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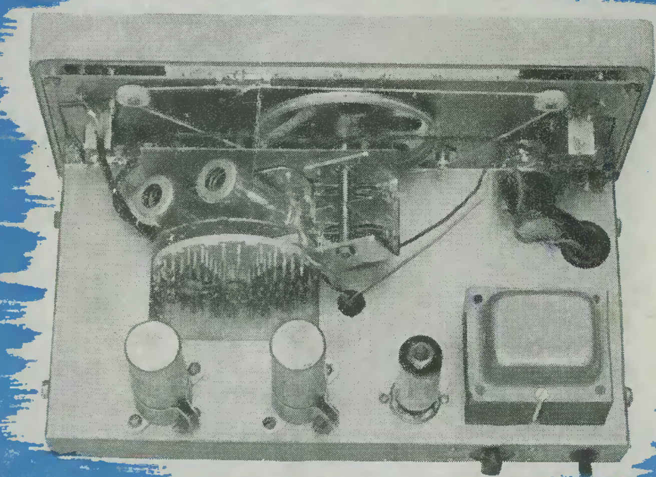
VOLUME 14
NUMBER 3
OCTOBER
1960

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

The "WII" AM, FM, TV WOBBULATOR



A Jason Design — *Described by R. J. Caborn*

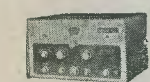
Included in this issue

DATA Publications 1/9

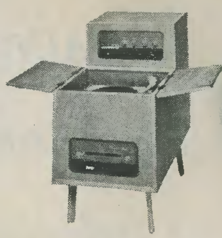
The World-famous Heathkit range of equipment

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 a 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, 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. **£10.10.0**

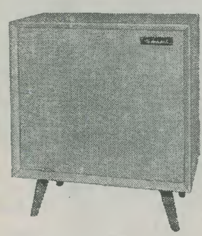
TRANSCRIPTION RECORD PLAYER

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.** Extra heavy duty, **£15.0.0.**

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. **£17.8.6**



THE "COTSWOLD"

THE "COTSWOLD". This is an acoustically designed enclosure 26″ x 23″ x 15⅛″ 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**

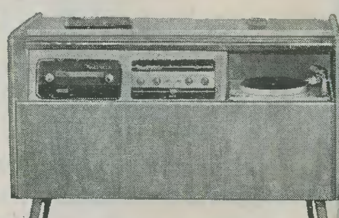
NEW KITS JUST RELEASED

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-I. **£9.18.6**



The "GLOUCESTER" (open)

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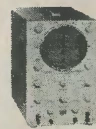
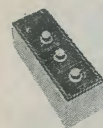
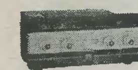


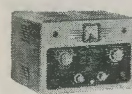
O-12U



DC-1U

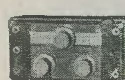


S-33

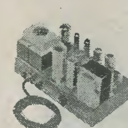


DX-40U

AG-9U



UJR-1



MA-12

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**
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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 D.C. 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. 75 W. CW; 60 W. pk. c/s phone; 40 W. 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)

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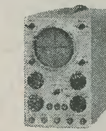
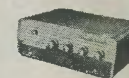
VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. **£10.12.0**
AUDIO WATTMETER: AW-1U. Up to 25 W. continuous, 50 W. intermittent. **£13.18.6**
AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V A.C. 10 c/s to 400 kc/s. **£13.18.6**
ELECTRONIC SWITCH: S-3U. This extremely useful 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**

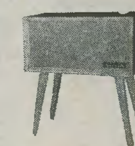


OS-1

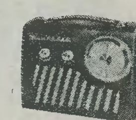
V-7A



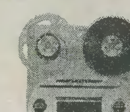
S-88



SSU-1



UXR-1



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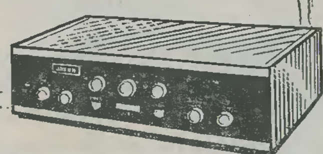

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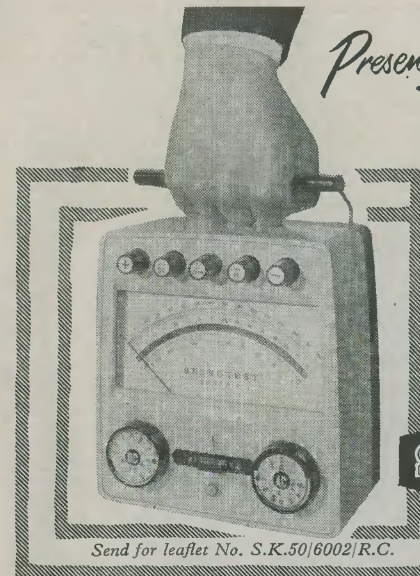

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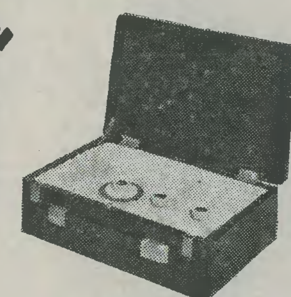

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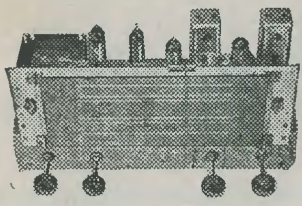

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Acos 73 Hi-Fi Pick-up for LP, 78 and Stereo 7", 10" and 12" records. Silent motor heavy turntable, auto stop.
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COLLARO 4-speed Gram-Pick-up Unit — £3.15.0
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or **£9.9.0** complete kit post free

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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
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6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
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6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
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3W Lab. Colvern, etc. Standard size Pots, 2¼" Spindle, high grade. All values, 100 ohms to 50k, **6/6**; 100k, **7/6**. W/W EXT. SPEAKER CONTROL 10Ω, **3/–**.

MAINS TRANSFORMERS—200/250 AC

STANDARD 250–0–250, 80mA, 6.3V tapped 4V 4A, Rectifier 6.3V 1A, tapped 5V 2A and 4V 2A	22/6
Ditto 350–0–350	22/6
MINIATURE. 200V 20mA, 6.3V 1A	10/6
MIDGET. 220V 45mA, 6.3V 2A	15/6
SMALL. 220–0–220V 50mA, 6.3V 2A	17/6
STANDARD. 250–0–250 65mA, 6.3V 3.5A	17/6

HEATER TRANS. 6.3V 1½A **7/6**. Ditto, sec. 6.3V 3A **10/6**. Ditto, tapped sec. 2, 4, 6.3V 1½A, **8/6**.
Mullard "510" Osram "912" 300–0–300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V — **38/6**
General Purpose Low Voltage. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V at 2A — **22/6**
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/–**.
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CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ⅞" x 3/16"
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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/–**.
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40 CIRCUITS FOR GERMANIUM DIODES, 3/–.
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Twin Screened Balanced Feeder, 1/6 yd, 80 ohms.
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BLACK CRACKLE PAINT. Air drying, **3/–** tin.
P.V.C. CONN. WIRE, 8 colours, single of stranded, **2d.** yd. Sleeving 1, 2mm, **2d.**; 4mm, **3d.**; 6mm, **5d.** yd.
NEON MAINS TESTER SCREWDRIVERS, 5/–.
SOLDER RADIOGRADE, 4d. yd, ½lb **2/6.**

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

Miniature Contact Cooled Rectifiers. 250V 50mA, **7/6**; 250V 85mA, **9/6. Selenium Rect.** 300V 85mA, **7/6.**
Coils. Wearite "P" type, **3/–** each. Osmor Midget "Q" type, adj. dust core, from **4/–** each. All ranges.
Teletron D.W.R. L. & Med. T.R.F. with reaction, **3/6.**
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6.**
Ferrite Rods 8" x ⅜", **2/6**
T.R.F. Coils A/HF, **7/–** pair. **H.F. Chokes, 2/6.**
Speaker Fret. Gold cloth, 17" x 25", **5/–**; 25" x 35", **10/–**. **Tygan,** 4' 6" wide, **10/–**; 2' 3" wide, **5/–** ft. Samples, S.A.E.
Condensers. 0.001μF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 0.1μF 7kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.05, **9d.**; 0.1, **1/–**; 0.25, **1/6**; 0.1/350V, **9d.**; 0.5/250V, **1/9**; 0.01/2,000V, **1/9**; 0.1/2,000V, **3/6.**
Ceramic Condensers. 500V 0.3pF to 0.01μF, **9d.**
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8/450V	2/3	500/12V	3/–	2,500/3V	4/–
8/500V	2/9	8+8/450V	3/6	5,000/6V	5/–
16/450V	3/–	8+8/500V	5/–	32+32/350V	5/–
16/500V	4/–	8+16/450V	3/9	32+32/450V	6/–
32/450V	3/9	8+16/500V	5/6	32+32+32/350V	7/–
25/25V	1/9	16+16/450V	4/3	50+50/350V	7/–
50/25V	2/–	16+16/500V	6/–	64+120/350V	11/6
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Toggle Switches, s.p., **2/–**; d.p., **3/6**; d.p.d.t., **4/–**.

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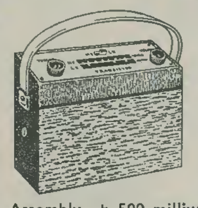

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95/– plus 3/– P. & P.

Technical specifications: separate bass and treble controls. Valve line-up EF86, EL84, EZ80. Voltage adjustment for a.c. mains from 200/250 volts, 3 or 15 ohms impedance. Negative feedback. Size 7" x 5" x 2", overall height 5". Silver hammered finish chassis.

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3S4	6/9	12AT7	5/–	DL94	7/6	EZ40	6/6
3V4	7/6	12AU7	6/–	DL96	8/–	EZ80	6/6
5U4G	6/–	12AX7	9/–	EB91	4/6	EZ81	7/–
5Y3GT	7/6	12BH7	10/6	EBC41	9/6	PL81	13/6
5Z4G	9/–	12K7GT	8/6	EBF80	10/6	PL82	10/6
6AK6	6/6	12K8GT	13/6	ECC81	5/–	PY81	8/–
6AL5	4/6	12Q7GT	6/6	ECC82	6/–	PY82	7/–
6AM6	4/–	25A6G	10/6	ECC83	7/6	PCC84	9/6
6AT6	7/6	25L6GT	9/–	ECC84	7/6	PCF80	9/–
6BA6	8/6	35Z4GT	8/6	ECF82	7/6	PCF82	11/–
6BE6	7/6	35L6GT	9/6	ECH81	10/6	PCL82	7/6
6BR7	10/6	5763	10/6	ECH42	8/6	R19	12/6
6BW6	8/6	DAF91	6/6	ECL80	9/6	U76	8/6
6J7GT	8/6	DAF96	8/–	EF41	8/6	UBC41	10/–
6K7G	7/6	DF91	4/6	EF80	8/–	UCH42	10/6
6Q7G	7/6	DF96	8/–	EF86	9/6	UF41	10/–
6SL7GT	8/–	DH76	8/6	EF91	4/–	UL41	8/–
6SN7GT	8/6	DH77	7/6	EF92	5/6	UY41	8/–
6V6G	7/6	DK91	6/6	EL41	9/–	W76	8/6

Matched Pairs. EL84, **23/–**; EL85, **25/–**; 6V6G, **17/–**; 6BW6, **18/–**; KT33C, **19/6**; 807 **14/6** pair. KT66 **32/6**

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UCH42, UF41, UBC41, UL41, UY41	**35/–** per set

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

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

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

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

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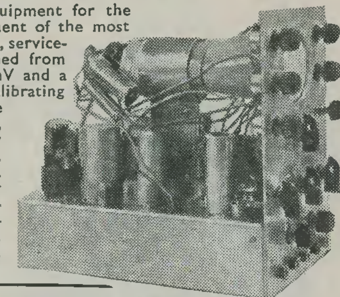

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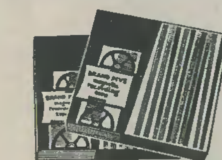

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CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate 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

No. 119 A 3-valve 9-watt Record-Player Amplifier

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

There is always a keen interest amongst readers in a.f. amplifiers and, because of this, such amplifiers have been the subject of several Suggested Circuit articles over the past few years. The circuit discussed in this month's contribution is also that of an a.f. amplifier, and it should be of especial interest to those constructors who require a unit capable of delivering a high power output without the use of expensive and critical components.

The amplifier described here provides an output of 9 watts. It requires only three valves, one of which is the h.t. rectifier, a considerable economy having been effected by the use of two triode-pentodes in the a.f. stages. Few of the components are in any way critical. The amplifier is intended to be used with a crystal pick-up and it could be installed, with the gram motorboard, in one of the larger record player cabinets currently available. There are three controls, these varying volume, treble and bass response. A small degree of negative feedback is incorporated, this allowing bass boost to be obtained in the amplifier stages which follow the tone controls.

It was decided to specify a mains transformer instead of employing an a.c./d.c. power supply arrangement in order to overcome the difficulties which arise with the latter. Such difficulties consist mainly of the necessity of avoiding hum and excessive heat dissipation, and of guarding against shock. With the power supply circuit shown here the amplifier chassis is completely isolated from the mains and may be bonded direct to the frame of the gram motorboard. The mains transformer required need not be excessively large in physical size nor heavy in weight, and suitable types are available through the usual channels at reasonable cost.

It should be pointed out that this amplifier is not claimed to fall into the true hi-fi category. Nevertheless, it should be capable of offering a performance which is at least as good as that of many commercial record player amplifiers having push-pull output.

The Circuit

The pick-up employed with the amplifier connects into the tone and volume control circuit offered by C_1, R_1, R_2, R_3, R_4 and C_2. The slider of the last potentiometer in the circuit, R_4, connects direct to the grid of $V_{1(a)}$. $V_{1(a)}$ is a voltage amplifier triode, and the signal on its anode is passed, via C_5, to the grid of the phase-splitter, $V_{2(a)}$. $V_{1(a)}$ and $V_{2(a)}$ are the triode sections of the two triode-pentode valves employed in the circuit.

Equal signals of opposing phase appear across the anode and cathode loads, R_9 and R_{11}, of $V_{2(a)}$, and these are applied, via C_6 and C_7, to the grids of the output pentodes $V_{2(b)}$ and $V_{1(b)}$. The pentodes operate in

push-pull, their anodes feeding into the centre-tapped speaker transformer primary in normal manner. A small degree of feedback from the speaker transformer secondary to the cathode of $V_{1(a)}$ is obtained via C_9 and R_{12}. C_9 causes feedback at the lower frequencies to be less than occurs at middle and high frequencies, thereby providing a measure of bass boost.

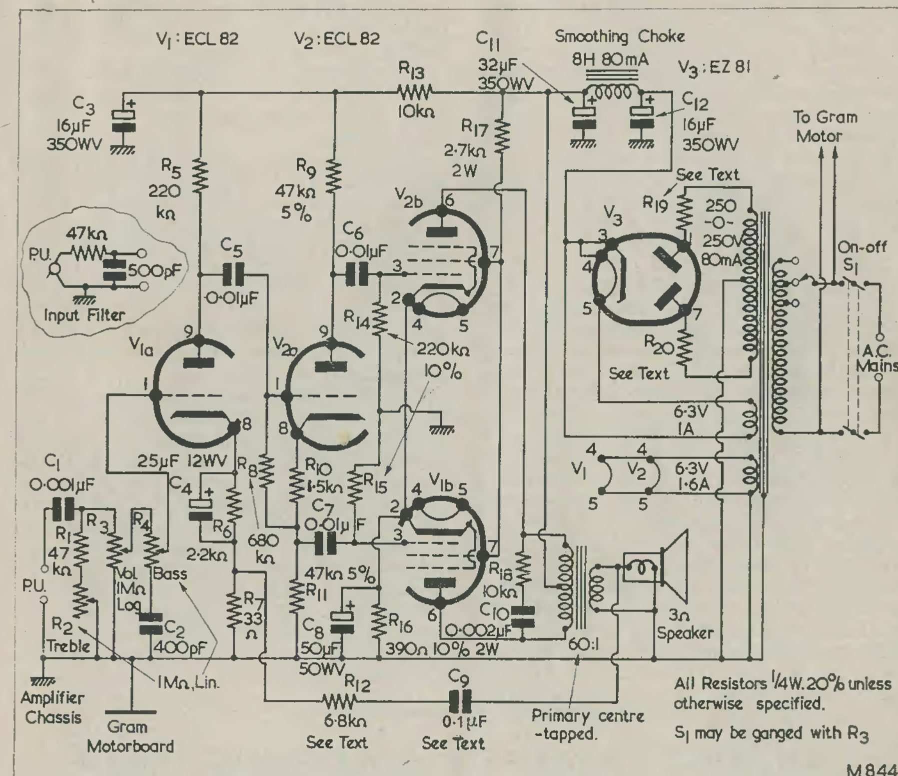
The power unit circuit is quite conventional, a mains transformer having a centre-tapped h.t. secondary feeding the full-wave rectifier, V_3. A relatively low inductance choke provides smoothing after the reservoir condenser, C_{12}. Further smoothing, for $V_{1(a)}$ and $V_{2(a)}$, is given by R_{13} and C_3.

Design Points

There are several design points which need to be discussed.

The rectifier specified in the V_3 position is an EZ81, this having been chosen because it is of "all-glass" construction and, therefore, fits in comfortably with a layout employing two ECL82's. However, any other rectifier capable of operating from a 250–0–250 volt h.t. secondary at a rectified current of 80mA may be employed in place of the EZ81, should this be desired. Alternate rectifiers may, of course, have heater voltage and current requirements other than these noted in the diagram for the EZ81.

If the EZ81 is employed it should, under the conditions in which it is used in the circuit, have a minimum limiting resistance for each anode of 150Ω. In the diagram limiting resistors are shown as R_{19} and R_{20}. In practice, mains transformer losses including winding resistances, will provide much, if not all, of the limiting resistance required. A satisfactory approach in this particular instance would consist of measuring the d.c. resistance of each half of the h.t. secondary winding of the transformer employed and, if this is below 150Ω, inserting resistors in the R_{19} and R_{20} positions having values which would make the total resistance up to this figure. Thus, if it is found that each half of the h.t. secondary has a resistance of 120Ω, then R_{19} and R_{20} may be given



values of 30Ω. For values of 50Ω and below, R_{19} and R_{20} should preferably have a rating of 1 watt, above 50Ω they should have a rating of 2 watts. Should the d.c. resistance of each half of the h.t. secondary be greater than 150Ω R_{19} and R_{20} are not needed, and the outside terminals of the winding may be connected direct to the anodes of V_3.

It will be noted that R_{18} and C_{10}, connected across the primary of the speaker transformer, provide top-cut and that they appear inside the feedback loop. It is, theoretically, an undesirable practice to have a top-cut circuit inside the feedback loop; but this is often done in commercial amplifiers of the class under consideration here and in which the level of feedback is low. If it is so wished the constructor may, after the amplifier has been completed, experimentally determine whether in his particular case these two components are needed. It will probably be found that they give a small but noticeable improvement to the overall response.

The speaker transformer employed should be capable of passing a current of 30mA in each half of its primary winding.

Negative Feedback

After the amplifier has been completed it should be initially tried out *without* the negative feedback loop connected. The feedback loop may be broken by opening the circuit between C_9 and the speaker transformer secondary. If, when C_9 is connected up after initial tests it happens that the voltage from the speaker transformer secondary is in incorrect phase, positive feedback will occur, resulting in a heavy oscillation which may damage the speaker. In consequence, C_9 should be connected up whilst the amplifier is switched off, the speaker being protected by connecting a resistor of some 20Ω in series with it. The amplifier may then be switched on. If there is evidence of oscillation, audible as a loud howl from the speaker, the amplifier should be switched off again immediately. The connections to the speaker transformer secondary should then be reversed, whereupon the phase should be such that correct negative feedback takes place.

The degree of feedback allowable in the amplifier depends to a large extent upon the quality of the speaker transformer. Too high a feedback level will cause oscillation. Such oscillation may be differentiated from the loud howl given in the positive feedback instance just described because it will probably occur at a supersonic frequency, making itself evident in the form of a hiss, or of distortion on transients. The value specified for R_{12} should be sufficiently high to obviate this possibility. R_{12} may, nevertheless, be increased in value if it is felt that the feedback level is too high.

The value of C_9 may be experimentally altered, if desired, to vary the degree of bass boost offered in the amplifier.

Final Points

Little else needs to be said about the amplifier since it is very simple and straightforward in design. There should be few difficulties in layout, provided that the normal precautions are taken. The tone and volume control components in the grid circuit of V_1 are liable to pick up hum and, if S_1 is ganged with the volume control R_3, care should be taken to see that the mains wiring to the switch does not approach these components too closely.

It is possible for R_2, R_3 and R_4, together with the components immediately connected to them, to be mounted on a small metal panel separate from the main chassis. If this course is adopted the connection to the grid of $V_{1(a)}$ should be made via screened cable, the screening being used to bond together the metal panel and the amplifier chassis.

It may be found that some pick-ups cause reproduction to have an excess of treble. Should this occur a top-cut filter may be connected between the pick-up and the input terminals of the amplifier. A suitable filter is shown in the inset.

CARTRIDGE HEATED SOLDERING IRON

A new cartridge heated soldering iron, named the "Quik-Shot", has been introduced by Jenolite Ltd., 13–17 Rathbone Street, London, W.1. Unlike other soldering irons the "Quik-Shot" does not require electricity, flame, blowtorch or external heat of any kind. The heat is provided by a patented cartridge which contains 10,000 calories of heat energy supplied by a thermic mixture sealed in a steel shell. The "Quik-Shot" is especially useful in cases of emergency where electricity is not available.

Two steps only are required to make the "Quik-Shot" ready for use. Firstly, the copper bit is unscrewed at the centre, the cartridge heat unit inserted, and the bit replaced. Secondly, a knob at the back of the handle is pulled out and released sharply, thereby triggering the cartridge.

The cartridge brings the copper tip up to 862°F. within seconds, and maintains a steady soldering temperature for 6 to 8 minutes.

IN YOUR WORKSHOP

This month Smithy the Serviceman and his able assistant, Dick, discuss the basic principles of servicing

"WHAT, REPLACE THE *whole* PRINTED circuit board?" said Dick incredulously.

"That's right," affirmed Smithy. "I've got a spare board for the model you're servicing tucked away in the cupboard for just such an eventuality as this."

"But the present printed circuit board constitutes nearly half the set!" protested Dick.

