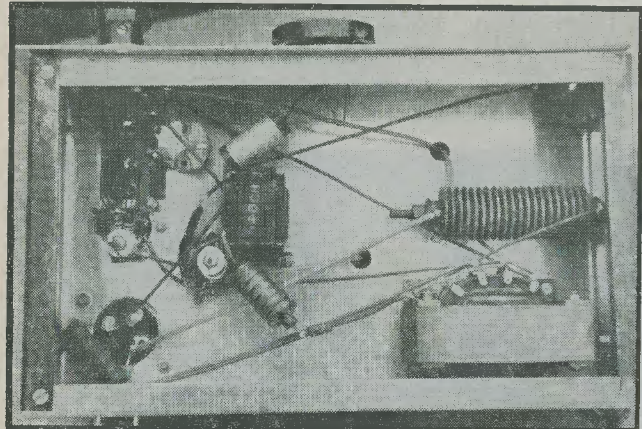
Condensers

- C_1 40pF air-spaced preset trimmer
- C_2 100pF silvered mica
- C_3, C_{12} 1,000pF silvered mica
- C_4, C_5, C_{19} 0.01μF 400V paper
- C_6, C_{10} 20pF silvered mica
- C_7, C_{11}, C_{18} 0.002μF 350V paper
- C_8 470pF silvered mica
- C_9 0.1μF 400V paper
- C_{13} 20pF preset trimmer
- C_{14} 8pF variable
- C_{15} 25pF variable
- C_{16}, C_{17} 390pF silvered mica
- C_{20} 32μF 350V electrolytic
- C_{21} 16μF 500V electrolytic

Miscellaneous

- RFC_1, RFC_2 2.5mH r.f. choke
- Ch_1 L.F. choke
- L 25 turns, 24 s.w.g. enamelled copper wire, close spaced on ¾in former with dust iron core
- V_1, V_2, V_3 EF80
- MR_1 250V, 40mA metal rectifier
- S_1 3 position progressively shorting wafer switch
- T_1 250V, 40mA and 6.3V, 1A mains transformer
- PL_1 6.5V, 60mA pilot bulb
- J_1 Headphone jack
- J_2 Coaxial output socket
- Xtal 100 kc/s quartz crystal

that the position of the condenser C_{15}, when its pointer is at 0 and 100 kc/s, produces a zero beat. This requirement is necessitated, of course, so that the variable oscillator will be at zero beat with the harmonics from the crystal oscillator at these two positions. C_{14} is provided, therefore, to compensate for any drift in the instrument after it has been on for a considerable period.



Under-chassis view of the frequency meter showing the position of the power supply and other components

Power Supply and Switching

An integral power supply employing a simple half-wave metal rectifier circuit is used. This provides an h.t. voltage of approximately 200 volts, and l.t. of 6.3 volts a.c. The h.t. switch is of the progressively shorting type. Thus, in the first position neither of the oscillators are operating; in the second position, only the crystal oscillator is working, and therefore the 100 kc/s harmonics will be detected; lastly in the third position, both oscillators are operating.

The unit was built on a chassis 10 x 6 x 2in, and fitted into a metal cabinet of proportionate dimensions. Screening is desirable with this unit in order to prevent any unwanted radiation and for that reason it is recommended that it be built into a metal case.

THE PHONE-GUARD by R. M. SUMMERS

The Phone-Guard is a device which gives visual warning of the ringing of a telephone bell. Its sensitive circuit is capable of responding also to any other sound of reasonable intensity

A DEVICE WHICH GIVES VISUAL INDICATION when a bell is rung can be extremely useful in a household wherein any member happens to be hard of hearing or where it is occasionally necessary to occupy a room in which the bell cannot normally be heard. The Phone-Guard has been developed to meet this situation, and it employs an inexpensive amplifier and relay energising circuit which causes the actuation of the relay contacts whenever the associated microphone picks up the sound of the bell. With the application described in this article the relay causes a lamp, or lamps, to be illuminated. The relay contacts can, of course, cause any other electrical operation to take place, should this be desired, on the ringing of the bell. The device is sensitive; and it may be employed to give visual warning of the presence of sounds other than that given by a bell. It would, for instance, be perfectly suitable for use as a baby alarm, the crying of the baby causing the warning lamps to light. Other applications may readily suggest themselves to the reader.

The component values employed in the relay energising circuit of the Phone-Guard have been chosen to give optimum performance with G.P.O. bells. They will also prove adequate if the unit is employed to detect alternative sounds, although small improvements in performance may result if time constants are adjusted slightly. This point is discussed in the article.

The Phone-Guard Circuit

The circuit of the Phone-Guard appears in Fig. 1. As may be seen few components are required. The two double triodes used are readily available, as are, also, the microphone transformer and relay. The only remaining components are seven fixed resistors, one potentiometer and four condensers, none of which need be a close tolerance type.

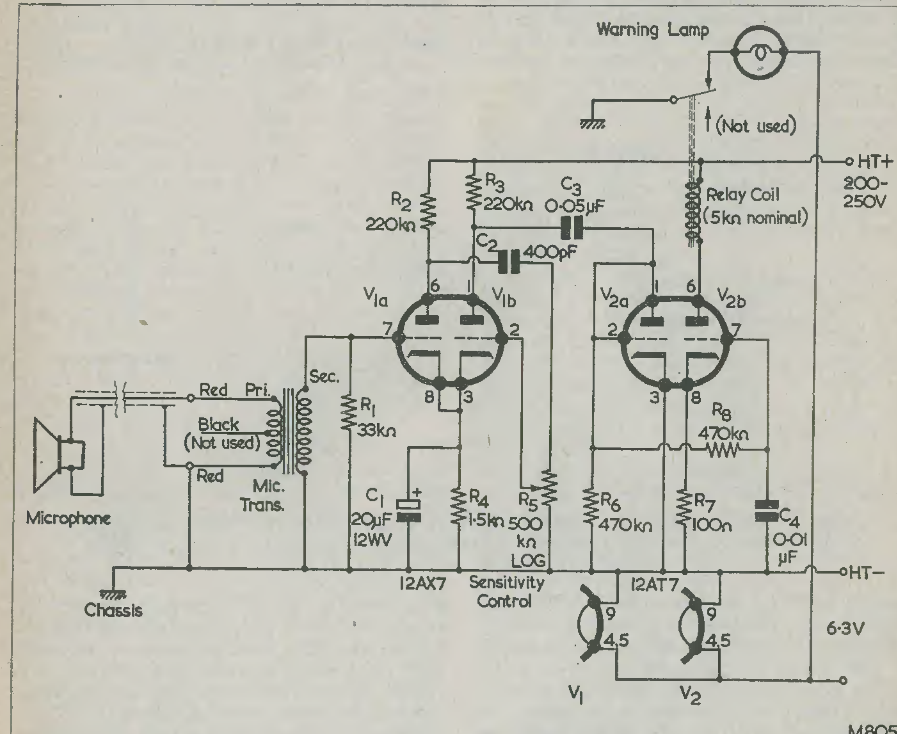


Fig. 1. The circuit of the Phone-Guard

The circuit functions by reason of the fact that sound picked up by a microphone (actually, a small loudspeaker) is amplified by V_1, detected by $V_{2(a)}$ and fed, as a negative d.c. voltage, to the grid of $V_{2(b)}$. The relay is connected in the anode circuit of $V_{2(b)}$ and it de-energises when the negative voltage is applied to $V_{2(b)}$ grid, thereby causing the warning lamps, or whatever other external circuit is employed, to be switched on.

Examining the circuit in more detail it will be seen that the microphone couples to the grid of $V_{1(a)}$ via the step-up microphone transformer. This transformer has a ratio of 100:1 and R_1, connected across its secondary, causes a reflected impedance of 3.3Ω to appear across the primary terminals. This input impedance is an adequate match for the loudspeaker which is employed as a microphone. The amplified signal on the anode of $V_{1(a)}$ is fed, via C_2, to the sensitivity control R_5. C_2 and R_5 form a simple high-pass filter, and help to make the circuit more responsive to transients than to sounds in the lower frequency range. This filter also helps to reduce undesirable effects which may be caused by hum pick-up in the grid circuit of $V_{1(a)}$. R_5, the sensitivity control, is connected in the grid circuit of $V_{1(b)}$ rather than in that of $V_{1(a)}$ as this position reduces the risk of random hum pick-up in the chassis wiring and, therefore, eases component layout requirements. $V_{1(b)}$ amplifies the signal passed to its grid, the amplified signal appearing across R_3. Due, partly, to the presence of the high-pass filter C_2 and R_5, it is possible to dispense with separate cathode decoupling components for $V_{1(a)}$ and $V_{1(b)}$. Both cathodes are decoupled by the single bypass condenser C_1, and their bias voltages are developed across the common bias resistor R_4.

The circuit around V_1 provides an a.f. amplifier offering the very high overall gain of approximately 3,000 times, or 70dB. This high degree of gain offers a significant contribution to the sensitivity of the Phone-Guard.

The amplified signal on the anode of $V_{1(b)}$ is next fed, via condenser C_3, to $V_{2(a)}$. $V_{2(a)}$ has its anode and grid strapped and functions as a shunt detector diode, the detected voltage appearing across R_6. In the absence of signal, the voltage on the upper end of R_6 is slightly negative to chassis (due to contact potential in $V_{2(a)}$). When a signal is

The choice of valve employed in the V_2 position adds to the sensitivity of the device, in so far that the type specified has a short grid base. $V_{2(b)}$ will cut off completely for negative grid potentials around five to six volts.

The total h.t. current consumed by the Phone-Guard is of the order of 10mA only, this dropping to 1 to 2mA in the presence of a high-amplitude signal. Heater consumption is 6.3 volts at 0.6 amps (or 12.6 volts at 0.3 amps if the heaters are connected for 12.6 volt operation). These power requirements are low, and enable the Phone-Guard to be continually switched on with negligible consumption from the mains supply.

Operation with a Telephone Bell

As was mentioned earlier, the component

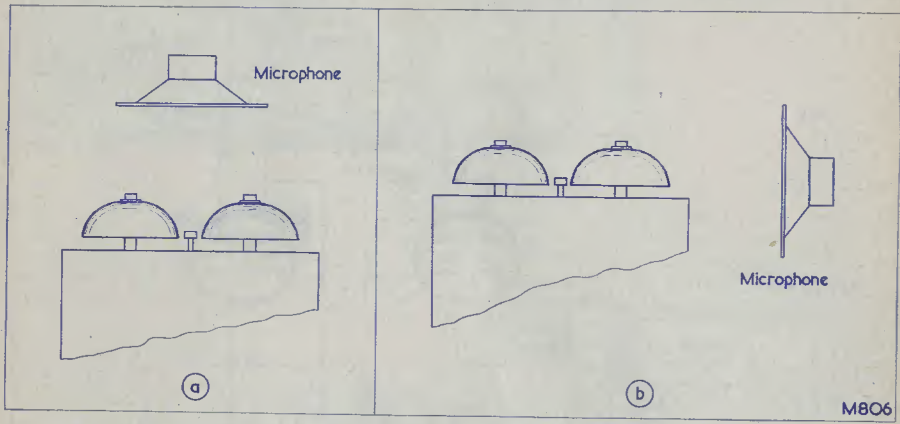


Fig. 2. The intensity of continued ringing from a telephone bell after the striker has come to rest is less if the microphone is mounted above the gongs, as in (a), than if it is mounted at their side, as in (b)

passed to $V_{2(a)}$ the upper end of R_6 goes negative to chassis by a potential which is proportional to the amplitude of the signal.

The voltage on the upper end of R_6 is fed to the grid of $V_{2(b)}$ by the low-pass filter R_8, C_4. These two components integrate the negative voltage from R_6 (which varies at the frequency of the amplified signal) and apply a relatively steady voltage to $V_{2(b)}$ grid. The cathode of $V_{2(b)}$ is biased by R_7, with the result that, in the absence of a signal from V_1, $V_{2(b)}$ draws (for an h.t. voltage of 225) approximately 7mA anode current. In the presence of a signal having the requisite amplitude, $V_{2(b)}$ anode current is reduced to a low value or becomes cut off altogether. In consequence of this wide variation in current, reliable and positive de-energising of the relay takes place when the actuating sound is picked up by the Phone-Guard microphone.

values around V_2 are especially intended for operation with a telephone bell. In order to to see why they were chosen it is necessary first to quickly examine the methods employed by the G.P.O. for transmitting ringing currents to subscribers' telephones.

Ringing currents fed along subscribers' lines may come from manual exchanges or from automatic exchanges. So far as manual exchanges are concerned there are several methods of obtaining the ringing current. It may, for instance, be generated by a cranked ringing generator, whereupon the frequency of the ringing current and the length of time this current is applied to the lines are variable. Alternatively, the ringing current may be generated in the exchange at a nominal frequency of 16.66 c/s, this current being switched by a key. Here it is only the length of time the bell rings which is variable. A third alternative is where ringing is con-

trolled by an automatic exchange elsewhere, through which an incoming call has been routed—the incoming ringing current being "passed on", as it were, by the manual switchboard operator. In this case, the ringing current and ringing periods will be the same as are given by automatic exchanges.

The larger, and some small, automatic exchanges provide interruption periods which result in the familiar "burr-burr . . . burr-burr" ringing cycle. The ringing current frequency here is again a nominal 16.66 c/s and the current is interrupted as follows: 0.4 sec. on, 0.2 sec. off, 0.4 sec. on and 2 sec. off. Small automatic exchanges may have ringing current generators which provide approximately 16 c/s, and in which the ringing current is interrupted at nominal periods of 0.75 sec. on and 0.75 sec. off.

