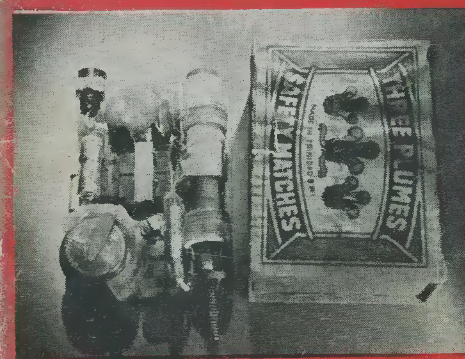
THE TUNNEL DIODE — IN THEORY AND PRACTICE, Part 3

VOLUME 14
NUMBER 6
JANUARY
1961

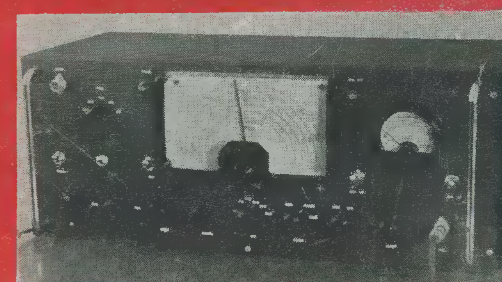
The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS



MATCHBOX Super-Regenerative Transistor Receiver

Compact Amateur Bands Transmitter



Included in this Issue

TWO-VALVE A.M. TUNER
TELEPHONE ADAPTOR UNIT
TELEVISION DISTRIBUTION SYSTEMS
A 1-WATT ADD-ON OUTPUT STAGE
"WAVEMASTER" PORTABLE/CAR RADIO, PART 2
SMALL COMPONENT HOLDER SOLDERING AID

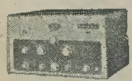
DATA Publications 1/9

The World-famous Heathkit range of equipment

For the Discerning who require the Best Performance at Minimum Price

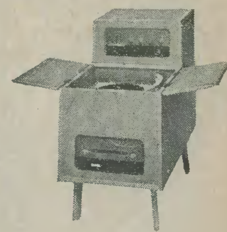
HI-FI FM TUNER

This model is available as two units which, for your convenience, are sold separately. They comprise an R.F. Tuner Unit, Model FMT-4U (£3.2.0 including Purchase Tax) with I.F. output of 10.7 Mc/s, and an Amplifier Unit complete with attractively styled cabinet, also power supply and valves. Model FMA-4U (£10.10.6) making a total cost for the equipment of £13.12.6.



AMATEUR TRANSMITTER Model DX-100U

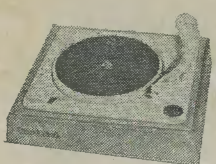
This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160–10 metres. Self-contained, including power supply, Modulator and V.F.O. **£78.10.0**



THE "CHEPSTOW"

This cabinet has specially been developed for those who require to house their equipment in as small a floor area as possible. Overall dimensions are 35″ x 18″ x 33″ high.

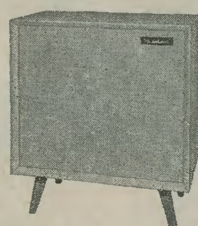
It will accommodate Record Player, FM Tuner, Stereo Amplifier and where a Stereo Control Unit is used, one or more power amplifiers as well. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Left in the white, veneered for finishing to personal taste. **£10.10.6**



TRANSCRIPTION RECORD PLAYER

TRANSCRIPTION RECORD PLAYER, Model RP-1U. This new RP594 Collaro Transcription Unit has a Ronette Stereo Pick-up, giving excellent results on stereo or mono (33, 45, or 78 r.p.m.) discs. Complete with furniture-grade wooden plinth. **£12.10.0** Heavy Turntable **£15.0.0.**

THE "COTSWOLD". This is an acoustically designed enclosure 26″ x 23″ x 15½″ housing a 12″ bass speaker with 2″ speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£19.18.6**



THE "COTSWOLD"

THE "GLOUCESTER". It will house Tape Deck and/or Record Player—as well as FM Tuner and Stereo Amplifier, and storage space is provided for records, tapes and power amplifiers. Furthermore, to meet the needs of those with whom room-space is an overriding consideration, provision is made in the cabinet ends for matched Hi-Fi Stereo Speaker Systems.

Mk. 1. Tape Deck or Record Player **£15.18.6**

Mk. 2. Tape Deck and Record Player. **£17.8.0**

NEW KITS

TAPE RECORDING/REPLAY AMPLIFIERS. Stereo (TA-IS) **£22.4.0.** Mono (TA-IM) **£16.14.0**

4 WAVE (Medium, Trawler and 2 Short) TRANSISTOR PORTABLE, Model RSW-1. **£20.18.6**

R.F. SIGNAL GENERATOR, Model RF-IU. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£11.11.0**

GRID DIP METER, Model GD-IU. **£9.19.6.** Transistorised version, Model XGD-1. **£9.18.6**

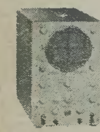
The "GLOUCESTER" (open)

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

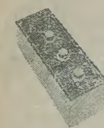
DAYSTROM LTD DEPT. RC1 GLOUCESTER ENGLAND

Easily-built Equipment Heathkit of excellent quality

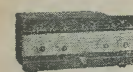
at much lower cost



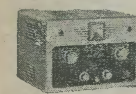
O-12U



DC-1U



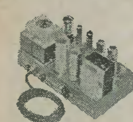
S-33



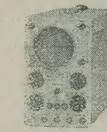
DX-40U

AG-9U

UJR-1

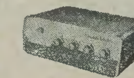


MA-12



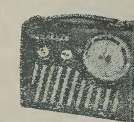
OS-1

V-7A



S-88

SSU-1



UXR-1

"STUDIO"

5″ OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/cm, 3 c/s to over 5 Mc/s. Rise time, 0.08 μsecs or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. **£34.15.0**

2¾″ PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5″ x 8″ x 14″. Wt. 10½lb. **£18.19.6**

DECADE CAPACITANCE BOX: DC 1U. Provides capacity values from 100 mmf to 0.111 mfd in 100 mmf steps. Ideal for experimental, development and design work. **£5.18.6**

VALVE VOLTMETER: V-7A. The world's largest-selling VVM. Measures volts to 1,500 (DC & RMS) and 4,000 pk. to pk.; resistance 0.1Ω to 1,000MΩ DC. Sensitivity: 7,333,333 ohms per volt. **£13.0.0**

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn. at 2½ watts per channel. **£11.8.0**

HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl. Many special features. **£25.5.6**

"HAM" TRANSMITTER: DX-40U. 75W CW; 60W pk. c/s phone; 40W into Aerial. **£29.10.0**

HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono in average room (left "in the white"). Legs **£1.7.0** extra. **£10.5.6**

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies attenuation. **£19.3.0**

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

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

SINGLE CHANNEL 12 WATT HI-FI AMPLIFIER: MA-12. Ideal for stereo conversions, etc. Generous auxiliary power provided. **£9.19.6**

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

(Following models not illustrated)

CAPACITANCE/RESISTANCE BRIDGE: C-3U. Measures capacity, 10pF to 1,000μF. Resistance 100Ω to 5MΩ; Pwr. factor. **£7.19.6**

VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. **£10.12.0**

AUDIO WATTMETER: AW-1U. Up to 25W continuous, 50W intermittent. **£13.18.6**

AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V AC. 10 c/s to 400 kc/s. **£13.18.6**

ELECTRONIC SWITCH: S-3U. This extremely useful device extends your single-beam "scope" for double-beam uses. **£9.18.6**

DIRECT READING CAPACITANCE METER: CM-1U. Full-scale ranges of 0–100 mmf, 1,000 mmf, 0.01 mfd and 0.1 mfd. **£14.10.0**

Money Saving "Packaged Deals" of Complete Stereo Equipment from £42.10.0

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A REVOLUTIONARY NEW BRITISH INVENTION!

- ★ **Uses standard tapes**
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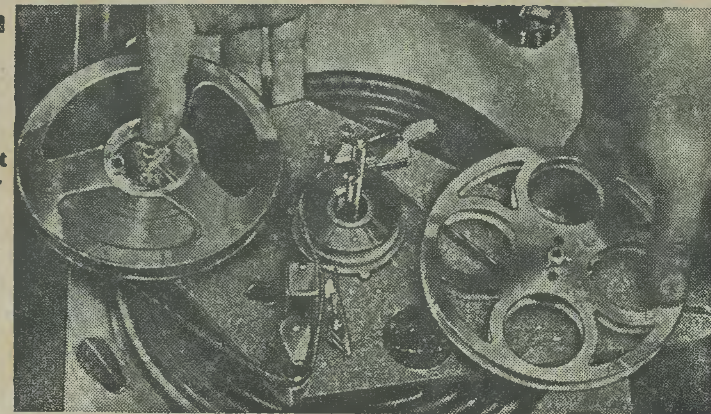
- ★ **Records direct from radio or microphone**



11 Gns.

13/– DOWN AND 18 FORTNIGHTLY SUMS OF 13/–

Ready to record, complete with Control Unit and 600 ft of Twin-track tape. Special moving coil microphone extra.

Easy Terms

Instantly turns any Gramophone into a first-class Tape-Recorder

and back into a record-player in a moment!

Gramdeck is completely *new* . . . a revolutionary and ingenious invention that instantly turns your gramophone into a tape-recorder and back into a gramophone at will! Slip the Gramdeck on to your turntable and you have the finest tape-recorder you've ever heard! Lift it off . . . your gramophone is ready to play records again. There are no motors or valves to go wrong—and *you get reproduction that has to be heard to be believed.*

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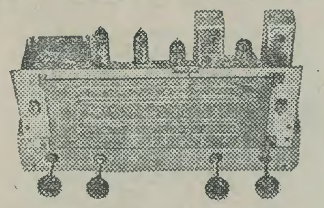
GRAMDECK TURNS A TURNTABLE INTO A TAPE-RECORDER



1961 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 feedback. 4.2 watts. Chassis 13½" x 5½" x 2½". 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

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, printed circuit, amplifier with two valves and 7" x 4" elip. speaker	£3.12.6

or **£9.9.0** complete kit post free

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.

Weyrad Standard Size 465 kc/s 3½" x 1½" sq. **12/6** pair

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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/–

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C.R.T. BOOSTER 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 10Ω–10MΩ. Ditto 5% 100Ω–5MΩ, **9d.** each.

WIRE-WOUND RESISTORS
5 watt, 10 watt, 15 watt — 25 ohms–10,000 ohms — 1/3, 1/6, 2/–
12.5 kΩ–50 kΩ 10W, **3/3**

WIRE-WOUND POTS Pre-set min. TV type. Knurled slotted knob. All values 25 ohms to 25k, 3/– each, 30k, 50k, **4/–**. Ditto ¼W 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.** 3A	10/6
Ditto 1.4, 2, 3, 4, 5, 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
Auto. Trans. 150W, 0, 10, 120, 200, 230, 250V	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 10 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 120mA, **12/6**; 10H 150mA, **14/–**.

CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ⅞" x $\frac{3}{16}$"
ACOS CRYSTAL HAND or DESK MIKE, 25/–

ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d**
0.3" FORMERS 5937 or 8 and cans TV1 or 2, ¾" 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. 1⅜" 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, **5/6** each.
TUNING AND REACTION CONDENSERS. 100pF, 300pF, 500pF, **3/6** each, solid dielectric.

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
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16/500V	4/–	8+16/450V	3/9	32+32/450V	6/–
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25/25V	1/9	16+16/450V	4/3	50+50/350V	7/–
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The Radio Constructor

Incorporating THE RADIO AMATEUR

JANUARY 1961

Vol. 14, No. 6

Published Monthly

Annual Subscription 25/–
(including postage)

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
CUNningham 6141
(2 lines)

Telegrams
Databux, London

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

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

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

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Suggested Circuits

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

No. 122. A 2-Valve AM Tuner

It is usual for high fidelity enthusiasts to confine their radio listening to the programmes provided by an f.m. tuner, since a tuner of this type enables a higher standard of reproduction to be achieved than is possible with an a.m. receiver operating on Medium and Long waves. Unfortunately, the only transmissions available on f.m. are those broadcast by the B.B.C. Many programmes of interest and value are broadcast on the Medium and Long wave bands by Continental transmitters, and it is frequently desirable to have facilities available for the reception of these programmes, despite their inevitably limited fidelity.

This month's contribution describes a simple two-valve tuner which has been especially designed to meet the requirement just stated. By the use of currently employed commercial techniques, economy of components has been achieved wherever possible. An attractive feature of the circuit is that, with the aid of an inexpensive mains transformer of the type initially introduced for Band III television converters, the tuner can be made completely self-contained whilst still having a fully isolated chassis. Alternatively, the tuner may receive its heater and h.t. supplies from the following amplifier.

The frequency-changer section employs a straightforward coil circuit which, at the expense of a little extra complexity in waveband switching, should be capable of offering the maximum protection against second channel interference which is possible with a single aerial tuned circuit. The selectivity of the tuner is governed by the composite response curve of the two i.f. transformers employed.

The Circuit

In the circuit, which accompanies this article, the aerial is applied to $S_{1(a)}$, this switch selecting either coupling coil L_1 or L_3. L_1 and L_3 couple respectively to the tuned coils L_2 and L_4, the latter being trimmed by C_1 and C_3. Whichever coil is selected by $S_{1(b)}$ is tuned by C_4.

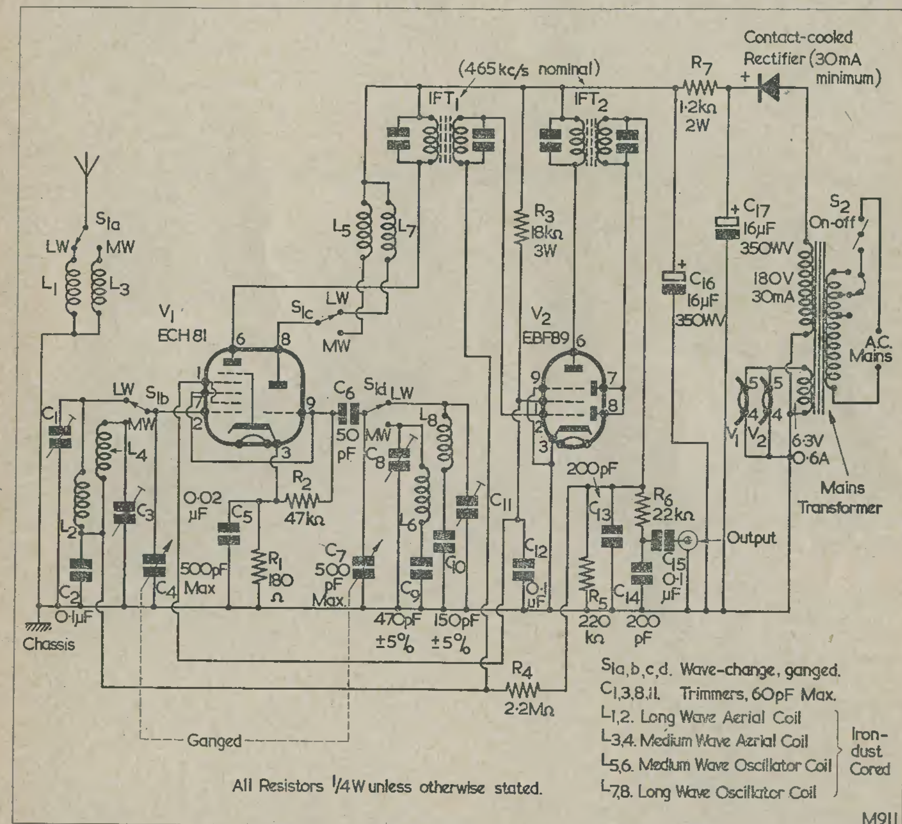
Switches $S_{1(c)}$ and $S_{1(d)}$ select the oscillator coupling coils, L_5, L_7, and the oscillator tuned coils, L_6, L_8. The coupling coils are connected directly between V_1 triode anode and the h.t. positive rail. Whichever tuned coil is selected by $S_{1(d)}$ is tuned by C_7, fixed condensers C_9 and C_{10} functioning as padders. L_6 and L_8 are trimmed by C_8 and C_{11} respectively.

V_1 triode is the oscillator, and its grid leak is returned to cathode in conventional fashion. The triode grid is connected to G_3 of the heptode section, the signal input being applied to G_1.

The i.f. signal available at the anode of the heptode is fed to i.f.t.$_1$ and, thence, to the grid of the double diode pentode V_2. The pentode section of V_2 amplifies the i.f. signal, applying it to i.f.t.$_2$. The secondary of i.f.t.$_2$ couples into the detector circuit, which is completed by the two strapped diodes of V_2, and the diode load, R_5, shunted by C_{13}. The detected a.f. signal appearing across R_5 is applied to the low-pass filter R_6, C_{14}, and thence, via C_{15}, to the output socket. C_{15} is a blocking condenser which prevents the d.c. component of the detected signal being fed to the subsequent amplifier. An a.g.c. voltage is also taken from R_5, this being applied to the grid circuits of V_2 and the heptode section of V_1 via R_4. A single condenser, C_2, bypasses the a.g.c. voltage for both grid circuits.

The mains transformer provides an isolated source of supply. Its heater winding feeds the heaters of the two valves, whilst the single-phase h.t. secondary connects to the half-wave contact-cooled rectifier. The rectified voltage from the rectifier is smoothed by C_{17}, R_7 and C_{16}. Condenser C_{16} provides an h.t. bypass for all the anode circuits in the tuner; there are no separate anode decoupling circuits.

Economies in the circuit are achieved in several ways. Firstly, the screen grids of V_1 and V_2 are connected together, being supplied via a single resistor and decoupled by a single condenser. Secondly, the cathode of V_2 is returned direct to chassis instead of via a cathode bias resistor and parallel condenser. In the absence of signal the pentode section of V_2 is then biased by contact potential in the diodes, together with any voltage which may be dropped across R_4 due to grid current in the pentode. In practice the negative voltage on the pentode grid may be increased by rectified noise picked up on the aerial or generated in the heptode stage. When a signal is received the pentode section of V_2 is biased in normal fashion by the resulting a.g.c. voltage. A third economy is effected in the oscillator circuit by returning the anode coupling coils direct to the h.t. positive rail instead of employing a resistance-capacity feed.



Design Considerations

When the idea of a *Suggested Circuit* covering an a.m. tuner was initially conceived, a number of decisions were made concerning the form in which it would finally appear. The first question to be decided was whether transistors or valves were to be used. Since the fact that the tuner was intended to feed into a subsequent amplifier would infer the presence of a mains supply or, possibly, heater and h.t. supplies, there was little advantage in running costs to be gained from the use of a transistorised unit. Furthermore it is possible, by using well tried circuit techniques, to obtain a reasonably good a.m. performance with two valves only, whereas three or more transistors would be needed in a transistorised version to obtain the same results. Also, the transistorised version would probably cost more than its valve equivalent. The final factor in favour of valves was that, due to the availability of low-cost "converter" mains transformers, the provision of an isolated power supply was a relatively simple and inexpensive matter.

R7 5kΩ 5W
with 240V transformer.

Having decided to employ valves, two further points had to be considered: the performance of the i.f. section of the tuner, and the performance of the r.f. section. Fortunately, the i.f. section could be looked after very simply by using a pair of i.f. transformers in conventional manner. If good quality components were employed here, the tuner would give a performance as acceptable as could be reasonably expected considering the state of the crowded Medium and Long wave bands.

So far as the r.f. section was concerned it was decided to use the arrangement shown in the circuit, wherein single sets of coils are switched in on each band. No bottom-end coupling is employed in either the signal or oscillator sections, and it was felt that the straightforward method of operation employed would enable the individual coils switched into circuit on each band to offer the optimum sensitivity and tracking of which they were capable. It was considered that there would be no advantage in fitting a ferrite frame in place of conventional aerial coils as the tuner unit would possibly be housed in a metal cabinet, or might be employed in a layout where it was surrounded by a number of metal-housed units.

The idea of switched station selection was also considered but it was felt that this would defeat the object of the tuner, whose function should be that of picking up any Continental transmission on the two bands concerned. It is, in any event, considerably simpler and, possibly, cheaper to fit a two-gang condenser than a switching circuit. The drive to such a condenser could consist of a simple epicyclic reduction gear or an equally simple drum and pulley arrangement.

Connecting to the Amplifier

Connecting the a.f. output of the tuner to the subsequent amplifier is carried out by screened cable between the two units. The input resistance of the amplifier is of considerable importance, since it qualifies the ratio between the a.c. and d.c. diode loads for the tuner. To prevent distortion on heavily modulated transmissions the input resistance of the amplifier must be at least four times the value of the diode load R_5. The tuner could, therefore, be coupled direct to an amplifier having an input resistance of 1MΩ or more. If the input resistance of the amplifier is lower than 1MΩ a series resistor should be inserted into circuit at the amplifier end of the connecting cable to bring the total input resistance up to this figure. Thus, if the input resistance of the amplifier were 250kΩ, the series resistor should have a value of 750kΩ. Inserting the series resistor will result in a loss of signal, but this is unavoidable. The series resistor is, of course, inserted into the "hot" and not the earthy lead from the tuner, and it could be wired into the amplifier after its input socket.

If the screened lead coupling the tuner to the amplifier has a self-capacity of some 150pF or more, C_{14} may be omitted, since its function will then be carried out by this self-capacity.

No volume control is employed in the tuner, as it is assumed that such a control would be fitted in the subsequent amplifier. If desired, however, R_5 may be made a volume control (with a log track), the left-hand side of R_6 connecting to its slider. Such a modification to the circuit is not entirely desirable because the d.c. voltage across the volume control could cause noisy operation when it was adjusted quickly.

As was mentioned above, heater and h.t. supplies may be obtained from the main amplifier. The heater requirement is 6.3V at 0.6A. The h.t. requirement is 200V at approximately 25mA under no-signal conditions, the h.t. current dropping (due to a.g.c. action) to some 8mA or so under strong signal conditions. The h.t. supply should not rise above 250V at this reduced current. Condenser C_{16} should be retained on the tuner chassis if an external h.t. supply is employed.

Construction

To prevent regenerative effects (which, even if they did not cause actual instability, may still adversely affect the i.f. response curve) it is advisable to use a layout in which the successive stages proceed across the chassis in logical manner. Thus, the aerial tuned circuits should be furthest removed from the detector and output wiring. All anode and grid connections to the i.f. transformers should be kept as short as possible.

V_2 valveholder, which should have a metal centre spigot, should be positioned between the two i.f. transformers such that pin 2 is close to i.f.t.$_1$, and pins 6, 7 and 8 are close to i.f.t.$_2$. A useful technique for partially screening the grid and anode valveholder tags from each other then consists of running a wire through pin 3 tag, the centre spigot, and pin 9 tag, and earthing it at both ends to chassis tags secured under the valveholder mounting nuts.

C_{12} should be mounted close to pin 1 of V_2, and the lead connecting this point to pin 1 of V_1 should be kept short. C_2, on the other hand, should be mounted near V_1, bearing in mind that it completes the tuned circuits of which L_2 and L_4 are the coils. The lead coupling the secondary of i.f.t.$_1$ to C_2 should also be kept short.

Care should be taken, when initially checking the circuit, to ensure that the triode section of V_1 is oscillating. If, due to incorrect wiring, this valve does not oscillate it may draw an excessive anode current. There are several methods of ensuring that oscillation is present, one of the simplest consisting of connecting a voltmeter between chassis and the triode grid, a resistor of some 30 to 50kΩ being inserted in series with the test prod which connects to the grid. The presence of oscillations will be indicated by a negative voltage, relative to chassis, on the grid. Alternatively, the voltage dropped across R_1 may be checked. If this is considerably in excess of 2V (the approximate figure to be expected under no signal conditions) lack of oscillation in the triode section would be indicated.

Should there be a tendency to squeg (evident as a loud hiss in the reproduced output) at certain parts of either band, the value of C_6 should be reduced until the effect clears. Constructors who wish to obtain optimum oscillator operating conditions, and who are prepared to go to the trouble, may adjust the value of C_6 after the tuner has been aligned such that the grid current flowing through R_2 averages at 200μA on both bands for all settings of the tuning condenser. The current measuring meter may be inserted at the lower end of R_2 and should be bypassed by a 0.1μF condenser.

The use of separate coils eases alignment problems, the adjustable iron dust cores being employed to bring the aerial and oscillator coils on to correct frequency at the lower frequency end of each band, and the trimmers to bring the coils on to correct frequency at the higher frequency end of each band.

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.

Tape Recorder Automatic Time Switch.—M. Walker, 182 Station Drive, Four Ashes, Wolverhampton, wishes to obtain a circuit that will automatically record or replay.

1585 Receiver (U.S.A.), R1475 and 1392A.—A. G. Gaunt, Great Fencote, Northallerton, Yorks, wishes to obtain circuits, modifications and any other information with respect to the above units.

CRV46068-B Receiver (U.S.A.).—F. Thomasson, 28 Starcliffe Street, Bolton, Lancs, wishes to convert this equipment for amateur band coverage.

Ex-Admiralty Tuner Amplifier B36.—R. E. Parkes, Great Oats, Green Lane, Blackwater, Camberley, Surrey, would like to purchase or borrow the manual and obtain information concerning and using the D.F. provisions on this receiver.

VCR97.—R. O. Payne, 3 Council Houses, Acton, Stourport-on-Severn, Worcs, would like to hear from any reader who has constructed an oscilloscope using the above c.r.t.

Bendix RA10-DB Receiver.—A. J. Stock, 7 Dunkirk Road, Southport, Lancs, would like to borrow a circuit diagram or manual.

Sagatone Tape Recorder (Collaro).—L. Jurd, 28 Thorndon Gardens, Ewell, Surrey, wishes to purchase or borrow circuit diagram.

RCA AR88D Communications Receiver.—L. H. Taylor, 60 Headley Park Avenue, Headley Park, Bristol 3, would like to obtain the circuit diagram and any other useful information in respect of this receiver. Borrow or purchase.

Indicator Type 62A and Tx/Rx 1986.—P. G. Turton, 26 Oxford Road, Acocks Green, Birmingham 27, urgently requires to borrow or purchase the service sheets or manuals on both these units.

Emerson Transistorised Pocket Radio Model 838.—J. Kirkley, 26 Higher Reedley Road, Brierfield, Lancs, requires any information available.

WS46 Transmitter/Receiver.—G. B. Coman, 102 Bullard Road, Catton Grove, Norwich, Norfolk, wishes to obtain data and information on this walkie/talkie, connections, etc. Also where crystals may be obtained.

Imperial AM/FM Chassis.—M. Metcalfe, 126 Ellison Road, London, S.W.16, would like to obtain a circuit diagram and any other information about this receiver. Of Continental manufacture, this equipment was imported two or three years ago and retailed by Messrs. Stern Radio of Fleet Street, E.C.4. The valve line-up is ECH81, EF89, EABC80 and EL42.

Bendix RA10 Receiver.—G. M. Watson, 2 Winn Court, Winn Road, Southampton, would like to obtain a copy of the original circuit and list of components.

R1155 Receiver.—K. Laycock, 274 Leeds Road, Bradford 3, Yorks, would like to purchase any information on this receiver and would also like to obtain obtain a copy of *The Radio Constructor* April 1950.

R103 Canadian Receiver.—D. J. Reid, 112 Prince of Wales Avenue, Flint, N. Wales, requires to borrow or purchase the manual or circuit diagram of this receiver.

Diomatic Frequency Controlled Switched FM Tuner.—R. Williamson, 12 New Rents, Ashford, Kent, wishes to obtain coil winding data for this tuner, particularly L_1, L_2 and L_3. Circuit diagram was published in the April 1959 issue of *The Radio Constructor.*

R1125D Receiver.—J. C. Phillips, 1 Hornbeam Close, Buckhurst Hill, Essex, requests any information relating to this receiver—particularly with reference to voltages, socket connections, etc.

Wavemeter LM14.—F/Sgt. E. Briggs, G3IJU, Sgts. Mess, R.A.F. Upavon, Wilts, would like to borrow or purchase a calibration book and circuit diagram.

P104 Receiver.—P. E. Stone, Parliament Cotts, Longcombe, Nr. Totnes, S. Devon, wishes to obtain the manual or circuit diagram.

Radio City Products Valve Tester Model 314.—C. D. Wilde, Orchard Farm, Halfway House, Shrewsbury, Shropshire, would like to hire, borrow or purchase the manual or obtain information from any reader with experience of this unit.

IN YOUR WORKSHOP

This month Smithy and Dick find that life, immediately after Christmas, is pleasantly quiet and uneventful

DICK AND SMITHY HAPPENED TO REACH the Workshop at the same moment on Wednesday the 28th of December. They both wore expressions of satiated content and they sauntered into the Workshop in a comfortable and leisurely manner.