The Serviceman and his assistant stared at one of the two printed circuit boards in the television receiver which Dick had selected from the rack. The receiver chassis had received a severe bump at some time in its life and the mounting points for the printed circuit board had been bent out of position, thereby over-stressing it. The board had, eventually, given up the unequal struggle and, whilst in the set-owner's home, had split along its entire length. The fact that the broken board carried the vision and sound i.f. strips, the audio amplifier and output stages, and the video output stage was obviously a source of distress to Dick.

"Can't we patch it up in some way, Smithy?" he continued.

"Not a chance," replied the Serviceman. "The copper pattern's completely broken along the split and it would be hopeless to even attempt to bridge the connections over. There's nothing for it but to change it."

"That means", said Dick, "fitting a whole new set of i.f. coils, resistors and condensers when all that's wrong with the old ones is that they had the misfortune to be mounted on a board which has cracked."

"I appreciate your feelings," said Smithy. "But there's nothing else to do but change it."

Changing the Board

Dick sighed and accepted the inevitable. Smithy silently handed him a new printed circuit board, complete with components, and left him to carry out the change.

Dick commenced by examining the wires from the remainder of the set which connected into tags mounted on the board. There were approximately fifteen of these and they included leads carrying h.t. and heater supplies, leads taking output from, and a.g.c. to, the tuner unit, wires connecting to the speaker and to the cathode ray tube, and leads connecting to the volume and contrast controls. Dick clicked his tongue with annoyance when he found that the service data in the Workshop on this particular receiver did not include an illustration of these connections. He realised after a few moments' further examination, however, that each tag on the board to which external connection was made was numbered, and he decided to record each connection on a sheet of paper.

Sitting down at his bench he scribbled down the number of each tag as he removed the lead connected to it, together with the colour of that lead. Where two leads had the same colour and there was a risk of their being transposed when the new board was connected in later, he marked one by twisting an inch or so of thin solder wire around its insulation, recording this fact on his list. Almost all the connections were of the wire-wrap type (that is, twisted under tension around a specially shaped tag—Fig. 1) and, since these had no solder, they could be untwisted with a pair of pliers.

"Ah!" he remarked with a sigh of satisfaction as he disconnected the last lead from its tag.

Dick next took out the screws holding down the broken board and removed it completely. He then bent the strained chassis to ensure that it would not stress the new board and fitted this latter into position. As he finally tightened the mounting screws he noticed with satisfaction that it was not subjected to any strain. Working from his scribbled list he started to reconnect the leads to the tags on the replacement board. The leads which had previously been wire-wrapped he now soldered. When all the leads had been connected he removed the pieces of solder wire he had used as markers on leads of the same colour and decided, after a final examination, that his task was now completed. He nevertheless experienced a slight feeling of trepidation when he plugged the receiver into the mains, fitted an aerial and switched on.

His trepidation was uncalled for. The receiver worked perfectly.

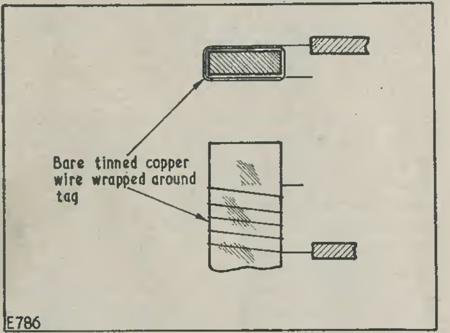


Fig. 1. The wire-wrap connections encountered by Dick when removing a printed circuit board. Connections of this type employ no solder

Simple Servicing

"There you are," said Smithy, whose attention had been caught by the sound of music from Dick's bench. "It wasn't too hard a job after all, was it?"

"Not really," confessed Dick. "Despite the fact there are so many connections to transfer. If I hadn't made a record of each connection when I took it off the old board I'd have been in a terrible muddle when I started to connect up the new one."

"You would indeed," commented Smithy. "It's essential to keep a record of wiring whenever you remove a component which has a large number of tags. You may not believe it, but I've even known service engineers make mistakes in re-wiring something as simple as a replacement a.f. volume control. The golden rule is this: if ever there's the slightest risk of making an incorrect connection when you change a component, always keep a note of the wiring. Keeping a record only takes a few seconds but it can save ages of circuit tracing later on, if you happen to make a mistake."

"There are times", said Dick, "when I feel that it's really worthwhile emphasising simple things like that."

"That's very true," agreed the Serviceman. "Revising basic stuff every now and again is always a good plan. It's just about time we had a cup of tea so, whilst the kettle's boiling up, how about a bit of a gen-session?"

"Coo," remarked Dick. "You're in a good mood today, aren't you?"

"Not at all," replied Smithy equably. "I'm always prepared to drop work any time you want some information."

Dick abstained from comment and applied himself to the task of filling the battered Workshop kettle. Smithy tended to be a little unpredictable at times.

"When you've finished clattering around", said Smithy, "we'll start."

"I'm all ready," replied Dick, settling himself down.

"Right!" said the Serviceman. "Now if we're going into the basics of servicing we must first of all decide what servicing is *for*."

"That's easy. A set comes in duffy and we fix it!"

"Fair enough. But I think we should be a little more detailed than that. Now, the function of servicing is to bring a receiver back to the working condition it was in when it left the factory. If a receiver has ceased to function then some component or components in it have failed. The service engineer then has two jobs: he has firstly to *locate* the faulty component or components, and he has secondly to *replace* or *repair* them. This two-fold operation should then bring the receiver back to the condition it was in when it left the factory.

"Now there are several exceptions to what I've just said," continued Smithy.

"I'll say there are!" interrupted Dick. "What about sets which gradually wear out, and where a lot of components may need replacing if you're going to make the set as good as it was when it left the factory? What about the mods which the manufacturers themselves keep bringing out on their models? And what about those sets we get straight from the factory which don't work at all, and which we have to fix before they can be sold?"

"Hang on a minute," protested Smithy. "I *said* there were snags! In actual fact you've brought out the main ones. Let's deal with your last point first. New sets which we get straight from the factory in non-working condition have faults which are usually caused by the conditions under which they've been stored or handled. Sometimes the faulty sets are the result of slipshod inspection at the factory—but so far as that is concerned it would be an ideal world if all human operations were 100% reliable. Perhaps we had better say that the function of servicing is to bring these particular receivers back to the condition they *should* have been in when they left the factory. Now, let's look at this question of mods. After a manufacturer has produced a large number of a particular model—and the quantity involved may be up in the tens of thousands—he may find that certain weaknesses in the design show up in a percentage of receivers. The manufacturer then works out a modification which overcomes these shortcomings, introduces this on his own production line, and circulates the dealers. Normally, it is then up to the individual dealer to use the modification information in the way that best suits him. If the modification clears snags he has himself encountered, then he puts it in on all sets passing through his hands. If he's experienced no trouble he keeps the mod information available, just in case he bumps into the snag in the future.

"Your first point", continued Smithy, "about sets gradually wearing out is also important. Mind you, this business of gradual wearing out of receivers is a bit overplayed to my mind. Very often sets which are said to be worn out just suffer from a combination of several faults; whereupon a little careful trouble-shooting should enable these to be eliminated one by one and allow the set to be restored pretty close to its original pristine freshness. If a set is *truly* on its last legs then a compromise has to be reached, and the service engineer has to decide what level of performance can be obtained without embarking on grossly uneconomic repairs."

"That seems fair enough," commented Dick.

"I think it is," agreed Smithy. "Now, having gone over that little bit, let's get back to the two-fold function of the service engineer. As I said just now, he has first to *locate* the faulty component, and he has secondly to *replace* or *repair* it."

"You seem to be putting a lot of emphasis of this two-fold function," commented Dick.

"I am," said the Serviceman. "And I'm doing so because of its importance. What were the first jobs I gave you immediately after the ill-fated day on which you condescended to join me?"

"Replacing faulty components," said Dick promptly, ignoring the comment which accompanied the question. "You used to give me a set and tell me to replace the line output tranny, or the speaker, or the electrolytics. All sorts of jobs like that."

"Exactly," said Smithy. "In other words you started off by replacing and repairing. Whilst I was doing the locating."

"I'm still not with you."

"What I'm getting at," explained Smithy, "is that almost anyone who has reasonable competence with a screwdriver and a soldering iron can replace and repair; with the result that this part of servicing becomes a routine function which takes up a fairly readily assessed length of time. But not everyone, however skilled with his hands, can *locate* the faulty component in the first place. It takes a service engineer to do that!"

"I hadn't looked at it in that light before," confessed Dick.

"Well, let's take it a stage further," continued Smithy. "As you know, the biggest enemy of the service engineer is time. In consequence, the best service engineer is the one who repairs his sets in the shortest possible time. The time taken to replace or repair a component is relatively fixed, because it is a routine job. On the other hand, the time taken to locate a fault is variable, and it depends on the skill of the engineer, the quantity and efficiency of his servicing aids—testmeters, signal gennies and the like—plus a certain amount of luck."

"I'm beginning to see the light," remarked Dick. "To take an example, you could have a set with, say, a faulty resistor which would take five minutes to swap. Serviceman 'A' takes ten minutes to fix the set and Serviceman 'B' takes two hours. When their work is analysed you would find that Serviceman 'A' took five minutes to locate the resistor and five minutes to replace it, whilst Serviceman 'B' took one hour and fifty-five minutes to locate the resistor and five minutes to replace it. Serviceman 'B' is just as good as Serviceman 'A' in replacing the faulty components, but he's a dead loss compared with Serviceman 'A' in locating it."

"That's exactly right," confirmed Smithy. "Kettle's boiling!"

Logic and Luck

"You said just now," remarked Dick, as he poured the contents of the kettle into the teapot and stirred it vigorously with a steel rule, "that there is an element of luck in fault-locating."

"That's correct," said Smithy. "Haven't we got any spoons around the place?"

"I used the last one to stir up some of that patent cold-setting glue powder you bought last week. I didn't like to use it for tea afterwards so I threw it away."

"Well, I think that stirring the tea with a steel rule is *most* unhygienic," said Smithy.

"I wiped it on my trousers first."

"That alarms me even more."

"Well, the water's boiling, isn't it? That should sterilise the rule!"

"It doesn't stop the dirt in the divisions dissolving out into the tea," said Smithy firmly.

Dick remained silent for a moment.

"Well anyway," he said inconsequentially, "the cold-setting glue hasn't set either."

Smithy sipped morosely at the cup which Dick passed over to him.

"I know it hasn't," he agreed lugubriously, "there must be something about the atmosphere in this workshop. *None* of these patent adhesives works for me."

"Anyway," said Dick, changing the subject, "what about the element of luck you mentioned just now?"

"Oh yes," remarked Smithy. "What I said was that quickness in locating faults includes an element of luck. The reason for this is that, whilst fault-finding is essentially a logical process, it is always worthwhile taking a few short cuts. If, for instance, you suspect that a fault lies in a particular section of a receiver it is almost always advisable to start swopping the valves in that section before looking elsewhere. This is because swopping valves is a quick operation and can, indeed, usually be done without even having to remove the chassis from the cabinet. It is possible, though not necessarily probable, that one of the valves may be causing the trouble. If that is the case you will then have been lucky enough to have cured the fault in a short time. And without having to apply any real logic or head-scratching to the task at all."

"You've always told me," remarked Dick, "that it's a good plan to have a quick look around the chassis before getting down to checking with testmeters and things like that."

"So it is" replied the Serviceman. "There are two reasons for this. First of all, there's the luck element again. A very quick visual examination quite frequently reveals obvious faults such as broken or poor connections. It can also enable you to see grossly over-cooked resistors which, if they are present, may give you a quick lead to the fault. If you're lucky, a visual examination may show up something which would take quite a time to find with the basic logical approach."

"*Grossly* over-cooked resistors?"

"Yes," said Smithy, "some resistors in a chassis may acquire a nicely-done brown shade because they're run to the limit in the design. Such resistors are definitely worth a quick check with the testmeter to see if their value and the immediate circuit are all O.K. They can, if you like, be replaced by components of higher wattage. But the real significant resistors are those which have cooked up heavily very quickly, this being probably due to a sudden excess of current through them."

Smithy sipped at his tea.

"And that," he continued, "covers the luck element I mentioned just now. The second reason for making a quick visual examination is that this enables you to size up the chassis and get a clear picture of its layout in your mind. The visual inspection shouldn't take more than a minute or so."

"You often", offered Dick, "meet engineers who, when they are told of a particular fault in a particular set, say that it's bound to be such and such a component, because that's the one which always gives trouble. You've heard them!"

"I have indeed," agreed Smithy. "Refill, please!"

"Do you agree with their outlook?" asked Dick, as he filled the Serviceman's cup.

"Up to a point," said Smithy. "I don't believe in being too dogmatic about a particular chassis myself before I've started work on it; but it is a definite fact that chassis of a particular make and type tend to exhibit continually recurring faults peculiar to themselves. You soon discover what these faults are through experience, and by nattering with other people who are in the game. Here again, I would say that it's worthwhile quickly checking for a known prevalent fault before you get down to the logical approach. You may, once more, be lucky."

As the Serviceman sipped his tea a suspicious expression crossed his face.

"Is the milk all right?" he asked tentatively.

"Brand-new half-pint this morning."

"Well, there's something queer about this tea," said Smithy. "I thought the first cup tasted a little funny. This one is worse."

"It *should* be all right," replied Dick. "The tea's out of the same packet we've been using over the last few days. Mine's O.K."

"Hmm," grunted the Serviceman. "Perhaps it's my imagination."

"A train of thought started by my using the steel rule for stirring?"

"Could be," said Smithy doubtfully.

Logical Approach

"What about the logical approach to fault-finding itself?" asked Dick.

"Well," said Smithy, dismissing the tea from his mind, "this comes into operation after you've carried out your quick initial checks. Logical fault-finding is, essentially, a matter of elimination.

"The first thing to do is to mentally divide the job you're working on into blocks. Let's take the simplest example I can think of, this being a straightforward a.m. five-valve superhet. You can divide such a receiver into seven blocks. Like this." Smithy picked up a notebook and sketched out the blocks. (Fig. 2.) "The blocks are: frequency-changer, oscillator, i.f. amplifier, signal and a.g.c. detector, a.f. voltage amplifier, a.f. output, and power supply. You should mentally add a line back from the sound and a.g.c. detector to the frequency changer and i.f. amplifier. This represents the a.g.c. line, which can also give trouble.

"Right! Now let's assume we have such a receiver and that it produces no signals whatsoever. How would you tackle it?"

"Well," said Dick. "The first thing I'd check is the power supply for heater and h.t. volts, following on to the output valve. A visual check will tell you whether the valves are getting a heater supply and a quick prod with the testmeter will indicate whether h.t. is present or not. If you next touch the grid of the output valve with your finger you should get a slight hum from the speaker. If you then touch the grid of the a.f. voltage amplifier, with the volume control set to maximum, you should get a loud hum. It's not a bad idea to start off by touching the grid of the a.f. voltage amplifier first of all. If this gives you a loud hum, then both a.f. stages are working and h.t. *must* be present."

"Very good," approved Smithy. "Let's assume that you get your loud hum when you touch the grid of the voltage amplifier. What happens next?"

"What happens then" said Dick, "is that you've got to start looking into the stages preceding that grid. One technique would be to set the signal generator up to the intermediate frequency and apply its output, modulated, of course, to the grid of the i.f. amplifier and the signal grid of the frequency-changer. However, I think personally that it's quicker to work with the testmeter on its own. If you apply the testmeter between chassis and the anode of the i.f. amplifier you should get a crackle from the speaker. (Fig. 3.) Also, the testmeter will tell you whether there is h.t. voltage on the anode or not. If you don't hear the crackle then the fault lies between the anode and the grid of the a.f. voltage amplifier.

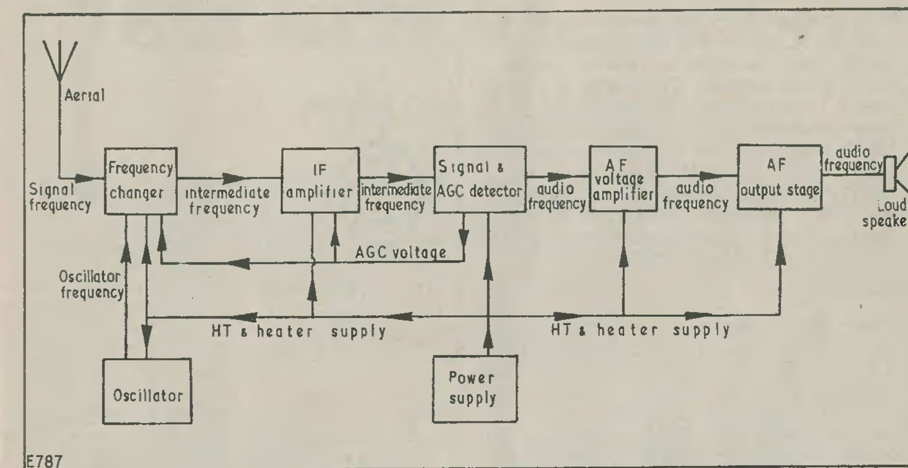


Fig. 2. Block diagram of a five valve a.m. superhet. The faulty stage may be isolated by logical servicing techniques

"You then repeat the process on the frequency-changer anode, whereupon you should get quite a good loud crackle. As well, of course, as a reading in the testmeter if h.t. is present."

"Let's assume you get h.t. on the anode of the frequency-changer but no crackle."

"Then," said Dick, "you're losing your signal in the i.f. amplifier. A quick prod with the testmeter on the screen and cathode pins will most probably tell you what's happening here. (Fig. 4.) If there's no voltage on the screen-grid then it's almost certain that the series resistor has gone open or that the decoupling condenser is short-circuited. If you get no voltage on the cathode then either the cathode decoupling condenser has gone short-circuited or the valve is drawing no current. In this case it will almost certainly be the latter, because a

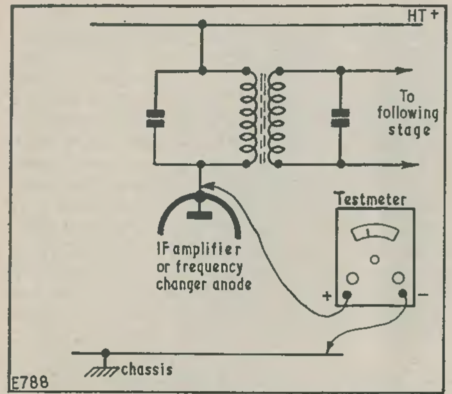


Fig. 3. A useful test for isolating the faulty stage in an a.m. receiver which picks up no signals. Connecting a testmeter (switched to a suitable voltage range) between chassis and the anode of the i.f. amplifier valve will cause a crackle to be heard from the speaker if the succeeding stages are capable of passing a signal. Similarly connecting to the anode of the frequency-changer should cause a louder crackle

short-circuited cathode decoupling condenser wouldn't cause the set to go completely dead. If you haven't swapped valves initially, the i.f. amplifier valve should definitely be swopped at this stage. Should a new valve draw no current then the fault may quite probably be poor connections to valveholder contacts, or something silly like that!"

"That covers the most probable points," agreed Smithy. "Let's now imagine that you

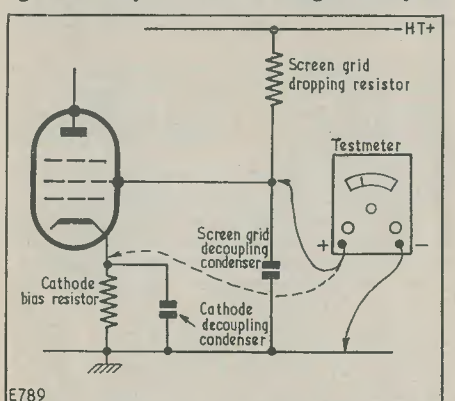


Fig. 4. Checking for the presence of voltage on the screen-grid and cathode of the i.f. amplifier

get a loud crackle when you touch the anode of the frequency-changer with your prod."

"Okey-doke," said Dick. "The loud crackle will tell us that the set is almost certainly capable of passing a signal from the frequency-changer anode onwards, and so we start looking into the frequency-changer and the oscillator. Here, again, the testmeter can be brought into play. I would first of all check that the oscillator was running; and a very quick test here consists of checking for voltage on the oscillator grid with a 47kΩ resistor in series with the test prod. (Fig. 5.) A healthy oscillator will still keep running with this additional load on its grid and the reading on the testmeter should indicate some 7 to 20 volts negative relative to cathode. In all cases when I've used this

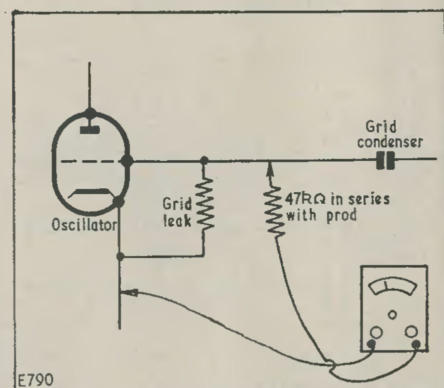


Fig. 5. Oscillator operation may be checked by connecting a testmeter, switched to a suitable voltage range, to the grid and cathode as shown here

test in practice, incidentally, I've found that the oscillator still keeps running if you apply the meter lead direct to the grid without a series resistor at all. However, that's by the way. If the oscillator isn't running then it is in this stage, obviously, that the fault is situated. You therefore do the usual prodding around for h.t. at the anode and things of that order. If the oscillator *is* running then you check around the frequency-changer in the same manner. Oh, and, of course, you swop the bottle in either instance if this hasn't been done earlier."

"That seems very fair," said Smithy. "The process takes a little time to explain but it can be carried out very quickly. As, in fact, can most other service jobs if you use a logical process of elimination."

Success at Last ?

The Serviceman took a final sip at his tea, whereupon he gave a startled exclamation and spat back into the cup again.

"Ye gods," he said. "There *is* something wrong with this tea!"

He picked up a screwdriver and stirred the dregs in his cup. He drew it out again to find that its blade was covered with a white treacly substance which was visibly hardening as they watched it.

"Oh lor," said Dick, his eyes dilating with horror. "That must be the cup I mixed the cold-setting glue in!"

* * *

Reflecting later about the period immediately following this incident, Dick could not help but admit to himself that it would have been more tactful if he hadn't pointed out to Smithy that they had, at last, stumbled on a successful method of getting a glue to set in the Workshop.