It was decided, after reviewing these various ringing currents and ringing periods, that it would be advisable to design the warning device such that it was capable of operating with a sound consisting of approximately 32 transient pulses per second. (A 16 c/s ringing current causes the bell armature to strike its associated gongs 32 times per second.) Ideally, the circuit should be sufficiently quick-acting to enable the visual warning lamp to "follow" the ringing cycle given by the larger automatic exchanges. The device should certainly be sufficiently quick-acting to be able to "follow" the 0.75 sec. on, 0.75 sec. off, ringing cycle offered by the smaller automatic exchanges.

The time constant offered by C_3, R_6 in the detector circuit of the Phone-Guard is approximately 0.025 sec. and it was felt that this would enable a high detected potential to be obtained for an input signal of 32 transient pulses per second without excessive discharge time when the ringing ceased. The time constant of R_8 and C_4, at 0.05 sec. approximately, is shorter than that of C_3 and R_6. It was found, in practice, that a short time constant here speeded relay operation significantly, but that care had to be taken to prevent it being so short as to allow relay chatter to occur. The values specified in Fig. 1 for R_6 and C_4 enable quick relay action to be realised without the risk of chatter.

On checking the unit in practice a difficulty arose which had not been foreseen. This was due to the fact that the telephone bell gongs continued to emit a relatively high amplitude ringing sound after movement of the striking armature had ceased. Because of this the negative voltage on the grid of $V_{2(b)}$ did not immediately drop to chassis potential at the end of a ringing period, but tended to decay at a rate proportional to the decay in actual sound.

As would be expected, the ringing of a bell gong after being struck is at its greatest strength along its sides, and is at its weakest at its top. In consequence, it was found that continued ringing of the bells after striking caused least trouble when the Phone-Guard microphone was positioned above them, as in Fig. 2 (*a*), than when it was positioned at their side, as in Fig. 2 (*b*). Unfortunately, many telephone installations have completely enclosed bells, and it is difficult to find a position for the microphone which causes minimum ringing pick-up.

Practical results achieved with various telephone installations were extremely good. When the microphone could be mounted as shown in Fig. 2 (*a*) it was found possible to have the relay operate in sympathy with the ringing period given by larger automatic exchanges without too critical an adjustment in the sensitivity control, R_5. If sensitivity were advanced beyond the condition where the warning lamp "followed" the ringing cycle, it remained illuminated during the 0.2 sec. period, but extinguished during the 2 sec. period. The sensitivity setting required for this mode of operation was markedly broad and non-critical.

In cases where the bell was completely enclosed it was found possible to make the relay follow the ringing period, but the requisite setting of R_5 was critical. However, no difficulty was experienced in obtaining a reliable warning lamp cycle in which it remained illuminated during the 0.2 sec. period and became extinguished during the 2 sec. period.

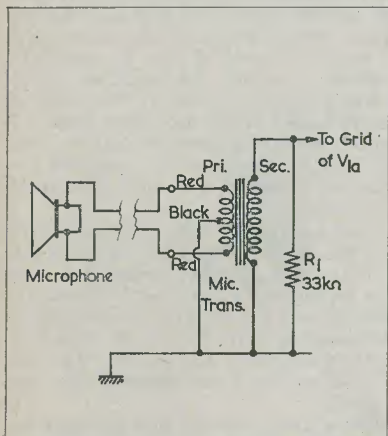
In view of these findings it is felt that the setting of the sensitivity control (and hence, the mode of operation) would best be left to the choice of the person using the device. It should be remembered that it is possible to advance sensitivity such that, even with microphone positioning such as that of Fig. 2 (*a*), automatic exchange ringing causes the warning lamp to be continually illuminated. The reason for the continual illumination is that the amplified signal voltages applied to V_2 during the ringing period became so high at this sensitivity setting that the associated condensers cannot discharge during the 2 sec. "off" period. This method of operation has the advantage that the Phone-Guard is operating with considerable sensitivity "in hand" and the disadvantage that there is no continual switching on and off of the lamp to attract attention.

All the above tests were carried out on telephones connected to a large automatic exchange. There is little doubt, with small automatic exchanges offering the 0.75 sec. on and 0.75 sec. off ringing periods, that the setting of the sensitivity control which causes the relay to "follow" the ringing period should be much less critical, as the "off" period is not as short as 0.2 secs. Here again, of course, the sensitivity control can be advanced such that the lamp is illuminated continually. With manual exchanges, where the length of the ringing period is variable, the sensitivity control merely needs to be set to a position which causes the relay to operate reliably when the bell rings.

Fitting the Microphone

As has already been mentioned, the microphone employed with the Phone-Guard consists of a loudspeaker. A small unit, 4in or less, should be used here. The speaker should have a voice coil impedance of 3Ω.

The speaker, functioning as a microphone, for the screened cable would be provided by television coaxial cable. In some instances, however, it might be considered cheaper or more convenient to make the microphone connection via unscreened twin cable. This type of cable can be used provided that hum pick-up is not excessive; it should, for this reason, be kept well away from unscreened mains wiring. When unscreened twin cable is employed the input connection to the Phone-Guard amplifier should be balanced about chassis in the manner illustrated in Fig. 3. It may also be necessary to connect the amplifier chassis to earth. (An earth connection is not needed when the screened cable is employed.) Checks for hum pick-up level with unscreened microphone wiring may



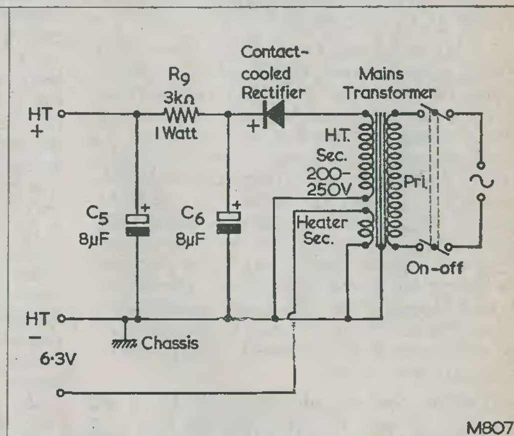


Fig. 3 (left). An alternative input circuit which may be used when the microphone is coupled to the amplifier via unscreened twin cable. With this method of connection it may be necessary to earth the chassis in order to reduce hum pick-up

Fig. 4 (right). A suitable power unit for the Phone-Guard. H.T. and heater current consumption are discussed in the text

should be mounted fairly close to the telephone bell. This ensures the existence of a high ratio between the sound level of the bell and the sound level of other noises in the household, and thereby guards against accidental operation of the relay for noises other than that from the bell. It is desirable to provide the speaker with a simple resilient mounting with the aid of polyurethane foam or any similar material, in order to prevent the direct transmission to it of sounds such as the slamming of doors, etc. Polyurethane foam may also be fitted behind the speaker in order to prevent sound pick-up on the back of the cone.

The circuit of Fig. 1 shows the microphone connected to the Phone-Guard amplifier via screened cable, such cable being employed to obviate hum pick-up. An excellent choice be made by temporarily connecting a pair of high impedance phones across R_6 and listening to the amplified signal from V_1.

Power Supplies

The power requirements of the Phone-Guard are low, and they may be adequately met with a power unit circuit of the type shown in Fig. 4. A contact cooled h.t. rectifier is illustrated in the diagram, but a valve or metal rectifier may be readily employed in its place, should this be desired. There is no necessity to regulate the h.t. output of the power unit. It should be remembered that the heater winding has to provide current for the warning lamp, or lamps, as well as for the heaters of the two double triodes.

It will be noted that the mains transformer has a separate single-wave h.t. winding. A transformer of this type provides complete isolation from the mains, and its cost is only slightly higher than that of a conventional heater transformer. Isolation from the mains is essential in a device of this type, since it connects into wiring which is routed around the house.

If a power unit having the circuit of Fig. 4 is fitted on a separate chassis to that on which the amplifier and relay energising circuit are mounted, the interconnecting leads should not be longer than 2 ft. If longer interconnecting leads are employed the smoothing condenser, C_5, should be fitted to the amplifier and relay energising circuit chassis, instead of on the power unit chassis. C_5 decouples the anode circuits of V_1 and V_2 as well as smoothing the rectified h.t., and long leads to this condenser may result in instability.

The Relay

The relay specified for the Phone-Guard is a lightweight type having a quick action. The current drawn through its coil by $V_{2(b)}$ in the absence of signal is comfortably in excess of the minimum required for dependable energising and so its operation becomes extremely reliable. The relay should be set up such that, when energised, a gap of some 0.02 to 0.03in remains between the underside of the armature and the top of the core. This setting is not at all critical and its main purpose is to help in providing quick de-energising when $V_{2(b)}$ anode current drops.

The moving contact of the relay is common to its armature and to its mounting bolt. If the relay switching circuit is wired up as shown in Fig. 1, securing the relay to the chassis automatically completes the circuit to the moving contact.

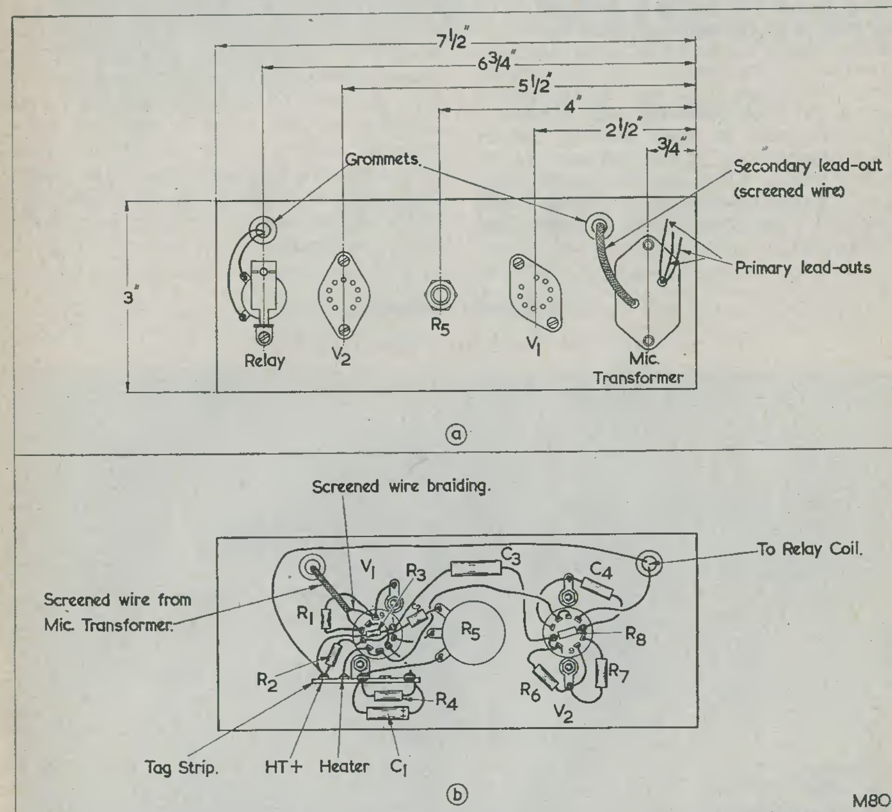


Fig. 5 (a) (above). Top view of chassis, showing suggested layout of components. (b) (below). Below-chassis view of components and wiring. The warning lamp wiring and microphone input connections are completed above chassis and are not shown here

Other Applications

It is possible that the Phone-Guard may be employed for applications other than for visual indication of the ringing of a telephone bell. Where a sound other than from a bell actuates the device it may be found desirable to alter the values of C_3 and C_4.

As they stand, C_3 and C_4 are quite satisfactory if it is intended to operate the device by speech. If the sound which operates the device is of a high pitched nature it should be possible to reduce the value of C_3 without losing sensitivity. Increasing the value of C_3 will increase the time taken for the relay to energise after the sound has ceased, and such a feature may be desirable in some applications. The value of C_4 may be reduced, if desired, to speed operation, but too low a value will result in relay chatter. Chatter will normally occur at the frequency of the applied sound. Large increases in the value of C_4 are not recommended, as these would merely slow up de-energising and energising of the relay.

Construction

Due to the small number of components involved, construction of the Phone-Guard is simple and quick.

The prototype was built on a chassis measuring 3in by 7¾in by 1in deep and employed the component layout illustrated in Figs. 5 (*a*) and (*b*). Fig. 5 (*b*) also illustrates the wiring of the under-chassis components. This diagram does not include the power unit. In the writer's case the power unit happened to be mounted on a separate small chassis, and the reader may follow this practice if he so desires. Alternatively the chassis shown in Fig. 5 may be extended at the relay end to accommodate the mains transformers and other power unit components. Such a layout will provide more than adequate spacing between the mains transformer and the microphone transformer, and eradicate the risk of induced hum in the latter component.

List of Major Components

Amplifier and Relay Chassis (Fig. 1)

Resistors
(All fixed resistors 20% ¼W)
- R_1 33kΩ
- R_2 220kΩ
- R_3 220kΩ
- R_4 1.5kΩ
- R_5 500kΩ potentiometer, log track
- R_6 470kΩ
- R_7 100Ω
- R_8 470kΩ

Condensers
- C_1 20μF, 12 w.v., electrolytic
- C_2 400pF, 250 w.v., silver-mica
- C_3 0.05μF, 250 w.v., paper
- C_4 0.01μF, 250 w.v., paper

Valves
- V_1 12AX7 (or ECC83)
- V_2 12AT7 (or ECC81)

Microphone Transformer
Ratio 100:1, shielded, Cat. No. M22, Home Radio (Mitcham) Ltd.