"Well", yawned Smithy, as he hung up his mackintosh, "that's got Christmas over".

"It has indeed", agreed Dick. "Cor, I had a smashing Christmas Eve!"

"Mine wasn't too bad, either", admitted Smithy.

"And I didn't", continued Dick happily, "insult *anyone*".

"Neither did . . ." started Smithy. He hastily corrected himself. "Neither should you have done", he concluded primly.

Taking It Easy

"What is more", said Dick, ignoring Smithy's interjection, "the Christmas rush is now finally over".

Smithy glanced around the racks in the Workshop. These held three sets only—long-term jobs which had not been required for Christmas.

"Yes", he agreed. "We can take it easy today. There's only three sets to clear up. If you like, we'll tackle them together".

"That would be fine", said Dick. He switched on his soldering iron and prepared his bench for business. "Well, I'm all ready".

"Right", said the Serviceman. "How about starting off with a nice easy one?"

"What's the fault?"

"Low height", said Smithy, reading from the label tied to the 110° television receiver he had selected.

"Fair enough", said Dick briskly.

He walked over, took the receiver indicated by Smithy from the rack, and carried it to his bench. He next plugged it into the mains, applied an aerial and switched on. After some moments, the sound channel became audible from the loudspeaker and Dick noted that this was satisfactory both with regard to volume and quality. Shortly afterwards, the line output stage commenced to function, and a picture became evident on the screen. The picture had correct width, but its height was only half that of the screen.

"Waggle the height control".

Obediently, Dick adjusted the control.

"It's hard over already", he said.

"O.K.", commented Smithy, "I'll leave it to you. What's the next move?"

"The first thing to do", said Dick, "is to quickly examine the picture itself. The vertical linearity, within the limited height of the picture, seems to be quite good. To my mind, that rather eliminates the possibility of the frame output valve causing the trouble".

Smithy beamed.

"Very good", he remarked. "Why do you say that?"

"Because", replied Dick, "when the frame output valve gets tired of life it is usually because it has lost emission with the result that not only do you lose height, but the frame scan gets heavily cramped at the bottom of the picture, because that's where the frame output valve has to draw most current".

"Excellent."

Dick checked the operation of the frame hold control.

"Frame hold also seems to be O.K.", he pronounced, "so I would say, at a rough guess, that there isn't much wrong with the frame oscillator valve either".

"That's a reasonable assumption", said Smithy, "so what's your next step?"

"I'm going to swop the frame output and frame oscillator valves!"

Smithy laughed.

"Which is exactly the right course to adopt", he remarked. "I think this is a classic case of sensible practical servicing. We both know it is doubtful whether the frame output or the frame oscillator valves are causing the trouble, and yet the first thing we do is to change them! Just for the record, why *do* you suggest swopping them?"

"Because", replied Dick promptly, "it's the quickest thing to do. We can very easily change the bottles without even having to take the chassis out of the cabinet and, if we're lucky, it may turn out that one of them is causing the fault after all".

"Right", said Smithy. "Before you start, though, is there anything else you can see in the picture?"

"Not right off", said Dick doubtfully. "The picture's nice and bright, which means that the line output stage and booster diode are working O.K. The focus looks a bit fuzzy but I should think we can fix that after we've got the height fault put right".

"That fuzziness", commented Smithy gently, "*could* give us a lead, you know. Anyway, try the frame oscillator and output valves first. As swopping these valves is rather a long shot I should change both of them at the same time".

Dick switched off the receiver and removed the two valves in question, replacing them with valves from his bench stock. He switched on the receiver again, to find that the fault persisted. With a shrug of his shoulders he took out the replacement valves and reinserted the originals.

"Fair enough", said Smithy. "If replacing the valves *had* cleared the fault we would, of course, finally have had to find which of the two was at fault before returning the set to its owner. It looks as though you'll have to get the chassis out of its box now. While you're doing that, I'll hunt up the book of words".

Leisurely, the Serviceman sought out the service manual for the receiver, whilst Dick removed the chassis from its cabinet.

"Isn't it nice", remarked Smithy, as he thoughtfully lit a cigarette, "not to be rushed off our feet just for once".

"Fine", agreed Dick, as he removed the last bolt.

"Well," said Smithy, watching his assistant, "if you check the h.t. supply to the frame oscillator you'll probably find the fault."

"Just like that?" said Dick, setting the chassis up on the bench and re-connecting it to the mains and the aerial.

"Just like that", repeated Smithy. "We know that the frame oscillator and frame output valves are O.K. A possible cause of low frame height would then be low h.t. voltage to the frame oscillator."

Dick examined the service manual.

"I wouldn't say it was possible in this case", he remarked at length. "I would think it was improbable, even. The frame oscillator gets its h.t. from the boosted h.t. line, and there *must* be boosted h.t. or the line output stage wouldn't be working properly."

"Look again", chuckled Smithy. "As you say, there must be boosted h.t. on the line output stage, and so there is. But the frame output stage doesn't get its h.t. direct from the boosted h.t. reservoir condenser sitting at the top of the line output transformer winding. Instead, it gets it *after* a decoupling resistor and condenser." (Fig. 1.)

"So it does", agreed Dick. He looked at the circuit more closely. "I see also that the smoothed boost voltage goes to one of the cathode ray tube electrodes."

"You've got it", said Smithy. "It's an electrostatic focus tube, whose focus electrode gets its potential from a potentiometer connected between the smoothed boosted voltage and the ordinary h.t. rail. The potentiometer is, actually, the focus control for the receiver."

"I see what you meant just now", remarked Dick excitedly. "When I mentioned the fuzzy focus you didn't look upon it as a separate snag but as another symptom of the present fault."

"Exactly," replied Smithy. "I said just now that a possible cause of the low height is reduced h.t. voltage to the frame oscillator. The fact that focus is a little off as well and that the focus electrode gets its supply from the same point, makes the possibility a probability."

But Dick had already applied his test prods between chassis and the decoupled boosted h.t. supply.

"Seventy volts!" he called out.

"The picture height dropped only very slightly when you applied the prods", commented Smithy, who had been watching the screen of the receiver. "Which means that the current drawn by the meter isn't causing your low voltage reading. I should switch off the set and have a quick shufti for leaks to chassis."

Dick carried out Smithy's instructions and soon found that the boosted h.t. decoupling condenser had developed a low-resistance leak. He snipped out the offending component and, with Smithy's instructions to "use a 500 volt condenser as it's on the boost line" ringing in his ears, selected and soldered in a replacement. He next switched the receiver on again, and the pair were rewarded with a picture which grossly overscanned the screen in the vertical direction. Dick adjusted the height control, finally producing a picture with correct height and reasonable focus.

Adjusting Focus

"Easy, wasn't it?" commented Smithy. "I should give the focus pot a touch before finally putting the set back in its cabinet. The leakage in the condenser might have developed gradually and the focus may have been adjusted accordingly as the fault got worse and worse. I should try and adjust the focus with a test card if possible."

"That's gilding the lily a bit, isn't it?" remarked Dick. "I always adjust focus for maximum lininess!"

"Well, you shouldn't", said the Serviceman reprovingly. "You never know if the tube hasn't got a touch of the astigmatics; and you should, therefore, adjust the focus control for optimum horizontal definition. If you've got a test card up this is dead easy—all you have to do is to work on the vertical frequency gratings."

"What if there isn't a test card?"

"You should", replied Smithy, "try to find a spot in the picture having plenty of horizontal detail which is not too near the edges, and concentrate on that. Do your best to ignore the lines of the picture or you'll find yourself focusing on them subconsciously after all."

"What if the tube is badly astigmatic?"

"In that instance", said Smithy, "you have to adjust focus for a compromise. But a tube has to be pretty bad these days for that to happen. To keep the story straight I think I had better add that astigmatism can be caused by the deflection yoke as well as by the tube."

Smithy fell silent as his assistant, having adjusted the focus potentiometer, replaced the television chassis in its cabinet. Dick finally checked out the set and declared himself satisfied with its condition.

"I'll leave you to choose the next one yourself", said Smithy lazily.

"O.K., dad," replied his assistant.

"I do wish", said Smithy peevishly, "you wouldn't keep calling me 'dad'. Ever since you went to hear Mr. Acker Bilk and his Paramount Jazz Band you keep using this 'dad' routine."

A glint came into Dick's eye.

"You must admit", he said fervidly, "that he's there."

"Where?"

"Way out."

Smithy looked lost.

"The latest, however", continued his enthusiastic assistant, "is Theophilus Monk. *He* gets quarter-tones out of the piano by playing the notes on either side together."

"Quite an achievement."

"*And* he wears specs with bamboo stems."

"Very sensible."

"Of course", said Dick loftily, "you didn't have things like that in your young days."

"I don't know", replied Smithy. "We used to have Harry Roy every Friday night on the radio."

"What did they play in those days?"

"Oh", said Smithy, frowning in thought. "There was 'Tiger Rag', and I seem to vaguely remember 'St. Louis Blues'. Occasionally we'd have an oldie like 'Tea for Two'."

An incredulous expression crept over Dick's face.

"In *those* days?"

"You sound", said Smithy irritably, "as though I was born in the Ice Age".

Dick looked dumbfounded.

"I always thought those were modern tunes", he exclaimed. "'Tea for Two' was an oldie *then*?"

"Since you continue to delegate my youth to the mists of antiquity", replied Smithy testily, "I'd better hasten to say that 'Tea for Two' appeared before, even, my time. It came out in a musical called 'No, No, Nanette' which was produced around 1920."

Dick's jaw dropped.

"I honestly thought", he said, in awed tones, "that it was introduced this year in 'Jazz on a Summer Afternoon'."

Smithy looked at his assistant with scorn.

"You want to get with it, son", he remarked crushingly.

And even the irrepressible Dick had no retort to make to this observation.

More Bangs

"Anyway", said Smithy, cheerfully aware that he had, for once, scored a significant point so far as Dick's musical tastes were concerned, "I thought you were getting another set for servicing."

Dick collected his thoughts.

"Why, so I was", he remarked, walking over and examining the two receivers left. "Why, here's a coincidence."

"What's a coincidence?"

"There's an a.m. sound radio with a complaint of 'intermittent bangs', just like the t.v. we had on Christmas Eve! Do you remember, the one in which the h.t. electrolytic kept discharging over the surface of one of the ceramic feedthrough condensers?"

"I remember it", said Smithy. "I doubt

if this set has the same complaint, though. Even if only because it is a sound radio and has, therefore, much smaller electrolytics across the h.t. line than the t.v. set had. Anyway, pop it on and let's see what happens."

Dick connected the receiver to the mains and applied a short test aerial to it. As the set warmed up the Serviceman gave it a quick glance.

"Ah", he remarked, "I know this model quite well. It's an honest-to-goodness a.m. superhet with no especial frills or gadgetry. It shouldn't take us long to sort it out".

As he spoke the receiver finally warmed up. The programme it was tuned to consisted of a talk, and the speech was reproduced with what seemed to be quite reasonable quality.

"No bangs yet", remarked Dick.

"See if you can find some orchestral music", commented Smithy.

"Right you are", said Dick, swinging the dial.

He found a suitable programme and he and the Serviceman listened carefully. On music the quality of reproduction was still quite acceptable.

"It sounds quite a nice set", commented Dick. "It has a bit more top than these a.m. receivers usually have."

"I wonder", remarked Smithy thoughtfully, "if that's the cause of the trouble."

"Hey?"

"I'm only deliberating to myself", said the Serviceman. "Turn the wick up a bit. Until it's nearly overloading".

The sound of the music from the receiver filled the Workshop. There was suddenly a loud passage on strings. As soon as this commenced a succession of violent cracks came from the loudspeaker, these ceasing only when the passage came to an end.

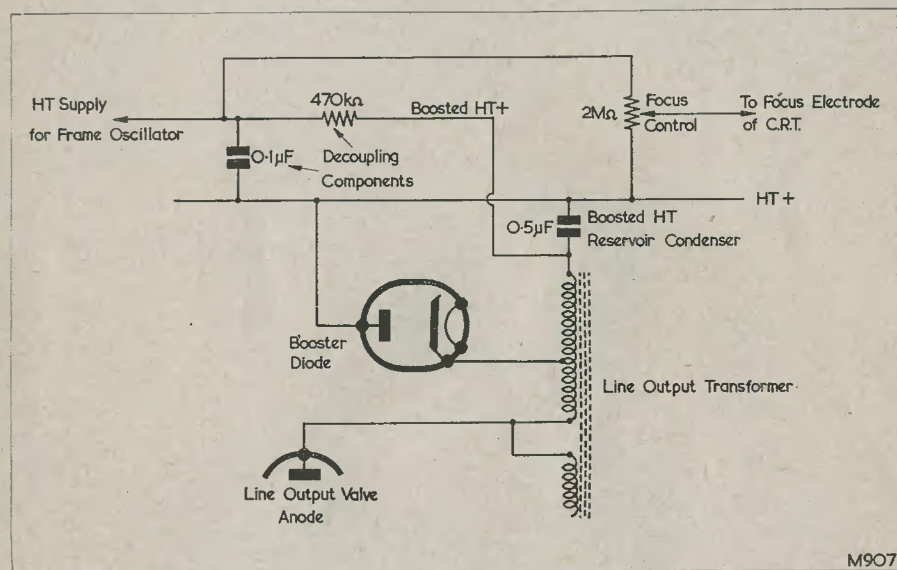


Fig. 1. A typical boosted h.t. supply circuit. In this diagram the boosted h.t. voltage is decoupled by the 470kΩ *resistor and the* 0.1μF *condenser, after which it is applied to the frame oscillator and the focus electrode of the cathode ray tube. Leakage in the* 0.1μF *condenser caused two faults: low picture height and poor focus*

"What on earth happened then?" gasped Dick. "It sounded almost like machine-gun fire!"

"It's a pretty easy snag", said Smithy. "And a fairly common one too. What is almost certainly happening here is that there's sparking in the output stage. (Fig. 2 (*a*).) The speaker transformer circuit is probably a little resonant fairly high up the audio scale, which is why the set seemed to have such a nice top response. The sparks are caused by audio frequency voltages at the output anode and they are picked up by the aerial. They then become reproduced over the receiver, to emerge as the loud cracks we heard."

"Do you think that string section was on the resonant frequency you've just mentioned?"

"Near enough to cause a hundred jolts or so of a.f. to appear at the output anode", commented Smithy laconically. "My guess is that the sparking's occurring at the valveholder. That's the usual place."

Whilst he was talking, Dick had removed the chassis from its cabinet and had placed it on its side so that the underside was visible.

"There doesn't appear to be any evidence of sparking", commented Dick cautiously.

"Perhaps not", remarked Smithy, looking at the chassis. "I see that the output valve is a B9G job and that the valveholder employs two pieces of Paxolin in a sort of sandwich construction. (Fig. 2 (*b*).) Turn the set on again and see if you can get the effect to reappear. It would be a good idea to turn the lights off so that the sparks will show up better."

Dick switched off the Workshop lights and drew a curtain over the nearest window. In the resultant semi-darkness he switched the receiver on again, to find that the orchestral music was still being broadcast. The succession of cracks suddenly became evident again, and was accompanied by vivid violet flashes from the inside of the valveholder.

"There you are", said Smithy, pleased, as he switched off the receiver. "The sparks seem to be following a track on the inside surface of one of the two pieces of Paxolin which make up the valveholder. That's why there was no visible track on the outside. The sparks will be occurring between the anode contact and one on either side of it, the second contact either being at chassis or at screen-grid potential."

"What's the cure?"

"A new valveholder, and a good quality moulded one at that. Incidentally we were rather lucky, you know, to find the sparking in the valveholder, even though this *is* the most likely spot. It could have been hidden away inside the speaker transformer, in which case we'd have had to swop it in the *hope* that we'd cured the fault."

"Any other places?"

"Well, if there's a tone-correction condenser connected directly across the primary, sparking in this might have caused the trouble; although I've never encountered it myself. Another possibility would occur where the speaker voice coil was not earthed to the speaker frame.

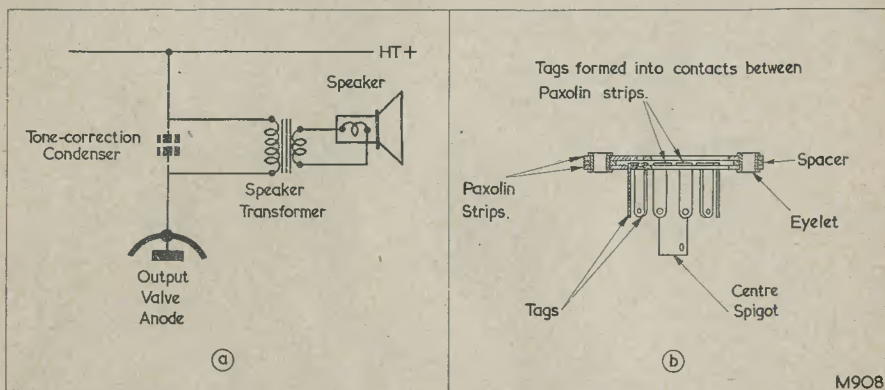


Fig. 2 (a). A conventional sound output stage, in which it is usual to have a tone-correction condenser (sometimes in series with a resistor) connected across the speaker transformer primary. Under certain conditions it is possible for high a.f. voltages to appear on the anode

(b) A common method of valveholder construction employing two strips of Paxolin. The contacts, an integral part of the tags, are sandwiched between the two strips

Tips and Hints

"I see", said Dick. "Well, anyway, that's another fault cleared."

"So it is", remarked Smithy. "Dear me, there's only one t.v. left to do."

"And all that's wrong with that", said Dick, examining the label attached to the receiver, "is that it won't switch off!" He turned the volume control experimentally. "There's certainly no clicking action when I turn the volume fully back."

"I doubt if there would be", remarked

Smithy drily. "That model has a separate on-off switch!"

Dick looked a little sheepish.

"Well, he remarked defiantly after a further investigation, "*that* doesn't click, either."

"Sounds like a straightforward replacement job to me", said Smithy. "Anyway you can tackle it later. Right now I've got a nice little selection of hints and tips to pass on."

"Good show", said Dick. "We haven't had a session on those for months."

Smithy opened a drawer and took out some letters.

"Well, the first one[1] has to do with mounting components in deep and awkward chassis. What you do is to slip a length of polythene tubing over the nut or bolt and use it as a flexible box spanner. The polythene tubing is that which is sold by model shops as fuel tubing for model diesel engines, and the internal diameter needs to be slightly greater than the distance across the flats of the appropriate size of nut. If the correct size of tubing is chosen it will hold the nut until it is more than finger tight, whereupon the tubing can be pulled off and a conventional spanner used for final tightening."

"That's a neat idea."

"It is, isn't it? The contributor says he's found it invaluable over the past few years, and he feels sure it saves a lot of time and rude words!"

"There are never any rude words in *this* Workshop."

"I have", remarked Smithy loftily, "no comment to make on that particular statement. The next idea[2] is also in the highly knobby category. This consists of employing an old ball pen as a solder dispenser. (Fig 3.) You coil the solder around a suitable screwdriver shaft and pop it into the barrel of the pen. You then fit the bush at the bottom with a bit of solder poking out through its centre hole and, hey presto, you've got a solder dispenser! All you do is pull out the solder as you need it."

"Can you get much solder into the dispenser?"

"As much as five feet of the thinner gauges."

"Must it be a particular type of pen?"

"Well, it will need to have a suitable bush at the bottom. The one used in the prototype of this idea is a Platignum 'Fluid-Lead'. Don't forget, incidentally, that you can clip the dispenser into your pocket just like an ordinary pen."

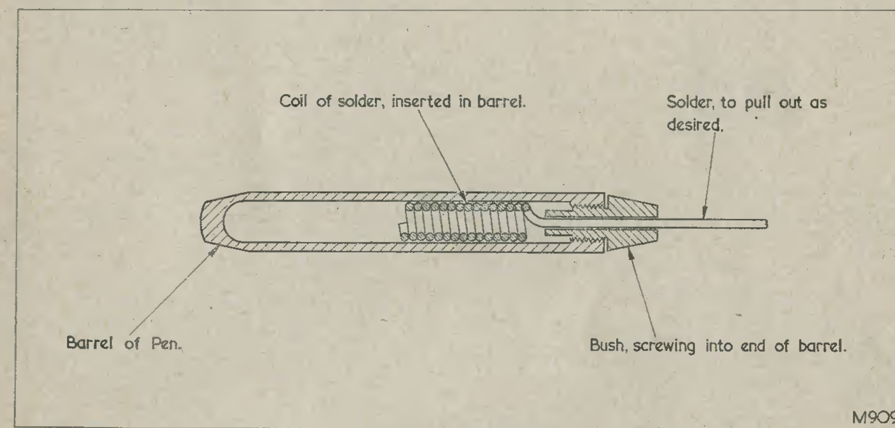


Fig. 3. A cross-section through the solder dispenser described in the text

"Very neat."

"Here's another",[3] remarked Smithy. "I'll read the letter to you. 'Waxed tubular paper condensers often become useless due to the ingress of moisture. In an RC-coupled amplifier even a leak of several megohms is sufficient to seriously upset the circuit conditions, and in the case of an output valve the application of a positive voltage to the grid may have quite expensive consequences.

" 'A simple precaution taken when building new equipment, or replacing faulty condensers, may prevent trouble and expense in the future. The act of bending the lead-out wires to shape when wiring in a new condenser is often liable to upset the seal where the lead-out wires join the body of the component. A quick touch of the soldering iron

[1] Contributed by Mr. B. E. Roberts, East Ham, London, E.6.

[2] Contributed by Mr. E. W. Barnes, Atherton, Lancs.

[3] Contributed by Mr. R. Wallace, Teignmouth, Devon.

to each end of the condenser, after it has been finally soldered into position, will melt the wax around the join again, thus forming a new seal to ensure that no damp can penetrate to the inside of the component. In the case of a moulded paper condenser a small piece of wax—taken from an old waxed condenser—can be melted on to the seal between the wire and the case at each end'."

"That's a good point", approved Dick. "Any more?"

"Oh yes", said Smithy. "This one has to do with burnt-out or damaged potentiometers.[4] If the threaded bush of the pot has an inside diameter of $\frac{1}{4}$in, as is normally the case, you cut this from the body of the pot and mount it, with the aid of a couple of nuts, on to a suitable piece of Paxolin or similar insulating material. (Fig. 4.) You then fit a couple of pieces of appropriately shaped brass contact strip and you have a jack socket! The idea can result in quite a saving of money when a number of sockets are required, as in a pre-amplifier."

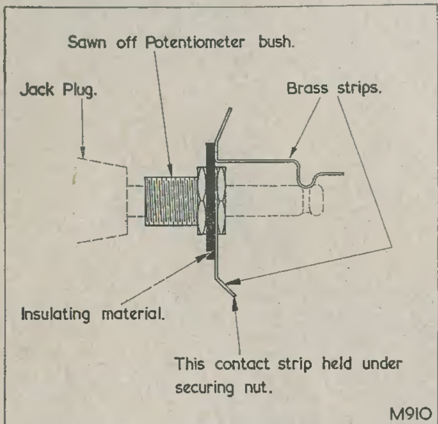


Fig. 4. An inexpensive home-constructed jack socket

"Very good", approved Dick. "I'm all for saving the old lolly!"

"Well", said Smithy, "that's the lot for this session. Of course, we're always interested in hearing about new ideas, gadgets and servicing dodges, and we always like to pass them on."[5]

Nothing Much To Do

"Well, that's about the lot for now, isn't it?" said Dick.

"Just about", confessed Smithy, drawing up a chair and settling himself comfortably. "I would suggest that you have a go at that last t.v. And, when you've got it fixed, we'll call it a day."

"Call it a day?"

"Yes", confirmed Smithy lazily. "You and I will be very wicked and non-productive, and we'll take the rest of the day off."

"You", remarked Dick, "are a kind, benevolent, indulgent and understanding guv'nor."

"I'm getting in training", replied Smithy, "for 1961!"

[4] Contributed by Mr. R. A. Jeffrey, Eltham, London, S.E.9.

[5] Payment is made for all contributions used in "In Your Workshop"—*Editor.*

Marconi Underwater TV Helps Fish and Hydraulic Research in Scotland

A Marconi-Siebe, Gorman underwater t.v. camera ordered by the North of Scotland Hydro-Electric Board will be used for research into fish and hydraulic problems on Scottish lochs. Among other things the camera will inspect the huge fish screens which guard the turbine intakes and prevent smolt (young salmon between one and three years old) from being swept into the turbines. The job of inspecting these screens—which also guide the migrating fish into the fish passes and hence to the sea—was previously done by divers.

The camera will also be used to study fish behaviour in the fish passes and to inspect the tunnels linking the dams and power stations. Engineers will therefore be able to report on the condition of the tunnels without dewatering, a costly job in men and materials.

The Hydro-Electric Board have already carried out satisfactory tests with underwater t.v. equipment, using the camera to inspect fish screens which may be 120 feet below the surface. The 14in monitor supplied with the camera was found to give better pictures than a diver could see in murky water.

When in general use the Marconi equipment will be taken from loch to loch all over Scotland for these on-the-spot investigations.

UNDERSTANDING TELEVISION

PART 36

By **W. G. MORLEY**

The thirty-sixth 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 a.g.c.,[1] discussing the a.g.c. systems employed in the sound section of the television receiver, and the mean level a.g.c. system employed in the vision circuits. Also discussed was a simple protection circuit, employed at the grid of the last vision i.f. stage, which prevents blocking of the mean level a.g.c. system if a very high level signal is suddenly applied to the input terminals of the receiver.

We shall now carry on to gated a.g.c. systems.

Gated Vision A.G.C.

As we have seen, it is possible to obtain automatic gain control in the vision section of a television receiver by using, as a control voltage, a proportion of the mean signal level voltage available at the sync clipper grid. Such an a.g.c. system has the disadvantage that the automatic gain control voltage obtained does not bear a constant relationship to signal strength. As the overall brightness of the transmitted scene increases so does the a.g.c. control voltage, and vice versa.

Fig. 216 (*a*)[1] illustrated several lines of a 405 line signal and demonstrated the fact that the only parts of the composite waveform which have a constant relationship to signal strength are the front and back porches of the line sync pulses, these being maintained at the blanking level, which is 30±3% of peak white level. It is possible, by the use of special gate circuits[2] to extract an a.g.c. voltage from the composite waveform whose amplitude is proportional to that of the front or back porch and which is, therefore, proportional to signal strength. Systems employing circuits of this type are known as *gated a.g.c.* systems.

A number of different gated a.g.c. circuits, employing varying principles, have been developed for British television receivers, and it is a little difficult to cover all these by reference to simple fundamental techniques. In consequence we shall deal with two representative basic designs which have been frequently used, and conclude with a circuit which is currently employed in many present-day receivers.[3]

Synchronising Pulse Cancelled Circuit

A circuit which relies on the cancellation of the line sync pulse in the composite video waveform is illustrated in Fig. 219.[4] In this diagram, a video waveform having positive-going sync pulses is applied, in conventional manner, from the video output anode to the grid of the sync clipper valve. Negative-going sync pulses appear at the anode of the sync clipper, and the series grid condenser takes

[1] Published in last month's issue.

[2] Circuits which "open" (and allow the passage of information) at certain periods of time or for certain conditions of voltage.

[3] The information concerning the circuits of Figs. 219 to 223 inclusive is taken from *A.G.C. Circuits for Positive Modulation Television Receivers*, published in Mullard Technical Communications, Vol. 3, No. 27, and based on a report prepared by P. L. Mothersole of Mullard Research Laboratories.

[4] The synchronising pulse cancelled circuit is due to E.M.I. Electronics Ltd.

up a charge such that the positive tips of the sync pulses are slightly positive of the sync clipper cathode. The grid waveform is passed, via resistor R_1, to the anode of diode V_2. At the same time, the negative-going sync pulses on the anode of the clipper valve are passed, via C_1 and R_2 to the same anode. The negative-going pulses from the sync clipper anode are larger in amplitude than the positive-going pulses in the video waveform, and a combined waveform having the appearance of that shown in Fig. 219 appears at the anode of V_2. In this waveform, a large negative excursion occurs at the positions previously occupied by the positive-going sync pulses in the video input, the latter having been "cancelled" by the negative-going pulses from the sync clipper anode.