TRADE REVIEW

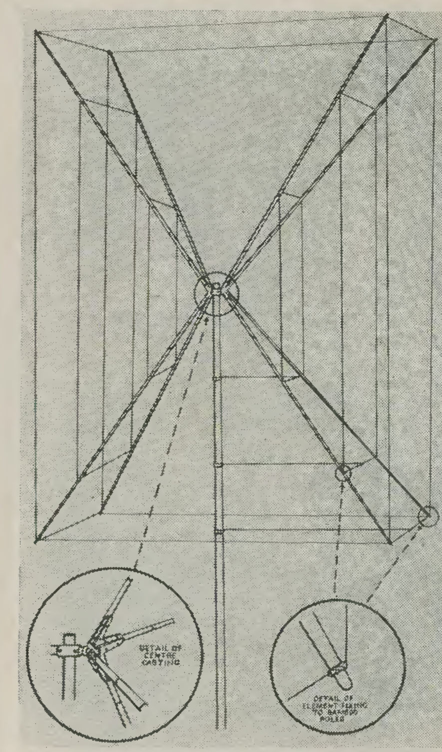
14, 21 and 28 M/cs Quad Array introduced by Labgear

Due to their lightness and high efficiency, quad aerials have been steadily growing in popularity amongst amateurs over the last few years, and it is interesting to note the introduction of a commercially manufactured array (supplied in kit form). The array, known as the Three-Band Quad Aerial Kit, type E.5050, is available from Labgear Ltd., Willow Place, Cambridge.

The accompanying illustration shows the assembled Labgear kit. Eight bamboo supports splay out from the alloy centre casting, supporting three separate quad driven elements and three separate quad reflectors. The driven elements are on the right and three separate coaxial feeders connect into the centres of their bottom horizontal spans. The reflectors are on the left of the illustration. The four horizontal lines joining the tips of the bamboo supports at top and bottom represent nylon cord, which braces the whole assembly.

Each driven element is intended to be coupled to its own coaxial feeder (not supplied with the kit), thereby overcoming the losses and mismatch which might be caused by coupling all aerials to a single feeder. Spacing and element lengths are such that no tuning is required after assembly. The impedance of each driven element is 75Ω and a standing wave ratio of less than 2:1 over the amateur bands in question is claimed. Forward gain, on each band, is not less than 9dB, with a front-to-back ratio of 30dB minimum.

The assembly employs non-corroding alloy castings and the mast head fitting accommodates masts up to 2in in diameter. The bamboo supports are 15ft in length and the complete assembly forms a cube having a side of approximately 17ft.



The Labgear Three-Band Quad Aerial in its assembled form

UNDERSTANDING TELEVISION

PART 33

By W. G. MORLEY

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

In last month's issue we discussed the manner in which frame sync pulses are extracted from the composite transmitted synchronising information. We showed that, in the 405 line system (which, unlike the 525 and 625 line systems, does not have equalising pulses before and after the frame sync pulses) the integrated frame pulses for even and odd frames differ in time relative to the leading edge of the first frame pulse; and that special circuit techniques are employed to overcome this tendency and, thereby, obtain satisfactory interlace. In this month's issue we shall carry on to flywheel sync circuits.

Flywheel Sync

In a receiver whose line sawtooth generator is directly synchronised by differentiated line sync pulses, it is possible for line flyback to be initiated before its proper time by random bursts of impulsive interference. The result is that one or more lines may be displaced from their correct position in the reproduced picture until the line sawtooth generator settles down to correct frequency again. The displacement of a line or lines in the picture due to interference is described as *line tearing*.

Line tearing is obviated in receivers employing flywheel sync circuits because flyback is not initiated by the line sync pulses Instead, the frequencies of the line sawtooth generator and the line sync pulses are *compared*, a d.c. control voltage proportional to their difference being fed back to the sawtooth generator via a time delay circuit. This d.c. control voltage is capable of varying the frequency of the sawtooth generator. The block diagram of Fig. 198 illustrates the arrangement.

If the frequency of the line sawtooth generator is higher than that of the line sync pulses the d.c. control voltage causes it to be reduced. If, on the other hand, the frequency of the line sawtooth generator is lower than that of the line sync pulses the d.c. control voltage causes it to be raised. Thus, the line sawtooth generator is made to operate at line sync frequency without line sync pulses being actually applied to it.

The important feature of the flywheel sync principle is that, due to the time delay undergone by the control voltage, dissimilarities between line sync pulse frequency and line sawtooth generator frequency are corrected relatively slowly. In consequence, single lines (and those immediately following them) cannot be displaced from their position in the reproduced picture by random pulses of interference. It is the relative slowness of frequency correction which provides the essential "flywheel" action. In practical receivers, the time delay suffered by the control voltage may vary between the period occupied by several lines and that occupied by several hundred lines.

It is the usual British practice to employ flywheel sync in receivers designed for "fringe" reception only, direct line synchronising being used in "soak" receivers intended for areas of high signal strength. Often, indeed, the only major difference between the "fringe" and "soak" versions of a particular British model is that the former has flywheel sync and that the latter has direct line sync. 525 and 625 line receivers are frequently called upon to receive signals whose strengths are markedly dissimilar (as opposed to the situation existing in Britain where "soak" and "fringe" areas for the two channels available may be fairly readily defined) with the result that almost all such receivers employ flywheel sync.

Flywheel sync circuits are not employed in the frame timebases of television receivers.

Controlling Sawtooth Generator Frequency

An essential requirement in a flywheel sync circuit is that the frequency of the line sawtooth generator must be capable of being controlled by a d.c. voltage. We shall now examine how such control may be achieved.

Fig. 199 (*a*) illustrates a blocking oscillator, to the lower end of whose grid leak a control voltage is applied. If the control voltage is at chassis potential, then the blocking oscillator behaves in the manner with which we are already familiar[1] and will give the grid voltage waveform shown in Fig. 199 (*b*). Before point A in this waveform the grid condenser is slowly discharging into the grid leak, thereby causing the grid to become progressively less negative. At point A grid voltage becomes equal to cut-off voltage and anode current commences to flow. The flyback period then commences, causing the grid to swing violently negative to point B; after which there is a small positive excursion to point C, this latter being caused by the transformer secondary voltage returning to zero. Following point C we have a slow decrease in negative grid voltage as the grid condenser discharges into the leak. At point D cut-off potential is reached once more.

If we continue the slow discharge curves of Fig. 199 (*b*) beyond the cut-off points at A and D we obtain a continuation of the familiar curve given by a condenser discharging into a resistor which is connected across it. The extension of the curve is shown in dotted line in the diagram.

If we now change the control voltage from chassis potential to a potential which is positive of chassis, we will obtain a grid waveform similar to that shown in Fig. 199 (*c*). In this diagram points "P", "Q" and "R" correspond to points "A", "B" and "C" in Fig. 199 (*b*), because the grid condenser receives a charge, during the flyback period, in exactly the same manner. After point "R" the condenser commences to discharge.

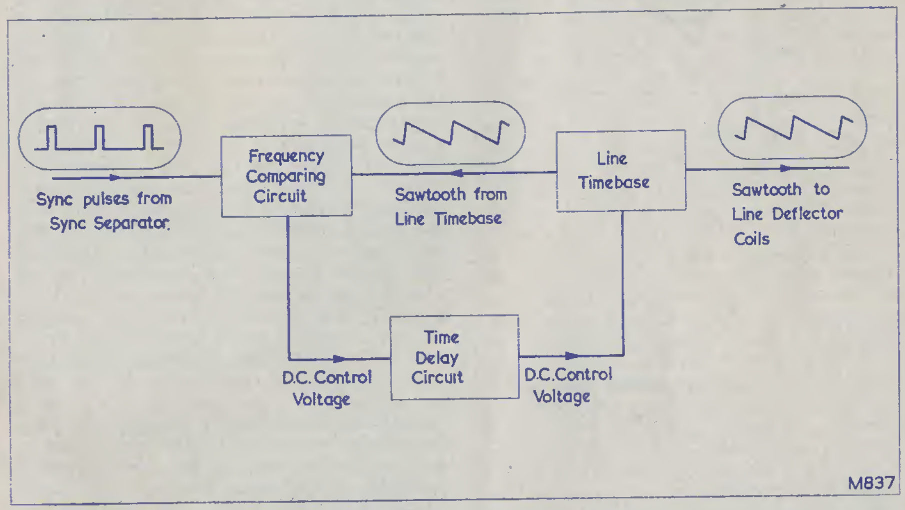


Fig. 198. Block diagram illustrating a basic flywheel sync system. Sync pulses from the sync separator and a sawtooth from the line timebase are fed to a frequency comparing circuit and a control voltage obtained therefrom. This control voltage corrects differences between line timebase and sync pulse frequency. The system also enables the requisite phase relationship between the two frequencies to be achieved

[1] Blocking oscillator operation was fully described in "Understanding Television" part 23, December 1959 issue.

This time, however, it discharges into a resistor whose remote end is held at a positive potential relative to chassis. In consequence, the discharge curve of the condenser is steeper and it cuts the cut-off voltage line at an earlier moment, at "S", than it did, at "D", in Fig. 199 (*b*). The discharge curve of the condenser is continued in dotted line in Fig. 199 (*c*) and it will be seen that it now tends towards the positive control potential rather than to chassis (zero) potential.

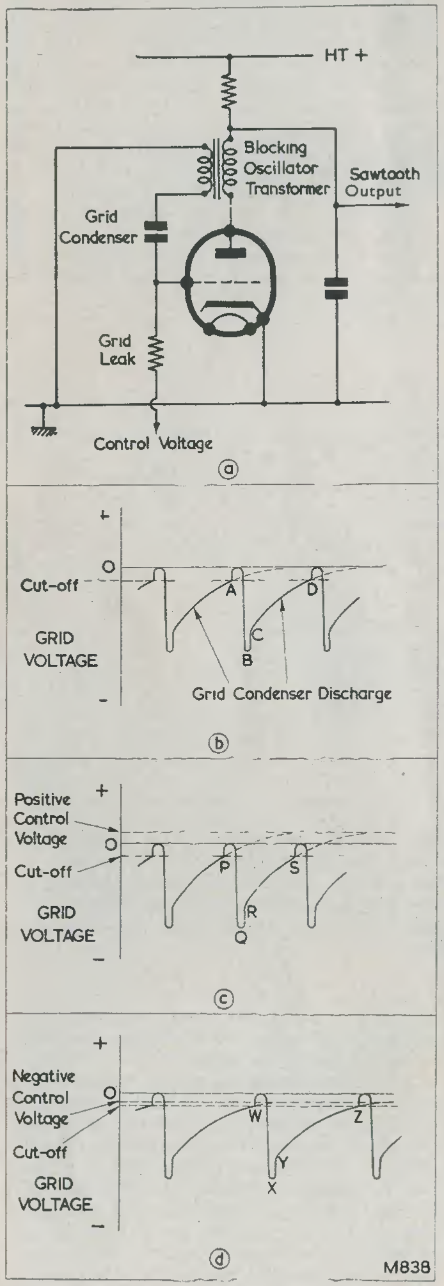


Fig. 199 (*d*) illustrates the grid waveform which results when the control voltage applied to the grid leak is negative of chassis. In this case the condenser discharge curve is less steep than that of Fig. 199 (*b*), and it cuts the cut-off voltage line, at "Z", at a later instant in time. Points "W", "X" and "Y" of Fig. 199 (*d*) correspond once more to points "A", "B" and "C" of Fig. 199 (*b*), and the discharge curve is continued in dotted line.

The three waveforms of Fig. 199 illustrate the fact that the frequency of a blocking oscillator may be varied by varying a d.c. control voltage applied to its grid leak. If the control voltage is made positive of chassis the frequency increases (Fig. 199 (*c*)), and if it is made negative the frequency decreases. (Fig. 199 (*d*)). An important point which has not yet been referred to is that the control voltage must not be made more negative than the cut-off potential for the valve, or the oscillator will cease to function. (Because grid voltage cannot then rise above cut-off potential to initiate the flyback period.) In practical line flywheel circuits the control voltage normally varies between two limits which are both positive of chassis, whereupon the possibility of oscillator cessation does not arise.

Multivibrators[2] may similarly have their frequencies controlled by the application of a d.c. control voltage. In this case the control voltage is applied to the grid leak of the valve which is cut-off during the scan period, whereupon it once more controls the time taken for the grid to rise to cut-off potential as its condenser discharges. Again, in practical receivers, it is usual for the control voltage to vary between two limits both of which are positive of chassis.

An alternative method of controlling line sawtooth generator frequency consists of employing a *reactance valve* in combination with a sine wave oscillator. The latter runs at line frequency and its sine wave output is shaped to make it suitable for application to the grid of the line output valve.[3] The reactance valve is connected across the oscillator tuned circuit in a manner which causes it to function as a capacity or inductance, a typical instance being illustrated in Fig. 200.

[2] Multivibrator operation was described in "Understanding Television", part 24, January 1960 issue.

Fig. 199. Illustrating how a blocking oscillator, shown in (a) may have its frequency controlled by a d.c. voltage applied to its grid leak. In (b) the control voltage is at chassis potential, in (c) it is positive of chassis, and in (d) it is negative of chassis. The positive control voltage causes an increase in frequency and the negative voltage a decrease in frequency

In Fig. 200 the reactance valve consists of a pentode having a condenser, C_1, coupling its anode to its grid. The anode and cathode of the valve are connected effectively across the tuned circuit (the d.c. blocking condenser, C_3, having negligible reactance at the frequency of oscillation) and a control voltage is applied via resistor R_1 to the grid. Due to the presence of the anode-grid condenser the reactance valve appears to the tuned circuit as a capacity, the value of which is directly proportional to its mutual conductance.[4] The mutual conductance of the valve may be altered by varying its grid voltage. In consequence, the control voltage of Fig. 200 is capable of varying the effective capacity applied across the tuned circuit and, therefore, the frequency at which the latter oscillates.

Unlike the blocking oscillator and multivibrator instances, the control voltage applied to a reactance valve may not go positive of its cathode. Control voltage limits lie between cathode potential and cut-off potential for the valve.

Comparing the Frequencies

A number of different methods have been evolved for comparing line sync pulse and sawtooth generator frequencies in flywheel sync circuits. Some of these tend to be complex. Modern British design appears, however, to be centring around two relatively simple basic circuits, and these will now be considered.

Fig. 201 illustrates what is sometimes described as a *coincidence detector*[5]. The valve in this diagram is a pentode to whose screen-grid are fed positive-going line sync pulses. Such pulses may be obtained by applying negative-going sync pulses from the sync clipper anode to the grid of a separate amplifying/inverting valve, at the anode of which positive-going sync pulses of good amplitude then appear. This anode may be connected directly to the screen-grid of the pentode. Between sync pulses the screen-grid of the pentode is close to chassis potential, and the valve is capable of passing only a low anode current. The sync pulses raise the screen-grid to a potential which is well above chassis, thereby allowing the valve to pass its normal anode current when they are present.

Applied to the control grid of the pentode is a sawtooth derived from the line sawtooth generator or from the line output stage. In the example illustrated in Fig. 201 the waveform is positive-going during the short, flyback, period. The condenser and grid leak, C_1 and R_1, cause leaky-grid biassing action to take place, with the result that the most positive part of the sawtooth is approximately at cathode potential. The amplitude of the sawtooth waveform is made such that its most negative part does not fall outside cut-off potential.

Figs. 202 (*a*), (*b*), and (*c*) illustrate the grid voltage and anode current waveforms of the pentode for three different phase relationships between the sync pulses and the sawtooth; that shown in Fig. 202 (*a*) representing the desirable case wherein both frequencies are equal. In Fig. 202 (*a*) the sawtooth waveform is applied to the grid such that the central part of its flyback section is coincident with the duration of the line sync pulse. The valve passes current during the presence of the line sync pulse, with the result that anode current flows as shown in the diagram.

Fig. 202 (*b*) shows what occurs if the frequency of the sawtooth is higher than that of the line sync pulses. Since the sawtooth frequency is higher its flyback section arrives earlier, and its upper section is now coincident with the line sync pulse. Because, during its period of conduction, the control grid of the pentode is more positive in Fig. 202 (*b*) than it is in Fig. 202 (*a*), the anode current passed is greater.

In Fig. 202 (*c*) we have the case where the sawtooth frequency is lower than sync pulse frequency. The flyback section of the sawtooth now arrives later, and it is its earlier, lower, section which is coincident with the line sync pulse. Since, during the period of conduction, the control grid is more negative in Fig. 202 (*c*) than it is in Fig. 202 (*a*), the anode current passed by the pentode is less.

We can now see that, when the sawtooth generator oscillates at too high a frequency the pentode of Fig. 201 draws an anode current which is greater than average and that, when the sawtooth generator oscillates at too low a frequency the pentode draws an anode current which is lower than average. These changes in anode current cause different voltages to be dropped across the

[3] The shaping may be given by applying the sine wave to a valve connected into circuit in such a manner that it is heavily overloaded. This valve may form part of the oscillator itself. The resulting waveform, an assymetric square wave, then has its pulse sides "sharpened" by feedback from the line output stage.

[4] The effective capacity offered by the valve is approximately equal to *gm RC*, where gm is mutual conductance, "R" the grid resistor, and "C" the anode-grid condenser.

[5] Other names may be encountered, such as "phase comparator", "sync discriminator", etc. "Coincidence detector" would appear to be a term which accurately describes the circuit.

anode resistor, R_2; the high sawtooth frequency resulting in a lower than average anode voltage and the low sawtooth frequency resulting in a higher than average anode voltage. In Fig. 201 the anode is connected to a network (R_3, C_2, R_4, C_3) which causes the average anode voltage to appear at the point designated "Control Voltage". The voltage available at this point may be applied direct to the grid leak of the blocking oscillator of Fig. 199 (*a*); whereupon a flywheel sync system is at once set up. When with this arrangement, the blocking oscillator runs at too high a frequency the control voltage drops, bringing it back to correct frequency again. When the blocking oscillator operates at too low a frequency the control voltage rises, returning it to the correct frequency once more. Exactly the same result would be given if the appropriate grid leak of a multivibrator were similarly connected.

In Figs. 201 and 202 it is assumed that a rectangular line sync pulse is fed to the screen-grid of the pentode. The circuit may also function if the line sync pulse is differentiated and a positive-going spike-shaped pulse corresponding to its leading edge is fed to the screen-grid instead. In the latter case the desirable phase relationship will occur when the centre of the flyback period of the sawtooth is coincident with the spike-shaped pulse.

The line frequency, or line hold, control required with the combination of coincidence detector and blocking oscillator may be given by making the blocking oscillator grid leak a variable component, in just the same way as would be done if it were returned to chassis. A significant factor not yet discussed is that adjustment of this control, within the range over which it enables sawtooth frequency to be controlled by the flywheel sync system, will cause variations in *phase* between the two frequencies. If the control is set to minimum resistance within the range the sawtooth generator will attempt to run at too high a frequency, causing the pentode anode voltage to fall to a lower than average level in an attempt to correct it. At the same time, if the control is set to maximum resistance within the range the sawtooth generator will tend to run at too low a frequency and the pentode anode voltage will rise to a higher than average level in an attempt at correction. These two conditions correspond to those

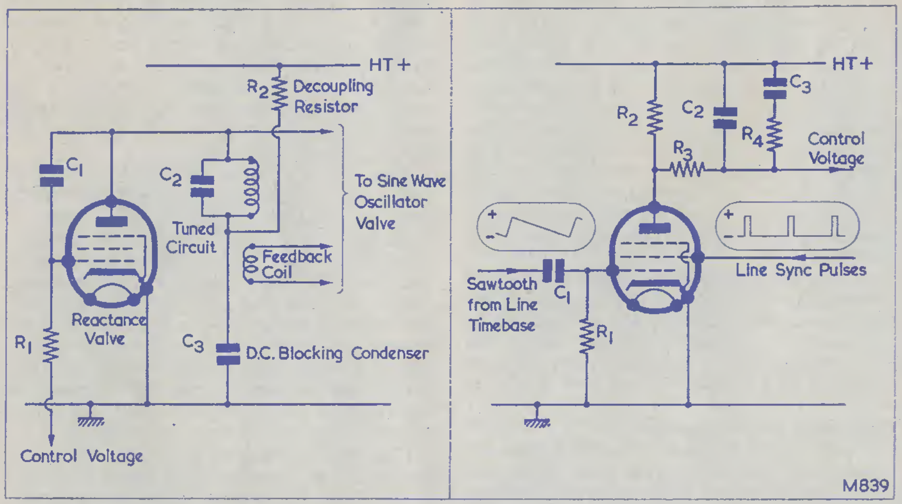


Fig. 200 (left). A reactance valve coupled to the tuned circuit of a sine wave oscillator. Variations in control voltage cause the reactance valve to apply varying effective capacity across the tuned circuit, thereby altering its resonant frequency. The decoupling resistor, R_2, and d.c. blocking condenser, C_3, provide a convenient means of applying h.t. to the anode of the reactance valve via the coil of the tuned circuit. The blocking condenser has negligible reactance at oscillator frequency Fig. 201 (right). A coincidence detector. In the presence of line sync pulses the screen-grid of the pentode is raised to a potential which allows the valve to pass its normal anode current. R_3 and C_2 form a time delay circuit for the control voltage on the anode

illustrated in Figs. 202 (*b*) and (*c*) respectively. Figs. 202 (*b*) and (*c*) also show the phase relationships which exist for the two conditions. Thus, minimum line frequency control resistance within the useful range gives a phase relationship similar to that of Fig. 202 (*b*), and maximum control resistance within the useful range a phase relationship similar to that of Fig. 202 (*c*). The visible effect on the reproduced picture is that the latter moves bodily from left to right, or from right to left, as the line frequency control is adjusted within the range over which flywheel sync is effective. Whilst it would appear most desirable to set the line frequency control to the centre of its useful range, thereby obtaining the phase relationship of Fig. 202 (*a*) with optimum control, in both directions, of sawtooth frequency, it may occasionally be necessary, with practical receivers having relatively long line flyback periods, to choose an operating point which gives a phase relationship lying midway between Figs. 202 (*a*) and (*b*). Such an operating point causes line flyback in the receiver to be initiated at an earlier time relative to the leading edge of the line sync pulse than occurs in Fig. 202 (*a*), with the result that line foldover at the left hand side of the picture is obviated.[6] If, instead of the line sync pulse, a differentiated spike-shaped pulse obtained from the leading edge of the pulse were applied to the screen-grid of the pentode, this situation would be slightly eased, as the period of coincidence would then occur at a relatively earlier time.

The second type of frequency comparing circuit to be discussed is illustrated in Fig. 203. This circuit can be described as a *phase discriminator*.[7] In Fig. 203 we have a phase-splitting triode, V_1, to whose grid are fed negative-going line sync pulses. The phase-splitter (which acts in exactly the same manner as would a similar circuit in a conventional a.f. amplifier) causes positive-going line sync pulses to appear at its anode and negative-going line sync pulses to appear at its cathode. These pulses are applied to the two diodes in series via the condensers C_2 and C_3.