Microphone
3Ω speaker, 4in or less

Relay
Lightweight, heavy-duty, Cat. No. Z70, Home Radio (Mitcham) Ltd.

Warning Lamps
6.3 volts. Quantity and type to suit individual requirements

Power Unit Chassis (Fig. 4)

Resistors
R_9 3kΩ 20% 1W

Mains Transformer
As specified in Fig. 4 and text

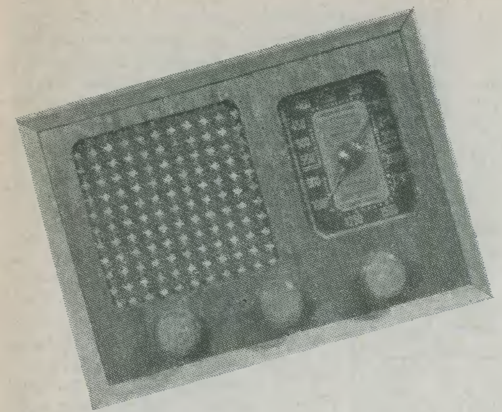
Switch
1 on-off switch

Condensers
C_5, C_6 8+8μF 250 w.v., electrolytic

Rectifier
Contact cooled (or equivalent metal or valve component)

BRADFORD TECHNICAL COLLEGE, Central Hall, Bradford 5 (Department of Engineering). A course of lectures in preparation for the City and Guilds of London Institute's Radio Amateurs Examination will be held during the forthcoming session on Wednesday evenings from 7 to 9 p.m. Lecturer: D. M. Pratt, G3KEP. Further information and details of registration, etc., may be obtained from the General Office, Telephone: 25763.

OPENSHAW TECHNICAL COLLEGE (Radio Club), Whitworth Street, Openshaw, Manchester 11.
Classes for the R.A.E. examinations, written and Morse, will continue to be held during the 1960/61 evening session.
The classes are arranged for first year candidates, and also a second year class is available for those who have passed part or all of the R.A.E. requirements, during which constructional work may be carried out, and the equipment tested, checked and calibrated under the college call sign G3NLT.



A Simple Reflex Superhet

By A. A. Baines

This receiver was built to fulfil a requirement for a "second" mains radio that was capable of being easily transported from room to room and was to be of a small size in order to facilitate its use. Medium and Long wavebands were thought to be desirable and a good acceptable level of performance was essential, but an equally exceeded expectations.

Economy has resulted in a receiver using dual range coils, three valves in a reflex circuit, heater transformer, metal rectifier and resistance smoothing. Good surplus components were used where possible and although many components were already available, it is thought that with selective

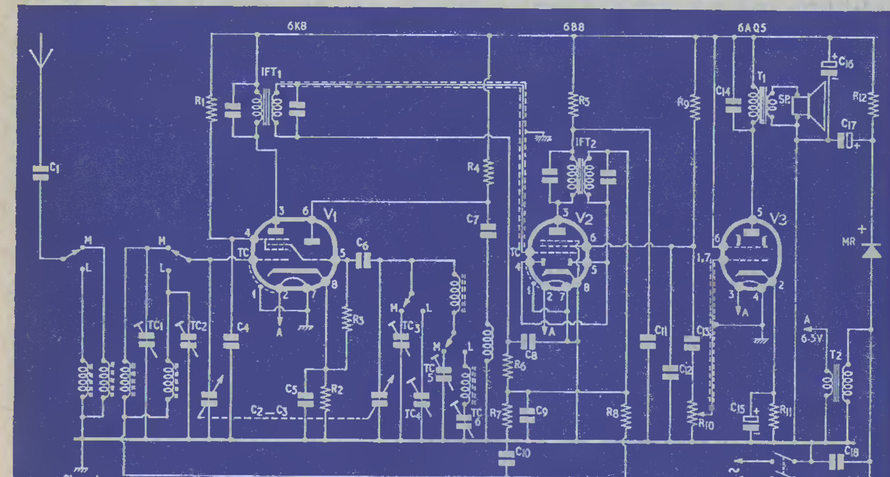


FIG. 1
CIRCUIT OF THE SIMPLE REFLEX SUPERHET

important requirement was that the receiver had to be inexpensive to build. These requirements naturally mean that some compromises had to be made and quite a good deal of thinking, and searching through the spares box, was undertaken before the final design was completed. The finished article has, however, achieved the above aims quite successfully and its performance has purchasing from advertisers in this magazine the total price of building this receiver, excluding cabinet, should not exceed £5 approximately.

The chassis size is 7⅞ x 5in and by specifying metal or GT valves for V_1 and V_2, small i.f. transformers and a 3½in speaker, the internal cabinet size is no more than 7¾ x 5½ x 5¾in. Transportability is further facilitated by the need for a small aerial for all normal purposes; the aerials tried so far ranging from a 5in electrician's screwdriver inserted in the aerial socket to 8 feet of wire wound around the inside of the back of the cabinet. Consideration was given at one time to the incorporation of a ferrite rod aerial but the idea was rejected solely on economic grounds. The above length of wire around the back of the cabinet has been quite suitable but a ferrite rod aerial and matching oscillator coils could easily be substituted if so desired.

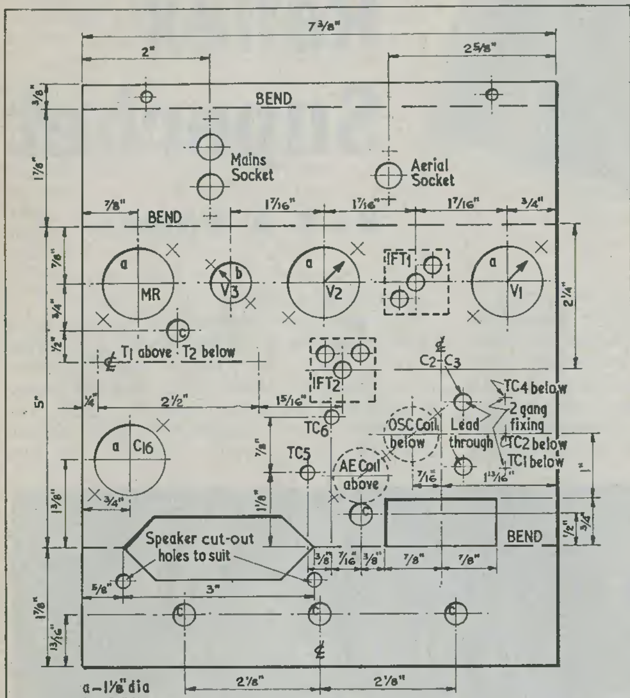


FIG. 2

DRILLING DIAGRAM—TOP VIEW

Sensitivity and selectivity are excellent for such a radio; stations being received all around the dial from the Third on 464 metres to the Third on 194 metres, and the West Home Service on 206 metres and Luxembourg, 208 metres, are clearly separated without cross interference, this being no mean feat in the writer's district. Volume is more than ample for all normal purposes.

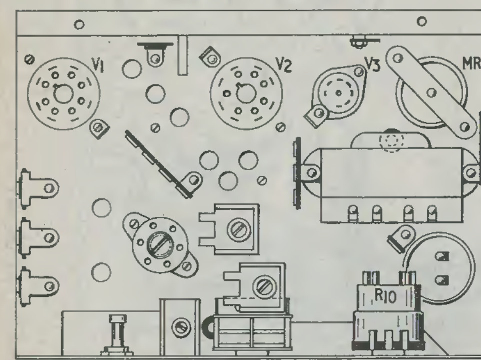
Circuit

Fig. 1 shows the circuit diagram from which it is seen the selected waveband of the aerial windings of a dual wave coil is fed to V_1, a 6K8 frequency changer in a conventional circuit. V_1 is coupled into the i.f. stage through a high "Q" i.f. dust cored transformer, IFT_1. This, and IFT_2, is of a miniature type measuring 2 x 1 x 1in. If the transformers specified are used, IFT_1 must be removed from its screening can after straightening the lugs at the bottom and a length of p.v.c. flexible connecting wire soldered to the grid terminal of its secondary winding. The flexible wire is then threaded through the hole existing in the top of the can before replacing the transformer windings. This lead is the flying lead to the top cap of V_2 and it was not found to be necessary for it to be screened. Screening of this lead may, however, be desirable with other models built to the present design. The i.f. signals from the frequency changer are fed to a 6B8 double diode pentode valve operating in one instance as a normal pentode i.f. amlifier; in addition, the signals are demodulated by the strapped diodes. The audio voltages are now returned to the grid and amplified, the a.f. output being taken from the screen grid. Further to this, as the 6B8 has semi-variable mμ characteristics, a measure of a.g.c. is fed back, both to this valve and to V_1. A reflex circuit, such as the one described, has a tendency to accentuate any instability that might be present but in practice instability with this stage has never been experienced. A fairly comprehensive r.f. filter and decoupling network was built into the receiver initially to nullify any instability that might arise as a result of a rather cramped layout; but it is suggested that the circuit could be built without the decoupling resistor and condenser, R_5 and C_{11}, at first, incorporating these later only if they appear to be necessary when testing the receiver.

The output of V_2 is passed via C_{13} and R_{10}, through a screened lead to V_3, C_{13} being as close as possible to R_{10} to minimise any possibilities of hum pick-up; no other screening was found to be necessary on the original receiver. V_3 is a 6AQ5 and was chosen for its small size, although any similar valve, such as a 6BW6, could be utilised in this position after due regard to the appropriate value of the cathode resistor and valve holder. It should be noted, however, that if an octal based output valve is used, some alterations to the chassis layout may be desirable, the height of the cabinet consequently would have to be increased.

often vary in size from the specified parts. This action, of course, being mainly dictated by financial considerations! Although no miniaturised components, and only easily obtained standard items of small dimensions were utilised, it may be as well to obtain the major and larger parts before drilling and bending the chassis in order to ensure that these can be installed without difficulty.

A little forethought in the construction will be amply repaid and it is recommended that, where possible, the construction of the receiver is made as a series of sub-assemblies instead of the more usual sequence of heater wiring, grid, anode, feeds, etc. This recommendation is due to past experience with small receivers and it eliminates some of the difficulties associated with a hot soldering iron in a confined space full of wires, condensers and other small components! A typical sub-assembly would be the wave-change switch which should be wired up as in Fig. 4, preferably with different coloured p.v.c. wires; the connections to the coils, trimmers, etc., being made after installing the switch on the chassis. The switch actually used was a 4 pole 3 way rotary type with the third position rendered inoperative by bending up the appropriate stop tag on the front plate. A general view of the underneath layout of the chassis is given in Fig. 3 and a further diagram, Fig. 5, indicates the component layout. This diagram, together with the accompanying photographs should minimise any difficulties which may arise with the construction of the set. For clarification, some licence has been taken with the layout in Fig. 5 and, in practice, all signal



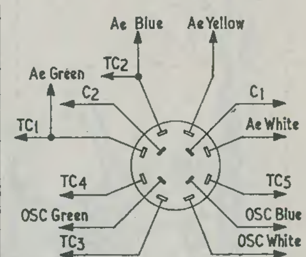


FIG. 4

SWITCH CONNECTIONS

FIG. 3

UNDER-CHASSIS MAIN COMPONENT LAYOUT

Resistance smoothing, together with a metal rectifier and a heater transformer, were used in the interests of economy and size, as already stated, and therefore heed must be taken of the warning that the chassis is "live". For this reason it is recommended that a double pole switch, incorporated with R_{10}, be used and that no direct connection to earth be made. Possibly because of the fairly high values of smoothing and reservoir condensers, the hum level of this receiver is not obtrusive. A surplus 80mA metal rectifier was obtained and mounted vertically on a strip of metal supported across an octal sized hole cut in the chassis; this hole greatly assisting in the maintaining of a cool temperature. A contact cooled rectifier of similar specification could, however, be substituted and a suitable position for mounting this would be on the rear wall of the chassis.

Construction

Details of the chassis dimensions are given in Fig. 2, but it will be noted that only the major dimensions are quoted—constructors generally using existing components which

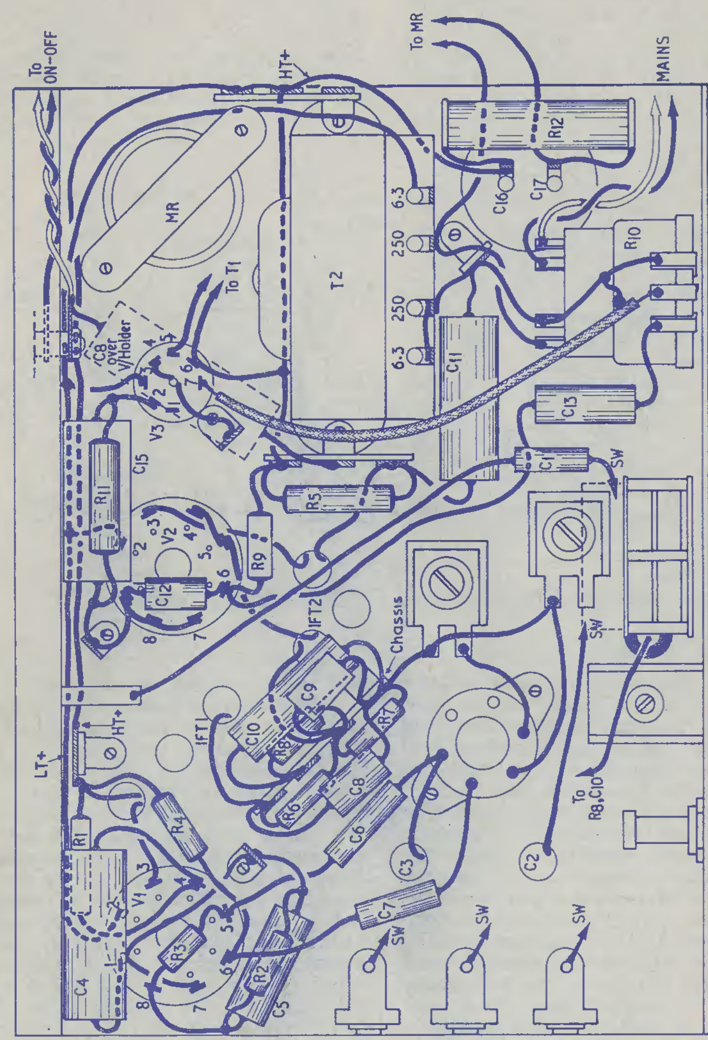


FIG.5
WIRING & COMPONENT DETAILS

For Switch details see FIG.3.

leads should take the shortest and most direct route, provided that grid and anode leads do not run together. Signal leads should also be separated from h.t. or heater wiring, which can take a longer path. The heater wiring, in particular, should be tucked away in the fold of the chassis wherever possible. C_{14}, which is for tone control purposes, was mounted across the primary tags of the output transformer T_1 and the value of this condenser can be modified to suit personal requirements.