Examination of the waveform applied to the anode of V_2 shows that it is at all times negative of chassis and that its most positive parts occur at the front and back porch periods on either side of the "cancelling" pulses. The front and back porch levels will go negative when signal strength increases (and *vice versa*), because the sync pulse tips are held at a fixed potential slightly positive of the sync clipper cathode. If, therefore, with the aid of V_2, we can obtain a voltage which is equal, or nearly equal, to that at the front and back porches, such a voltage may be used for automatic gain control. The cathode load, R_3, of V_2 cannot, however, be returned to chassis in order to do this because the cathode would then always be positive with respect to the anode and the valve could not conduct. In consequence, the cathode load resistor has to be returned to a point which is negative of chassis, with the result that the diode conducts during the more positive parts of the applied waveform, causing condenser C_2 to charge up to the peak potential held by the front and back porches. A voltage suitable for automatic gain control appears on the lower plate of C_2.

The value of the negative potential to which R_3 is returned is not of great importance provided that it is always more negative than that liable to be held by the front and back porches. A negative voltage at adequate level is normally available at the grid of the line output valve and this is employed in the present circuit. (The negative voltage available at the grid of the line output valve is caused by leaky-grid action, and it has an average potential equal to that of the waveform applied to the series grid condenser by the line sawtooth generator.)

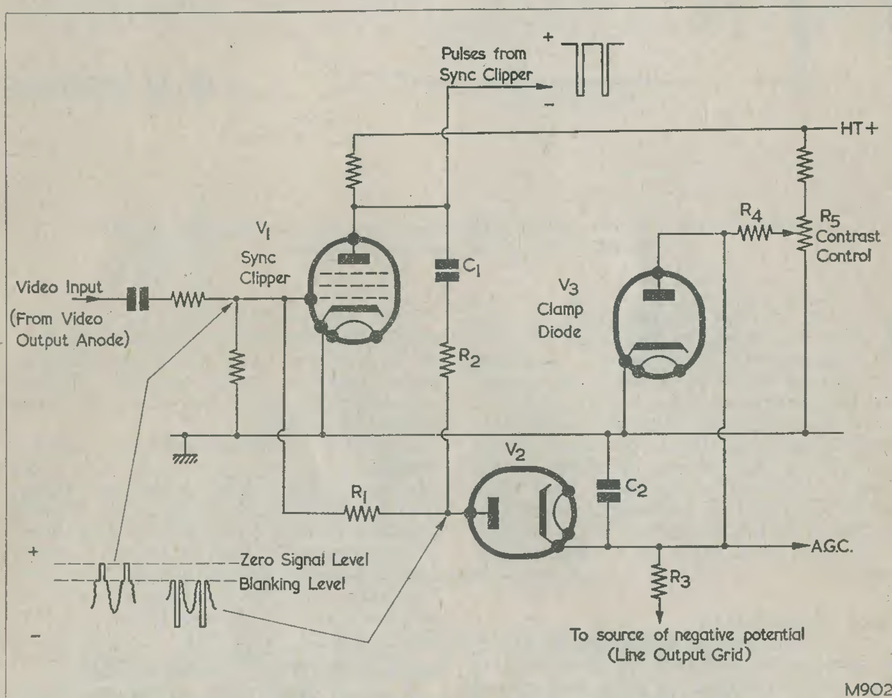


Fig. 219. An a.g.c. gate circuit in which line sync pulses are cancelled out. The most positive parts of the combined waveform at V_2 anode are at blanking level. An a.g.c. voltage appears on the lower plate of C_2

In order to provide a suitable voltage delay and contrast control in the circuit of Fig. 219, the lower plate of C_2 is connected to the anode of the clamp diode V_3 and thence, via R_4, to the contrast control potentiometer R_5. This clamp circuit functions in the same manner as did that of Fig. 217 (*b*).[5]

A Diode Gate Circuit

A diode gate circuit with positive feedback is illustrated in Fig. 220.[6]. In this diagram the anode of diode V_1 is connected via a d.c. coupling (i.e. without a series condenser) to the anode of the video output valve. The potential at the cathode is that tapped off the relatively low value i.f. decoupling resistor R_5 and is, in consequence, close to the potential held by the h.t. positive rail. The video output anode is always negative of the tap in R_5 with the result that, so far as the potentials applied to V_1 by the video output anode and R_5 are concerned, this diode does not conduct.

Applied to condenser C_2 is a positive-going pulse derived from the line output transformer. This pulse is a stepped down version of the line flyback pulse, and is obtained by tapping into the anode winding. C_2 and R_2 differentiate this pulse, causing a waveform having a positive-going spike (caused by the leading edge of the pulse) and a negative-going spike (caused by the trailing edge of the pulse) to be applied to the lower end of R_1 and, thence, via the relatively high value condenser C_1, to the cathode of V_1. The average level of the differentiated waveform is approximately equal to its level between spikes and, on V_1 cathode, this level becomes equal to the potential tapped off R_5. Between spikes, therefore, the cathode of V_1 is at the same potential as the tap into R_5 and it does not conduct. The first, positive-going, spike of the differentiated waveform merely carries the cathode more positive than the tap into R_5 with the result that the diode still does not conduct. However, the negative-going spike, which appears at the same time as the back porch in the video input, carries the cathode sufficiently negative for the diode to conduct. The circuit which feeds the diode anode (i.e. the video output anode circuit) has a much lower impedance than that offered by R_1, with the consequence that, when the diode conducts during the negative-going spike, the potential on the cathode can go only slightly negative of the level held by the back porch. This potential is held until the negative-going spike, on returning, carries the diode cathode positive of back porch level again.

Examining the waveform on the cathode of V_1 we may see that it comprises a positive-going section and a negative-going section. The positive-going section remains the same whatever the input signal strength, but the amplitude of the negative-going section is controlled by the level of the back porch. Because the sync pulse tips (corresponding to minimum anode current in the video output valve) hold a relatively fixed potential, an increase in signal strength will cause the back porch level to go negative, and *vice versa*. In consequence the negative-going section of the waveform at V_1 cathode will increase in amplitude for an increase in signal strength, and will decrease in amplitude for a decrease in signal strength.

Because of the large capacity of C_1, the waveform on its lower plate is the same as that on its upper plate. However, the average voltage of the waveform on the lower plate is equal to that applied, by R_2 and the potentiometer R_4, to the lower end of R_1. Potentiometer R_4 is set up such that the most negative part of the waveform on the lower plate of C_1 is negative of chassis. This waveform is applied to diode V_2 with the result that a negative voltage, nearly equal to the most negative part of the waveform, appears on the upper plate of C_3. This negative voltage, which is proportional to signal strength, may be employed as an automatic gain control voltage.

Potentiometer R_4 is capable of carrying out two functions. It can, first of all, provide a voltage (positive of chassis) which may prevent diode V_2 from conducting until the negative-going section of the waveform on the lower plate of C_1 is sufficiently large in amplitude to merit the use of a.g.c. It offers, in consequence, a delay. Secondly, after the delay it provides has been overcome, R_4 varies the average voltage of the waveform on C_1 and, in consequence, the negative voltage appearing on the upper plate of C_3 and on the a.g.c. line. R_4 may, therefore, be employed as a contrast control. In practice, component values in the circuit are such that, for all signals having sufficient amplitude to merit the use of a.g.c., the desired setting of R_4 causes the delay to be overcome.

D.C. feedback is provided by one of the i.f. valves, shown in Fig. 220 as V_3. This valve is coupled to the a.g.c. line as shown. When the a.g.c. line goes negative V_3 draws less anode current and the voltage tapped off

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[5] Published in last month's issue.
[6] The diode gate circuit with positive feedback is due to E. K. Cole, Ltd.

R_5 goes positive. The voltage tapped of R_5 is equal to the average voltage of the differentiated waveform at the cathode of V_1. If this average voltage rises the negative-going spike in the waveform can go more negative before it reaches blanking level at the back porch of the video waveform. In consequence the negative-going section of the waveform on the lower plate of C_1 goes further negative, and so also does the voltage on the upper plate of C_3. The overall action of the feedback circuit is such that, when the a.g.c. line goes negative, the feedback circuit causes it to go even further negative. The resultant the advantage that a.g.c. level is proportional to blanking level in the composite video waveform. A.G.C. voltage does not alter when the brightness of the transmitted scene varies, as occurs with mean level systems.

In common with mean level a.g.c. circuits, the *gain*[7] of the circuit of Fig. 219 tends to be low. In Fig. 220, effective amplification is provided by the d.c. feedback circuit and there is an improvement in gain.

Fig. 219 differs from Fig. 220 in that its "gate-opening" pulses are derived from the sync clipper anode. In Fig. 220 they are derived from the line output stage, whereupon

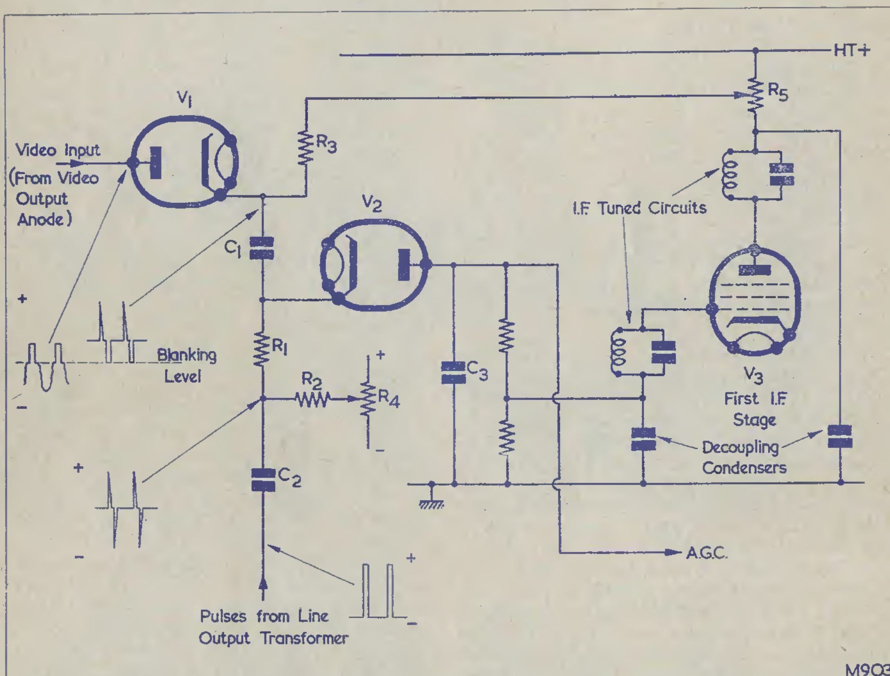


Fig. 220. A diode gate circuit with positive feedback. The negative-going section of the differentiated waveform on the cathode of V_1 terminates at the back porch. Rectifier V_2 causes C_3 to charge to a potential proportional to the amplitude of the negative-going section, and an a.g.c. voltage is provided thereby. D.C. feedback is given by the circuit around V_3

effect is that the a.g.c. voltage is effectively amplified. The a.g.c. system is, therefore, enabled to hold the signal passed to the modulating electrode of the cathode ray tube at a more constant level, despite variations in applied signal strength, than it could without the feedback circuit.

Advantages and Disadvantages

Both the circuits of Figs. 219 and 220 have several difficulties arise. Firstly, the a.g.c. system cannot function correctly unless the line sawtooth generator is synchronised with the incoming signal. Without correct synchronism, the negative-going spikes on the cathode of V_1 will not terminate at blanking level but will terminate, in random fashion, at any part of the composite waveform. This will most frequently be at picture information level and a disproportionately high a.g.c. voltage may be formed, causing a reduced signal amplitude to be passed to the video output valve. The sync pulses passed to the sync clipper could then be too small for the latter to function correctly. Secondly, no a.g.c. voltage can appear until the gate pulses are obtained from the line output transformer. The line output stage becomes operational, after switching on the receiver, some considerable time after the valves in the remaining stages of the receiver have reached operating temperature, this being due to the long warm-up period of the booster diode. If, when it is switched on, the receiver is tuned to a strong signal the last i.f. amplifier valve, the vision detector (assuming a germanium diode), and the video amplifier may be overrun before the booster diode finally warms up, unless a protection circuit, such as that shown in Fig. 218[8] is employed. Thirdly, if a flywheel sync circuit is used, there may be a difference in phase between the pulses derived from the line output stage and the sync pulses in the received signal. Such phase differences may cause the negative-going spikes on the cathode of V_1 to terminate at picture information level instead of at blanking level, and the system will operate incorrectly. These three difficulties may be overcome if the gate pulses (after suitable manipulation and amplification) are obtained from the sync clipper instead of the line output transformer.

A.G.C. systems employing gate pulses from the sync clipper are liable to suffer an effect, usually described as *paralysis* or *lock-out* (and, sometimes, as blocking), which is rather similar to the blocking effect possible with the mean-level systems. If a strong signal is suddenly applied to the receiver the

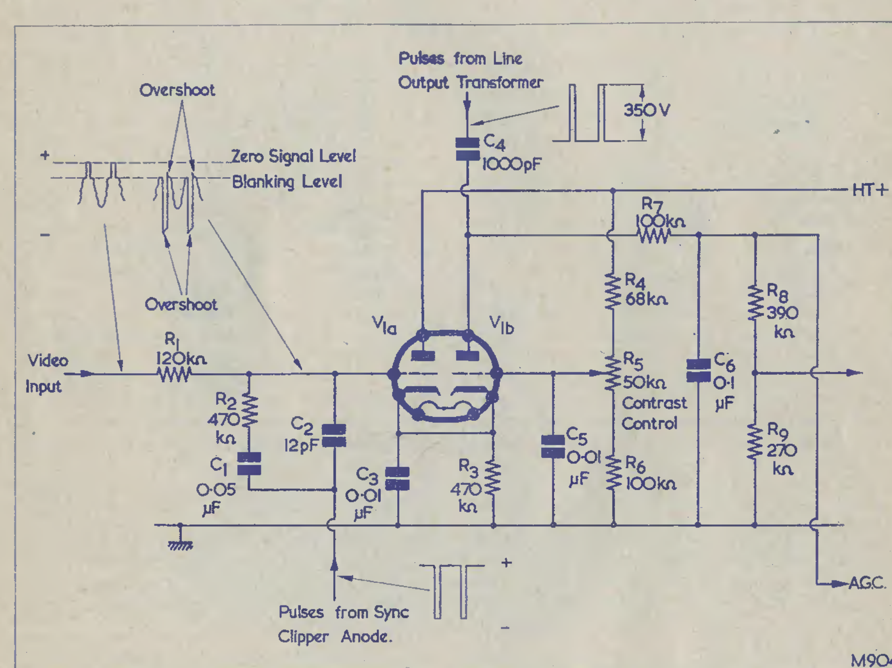


Fig. 221. A circuit employing cancelled sync pulses and an a.g.c. amplifier. Due to cathode follower action, the potential on the upper plate of C_3 is close to that on the positive-going overshoot tip applied to $V_{1(a)}$ grid. $V_{1(b)}$ is the a.g.c. amplifier. In practical applications, the proportion of the full a.g.c. voltage available at the junction of R_8 and R_9 may be applied to an i.f. amplifier

[7] The gain of an a.g.c. system may be defined by the expression: $\frac{\text{change in applied signal strength}}{\text{change in control voltage}}$

[8] Published in last month's issue.

detected video waveform passed to the video output grid (which, in conventional receivers, has negative-going sync pulses) may be so large that the sync pulses are outside cut-off potential. In consequence, no sync pulses are passed to the sync clipper and a correct a.g.c. voltage cannot be obtained. Paralysis may be avoided by the use of the protection circuit of Fig. 218, or by employing circuits which cause the high amplitude video signal to make the a.g.c. line go temporarily negative.

voltage is obtained, either with a simple potential divider as in Fig. 222 (*a*) (which gives a partial d.c. coupling), or with a cathode follower as in Fig. 222 (*b*) (which gives a full d.c. coupling). The waveform provided by either of these circuits should be such that blanking level at the grid of $V_{1(a)}$ corresponds to 100 volts above chassis when the receiver h.t. potential is of the order of 200 volts. Incidentally, the circuit of Fig. 222 (*b*) does not incur the use of an extra valve, because it would only be

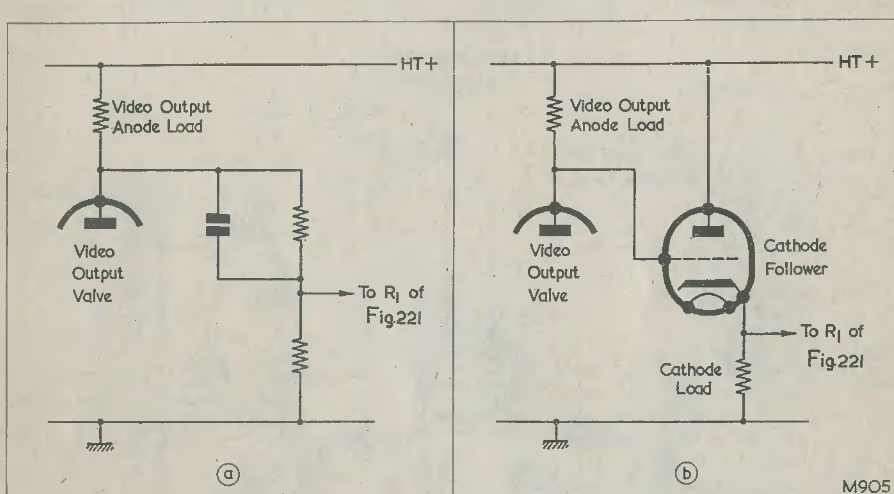


Fig. 222. The voltage on the anode of the video output valve is normally too high for direct application to the circuit of Fig. 221. In consequence it has to be reduced by a simple potential divider circuit, as in (a), *or by the use of a cathode follower, as in* (b). *The condenser across the upper resistor of the potential divider in* (a) *allows the passage of the higher video frequencies*

A High-Gain Gate Circuit

The third gated a.g.c. circuit to be discussed, that which is currently employed in many present-day receivers, is illustrated in Fig. 221.[9] It has a number of advantages which will be considered after a description of its operation.

In Fig. 221, the grid of $V_{1(a)}$ is connected to the output of the video amplifier by a d.c. coupling (or a partial d.c. coupling). To meet circuit operating requirements, a connection direct to the video output anode cannot normally be employed, as the voltage at this point is too high. Instead, a lowered

[9] This circuit, *Synchronising Pulse Derivative Cancelled A.G.C. Gate with D.C. Amplifier*, was developed at Mullard Research Laboratories.

employed in receivers whose design already called for a cathode follower between the video output valve anode and the modulating electrode of the cathode ray tube. (In other receivers the potential divider in Fig. 222 (*a*) may be similarly already called for, the junction of the two resistors in the potential divider feeding the modulating electrode of the cathode ray tube.)

The video waveform obtained from either Fig. 222 (*a*) or (*b*) is similar to that at the anode of the video output valve and is illustrated, as the video input, in Fig. 221. Also applied to the grid of $V_{1(a)}$ in Fig. 221 are negative-going sync pulses obtained from the anode of the sync clipper. Ignoring C_2 for the moment, the negative-going pulses are applied, via C_1 and R_2, to the right hand

end of R_1, whereupon they "cancel out" the positive-going sync pulses in the input signal. The effect is exactly the same as occurred when the positive-going sync pulses in the input signal were "cancelled out" in Fig. 219.

The presence of the low value condenser C_2 causes a small degree of differentiation to occur with the pulses from the sync clipper. Because of this differentiation, a small spike (which we will describe here as an "overshoot") occurs at the end of the negative-going edge of the "cancelling pulse", and a similar small spike (or "overshoot") occurs at the end of the positive-going edge. The two points at which overshoot occurs are indicated in the waveform for $V_{1(a)}$ grid.

$V_{1(a)}$ functions as a cathode follower and it causes condenser C_3 to charge up to a voltage slightly lower (due to voltage drop in the conducting triode) than the most positive part of the waveform at its grid; that is, the tip of the positive-going overshoot at the end of the "cancelling pulse". The voltage on the upper plate of C_3 decays slightly between positive-going tips but the overshoot, by applying a potential to $V_{1(a)}$ grid which is higher than blanking level, ensures that this voltage does not drop to a level corresponding to picture information. As a result, the voltage across C_3 is proportional to the blanking level of the applied signal and is unaffected by picture information.

If the received signal increases in strength the blanking level in the video waveform applied to R_1 goes negative (because the sync pulses in this waveform increase in amplitude and the sync pulse tips, corresponding to minimum anode current in the video output valve, are at a relatively fixed potential). The voltage on the upper plate of C_3 goes negative also. The upper plate of C_3 connects to the cathode of $V_{1(b)}$ with the result that, when the received signal increases in strength, this cathode goes negative as well. Obviously, the reverse effect also takes place: when signal strength reduces, the cathode of $V_{1(b)}$ goes positive.

$V_{1(b)}$ is the a.g.c. amplifier. A positive-going pulse, obtained during the flyback period from the line output transformer anode winding, is passed to $V_{1(b)}$ anode via C_4. If the grid-cathode potential of $V_{1(b)}$ is such that it is capable of drawing anode current, C_4 receives a charge during each pulse. Between pulses C_4 discharges into the network provided by R_7, R_8, R_9 and C_6, causing a potential, which is negative with respect to chassis, to appear on the upper plate of C_6. In addition, R_7, C_6 provide a low-pass filter which causes the voltage on the upper plate of C_6 to maintain a steady value. When, due to increasing signal strength, the cathode of $V_{1(b)}$ goes negative,

the anode current it passes increases and C_4 receives a greater charge. In consequence, a higher negative voltage is applied to R_7 between pulses and the negative voltage on the upper plate of C_6 increases.

The circuit around $V_{1(b)}$ provides d.c. amplification, therefore, since a change in d.c. voltage on the cathode causes a change in d.c. voltage on the upper plate of C_6, both changes being in the same direction. Component values are such that the change in d.c. voltage on the upper plate of C_6 is greater than that at the cathode of $V_{1(b)}$, with the result that useful amplification of the voltage on the cathode is achieved. The amplifier circuit is of interest because the amplified d.c. voltage is negative of chassis. It should be noted that, although pulses from the line output stage are employed by the amplifier, the line sawtooth generator need not be in synchronism with the signal for the amplifier to operate. Provided that a train of pulses is applied to C_4 an amplified voltage will appear across C_6.[10]

Since an increase in signal strength causes the voltage on the upper plate of C_6 to go negative, this voltage may be employed for automatic gain control.

The potentiometer R_5 varies the voltage on the grid of the amplifier $V_{1(b)}$. This potentiometer may be adjusted such that $V_{1(b)}$ does not conduct until its cathode goes negative to a predetermined level. Thus, potentiometer R_5 provides a delay. By varying the potential on the grid of $V_{1(b)}$, R_5 also controls the anode current passed by this valve and, in consequence, the charge, during pulses, held by C_4. Thus, R_5 varies the degree by which the voltage on the upper plate of C_6 goes negative of chassis and it can be used as a contrast control. The component values in the circuit are such that, for all signals having sufficient amplitude to merit the use of a.g.c., the desired setting of R_5 causes the delay to be overcome.

The circuit of Fig. 221 has three main advantages. Firstly, because of the amplification it provides, it gives a high gain; with the result that large changes in input signal strength cause very small changes in the signal output applied to the modulating electrode of the cathode ray tube. Secondly, it is free from paralysis effects. If the signal applied to the video output valve has a very large amplitude the voltage at the anode of the latter drops. Since the video amplifier anode is d.c. coupled (or partially d.c. coupled) to the grid of $V_{1(a)}$, the cathode voltage of the latter drops also, causing the formation of a high a.g.c. voltage which

[10] The *gain* offered by the amplifier may vary for different pulse repetition frequencies. Such variations in gain should not be sufficiently great to adversely upset a.g.c. operation

removes the overload. Thirdly, the circuit does not require that the line sawtooth generator be synchronised with the received signal.

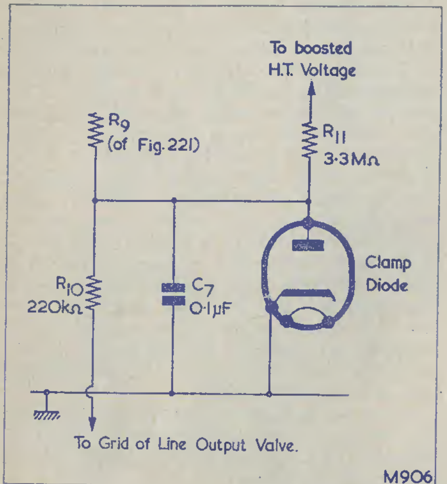


Fig. 223. A protection circuit which causes the a.g.c. line to go negative in the period immediately before the booster diode warms up after switching on the receiver

The circuit does not provide protection against overload after switching on in the period immediately before the booster diode has warmed up, because no a.g.c. voltage is formed until pulses appear from the line output transformer. In consequence, it is desirable to have a protection circuit, which could be of the type shown in Fig. 218. It is normal practice, however, to use a circuit similar to that shown in Fig. 223. In this diagram the earthy end of R_9 in Fig. 221 is connected to the junction of R_{10} and R_{11}. R_{10} connects to the grid of the line output valve, and R_{11} to the boosted h.t. positive rail. As soon as the line output valve and the line sawtooth generator warm up, a negative potential is applied from the grid of the line output valve to R_{10}, and this potential causes the a.g.c. line to go sufficiently negative of chassis to prevent overloading. When the booster diode warms up and boosted h.t. appears, the voltage at the junction of R_{10} and R_{11} tends to swing positive of chassis, and is held at chassis potential by the clamp diode. The circuit then functions in the same manner as it would if R_9 were returned direct to chassis.

Next Month

In next month's issue we shall consider the simpler a.g.c. circuits fitted to receivers designed for negative modulation signals, after which we shall carry on to power supply circuits.

TRADE REVIEW

NEW BIB TAPE RECORDING ACCESSORIES KIT

Multicore Solders Ltd. have now incorporated in a printed 2-colour fitted carton a comprehensive tape accessories kit for recording enthusiasts.

The Bib Tape Accessories Kit, shown alongside, contains the already well-known tape splicer, a reel of Scotch splicing tape on a dispenser, an additional supply of cutters and the Bib tape data card calculator. The data card provides up-to-date information on tape spools, playing times for all types of tape at 4 different speeds and, in addition, contains the recording times of nearly 50 orchestral works. In a packet affixed to the lid of the kit, there are 24 Bib tape reel labels which are, like the Bib recording tape splicer, available separately.

The Bib tape reel labels, which are self-adhesive, provide an instant identification of all recorded reels of tape. They may be typed on or written on in pencil or ink and allow the titles, composer, artist, reel number, date, speed and type of tape to be noted.

Multicore Solders Limited announce that the Bib Tape Accessories Kit containing the 5 items retails at 28s. 6d., whilst the splicer at 18s. 6d. and the Bib tape reel labels at 2s. 6d. are available separately if required.

A Telephone Adaptor Unit for use with a Tape Recorder

By **R. B. BERNARD**

Occasionally, like myself, the owner of a tape recorder finds the need for a telephone adaptor, but this is a comparatively costly item to purchase. However, the writer has achieved excellent results with the following simple piece of apparatus, this being constructed in a few minutes from parts out of the "junk box" and at negligible expense.

Basically, the unit is a small iron cored coil encased in non-magnetic material. This coil is placed close to the magnetic field of the induction coil (microphone transformer) which is usually installed in the base of a telephone handset.

The output from the "pick-up coil" is then fed into an appropriate socket of the tape recorder. Suitable points, may be, at the "radio diode" or crystal microphone inputs.

The case is a small aluminium container about one inch in diameter and one inch deep, such as may be obtained from chemists' shops. The coil unit is mounted in the lid, and a small rubber suction cup is fitted to the bottom of the case. One end of a length of lightweight screened pick-up lead is passed through the lid, the braiding then being fixed to one of the coil mounting screws together with one connection from the coil. The other connection is taken to the core of the screened lead.

If preferred, the coil may be isolated from the case; its leads would then be connected to twin cores of a pick-up cable.

The coil used with this telephone adaptor is a single iron cored high resistance coil salvaged from an old earphone.

The only article which may prove difficult for readers to obtain is the rubber sucker. This may be available at a local hardware store. Suitable suckers often form part of various small kitchen or bathroom fittings, etc., as well as car ashtrays.

It is not, of course, essential to employ a cylindrical canister—a cubical type will serve quite well, the simple construction of the instrument being noted from the diagram.

The best position for mounting the adaptor unit must be found by trial, and this will probably prove to be fairly low down at the rear of the telephone base.

The procedure for use is as follows: Plug the adaptor into the tape recorder. Lift the telephone receiver and monitor the dialling tone. When the best position for the adaptor has been found, moisten the suction cup and stick into place. You can now telephone a friend* and record the conversation.

*(Or enemy!)