[6] Line foldover at the left hand side of the picture occurs when picture information in the following line commences before flyback, in the receiver, has been completed. Such information can appear, expanded and faint (because of the high scanning speed during flyback) on the screen.

[7] Other names, such as "sync discriminator", etc., may be encountered.

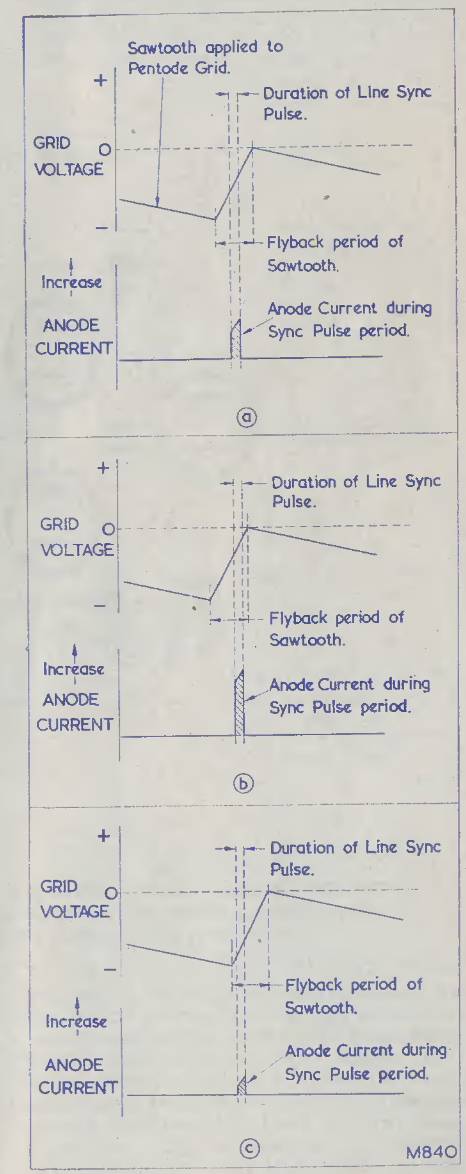


Fig. 202. The anode current passed by the pentode of Fig. 201 for different phase relationships between the sawtooth waveform and the line sync pulses. In (a) the line sync pulse appears at the centre of the flyback section of the sawtooth. In (b) the sync pulse period coincides with the later, more positive, part of the flyback section of the sawtooth and anode current increases in consequence. This corresponds to too high a sawtooth frequency. Too slow a sawtooth frequency is illustrated in (c). In this instance the early part of the flyback section coincides with the line sync pulse and anode current reduces

When the two sets of sync pulses are applied to the diodes the latter conduct, causing C_2 and C_3 to charge. Between sync pulses the diodes become non-conductive, and C_2 and C_3 discharge slowly. Thus, the diodes conduct when sync pulses peaks are present and are non-conductive between such peaks.

A sawtooth having a positive-going flyback section, and an average voltage equal to chassis potential (because of the coupling condenser, C_4, through which it is applied), is obtained from the line sawtooth generator or line output stage and fed to the junction of the two diodes. The potential held by the sawtooth during the period of diode conduction appears (with the addition of a small potential due to voltage drop in the conducting upper diode) on the anode of the upper diode, and (with a small potential loss due to voltage drop in the conducting lower diode) on the cathode of the lower diode. The small gain and loss in potential in the conducting diodes are cancelled out at the junction of the two equal-value resistors R_6 and R_7; whereupon the potential at this junction becomes equal to that held by the sawtooth at the period when the diodes conduct. This potential may be employed as a control potential in a flywheel sync system.

Figs. 204 (*a*), (*b*) and (*c*) give waveforms to illustrate the process. As may be seen, these diagrams follow much the same principle evident in Figs. 202 (*a*), (*b*) and (*c*).

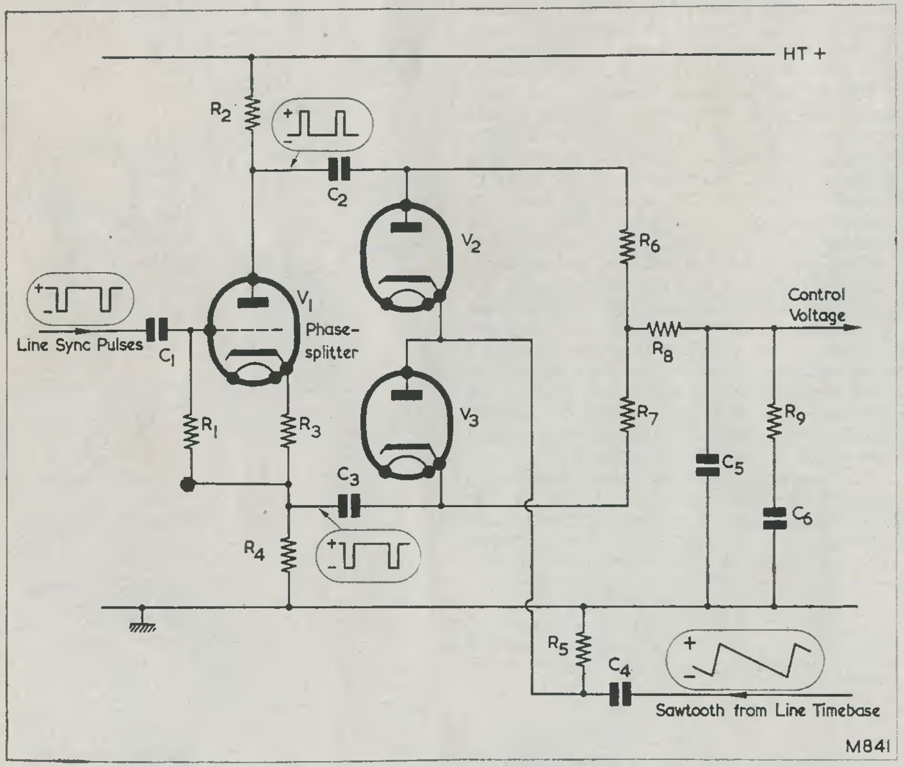


Fig. 203. A phase discriminator circuit. The diodes conduct in the presence of sync pulse peaks, the voltage on the sawtooth waveform at the time of conduction appearing at the junction of the equal-value resistors R_6 and R_7

Again, Fig. 204 (*a*) represents the preferable central, case. In Fig. 204 (*a*), where the diodes conduct during the middle of the flyback section of the sawtooth, the control voltage obtained centres at chassis potential. In Fig. 204 (*b*) sawtooth frequency is greater than line sync pulse frequency, with the result that the conducting period of the diodes occurs during the latter part of the flyback section. The control voltage goes positive of chassis. Fig. 204 (*c*) illustrates the case where the sawtooth frequency is lower than line sync pulse frequency. In this instance the diodes conduct during an early part of the flyback section and the resultant control voltage is negative of chassis.

The control voltage obtained from the circuit of Fig. 203 is not normally suitable for application to a blocking oscillator or a multivibrator because it can go negative of chassis. Also, change of voltage for change of sawtooth generator frequency may be too low for adequate control. In consequence, it is usual to apply the control voltage to the grid of a triode which amplifies and inverts it, as in Fig. 205.[8] We now have the case where too high a sawtooth generator frequency results in a positive-going voltage from the diodes and, in consequence, a negative-going voltage at the following triode anode. Similarly, too low a sawtooth generator frequency results in a negative-going voltage from the diodes and a positive-going voltage at the triode anode. Thus, the grid leak of a blocking oscillator or multivibrator may be connected to the anode of the following triode and a flywheel sync system set up.

As with the pentode coincidence detector case, line frequency control may be obtained by making the oscillator grid leak variable. Exactly the same remarks about the effect exerted by this control on phase relationship between the two frequencies are applicable here. Also, it may in practice be necessary to make the desired line frequency control setting that which causes the phase relationship to lie between Fig. 204 (*a*) and (*b*) if foldover at the left hand side of the picture is to be avoided.

In some receivers the phase-splitting valve of Fig. 203 may be replaced by a transformer having a centre-tapped secondary, as shown in Fig. 206. Sync pulses are fed to the primary of this transformer, causing pulses of opposite polarity to appear at the outside terminals of the secondary. The circuit functions in the same manner as that of Fig. 203.

The thermionic diodes shown in Figs. 203 and 206 may, in some instances, be replaced by germanium diodes or by small metal rectifiers.

Points of Comparison

In Fig. 201 the delay circuit inserted in the control voltage line to the oscillator grid leak is provided by R_3 and C_2. In Fig. 203 it is provided by R_8 and C_5. Also shown in these two diagrams are a further resistor and condenser in series between the control voltage line and chassis (or the h.t. positive rail). These are R_4 and C_3 in Fig. 201 and R_9 and C_6 in Fig. 203. The series resistor

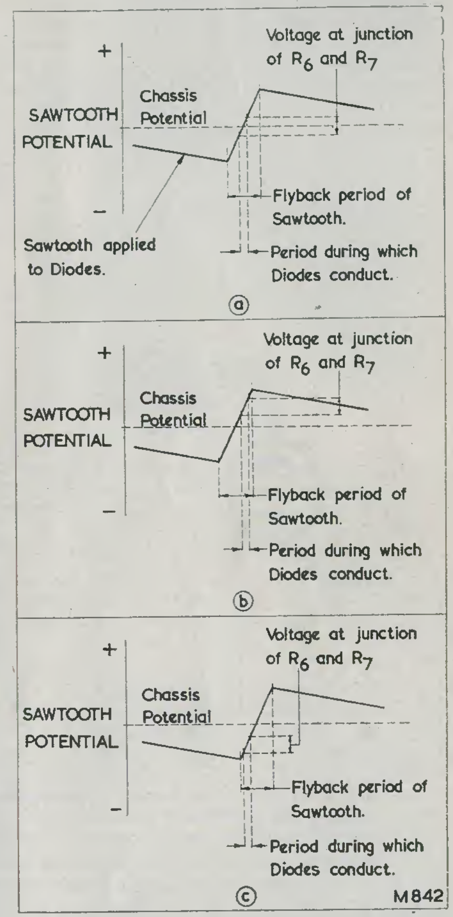


Fig. 204. The control voltages given at the junction of R_6 and R_7 of Fig. 203 for different phase relationships between sawtooth waveform and line sync pulses. In (a) the period of diode conduction occurs at the centre of the flyback period and the average control voltage is at chassis potential. In (b) sawtooth frequency is high, and the control voltage is positive of chassis. In (c), sawtooth frequency is low, resulting in a control voltage which is negative of chassis

and condenser form a "damping circuit" and their function is that of preventing undue change of control voltage during the frame blanking period when regularly-spaced line

[8] This triode may serve the further function of operating as a "buffer", or isolating stage, which prevents unwanted coupling from the sawtooth generator back to the discriminator circuit.

sync pulses are not transmitted. Their values are, normally, critical.

Both the circuits of Fig. 201 and Fig. 203 are susceptible to impulsive interference. If an interference pulse sufficiently large to cause the pentode of Fig. 201 to pass current is applied to its screen-grid, an anode current whose amplitude is dependent upon that of the pulse and on that of the sawtooth applied to its control grid at that instant will flow. Such a current will constitute an error signal. changing, etc.) the line sawtooth generator still runs at approximately the correct frequency. On the other hand absence of sync pulses with the circuit of Fig. 201 causes the anode potential of the pentode to rise, and thereby increase sawtooth generator frequency. This last difficulty may be overcome by employing an additional valve in the circuit, to whose grid is fed a video signal with positive-going sync pulses by way of a grid condenser and leak. This valve passes

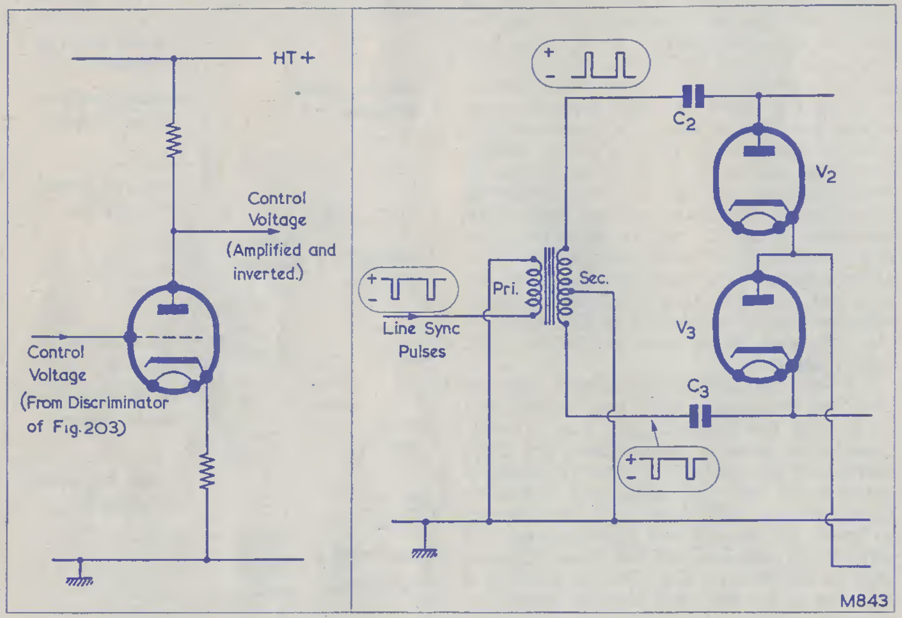


Fig. 205 (left). The control voltage available from the circuit of Fig. 203 is not suitable for application to a blocking oscillator or multivibrator. It is, therefore, usually amplified and inverted by a simple valve amplifier, as shown here

Fig. 206 (right). The phase-splitting valve of Fig. 203 is sometimes replaced by a transformer with a centre-tapped secondary, as illustrated here

At the same time, if an interference pulse equal to, or greater than, sync pulse amplitude is passed to the phase-splitter of Fig. 203, the diodes will conduct and cause a voltage to appear at the junction of R_6 and R_7 which is equal to that of the sawtooth at that instant. Again, there is an error signal. Practical difficulties resulting from interference pulses are, however, slight because the time delay network allows sawtooth generator frequency to change at a slow rate only.

The circuit of Fig. 203 has an advantage over that of Fig. 201 inasmuch that, in the absence of sync pulses, the control voltage is at chassis potential, and is therefore equal to, or close to, the desired control potential. Thus, if sync pulses are lost for a period of time (due to transmitter breakdown, channel

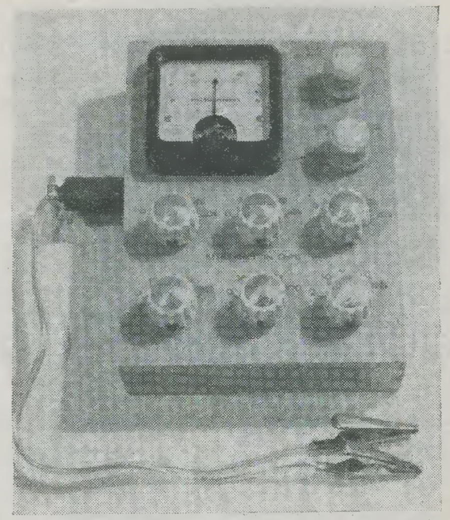
anode current, therefore, only when sync pulses are present. Should there be a cessation of signal the additional valve passes a much higher anode current. By connecting the anode of the additional valve to that of the pentode by means of a suitable resistance coupling, it is possible for this increased anode current to bring the pentode anode back to its normal operating point, whereupon the sawtooth generator runs at approximately correct frequency.

Next Month

In next month's issue we shall conclude our discussion of flywheel sync circuits, dealing with reactance valve and sine wave oscillator combinations.

An ACCURATE Resistance Measuring BRIDGE

By P. NELSON



IT IS OFTEN NECESSARY IN EXPERIMENTAL and servicing work to measure resistance in a circuit. Though this is conveniently done by simply applying a voltage and measuring the current flowing (as in most multimeters), such a system has some disadvantages. For instance, a set zero control must be included to compensate for changes in battery voltage with age, and the scale is always non-linear. This means that the measurement of resistance is difficult with an accuracy greater than about 5% even in the centre of the scale; also, to cover the wide range of resistance normally met with in radio work, a number of ranges have to be provided. Where greater accuracy is required it is necessary to use some form of bridge.

Circuit

The present unit is based on the familiar Wheatstone Bridge circuit (Fig. 1). In this instance, resistors A and B are made equal, D represents the unknown resistance, and C is a variable known resistance. If C is adjusted to obtain zero reading on the meter (i.e. to balance the bridge) its final value will equal that of the unknown resistance. Thus resistance may be measured, independently of battery voltage, with an accuracy dependent upon the accuracy of the standard resistance.

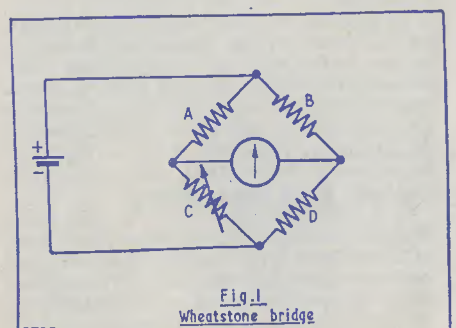


Fig. 1
Wheatstone bridge

The circuit of the bridge is given in Fig. 4. It was decided that 1% resistors would be used as standards since they are readily available, and they are so arranged that, by using switches S_3 to S_8 the maximum possible coverage of resistance (over the range 1Ω to 1.1MΩ) is obtained.[1] R_1 and R_2 are the equal resistors (corresponding with A and B in Fig. 1) and these should be matched as accurately as possible. A good idea is to obtain three resistors of the value needed (27kΩ, 1%) and to measure them on a standard resistance bridge, if access to one is available. The two with the nearest values are then used.

[1] The standard resistors are switched by S_3 to S_8 (in series) so that the total resistance in circuit is the sum of those values indicated by the switches. (See Figs. 2 and 3.) 1Ω and 2Ω appear on S_3, 3Ω on S_4 and 5Ω on S_5; 4Ω may be obtained using 1Ω on S_3 and 3Ω on S_4, and values from 6Ω to 10Ω using S_3, S_4 and S_5 together. The same system is used for resistances in 10Ω steps up to 100Ω on switches S_6 to S_8. Thus, by using all the switches, any value of resistance up to 100Ω may be chosen. Similarly, any two figure value of resistance, within the stated range, may be obtained, since each decade of values appears on the opposite row of switches (S_3 to S_5 or S_6 to S_8) from its higher or lower decade.

The meter used in the prototype was a small 50–0–50μA type obtained quite cheaply, though other centre zero meters could, of course, be employed. In the latter case, however, it may be necessary to increase the battery voltage (say to 24V) to retain the desired sensitivity. The battery is a miniature hearing aid type, and should not need very frequent replacement, since the maximum current drain is only about 1mA.

Switches S_3 to S_8 are 5-way, 2-pole wave-change types (only one pole being used in each case) and S_1 and S_2 are 3-way, 4-pole types. S_2 is used to switch the battery off when not in use, and in position 1 ("off") also places a short-circuit across the meter. This damps the movement so that the unit load. Position 3 ("Bridge 2") is then used to obtain the final balance.

Construction

For convenience, the prototype was constructed from ⅛in hardboard, small wood screws being used to hold the box together. A hinged back was provided for ease of access in changing the battery or for maintenance (should this be necessary). The dimensions and general layout are given in Figs. 2 and 3—details are not given since these will depend on the size of the meter, the types of switches available, etc. The unit was finished with a coat of paint, the positions of the switches being marked by Panel-Signs transfers.

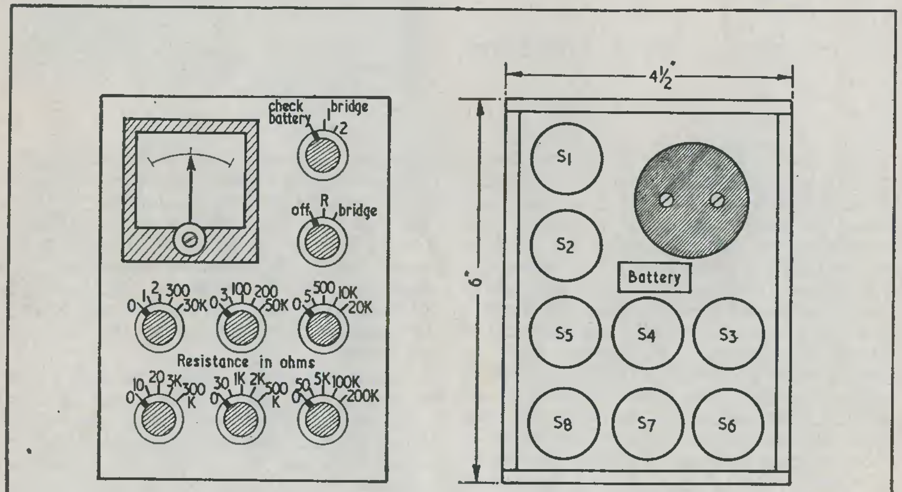


Fig.2 Front

Fig3 Rear

may be carried about without fear of damage to the meter. Position 2 of S_2 ("R") places the standard 1% resistors directly across the terminals, so that the unit may also be used as a resistance substitution box, making the fullest use of these accurate components. In position 3 ("Bridge") the circuit is re-arranged as a Wheatstone Bridge. S_1, which is only operative in this last position, enables (in position 1) the battery voltage to be checked in the condition of maximum load (in the prototype the value of R_{28} was chosen so that the scale would read directly in volts). In position 2 of S_1 ("Bridge 1"), the meter is shunted so that during the initial balance it is not subjected to an over-

Conclusion

In practice, the unit has been extremely useful, both in its resistance measuring bridge form, and as a substitution unit. Resistances over the range of 100Ω to several hundred kilohms may be measured with an accuracy of 1% (above this, sensitivity falls off so that at 1MΩ only 5% discrimination is obtained). Below 100Ω, resistance may be measured to the nearest ohm.

As a substitution unit, care should be taken that the rated wattage (in this case ½ watt) of the resistors is not exceeded; and it should be remembered that inevitable stray capacitances (about 20pF) make it unsuitable for use at higher than audio frequencies.