Alignment

Lining up the receiver without a signal generator should present no great problem.

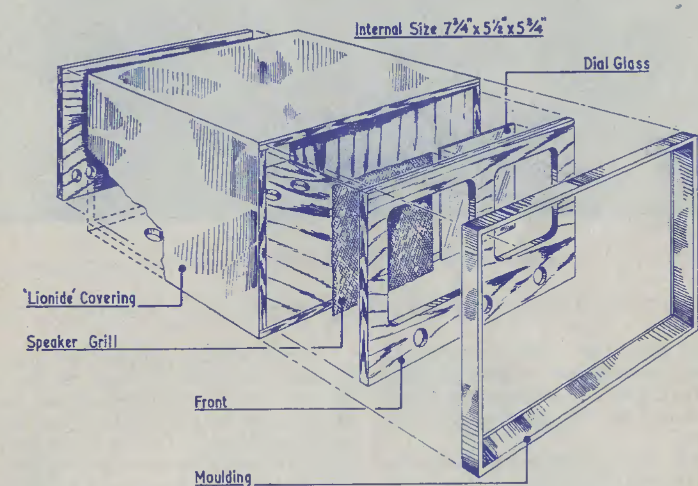
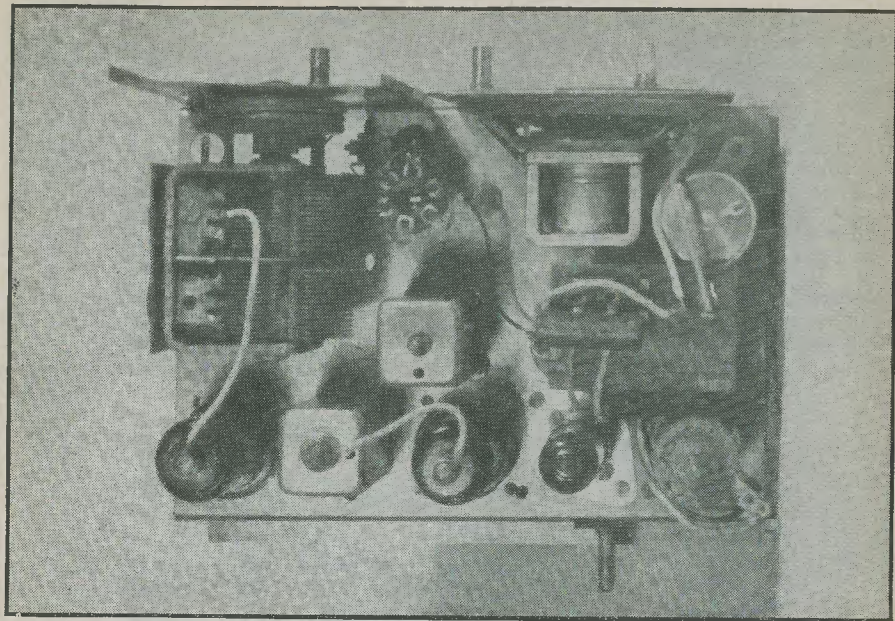


FIG.6
CABINET DETAILS

If the padders and trimmers are set to approximately their mid-position, and the volume control set to maximum, it should be possible to tune in the local station. When this is received, ignoring the dial reading, the cores of the i.f. transformers are carefully adjusted to give maximum volume, i.f.t.$_2$ being adjusted first and followed by i.f.t.$_1$. As the transformers are aligned and the volume increases, signal input can be reduced to suit by shortening the effective length of the aerial. When no further improvement can be obtained, the Long waves are selected and the dial pointer set to read 1,500 metres. Padder TC_6 is then adjusted until the Light Programme is brought to the correct position on the dial as indicated by the pointer. A station of lower wavelength is then found and trimmer TC_4 is adjusted for correct dial tuning and trimmer TC_2 varied to give maximum volume. A return is made to the Light Programme and, after tuning in this station, any shift in the dial position of the pointer is rectified by carefully altering TC_6. Likewise, any shift of the dial position of the lower wavelength station after this adjustment is corrected by means of TC_4. The Light Programme is checked again and any deviation of position can be corrected as before. This completes the alignment of the Long waves.

Switching to the Medium waves, the pointer is set to 464 metres and the padder TC_5 is adjusted to bring the Third Programme to the dial setting. Trimmer TC_1 can then be varied to give maximum volume. The West Region is then tuned in and TC_3 is adjusted to bring this station into line with 206 metres on the dial. Reverting back to the Third Programme, any shift of this station arising from the previous adjustment is corrected by small adjustments to TC_5 and similarly, TC_3 is altered to counteract any change from the dial position of the West Region. TC_1 should be finally adjusted for maximum volume at 206 metres. This completes the alignment of the Medium waves.[1]

The adjustments to be made are only of a small nature and a little care is required with the final touches. Sealing of the padders and



Above chassis view of the Reflex Superhet

trimmers is advisable when satisfactory alignment has been achieved to prevent them vibrating "off-station". The writer has found that his wife's nail varnish makes an excellent fixing solution!

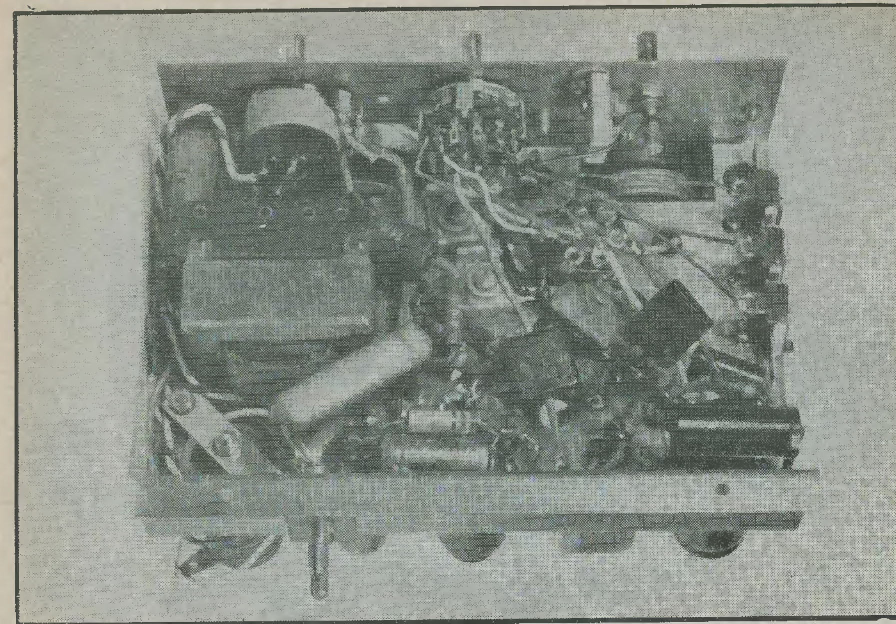
The cabinet was constructed from ¼in plywood with half-lap joints glued and pinned, finally covering with a decorative rexine. A row of ventilation holes was drilled in the bottom of the cabinet to which four small rubber feet were fixed. The back was made of thin plywood, this also having ventilation holes drilled together with clearance holes cut for the mains socket and aerial plug. Four short dowels approximately ½in long were fixed to the back, one in each corner, and around these were wound a length of thin covered wire acting as the aerial. The front face of the cabinet is of thin polished plywood with suitable apertures cut for the dial, speaker and spindles, and with a cloth grille and Perspex dial covering stapled to it. The front is supported by strips of decorative moulding these being glued around the edges and which also serve to cover the unsightly plywood face edges of the cabinet. If desirable, a fold-flat attache case handle could be added to the top of the cabinet. Fig. 6 gives a general view of the cabinet.

The completed receiver has been in continuous daily use for over a year and has proved to be reliable and satisfactory in every way; its performance has been particularly praised[2]. The small cabinet size has proved useful in transporting the receiver and for tucking it away in confined spaces, for instance, on a book-case shelf. The only point to bear in mind with respect to similar locations is that a little space must be maintained at the back of the set to ensure a free flow of air.

Any qualms the writer had about using a reflex circuit have been dispelled and in future, when faced with the construction of a conventional superhet, he will seriously consider replacing the usual 6K7 and 6Q7, or their miniature equivalents, with a 6B8, particularly in view of the fact that the latter can be obtained for about 4s. on the surplus market!

[1]Transmitters other than the two quoted here may, of course, be used for Medium wave alignment provided that their wavelengths are known and are close to those of the two signals specified.

[2]One difficulty initially encountered was acoustic feedback to the tuning condenser but this was completely eliminated by the use of rubber grommets in the holes through which the speaker bolts pass.



Showing component layout and wiring of the receiver constructed by the author

Components List

Resistors

R_1 27kΩ 1W
R_2 270Ω
R_3 47kΩ
R_4 47kΩ
R_5 27kΩ
R_6 100kΩ
R_7 470kΩ
R_8 2MΩ
R_9 100kΩ
R_{10} 500kΩ Pot. Log.
R_{11} 220Ω 1W
R_{12} 1kΩ 5W
All resistors ½W except where otherwise stated

Condensers

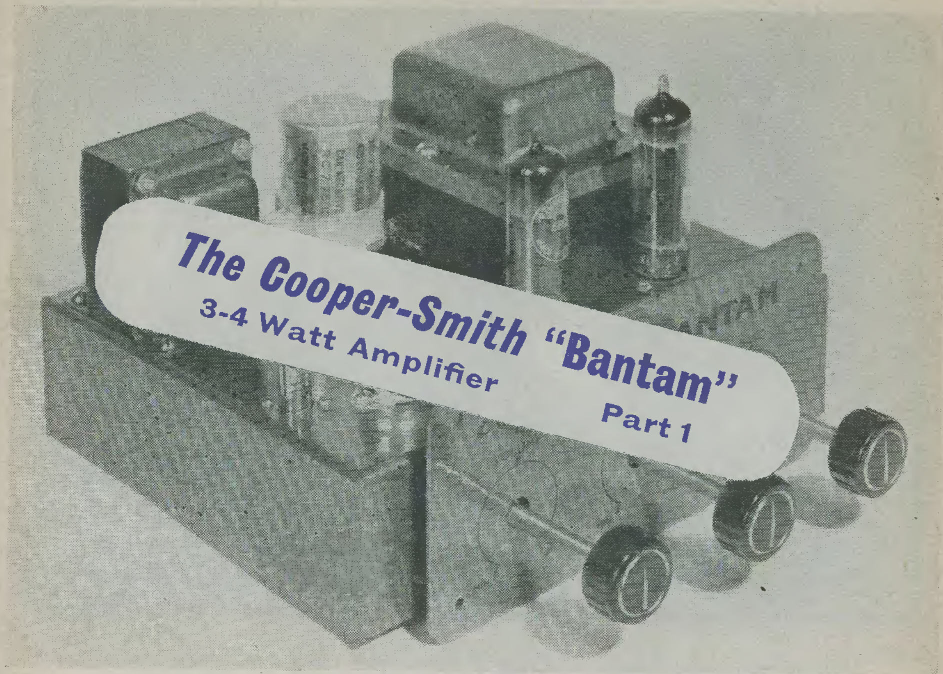
C_1 0.02μF 750V
$C_{2\text{-}3}$ 500pF variable 2-gang
C_4 0.1μF 350V
C_5 0.1μF 150V
C_6 100pF
C_7 100pF
C_8 470pF
C_9 470pF
C_{10} 0·05μF 150V
C_{11} 0.1μF 350V
C_{12} 300pF
C_{13} 0.01μF 350V
C_{14} 0.02μF 350V
C_{15} 25μF 25V electrolytic
$C_{16\text{-}17}$ 24+24μF 350V electrolytic
C_{18} 0.005μF 750V
$TC_{1\text{-}4}$ 70pF trimmers
TC_5 550pF padder, variable
TC_6 250pF padder, variable

Valves

V_1 6K8
V_2 6B8
V_3 6AQ5

Miscellaneous

Coils—Repanco SH4 dual range
I.F.T. 1-2—Radio Component Specialists
Speaker—3½in 3Ω
Metal rectifier 250V 60-80mA
T_1 40:1 output transformer
T_2 6.3V filament transformer
4-pole 2-way wavechange switch
I.O. valveholders—2 off
B7G valveholder—1 off
Dial, reduction drive



Described by W. Holmes

This article gives full constructional details of an inexpensive amplifier which is capable of a very high performance level

Despite the fact that present-day audio amplifying and reproducing equipment tends to be centred on complex and relatively costly amplifiers there is a very considerable demand amongst constructors for amplifiers which, whilst being capable of offering a high performance level, are smaller and less expensive. The Cooper-Smith "Bantam" falls into this category, and it has been designed to give a quality of reproduction which is considerably in advance of that provided by standard radios and radiograms. The "Bantam" possesses all the features normally found in much more complex equipment: it has continuously variable bass and treble controls, it contains its own mains power unit, it can provide heater and h.t. power for ancillary equipment such as f.m. tuner units and the like, and it is capable of driving speakers at either 15Ω or 3.75Ω impedance. The output stage is single-ended, the output valve specified being rated at a high power figure. This valve works into an output transformer having a generously heavy core, negative feedback from its secondary being applied to the stage preceding the output valve.