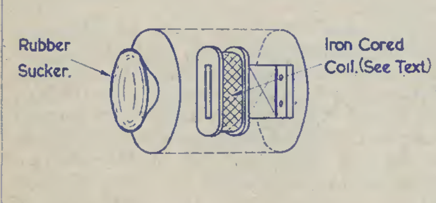


FIG.1.
The simple construction of the Telephone Adaptor Unit.

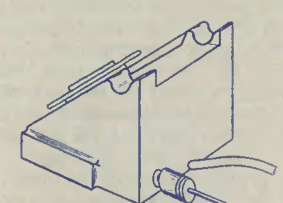


FIG.2.
Method of fixing the Adaptor to the base of a telephone.

M825

A MATCHBOX

SUPER-REGENERATIVE TRANSISTOR RECEIVER for the MEDIUM WAVE BAND

by B. Fistein

Our contributor, resident in the West Indies, describes an ingenious super-regenerative transistor receiver having a high degree of sensitivity. The coils employed are wound on an American loopstick former which was slightly shortened. The American component has a former of diameter $\frac{1}{4}$in, and a core $1\frac{1}{8}$in long with a diameter of approximately $\frac{7}{32}$in. The position of the core in the former and, hence, the tuning of the associated tuned circuit, can be varied by turning a threaded brass stem $1\frac{1}{8}$in long fixed to the core. A British made loopstick having approximately the same former and core dimensions is available from R.C.S. Products (Radio) Ltd., 11 *Oliver Road, Walthamstow, London, E.*17. *The two mercury cells, Mallory ZM-625, are available from Arthur Gray Ltd., Gray House,* 125 *Tottenham Court Road, London, W.*1.*—Editor*

General Principles

The super-regenerative detector is the most sensitive detector circuit ever devised, it has a possible gain of the order of millions and combines this with good selectivity. For this reason a super-regenerative circuit was selected for the design of an extremely compact receiver.

The gain of an r.f. amplifier or detector may be increased by the application of positive feedback (regeneration). However, the increase in gain that can be obtained in this way is limited by the fact that, given sufficient positive feedback, the detector or r.f. amplifier will begin to oscillate and therefore become useless for amplification. On switching on an r.f. amplifier in which positive feedback is so adjusted that the amplifier will oscillate, oscillation will begin and will increase in amplitude until it reaches the maximum amplitude possible for that particular circuit. If, on switching on, an r.f. signal is applied to the amplifier, then the rate at which the oscillation increases in amplitude will depend on the strength of the r.f. signal. In a super-regenerative detector, sufficient r.f. positive feedback for oscillation to occur is applied, but oscillations are quenched before they can reach the maximum amplitude. This results in bursts of oscillation, the amplitude of which depends on the r.f. signal. After r.f. and quench frequencies are filtered from the output, the output will consist of the audio frequency modulation of the r.f. signal. As sufficient positive feedback for oscillation to occur has been applied, the gain of the detector will reach extremely high values.

Two methods for quenching oscillations are commonly used. (1) the detector is adjusted to be just on the point of oscillation, and a quench frequency obtained from a separate oscillator is injected into a suitable point of the circuit so that it will cause the detector circuit to go in and out of oscillation. (2) The detector is adjusted so that it oscillates, and the circuit is so arranged that when oscillation reaches a certain amplitude, the detector biases itself so that it stops amplifying, i.e. the oscillation is self-quenching. The sensitivity attainable by the first method is somewhat greater, provided that the quench signal is of suitable amplitude and frequency and that positive feedback is adjusted to the optimum setting. The second method, while providing lower gain, has the advantages of being simple and, to some extent, self-adjusting.

The quench frequency must be chosen so that oscillations have time to build up and die down with each cycle. The quench frequency is generally chosen to be 1/100 of the signal frequency or less. The receiver here described was found to operate reliably at the low frequency end of the Medium wave band with a quench frequency of about 10 kc/s, which is near the upper limit of audibility.

Circuit and Mode of Operation

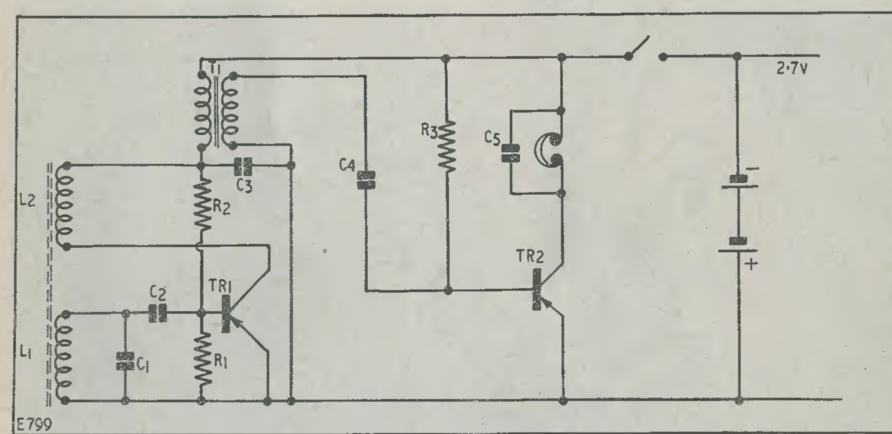
Since it was desired to make a very small receiver, a self-quenching circuit was selected

and the controls of the receiver were thereby reduced to a minimum. The receiver has in fact only a tuning control and a switch incorporated in the miniature phone jack.

The receiver is tuned by varying the inductance of L_1 with a dust core. L_1 consists of 60 turns of 9-strand Litz wire wound in two layers on the former of a "loopstick antenna" and the original core is used for tuning. L_1 and C_1 form the tuned circuit. L_1 is insulated with plastic insulating tape and L_2 is wound over this. It consists of 10 to 20 turns of 36 s.w.g. d.s.c. wire close-wound over the end of L_1 nearest the ferrite core when the ferrite core is fully out of L_1, and the optimum number of turns must be found by trial and error. One side of L_1 is connected to the base of TR_1 through the coupling condenser C_2, and R_1 and R_2 are bias resistors for TR_1. The quench frequency is determined by the time constant of C_2–R_1 the amount of feedback, losses in the circuit, and the strength of signal.

The r.f. signal is amplified by TR_1 and fed back to L_1, C_1, by L_2 so that TR_1 oscillates. However, the emitter and base of TR_1 form a diode which rectifies the signal, and as the amplitude of oscillation increases, rectification results in C_2 being charged to an increasing voltage. Since L_1 has very low impedance at low frequencies, for such frequencies or d.c., one side of C_2 may be considered as being connected directly to the emitter of TR_1. The charge accumulating in C_2 will result in the emitter-base diode of TR_1 being biased such that it does not conduct. When this happens, oscillation ceases and C_2 discharges through R_1 until the emitter-base diode of TR_1 conducts again, TR_1 amplifies again, oscillation is re-started, and the quench cycle begins anew. C_3 filters r.f. from the output of TR_1.

The audio output is taken from the secondary winding of T_1, and C_4, R_3, and TR_2 form a very simple audio amplifier. In order to save space no volume control is included. C_5 filters most of the quench signal from the output of the receiver. It is connected in parallel with a low impedance



Components List

Resistors
- R_1 4.7kΩ
- R_2 120kΩ
- R_3 100kΩ

Transistors
- TR_1 "White Spot" r.f. type
- TR_2 "Red Spot" a.f. type

Battery
- 2 Mercury cells (Mallory ZM-625)

Condensers
- C_1 500pF
- C_2 0.002μF
- C_3 0.02μF
- C_4 8μF
- C_5 1μF

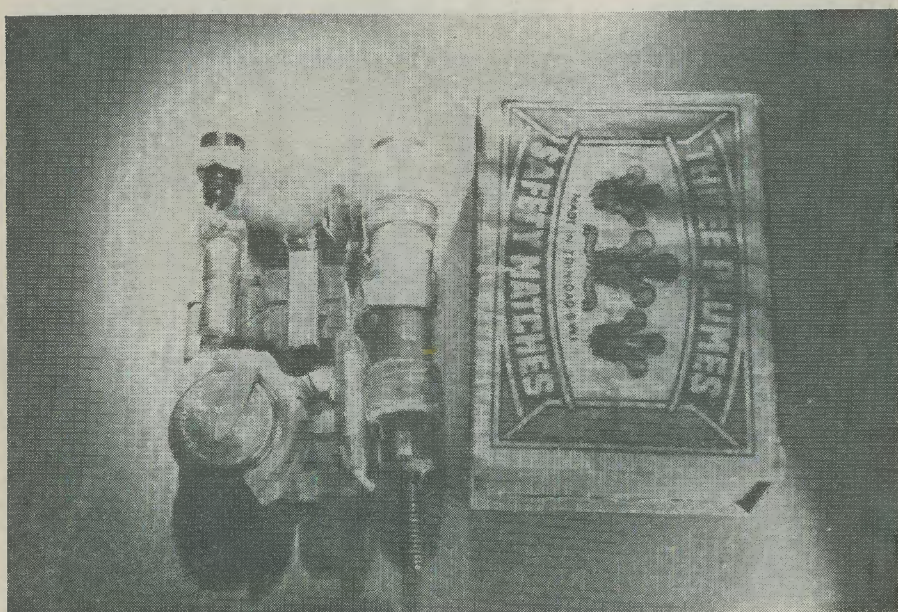
Miscellaneous
- T_1 5:1 Ardente type 1079 (see text)
- L_1 (See text)
- L_2 (See text)

hearing-aid earpiece, the d.c. resistance of which is 100 ohms.

The negative end of R_2 is connected to the transformer rather than to the negative pole of the battery in order to provide some negative feedback to the super-regenerative detector. This results in the detector being more stable, and less sensitive to changes in battery voltage and resistance.

Mercury cells are used because of their small size, and because the voltage varies little during their life.

Negative feedback and constant voltage cells ensure that the detector will operate satisfactorily over a relatively wide frequency range during battery life, without adjustment of the regeneration. In order to save space, a regeneration control has not been included.



The compact receiver constructed by the author

Construction

The "chassis" of the receiver was made from a piece of Perspex $\frac{1}{16}$in thick. The holder for the batteries was made from a section of Perspex tubing, and the battery contacts were made from thin strips of springy brass bent to shape and cemented to the outside of the section of tubing. The battery holder is then cemented to the chassis from which a circular section is cut out so that the battery holder fits snugly into it. The socket for the miniature 'phone plug was made from a piece of Perspex, and the contacts from thin brass sheet. Three contacts are provided. Two of these touch the sleeve of the 'phone plug when it is pushed home. One of these two contacts is connected to the negative terminal of the battery, and the other to the negative terminal of the receiver, so that inserting and removing the 'phone plug from the socket switches the receiver on and off. The holder for the coil was made from a small piece of Perspex which was cemented to the chassis. The resistors are small $\frac{1}{4}$ watt types, and C_4, C_5, are sub-miniature electrolytic condensers. The other condensers used were miniature disc ceramic types, though a sub-miniature paper condenser can be substituted for C_3. All components are mounted on one side of the chassis and are held in place by their wire ends, these passing through small holes drilled in the chassis. The wire ends of the components are sufficient for most of the wiring and connections. Lastly, transistors are soldered in place, taking care to avoid overheating the junctions by using heat shunts.

L_2 must be connected in the right sense to provide positive feedback. When TR_1 is not oscillating its quiescent current is between 100 and 150μA. If the primary of T_1 is short-circuited and L_2 is connected in the correct sense, TR_1 will oscillate freely and the collector current will rise to a few mA. This can be used as a test of whether L_2 is connected in the right sense. This test should be done with the core screwed into the coil. The short circuit across the primary of T_1 is now removed, and turns are taken off L_2 until the detector "super-regenerates" (i.e. until a whistle of about 10 kc/s is heard), when the collector current of TR_1 will drop to about 400μA. During this adjustment C_5 may be removed so that the high-pitched whistle may be heard more clearly. The optimum number of turns of L_2 for maximum sensitivity and output for the stations required must be found by trial and error by adding and removing turns from L_2.

The layout of components was not found to be critical.

A sub-miniature socket for an outside aerial was provided. This was connected to the "live" end of L_1. However, if more than a few feet of aerial are to be used, a separate aerial winding should be wound over L_1 and L_2, one end being connected to the earthy end of L_1 and the other to the aerial socket.

If a larger construction is allowable, a more elaborate audio amplifier could be used incorporating a volume control. T_1 is a sub-miniature transformer (Ardente type 1079). In a larger version a larger transformer may be used, and therefore the collector current of TR_1 increased. This can be done by disconnecting the negative end of R_2 from the transformer, reducing its value to about 50kΩ and connecting it to the negative side of the battery through a variable resistor of 150kΩ, thereby providing a regeneration control which can be set for maximum sensitivity for each station. This will also enable the receiver to operate on a wider frequency range. L_2 may require more turns.

If regeneration controls, volume controls, and d.c. stabilisation are provided, conventional dry cells may be substituted for the mercury cells.

Other configurations of the regenerative detector may be tried. In particular TR_1 may be connected in a common base circuit, though a method of controlling positive feedback will be necessary. Other methods of providing positive feedback may be tried.

Performance

As described, this receiver has a sensitivity and selectivity comparable to that of a superheterodyne receiver with one i.f. stage. It operates without adjustment on frequencies of 500 to 1,100 kc/s. Reception of local stations without an external aerial is good, and the volume is more than adequate. When reception is particularly good, stations a few hundred miles away may be heard without using an external aerial. However, though the volume is adequate with distant stations background noise is loud. With an external aerial of a few feet, distant stations are heard clearly. Reception of local stations without using an external aerial is adequate even in a steel frame building. On local stations, adequate volume may be obtained from the detector without further audio amplification by connecting high impedance headphones in place of the primary of T_1.

When not tuned to a station, a loud hissing noise is heard in the earpiece, together with the quench frequency whistle. On the receiver being tuned to a station the hiss disappears and the quench frequency whistle increases in frequency and may become inaudible.

The receiver is directional, but the self-regulating properties of the circuit render the orientation of the receiver less critical. When the receiver is tuned to a strong local station, on being turned to the least favourable direction the background hiss becomes audible, the quench frequency whistle becomes lower pitched, and the volume decreases somewhat.

As described, the tunable frequency is limited. For other frequency ranges the number of turns of L_1 should be changed.

"Experiment in Sound"

A lecture and demonstration will be given by F. C. Judd, A.Inst.E. (Technical Editor of *Amateur Tape Recording* and *Popular Hi-Fi* magazines) at the Grafton Radio Society, Montem School, Hornsey Road, Holloway, N.7, on 3rd February, 1961, at 8.30 p.m. Nearest Tube station—Holloway Road and Finsbury Park; Buses 73 and 29, also trolley-buses from Tottenham Court Road. The school is almost at the corner of Hornsey Road which is about 100 yards along Seven Sisters Road from the "Nag's Head", Holloway. Refreshments are available between 8 and 8.30 p.m. and the lecture commences promptly at 8.30 p.m.

Aircraft Flutter in Hi-Fi FM Receivers

by B. H. Coleman

In this short article, our contributor gives details of an unusual fault and describes how it was corrected

A FEW DAYS AGO A FRIEND WITH A RATHER apprehensive expression called to ask for help with a radio problem.

His hi-fi set-up, which usually fluttered when aircraft passed over, had made more awful noises than usual, building up to a crescendo and finishing abruptly in complete silence. He had tried the gram section, but it, too, was dead. Had the speaker burned out? We took a rather battered spare to check.

The set-up was a Jason tuner followed by a Mullard "5-10" with controls, the latter feeding into a Goodmans Axiom 150 in a 9 cu. ft. corner cabinet. I had previously noted, during a record playing session, that the cloth covering on the speaker opening moved in and out at twice the record revolutions, so the bass response certainly extended very low.

To relieve the rather tense atmosphere we put a battery across the speaker leads and, to my friend's intense relief, heard a healthy "plop".

Checking back, the transformer primary and secondary were found to be satisfactory. Further testing with the mains switched on revealed that there was no h.t. due to a blown fuse. Apparently the large variations due to the aircraft flutter had driven the output valve grids so heavily positive as to cause the h.t. fuse to blow.

The writer decided that the bass response at the extreme low and sub-audio frequencies must be reduced in order to avoid further alarm—not to mention the possibility of damage. A suitably chosen condenser input to the "5–10" amplifier would be effective on both pick-up and tuner inputs. A glance at the circuit showed that the input impedance would be slightly less than 1MΩ. Old copies of *The Radio Constructor* (April 1957)* gave the formula $f_o = \frac{1}{2\pi CR}$, and from this we calculated that for 0.004μF the 3dB-down point, f_o, would be around 40 c/s. Accordingly, a 0.004μF condenser was fitted in series with the lead from the input socket.

I expected there would be some bass-cut with this value, but a careful listening test did not reveal it; and certainly now the cloth covering did not go in and out at turntable frequency!

One thing which greatly improved, incidentally, is the tuning of the Jason unit. Previously, rapid tuning through a station would cause cut-off in the amplifier due to the large change in voltages developed at the discriminator. This effect is now absent. The removal of the extreme low frequency has also cleaned up the rumble from the crystal pick-up, and considerably improved the quality of reproduction.

* Design Charts for Constructors, No. 13, by Hugh Guy, *The Radio Constructor*, April 1957.

B.A.R.T.G. Dinner

The first Dinner and Get Together held by the British Amateur Radio Teleprinter Group, at the New Horticulture Hall, London, on Saturday, 26th November, proved to be a most successful and enjoyable occasion. Timed to coincide with the last day of the Exhibition, some twenty-two members were present including Jan Adams, PAØFB, who represented Dutch R.T.T.Y. enthusiasts. A telegram of congratulations and best wishes for the future of the Group was also received from DL1GP on behalf of the West German R.T.T.Y. Group.

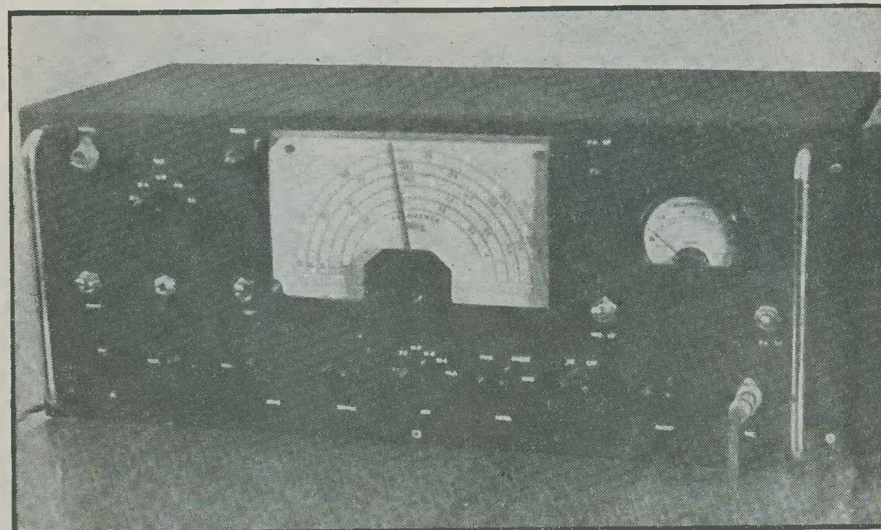
Following upon an excellent dinner, which concluded with the wife of the Hon. Secretary cutting a birthday cake, a formal statement was made by the Hon. Secretary regarding the future of the Group.

The gathering unanimously agreed to appoint L. E. Newnham, B.SC., G6NZ Chairman, and Messrs. Brennan, G3CQE; Bagley, G3FHL; Tuke, G3BST and Partner, G3HKT, as Committee Members.

Dr. Arthur C. Gee, G2UK, was asked to continue his good work as Hon. Secretary of the Group. It was agreed to seek closer liaison with the Radio Society of Great Britain either by affiliation or such other means as the Hon. Secretary may be able to negotiate with the R.S.G.B. Council.

A COMPACT AMATEUR BANDS TRANSMITTER

by Arthur C. Gee, G2UK



THE AVAILABILITY OF THE GELOSO V.F.O. unit in this country has made possible the home construction of very compact multi-band transmitters. That described herewith is presented as a typical example of the equipment which can be designed around this excellent little unit. In fact, by using a Labgear (Cambridge) Ltd. switched coil turret, very little constructional work is necessary apart from some chassis and panel cutting; and if the layout is first carefully planned, the chassis and panel drawings may be sent to one of the firms who specialise in producing such items to individual requirements. In this manner most of the hard work will have been done and the whole transmitter can be built in quite a short time.

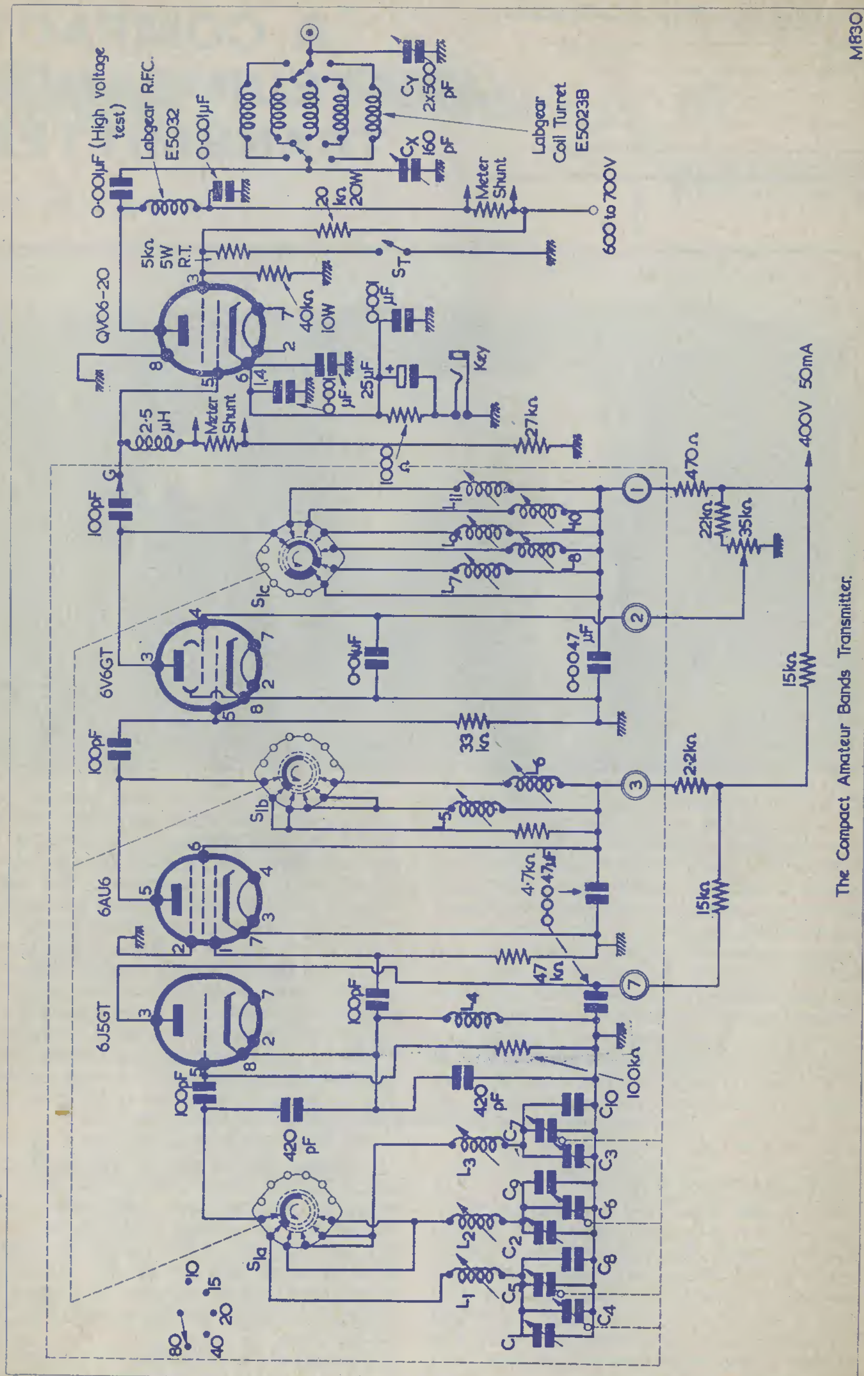
The Geloso V.F.O. Unit

The Geloso v.f.o. unit is of Italian manufacture and is readily obtainable in this country. The writer's acquaintance with it began whilst "on-the-air" when increasing numbers of Italian stations reported that their transmitters were "Geloso v.f.o. into 807" or some such similar arrangement. The stability and quality of the signals from these stations was quite noteworthy.

The transmitter described herewith was constructed some time ago and uses the Model N.4/101 Geloso v.f.o. unit. It has given excellent service and time has proved the reliability of the equipment. The Model N.4/101 has now been replaced by a similar unit using two miniature valves instead of the three shown in the accompanying circuit. There is a further model, the N.4/102 which is similar to the N.4/101, the 6V6 having been replaced by a 6L6, thus permitting excitation of two 807 or equivalent valves. Whichever model is used, adequate instructions and a circuit diagram are supplied with the unit. The design given herewith is presented as a basic one for use with these units.

The basic circuit of the unit is a Clapp type of variable frequency oscillator using a 6J5GT valve, which feeds into a 6AU6, which in turn feeds into either a 6V6 in the Model N.4/101 or into a 6L6 in the Model N.4/102. Model N.4/101 was intended to drive a single 807 or similar p.a. stage; Model N.4/102 is designed to give extra output suitable for driving a pair of 807's in the p.a. stage.

The newer Model referred to above, the N.4/104, replaces the N.4/101 and is intended



The Compact Amateur Bands Transmitter.

to drive a single 807 or equivalent. This design too, uses a Clapp oscillator, but the 6CL6 valve employed also functions as a buffer-doubler. A tetrode 5763 or QVO3–12 is used following this, as a driver stage.

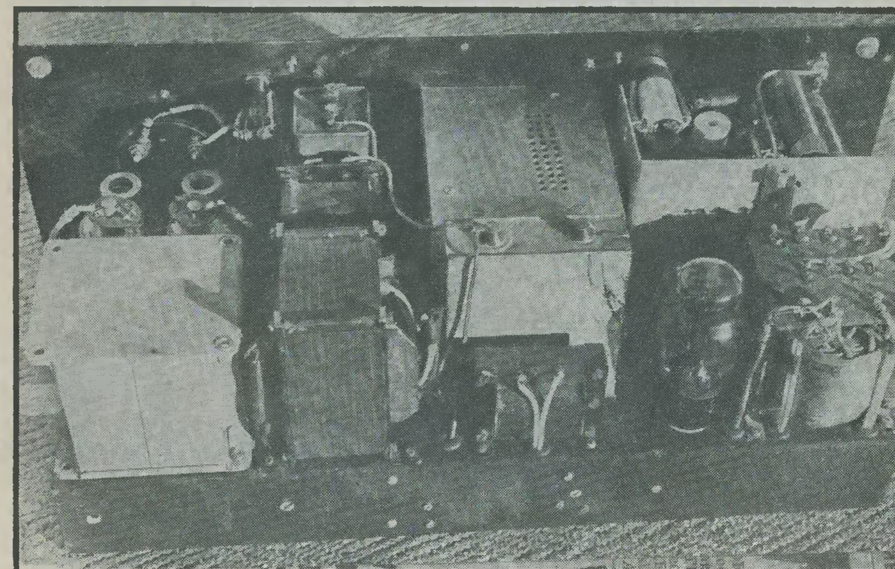
By means of switching, output can be obtained on any amateur band from 80 metres through to 10. A very useful feature is that the screen of the final valve in the v.f.o. unit is taken to a separate terminal so that it can be connected to a potentiometer. In this way, the screen voltage can be varied thus providing some control of the output of the unit; a most useful feature enabling just the right amount of grid drive to be obtained for the particular p.a. valve in use. It also enables compensatory adjustments to be made to the grid drive depending on the band in use. For instance, the drive available on 80 metres is naturally greater than that on, say, 21 metres, and by means of this potentiometer, the correct drive for the p.a. valve can always be provided.

It may be thought on first sight that the Geloso v.f.o. unit is rather lightly constructed, but as it is intended that it shall be fitted into a cut-out section of the chassis and then screened top, bottom and sides, it will be realised that its construction is quite adequately substantial. In fact one of the best features is that it has been cleverly designed, full use being made of miniature coils and other components, no space being wasted, and a really compact unit resulting. As can be seen from the photographs, it is fitted with an attractive dial which is very easily fixed, no cut-out in the panel being necessary.