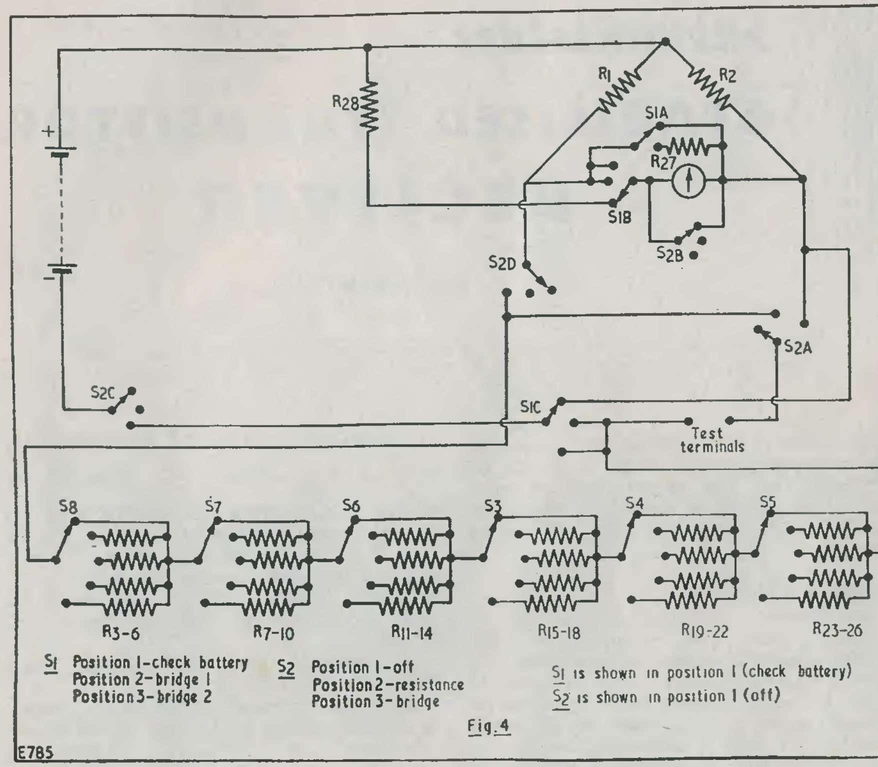


Fig.4

Components List

Resistors

R_1 27kΩ½W 1% } Matched pair
R_2 27kΩ } (see text)
R_3 50Ω ½W 1%
R_4 5kΩ ½W 1%
R_5 100kΩ ½W 1%
R_6 200kΩ ½W 1%
R_7 30Ω ½W 1%
R_8 1kΩ ½W 1%
R_9 2kΩ ½W 1%
R_{10} 500kΩ ½W 1%
R_{11} 10Ω ½W 1%
R_{12} 20Ω ½W 1%
R_{13} 3kΩ ½W 1%
R_{14} 300kΩ ½W 1%
R_{15} 1Ω ½W 10%
R_{16} 2Ω ½W 10%
R_{17} 300Ω ½W 1%
R_{18} 30kΩ ½W 1%
R_{19} 3Ω ½W 10%
R_{20} 100Ω ½W 1%
R_{21} 200Ω ½W 1%
R_{22} 50kΩ ½W 1%
R_{23} 5Ω ½W 10%
R_{24} 500Ω ½W 1%
R_{15} 10kΩ ½W 1%
R_{26} 20kΩ ½W 1%
R_{27} 56Ω ½W 10%
R_{28} 1MΩ ½W 1%

Miscellaneous

Meter 50–0–50μA
Battery 15V deaf-aid type
Switches—see text

AUTOMATIC WARNING FUSE HOLDER

Currently under development by A. F. Bulgin and Co. Ltd. is a new panel-mounting cartridge fuse holder, list No. D/F826, which incorporates a neon lamp. When the fuse blows this lamp becomes illuminated, thereby enabling quick location of faults on instrument panels. The fuse holder accepts a standard 1¼ by ¼in fuse, and the neon is visible from the front of the panel.

Subminiature STABILISED TRANSISTOR RECEIVER

By S. SMITH

This article describes the circuit of a subminiature two-transistor receiver and provides a comprehensive description of the manner in which it was designed

THE CIRCUIT OF THE COMPLETE TRANSISTOR receiver appears in Fig. 1. It will be seen that this circuit employs what may, at first sight, be somewhat unconventional design features, and these will now be discussed.

Transistor Stabilisation

The collector current in a transistor is almost at zero with a d.c. short-circuit between base and emitter. Assuming a p.n.p. transistor, an increase in positive potential on the base (relative to emitter) produces no change, whilst an increase in negative potential produces a substantial increase in collector current. If, therefore, we have a circuit such as that of Fig. 2, where L is the low impedance match to an aerial input tuned circuit, an incoming a.m. signal is rectified and amplified, producing an audio output across the collector load.

This arrangement is thermally stable because, for a.c. purposes, it is equivalent to an earthed base configuration. So far as a.c. is concerned, it functions in the earthed emitter mode. Fig. 2 represents the method of operation of TR_1 in the complete receiver circuit.

The second transistor functions as an earthed emitter stabilised amplifier, the principle of stabilisation being illustrated in Fig. 3.

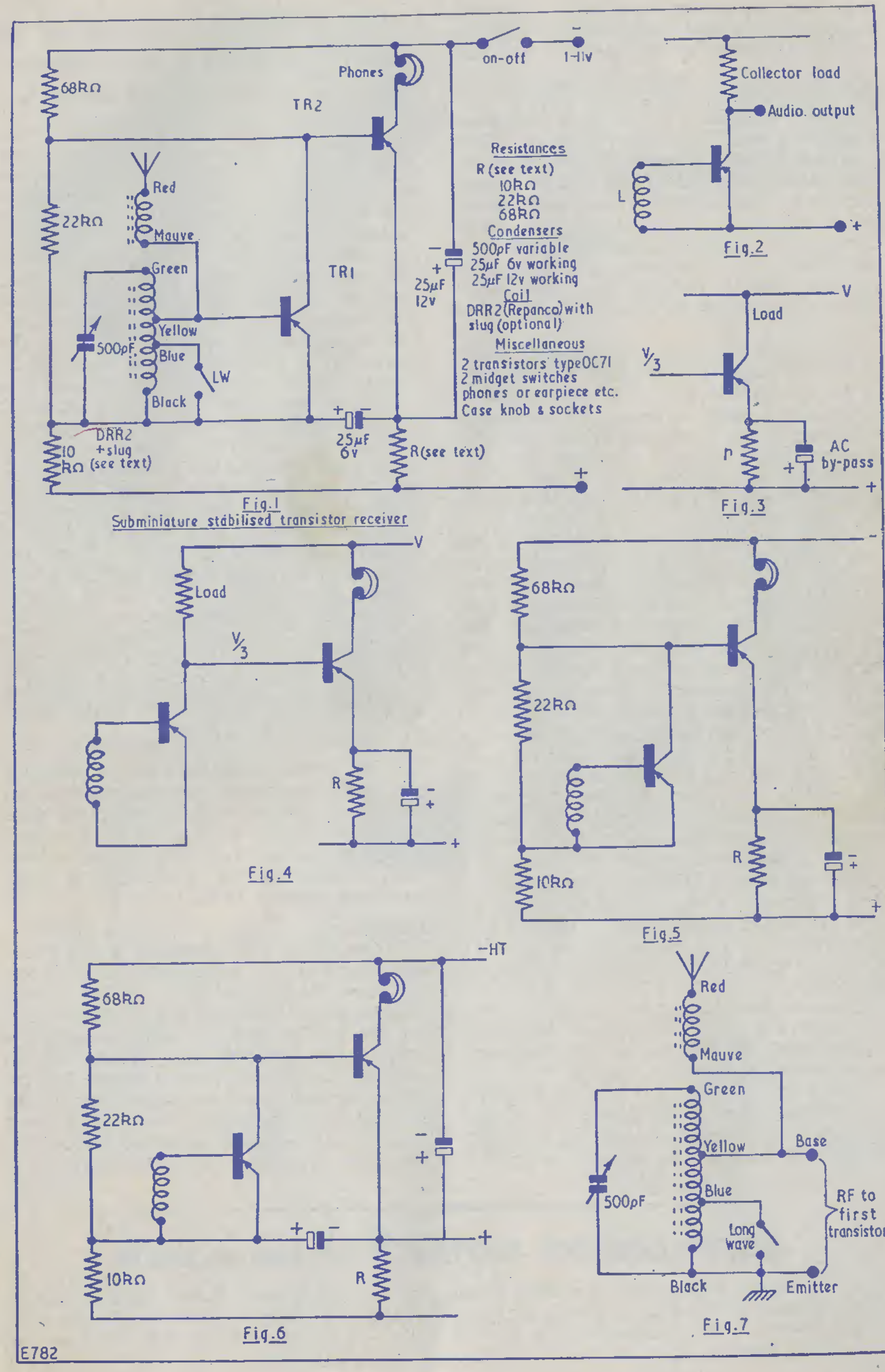
For reasons which will shortly be explained, the base potential in Fig. 3 is a third of the applied voltage V ($=\frac{V}{3}$). Because of this the emitter potential must be substantially $\frac{V}{3}$ also; if it is lower, the resulting increase in base-emitter current raises the collector current and so builds up the emitter potential across the resistance "r". Similarly, too high an emitter potential results in a decrease of collector current, and hence a reduction of emitter potential. Thus the current through "r" is approximately $\frac{V}{3r}$, whence the potential drop across the collector load can be calculated accordingly. "r" should be such that the voltage drop across "r" plus the voltage drop across the load leaves sufficient remaining voltage to operate the transistor under the required signal conditions.

By combining the circuits of Fig. 2 and Fig. 3 we obtain Fig. 4.

Since the collector of the first transistor is directly coupled to the base of the second transistor it is desirable for an adequate potential to be present at this point. It was assumed at this stage of design that the minimum applied voltage in Fig. 4 would be of the order of 3 volts. The signal voltage swing on the collector of the first transistor would be very small and it was felt that a nominal supply potential of 1 volt would prevent the "knee" of the characteristic from being too closely approached. It was decided at this point, therefore, to make an an arbitrary choice of $\frac{V}{3}$ for the potential at the collector of the first transistor (and at the base of the second transistor).

The first transistor takes only a few micro-amps quiescent current, so the load can be high. However, there is no point in making the load much greater than, say, ten times the input impedance of the second transistor, which is sufficiently low (one or two thousand ohms) to be the dominant component of the whole load. A figure of 20kΩ for the load of Fig. 4 would be quite satisfactory. To achieve such a load, and a resultant d.c. output potential of $\frac{V}{3}$ we can use a fixed potentiometer across the supply with 68kΩ and 33kΩ in its arms.

If the minimum overall supply potential



were increased above the 3 volts previously considered it would be possible to provide the first transistor with a collector potential less than $\frac{V}{3}$ volts whilst still retaining the nominal minimum of 1 volt. In consequence it becomes possible to split the lower (33kΩ) arm of the potentiometer such that, whatever the quiescent current of the first transistor, there is an irreducible minimum below which the bias voltage on the second transistor cannot fall. By this means we shall have stipulated the maximum and minimum possible currents through the second transistor. The circuit now takes the form of Fig. 5.

If the electrolytic bypass condenser is taken to the h.t. negative line it does double duty: as an a.c. bypass, and as a low impedance across the battery to cope with increasing resistance as the latter runs down. We need another condenser to complete the a.c. circuit between the base and emitter of the second transistor; and the circuit now looks as shown in Fig. 6.

The input resistance of a transistor is low and therefore matching to the aerial tuned circuit is particularly important. The author has found that the circuit of Fig. 7, employing a Repanco DRR2 Medium and Long wave coil, provides a sensitive and selective arrangement. The DRR2 coil is not fitted with a dust core, or slug, and it was found that sensitivity (already at a high level) could be increased by the addition of such a slug. The slug changed the tuning range of the coil but it was found possible to adjust its position such that an increase in sensitivity was obtained whilst still being able to obtain the Light Programme on 247 metres at the high frequency end of the tuning condenser range. The slug is optional and was employed by the author to satisfy his own particular requirements. Provided that a reasonable aerial, some feet long is employed, the DRR2 coil may be used as supplied.

The resultant complete circuit is that shown in Fig. 1. It only remains to discuss the value of "R" (the emitter resistance) and to calculate the battery voltage.

When determining "R" it is most helpful to consider the circuit made up by the phones, the second transistor and "R" itself. The base of the second transistor is held at $\frac{V}{3}$ volts. The potential on the collector should be between the two extremes: $\frac{V}{3}$ volts at maximum collector current, and the battery voltage at zero collector current.

Earphones, or a personal earphone, normally have a relatively high d.c. resistance and, if "R" is made equal to that resistance (plus about 1kΩ to provide a safety margin) the collector potential lies approximately half way between the two extremes just quoted. This reasoning is approximate but it held good on the prototype which was checked with phones having a d.c. resistance of 3kΩ. The corresponding value of "R" (to the nearest 10% preferred figure) was 3.9kΩ. Care should be taken to ensure that too low a value is not chosen for "R" or excessive collector current will flow. If, for example, the collector load is provided by an output transformer having a low d.c. resistance "R" must be much greater than that resistance, a value between 1 and 5kΩ proving satisfactory in general. The maximum limiting collector current for the OC71 is 10mA but it would be advisable to keep well below this current, in practice.

From the data sheets for the OC71, we find that the maximum voltage across the first transistor ($r_{b-e}=0$) is 20V; and across the second transistor (r_{b-e}=about 20kΩ) is 8V. Thus the maximum battery voltage is $8V+\frac{V}{3}$ across "R" $\sim$ 11V.

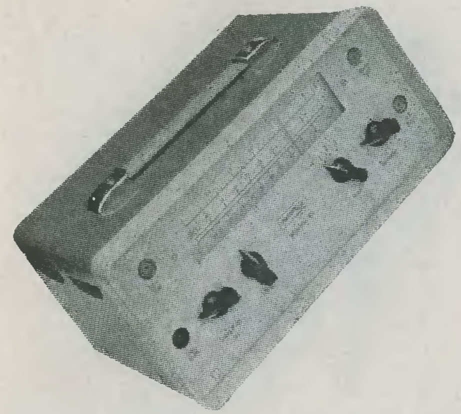
It was found, despite the assumptions made previously concerning operating potential for the first transistor, that the prototype gave satisfactory results in practice for a battery voltage as low as 1 volt. The battery voltage may, in consequence, be specified as being anywhere between 1 and 11 volts.

Performance

When the set was completed it was found that it gave a very satisfactory performance. In the London area (S.W.) strong output was obtained from all B.B.C. transmitters for the region, and (at night) satisfactory output was obtained from several foreign stations. A six-foot vertical aerial, and no earth connection, was employed during these tests, the receiver being powered by a 4.5 volt battery. The phones employed had a d.c. resistance of 3kΩ, as described above.

EAST LONDON DISTRICT of the R.S.G.B.

An invitation is extended to readers by the East London District of the Radio Society of Great Britain to attend a lecture to be given by Capt. P. P. Eckersley, entitled "Radio from the Beginning". The lecture will be held at 3 p.m. on Sunday 9th October, 1960, at the Town Hall, Ilford.



THE "W11" AM/FM/TV Wobbulator

A Jason Design

Described by R. J. CABORN

Introduction

A wobbulator, or frequency modulated oscillator, is a test instrument which, in collaboration with an oscilloscope, allows the frequency response of equipment under test to be visually displayed. The modulating voltage which changes the frequency of the oscillator is applied also to the X plates of the oscilloscope cathode ray tube, whereupon the spot presented on its screen moves horizontally in sympathy with the change of frequency. By suitably connecting the two instruments it is possible for the furthermost left-hand point of the line traced out on the c.r.t. screen to correspond with the lowest frequency from the oscillator, and the furthermost right-hand point to correspond with the highest frequency from the oscillator (or vice versa), intermediate points along the line corresponding to frequencies between the low and high limits.

The output of the frequency modulated

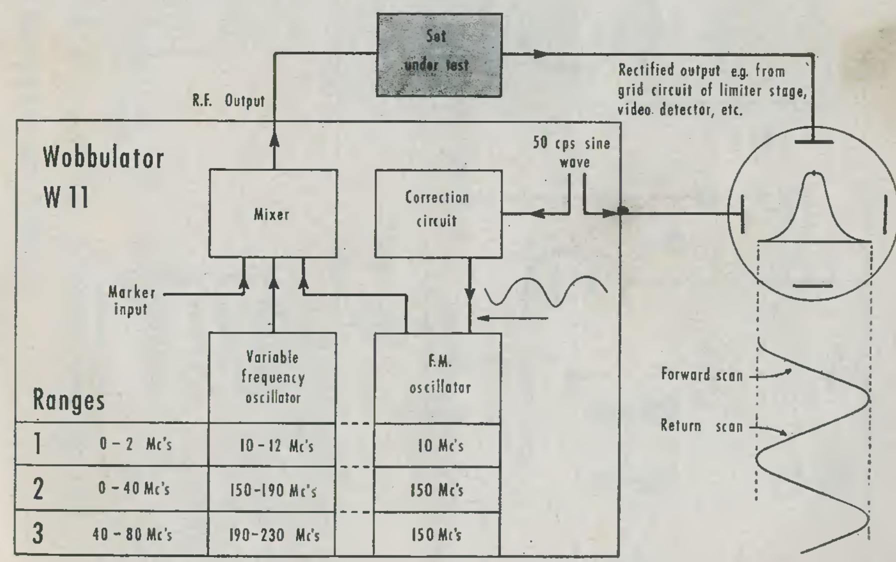


Fig. 1. Block diagram, illustrating principle of operation

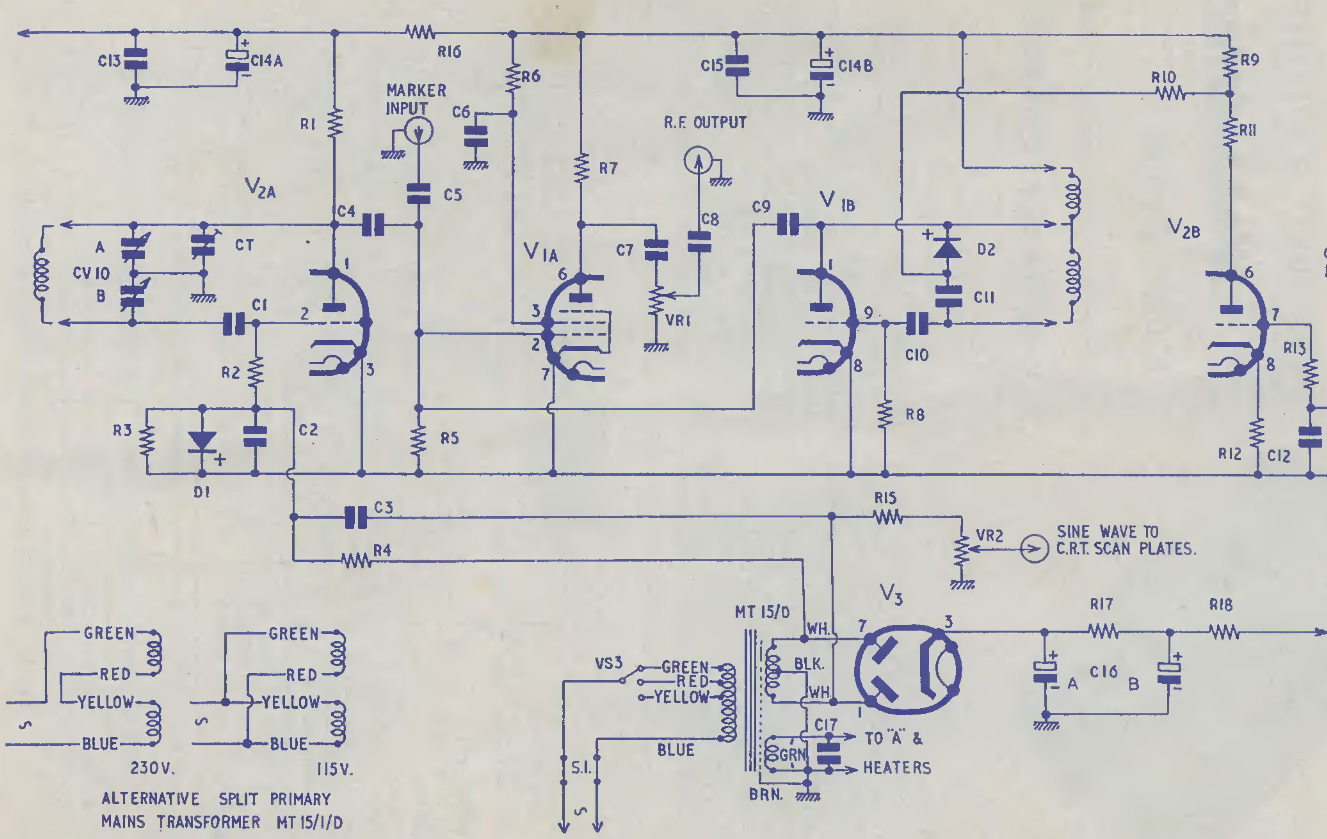


Fig. 2. The circuit of the wobbulator

oscillator is fed to the input terminals of the equipment under test; and the Y plates of the oscilloscope are coupled to the rectified output from that equipment. (A rectified output is available in most instances across detector loads, at the grids of limiter valves, or at any similar points where rectification occurs.) The Y plates provide vertical deflection of the oscilloscope c.r.t. beam with the result that, when correctly connected, greatest rectified output from the equipment under test causes greatest upward deflection of the beam. As the oscillator frequency applied to the equipment under test varies, the output voltage applied to the Y plates of the oscilloscope changes according to the response of its tuned circuits, and the line traced out on the c.r.t. screen corresponds to the frequency response.

In order that individual points along the line traced out may be identified in terms of frequency, it is common practice to inject one or more single fixed frequencies into the system at any point before the detector or rectifier in the equipment under test (and preferably before its input terminals to avoid detuning effects). The fixed frequencies beat with the output of the frequency modulated oscillator as it passes through coincidence with them, causing "pips", or "markers", to appear on the c.r.t. trace at the appropriate points. The fixed frequencies are described as "marker frequencies".

It is necessary for the oscilloscope c.r.t. beam, after having completed the tracing out of a line, to be deflected back horizontally to its commencing point again so that a further line may be traced out. At the same time, the frequency of the oscillator has to be returned to that which occurs at the beginning of the scan period. The process of beam retrace causes, therefore, a horizontal

Components List

Set out for easy reference to Fig. 2

Oscillator Unit

(These components are part of the Oscillator Unit which is supplied fully assembled and pre-aligned.)