As may be seen from the photograph at the head of this article, the completed amplifier presents a very neat and professional appearance. A separate escutcheon, also shown in the photograph, enables the amplifier to be mounted in a cabinet, if desired, the control spindles protruding through the escutcheon.

Technical features for the "Bantam" are as follows:

Power Output: 3–4 watts.
Frequency Response: 40–25,000 c/s ± 1dB at 1 watt (tone controls flat).
Tone Controls: Bass and treble cut and boost, continuously variable.
Output Impedances: 3.75Ω and 15Ω.
Input Sensitivity: 60mV for 3 watts output.
Valves: ECF80, EL84 (or 6BQ5), EZ81.
Spare Power: 250V at 45mA, 6.3V at 2A.
Weight: 8¾lb.
Size: 8 x 6½ x 4½in.

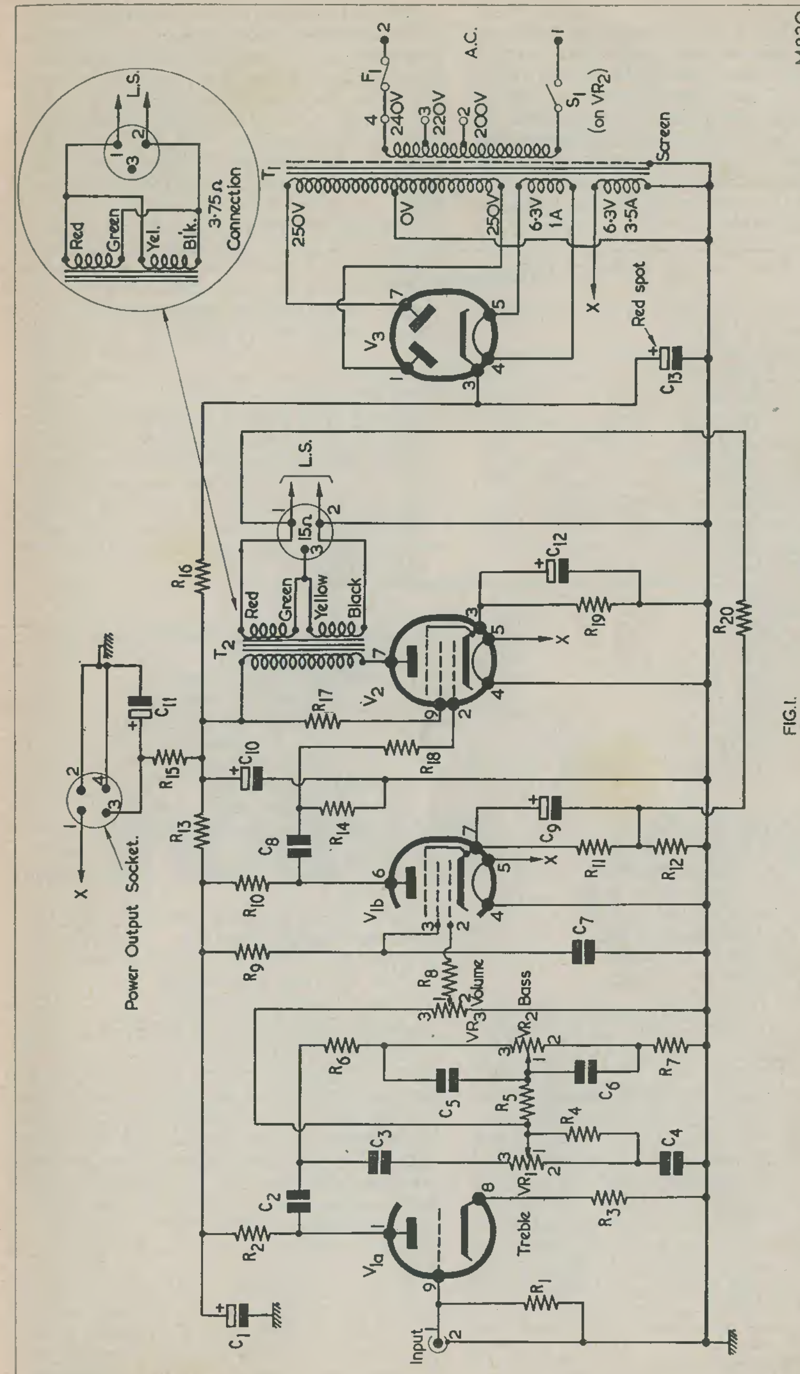


Fig. 1. The theoretical circuit of the Cooper-Smith "Bantam". The identification numbers on potentiometers and sockets apply to the similarly numbered tags in Fig. 2

The Circuit

The circuit of the Bantam appears in Fig. 1. The input signal is applied to the grid of $V_{1(a)}$, this being the triode section of an ECF80. $V_{1(a)}$ functions as a triode voltage amplifier and compensates for the loss of signal voltage occurring in the subsequent tone control circuit. A small degree of current negative feedback is applied to the input stage by means of the un-bypassed cathode resistor R_3 to the pentode section, $V_{1(b)}$ of the ECF80.

The pentode also functions as a voltage amplifier, the amplified signal appearing across its anode load, R_{10}. Due to the choice of valve and operating conditions, $V_{1(b)}$ anode has a relatively low impedance to chassis. The anode of $V_{1(b)}$, working at this relatively low impedance, then drives the grid of the output valve, V_2, via the grid stopper, R_{18}.

The output valve functions in conventional

Components List

Resistors

R_1	1MΩ ⅛W 20%
R_2	100kΩ ½W 20%
R_3	1.2kΩ ¼W 20%
R_4	47kΩ ⅛W 20%
R_5	39kΩ ¼W 20%
R_6	68kΩ ¼W 20%
R_7	6.8kΩ ¼W 20%
R_8	1kΩ ⅛W 20%
R_9	470kΩ ¼W 20%
R_{10}	100kΩ ¼W 20%
R_{11}	1.8kΩ ¼W 20%
R_{12}	100Ω ¼W 20%
R_{13}	22kΩ ½W 20%
R_{14}	1MΩ ¼W 20%
R_{15}	See text
R_{16}	470Ω 5W 20%
R_{17}	100Ω ¼W 20%
R_{18}	10kΩ ⅛W 20%
R_{19}	150Ω ½W 20%
R_{20}	For 15Ω output 22kΩ ¼W 20% For 3.75Ω output 10kΩ ¼W 20%

Condensers

C_1	16μF 275 W.V. Daly
C_2	0.02μF 350 W.V. static
C_3	560pF silver mica, R.B.S.
C_4	8,000pF silver mica, R.B.S.
C_5	2,000pF silver mica, R.B.S.
C_6	0.02μF Moldseal
C_7	0.1μF 350 W.V. Static
C_8	0.05μF 350 W.V. Static
C_9	50μF 12 W.V. Daly
C_{10}, C_{13}	50+50μF, 350 W.V., with clip, Daly
C_{11}	8μF 350 W.V. Daly
C_{12}	50μF 25 W.V. Daly

Potentiometers

VR_1	250kΩ Log., A.B. Metal
VR_2	250kΩ Log with switch
VR_3	1MΩ Log., A.B. Metal

Valves

V_1	ECF80
V_2	6BQ5 or EL84
V_3	EZ81

Miscellaneous (all available from H. L. Smith & Co. Ltd.)

T_1	Mains Transformer, 250–0–250V 100mA 6.3V 3.5A, 6.3V 1A
T_2	Output Transformer, Electro-Voice D91

Valveholder B9A (2)
Valveholder B9A with skirt (1)
Mains plug and socket, Bulgin
Speaker plug and socket (3-pin), Cinch
Power output plug and socket (4-pin), Cinch
Input plug and socket, coaxial
Mains selector, fused 2A
Tagstrips, 12-way (pair)
Wire, sleeving, screws, nuts
Chassis, punched, bronze
Control panel, gold hammered
Control knobs, gold insert (3)

The signal on the anode of $V_{1(a)}$ is fed to the tone control circuit around potentiometers VR_1 and VR_2. This circuit[1] is one which has been well-proven in practice, and was successfully incorporated in the Cooper-Smith Mark II Control Unit.[2] The output from the tone control circuit is applied to the upper terminal of VR_3, the volume control; the signal level tapped off by the slider of this control being fed, via the grid-stopper R_8, manner, feeding into the speaker transformer T_2, the secondary of which connects to the loudspeaker output socket. In the main circuit diagram the two secondary windings are connected in series, thereby offering an output impedance of 15Ω. In the "inset", the secondary windings are connected in parallel, offering an output impedance of 3.75Ω.

Negative feedback is obtained from the secondary of the speaker transformer via R_{20}. This resistor, with R_{12}, forms a fixed potentiometer which causes a proportion of the secondary output voltage to be injected into the cathode of $V_{1(b)}$. For 15Ω output operation R_{20} has a value of 22kΩ. For 3.75Ω output operation (in which half the signal voltage given for 15Ω operation is available across the secondary of T_2) R_{20} has a value of 10kΩ.

H.T. power in the "Bantam" is obtained by means of a mains transformer having a full wave h.t. secondary, rectification being provided by V_3. V_3 cathode connects into the filter components C_{13}, R_{16}, and C_{10}, the output valve, V_3, obtaining its h.t. supply from the smoothed voltage appearing across the latter condenser. Further smoothing is provided by R_{13} and C_1, the voltage across C_1 being employed for $V_{1(a)}$ and $V_{1(b)}$.

The power supply has been designed to provide an h.t. output of 250 volts at a maximum current of 100mA. The amplifier current requirement is 55mA only, with the result that an h.t. voltage of 250, with a maximum current of 45mA, becomes available for ancillary equipment such as radio tuners, etc. Such equipment may obtain h.t. and heater power from the power output socket shown in Fig. 1. Since individual requirements may vary, a value for the h.t. series resistor, R_{15}, has not been specified; this being chosen to suit the particular needs of the equipment envisaged. If, to take an example, the ancillary equipment were to require an h.t. supply of 200 volts at 40mA, then R_{15} would be required to drop 50 volts (from the 250 volts available in the amplifier) at this current. From Ohms Law $R = \frac{E}{I}$ the required value for R_{15} under these circumstances would be $\frac{50}{0.04} = 1{,}250\Omega$. Should the amplifier be purchased in kit form, either the value for R_{15}, or the voltage and current requirements of the associated equipment, should be specified.

A 6.3V heater supply is also available at the power output socket, this being obtained from the same heater winding of the mains transformer which feeds the heaters of $V_{1(a)}$, $V_{1(b)}$, and V_2. The heater current available at the socket is 2A.

[1] "Design for a Pre-Amplifier", D. H. W. Busby, *Wireless World*, July 1955.
[2] "The Cooper-Smith Mark II Control Unit", J. Cooper, *The Radio Constructor*, February, 1958.

RADIO topics

BY RECORDER

THE PILKINGTON COMMITTEE, DUE TO report in just under two years' time, has the unenviable task of sorting out what further alternative television programmes are to be transmitted in this country. My normal reaction to the setting up of a Governmental Committee is that this is an easy way to delay decisions. In this instance, however, I cannot help but feel that the situation is sufficiently complicated to fully merit the setting up of a committee in order that the very many views and opinions currently held may be examined and presented in digestible form. It is to be hoped that the requisite Governmental decisions resulting from the Committee's findings will be made within a reasonably short time of the latter being made known.

The Pilkington Committee was set up shortly after the publication of a report made by a previous body—the Television Advisory Committee.[1] The Television Advisory Committee has had a job to do which is at least as complicated as that now facing the Pilkington Committee. Amongst other things it had to recommend whether the existing 405 line standard was likely to remain adequate for all purposes for the next 25 years, to state whether there was any reason why the United Kingdom should not adopt a 625 line standard in Bands IV and V[2], and to see whether advantage could be

[1] *Report of the Television Advisory Committee*, 1960 H.M.S.O. Price 1s.
[2] Band IV is 470–582 Mc/s and Band V is 606–960 Mc/s.

gained from the use of higher standards (i.e. more lines) in Bands I and III. The Committee had, also, to investigate the possibilities of colour in Bands IV and V, recommend the best technical means of transmitting colour in these Bands, and to report on any proposals concerning colour made by the B.B.C. or I.T.A.

This was quite a sizable programme and the Advisory Committee has handled it very well indeed. It is a pity that the findings of the Committee have not been more accurately reported, particularly in the lay press. (Even in the august *Sunday Times* the television correspondent held forth learnedly about 405 lines *per inch.*)

Committee Findings

The findings of the Committee are, briefly, as follows. Firstly, the existing 405 line system will not be adequate for all purposes for the next 25 years. Secondly, assuming that television were to be confined to Bands I and III, a changeover to higher standards (more lines) would not be practicable on these Bands. Thirdly, Bands IV and V must be brought into use if it is intended to provide a 625 line system (even if no additional programme is intended) or to offer more than three programmes (whatever line standard is used). Fourthly, the use of Bands IV and V would offer the last chance to make a change in line standards, and, if such Bands and standards were used, a 625 line system with 8 Mc/s channel width should be employed. Fifthly, whatever colour system is used should be fully compatible; but that a decision concerning its introduction should only be made after a decision has been made on line standards. Sixthly, whatever decisions are made, the current 405 line services should be retained for many years so that existing receivers would not become prematurely obsolescent.