The Transmitter and Power Supply

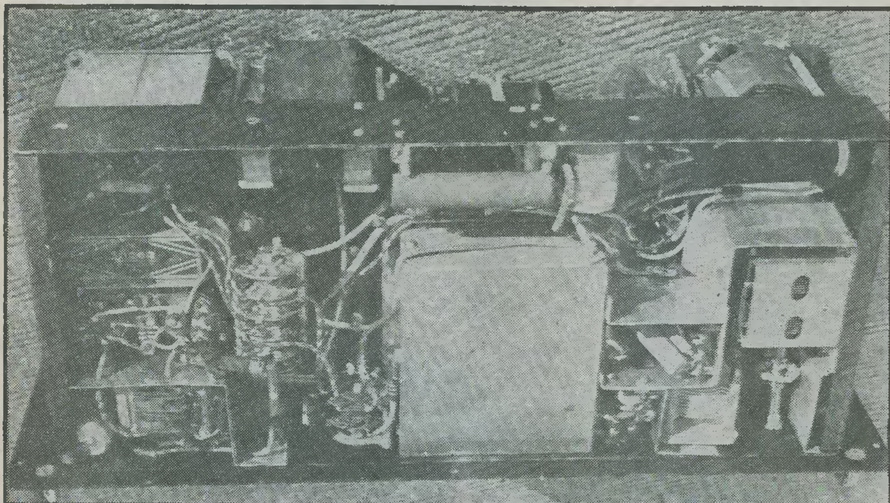
The transmitter described herewith uses the Mullard equivalent of the 6146, viz. QVO6-20; a nice compact valve with good ratings. A pair of Mullard QVO5–25's are used as modulators, driven by a Mullard EC90. A Mullard ECC83 provides sufficient pre-amplification for a crystal microphone. The QVO5–25's are operated in Class AB1, bias being provided by a miniature 30 volt battery. Since little grid current is drawn, the life of this battery is virtually that of its normal shelf-life.

As adequate illustrations are given, and the circuit diagrams are self explanatory, little comment is necessary regarding construction. Dimensions relating to chassis and panel, etc., are not given, the writer considering that the best way to approach this problem is to



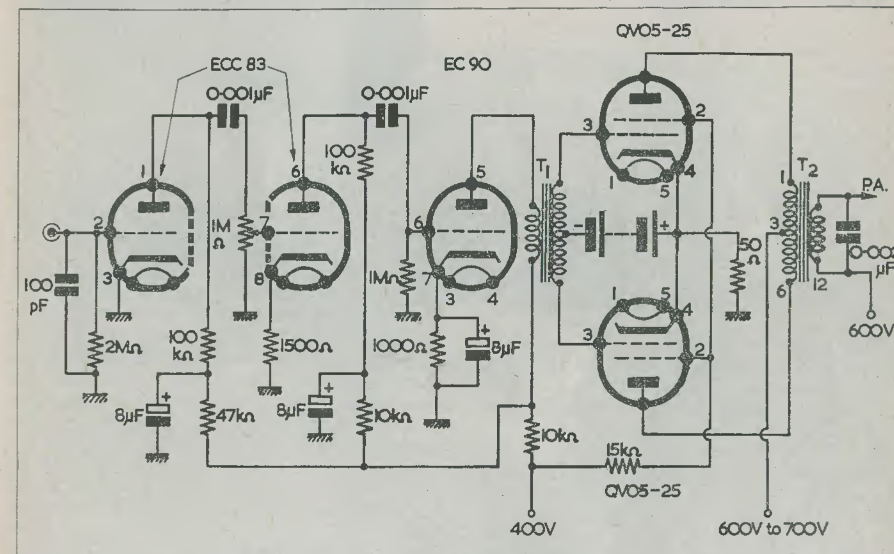
Above-chassis view of the transmitter showing the P.A. coil turret (top right), V.F.O. screening (centre), modulation transformer (extreme left) with QVO5-25's adjacent ascertain what components in the way of mains transformers and so on are available—then spacing them on a sheet of paper in such a way that as compact an arrangement as possible is obtained. In this manner one can use available components and, at the same time, work out the neatest layout possible. Provision must be made for two power packs, one to provide 400 V.d.c. at about 70 to 80 mA for the Geloso v.f.o. and the pre-amplifier stages of the modulator and the other 600 to 700 volts at about 140mA for the p.a. valve and modulator anode supply. The N.4/104 requires between 275 to 300 volts at 60mA. In addition, filament is employed under conditions approaching those for which the manufacturers advise delayed h.t. switching, h.t. for the p.a. and modulators is only switched on after the transmitter heaters have warmed up. Other power supply arrangements can, of course, be utilised according to the constructor's preferences and the components available.

The chassis photograph below shows the general layout. The v.f.o. unit is arranged in such a manner that the dial fits centrally on the panel. The p.a. unit, with its coil turret and the Mullard QVO6–20, are in a screened compartment to the left of the v.f.o. compartment, the modulator valves being to



Under-chassis view of the transmitter showing compact layout

current must be provided for two rectifiers and for the valves in the transmitter itself. In the writer's case, a transformer giving 350–0–350V, 6.3V 8 amp, 5V 2 amp and 5V 2 amp was available, so that the 6.3V 8 amp winding was used for the transmitter proper, one 5V 2 amp winding for a 5Y3GT rectifier and the other 5V 2 amp winding for a 5R4GY rectifier. H.T. was broken by having secondary winding centre tap taken to earth the through a normal rated toggle switch which proved quite satisfactory. This transformer thus takes care of the filament requirements of the whole transmitter together with the h.t. supplies for the v.f.o., etc. H.T. for the p.a. and the modulators is provided from a 700–0–700 volt transformer having no heater windings, switching being arranged in this case in its primary circuit. Since the 5R4GY the right with the modulation transformer, a Woden MU 1, and power supply components, toward the rear of the chassis. Dropping resistors, the pi-coupler variable condensers, the "below-deck" part of the v.f.o. unit and the speech amplifier components are all beneath the chassis. The controls seen on the front panel are as follows: from left to right, first the two pi-coupler variable condensers, next the knob for the grid drive potentiometer, then the v.f.o. tuning control followed by the v.f.o. bandswitch. Then there is the meter switch knob. A single 0–1mA meter is used with appropriate shunts for reading grid drive to the p.a., p.a. anode current and modulator anode current. The next control is the phone/c.w. switch, followed by the speech amplifier gain control and finally a coaxial socket for microphone input. The aerial output socket is at the top left hand corner of the panel, with the coil turret switch knob to the left of the v.f.o. tuning dial, and the keyjack socket below it. Two miniature a.r.c.u. neon indicators are fitted as shown, one indicating mains on/off, the other lighting up when the h.t. to the p.a. is on. Dealing with the switches, the first is a double pole mains on/off switch. The second is for switching the resistor RT into circuit. This resistor drops the p.a. screen voltage whilst tuning. The third is in the 400 volt supply centre tap and switches the power to the v.f.o. on and off and the fourth is a double pole mains toggle, breaking the primary to the 700 volt transformer. cabinet, it was necessary to mount their bases below chassis level on small stand-off insulators. The modulation driver transformer is a Radiospares standard LF 3:1. Suitable screening should be arranged around the pre-amplifier sections of the modulator. The circuit of the modulator and pre-amplifier stages is a well tried straightforward one which is quite stable and reliable in operation. Terminal connections are shown in the circuit diagram. Phone/c.w. switching is provided by means of a four section Yaxley wafer switch. Section 1 removes h.t. from the modulator screens and speech amplifier in the c.w. position. Sections 2 and 3 bypass the secondary of the modulation transformer in the c.w. position.



The Modulator

Layout

Having spaced everything out and made certain all the components can be fitted in, measure up for chassis and panel. The writer managed to get everything on a chassis 19½ x 8¾ x 2¾in in size, with a panel 22 x 8¾in. A cabinet to match was ordered at the same time and, as can be seen from the photographs, a very well proportioned rig has resulted from this initial planning. It is worthwhile taking some time over the layout procedure; trying various arrangements of components until the most satisfactory layout is found.

As already mentioned, the modulator consists of a pair of Mullard QVO5–25's run in Class AB1, with 30 volts of bias applied from a miniature battery (type L5517). In the writer's unit, in order to get these valves into the limited headroom available within the Section 4 removes h.t. from the modulator anodes in the c.w. position. Normal t.v.i. precautions have been taken, all heater leads, etc., being screened and bypassed. With a low-pass filter in the aerial lead to an aerial tuner, t.v.i.-free operation is possible at the writer's QTH on all bands in spite of the fact that the local t.v. transmitter is on Channel 3 and is of temporary low power.

Finally, mention must be made of one of the most useful features of the design, and that is the provision of a means of reducing power to the p.a. valve during tuning-up operations. This is provided by the 5,000Ω resistor, RT, in the screen circuit of the QVO6–20. By means of switch ST, this can temporarily be switched in whilst tuning up, thus preventing damage to the QVO6–20 through off-resonance heavy anode current.

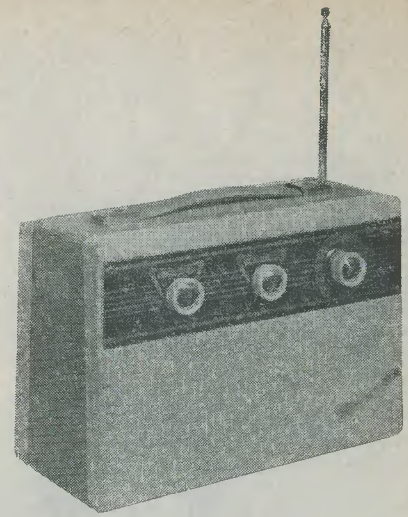
THE

wavemaster

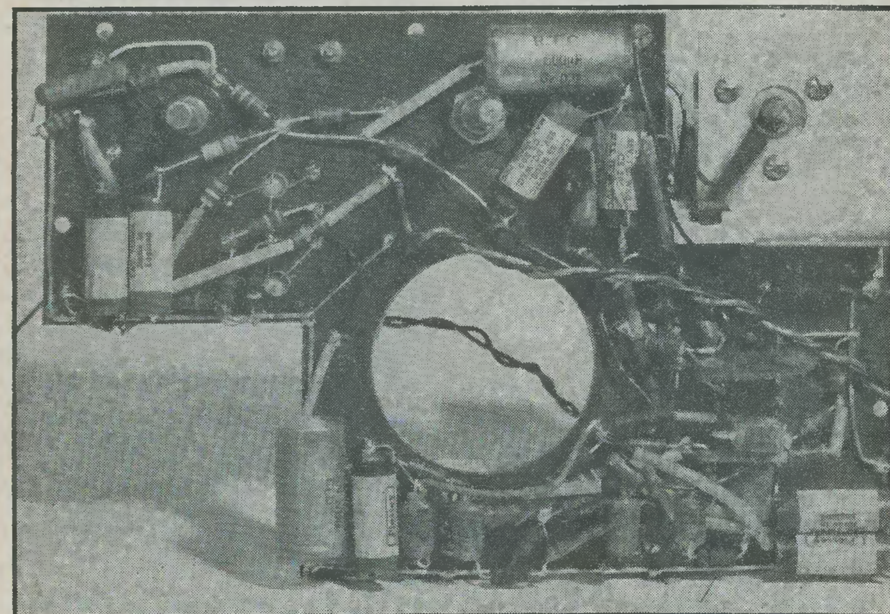
7-Transistor Portable/Car Radio

Described by
ALAN G. HEPWORTH

Part 2



50. Connect a short lead between earth tag "A" and earth tag "B".
51. Join in series C_1 (0.01μF) and R_1 (47kΩ, yellow, violet, orange).
52. Take the free end of C_1 to eyelet 17 and the free end of R_1 to tag 6 of the oscillator coil L_3.
53. Solder one end of R_2 (4.7kΩ, yellow, violet, red) to earth tag "B" and the other end to the junction of C_1 and R_1. Identify the emitter, base and collector leads from Fig. 1. Note the white spot.
54. With the details contained in the "Constructional Notes" and "Transistors" paragraphs clearly in mind, the transistor TR_1 (XA102) may now be fitted from the top side of the chassis, the connecting leads protruding through to the underside of the board.
55. Solder lead "E" of TR_1 to eyelet 1.
56. Solder lead "B" of TR_1 to that end of R_2, going to the junction of C_1, R_1 (fitted in para. 53).
57. Solder lead "C" of TR_1 to tag 3 of IFT_1.
58. R_{16} (100kΩ, brown, black, yellow) is now fitted between eyelet 2 and eyelet 3.
59. Joint a short lead between eyelet 2 and tag 6 of IFT_2.
60. Connect a short lead between tag 3 of the oscillator coil, L_3, and tag 1 of IFT_1.
61. Solder a short lead between eyelet 18 and tag 1 of the oscillator coil.
62. R_4 (1kΩ, brown, black, red) should now be fitted between eyelet 3 and tag 6 of the oscillator coil.
63. One end of the components R_{12}, C_{12}, C_{11}, R_{14} and "E" lead of TR_2, etc., are all shown joined together at point "O" in Fig. 3, no tag or eyelet being provided at this point—all the leads are twisted together and soldered. These components have been drawn in an "exploded" manner in order to avoid possible confusion. When, in the steps which follow, connections are made to point "O", keep all the leads as short as possible (including the "E" lead of TR_2) and arrange all components and leads so that the shortest route is taken. It may be necessary to extend the existing "E" lead of TR_2 so that it will reach point "O". Should this be necessary keep the extension as short as possible.
64. With the aforementioned information in mind, TR_2 (XA101) may be fitted as follows.
65. Fit sleeving to all leads of TR_2 and coil or loop them as previously described.
66. Using a pair of pointed nosed pliers forming a heat shunt, connect "B" of TR_2 to tag 5 of IFT_1.
67. Connect "C" of TR_2 to the unmarked tag that is between 1 and 6 of IFT_2.
68. Leave the "E" lead of TR_2 free for the moment.
69. Take R_{12} (15kΩ, brown, green, orange), C_{12} (0.002μF), C_{11} (0.04μF) R_{14} (1kΩ, brown, black, red) and join together at point "O". (See Fig. 3.)
70. Take the free end of R_{12} and solder to eyelet 3.
71. Take the free end of C_{12} and connect to tag 2 of IFT_2.
72. Dealing with the free end of C_{11}, solder this to tag 4 of IFT_1.
73. Take the free end of R_{14} and solder to eyelet 4.
74. Join a short lead between point "O" and tag 6 of IFT_3.
75. Connect a short lead between eyelet 4 and the positive bus-bar.
76. Join the free end of "E" lead (TR_2) to point "O".
77. Sleeve and coil the wire ends of TR_3 (XA101) and insert through the board.
78. Solder the "E" lead of TR_3 to the junction of C_{19} (0.002μF), C_{18} (0.04μF), R_{19} (1kΩ, brown, black, red)—these latter components having been previously fitted in steps 28–30.
79. Join "C" lead of TR_3 to the unmarked tag that is between 1 and 6 of IFT_3.
80. Connect the lead "B" of TR_3 to tag 5 of IFT_2.



Showing the positions of components on one side of the paxolin board

81. Join R_8 (10kΩ, brown, black, orange) between eyelet 14 and tag 4 of IFT_1. Extend one end if necessary and cover the join with sleeving.
82. R_{18} (470Ω, yellow, violet, brown) is now fitted between tag 2 of IFT_3 and eyelet 3. Keep leads as short as possible.
83. Join a short lead between eyelet 5 and tag "K" of T_2. (See Fig. 3.)
84. Connect a lead from tag "K" to eyelet 6.
85. Join a lead from tag "K" to tag "E" of T_1.
86. Sleeve ends of TR_6 (XC101) and TR_7 (XC101). Prepare leads as previously explained. Fit TR_6 and connect as follows.
87. Take the "B" lead of TR_6 to tag "F" of T_1.
88. Take the "C" lead of TR_6 to tag "J" of T_2.
89. Fit TR_7 (XC101) and connect as follows.
90. Join "B" lead of TR_7 to tag "H" of T_1.
91. Join the "C" lead of TR_7 to tag "L" of T_2.
92. Join "E" leads of TR_6 and TR_7 together.
93. To the junction of these two "E" leads join one end of R_{32} (10Ω, brown, black, black).
94. Take the free end of R_{32} to the positive bus-bar.
95. Prepare and fit TR_5 (XB103) as previously mentioned.
96. Take the "E" lead of TR_5 to eyelet 12.
97. Take the "C" lead of TR_5 to tag "D" of T_1. Leave "B" lead for the moment.
98. Join R_{25} (39kΩ, orange, white, orange) between eyelet 13 and eyelet 7.
99. Solder R_{28} (100kΩ, brown, black, yellow) between eyelet 13 and tag "M" of T_2.
100. Connect a short lead between tag "N" of T_2 and the positive bus-bar.

101. Join the "B" lead of TR_5 to eyelet 13.
102. Fit the positive end of C_{29} (25µF) to the positive bus-bar.
103. Join the negative end of C_{29} to eyelet 11.
104. Join the negative end of C_{28} (25µF) to one end of R_{24} (5.6kΩ, green, blue, red).
105. Join the positive end of C_{28} to eyelet 13.
106. Take the free end of R_{24} to eyelet 7.
107. Join a short lead between eyelet 10 and eyelet 9.
108. Prepare and fit TR_4 (XB103).
109. Take the "B" lead of TR_4 to eyelet 10.
110. Solder the "E" lead of TR_4 to eyelet 11.
111. Connect the "C" lead of TR_4 to the junction of C_{28} and R_{24}.
112. Cut two 8in leads of insulated wire, twist together, bare the ends and solder one lead to tag "M" of T_2 and the other to tag "N" of T_2. The other ends of these leads are later connected to the two speaker tags.

This completes the wiring on this side of the chassis.

Stage 3 (Fig. 2)

113. Solder a lead to VC_2 variable condenser tag (this tag actually protrudes from the gang on the opposite side of the chassis—see Fig. 3) and take the other end to TC_2 tag (Medium wave oscillator trimmer).
114. Solder a lead to VC_1 tag and take the other end to TC_2 tag (Medium wave aerial trimmer).
115. Continue this latter lead to tag "P" of S_1 switch section (wavechange switch).
116. Join a short lead between eyelet 18 and tag "P" of the S_3 switch section.
117. Join a short lead between eyelet 17 and tag "P" of S_2 switch section.
118. Fit C_6 (350pF) between earth tag "D" (adjacent to TC_4 on trimmer bank) and tag 1 of S_3 switch section.
119. Join a short lead to tag 1 (S_3 switch section) to TC_4 tag (Long wave oscillator) trimmer.
120. Connect a short lead between TC_1 tag (Long wave aerial trimmer) and tag 1 of S_1 switch section.
121. Solder a short lead between eyelet 6 and tag "P" of S_4 switch section.
122. Join a short lead between tag 3 and tag 1 of S_4 switch section.
123. Cut one 6in length of stranded black insulated wire and one 3in length of red insulated wire.
124. Solder one end of the *black* lead to tag 1 of S_4 switch section. The other end *must* be soldered to the *thin* pin of the 2-pin battery plug.
125. Solder one end of the *red* lead to the positive bus-bar and the other end of this lead to the *thick* pin of the 2-pin battery plug.
126. Take the ferrite rod aerial and fit it to the mounting brackets as shown in Fig. 2. Using pliers, bend the tops of the brackets together in order to stop the aerial rod falling out.
127. Commence at the left-hand side of the rod aerial. Do not cut leads already fitted to the rod aerial. Connect as follows.
128. Take the lead coming from the end of L_1 coil and solder to earth tag "D".
129. Join the thick lead coming from the tapping on L_1 to tag 3 of S_2 switch section.
130. Join the lead coming from the right-hand side of $L1_A$ to tag 3 of S_1 switch section.
131. Carefully note the position of the *red spot* adjacent to L_2 coil. Wire as follows.
132. Take a short lead from the *red spot* tag (L_2) to eyelet 15.
133. Solder a short lead to the *upper* tag of L_2 and join the other end to tag 1 of the S_1 switch section.
134. Solder a short lead to the lower tag of L_2 and take the other end to tag 1 of the S_2 switch section.

This completes the chassis wiring.

135. Before fitting the speaker to the cabinet, solder the two loose leads from T_2 to the speaker tags.
136. Check over the circuit for errors, particularly checking all transistor connect tions and ensuring that the emitter, base and collector leads are connected to the correct points. A mistake with the transistor or battery connections may permanently damage the transistors.
137. Connect the battery and switch on the receiver. Set to the Medium wave position and adjust the volume control to maximum, at the same time rotating the tuning condenser. A faint signal should be heard from the local or other B.B.C. station.

Alignment

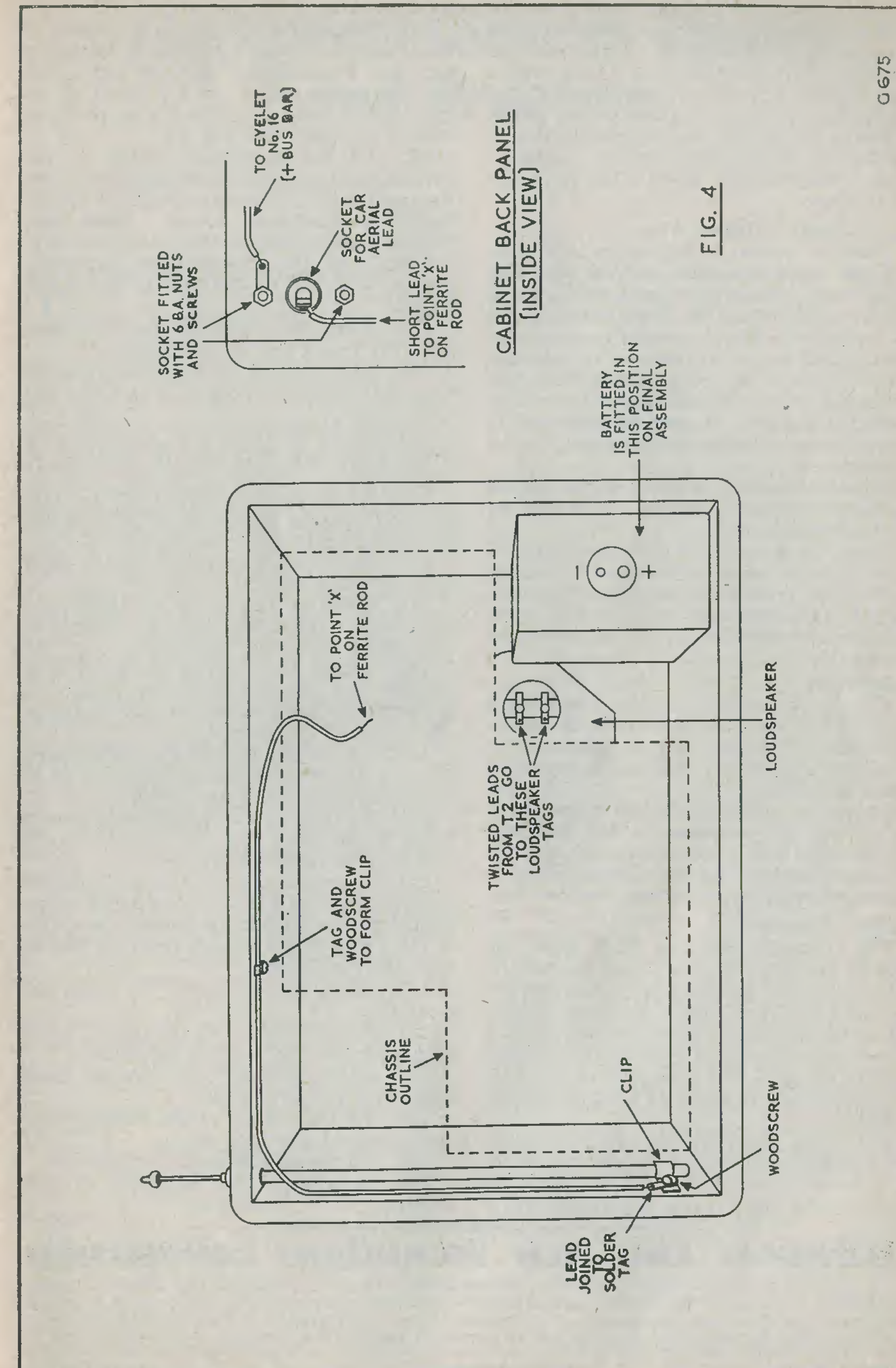
138. It is preferable to use a signal generator with the r.f. output 30% modulated. If an output meter is available, connect this across the speaker, the range being set for 50mW full scale deflection.

For the i.f. alignment, use a small input to give sufficient indication on the output meter, reducing the input as the tuned circuits come into line. As the cores are screwed in from the outside of the former, tune to the first peak.

For the r.f. alignment, the signal generator leads should be placed near to the ferrite rod assembly.

I.F. Circuits

Switch the receiver to the Medium wave position. With the variable condenser fully closed, the tuning pointer should be in the



CABINET BACK PANEL (INSIDE VIEW)

FIG. 4

horizontal position. Set the signal generator to 470 kc/s and connect the generator leads between the junction of P tag (S_2) and the positive (+) bus-bar (chassis). Tune, with a non-metallic screwdriver, the cores of L_9, L_8 (IFT_3); L_7, L_6 (IFT_2) and L_5, L_4 (IFT_1) in that order. Repeat these adjustments until no further improvement results. Refer to Figs. 2 and 3 which indicate the respective i.f. windings.

R.F. Circuits—Medium Wave

Tune the receiver to 500 metres (600 kc/s). Set the signal generator to 600 kc/s and adjust the core of L_3 (oscillator coil) to receive a signal. *NOTE*: From the underside of the chassis (Fig. 3) carefully *unscrew* L_3 core until it begins to emerge from the coil former. *Screw in* one complete turn, this giving the approximate setting of L_3 core for correct alignment. It may be necessary to adjust the core slightly a turn or so from this position.

Adjust the slider winding (L_{1A}) of the Medium wave aerial coil on the ferrite rod for maximum output.

Tune the receiver to 250 metres (1,200 kc/s). Set the signal generator to 1,200 kc/s. Adjust TC_3 to receive a signal and then peak TC_2 for maximum output. Repeat these adjustments until no further improvement results.

Long Wave

Switch the receiver to the Long wave position and set the pointer to 1,200 metres (250 kc/s). Set the signal generator to 250 kc/s. Adjust TC_4 and peak the received signal with TC_1.

Tune the receiver to 1,800 metres (167 kc/s). Set the generator to 167 kc/s and adjust aerial coil L_2 on the ferrite rod for maximum output. Repeat these adjustments until no further improvements result.

Cabinet Assembly

139. Unsolder the two leads from the speaker and bolt the speaker into the cabinet. Arrange the two speaker tags so that they are on the right-hand side inside the cabinet. Fit a 4BA tag under the lower fixing nut and solder one end of an 8in length of insulated wire to this tag. The other end of this wire is then soldered to eyelet 19 after the chassis is fitted.

140. Push the telescopic aerial through the hole in the top of the cabinet and secure in position at the lower end as shown in Fig. 4, using one No. 4 x ¼in woodscrew, a 6BA solder tag and a 5/16in clip.

141. Solder one end of a 14in length of insulated wire to the solder tag fitted under the clip. Fit a further 6BA tag and a No. 4 x ¼in woodscrew at the top (rear) of the cabinet and bend over the tag to hold the wire in position. (See Fig. 4.)

142. Fit the assembled chassis in the cabinet ensuring that the single lead from the speaker and the battery leads exit via the battery compartment cut-out. Make sure that all control spindles are nearly central in the holes of the cabinet front, especially giving attention to the tuning condenser spindle.

143. Screw the chassis into position using the three No. 4 x ⅜in woodscrews.

144. Join the end of the lead from the telescopic aerial to point "X" on the rod aerial.

145. Solder the free end of the single lead (from earth tag on frame of speaker) to eyelet 19.

146. Solder the two leads from T_2 (tags M and N) to the speaker tags visible in the battery compartment—see Fig. 4.

147. Rotate the condenser until it is either fully closed or open.

148. Push the pointer on to the tuning spindle, in a horizontal position, as close as possible to the plastic back plate.

149. Check the rotation of the tuning spindle and ascertain that the pointer is horizontal at both maximum and minimum excursions of this control.

150. Fit the dial (escutcheon plate) using No. 4 x ⅜in *BRASS* woodscrews to hold in position, fitting one at each corner.

151. Fit the control knobs, the pointer knob being fitted on the centre spindle (wavechange on/off control).

152. With nuts and bolts as shown in the small diagram on Fig. 4, the car aerial socket should now be fitted to the cabinet rear panel.