Resistors

R_1	10kΩ ½W carbon 20%
R_2	100kΩ ½W carbon 20%
R_5	100kΩ ½W carbon 20%
R_6	100kΩ ½W carbon 20%
R_7	270Ω ½W carbon 20%
R_8	22kΩ ½W carbon 20%
R_9	10kΩ ½W carbon 20%
R_{10}	10kΩ ½W carbon 20%
R_{11}	100kΩ ½W carbon 20%
R_{12}	3.3kΩ ½W carbon 20%
R_{13}	270kΩ ½W carbon 20%

Condensers

C_1	15pF ceramic 10%
C_2	1,000pF ceramic feed-through
C_4	3.3pF ceramic
C_5	3.3pF ceramic
C_6	1000pF ceramic
C_7	5,000pF ceramic
C_9	3.3pF ceramic
C_{10}	20pF S.M. 10%
C_{11}	33pF S.M. 10%
C_{12}	1,000pF ceramic feed-through
C_{13}	1,000pF ceramic feed-through
C_{15}	1,000pF ceramic feed-through
C_{17}	1,000pF ceramic feed-through
CT	0–15pF ceramic pre-set trimmer
$CV_{10(a)}$ and (b)	4–13pF twin-gang condenser

Diode

D_2	Silicon diode GEC SX761 or equivalent

Main Chassis

Resistors

R_3	220kΩ H.S. 5%
R_4	1MΩ H.S. 5%
R_{14}	33kΩ
R_{15}	100kΩ
R_{16}	470Ω 1W
R_{17}	470Ω 1W
R_{18}	470Ω 1W
VR_1	300Ω variable linear
VR_2	100kΩ pre-set linear
VR_3	10kΩ variable with switch S_1

Condensers

C_3	0.01μF paper 10% (2 x 0.005mF)
C_8	0.01μF ceramic
$C_{14(a)}$ and (b)	40+40μF electrolytic 300V
$C_{16(a)}$ and (b)	40+40μF electrolytic 300V

Diode

D_1	Germanium diode

Valves

V_1	ECF80
V_2	ECC81
V_3	EZ80

Miscellaneous

MT_{15}/D	Mains transformer
P/L	2 pilot bulbs 8V

1 Oscillator unit, complete.
1 Set metal work, including chassis, case, sockets, etc.
4 Knobs
1 Mains transformer.
Connecting wire, nuts, bolts, etc.

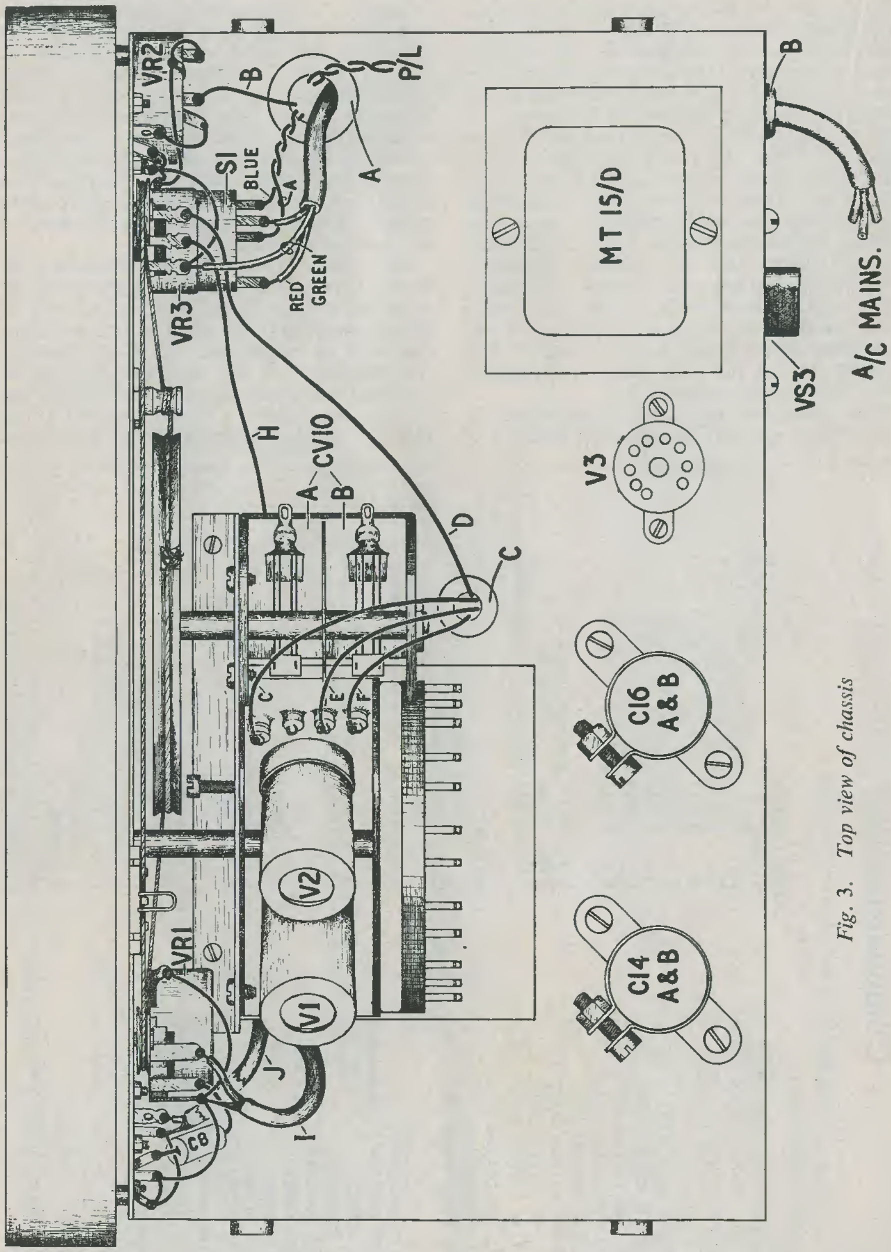


Fig. 3. Top view of chassis

deflection of the c.r.t. beam and a change in oscillator frequency, both in the reverse direction; and the response curve may be displayed on the oscilloscope screen once more. This is an undesirable effect, and many wobbulator designs attempt to remove it by applying a sawtooth modulating voltage to the frequency modulated oscillator and the X plates of the oscilloscope. Since the retrace period of the sawtooth is much

shorter than the scan period, the image produced on retrace is much less brilliant and may be ignored. A better system consists of using a sine wave modulating voltage and of suppressing the oscillator output during the retrace periods which occur on alternate half-cycles. The c.r.t. beam, on retrace, then traces out a line which corresponds to zero output from the oscillator. A reference line such as this is of especial value in examining response curves as it enables a positive assessment of curve skirt limits to be obtained, as well as providing a means of evaluating response amplitudes relative to zero input. The use of a non-linear modulating voltage still allows a linear presentation, in terms of frequency, on the c.r.t. screen because the relationship between beam position and oscillator frequency is unaltered. With sine wave modulation there is a variation in brightness along the line (the ends, where the beam moves most slowly, being slightly brighter than the centre) but the effect is negligible and almost unnoticeable.

Sine wave modulation with oscillator suppression during retrace is employed in the Wobbulator W11 described in this article.

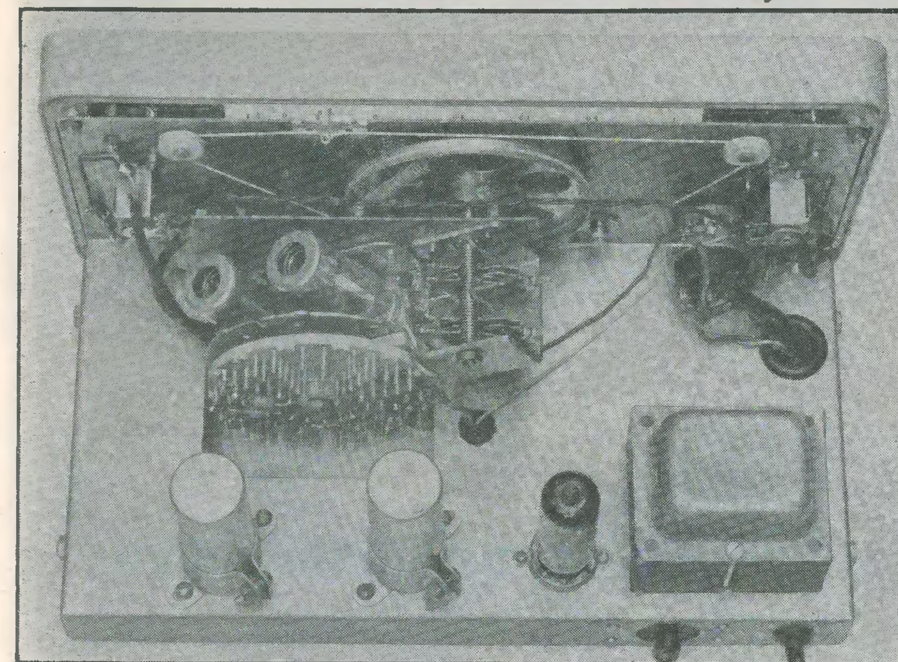


Illustration of above-chassis layout. Compare with Fig. 3 opposite

Basic Operation

The Wobbulator W11 is designed to provide a frequency modulated signal at all frequencies likely to be encountered in equipment testing and servicing. As may be seen from the block diagram of Fig. 1, there are three ranges of output frequency. Range 1 covers 0–2 Mc/s, frequency deviation being capable of variation from zero to 100 kc/s. This range covers all requirements in a.m. receiver i.f. circuits and the like. Range 2 covers 0–40 Mc/s with a frequency deviation variable between zero and 10 Mc/s, and is intended for the examination of v.h.f. and television i.f. strips. The third range, Range 3, is from 40 to 80 Mc/s, this catering for television r.f. circuits on Band I. The second harmonic of Range 3 (80 to 160 Mc/s) can be employed for testing Band II r.f. circuits and the third harmonic (120 to 240 Mc/s) for testing Band III r.f. circuits.

It would be impossible to provide the wide frequency deviation of 10 Mc/s over the ranges concerned with a single tunable oscillator. In consequence the Wobbulator W11 employs two oscillators, one frequency modulated about a fixed frequency, and the other tunable. Their outputs are then mixed in a separate stage.

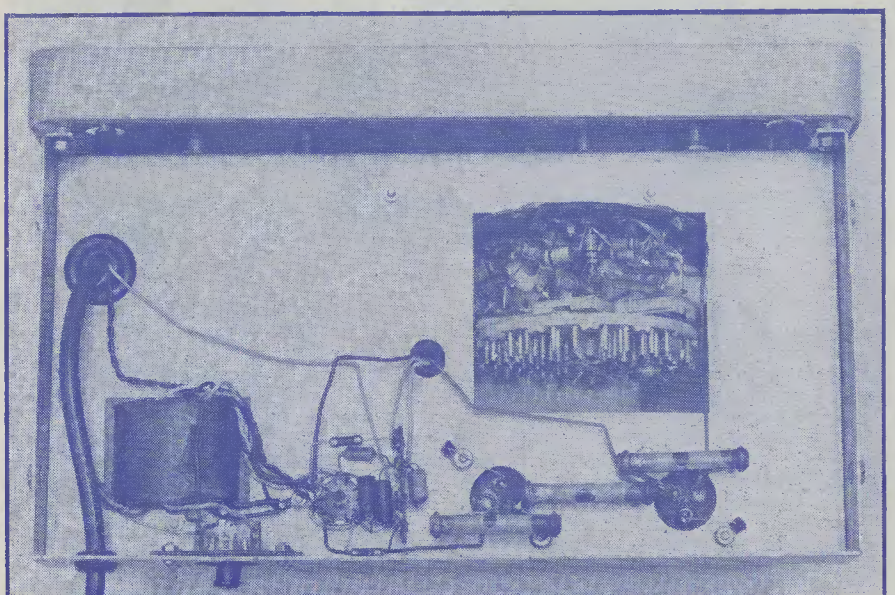
Fig. 1 shows the basic stage layout of the wobbulator. A 50 c/s sine wave, derived from the a.c. mains supply, is applied to the

X plates of the associated oscilloscope, and to the frequency modulated oscillator of the wobbulator via a correction circuit. The function of the correction circuit is to counteract non-linearity introduced by the frequency modulating device employed with the frequency modulated oscillator. (This point is explained in more detail later.) The oscillator is modulated about a fixed frequency, this being 10 Mc/s on Range 1 and 150 Mc/s on Ranges 2 and 3. The variable frequency oscillator is that which is tuned, and its output is fed to the mixer in common with that from the frequency modulated oscillator. On Range 1 the variable frequency oscillator is tunable from 10 to 12 Mc/s, with the result that an output from 0 to 2 Mc/s is available from the mixer. On Range 2 the variable frequency oscillator tunes from 150 to 190 Mc/s, causing an output to be available, from the mixer, of 0–40 Mc/s. The variable frequency oscillator tunes, on Range 3, from 190 to 230 Mc/s, providing an output, from the mixer, of 40–80 Mc/s. The tuning of the variable frequency oscillator is carried out from the front panel, its tuning condenser setting being indicated on the horizontal frequency scale visible in the photograph at the head of this article. The calibration of the scale refers to the frequency available from the mixer.

In Fig. 1 a marker frequency is also injected into the mixer. The output of the mixer is applied to the input terminals of the equipment under test, the rectified output from which is passed to the Y plates of the oscilloscope. The latter then traces out the frequency response of the equipment, the suppressed retrace causing a horizontal line, corresponding to zero output, to appear at the bottom of the curve. The marker frequency causes a marker to appear, in this instance, at the peak of the response.

The Circuit

The circuit of the Wobbulator W11 appears in Fig. 2. In this diagram the 50 c/s modulating voltage is provided by the secondaries of the mains transformer. A 50 c/s output for the oscilloscope X plates is obtained from one half of the h.t. secondary via R_{15} and VR_2. VR_2, the "Scan Width" control, varies the amplitude of the 50 c/s voltage passed to the oscilloscope. The 50 c/s modulating voltage for the frequency modulated oscillator is provided by the heater secondary, being passed, via R_{14} and VR_3, to $V_{2(b)}$. $V_{2(b)}$, together with its grid and cathode components, provides the waveshape correction referred to earlier. VR_3, "Sweep Width", controls the amplitude of the modulating voltage applied to the correction circuit, and, thence, to the frequency modulated oscillator; in consequence it controls the frequency deviation of that oscillator. The on-off switch, S_1, is ganged with VR_3.



Under-chassis view of the Wobbulator

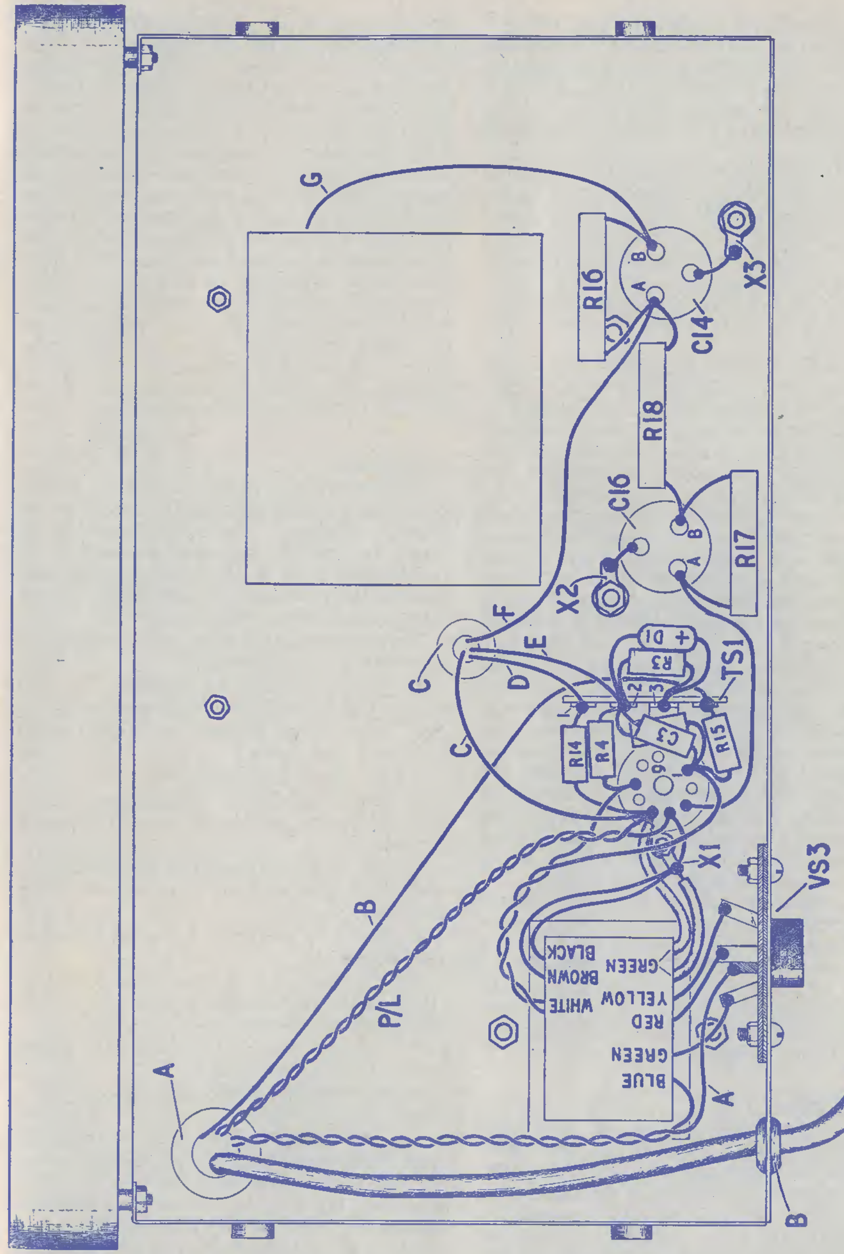


Fig. 4. The underside of the chassis

The corrected modulating voltage is applied to the variable capacity diode D_2. D_2 is a silicon diode which, when reverse-biased (i.e. biased in the manner which does not allow current to flow), exhibits a varying capacity for varying bias voltage. With the particular diode employed a change in reverse bias from -1 to -10 volts causes a change in capacity of approximately 4pF. The relationship between voltage and capacity is non-linear; the change in capacity for a voltage change from -1 to -2 being much greater than for a voltage change from -9 to -10. It is this non-linearity which the correction circuit around $V_{2(b)}$ is designed to counteract, the correction circuit causing a change in modulating voltage waveform which compensates for the non-linearity in the diode.

$V_{1(b)}$ is the frequency modulated oscillator, the coil in its tuned circuit being tuned by the variable capacity diode D_2 (and by valve and stray capacities). The coils presented to $V_{1(b)}$ cause it to oscillate at a centre frequency of 10 Mc/s on Range 1, and at a centre frequency of 150 Mc/s on Ranges 2 and 3. The output of $V_{1(b)}$ is fed, via C_9, to the mixer $V_{1(a)}$.

$V_{2(a)}$ is the variable frequency, or tunable, oscillator. The valve functions in a conventionable Colpitts circuit, and tuning is carried out by means of the twin-gang condenser $CV_{10(a)}$ and $_{(b)}$, and the trimmer CT. $CV_{10(a)}$ and $_{(b)}$ are adjusted by the "Tuning" control on the front panel.

On Range 1, the coil presented to $V_{2(a)}$ causes it to tune over the range 10–12 Mc/s. The coils presented on Ranges 2 and 3 cause $V_{2(a)}$ to tune over 150–190 Mc/s and 190–230 Mc/s respectively. Suppression of output voltage during the retrace period is achieved by causing $V_{2(a)}$ to cut-off, and therefore cease oscillation, during alternate half-cycles of the 50 c/s modulating voltage. Cut-off is obtained by applying a relatively high a.c. voltage, derived from the h.t. secondary of the mains transformer, to the earthy end of grid leak R_2. The diode D_1 prevents the application of positive voltage to the grid of $V_{2(a)}$ during scan periods, whilst permitting large negative excursions to take place during retrace periods. The output of $V_{2(a)}$ is fed, via C_4, to the grid of the mixer $V_{1(a)}$.

$V_{1(a)}$ functions as a grid leak biased additive mixer, the outputs of both oscillators (plus marker input frequencies via C_5) being fed to its control grid. The output of $V_{1(a)}$ is built up across its anode load R_7, and the potentiometer VR_1. VR_1, the "Attenuator" control, varies the amplitude of the r.f. output passed to the equipment under test.

Chassis Layout

The wobbulator consists of two basic assemblies. One assembly is the Main Chassis, on which are mounted the power unit components and some of the modulating circuit components. The other assembly is the Oscillator Unit, which contains the components directly associated with V_1 and V_2. The Oscillator Unit comprises a turret chassis and the twin-gang condenser $CV_{10(a)}$ and $_{(b)}$, these being mounted side by side on a steel bracket. At the rear of the turret unit is the coil disc, this carrying the coils which are presented to $V_{1(b)}$ and $V_{2(a)}$. The coil disc is capable of being rotated by the "Range" control on the front panel. The Oscillator Unit is clearly visible in the photograph of the rear of the unit, and the layout of the components in the turret chassis is illustrated in Fig. 6.

The Oscillator Unit is supplied completely assembled and pre-aligned, a point which considerably simplifies the construction of the wobbulator. In order to differentiate between components fitted to the Main Chassis and those fitted to the Oscillator Unit, these have been listed separately in the Components List. It should be noted that the 1,000pF ceramic feed-through condensers included in the Oscillator Unit parts list are components which are soldered to the turret chassis during manufacture, and are, therefore, an integral part of that chassis.

Construction

The construction of the wobbulator should be carried out with the aid of layout diagrams Figs. 3, 4 and 5. Care should always be taken to ensure that the orientation of components such as the mains transformer, electrolytic condensers and valveholder, is the same as that shown in the diagrams.