A factor touched on above is the reference to a 625 line standard with 8 Mc/s channel width. This is an extremely important point, because it qualifies almost all the argument at present being raised for and against an increase in the number of lines.

There are, at the time being, two 625 line standards currently operating in Europe. These standards are similar to each other in that both employ negative picture modulation (where increase in transmitter output causes decrease in picture brightness), frequency modulated sound, 50 frames per second and, of course, 625 lines per picture. They differ in channel width and vision bandwidth. One of these systems is that adopted by Western Europe. The Western Europe system has a channel bandwidth of 7 Mc/s and the vision signal occupies 5 Mc/s on one side of the carrier and 0.75 Mc/s (the vestigial sideband) on the other side of the carrier. Thus, the maximum video signal the system can carry is 5 Mc/s. The Eastern Europe system (the O.I.R.T. system) is that employed by Russia and the satellite countries. It has 8 Mc/s channel width, and the vision signal occupies 6 Mc/s on one side of the carrier and 0.75 Mc/s (the vestigial sideband) on the other side of the carrier. The highest video signal that can be handled is, therefore, 6 Mc/s. The 625 line system with 8 Mc/s channel width proposed by the Advisory Committee is different again, because it is recommended that the vision signal in this system should occupy 5.5 Mc/s on one side of the carrier and 1.25 Mc/s (the vestigial sideband) on the other. This is the same as the Eastern Europe system, with the exception that the vision sideband loses 0.5 Mc/s which is gained by the vestigial sideband. Maximum video frequency is 5.5 Mc/s.

Picture Quality Improvement

What improvement in picture quality would we gain from the proposed 625 line system with 8 Mc/s channel width, as compared with our present 405 line system, which has a channel width of 5 Mc/s? It is quite easy to work this out mathematically. The 405 line system has 377 active lines (approximately 28 being lost in the frame blanking periods) and the 625 line system has approximately 585 active lines. Thus, the latter would give us a picture having 585 visible lines as against 377 in the 405 line system; that is, an improvement of 1.55:1 or 55%. The length of a line (less sync pulse) in the 405 line system is approximately 80.7µs, and the maximum video frequency is 3 Mc/s, of which each cycle takes up, obviously, $\frac{1}{3}$µs of time. Thus, we can fit 242 cycles of picture information, or 484 picture elements, into each line of the 405 line system.[3] If the proposed 625 line system with 8 Mc/s channel width has the same line sync pulse as the Western Europe system, the active length of a line (less sync pulse) will be approximately 52.2µs. The maximum video frequency will be 5.5 Mc/s, with the result that each cycle will occupy $\frac{1}{5.5}$µs; and the maximum amount of cycles in an active line becomes 287. Which is equal to 574 picture elements. Thus the improvement in horizontal resolution over the 405 line system is 574:484, or 1.2:1. It follows that the improvements in picture quality given by the proposed 625 line system will, therefore, be an improvement in vertical resolution of 55% and an improvement in horizontal resolution of 20%.

[3] 80.7µs divided by $\frac{1}{3}$µs equals 242.1. One cycle of picture information contains two picture elements, one white and one black.

These results tie up with subjective tests mentioned in the Advisory Committee report. Viewers were asked to assess preference between 405 and 625 line pictures (the latter, during the tests, having a 5 Mc/s bandwidth); and it is reported that the 625 line pictures were noticeably better than the 405 line pictures with reference to visibility of lines. But, so far as an overall assessment of quality between the two systems was concerned, there was only a slight preference for the 625 line picture, and then only in areas of high field strength. (The 5 Mc/s 625 line pictures used in the tests would be able to resolve only 10% more picture elements per line than the 405 line pictures.)

Is It Worth While?

Accepting the improvement in picture quality—20% better horizontal resolution and 55% better vertical resolution—is the change from 405 lines to the proposed 625 line system worth while? A number of arguments have been raised against such a change, these stating, in the main, that the improvement in picture quality is too small, and that the 8 Mc/s channel width allows the use of fewer channels than does the current 5 Mc/s channel width of the 405 line system. The second point is undeniably true. Exponents of the first argument claim that all the new system can do is to reduce "lininess" in the reproduced picture. I cannot help but feel, myself, that reduced "lininess", and the consequent increase in vertical resolution given thereby, is something which should not be sneered at.

Speaking for myself, I am whole-heartedly in favour of a change to the proposed system. I feel, apart from the improvement given in picture quality (and I'm prepared to admit that this isn't all that *fantastically* great), that other important advantages will be brought into being in the new system. The new system will, for instance, provide negative picture modulation which means that, in simple receivers, interference pulses will show up on the screen as black instead of white, and that a.g.c. voltage can be taken from the tips of the sync pulses instead of from average picture level (thereby obviating the case where contrast increases when the overall brightness of the picture decreases). The proposed scheme will also provide f.m. sound with its attendant suppression of impulsive interference. Further, it will give us frame sync signals with equalising pulses, thereby eliminating the circuit skullduggery used in present 405 line receivers to obtain good interlace. Finally, and, in my opinion, most important of all, it will enable us to manufacture receivers for the home market which, with little modification, will be capable of being exported to all countries employing not only 625 but also 525 line systems. Such countries include Australia (625 line) and, of course, North America (525 line).

This final advantage may require a little amplification. It is not generally realised that a very large difference exists between a 625 line receiver and a 405 line receiver. Not only is there the obvious difference between line time base circuits and components, but there is also the fact that the two systems call for entirely different circuitry between the tuner unit and the vision and sound detectors. A 405 line receiver has separate vision and sound i.f. strips. A 625 line receiver has a single strip between the tuner unit and the vision detector, intercarrier sound being taken off that detector and fed into a separate intercarrier amplifier before application to the sound discriminator. The very large difference in the i.f. sections renders the two types of set so dissimilar that they cannot economically employ the same chassis layout and can by no means share the same production line. There would, on the other hand, be proportionately very little difference between a receiver intended for the proposed 625 line system, and one intended for export to a 625 or 525 line country. Also, strong home sales would iron out the production and performance snags likely to crop up in the export versions. 525 line receivers employ much the same stage layout as 625 line receivers (intercarrier sound, etc.) and their time bases can be near-identical. This is because the line frequency of the 525 line system is 15,750 c/s (as opposed to the 15,625 c/s in the 625 line system) and frame frequency is 60 c/s (as opposed to 50 c/s in the 625 line system). There are differences in recommended intermediate frequency and in intercarrier frequency, but these are not so great as to prevent a common chassis layout being employed in production receivers.

I would suggest, therefore, that arguments against the introduction of a 625 line system in this country are vastly outweighed by the advantages which would accrue. These latter consist of a small but significant improvement in picture quality (especially in vertical resolution), an improvement in interference suppression on both picture and sound, an improvement in the a.g.c. characteristic of cheaper receivers together with the easing of interlace problems, and the introduction of a domestic receiver export potential where production difficulties can be almost entirely overcome by large scale home market experience.

Getting the Record Straight

I am indebted to two readers who have

very kindly given me chapter and verse for the "sug and plocket" limerick I reconstituted from memory in the July issue. I am informed that the limerick originally appeared in the May 1954 issue of *Wireless World*, and its author was "M.F.R.". My correspondents[4] give me the correct version, which is as follows:

An "n-pole free (male moulding) socket"
Means hard work for storemen who stock it;
Why not use the word "sug"
For a "fixed (female) plug",
And call a free socket a "plocket"?

Many thanks for helping me out.

My comments on the use of "oscilloscope" and "oscillograph" has prompted a letter from another reader.[5] He states:

"In stating that 'oscillograph' is considered to be more correct than 'oscilloscope', you appear to have transposed the two words. In its early days the c.r.o. was always referred to as an oscillograph, but it is now the established practice to reserve the term 'oscillograph' for instruments having facilities for photographing or otherwise recording the trace, instruments without these facilities being distinguished by the term 'oscilloscope'. The photographic or other record obtained from an oscillograph is termed an oscillogram, apparently by analogy with the words 'telegraph' and telegram'."

I must confess that this is a view I hadn't thought of up to now. And my thanks for the information.

[4] Mr. H. Bradbury, Hyde, Chester, and Mr. C. Pierrepoint, New Malden.
[5] Mr. R. R. Hamilton, Ashtead.

RTTY In Theory and Practice

by J. B. Tuke, G3BST **PART 5**

We now come finally to the choice of a receiver system, the object of which being to convert the signals received from a distant r.t.t.y. station into d.c. reversals suitable for application to the teleprinter magnet. The equipment to be considered in this article will be that suitable for the reception of f.s.k. signals, since it has already been shown that, on the h.f. bands at any rate, this is the only practical system.

Let us first consider the task which the receiving terminal (and this expression includes the actual radio receiver, teleprinter circuit and any auxiliary equipment) must achieve. The signal, as picked up by the aerial, will consist of a wave having frequency shift keying for its modulation—one of the frequencies corresponding to Mark, and the other to Space, and these two radio frequencies have to be converted into d.c. voltages having opposite polarity. The receiving terminal must also be able to select the required signal from spurious signals—i.e. it must possess selectivity. It must only respond to frequency modulation as opposed to amplitude modulation. The signals finally delivered to the teleprinter must have the correct voltage amplitude, and be independent of any changes in received signal amplitude. Telegraph distortion, if introduced at all, must be kept to a low figure. We will now consider these various requirements in greater detail under separate headings.

Selectivity

There are two main ways of dealing with this problem, (*a*) the use of a highly selective receiver, having a "square-topped" bandpass one kilocycle wide. This bandpass will accept an f.s.k. signal having an 800 c/s shift, together with sufficient sidebands to ensure low distortion. If we are sure the receiver can do this job to perfection then the signal from the receiver, at its intermediate frequency or second intermediate frequency, if it is a double superhet (which is normal for this type of work) is passed on to a frequency modulator detector which, in itself, does not contribute in any way to the selectivity but simply produces an output voltage, the direction of which is dependent upon the frequency being received.

(*b*) The alternative method is to have most of the selectivity in the frequency modulation detector itself, or its close circuitry. In this case, the receiver converts the incoming f.s.k. signal into two very much lower frequencies (normally audio tones) the detector producing d.c. outputs from these two tones only, having sufficient inherent selectivity to ignore other nearby tones produced by interfering signals.

The choice before the amateur of one of the above systems is dictated largely by the capabilities of the receiver. System (*a*) can only be used if the receiver really does have the required selectivity characteristic. This is unlikely to be attained unless a multiple crystal filter is fitted or very low frequency triple conversion adopted. Adaptor units which accept a normal 465 kc/s i.f. can be made to convert this frequency to a lower one having the required filter at this point, but they are of necessity, very involved. It is of little use having a response which is "6dB down at 1 kc"—the 1 kc bandpass must have an almost vertical skirt. Without additional conversion, the average receiver in use at an amateur station is simply not suitable for this type of work, and unless suitable test gear is available experiments along this line are likely to lead to disappointment from the selectivity angle. If, however, a suitable receiver is available, then it is only a matter of picking up the final i.f. and passing it to an f.m. detector.

While the (*a*) system is not normally suitable for amateur use the alternative method is quite attractive. In this, the majority of the selectivity is in the detector. The f.s.k. signal is taken from the receiver at the normal a.f. output point in the form of two audio tones. These tones (one for Mark, the other for Space) together with any interference that may be present are applied to highly selective tuned a.f. circuits which may, or may not, be part of the detector circuit itself. These circuits, having regard to the low frequencies involved, have sufficient selectivity to have little or no response to any other frequencies apart from those chosen to represent Mark and Space. This set-up, which may be termed "receiver plus r.t.t.y. adaptor" is, in the usual case, more suitable for amateur application since it enables the normal station receiver to be used for r.t.t.y. and also permits quite phenomenal selectivity to be achieved with simple circuitry.

Whichever system is used, it cannot be too strongly emphasised that *selectivity is essential* for successful r.t.t.y. working. If there should be any response to signals more than 200 c/s away from the required signal then, under amateur conditions certainly, consistent reception cannot be expected.

Response to FM Signals Only

In some ways this could also be considered under the heading of selectivity since it concerns the rejection of unwanted signals but, as the mode of rejection is completely different, it will be considered separately. The rejection of amplitude modulated signals, or signals having any amplitude change, is necessary on two counts. Firstly, within reasonable limits, the voltage applied to the printer coils must not vary if the received signal is subject to fading. This point, however, can be dealt with quite well after the detector stage. In the second case, amplitude modulated interference such as phone or c.w. is obviously to be expected in association with the required signal, therefore if the detector is made insensitive to this type of signal then interference will not result.

The removal of amplitude modulation is achieved in the normal manner—that is by means of a limiter. This may be an r.f. limiter somewhere in the i.f. chain, or if the "r.t.t.y. adaptor" technique is employed, it may be an a.f. limiter between the receiver output and the adaptor input (although it may, of course, be part of the adaptor itself as far as construction goes). Whichever method is used it must work properly for, along with selectivity, satisfactory limiting is another "must" for r.t.t.y. working—its omission resulting in a.m. signals producing output, which is plainly a hopeless situation.