153. Join the short leads from the rear of the socket as follows.

154. Short lead to eyelet 16 from the earth tag.

155. A short lead from the centre of the socket to point "X" on the rod aerial.

156. *Keep all battery and speaker leads away from the aerial leads.*

157. Fit the battery in the battery compartment and insert the plug.

158. Fit the cabinet back into position.

This completes the assembly of the receiver. *(Conclusion)*

TELEVISION AND FILM TECHNIQUES CONVENTION

A two-day convention, jointly sponsored by the British Kinematograph Society and the Television Society, is to be held in London on 20th and 21st April, 1961, at the Institution of Electrical Engineers, Savoy Place, W.C.2. Covering a range of new techniques which are of common interest to workers both in films and television, several aspects of colour film and colour television will be included in the lecture programme. Attendance fee will be three guineas. Registration forms for delegates, and further information can be obtained from The Convention Secretary, the Television Society, 166 Shaftesbury Avenue, W.C.2.

The Tunnel Diode in Theory and Practice

by **J. B. DANCE, M.Sc.** **Part 3**

Some Advantages of the Tunnel Diode

Tunnel diodes can be used at very high frequencies. They have already been used in low level oscillator circuits operating at frequencies up to about 10,000 Mc/s but it is probable that, as development proceeds, much higher frequencies will be reached—perhaps 100,000 Mc/s. As the frequency is increased the reactances of the diode (see Fig. 16) reduce the effective negative resistance until eventually the diode resistance becomes positive. The frequency at which this happens is called the negative resistance cut-off frequency and it represents the upper frequency limit at which the diode is useful. As improved containers with lower reactances are developed, the cut-off frequency will doubtless be raised. The cut-off frequency is also affected by the percentage of impurity atoms in the material because this controls the junction time constant (Negative resistance × Capacitance). Doubling the impurity concentration may decrease the time constant a hundred times. In the microwave region the diode connections must have an extremely low inductance, as the diode itself has a high admittance; the diode is usually mounted in the transmission line.

If the L/C ratio of the oscillator tuned circuit is high, the waveform of a tunnel diode oscillator may be almost square owing to the high harmonic (and possibly subharmonic) content which is caused by the non-linear characteristic of the diode. It may even be difficult to decide which mode is the fundamental frequency of oscillation. If the L/C ratio of the tuned circuit is very low, however, the tunnel diode can be made to oscillate so that the wave is almost purely sinusoidal.

The value of the negative resistance of the diode is almost constant from d.c. to microwave frequencies and varies little with temperature.

The tunnel diode is very insensitive to temperature variation and silicon types have been operated satisfactorily from temperatures as low as −268° C to high temperatures of the order of 400° C. Germanium tunnel diodes have an upper useful temperature limit of about 200° C, as the negative resistance region of the curve gradually becomes smaller with increasing temperature until it vanishes altogether at about 250° C. The transistor is very much more sensitive to changes of temperature than the tunnel diode. The tunnel diode consumes little power and will therefore not get hot of its own accord in normal operation—an important advantage in miniature equipment.

From the point of view of the manufacturer, the tunnel diode is much less sensitive to impurity contamination than the transistor and therefore less control over impurities will be required during manufacture. In addition the careful surface cleaning and hermetic sealing which transistors require will not be necessary for tunnel diodes. These facts together with the relatively simple construction should eventually enable tunnel diodes to be manufactured quite cheaply.

The tunnel diode is likely to be very useful as a simple low noise amplifier. The noise generated by various devices is most conveniently expressed as their noise temperature to which it is proportional. The noise temperature of the tunnel diode (due to shot effect) is between about 100° K and 300° K at 1,000 Mc/s. The only amplifiers which generate less noise than this are the maser and the parametric amplifier with noise temperatures of about 25° K. The tunnel diode can be made to generate rather less noise than the klystron (300° K) or the travelling wave tube (300° K) and much less noise than the thermionic triode (1,000° K) and the transistor (2,500° K). All of the noise temperatures mentioned refer to a frequency of 1,000 Mc/s. Whilst the maser and parametric amplifier will still be required for the lowest noise equipment, the tunnel diode will come into its own when a simple low power device with fairly low noise is required.

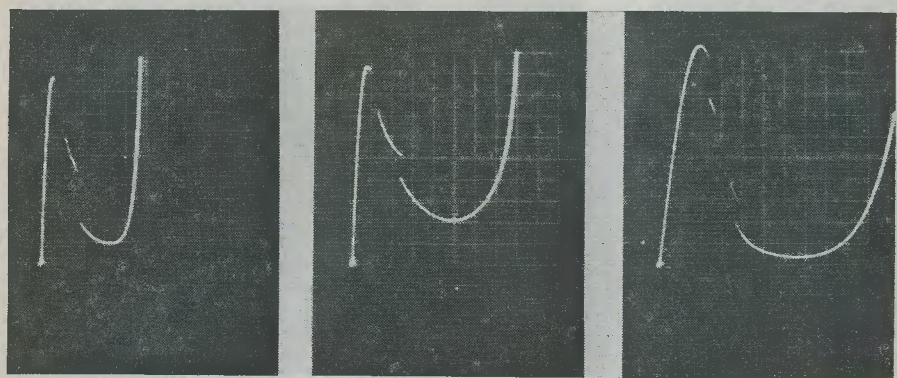
Low noise high gain conversion of a high frequency signal has not yet been satisfactorily attained with ordinary crystal mixers which use the non-linearity of their positive resistance characteristic. They generally exhibit conversion loss and have a poor noise factor. If parametric amplifiers are employed, it is almost impossible to convert microwave frequencies to a low i.f. and obtain a reasonable noise factor. Very successful results have been obtained, however, by the use of the non-linear negative resistance characteristic of the tunnel diode for conversion. Noise factors of about 3dB have been obtained using a gallium arsenide diode and a signal frequency of about 200 Mc/s.

Tunnel diodes are more resistant to the effects of nuclear radiation than transistors because they operate on different principles. If a tunnel diode is irradiated, the minimum current in the valley of the curve becomes greater and the negative resistance effect is not so pronounced. The amount of radiation required to cause an appreciable change is, however, fairly high. Tunnel diodes may therefore be very useful in atomic physics research in radioactive areas, etc.

The frequency response of tunnel diode circuits is usually very wide and therefore

The transistor requires a minimum of about a milliwatt and the thermionic valve about a tenth of a watt, whilst klystrons, travelling wave tubes and parametric amplifiers all require at least 10 watts. The maser uses nearly 500 watts. Thus the use of a tunnel diode in a satellite transmitter is likely to enable it to operate for a longer period. Alternatively, in the case of transmitters deriving their power from solar radiation, more electronic equipment can be used.

The tunnel diode is almost certain to be invaluable in medical research and diagnosis. It will be possible to build a transmitter the size of a pill which can be swallowed and which will then transmit data from inside the body. For instance it could transmit information on temperature, pressure, body sounds, acidity and, perhaps, detect the presence of certain chemicals. Such miniature transmitters could also be implanted in



Tunnel diode voltage-current characteristics photographed from an oscilloscope screen. The trace on the left is for a tunnel diode made from germanium, that in the centre from silicon, and that on the right from gallium arsenide.—General Electric Co., U.S.A.

"reflex" operation can often be used in which a single diode performs several functions simultaneously at different frequencies. For example, a single tunnel diode has been used as an r.f. amplifier, mixer, oscillator and i.f. amplifier; the input frequency was about 100 Mc/s and the i.f. about 10 Mc/s.

Tunnel diodes will probably be much used in artificial satellites, weather balloons, etc. Their small size and weight, simplicity, reliability, radiation resistance and the fact that they operate from a low voltage make them very suitable for this purpose. Perhaps even more important, however, is the fact that a single tunnel diode can perform several functions at once with a total power consumption of the order of a micro-watt.

various organs.

The low operating voltage of the tunnel diode will enable it to be used as a low voltage d.c. to a.c. converter. This will be useful for transforming the low output voltage from thermocouples, solar cells, etc., to any higher voltages which may be required.

Disadvantages

The tunnel diode is only suitable for low level operation and can give little power or voltage output.

One of the greatest difficulties in the design of tunnel diode circuits is the fact that the impedance of the device is very low, this making it difficult to use in circuits in which other amplifying devices with higher im-

TABLE 2

Type	JK9A	JK10A	JK11A	JK19A	JK20A	JK21A
Typical Peak Current (mA.) (Tolerance ±10%)	1.0	5.0	15.0	1.0	5.0	15.0
Peak/valley current ratio:						
Minimum	2	2	2	5	5	5
Typical	4	4	4	7	7	7
Maximum	5	5	5	—	—	—
Typical Negative Resistance (ohms)	111	20	6.7	111	20	6.7
Typical Junction Capacitance (pF)	230	1,000	1,300	230	1,000	1,300
Typical Resistive Cut-off Frequency (Mc/s)	130	80	110	130	80	110

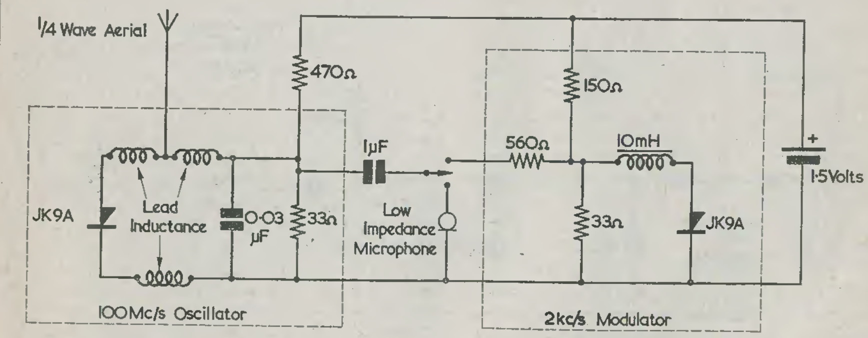
Characteristics of the present range of S.T.C. germanium tunnel diodes at 25° C

pedances are used.

The difficulty of separating the input and output circuits in two terminal devices has already been mentioned. It makes the design of multi-stage tunnel diode amplifiers operating at a single frequency impossible with present circuit techniques.

Gallium Arsenide

Until recently gallium arsenide was a little known and rarely used semi-conductor. It is now, however, believed to be the best material which has yet been used for the manufacture of tunnel diodes and it is quite probable that it will never be surpassed for this purpose. This is due to the fact that the forbidden region between the conduction and valency bands is larger than that in other semi-conductors. Although gallium arsenide tunnel diodes have a voltage-current curve which is very similar in shape to that of other semi-conductors, it can be seen from the oscilloscope photographs accompanying this article that the valley current occurs at appreciably higher voltages in the case of gallium arsenide. In addition it can also be seen that the ratio peak current/valley current is greater for gallium arsenide than it is for germanium or silicon. The General Electric Company of America have manufactured



To produce a deviation of ± 75kc/s the modulation must change the bias voltage by ±5%

FIG.21.

Tunnel Diode 100Mc/s Transmitter with provision for frequency modulation by speech or a 2kc/s tone. (Standard Telephones and Cables Ltd.)

M895

gallium arsenide tunnel diodes with peak/valley current ratios of up to 60:1, whereas the maximum ratio previously obtainable was about 14:1 for germanium tunnel diodes.

As a direct result of the large forbidden region in gallium arsenide, voltage swings of up to 1.2 volts can be used with tunnel diodes made of this material—enough to "fire" transistors in ultra high speed computers. The maximum voltage swing for silicon tunnel diodes is 0.75 volts and for germanium 0.45 volts. The maximum voltage swing must always be less than the width of the forbidden region measured in volts. In addition gallium arsenide tunnel diodes can be operated at very high current densities —about 5 to 10,000 amps per sq. cm.—which are of the same order as the current density in house wiring at full load. The wide voltage swing and high current density enable gallium arsenide tunnel diodes to handle three to four times the power in the kilo-megacycles region which can be handled by germanium diodes.

The Tunnel Diode in Practice—S.T.C. J.K. Range

The present range of tunnel diodes manufactured by Standard Telephones and Cables Ltd., types JK9A, JK10A, JK11A, JK19A, JK20A and JK21A, are available on short delivery to Government, Industrial and Educational establishments only (at the time of going to press), but it is hoped that they will soon be generally available.

The maximum forward and inverse voltages which can be safely applied to S.T.C. tunnel diodes are determined by the maximum current rating; this is 10mA for the JK9A and JK19A, 50mA for the JK10A and JK20A and 150mA for the JK11A and JK21A. The series resistance is between 0.18 and 0.25Ω. Other data is shown in Table 2, but it is liable to be revised by the manufacturers. These diodes are general purpose devices, but their junction capacity is too high for use at microwave frequencies.

The size of the present diodes, excluding lead-outs, is 13.72mm long by 6.1mm. If the lead which is tapered from the base seat is made the negative terminal, the diode is biased in the forward direction. The untapered lead is the positive terminal. (See Fig. 1.*)

Practical Circuits

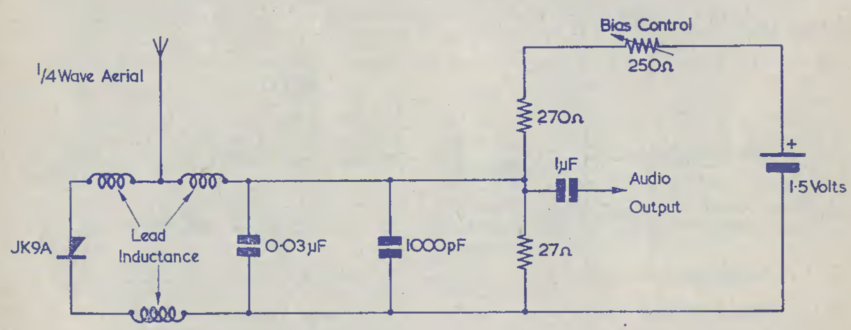
The three circuits shown in Figs. 21 to 23, and described below, have been designed in the laboratories of Standard Telephones and Cables Ltd.

100 Mc/s F.M. Transmitter

The circuit of an f.m. transmitter which operates at 100 Mc/s and employs a single JK9A tunnel diode is shown in Fig. 21. If desired, a second tunnel diode may be used as an audio oscillator to modulate the carrier with a steady note when the microphone is not being used. The modulator circuit shown provides an audio note of about 2 kc/s.

In order to achieve a frequency of oscillation as high as 100 Mc/s, the inductance in series with the diode leads must be very small; it consists of the leads of the diode itself in series with the leads of the 0.03μF decoupling condenser. The aerial is connected at a point on the diode leads such that the diode circuit just oscillates; maximum

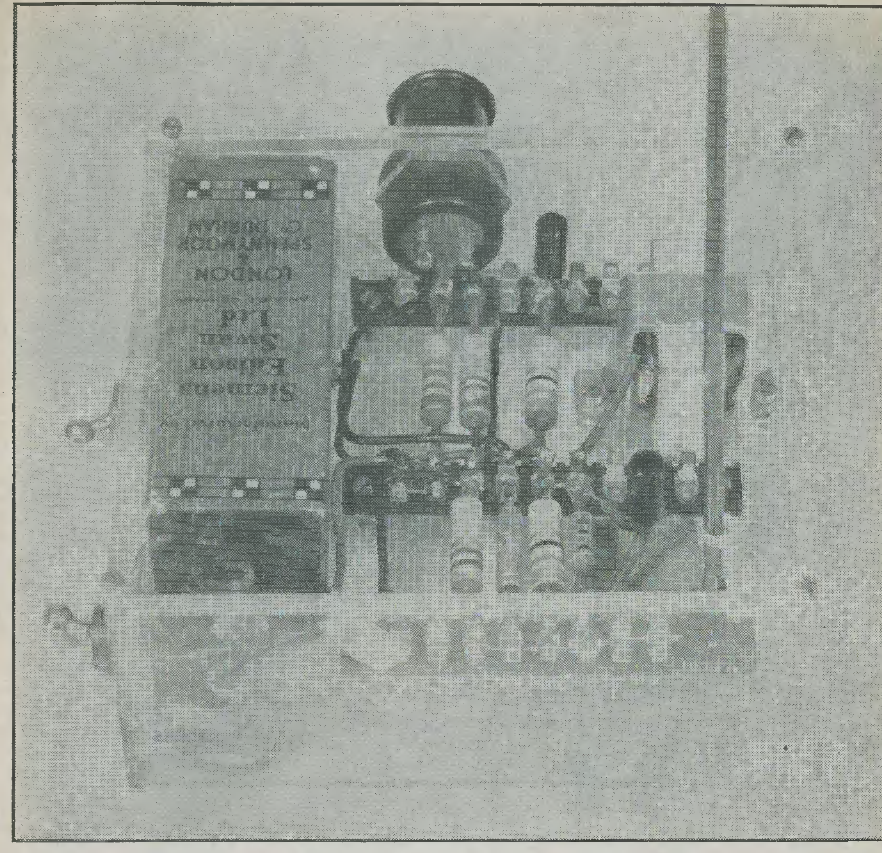
* Published in the November issue



Tuning is obtained by varying the lead inductance to the Diode by means of a Ferrite Rod tuning slug.

FIG.22.
Tunnel Diode Synchrodyne Receiver (80 to 100Mc/s)
(Standard Telephones and Cables Ltd.)

M896



A 100 Mc/s tunnel diode transmitter with 2 kc/s modulator.—Standard Telephones and Cables Ltd.

energy is then transferred from the diode to the aerial.

In order that the tunnel diodes in both the transmitter circuit itself and in the modulator circuit may oscillate, the conditions mentioned previously must be satisfied in each of the two circuits, namely:

(*a*) The tunnel diodes must be biased so that they operate in their negative resistance region and the sources of the bias voltages must have an internal resistance numerically less than the negative resistance of the diodes. This condition is satisfied by the use of suitable low resistance potential dividers as shown in Fig. 21.

(*b*) The dynamic resistance at the frequency of oscillation presented across the diode must be greater than the numerical value of the negative resistance of the diode.

The exact frequency of oscillation is dependent on the d.c. bias point in the negative resistance region, being higher for larger bias voltages. The audio voltage from the microphone or modulator circuit can therefore be used to modulate the bias voltage which in turn causes the transmitter oscillations to be frequency modulated. A change of bias of ±5% will produce a frequency deviation of approximately ±75 kc/s.

The microphone should be a low impedance moving coil type, but a small loudspeaker would be fairly satisfactory. The power output of the transmitter is only of the order of tens of microwatts, but it has the advantages of being physically very small, consuming little power and of being extremely portable. A photograph of the transmitter accompanies this article.

Synchrodyne F.M. Receiver

The synchrodyne is a special type of receiver in which the incoming modulated signal is mixed with a local unmodulated signal, the two signals being synchronised together. The output consists of the required modulation which is fed into an audio amplifier.

In the receiver circuit shown in Fig. 22, for use between 80 and 100 Mc/s, the tunnel diode oscillator circuit "locks" itself to the frequency of the incoming signal. The average d.c. voltage across the diode is dependent upon the frequency at which the tunnel diode oscillates and therefore direct demodulation of an f.m. signal can be obtained. If the audio output undergoes several successive stages of amplification, the signal can be used to operate a loudspeaker. The audio amplifier may consist of four or five transistor stages. In the circuit shown, a signal of about 10µV in amplitude, modulated to a depth of ±75 kc/s, is received with very little distortion. A photograph of the receiver was given in the November issue.

The locking action of the oscillator can be explained as follows. Consider the tunnel diode as being biased at a voltage just over the peak of its characteristic in the negative resistance region. If a small signal of a frequency just less than that at which the tunnel diode is oscillating is superimposed on the bias voltage, the cycle of oscillation of the diode is delayed at the peak of its characteristic until the signal starts on its positive half cycle. The nearer the bias voltage is to the peak voltage of the diode, the smaller is the incoming signal required for synchronisation.

Receiver for 908 kc/s

Fig. 23 shows an r.f. amplifier and detector circuit employing two JK11A tunnel diodes. The ferrite rod serves both as the pick-up for the signal and as the coupling between the tuned circuit, the r.f. amplifier and the detector. R.F. amplification is obtained with a tunnel diode circuit if the negative dynamic resistance of the diode is used to raise the "Q" of a circuit tuned to the signal frequency by cancelling out most of the positive resistance of the tuned circuit. The "Q" of the tuned circuit would be very low without the tunnel diode owing to the damping imposed by the detector circuit.

The tunnel diode used in the r.f. amplifier is biased in the negative resistance region by a low resistance d.c. source consisting of the 8.2Ω and 1Ω resistors as a potential divider. The tunnel diode is connected across a tuned circuit, the dynamic resistance of which is slightly less than the numerical value of the negative resistance of the diode. If the tunnel diode two-turn winding is not separately tuned to roughly the correct frequency, the circuit is liable to give spurious high frequency oscillations. As the negative resistance is dependent on the bias voltage, the bias has to be critically adjusted to provide the largest amplification, this being of the order of 40dB (i.e. a voltage gain of 100 times).

The detector consists of a tunnel diode biased at the peak of its characteristic. This provides full wave rectification with only one diode, since the charging current through the diode is in the same direction whether the signal is in its positive or negative half cycle. This circuit has the additional advantage that it rectifies on very low input voltages, as there is no contact potential to overcome as with conventional diodes.

In the circuit shown, the audio output is taken from the detector via a step up transformer of ratio 1:10 in order that the output of the circuit shall match into a transistor audio amplifier. A four stage conventional transistor amplifier will give a suitable amount of gain.

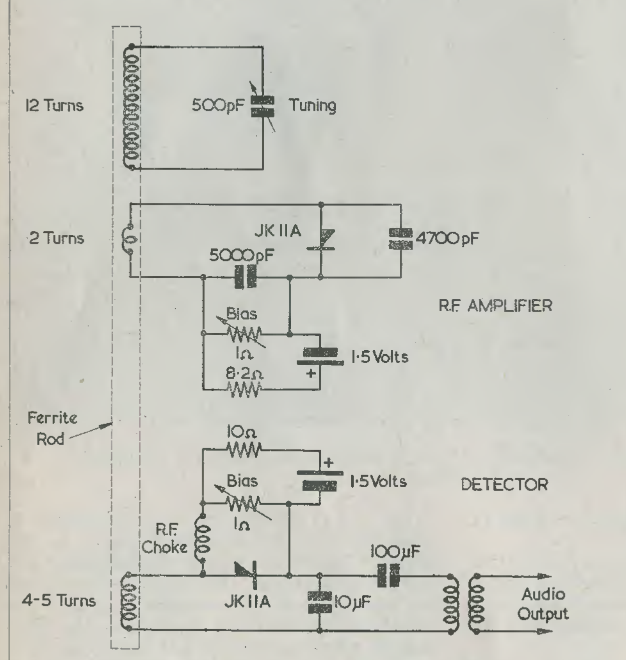


FIG.23.
Tunnel Diode Receiver for 908kc/s incorporating R.F. Amplifier and Detector.
(Standard Telephones and Cables Ltd) M897

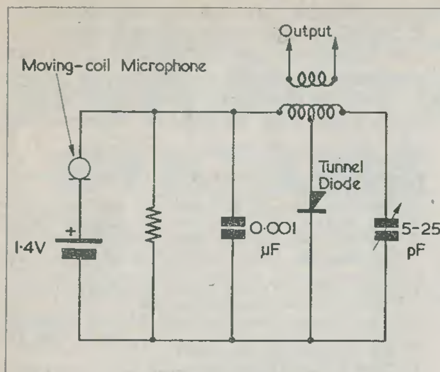


FIG.24.
An F.M. Transmitter
(General Electric Co. U.S.A.)

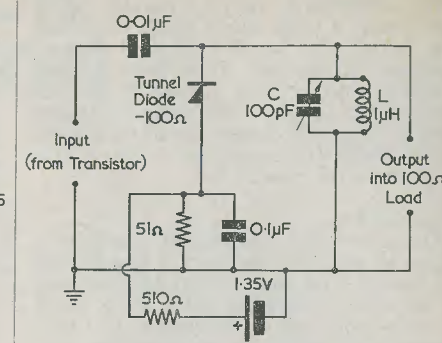


FIG.25.
A Tunnel Diode 465kc/s Amplifier.
(From 'Electronics' 27th Nov.1959) M898

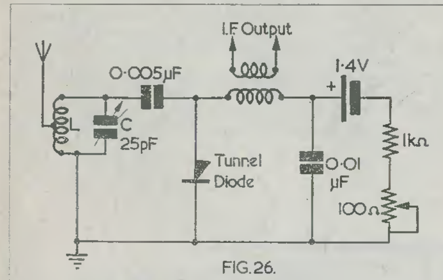


FIG.26.
A Tunnel Diode Converter Circuit.
(General Electric Co. U.S.A.)

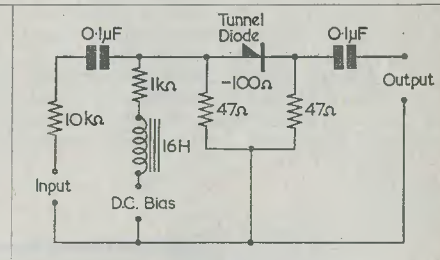


FIG.27.
An Audio Amplifier using a Tunnel Diode.
(From 'Electronics' 27th Nov. 1959)

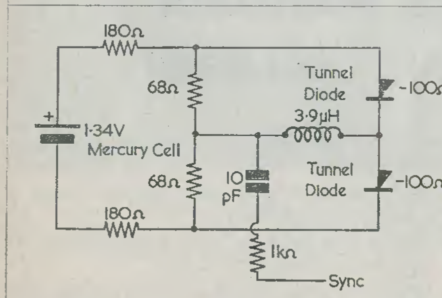


FIG.28.
A Multivibrator employing two Tunnel Diodes and operating at 10Mc/s.
(From 'Electronics' 27th Nov. 1959)

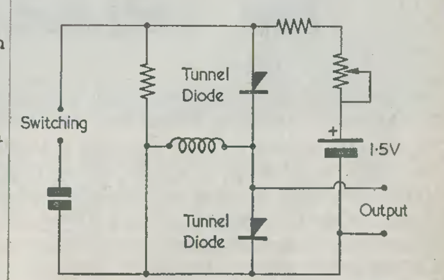


FIG.29.
A 'Flip-flop' Bistable Counting Circuit.
(General Electric Co. U.S.A.) M899

F.M. Transmitter

Fig. 24 shows the circuit of an f.m. transmitter using a single tunnel diode which has been constructed by The General Electric Company of America. It is about the size of half-a-crown and has a range of approximately half a mile. The audio frequency current in the microphone circuit modulates the oscillator frequency, but there is also some amplitude modulation.

I.F. Amplifier

The circuit of a 465 kc/s i.f. amplifier is shown in Fig. 25. The gain is about 20dB (10 times). The tuned circuit LC resonates at the i.f., a convenient value for L being 1 micro-henry. It is convenient to use a transistor to drive such an amplifier. The bias is provided by a mercury cell.

Fig. 26 shows the use of a tunnel diode as a converter for inputs of the order of 100 Mc/s, whilst Fig. 27 gives a tunnel diode audio amplifier circuit. Figs. 28 and 29 are included to show the wide variety of circuits which can employ the tunnel diode.

The Future

It is quite certain that much more will be heard about the tunnel diode in future years when the diode and its circuits have been further developed. The price of the device will fall rapidly as increasing demand leads to mass production. In America the price of General Electric tunnel diodes has recently dropped from 60 and 75 dollars to 10 and 12.5 dollars (i.e. to about £4) and will no doubt fall more still in the near future. Tunnel diodes are simple devices which should eventually become quite cheap; it is to be hoped that considerable quantities will soon become available in this country for use by both professional engineers and the ordinary amateur constructor. *(Conclusion)*

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PHILIPS SERVICE MANUALS FOR TECHNICAL COLLEGES

Philips have given an important lead to the radio and television industry in connection with the provision of technical information for technical colleges.

An issue of service manuals covering the company's current radio and television range is to be made to all of the main technical colleges throughout Britain.

Until now, while manuals and other technical information have normally been supplied to technical colleges on request, there has been no "as a matter of course" issue.

Philips' offer was made direct to the Ministry of Education, and colleges receiving the manuals are being asked to treat the information being made available as confidential and to use it only for academic purposes.

A spokesman for one technical college with which Philips has close connections said that he could not recall a previous case of a radio and television manufacturer offering such manuals, although there has never been any great difficulty in getting information specifically asked for.

TELEVISION DISTRIBUTION SYSTEMS

by **A. S. Dunston,*** A.M.Brit.I.R.E.