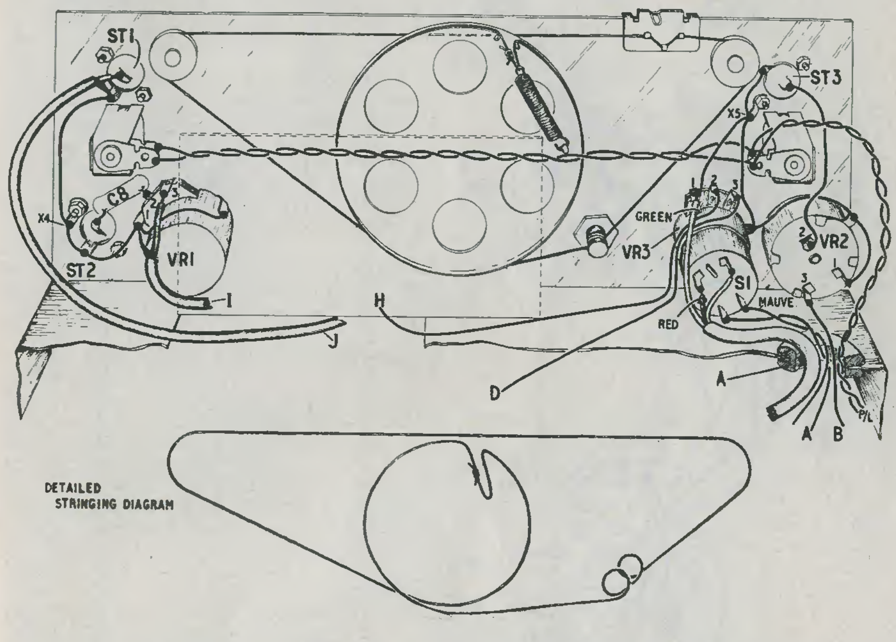
The processes involved in initial mechanical assembly are as follows:

1. Fit V_3 valveholder, tagstrip TS_1, and chassis tag X_1, with 6BA nuts and bolts.
2. Fit voltage selector panel VS_3, with 6BA nuts and bolts.
3. Fit mains transformer.
4. Fit $C_{16(a)}$ and $_{(b)}$, and chassis tag X_2, with 4BA nuts and bolts, using the clamp provided.
5. Fit $C_{14(a)}$ and $_{(b)}$, and chassis tag X_3, with 4BA nuts and bolts, using the clamp provided.
6. Fit $\frac{3}{8}$ in grommet A (upper left-hand corner, Fig. 4).
7. Fit the two $\frac{3}{8}$ in grommets B and C. (B is on the rear chassis apron, and C is in the centre of Fig. 4.)
8. Fit VR_1 and VR_3, S_1, using the shake-proof washers provided.
9. Fit VR_2 with two 6BA screws $\frac{3}{16}$ in long.
10. Fit coaxial sockets ST_1, ST_2 and ST_3 with 6BA nuts and bolts, spacing them forward of the panel with $\frac{1}{4}$in. spacers. Also fit chassis tag X under nut securing ST_2, and chassis tag X_5 under nut securing ST_3.
11. Fit cord drive drum to the twin-gang condenser CV_{10}, fixing screws being nearest bracket.
12. Fit the Oscillator Unit to the Main Chassis with 4BA nuts and bolts.
13. Fit the tuning drive spindle, using the shake-proof washer provided.

14. String the tuning drive up as shown in Fig. 5, fitting the pull-off spring and pointer.

The mechanical assembly is now partly complete and wiring proceeds as described in the following instructions. Connections should not be soldered unless indicated. Unless otherwise stated, connections are made with p.v.c. insulated wire. The lettered leads from the Oscillator Unit turret chassis may be identified with the aid of Fig. 6.

1. Connect one white lead from the mains transformer to V_3 pin 1.
2. Connect the remaining white lead from the mains transformer to V_3 pin 7.
3. Connect the black lead, the brown lead, and one green (enamelled) lead from the mains transformer to chassis tag X_1.
4. Connect the remaining green (enamelled) lead from the mains transformer to V_3 pin 5.
5. Connect the mauve lead from the mains transformer to switch S_1 (see Fig. 5) and solder.
6. Connect, via lead A, switch S_1 (see Fig. 5) to voltage selector panel (see Fig. 4) and solder both ends.
7. Connect the green lead from the mains transformer to the 240/250 volts tap on the voltage selector panel and solder.
8. Connect the red lead from the mains transformer to the 220/230 volts tap on the voltage selector panel and solder.
9. Connect the yellow lead from the mains transformer to the 200/210 volts tap on the voltage selector panel and solder.
10. Connect V_3 pin 4 to chassis tag X_1 with bare wire. Solder at X_1 (including the previous connections made thereto).
11. Fit R_4 between tag 2 of tagstrip TS_1 and V_3 pin 7. Solder at pin 7 (including previous connection made thereto).
12. Fit C_3 (two $0.005\mu F$ condensers in parallel) between tag 2 of tagstrip TS_1 and V_3 pin 1.
13. Fit R_{15} between tag 4 of tagstrip TS_1 and V_3 pin 1. Solder at pin 1 (including previous connections made thereto).
14. Fit diode D_1 between tags 2 and 3 of tagstrip TS_1, observing polarity.
15. Fit R_3 between tags 2 and 3 of tagstrip TS_1, soldering at tag 3 (including previous connection made thereto).
16. Fit R_{14} between tag 1 of tagstrip TS_1 and V_3 pin 5.
17. Connect V_3 pin 3 to $C_{16(a)}$, soldering at pin 3.
18. Connect C_{16} (black tag) to chassis tag X_2 with bare wire, soldering both ends.
19. Connect C_{14} (black tag) to chassis



Part 5. Part of the above-chassis wiring, including a detailed diagram of tuning drive stringing

tag X_3 with bare wire, soldering both ends.

20. Fit R_{17} between $C_{16(b)}$ and $C_{16(a)}$, soldering at $C_{16(a)}$ (including previous connection made thereto).

21. Fit R_{18} between $C_{14(a)}$ and $C_{16(b)}$, soldering at $C_{16(b)}$ (including previous connection made thereto).

22. Fit R_{16} between $C_{14(a)}$ and $C_{14(b)}$.

23. Connect turret lead F to $C_{14(a)}$ and solder (including previous connections made thereto).

24. Connect turret lead G to $C_{14(b)}$ and solder (including previous connection made thereto).

25. Connect turret lead E to tag 2 of tagstrip TS_1 and solder (including previous connections made thereto).

26. Connect, via lead D, tag 1 of tagstrip TS_1 to tag 3 (see Fig. 5) of VR_3, soldering at both ends (including previous connection made to tag 1).

27. Connect turret lead C to V_3 pin 5.

28. Connect turret lead H to tag 2 of VR_3 and solder.

29. Connect, via lead B, tag 4 of tagstrip TS_1 to tag 3 of VR_2 (see Fig. 5), soldering both ends (including previous connection made to tag 4).

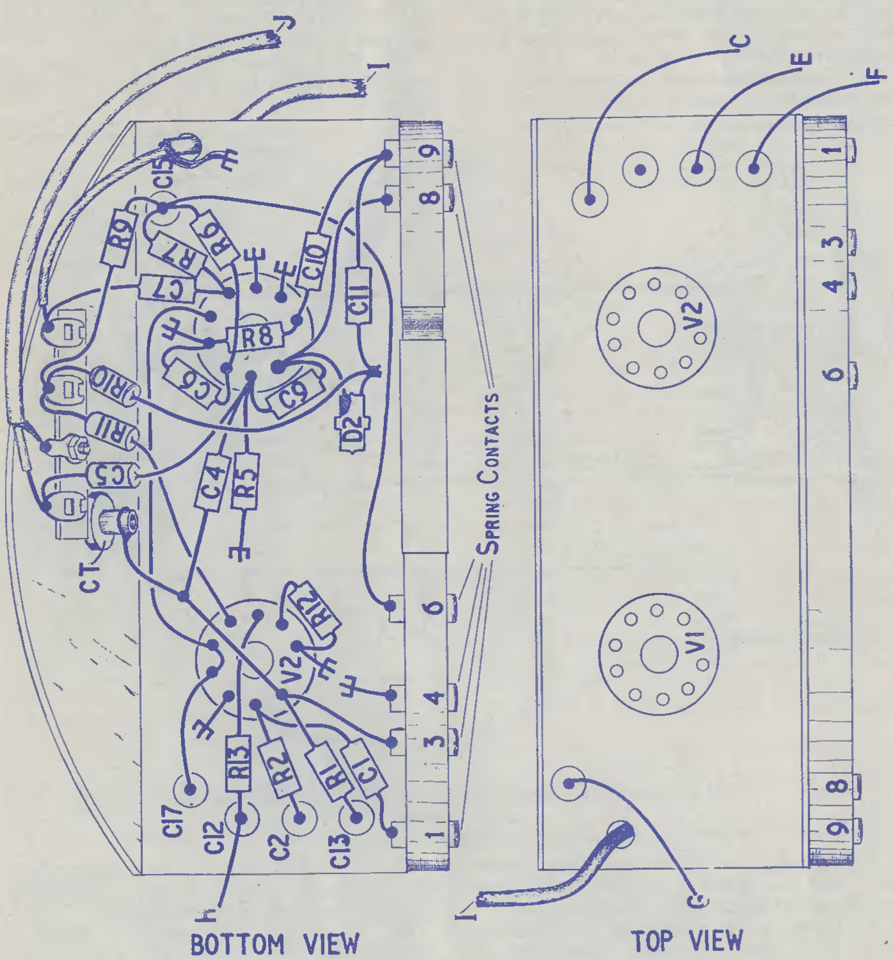


Fig. 6. Two views of the turret section of the Oscillator Unit

30. Connect body tag of VR_1 to tag 1 of VR_1 (see Fig. 5) with bare wire. Solder at body tag.

31. Connect tag 1 of VR_1 to outer tag of coaxial socket ST_2, and continue to chassis tag X_4, with bare wire. Solder at outer tag of ST_2.

32. Connect outer tag of coaxial socket ST_1 to chassis tag X_4 with bare wire, soldering at X_4 (including previous connection made thereto).

33. Connect inner of turret lead 1 to tag 3 of VR_1 and solder.

34. Connect outer of turret lead 1 to tag 1 of VR_1 and solder (including previous connections made thereto).

35. Fit C_8 between tag 2 of VR_1 and centre tag of coaxial socket ST_2, soldering both ends.

36. Connect outer of turret lead J to outer tag of coaxial socket ST_1 and solder (including previous connection made thereto).

37. Connect inner of turret lead J to centre tag of coaxial socket ST_1 and solder.

38. Connect tag 1 of VR_2 to body tag of VR_2, continuing to body tag of VR_3, with bare wire, soldering at tag 1 and body tag of VR_2.

39. Connect chassis tag X_5 to body tag of VR_3 with bare wire, soldering at VR_3 body tag (including previous connection made thereto).

40. Connect tag 1 of VR_3 to chassis tag X_5 with bare wire.

41. Connect outer tag of coaxial socket ST_3 to chassis tag X_5 with bare wire, soldering both ends (including previous connections made to chassis tag X_5).

42. Connect tag 2 of VR_2 to centre tag of coaxial socket ST_3, soldering both ends.

43. Fit mains cable through grommets B and A, stripping outer covering back for $1\frac{1}{2}$ in.

44. Connect green lead of mains cable to tag 1 of VR_3 and solder (including previous connection made thereto).

45. Connect red lead of mains cable to switch S_1 (see Fig. 5) and solder.

46. Connect black lead of mains cable to switch S_1 (see Fig. 5) and solder.

47. Twist together two 9in. lengths of p.v.c. wire.

48. Connect one wire of the twisted pair to V_3 pin 5 and solder (including previous connections made thereto), and connect the other wire to V_3 pin 4 and solder (including previous connection made thereto).

49. Connect the other end of the twisted pair to the two contacts of the right hand pilot lamp holder (see Fig. 5).

50. Twist together two 10in lengths of p.v.c. wire.

51. With this twisted pair connect together (in parallel), the two pilot lamp holders and solder (including the connections previously made to the right hand pilot lamp holder).

52. Fit the pilot lamps.

All that now remains is the final assembly of the unit. This proceeds as follows:

1. Fit the frame casting to the chassis with 4BA $\frac{1}{2}$in. nuts and bolts, using $\frac{1}{8}$in. spacers.
2. Assemble the front panel with two clamps and $\frac{5}{16}$in. nickel plated bolts and nuts, and fit the glass scale, using rubber bands over each side. Tighten clamps.
3. Fit the front panel to the frame casting, using $\frac{1}{4}$in. self-tapping screws and clips.
4. Fit all knobs.
5. Fit V_3.
6. Select the mains voltage tapping required on the mains voltage selector panel.
7. Fit the handle to the outer surround with the nuts provided.
8. Fit the rear cover to the outer surround with self-tapping screws.
9. Fit rubber feet to the outer surround.
10. Fit the perforated bottom cover to the outer surround with self-tapping screws.
11. Fit the complete outer assembly to the chassis with self-tapping screws (two on each side).

The construction of the Wobbulator W11 is now complete.

Marconi Doppler Tested at *Mach 2*

A Marconi AD2300 doppler navigator has recently been flown at Mach 2 at high altitude in the Mirage IV, when its accuracy was shown to be well within its specification.

The equipment has been undergoing comprehensive evaluation trials at the Centre d'Essais en Vol since September 1959, when a substantial order was received from Générale Aéronautique Marcel Dassault for AD2300 doppler navigation equipment and specially developed navigation computers for the Mirage IV.

The Marconi AD2300 series of equipments now includes versions suitable for aircraft flying at 100 knots and up to 1,300 knots. The navigation computers range from relatively simple track guidance computers for civil airlines to highly accurate complicated devices for military purposes.

The New Frame Grid Valves

By J. B. DANCE, M.Sc.

During the last twelve months the Mullard Valve Company have introduced a series of valves known as "frame grid" valves. These are the latest developments in the quest for high stage gain in radio frequency amplifiers operating at television frequencies.

It can be shown theoretically that the gain of any radio frequency or intermediate frequency amplifier is almost exactly proportional to the mutual conductance of the valve used. Some of the first screen grid valves to be manufactured (such as the ARS6 about 1927) had a mutual conductance of about 0.6mA/volt. The conventional high gain sharp cut-off pentodes such as the EF80 and the 6AC7 have a mutual conductance of about 7 to 10mA/volt. In the frame grid range, however, the EF184 has a mutual conductance of about 15mA/volt. As a high frequency amplifier it will therefore give about twice the gain of a conventional high gain pentode, but this gain can be varied only within a limited range by the application of bias.

Table 1

PCC89:	Variable-mu r.f. double triode for use as cascode amplifier.
PCF86:	Triode-pentode frequency changer.
EF183:	Variable-mu r.f. pentode for use as a.g.c. controlled i.f. amplifier.
EF184:	Straight pentode for use as i.f. amplifier.

The Mullard series of Frame Grid valves intended for use in t.v. receivers. All of the above valves require a heater current of 300mA and are therefore suitable for a.c./d.c. series operation.

The advantages of the variable-mu EF183 are even more striking. The conventional 6K7 or EF39 type of valve has a maximum mutual conductance of about 2mA/volt. The miniature 6BA6 gives a higher gain as an r.f. amplifier because its maximum mutual conductance is about 4.4mA/volt. The EF183, however, has a maximum mutual conductance of about 13mA/volt. It will therefore give about three times the gain of a 6BA6 or about seven times the gain of a 6K7. The gain of an EF183 amplifier can be varied over a wide range of values.

Frame Grid Construction

The mutual conductance of a valve can be increased by a suitable choice of dimensions for the control grid. In order to obtain a high mutual conductance, the grid must be wound with very fine wire closely spaced and should be placed very near to the cathode in order that it can exert the maximum control over the electron stream. In addition, the dimensions of the grid must be very closely controlled, its manufacture becoming a matter of precision workmanship.

The grid winding in conventional valves must be fairly thick so that it is strong enough to keep the supporting wires at the correct distance apart; this limiting the mutual conductance obtainable. In the frame grid valves, however, these difficulties are overcome by closely winding a very fine wire grid under tension on an accurately made frame of stout wires. The grid supporting wires are rigidly fixed to each other by means of sturdy cross rods.

Other Advantages

The input capacity of the frame grid valves is similar to that of conventional valves and they can therefore be used as r.f. amplifiers. They have an input impedance of about 10kΩ at 40 Mc/s. As r.f. amplifiers, the frame grid valves not only give high gain but they also have the advantage that the signal to noise ratio, at the output of the stage, may be considerably greater than that at the output of a similar stage using a conventional valve. The frame grid double triode ECC189 is intended for use as a very low noise r.f. cascode amplifier at v.h.f. It has a mutual conductance of 12.5mA/volt.

The control characteristics of the frame grid valves are very good. For instance the PCC89 will handle about five times the signal which can be handled by a PCC84 without any cross modulation.

The danger of a valve becoming microphonic is less in the frame grid series because the fine wires under tension resonate at a frequency well above audio frequencies.

TV Receivers

Frame grid valves are especially useful in t.v. receivers. The four valves shown in Table 1 have been especially designed for this purpose. A receiver using the frame grid valves PCC89 (r.f. amplifier), PCF86 (converter) and the EF183 (i.f. amplifier) will be about eight times as sensitive (18dB) as a receiver using the PCC84, PCF80 and the EF85.

In fringe areas the use of frame grid valves may render the addition of extra front end amplification to a t.v. receiver unnecessary. Alternatively, if the local signal strength is fairly reasonable, a receiver using frame grid r.f. and converter valves could employ one valve less (an i.f. amplifier) than a similar receiver employing conventional valves. As a matter of economics this is bound to interest t.v. receiver manufacturers.

In addition to the above advantages, the use of frame grid valves in t.v. receivers will greatly reduce the possibility of sound break-through in the vision channel due to cross modulation.

Conclusion

It is to be expected that frame grid valves will have a very wide application in the future, especially in t.v. and other high frequency receivers. It is, however, somewhat doubtful if they will ever be used to any great extent in the ordinary 4+1 superhets, as the extra gain is not really required for most purposes.

The writer would like to thank Messrs. Mullard Ltd. for sending him details about some of their frame grid valves.

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.

VHF Receiver S460C, Serial No. JV1041.—N. A. Watson, 1 Strathearn Road, London, S.W.19, would like to receive the manual, or any other information, of this 10 valve superhet. The receiver has a crystal controlled oscillator and a coverage of from 65 to 85 Mc/s.

* * *

RCS Pre-selector.—J. Russell, 30 Wellington Road, Ellesmere Port, Cheshire, requires to know the values of the resistors and condensers used in the R.C.S. Products (Radio) Ltd. pre-selector.

* * *

Low Power Disc Recording.—H. G. Weston, 16 Pitfold Road, Lee, London, S.E.12, would like to obtain a copy of the Bernards (Publishers) Ltd., handbook No. 37—now out of print. Failing this, any assistance or advice with reference to low power disc recording. Actual recording will be on acetate cine film at 2.5in per second.

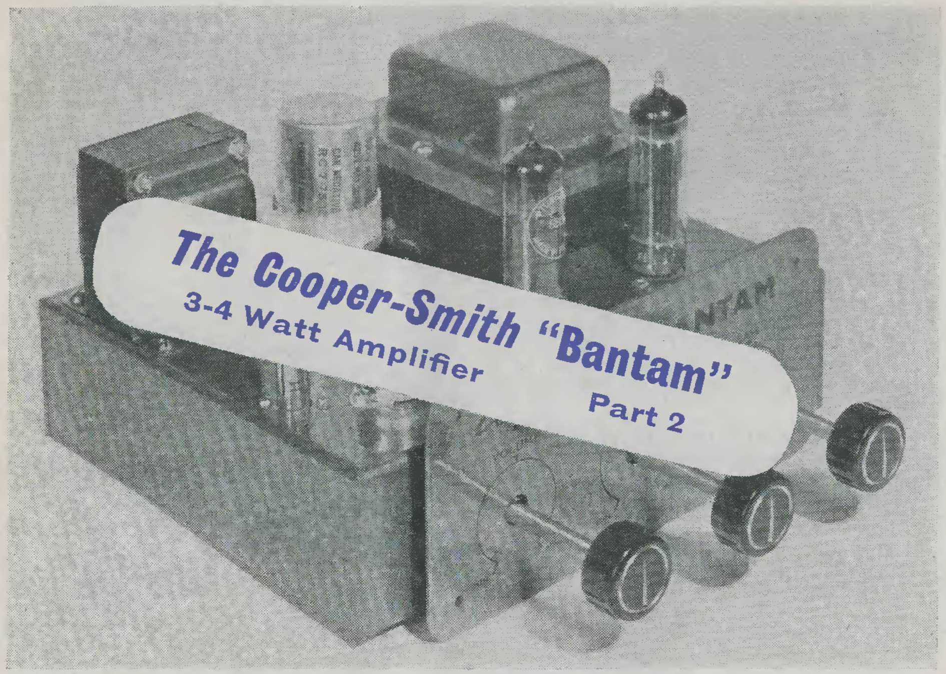
Bendix Radio Compass Receiver MN26C.—G. Wallace, 12 Newpath, Annan, Dumfriesshire, would like to purchase or borrow the manual or circuit or any other information on this receiver.

* * *

English Electric A21/1 Multi-Channel Adaptor Unit.—R. G. Parks, 8 Stratton Avenue, Wallington, Surrey, would be grateful to receive any information, circuit diagram and installation details, of this equipment.

* * *

HRO Senior Manual.—W. E. Rigg, VQ2AA, P.O. Box 371, Luanshya, Northern Rhodesia, wishes to obtain the loan of this manual. VQ2AA specifically requests that any reader willing to co-operate should, in the first instance, write to him—thus obviating duplicating offers. All postages, etc., gladly refunded.



The Cooper-Smith "Bantam" 3-4 Watt Amplifier
Part 2

Described by W. Holmes

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

Construction

Construction of the Cooper-Smith "Bantam" is a relatively simple procedure. The photographs accompanying this article show very clearly the clean and neat layout employed, and they will be of assistance during the process of mounting components and wiring up. A layout and wiring diagram is given in Fig. 2, this showing the position of all components and connections. It will be noted, in Fig. 2, that individual tags on potentiometers, valveholders, sockets and the mains voltage selector panel are numbered. These numbers correspond to those appearing in the circuit diagram of Fig. 1. Also shown numbered are the tags on the two 12-way tagstrips. All these tags are referred to by their numbers in the step-by-step instructions which follow. The rear apron of the chassis in Fig. 2 is shown opened out in order that connections made to the components mounted on it may be illustrated more clearly.

Step-by-Step Instructions

Construction proceeds as follows:

1. Fit the mains socket, mains selector panel, power output socket and speaker socket to the rear apron. All these are fitted from the inside except for the mains socket.

2. Fit the mains transformer T_1, ensuring that its tags take up the position shown in Fig. 2. Also, fit the speaker transformer T_2, bringing its leads out as shown in Fig. 2. It is necessary for the lower right-hand nut (adjacent to the tag—fitted later—numbered 23 in Fig. 2) to make good contact to chassis. Ensure good contact by scraping, or cleaning, the underside of the chassis before this nut is fitted.

3. Fit the dual condenser C_{10}, C_{13}, ensuring that the tag marked red is nearest the mains transformer T_1. Make certain of good chassis contact to the condenser clip by scraping the underside of the chassis at the points where the mounting nuts tighten down.

4. Fit the input socket, ensuring correct orientation (its earthy tag, 2, should take up the position shown in Fig. 2). Again, scrape the chassis to ensure good contact to its mounting nuts.