The Detector

Here again we can consider the two systems, previously described, separately. In the purely r.f. system, where a special receiver is used, the detector will act as the third unit in the chain, if we consider the first as a superhet receiver, and the second as a limiter. Having got rid of all interfering signals outside the passband in the receiver, and of all amplitude variations in the limiter, we now have to change the f.m. signals into d.c. reversals. Two circuits are common—the Foster-Seeley type, and the twin-tuned type—basic circuitry being shown in Fig. 1. A slight difference exists in the alignment, however. The twin-tuned circuit may be deliberately undercoupled so that the response curve relating d.c. output to r.f. input is non-linear, compared to the normal f.m. arrangement. This is to reduce the response to frequencies falling in between the Mark and Space values. It is not possible with single tuned circuits to produce this effect to any marked extent, but the curve to be achieved is that shown in Fig. 2 (*b*), Fig. 2 (*a*) showing the normal f.m. discriminator curve.

The output from either type of discriminator will consist of small reversal voltages varying in sympathy with the incoming f.s.k., and these voltages will eventually, after amplification, be applied to the printer.

Returning now to the audio frequency system, the detector requirements are rather different. Here we have two audio tones, one which has to be converted to d.c. in one direction, the other to d.c. in the reverse direction. We have also admitted that interference will be present and the detector must therefore not respond to any tones other than those of Mark and Space.

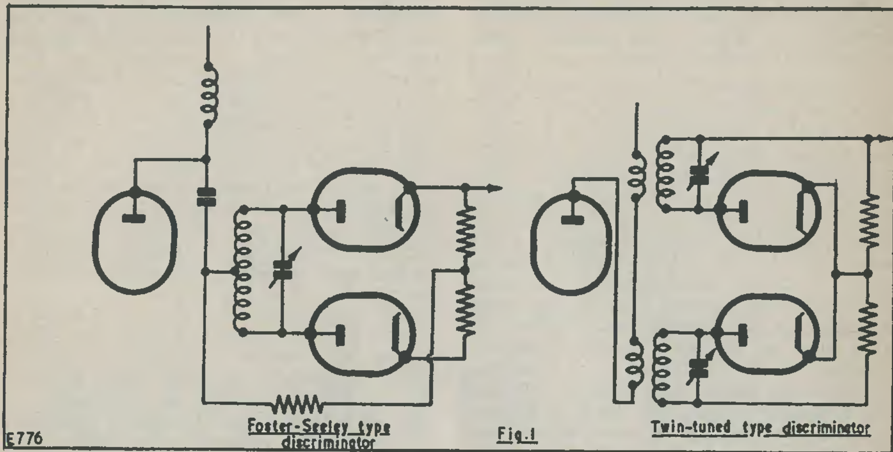


Fig. 1

A true discriminator on the Foster-Seeley lines at audio frequencies would be difficult to construct, and would also have little selectivity, so we must turn to other types of circuit.

The usual method is to arrange for two separate a.f. tuned circuits (one tuned to the Mark frequency, the other to the Space) to be fed in parallel from the receiver output. Each tuned circuit will eventually feed a diode detector, the outputs of which are combined in anti-phase, so that the direction of the current depends upon the incoming audio frequency. The detailed circuitry may be varied. For example, let us imagine that the two tones chosen to represent Mark and Space are 1,000 and 1,800 cycles respectively. We may start off with a pair of tuned amplifiers, one on each frequency, connected side by side to a common input. After this selective filtering, the signals may then be amplified to the required degree and passed to the diodes. Alternatively, the signal from the receiver may be amplified "as it stands" to the required level, and then fed to a pair of diodes via two highly selective audio coupling devices—see Fig. 3. The choice of circuit is left to the individual, either method producing good results.

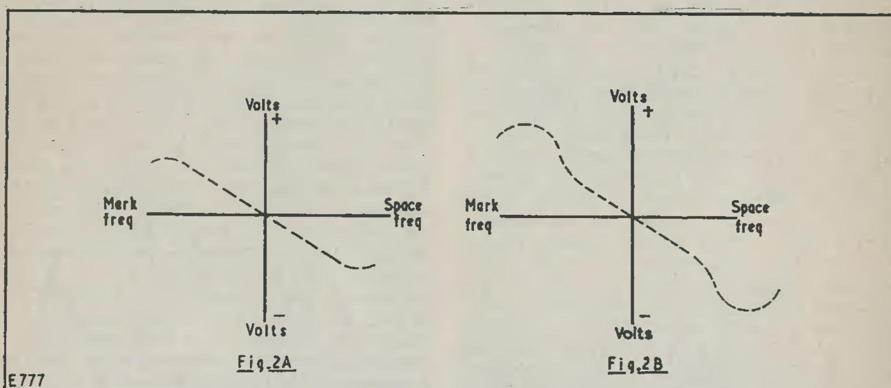


Fig. 2A Fig. 2B

Whichever comes first, the tuning or the amplification, it is important to design the tuning circuits for high selectivity. This is not easy at audio frequencies and, although conventional parallel inductance and capacity circuits are often used, trouble will almost certainly be experienced in getting a reasonable "Q". The highest quality inductances will be required—these will almost certainly have to be toroids. It may be necessary to use a number of these circuits in cascade to achieve the required result. An alternative method is to use RC bridge circuits and filters in place of the usual LC circuits.[1] The RC circuit is more convenient at audio frequencies and also easier to adjust to a particular frequency since R can always be made variable, whereas L and C cannot, except in steps. It is permissible to use a certain amount of regeneration in order to improve selectivity—but it must not be carried to excess. Regeneration introduces "ringing"—the prolongation of the original signal beyond its original length, and this is, of course, telegraph distortion. Carefully controlled regeneration will, however, improve the selectivity very considerably long before distortion becomes noticeable. The response curve to be aimed for is shown in Fig. 4. This indicates that while the frequencies chosen for Mark and Space will produce the appropriate voltage across the diode load, other frequencies produce little or nothing. This applies not only to frequencies either side of the Mark and Space frequencies, but to those in between as well. A correctly adjusted detector will print merrily away in the face of the most atrocious interference, while a poorly adjusted one will "garble" even with the slightest interference, it is therefore worthwhile going to some trouble obtaining the correct response.

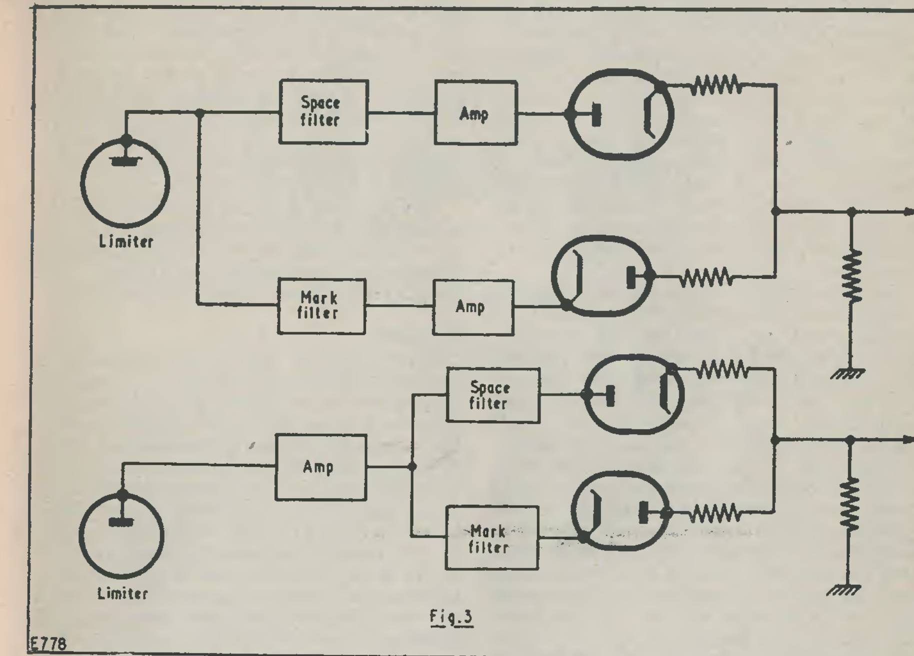


Fig. 3

[1] A more extended explanation of this method appeared in the March and April 1960 issues of the *Short Wave Magazine*, together with a circuit and constructional details of a terminal unit making use of these principles.—EDITOR.

Before leaving this type of circuit, we may consider for a moment what are the best a.f. tones to use for Mark and Space, since *any* two can be used providing they differ by the chosen value of shift—normally 800 c/s. Selectivity will be easier to achieve if low

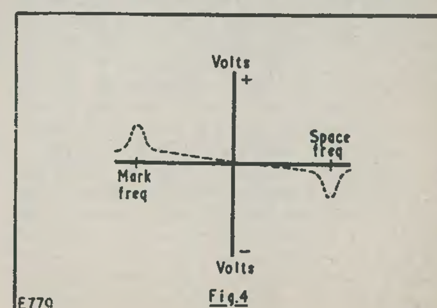


Fig. 4

frequencies are used—since the percentage shift is greater. But we have to remember that the minimum 20ms "burst" of signal is going to be turned into d.c. by the diode, and that if this consists of too few cycles some difficulty will be experienced in separating the a.c. and d.c. components. For example, a 20ms signal at 1,000 c/s will consist of 20 cycles. Assuming perfect separation of a.c. and d.c., the rise-time of the d.c. will be one-quarter of a cycle—i.e. a quarter of a millisecond. If we now consider the same 20ms signal, with a frequency of 100 c/s, the entire signal will only consist of 2 cycles, and the rise time will be 2.5ms. Since it is unlikely that perfect separation of a.c. and d.c. will be obtained, the rise-time (and consequently the fall-time) will probably be somewhat longer than shown here—and this is again a form of distortion. For this reason this example shows that the frequencies chosen cannot be too low; therefore it is inadvisable to choose figures much below 400 c/s if difficulty is to be avoided.

Two frequencies which are harmonically related must also be avoided—since if we chose, say 800 and 1,600 c/s, any harmonic distortion of the 800 c/s signal would appear as a 1,600 c/s signal and upset operation.

If too high a frequency is chosen, then harmonics of lower, interfering signals will produce response from the detector circuit. For example, if, say, the Space tone were 3,000 c/s, then an interfering signal on 1,500 cycles, being distorted in the limiter, would produce output. This effect must be present whatever frequencies are chosen but, if lower ones are used, the effect is not so noticeable since the overall a.f. response of the receiver may be deliberately reduced on the lower frequencies quite easily.

As can be seen, there are a number of conflicting requirements—but good results may be expected if the lower of the two frequencies is of the order of 400 to 500 c/s, with a shift of 800 c/s.

Final Stage

In this stage, the d.c. reversals appearing across the detector load are amplified and limited before being passed on to the printer itself. This may be accomplished by purely electronic, or by electro-mechanical means, or a combination of both. In the purely electronic method, the d.c. from the detector is used (after amplification) to trigger a bi-stable multivibrator. A pair of valves are set up in a bridge circuit, the teleprinter magnet coil being the cross arm of the bridge. If alternate valves conduct, current through the coils is reversed in sympathy. Clearly the current through the valves is independent of the trigger voltage so that d.c. limiting is applied automatically. This arrangement is a good one, the follow-on action of the circuit being so rapid that no appreciable distortion is introduced. Its main drawback is complication and rather large power consumption.

The alternative method is to use the d.c. from the detector (again after amplification) operating a centrally polarised relay. The relay makes one contact, or the other, according to the d.c. polarity, switching the teleprinter coils to an external d.c. supply first in one direction and then in the other. The advantage of this method is its simplicity but, of course, some distortion must be introduced since the relay cannot operate in zero time. Providing a correct type of relay is used, this distortion is not serious. Again, current flowing in the printer coils is unaffected by the current from the detector so that d.c. limiting is automatic.

Having covered all the essential points in a receiving terminal, we will now look at one or two additional items which are frequently found in commercial equipments, and consider them from an amateur viewpoint.

Repeaters

We have seen that from one cause or another, the signal fed to the receiving teleprinter must suffer some distortion. Circuits do exist which take the output from the terminal unit, using it to trigger multivibrators operating in pulses of 20ms. The triggering time may be a short sample of the entire signal length, so that a completely "new" signal is produced by the repeater circuit, thereby removing all the distortion. Unfortunately, circuitry of this type is very complicated, it being questionable whether it is worth the trouble and expense involved. However, there is scope for experiment along these lines.

Diversity Reception

Commercial r.t.t.y. links use both frequency and space diversity. With the frequency diversity method, the signal is transmitted on two separate frequencies, received on two receivers, and then gated to reject the poorer of the two before being fed to a single printer. It is doubtful if any amateur would want to use this system on account of the extreme complications, quite apart from the fact that, in this country, simultaneous transmission on two frequencies is not allowed. In any event, the harmonic relationship of the amateur bands would not make this an attractive system since, for long distance working, it is unlikely that two bands would be "in" at the same time.

Space diversity simply means having two aerial systems separated by a short distance, each being connected to a receiver, tuned to the same frequency. The outputs are again gated to reject the poorer signal, and being fed to a single printer. This could be used by amateurs, but it seems unlikely that it would prove popular to any great extent. Few of us have enough room for one aerial let alone for space diversity arrays.

It is hoped that these articles have unravelled some of the mysteries surrounding r.t.t.y. As with most radio systems, simple equipment will work adequately, but more consistent results can be achieved with sophisticated equipment, a parallel being that a 10 watt transmitter, together with an 0V1 receiver, will work anywhere in the world on c.w.—yet most amateurs use far more complicated equipment. It is much the same with r.t.t.y.—better equipment will produce good results more regularly. The aims of r.t.t.y. users should be the emission of a stable signal with the **EXACT** value of frequency shift and, on the receive side, the maximum possible selectivity. If this is achieved, r.t.t.y. will print successfully under conditions which make c.w. difficult, and telephony downright impossible.