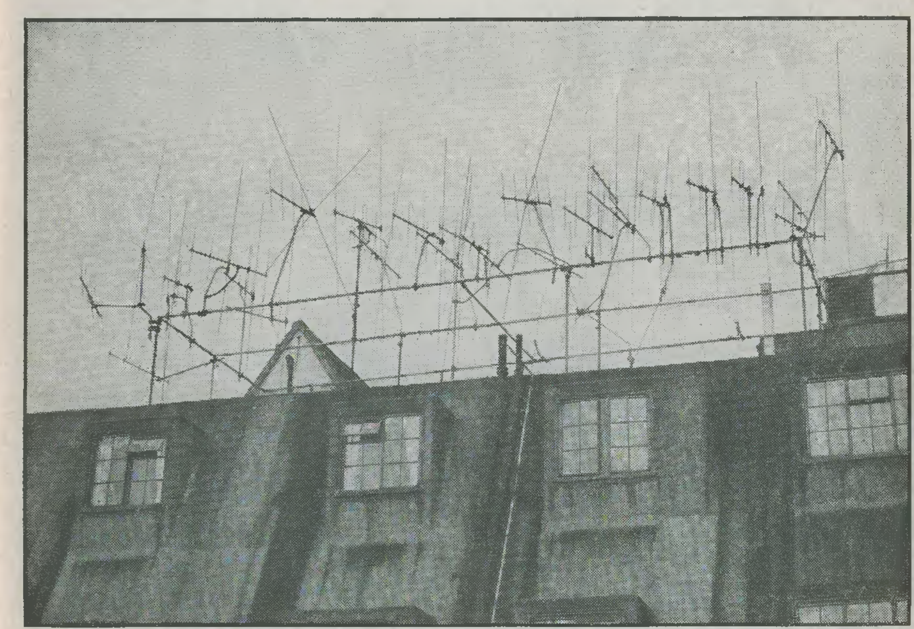
From time to time, considerable public comment is focused on the subject of unplanned and unsightly television aerial installations. Such installations, together with their technical shortcomings, are obviated by Communal Aerial Systems. This article gives details of Communal Aerial Systems intended for blocks of flats, describing their operation and the technical problems involved. Also given is a practical description of the Communal Aerial System installed in what is reputedly the largest block of self-contained flats in Europe.

Communal aerial systems for medium and Long wave broadcast reception have been in use for a very long time indeed, but it was not until 1937/38 that any serious work was done to provide communal aerial systems for television.

In 1946/47 in London there was a very considerable increase in the number of television owners, particularly amongst the tenants of large blocks of flats, and in practically no time the roofs became a forest of aerials and the situation chaotic.

Today, technically, the position is exactly the same, but it is now realised that television is almost an essential service, and a large number of block owners are having communal aerial systems installed as a standard service, by which every flat is provided with service and the costs included in the rental or service charges.

Communal aerials are usually provided to cater for large blocks of flats where it is



". . . the roofs became a forest of aerials and the situation chaotic . . ." This photograph shows a cluster of television aerials on a block of flats in St. John's Wood, a few minutes' walk from The Radio Constructor *offices in Maida Vale*

* Chief Engineer, London Rediffusion Service Limited.

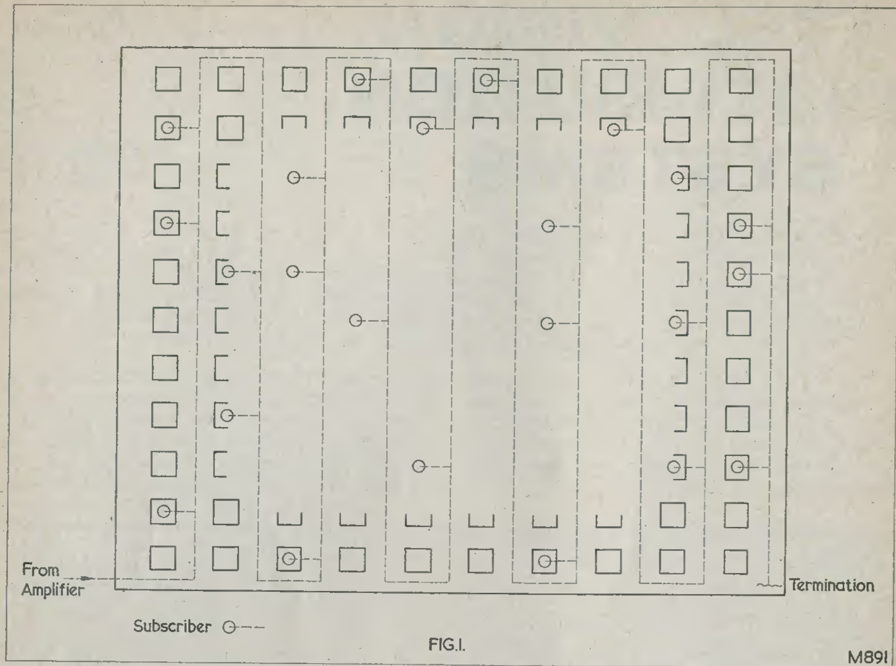


FIG.1.

The old Communal Aerial wiring layout employed at Dolphin Square, London, S.W.1. One very long feeder is used, this having a single termination at its remote end. Such a feeder was capable of causing "ghosting" when B.B.C. Channel 1 power increased, because subscribers' receivers could obtain a signal by direct pick-up which arrived slightly earlier than that from the distribution amplifier

impossible for individual tenants to erect outdoor aerials and where indoor aerials are unsatisfactory, because of low signal strength or ghosting due to the construction of the building.

The Basic Problem of a Communal System

The basic problem is to distribute, with the minimum number of repeaters, a satisfactory signal over the maximum distance from the receiving aerial. As the solution to this problem varies from site to site we will now deal with individual techniques involved.

Distribution Frequencies

As the attenuation of any cable on Band III is approximately twice its attenuation on Band I it will readily be seen that over a long run of cable Band III signal would soon disappear or, in any case, be very much weaker than the Band I signal (assuming that they are both sent at the same level). The solution to this problem is to frequency-change the Band III transmission to a spare channel of Band I. The only time when this need not be done is in the case of very small blocks of flats, say under 30 dwelling units.

Coaxial Cables

These vary in size from an inner conductor of 1/.022 to 1/.064 with an outer sheath of 0.25in to 0.490in respectively. Obviously the large cable has very much less attenuation, but in a large number of cases property owners do not approve of its appearance and it is also very difficult to work with, and expensive. A good compromise is to use, for main feeders, a cable with an inner conductor of 1/.044 and a smaller one with an inner conductor of 1/.029 for drop-ins.

The next question is the choice of screening. Coaxial cable of the type used for aerial downleads has a very open mesh screen and is not at all suitable for communal aerial installations. Coaxial cable designed for instrument work has one very close mesh screen and is a considerable improvement. Finally, there is now available double screened coaxial cable which is ideal.

It will be realised that screening is used for

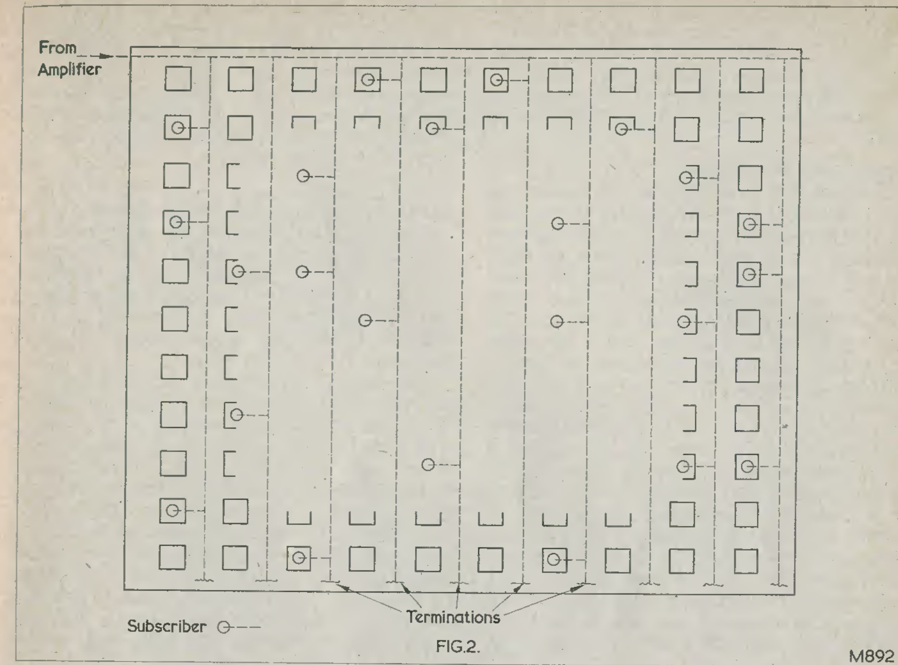


FIG.2.

The "ghosting" problem given by the Fig. 1 layout is obviated in the new Dolphin Square wiring installation, shown here. The length of feeder is reduced by employing a single trunk cable with numerous spurs, each terminated separately. Also, double screened wiring is used

two purposes. Firstly, to prevent radiation from the equipment and, secondly, to prevent unwanted signals being induced into the network. Today it is generally considered that double screened cable is essential throughout, unless conduit is used.

Converters

As the name implies this equipment converts, or frequency changes, signals in Band III to any channel in Band I. The essential factor is stability and this, in the case of high grade equipment, is achieved by the use of crystal control. Less expensive converters omit the crystal, but these are not recommended if optimum results are to be obtained.

Amplifiers

The average commercial repeater amplifier will give an output of approximately 500mV on any one channel in Band I, but satisfactory amplifiers can be obtained to give outputs of up to a maximum of 2V. In excess of 2V conditions become very difficult due to the problem of designing an amplifier which will not cross-modulate between sound and vision. The high voltages also introduce the problem of radiation.

Subscribers' Requirements

A modern set will function very satisfactorily from an input of 0.5mV, but in areas of high signal strength where there can be pick-up on the set wiring itself, an input of 1 to 2mV is recommended. Another requirement is at least 40dB separation between any two television sets; this means 20dB isolation between any outlet and the network. It is usual also to fit isolation condensers at the outlet point.

It is possible to design suitable transformers for connecting spurs and outlets to the feeder, but these are very expensive and it is more usual to employ straightforward resistive pads.

Distribution

It has been found preferable to employ a very small number of fairly large output repeaters, rather than a large number of low output repeaters in tandem. One of the reasons for this is the question of mains supply, but secondly it is felt that a number of repeaters in tandem are liable to create distortion or have other undesirable effects. It might be worth noting that wide band amplifiers normally only give an output of 100mV compared with up to 2V which can be obtained on a single channel amplifier in Band I.

Urban Area Distribution

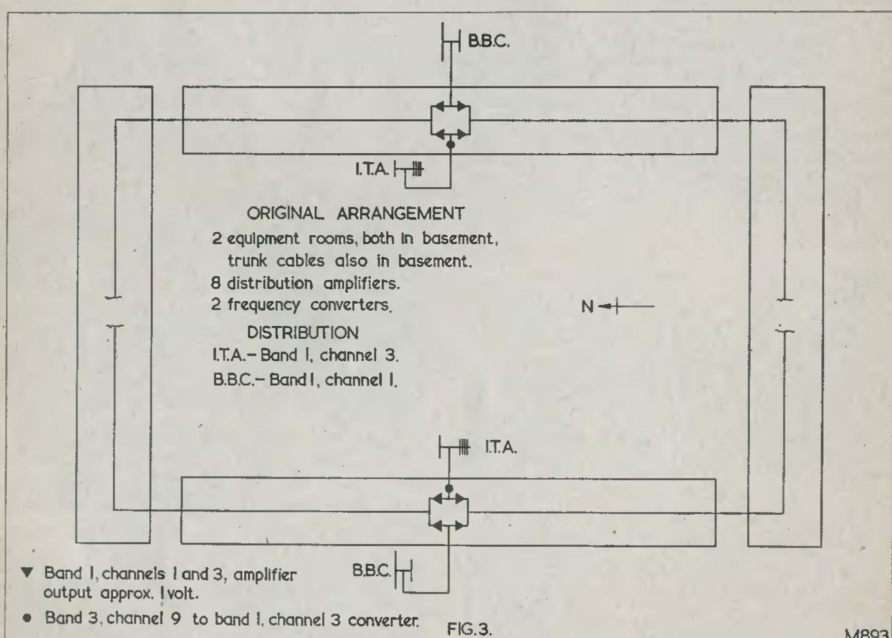
In conclusion it is felt that the communal aerial system is very satisfactory when used for the purpose for which it was originally designed, i.e. to feed a large block of flats, but where the problem is to feed an urban area it is considered that very much more satisfactory and economical results can be obtained by using a system where the video and sound signals are separated at source, and the video signal transmitted over balanced feeders at a carrier frequency in the neighbourhood of 10 Mc/s. The sound signals are then sent over the same pair of cables at loudspeaker level. The main advantage of such a system is that it is specifically designed as a complete link from reception site to viewer, including a simplified television set from which the turret tuner and sound receiver are omitted. It should be noted that, if required, a conventional television receiver, using a simple external or internal adaptor, can be used with this system and the same satisfactory results achieved. Another advantage of the low frequency system is that only one repeater is required for every eight or nine repeaters in a communal aerial system, where the signals are transmitted at or near original frequencies, and that distances of up to eight or nine miles can be obtained without degradation of picture.

A Practical Communal Aerial System

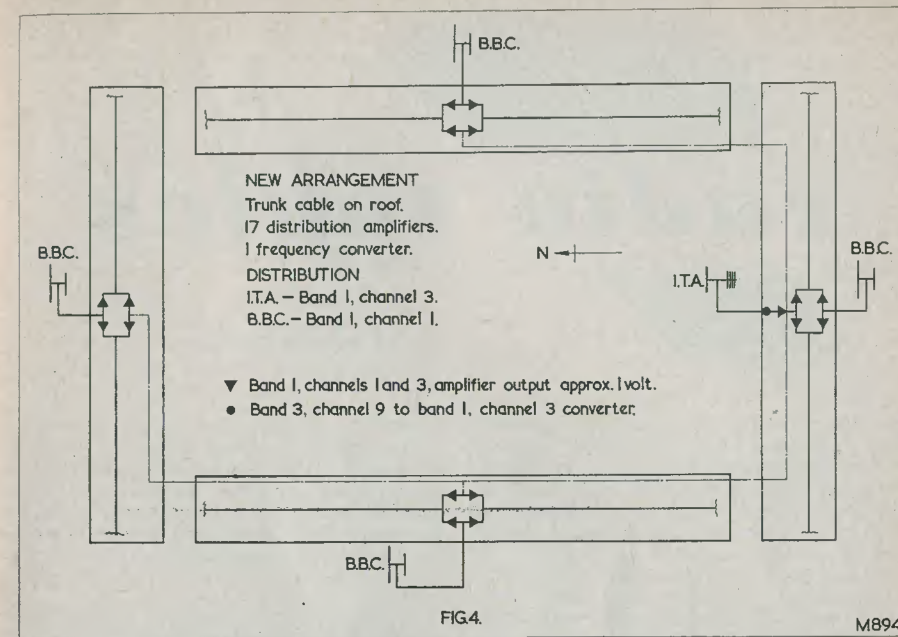
It is felt that it would be of interest to describe a communal aerial system which was installed at Dolphin Square, London, S.W.1 in 1946/47. Dolphin Square has a total of approximately 1,200 flats and is reputed to be the largest block of self-contained flats in Europe.

The system was originally installed to cater for the B.B.C. television programme only from Alexandra Palace which, at that time, was radiating on comparatively low power. Since that date, the I.T.A. have started transmissions and the B.B.C. transmitter has been moved to Crystal Palace with a very considerable increase in transmitted power.

It is said, and very rightly, that too much signal presents almost as difficult a problem as too little. What in fact happens is that, due to the impossibility of erecting a network with perfect screening and, also, due to the



The old installation at Dolphin Square employed two equipment rooms in the basement with the distribution layout illustrated in this diagram



The new Dolphin Square installation has four equipment rooms at roof level in order to split the block into small sections for the reception of B.B.C. transmissions, and to reduce the lengths of cables carrying the amplified signal. The I.T.A. signal is converted at one location only

fact that the television set wiring itself is not screened, a certain amount of direct pick up from the B.B.C. transmitter occurs and this signal arrives at the television set slightly in advanced of the required signal from the distribution amplifier. This is the well-known "ghosting", but this time it is a left hand ghost and not the familiar right hand ghost. The theoretical solution to this problem is 100% screening but this, in practice, cannot be obtained, and in any case it was necessary to deal with existing wiring where single screened close mesh coaxial cable had been used. The practical solution, relative to the B.B.C. signal, is to minimise the distance between the aerial and the last outlet. It will be appreciated that the I.T.A. signal does not suffer in the same manner due to the frequency change. The first simple solution was to change the basic wiring. Fig. 1 shows the original wiring which was of square wave formation, with the termination at the end of a very long feeder. Modern wiring consists of a double screen trunk cable with numerous spurs, each spur being separately terminated. As a matter of interest there are more than 100 spurs in the Dolphin Square network. (See Fig. 2.)

The next solution was to split up the block into smaller sections for the reception of B.B.C. Originally there were two equipment rooms, both in the basement; there are now four equipment rooms at roof level. Figs. 3 and 4 give details. The I.T.A. is converted at one location only, and a ring circuit is used to feed the Band I Channel 3 amplifiers.

Next Month . . .

Converting the BC 348 Receiver
An Audio Frequency Oscillator
A 20-watt Amplifier

radio topics

BY RECORDER

If, in your search for high fidelity reproduction, you find that wooden loudspeaker enclosures cause coloration due to resonance in the wood itself, what do you do? The answer, as many hi-fi enthusiasts know already, is to build the enclosure with bricks or concrete!

I have just been reading G. A. Briggs's *Cabinet Construction Sheet* (*June* 1960), and this includes details of four enclosures employing brick or concrete. The first to be described in the Sheet, which is published by Wharfedale Wireless Works Ltd., Idle, Bradford, could be described as a brick-built version of a standard wooden corner enclosure; it is a solid job and, once built, becomes a fixture. The second is a vertical column enclosure employing concrete blocks. The loudspeaker is fitted horizontally at the top of the column, with its magnet downwards and the front surface of its diaphragm directed upwards. A small cone-shaped diffuser is mounted above the centre of the diaphragm, this helping to diffuse high frequency sound in the horizontal plane. An acoustic filter is fitted two-thirds of the way down the inside of the column and, below this, is a port or opening. The outside dimensions of this particular column are 17in by 15in by 36in high.

Musique Concrète?

However, the most interesting concrete columns are the third and fourth described in the Sheet. These employ common-or-garden concrete drain pipes, which may be obtained quite cheaply from builders' merchants, and the principle of operation is much the same as for the concrete block column I have just described. The pipe is mounted vertically on a wooden base, gaps around the edge of the latter allowing a port at the bottom to be formed. An acoustic filter is fitted about a third of the way up the inside of the pipe, it being held in position by struts secured to the wooden base. Between the acoustic filter and the underside of the speaker is fitted a roll of special wadding. At the top of the pipe is the speaker itself, this being mounted on a circular baffle with the front surface of its diaphragm directed upwards, as occurs with the concrete block column. A cone-shaped diffuser is then fitted above the centre of the speaker diaphragm.

The idea of obtaining a loudspeaker enclosure by the simple process of fitting the appropriate bits and pieces into a concrete pipe strikes me as being particularly ingenious and imaginative. When I contacted Wharfedale Wireless Works Ltd. on this development I was told that this firm had commenced experiments with wooden columns in 1957 and had, shortly afterwards, decided to try a similar design made of concrete blocks. The results proved to be much cleaner, and concrete block columns have now been made up by hundreds of enthusiasts.

The pipe idea was suggested by a customer in South Africa who was enthusiastic over the results he had obtained with a circular concrete sewer pipe. Wharfedale experimented with a similar arrangement and the results were so pleasing that a pipe column fitted with an 8in speaker was demonstrated at last year's London Audio Fair. The resultant interest was so great that Wharfedale found themselves obliged to publish constructional details for making up pipe columns and offer the necessary wooden parts and accessories.

A fascinating aspect of home-construction in the sphere of radio and electronics is the inventive manner in which the most unlikely objects are put to practical use. Employing a humble concrete drain pipe as a loudspeaker enclosure is, I think, one of the most ingenious developments for quite a few years.

E.M.I. Robotugs

If you want to see British Railway trucks operating *without* rails you should go to their Herbert Street Goods Depot at Wolverhampton. On the goods platform at this depot driverless trucks pull trolleys loaded with goods along pre-arranged paths, the only guide being provided by a single wire laid half an inch below the surface of the platform. Each truck has an electronic programme unit which controls the route to be followed and the points at which it must stop. The trucks are described as Robotugs and are the result of two year's study and experiment by British Railways and E.M.I. Electronics.

The guide wire under the goods platform carries an alternating current of one-sixth of an amp at a specified frequency. Two sensing coils are mounted underneath each Robotug and, when the truck is in correct position relative to the guide wire, the voltages induced in these are low and balance out. If the tug travels off course, a higher voltage is induced in one of the coils and this, fed through a two-stage transistor amplifier, causes a steering motor to come into operation and correct the deviation. As soon as the Robotug is back on course the steering motor is switched off automatically.

Should the current in the guide wire fail, or the truck be caused to wander so far off course that no voltage is induced in the sensing coils, the truck driving motor switches off and the brakes are applied. The speed of the trucks is 2 m.p.h., this being considered adequate for their purpose.

There are five E.M.I. Robotugs installed at Wolverhampton and the cost of the whole installation is in the region of £10,000. British Railways state that the consequent saving in wages will pay the capital cost of the equipment within a few months. There is a serious staff shortage throughout the Midlands and this scheme will go a long way towards relieving it.

Tape Reel Identifications

For those who like their tape reels neat and Bristol-fashion, Multicore Solders Ltd. have produced some very neat self adhesive labels. These include spaces for "Title", "Composer", "Artist", "Reel Number", "Speed" and "Date". There is also a space to enable the type of tape to be identified, viz., Long Play, Double Play or Standard Play. The labels may be made out in pen or pencil, or on a typewriter, and they are provided with a backing which is peeled off when the tape is required. The backing enables the tape labels to be passed through a typewriter, when desired, without gumming up the works of the latter. The labels are retailed under the Multicore Solders Ltd. brand name, "Bib".

Storing Bits and Pieces

One of the minor snags I bump into as a home constructor and experimenter is the storage of my spare components. I am fortunate enough to have plenty of shelf space for my bits and pieces and I have found that the best containers for the larger items—trimmers, B7G and B9A valveholders, and the like—are pickle jars with screw tops. These jars are approximately the size of 1lb jam jars, and the screw tops enable the contents to be kept free from damp. The fact that the jars are made of glass has the advantage that the contents can be seen and immediately identified from any angle.

The procedure I follow nowadays may be worth while passing on. Whenever I start on a new project I take the components I need out of the appropriate jars and get down to work. Almost always some components are left over after the job has been completed and all the experimental work carried out. I just dump the left over components into a junk box I keep especially for the purpose. After a time this box begins to get rather full, whereupon I wait for a quiet spell (usually when there's something really good on the radio!) and spend a quiet hour or so sorting out the contents back into the appropriate containers again. This sorting-out process, incidentally, is strongly recommended for its therapeutic value to busy types whose jobs involve them in a lot of brain-fag! It makes a pleasant break from the grind and is, obviously, not a waste of time. The individual periods of time which would, otherwise, be occupied in tidying up at the end of each project are now combined into a single, long period. And the job is done, perhaps, more efficiently.

There are several snags to this method of working. Firstly, the inevitable is bound to occur from time to time; and I find myself scrabbling through the junk box for a special component which hasn't yet found its way back to its individual jar. Secondly, one needs to be a member of a family which has a taste for pickles! (Although there are, of course, products other than pickles which are sold in screw-topped glass jars.) Thirdly, rather careful washing of the jars and tops is needed if all the aroma of pickles is to be dispelled. I'm afraid that I tend to be a little slap-dash on this aspect of the process, with the result that quite a few of the chassis I build have a faint bouquet for the first week or so.

Printed Circuit Design

Did you know that the spacing between conductors carrying different potentials on a printed circuit board should be at least $\frac{1}{32}$in for every 150 volts d.c.? And that if you pass a current of 5 amps through a copper foil conductor 0.0014in thick and $\frac{1}{8}$in wide the temperature of that conductor is liable to rise by some 15 degrees Centigrade?

These are two of many facts which are contained in *The Printed Circuit Designer's Handbook*, a concise, free, booklet just issued by Tectonic Industrial Printers, Wokingham, Berkshire. This handbook is aimed mainly at the professional designer, although it will also prove to be of considerable interest to the serious experimenter. The information given is based on the practical design and production experience gained by Tectonic over a period of years, and I would especially recommend the booklet to anyone whose work brings him into contact with printed circuits from the manufacturing point of view.

A Baffling Problem

Finally, here's a dodge which will be of interest to those constructors who like to make small valve or transistor sound receivers which work into miniature speakers, the latter having cone diameters of the order of 3in or less. It frequently happens that, when sets of this type are in their chassis state, the impression is given that audible output is much lower than had been expected.

The cause of this apparent loss of output may, quite simply, be due to the fact that the speaker is not yet mounted into a cabinet; with the result that it has no baffle to prevent the lower audio frequencies from the back of the cone coming round to cancel out those generated from the front of the cone. With very small loudspeakers the apparent loss of volume sustained by the lack of a baffle can be surprisingly high.

When a completed receiver is being tried out, a temporary baffle for the speaker may be obtained by quickly cutting out a rough hole, approximately equal to cone diameter, in an old cardboard box or in a flat sheet of cardboard. There should be some 9in of cardboard between the edge of the hole and the periphery of the box or sheet. The speaker may then be placed on the bench, magnet downwards, and the box or sheet placed over it with the hole over the speaker cone. There is no need to fasten the speaker to the cardboard in a simple makeshift set-up such as this.

Provided that the associated receiver is capable of passing the lower audio frequencies to the miniature speaker you should find that the apparent increase in audible output resulting from the temporary baffle is almost startling.

I said just now that a rough hole should be cut in the cardboard. However, don't cut it so roughly that bits of cardboard project downwards. If the cardboard is sufficiently stiff these may damage the loudspeaker cone.

A SMALL COMPONENT HOLDER SOLDERING AID

by **J. H. Seal**

THE COMPONENT HOLDER TO BE DESCRIBED has been of considerable use to the writer for holding awkwardly sited condensers and resistors in position whilst being soldered. Both hands are consequently free for soldering operations and, as the component is held perfectly still, the risk of a fractured joint whilst the solder is setting is eliminated. The holder can be used either for constructional or service purposes and it is very easily made.

The materials required are as follows: 2ft of $\frac{1}{2}$ x $\frac{1}{8}$in mild steel (or any suitable alternative metal); 7in of $\frac{1}{4}$in dia. brass rod; three $\frac{5}{8}$ x $\frac{3}{16}$in bolts with wing nuts; one $\frac{1}{2}$ x $\frac{3}{16}$in bolt with nut; one 1 x $\frac{3}{16}$in thumbscrew; one $\frac{1}{2}$ x $\frac{3}{16}$in thumbscrew; one $\frac{1}{4}$in brass spindle coupler; and one small crocodile clip.

Construction

A glance at Fig. 1 will show that the component holder is assembled from five parts. These will now be considered in order. It should be noted that none of the dimensions given are very critical.

Fig. 2 shows the construction of Part A. This consists of two small pieces joined together with a $\frac{1}{2}$ x $\frac{3}{16}$in bolt and nut. The piece with the double bend should be made first, bending being carried out in the vice in normal fashion. When the double bend has been formed, drill a $\frac{3}{16}$in hole to take the bolt, and also drill and tap a $\frac{3}{16}$in thread for the thumbscrew. Now make and bend the other piece and drill the remaining $\frac{3}{16}$in holes. File all sharp edges and corners (this applies to all parts) and bolt the two pieces together.

Part A, now completed, is the clamp. This will secure either to a chassis under construction, or to the baseboard of a cabinet with its panel removed for servicing.

Fig. 3 shows the construction of Part B. Bend this to shape and drill the $\frac{3}{16}$in holes as indicated. It is important to note that the lower hole should be drilled at least $\frac{1}{2}$in from the inside of the bend to allow the wing nut to turn.

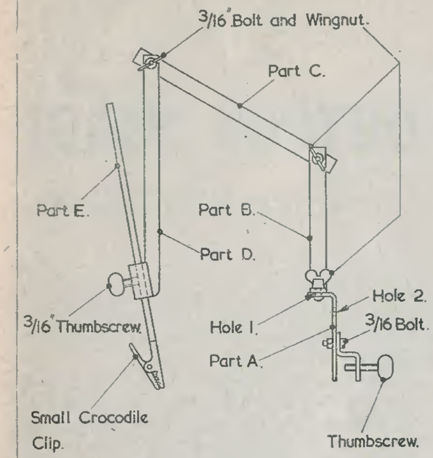
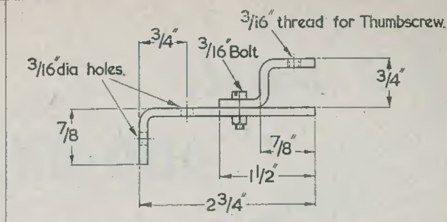
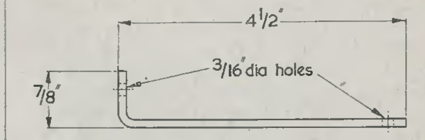


FIG.1.
Assembled Holder.



Material: 1/2in. x 1/8in. Mild Steel.

FIG.2.
Construction of Part A.



Material: 1/2in. x 1/8in. Mild Steel.

FIG.3.
Construction of Part B.

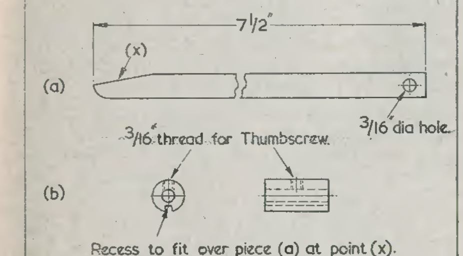


FIG.4
Construction of Part D.

M912

Part C which is also $\frac{1}{2}$ x $\frac{1}{8}$in is simply a flat bar with a $\frac{3}{16}$in hole drilled at each end. Its length is 4 to 4$\frac{1}{2}$in.

Fig. 4 shows Part D, which is made in two pieces. Piece (*a*) is $\frac{1}{2}$ x $\frac{1}{8}$in flat bar drilled with a $\frac{3}{16}$in hole at one end. At the other end one edge is filed at a small angle (x). Part (*b*) is a $\frac{1}{4}$in brass spindle coupler from which the grub screws have been removed. Along the line of the grub screw holes, a recess is cut to take point (x) of piece (a). The recess which may be roughly cut out with a hacksaw and finished with a small flat file, should give a good tight fit with (x). Directly opposite to the recess, drill and tap a $\frac{3}{16}$in thread for a $\frac{1}{2}$ x $\frac{3}{16}$in thumbscrew. This should run into the $\frac{1}{4}$in hole which passes through the coupler. Place piece (a) in the vice and tap the sleeve into place with a hammer. Solder can now be run along the edges to make a good joint.

Part E is simply a $\frac{1}{4}$in diam. brass rod, 7in long, on to one end of which is soldered a small crocodile clip. All the parts are now made.

Assembly

Assemble Parts B, C and D (Fig. 1) using $\frac{5}{8}$ x $\frac{3}{16}$in bolts and wing nuts, and insert Part E through the coupler spindle. Part A can now be assembled to Part B, this being done in one of two ways depending upon the type of work for which the holder is to be used. For constructional and service work, when the chassis is not in a cabinet, bolt through hole 1 (Fig. 1), so that Part A may be secured in a vertical position. For service work when the chassis is in a cabinet bolt through hole 2 (Fig. 1) so that Part A may be secured in a horizontal position. This will enable it to clamp to the cabinet baseboard when the panel is removed.

Clamp the component holder to the chassis or baseboard.

Use

In use the holder may be set to any desired position by loosening and tightening the appropriate wing nuts. After the component being soldered has been finally connected into circuit the thumbscrew on the spindle coupler should be loosened and Part E slid upwards. As soon as one has become familiar with the operation of the holder it is a matter of seconds only to bring it into use.

A 1-watt ADD-ON OUTPUT STAGE

by M. W. RIGNALL

THE MAJORITY OF TRANSISTORISED PERSONAL portables now available have several points in common. An external aerial socket is provided, enabling the radio to be used in a car, together with a push-pull output into a 35Ω speaker and 200–300mW of output power. The sensitivity is usually adequate for all but the most exacting requirements but, with body, wind and engine noise, the available output power falls short of the desired level. Approximately 1 watt would be adequate.

The basic requirements for the stages to be added are that they should couple directly to the 35Ω speaker in the portable receiver, (since this point is always readily accessible) but should not load the speaker, thus causing distortion through moving the working point of the push-pull stage. In the circuit shown in Fig. 1 these requirements are met by the use of two transistors.

Across the 35Ω speaker is approximately 9V peak-to-peak at full output, giving a high drive voltage for the OC72 first stage. This is an emitter follower, directly coupled to the Pye V30/30P output transistor. The output transistor is adjusted to a standing current of 0.5 amp and uses the 3Ω speaker as a collector load. This gives a permanent bias to the speech coil but the speaker is still capable of handling the required output power. The true peak power delivered to the loudspeaker is approximately 0.75 watt, but the volume compares favourably with a normal 1 watt output stage due to there being no losses in an output transformer.

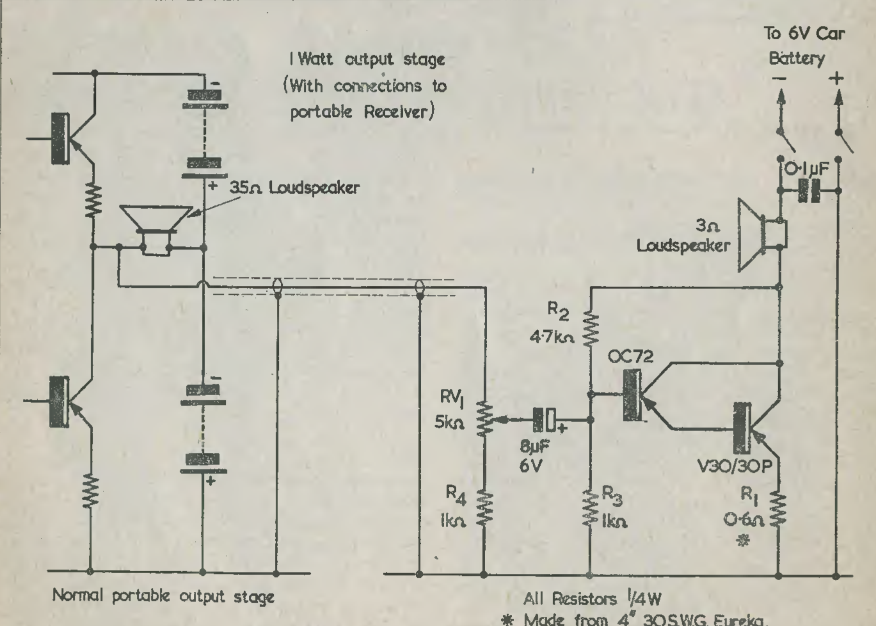


FIG.1.

The input resistance of the amplifier is of the order of 500Ω, due to the 0.6Ω emitter resistor and the feedback provided by R_2. This, of course, does not load the 35Ω speaker. The overall voltage gain of the two stages is four times, this enabling the portable to be worked at approximately half volume to give maximum output. In this manner the distortion on peaks is avoided and crossover distortion experienced, at lower output levels, is reduced.

The value of R_2 may require slight adjustment in order to compensate for variations of current gain in the two transistors but a final current of 0.4–0.5 amp should be the aim. R_4 prevents the polarity of the coupling condenser reversing at the minimum position of RV_1 which is combined with the on/off switch.

A 4 x 7in elliptical speaker was used although any 3Ω loudspeaker of 5in diameter or greater may be used. The baffle dimensions may easily be adjusted to suit the individual vehicle. A 16 s.w.g. aluminium heat sink of the dimensions shown in Fig. 2 is adequate, this not necessarily being mounted on the baffle. Care should be taken to insulate the heat sink from any surrounding metal objects since it has the same potential as the collector. Also fixed (by a simple metal clip) to this aluminium plate is the OC72 driver transistor.

The overall response of the unit is very pleasing due to the feedback provided by R_1, R_2, and the lack of an output transformer. Since the portable receiver output stage is also d.c. coupled, the overall bass response is excellent even for a small speaker.

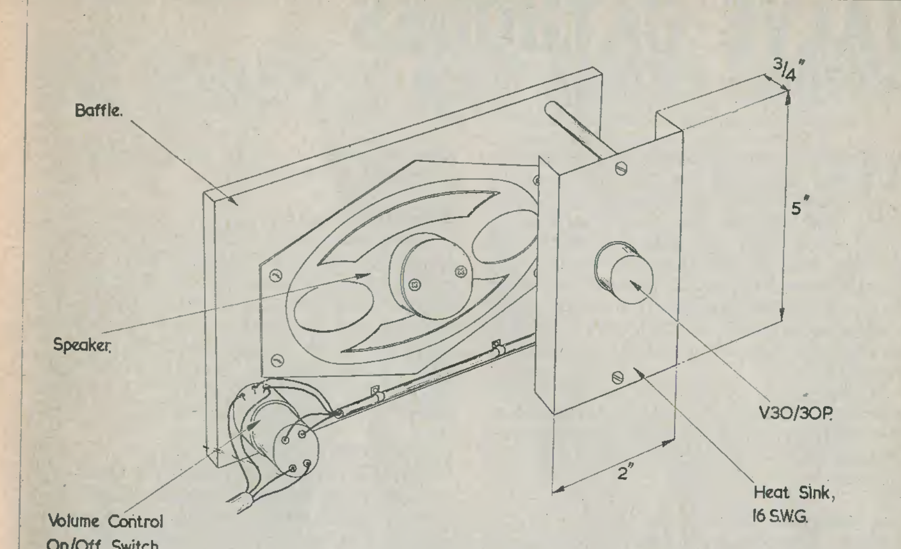


FIG.2.
Construction of 1 Watt Output Stage.

BIG DANISH RADAR INSTALLATION NEARS COMPLETION
Kastrup (Copenhagen) Airport

Kastrup, Copenhagen's new international airport—where work on the installation of a Marconi S264A high power (500kW) 50cm. radar is well on the way to completion—is expected to be operational some time this month.

The Kastrup installation comprises two transmitter/receivers feeding an aerial system on a main/standby basis; associated are duplicated distribution and M.T.I. racks and five fixed coil display units type SD1010 incorporating intertrace marking. Four of the displays are for operational use and one is a working spare. The range of the equipment extends from one to approximately 200 nautical miles.

VALVE CATHODES

by J. B. Dance, M.Sc.

A brief summary of the characteristics of valve cathodes in present-day general use

Most mains operated radio valves are indirectly heated because it is most convenient to use an a.c. heater supply and because the use of a directly heated valve with this type of supply will probably lead to the introduction of hum. Directly heated valves are normally used for battery operation because the heater power required by a small directly heated valve is less than that required by a similar indirectly heated valve.

All small radio valves have "oxide coated" cathodes, but there are two other types of valve cathode which are suitable for certain purposes, namely pure tungsten and thoriated tungsten.

Pure Tungsten

Electrons are emitted from pure tungsten only with some difficulty and a very high temperature (about 2,300°C) is required in order to obtain a reasonable anode current. Tungsten cathodes are therefore used only in directly heated valves, as it would not be practical to raise the whole of an indirectly heated cathode to such a high temperature. The heater power required is comparatively high and the valve gives out as much light as a small incandescent lamp.

Tungsten filaments are the only type which are suitable for use in valves operating at very high anode voltages (over a few kilovolts), as other types of cathode are destroyed if a high anode voltage is used. Tungsten filament valves also find an application in noise diodes which generate a very small amount of radio noise; this noise can be used to find the noise factor of a receiver. Tungsten filaments can also be used in valves for experiments on saturation anode currents.

Thoriated Tungsten

The addition of 1 to 2% of Thorium to the tungsten used for making valve filaments enables the filament to emit electrons more easily. Temperatures of about 1,600°C are suitable, but thoriated tungsten filaments are not satisfactory at very high anode voltages. The performance of thoriated tungsten is somewhere between that of pure tungsten and that of the oxide coated cathode.

Oxide Coated Cathodes

Oxide coated cathodes are the type which are most widely used because electrons are emitted from them very easily. The operating temperature is a red heat (about 780°C) but, if the anode current is small, satisfactory operation can be obtained at slightly lower temperatures.

Either directly heated tungsten filaments or indirectly heated nickel cathodes can be coated with a mixture of barium and strontium oxides. The electrons are believed to be emitted by a single layer of barium and strontium atoms on the surface of the cathode, but this layer can be easily damaged by impurities or by an incorrect operating temperature.

Oxide coated cathodes should not be used at anode voltages appreciably above one kilovolt or the cathode will probably be damaged. Oxide coated cathodes generate a type of noise known as "fluctuation noise" and are not therefore suitable as noise diodes.

BOOK REVIEW

HI-FI AMPLIFIER CIRCUITS. By E. Rodenhuis. 116 pages, 5⅝in x 8½in, 64 fig. Price 15s.

Until a few years ago, "Hi-Fi" (high fidelity sound reproduction) was an ideal which could only be approached by a few amateurs who could afford to pay large sums for their equipment. Nowadays the situation is very different. The quality of available "signal sources" (long-playing records, f.m. broadcasts and magnetic recording tape) and of reproduction equipment (amplifiers, pick-ups, turntables, loudspeakers, etc.) has been strikingly improved; growing interest has led to rapid increase in sales, and this in turn has had a most welcome effect on the prices at which makers can offer these devices.

This book can be seen as a sequel to the author's *Valves for A. F. Amplifiers*. It describes a number of pre-amplifier circuits which give high-quality results and can be built at a reasonable price by anyone who has acquired the minimum skills. Besides the choice of set-ups the book contains just the practical information and tips necessary for the best results. The book is intended for those who are interested in building and experimenting with high-quality amplifiers; for the manufacturer of Hi-Fi equipment on a modest scale; for sound engineers and service engineers; in short for all whose business or pleasure it is to make use of these exciting new techniques.

A Constructor visits the . . .

1960 International Radio Hobbies Exhibition

The 1960 radio hobbies exhibition opened, albeit a little late, due to the unavoidable delay of Mr. Brian Rix G2DQU who was rehearsing a play for t.v. presentation. The Exhibition was, as usual, well presented and attended, a record number of visitors having passed through the doors of the Royal Horticultural Society's Old Hall by the time the doors closed on Saturday, 26th November.

The annual award for the most outstanding piece of equipment shown by a manufacturer was presented to K.W. Electronics Ltd., for their "Viceroy" single sideband transmitter.

The free-entry competition for a Hallicrafter SX111 communication receiver was won by Mr. M. Palmer of London, S.E.6.

In the competition for the best home constructed equipment the results were as follows: Overall winner, E. St. B. Sydenham, G3LOK, of Cowes, I.O.W., for his heterodyne wavemeter; Best Club Entry: Aquila Radio Club (G3BRK) for equipment constructed by C. J. Salvage, G3HRO; Best Entry for Outside London: R. H. Hammans, G2IG, of Stockport; Runner-up: P. Lumb, G3IRM, of Bury St. Edmunds.

Radio amateur members of the Radio Society of Great Britain recently received Admiralty consent to adopt H.M.S. Hermes, Britain's latest aircraft carrier, which was lying at Gilbraltar during the period of the Exhibition. A radio link was established between the Exhibition station (GB3RS) and the *Hermes* (G3IPV/MM) during the periods 14.00 to 20.00 hours, using both telephony and c.w., with 150 watts on 10 metres. After the opening ceremony, the writer made a bee-line for the Feature Radio Stations display, for here were to be seen "ideal" amateur stations set out in "shack" form.

The **K.W. Electronics** "Ideal Station" consisted of a Hammarlund HQ170 receiver, specially designed for a.m./c.w. and s.s.b. reception with excellent bandspread on the amateur bands. For single sideband and c.w. operation, the "Viceroy" s.s.b. transmitter was fitted, the "Victor" 120 watt transmitter being for use on a.m. The whole assembly was neatly fitted into an Imhof console the bottom bay of which is available for a linear high power amplifier. Also included within the console were additional ancillary equipment such as aerial change-over relays, low pass filters, etc. A microphone and morse keys completed the station.

James Scott (Electronic Engineering) Ltd. had arranged an eye-appealing Hallicrafters station complete with the Hallicrafters HT37 transmitter, SX101A receiver and the HA1,TO keyer, this new electronic keyer being displayed complete with vibro-keyer.

The Radio Society of Great Britain station (GB3RS), using commercial equipment kindly loaned by manufacturers, was in continuous operation in contact with amateur stations in all portions of the globe.

Heathkits (Daystrom Ltd.) included in their display the TX-1 "Apache" 150 watt transmitter and the RX-1 "Mohawk" communications receiver, these two units in conjunction with the SB-10 s.s.b. adaptor covering all amateur bands from 10 to 80 metres. The alternative transmitter for medium range working was the well known DX-4OU/VF-1U combination. Other items of ancillary equipment here included the OS-1 Oscilloscope, V-7A Valve Voltmeter, GD-1U Grid Dip Oscillator, SSU-1 Speaker and the B-1U Balun Coil set.

Minimitter Co. Ltd. made an attractive line-up with their transmitter/receiver combination the "Mercury 200" and the new MR44/II.

The remaining two stands were taken up by the **Southampton Group Club Station,** consisting of entirely home constructed and designed equipment, and the 1960 National Field Day Winning Station G3FUR/P—both very fine stations indeed and a credit to all concerned.

Heathkits (Daystrom Ltd.) presented a very fine display of equipment available to the home constructor in kit form. A few among the many kits that caught the attention were amateur transmitters DX-40U and the DX-100U. The former transmitter covers the 10, 15, 20, 40 and 80 metres amateur bands while the latter extends this range to cover the additional 160 metre band. The DX-40U, known as "the little brother of the DX-100U", has an input rating of 75 watts c.w., 60 watts peak controlled-carrier phone and is capable of delivering over 40 watts into the aerial. The r.f. power output of the DX-100U is some 100–125 watts phone and 120–140 watts c.w. For public address purposes etc., the modulator stage will deliver 100 watts of speech via a special 500Ω tapping. The variable frequency oscillator kit VF-1U, designed for use with the DX-40U and other transmitters subject to the limitations imposed by crystal control, enables the maximum possible flexibility to be obtained. The v.f.o. is calibrated in frequency and covers all bands from 10 to 160 metres. The power requirements are 230–250V d.c. at 15–20mA and 6.3V at 0.4A. The VF-1U delivers an r.f. output of over 10V on fundamentals and will provide sufficient drive for most modern amateur transmitters. The "Mohawk" communications receiver also proved of great interest to those who visited the Stand as did the "Mohican" communications receiver. The latter covers the entire frequency range 5–30 Mc/s with calibrated bandspread provided over the amateur bands. The "Mohawk" kit is supplied with a completely preassembled, wired and aligned front end coil-bandswitch assembly for ease of construction and maximum efficiency. The "Mohawk" is a double superhet (1682 kc/s/50 kc/s i.f.s), fifteen valves, with selectable sideband.

Minimitter Co. Ltd. offered a fine display including the "Mercury 200" transmitter and the new MR44/II communications receiver—this having twelve of the new frame grid valves, a half lattice crystal filter, a crystal controlled oscillator, "Q" multiplier, fast and slow a.g.c., and noise limiter among its features. Power output is 2 watts. Also of note here was the new all transistor converter type TC1. This converter provides reception of amateur signals in the 1.8, 3.5, 7 and 14 Mc/s bands plus broadcast reception over the range 5 to 16 Mc/s to be resolved on any receiver or i.f. amplifier with an input frequency tunable to 600 kc/s. The three low frequency amateur bands are fully covered by the 5½in slide rule scale and the slow motion drive enables tuning of the broadcast bands to become a simple operation. The unit is self powered by one 4.5V battery and the total current drain is only 1mA. Three high frequency transistors are used, the unit being very compact and easily fitted, where required, to the dashboard of a car for mobile operation using the normal car radio as an i.f. amplifier. Provision is made for muting during transmission periods.

James Scott (Electronic Engineering) Ltd., on Stand 13 displayed one of the most comprehensive arrays of Hallicrafter receivers and transmitters for the amateur ever seen by the writer. Judging by the crowds around this Stand, and the "knob twiddling" that took place, these receivers are extremely popular. Amongst those on display were the S107, S108, SX62A, SX101A, SX110 and the SX111.

Radio Society of Great Britain, on Stand 1, provided an extremely interesting display of equipment entered for the Home Constructors' Competition. The U.H.F. Group on Stand 1A also featured several excellent examples of home constructed transmitters, receivers and associated equipment for use on the 72 Mc/s, 144 Mc/s, 420 Mc/s and higher frequencies. Of note to the writer were a 2 metre converter (P. West, G3JPN), cascode 2 metre converter (J. Gazeley, BRS20533), a two band transistorised s.s.b. transmitter/receiver for use on a motorcycle (V. Page, G3IVP), 2 metre mobile transmitter/receiver (G. E. Storey, G3HTC), an all band transmitter fitted into a 3 foot rack (A. Whetstone, G3LHM)—a very fine example of home constructed equipment in which a great deal of first class workmanship had been lavished. R. G. Scutt, G3IBI, had two items of equipment on show that caught the writer's eye, these being a 2 metre pushbike transmitter/receiver and a complete table top transmitter for "top band" operation. Altogether a very fine selection of home constructed and designed equipment was displayed and all due credit must be given to those enthusiasts who offered their handiwork for exhibition.

K. W. Electronics Ltd., in addition to their well known range of transmitters also featured a range of Hammarlund communication receivers among which the writer noted the HQ110, HQ145, HQ170 and the HQ180—all very fine examples of U.S.A. current receiver design. This year has brought a "new look" to the famous KW "Vanguard" 50 watt a.m./c.w. transmitter, a more modernistic cabinet together with an improved c.w. stability and performance providing the improvements. The KW "Viceroy" s.s.b. transmitter, the "Valiant" transmitter, the "Victor" 120 watt a.m./c.w. transmitter and the KW "One-Sixty" top band transmitter, complete with power supply, were all of great interest and a focal point of attention to the amateur transmitting fraternity.

Tiger Radio Ltd., on Stand 7, displayed their "Tiger" s.s.b. driver unit, the "Tiger" 200W linear amplifier 10–80 metres, the "Tiger" 150W linear amplifier 10–80 metres, the TT21 linear kit and the TR100 transmitter, the latter operating over the 10–160 metre bands with either 100W phone or 120W c.w. Focal point of interest was the new "Tiger" TR200X transmitter, 10–80 metres, input variable from 80 to 200 watts, phone or c.w., linear operation of power amplifier for s.s.b., the modulator being fitted with KT88s.

The next Stand which the writer visited was that of the **Jason Electronic Designs Ltd.**, if only for the reason that the house, being fitted with the well-known Jason f.m. tuners, is now requiring the installation of an a.m. Medium wave receiver. At the Stand it was apparent that many other visitors to the Show also had similar ideas about acquiring f.m. installations. Commencing some years ago with the Jason FMT1 f.m. tuner, the company now offers an extremely wide range of kits from test equipment to portable radios. Of great interest to the writer was the "Mercury" switched tuner, this having six positions providing reception of the B.B.C. (Home, Light, Third) auxiliary (f.m.) and both B.B.C. and I.T.V. sound programmes. The audio generator AG10 also occasioned much comment, this instrument tuning from 10 c/s to 100 kc/s in switched stages with facilities for both sine and square wave output (min. 100mV). The oscilloscope OG10 and the "Everest 7" portable transistor receiver, together with the many other well known items of Jason manufacture were also to be inspected here.

In common with everyone else who visited the Show the writer paid due attention to the **Mullard Ltd.** exhibition on Stand 15–16. Here were displayed many prototype audio amplifiers constructed around the well known Mullard circuit designs. Technical information, in the form of free leaflets, together with technical personnel available to answer queries on these and other Mullard designs were available. Among the prototypes on display were the 3 valve stereophonic amplifier, a 7 watt stereophonic amplifier, 4 channel input mixing pre-amp, a tape pre-amp, a 7 watt a.c./d.c. amplifier, 2 volt pre-amp, a 3 watt tape amplifier, a 10 watt and a 3 watt amplifier and a 3 valve pre-amp. Certainly there was much of interest for the home constructor here.

Webb's Radio featured a display of communication receivers in the famous Eddystone range—the 888A, 840A, 870A, 670A, 680X and 770R. The 870A was of some interest in that it is small, compact, and operates from either a 110 or a 240V a.c./d.c. supply. Also here to be seen were the National NC303, NC60 and NC109 receivers and the very interesting G.E.C. BRT400.

On Stand 19, **Short Wave Magazine Ltd.**, in addition to the magazine, displayed a full range of American technical books, manuals and periodicals. The "DX Zone Map" together with the various DX Operating Awards and Certificates made a fine showing.

AVO Ltd., in addition to the interesting display afforded by young ladies carrying out intricate assembly and soldering tasks, had on show their recently introduced two new instruments. The valve characteristic meter Mk. 4 and the transistor analyser—a compact battery operated instrument for testing npn, pnp and point contact transistors of small signal and medium power types.

Electroniques (Felixstowe) Ltd., interested the writer considerably with their various multiband "Qoilpax" and tuning hearts incorporating the new high performance "Stabqoils", these being a temperature compensated coil with built-in capacity trimmer. Some time was spent examining the new 6 amateur band "Qoilpax" which is supplied complete with a 3-gang tuning condenser. "Stabqoils" for r.f. chokes, b.f.o. coils and i.f.s, etc. "Qoilpax" are completely wired and tested coil packs using "Stabqoils" and incorporating the new low loss glass alkyd all moulded "Trolex" rotary wafer switches. Five standard models are available, models QP4 and QP44 for 500pF gangs and 470 kc/s i.f.s, QP5 and QP55 are for 320pF gangs and 470 kc/s i.f.s and model QP155 for 320pF gangs and an i.f. of 1.6 Mc/s. Shortly generally available will be the two special 6 amateur band only models QP66 and QP166 supplied complete with a 3 gang tuning condenser. Both of these models have an r.f. stage. QP66 will cover the normal amateur bands 10 to 160 metres at an i.f. of 470 kc/s and model QP166 likewise but for an i.f. of 1.6 Mc/s. These packs are supplied with full instructions and a trimming tool, the whole being delivered sealed in a plastic bag. Here, the writer felt, was the answer to one of the largest problems in home constructed receiver designs—where to obtain a first class assembled coil pack using the finest grade of materials available. The top band "Pathfinder" transmitter, the first of a series of new and original designs also proved of great interest. Measuring only some 12 x 7 x 7in, with an output in excess of 10 watts, phone or c.w., this compact transmitter should find a ready market among top band enthusiasts.

The British Recording Club at Stand 25 intrigued the writer, and many others apparently, with the ear-catching "Experiment in Sound"—the B.R.C.'s special electronic music recording demonstrated together with some of the equipment used for its composition. An old friend of the writer, F. C. Judd, A.INST.E., G2BCX, a frequent contributor to this magazine, whose handiwork this was, attended the Stand for much of the time. This year electronic music was featured for the first time at Dartington Summer School of Music at Dartington Hall, Totnes, Devon. Freddie was chosen to advise on the special electronic equipment required for demonstration and for the concert of electronic music given by the conductor and composer Signore Bruno Maderna of Milan. Associated British Tape Recording Clubs Ltd., are sponsors of the British Recording Club and publishers of the monthly magazines *Amateur Tape Recording* and *Popular Hi-Fi*

Data Publications Ltd., here the writer noted that a very great deal of interest was shown in the Tunnel Diodes display, these being featured, as readers are already aware, in a current series of articles in this magazine. The working model of the Suggested Circuits No. 121, A Single Transistor Periodic Switch, also caused much favourable comment—a meter showing collector current and two flashing bulbs adding greatly to the effect. In addition to *The Radio Constructor*, Data Books, Radio Reprints and the popular Panel-Signs transfers, a new book *Suggested Circuits* (DB15) was also on sale.

Altogether the 1960 Exhibition was an unqualified success and, in addition to the foregoing, there were many other displays such as the Navy, Royal Air Force, the Army, Amateur Radio Mobile Society and the British Amateur Television Club Stands to be seen by visitors. With the crowds that gathered into the Hall, it was very evident from the meetings of many old friends, and the consequent "rag-chews" ensuing, that this was not only an Exhibition but also an enjoyable social occasion.

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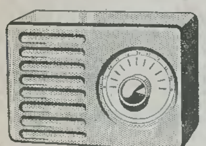

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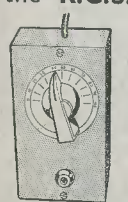

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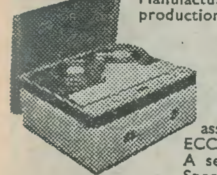

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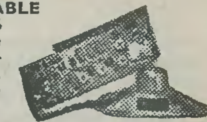

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continued on page 478

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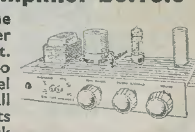

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Data Publications Ltd 57 Maida Vale London W9
Printed by A. Quick & Co. (Printers) Ltd 125 High Holborn London WC1 England *also at* Clacton-on-Sea
Obtainable abroad through the following Collets Subscription Service Continental Publishers & Distributors Ltd
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