A High-Gain V.H.F. Aerial

The Quad Plus

By A. S. Carpenter

In which the author describes an experimental aerial array incorporating both quad and dipole elements

Considerable interest has been aroused recently regarding the use of the Quad aerial for v.h.f. purposes since its gain is comparable, and can sometimes exceed, that of an 8-element Yagi. Furthermore, the Quad has a wider acceptance angle and a broader bandwidth than a Yagi, which is another point in its favour. As it is physically more compact than a Yagi it is well suited to loft or other indoor installation.

Readers unfamiliar with the Quad aerial should study Fig. 1 in which the essentials are shown. It has sides each effectively $\frac{1}{4}\lambda$ long and responds to horizontally polarised signals when the feed point opening is made as shown at (*a*) and to vertically polarised signals when the opening is made as shown at (*b*). The two loops, conveniently made into squares constitute, in effect, four half wave elements.*

The aerial, with a parasitic reflector spaced at 0.2λ (see Fig. 1 (*a*) or (*b*), can be made to have a gain of some 8-10db over a dipole, hence its popularity for t.v. and v.h.f. use. Gain can be further increased by adding another loop in front to operate as a director. The loops should be broadside on to the transmitter.

An Improved Aerial

The writer has found that the unique combination of dipoles and Quads depicted in Fig. 2 gives still higher gain, probably because it combines three vertical half wave elements (shown 1, 2, 3 in the diagram) and *two* quarter wave squares, all broadside to the transmitter.

Cable connections are made to the central point of the aerial and to facilitate accurate matching a $\frac{1}{4}\lambda$ stub is employed. The actual method of connecting coaxial cable is shown in Fig. 3. The point of connection will vary from aerial to aerial but should be approx. 3in from (*b*). Sliding clips are suggested, as at point (*a*) the impedance will be high whereas at point (*b*), there will be zero impedance due to the stub shorting bar (*c*). Somewhere, therefore from (*a*) to (*b*) the correct point can be found to suit the cable.

In areas of low signal strength it is essential to get as much resonant metal "skywards" as possible, especially at Band III frequencies, and a glance at Fig. 2 will reveal that there is as much metal involved here as in a 5-element Yagi. But, perhaps what is more important, is the fact that the "frontage" offered is much greater than that of the Yagi. The importance of supplying "frontage" is borne out by the numbers of twin Yagis (broadside/endfire arrays) erected in deep fringe locations.

To improve the broadside assembly illustrated in Fig. 2 all that becomes necessary is to add parasitic elements at front and back to make it a combination broadside/endfire assembly. The parasitic assembly may be made identical with the active one if desired, though the central vertical element will need neither stub nor opening, remaining as a

*In some instances the Quad assembly may be tuned by inserting a stub with a movable shorting bar into the reflector at a point corresponding to the outlet of the Quad.—*Editor.*

continuous length of rod. Perhaps the most effective and simplest method is to use a sheet reflector one wavelength square; although normal Yagi type parasitic elements may be used as reflectors and directors if preferred, these being 5% longer and shorter respectively than the dimension obtained from the formula mentioned later for (*a*) and (*b*).

Feed Point Impedance

The aerial, even when parasitic elements are added and spaced 0.2λ in front and back, is still of fairly high impedance. Despite this, 300-ohm balanced twin cable can be directly connected without serious mismatch. The matching section proves very useful however when 75-ohm cable is preferred, a good match resulting from connections made at approximately 2–3in from the shorted end as previously mentioned. Both types of cable have been used with the aerial during initial experiments.

Dimensions

The usual formula for finding the length of a half wave dipole *in feet* is $\frac{468}{f}$, or alternatively $\frac{5{,}616}{f}$ if the length *in inches* is required. However, experiments would suggest that a better formula for the higher frequencies with an aerial of this kind is $\frac{5{,}256}{f}$ ins per half wave.

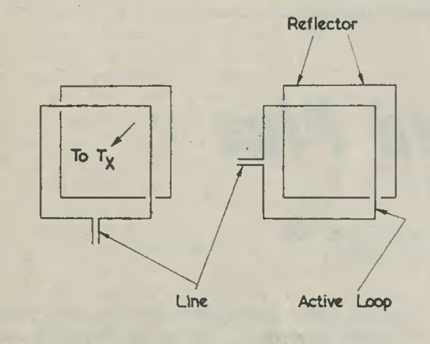


FIG. 1(a) FIG. 1(b)

The reflector should be placed 0·2λ behind the active loop. A 'director' loop may be placed 0·1λ in front if required as mentioned in text.

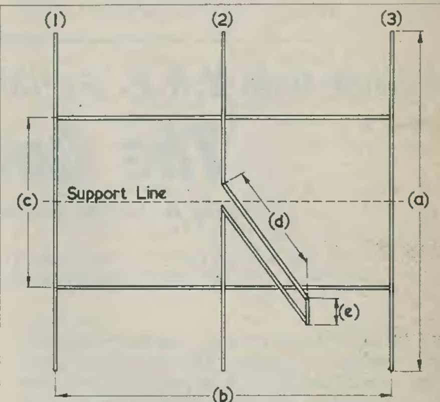


FIG 2

Rear View of the aerial. The transmitter being directly in front.

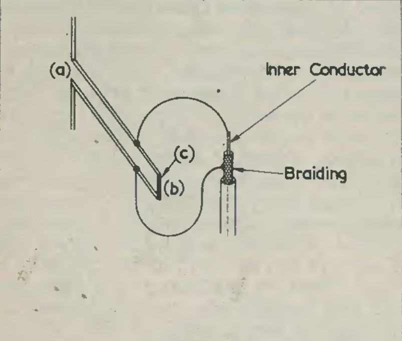


FIG.3

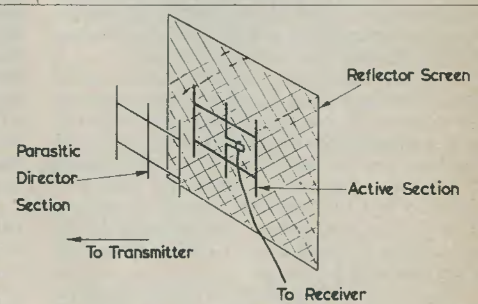


FIG.4

A suggested arrangement

M804

To determine the various dimensions *in inches*, therefore, only two simple calculations need to be made and, referring to Fig. 2,

$$(a) \text{ and } (b) = \frac{5{,}256}{f} = (\tfrac{1}{2}\lambda \text{ dimensions})$$

$$(c) \text{ and } (d) = \frac{2{,}628}{f} = (\tfrac{1}{4}\lambda \text{ dimensions})$$

$$(e) = 1\tfrac{1}{2}\text{in}$$

For *f*, insert the frequency of the desired transmission, i.e. if Channel 11 ITV is required insert 204.

Conclusion

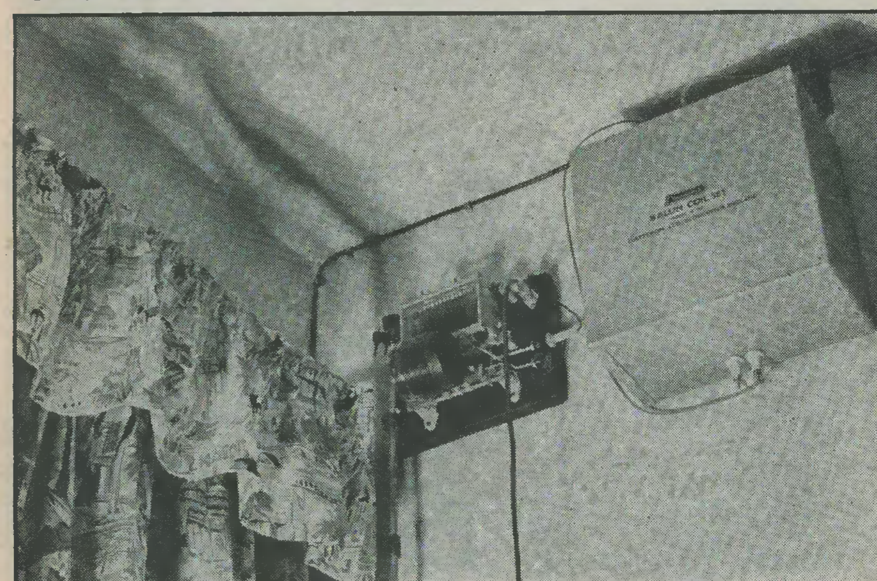
Mechanical details are not given as interested readers will not be short of ideas. Alloy tubing not less than ⅜in diameter should be used and can be bent where necessary by heating slightly. The vertical elements may be of larger diameter than the horizontals if desired, or *vice versa* (although this might modify the feed point impedance slightly), holes being drilled to permit the smaller ones to slide through the larger and bolts being finally passed through both to secure firmly. Points of low impedance (shown by the broken lines in the diagram) should be used for mounting purposes.

The aerial described is an efficient one and although the writer realises that further improvements are possible (and some keen enthusiasts will already have noted how) he prefers to leave it until actual tests have been made and such improvements confirmed.

TRADE REVIEW . . . Heathkit Balun Coil Set

One of the latest kits in the Heathkit range is of particular interest to the amateur transmitting enthusiast. The Balun Coil Unit fills a need which has long been felt by the amateur radio transmitter in this country, the home construction of this type of aerial tuning equipment presenting great difficulties that are not easy to overcome by those with the usual somewhat limited workshop facilities. The almost universal use of coaxial output facilities on present day amateur transmitters—and the equally common use of balanced fed aerial systems—makes the availability of such a unit even more desirable.

The Heathkit Balun Coil Set, Model B-1U, will match unbalanced coaxial lines into balanced feeders of either 70Ω or 300Ω impedance. It can be used without any adjustment over a frequency range of 10 to 80 metres and will handle outputs of up to 250 watts.



The kit supplied complies with the usual Heathkit high standard and can be assembled in a very short time.

As will be seen from the accompanying illustration, it is contained, once constructed, within a small convenient sized case which may be fixed to the shack wall near the aerial system feeders.

Having thoroughly tested one of these units over the last few months, we can thoroughly recommend their use. It is an accessory which will further assist in enabling a quick change from band to band being made with the greatest convenience, disposing as it does, with the tuning of an aerial tuning unit of the more conventional type.

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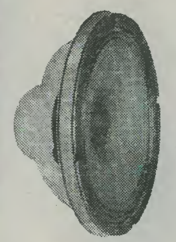

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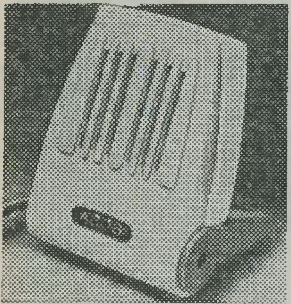

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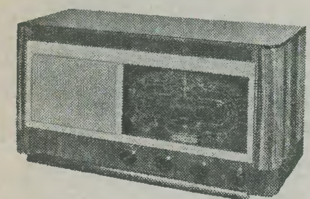

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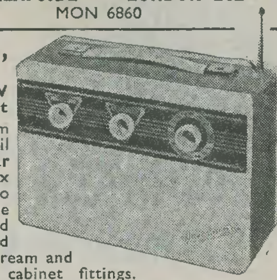

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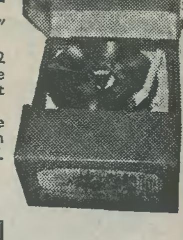

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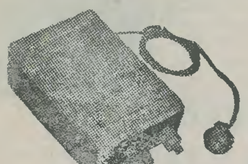

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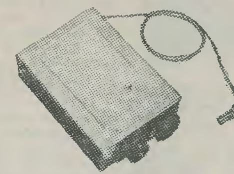

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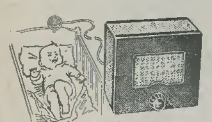

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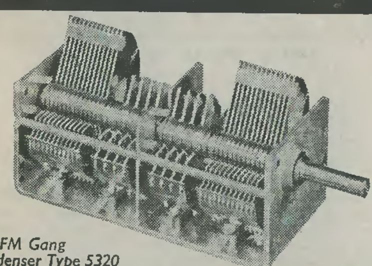

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1T4	3/11	12Q7	5/3	DM70	7/6	EY86	7/9
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6BA6	5/11	955	3/6	ECF80	9/–	PCF80	7/–
6BJ6	5/11	956	2/6	ECF82	9/–	PCL83	10/6
6C4	4/–	9001	3/11	ECL80	7/6	PCL82	7/6
6C6	4/9	9004	3/11	ECL82	10/–	PL36	10/9
6K7G	1/11	9006	3/11	EF36	3/–	PL81	8/9
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6SN7GT	4/3	CL33	12/6	EF50	1/9	PL83	7/–
6SA7M	5/9	DAF91	4/9	EF80	5/6	PY31	8/3
6SG7M	4/9	DAF96	6/11	EF86	9/9	PY80	7/–
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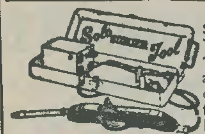

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6AK5	5/–	6SN7GT	4/–	830B	8/6	EM80	9/6
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6F6M	5/6	12BE6	7/6	EA50	1/6	TT11	3/–
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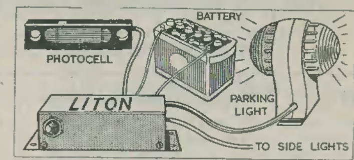

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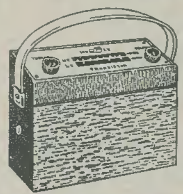

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