5. Fit the valveholders, ensuring correct orientation. Note that V_1 valveholder has a skirt (see photographs) and is mounted above the chassis, and that V_2 and V_3 valveholders are mounted below. Scrape the chassis to ensure good contact to the securing nuts for V_1 valveholder.

6. Fit a 6BA nut and bolt (again scraping the underside of the chassis to give good contact) to the hole hear V_2. (R_{18}—fitted later—is above this hole in Fig. 2.) Mount the two 12-way tagstrips as shown in Fig. 2. The lower tagstrip is mounted over the 6BA bolt just fitted, and over the outside bolt securing the input socket. The upper tagstrip is mounted over the lower right hand bolt securing the speaker transformer (referred to in step 2) and the lower bolt securing the dual condenser C_{10}, C_{13}. Both tagstrips are mounted over the nuts which have previously been tightened, and are secured by fitting additional nuts.

7. Fit the three potentiometers VR_1, 2

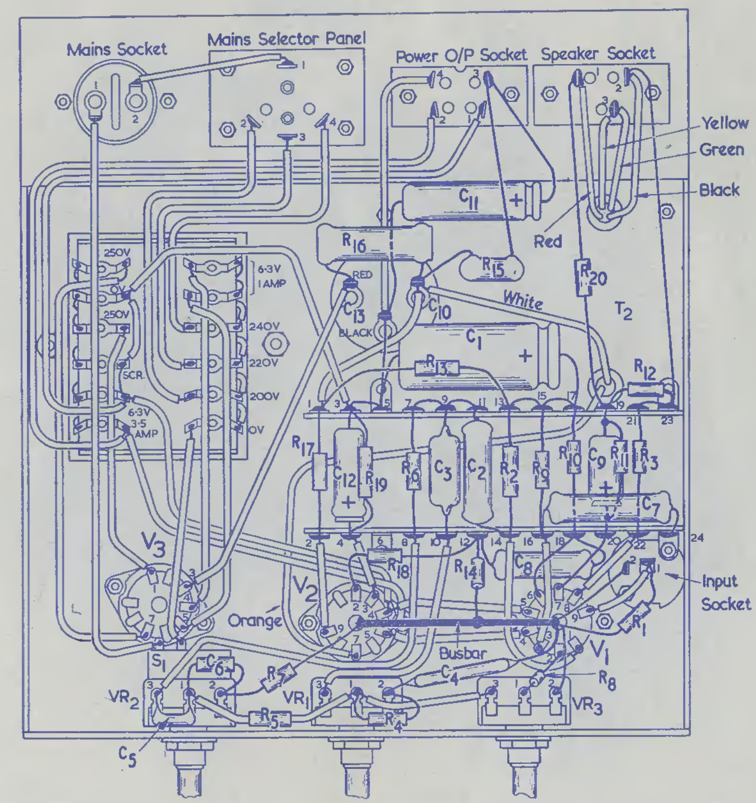
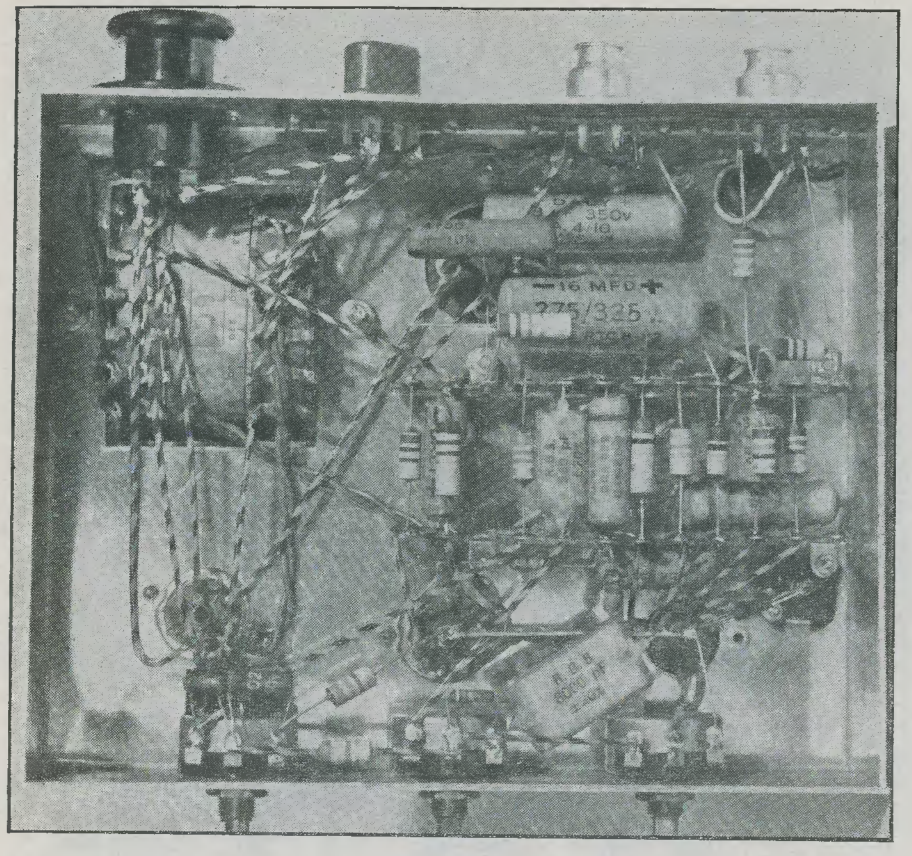


FIG.2. Layout and Wiring Diagram.

Fig. 2. Layout and wiring diagram. The rear apron of the chassis is laid flat to show the connections to the rear sockets and the mains selector panel more clearly



Under-chassis view of the "Bantam". This view, which demonstrates the clean wiring layout, may be compared with Fig. 2

and 3, to the front panel as shown in Fig. 2 (noting the locating holes in the chassis).

Wiring Up

Wiring up now commences. In order that all connections may be made to each individual tag before they are soldered to that tag, soldering should only be carried out where stated.

8. Using twisted wiring, connect in parallel pins 4 and 5 of V_1, pins 4 and 5 of V_2, the 6.3V 3.5A tags on T_1, and tags 1 and 2 on the power output socket. Solder all these joints except the 6.3V 3.5A tag on T_1 adjacent to the "SCR" tag. Also using twisted wiring, connect in parallel, and solder, pins 4 and 5 of V_3 and the 6.3V 1A tags on T_1. (Fig. 2 shows this wiring step with untwisted wire for ease of circuit tracing.)

9. Carefully following Fig. 2, connect the 6.3V 3.5A tag on T_1 adjacent to the "SCR" tag to that tag, carrying on to the 0V tag (h.t. secondary) on T_1, and to tag 3 of the tagstrips. Solder all joints except tag 3.

10. Carefully following Fig. 2, connect 0V tag (mains primary) on T_1, to one tag of switch S_1 and solder. Connect 200V tag on T_1 to tag 2 of mains selector panel and solder. Connect 220V tag on T_1 to tag 3 of mains selector panel and solder. Connect 240V tag on T_1 to tag 4 of mains selector panel and solder. Connect the two 250V tags on T_1 to pins 1 and 7 of V_3 and solder.

11. The speaker transformer, T_2, is next connected into circuit. Connect its orange lead (following route in Fig. 2) to pin 7 of V_2 and solder. Connect its white lead (following route in Fig. 2) to C10.

12. *For* 15Ω *output only.* Connect red lead of T_2 to tag 1 of speaker socket. Connect black lead of T_2 to tag 2 on speaker socket. Connect yellow and green leads to tag 3 on speaker socket, soldering at tag 3. These connections are shown in Fig. 2.

13. *For* 3.75Ω *output only.* Connect red and yellow leads of T_2 to tag 1 on speaker socket. Connect green and black leads of T_2 to tag 2 on speaker socket. These connections are **not** shown in Fig. 2.

14. Tagstrip connections come next. Connect R_{17} (100Ω) between tags 1 and 2.

15. Connect R_{19} (150Ω) and C_{12} (50μF, 25 W.V.) between tags 3 and 4, observing correct polarity in C_{12}. Join tags 3 and 5. Solder tag 3.

16. Connect C_1 (16μF, 275 W.V.) between tags 5 and 17, observing correct polarity.

17. Connect R_6 (68kΩ) between tags 7 and 8.

18. Connect C_3 (560pF) between tags 9 and 10.

19. Connect C_2 (0.02μF) between tags 11 and 14. Join, and solder, tags 7, 9 and 11.

20. Connect R_2 (100kΩ ½W—as opposed to the ¼W R_{10}) between tags 13 and 14.

21. Connect R_9 (470kΩ) between tags 15 and 16.

22. Connect R_{10} (100kΩ) between tags 17 and 18. Join tags 13, 15 and 17, soldering at 15 and 17.

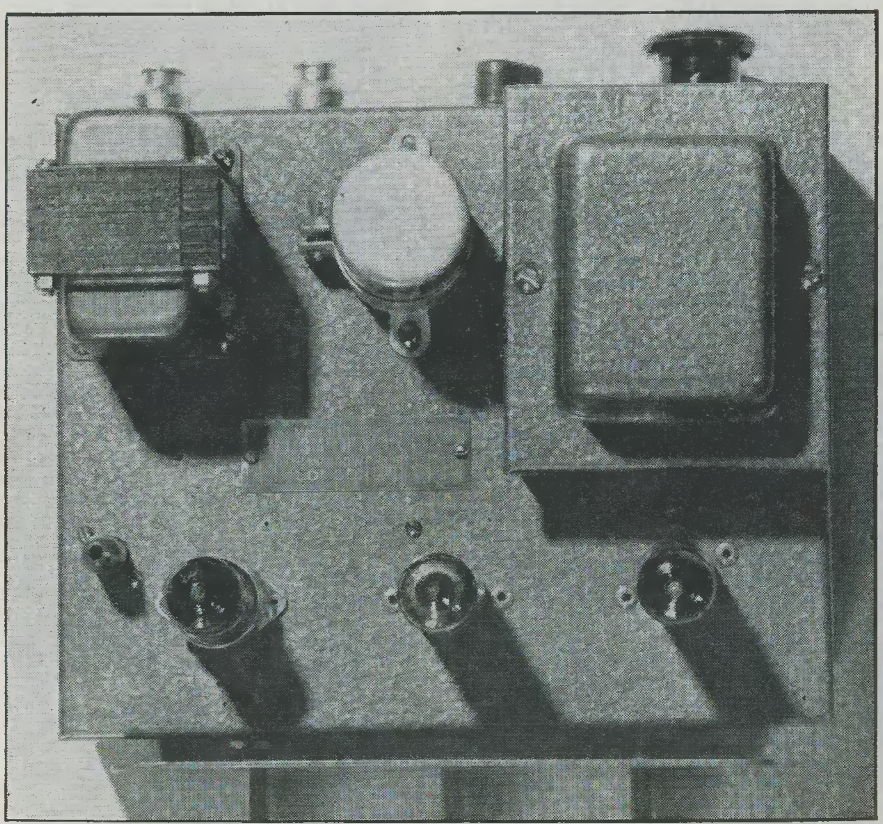
23. Connect C_9 (50μF, 12 W.V.) and R_{11} (1.8kΩ) between tags 19 and 20, observing correct polarity of C_9.

24. Connect R_3 (1.2kΩ) between tags 21 and 22.

25. Connect R_{12} (100Ω) between tags 19 and 23. Join tags 21 and 23, soldering at 21.

26. Connect R_{13} (22kΩ ½W—as opposed to the ¼W R_{20} when 15Ω output is used) between tags 1 and 13, soldering at 13.

27. Connect C_8 (0.05μF) between tags 12 and 18.



Top view of the chassis, illustrating its neat appearance. The rectifier, V_3, is at the mains transformer end of the chassis, whilst V_2 is in the centre

28. Connect C_7 (0.1μF) between tags 16 and 24, soldering at 24.

29. The rest of the wiring is now continued. Following the route shown in Fig. 2, connect pin 3 of V_3 to C_{13}, soldering at pin 3.

30. Following Fig. 2, connect and solder the remaining tag of switch S_1 to tag 1 of the mains socket.

31. Connect and solder tag 2 of the mains socket to tag 1 of the mains selector panel.

32. Following Fig. 2, identify the negative (black) tag of C_{10}, C_{13}. All the following connections involve this tag. Connect the negative tag of C_{10}, C_{13} to tag 5 on the tagstrips, soldering at tag 5. Connect the negative tag of C_{10}, C_{13} to tag 4 on the power output socket, soldering at tag 4. Connect C_{11} (8μF, 350 W.V.) between the negative tag of C_{10}, C_{13} and tag 3 on the power output socket, observing correct polarity. Solder at negative tag of C_{10}, C_{13}.

33. Following Fig. 2, connect C_{10} to tag 1 on the tagstrips, soldering at tag 1.

34. Following Fig. 2, connect R_{16} (470Ω) between C_{10} and C_{13}, soldering at C_{13}.

35. Following Fig. 2, connect and solder R_{15} (value according to requirements—see above) between C_{10} and tag 3 on the power output socket.

36. Connect and solder R_{20} (22kΩ for 15Ω output, 10kΩ $\frac{1}{4}$ watt, as opposed to the $\frac{1}{8}$ watt R18, for 3.75Ω output) between tag 19 of the tagstrips and tag 1 on speaker socket.

37. Join, and solder, tag 23 of the tagstrips to tag 2 on speaker socket.

38. Join tag 1 on input socket to pin 9 of V_1. Solder at pin 9.

39. Bend the supplied thick piece of wire at right angles, $\frac{3}{8}$in in from each end, and solder to centre spigots of V_1 and V_2 to form a busbar between them. (The bent ends enter the spigots, and the the busbar is shown in heavy line in Fig. 2.) All connections made to the busbar which follow are soldered at the busbar.

40. Join and solder pin 2 on the input socket to the busbar.

41. Connect and solder R_1 (1MΩ $\frac{1}{8}$W—as opposed to the $\frac{1}{4}$W R_{14}) between tag 1 of the input socket and the busbar.

42. Join and solder pin 8 of V_1 and tag 22 of the tagstrips.

43. Join and solder pin 7 of V_1 and tag 20 of the tagstrips. Use sleeving (omitted from Fig. 2 for clarity).

44. Join and solder pin 6 of V_1 and tag 18 of the tagstrips. Use sleeving (omitted from Fig. 2 for clarity).

45. Join and solder pin 3 of V_1 and tag 16 of the tagstrips.

46. Join and solder pin 1 of V_1 and tag 14 of the tagstrips.

47. Connect and solder R_8 (1kΩ) between pin 2 of V_1 and tag 1 of VR_3.

48. Connect R_{18} (10kΩ) between pin 2 of V_2 and tag 12 of the tagstrips. Solder at pin 2.

49. Join and solder pin 3 of V_2 and tag 4 of the tagstrips.

50. Join and solder pin 9 of V_2 and tag 2 of the tagstrips.

51. Join tag 3 of VR_2 to tag 8 of the tagstrips, and solder at tag 8. Follow route shown in Fig. 2.

52. Join and solder tag 3 of VR_1 to tag 10 of the tagstrips. Follow route shown in Fig. 2.

53. Connect and solder R_{14} (1MΩ) between tag 12 of the tagstrips and the busbar.

54. Connect C_5 (2,000pF) between tags 1 and 3 of VR_2. Solder at tag 3.

55. Connect C_6 (0.02μF) between tags 1 and 2 of VR_2.

56. Connect and solder R_7 (6.8kΩ) between tag 2 of VR_2 and the busbar.

57. Connect R_5 (39kΩ) between tag 1 of VR_2 and tag 1 of VR_1. Solder at tag 1 of VR_2.

58. Join tag 1 of VR_1 and tag 3 of VR_3. Solder at tag 3.

59. Connect R_4 (47kΩ) between tags 1 and 2 of VR_1. Solder at tag 1.

60. Connect and solder C_4 (8,000pF) between tag 2 of VR_1 and the busbar.

61. Join and solder tag 2 of VR_3 to busbar.

62. Fit valves and knobs.

Operation

The Cooper-Smith "Bantam" is now complete and ready for operation.

The voltage selector panel should be set to the mains voltage with which the amplifier is to be used. The main input fuse (rating 2A) is housed in the bridging plug of the panel. The speaker should be connected to pins 1 and 2 of the speaker socket (tag 3 of this socket, used for the 15Ω output impedance connection, is an anchoring tag only).

The input sensitivity of the amplifier is 60mV for 3 watts output, and care should be taken to avoid applying excessive inputs. If the associated radio tuner or pick-up provides an output considerably in excess of 60mV it will be necessary for this to be attenuated before coupling to the amplifier. Suitable attenuation will normally be given by providing a pre-set potentiometer before the input socket, this being adjusted until a smooth control is provided by VR_3. As a rough guide to the correct setting of such a potentiometer, the amplifier should begin to overload when VR_3 is some three-quarters advanced.

A Guide to the

EQUALISATION CHARACTERISTICS

of Records Imported from U.S.A.

By **A. Campbell Gifford**

Our contributor, recently returned from the U.S.A., where he has been carrying out extensive work on Hi-Fi and audio projects, gives comprehensive details of the equalisation characteristics required for American recordings

THE INCREASING NUMBER OF RECORDS OF U.S.A. origin becoming available here as a result of the relaxation of importation restrictions has started a controversy over relative qualities in playback. All the instances that have come to my notice have been connected with records of little known labels or records which have, according to the maker's sleeve, been manufactured before 1955.

The significance of 1955 is well known to most of us, it is the year in which most manufacturers changed from their own particular and peculiar equalisation arrangements to the R.I.A.A. curve.[1]

Most amplifiers of any quality offer some kind of equalisation selection, but few cater for the wide variations in existence before 1955. Assuming therefore that your amplifier offers you some, or most of the following equalisation settings, R.I.A.A., N.A.B., A.E.S., L.P., Ortho, the following notes will be of use should you acquire any imported records made before R.I.A.A. day 1955.

For the benefit of the uninitiated Hi-Fi enthusiast, let me say that equalisation is necessary because all L.P. discs are recorded with a treble boost to mask surface noise and a bass cut, to conserve groove space and reduce distortion. Therefore, to play back a disc and reproduce anything remotely resembling the original, the bass below a certain frequency must be boosted and the treble must be rolled-off at a certain number of dB at 10,000 c/s. Contrary to the stories told by some equipment manufacturers, this cannot effectively be done by manipulation of the bass and treble controls on the pre-amp alone.

Whether you have a simple control offering no more than R.I.A.A. or Ortho, N.A.B., A.E.S., and L.P., or an elaborate set of switches capable of reproducing almost any known equalisation figures, the information offered here will be of interest to all who have, maybe like myself, several hundred pre-1955 records (many of which are on my "preferred" list).

Perhaps it is because, perforce, most of my records are American that I find American manufacturers, on the whole, just a little more helpful than British. Firstly, most of them put the date of issue or date of recording on the back of the sleeve. If they do not do this, a letter to them promptly brings all the technical "know-how" one could ever need about that particular recording. Similarly, where the R.I.A.A. curve is used this is generally boldly printed along the bottom of the reverse side of the sleeve and sometimes on the front.

The information contained here has been collected and verified over the last three years. It will be seen that some makes involved themselves in some rather peculiar turnover and roll-off figures.

For the benefit of those not familiar with recording curve characteristics, here are the figures for the four most generally used.

	Bass Turnover (c/s)	*Table Roll-off at 10,000 c/s (dB)*
R.I.A.A./Ortho[2]	500	13.7
A.E.S.	400	12.0
N.A.B... ..	500	16.0
L.P.	750[3]	(Usually N.A.B. or A.E.S. equivalent)

If your equipment was manufactured before R.I.A.A. came into being and provides only L.P. and/or A.E.S. characteristics, quite

[1] The R.I.A.A. characteristic is incorporated in British Standard Specification 1928/1960.—*Editor.*

[2] The term "Ortho" is an abbreviation for characteristics defined by trade names. A turnover of 500 c/s with a roll-off of 13.7dB is common to R.I.A.A., R.C.A. Orthophonic and the new A.E.S. Orthophonic is a registered trade name for the R.C.A. system. Westminster records have a similar trade name, Panorthophonic, also registered. There is also Orthacoustic. All have a common turnover and roll-off. —*Editor.*

[3] A 750 c/s turnover for L.P. is typical of American practice. Many British amplifying equipments had a turnover at 500 c/s on L.P. A turnover at 400 c/s (with 12dB treble roll-off) may also be encountered. —*Editor.*

Label	PRE-1955 Bass Turnover (c/s)	PRE-1955 Roll-off (dB at 10,000 c/s)	POST-1955 Bass Turnover (c/s)	POST-1955 Roll-off (dB at 10,000 c/s)
Allegro +B ..	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
American Recording Society ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Angel	N.A.B. 500	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Atlantic	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Audiophile ..	300	− 8	Not known	
Audio Fidelity ..	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Arizona	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Allied	Not known		N.A.B. 500	N.A.B. −16
Bach Guild +B ..	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Banner +B ..	L.P. 750	N.A.B. −16	Not known	
Bartok	629	N.A.B. −16	Not known	
Boston	629	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Blue Note Jazz ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Cademon	630	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Canyon	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Camden	800	−10	Not known	
Capitol	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Capitol-Cetra ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Canyon	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Colosseum ..	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Cetra-Soria ..	Not known		N.A.B. 500	N.A.B. −16
Concert Hall ..	N.A.B. 500	N.A.B. −16	N.A.B. 500	−10.5
Columbia	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Contemporary ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Columbia (Harmony) ..	N.A.B. 500	N.A.B. −16	Mostly re-issues	
Cook	N.A.B. 500	A.E.S. −12 also −15	N.A.B. 500	A.E.S. −12
Coral	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	N.A.B. −16
Classic Edition ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Dial	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Decca	L.P. 750	N.A.B. −16	R.I.A.A. (unconfirmed)	
Dot	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Design	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Esoteric	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
E.M.S.	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Electra	630	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Epic	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Folkways	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Festival	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Good Time Jazz ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Haydn Society +B	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Handel Society +B	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
H.M.V.	N.A.B. 500	N.A.B. −16	R.I.A.A. (unconfirmed)	
Kendall	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
London	N.A.B. 500	−10.5	R.I.A.A. (unconfirmed)	
London International ..	N.A.B. 500	−10.5	R.I.A.A. 500	R.I.A.A. −13.7
Lyrichord	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
			(Some new issues may be R.I.A.A.	
Montilla	Not revealed		R.I.A.A. and	
M.G.M.	N.A.B. 500	A.E.S. −12	R.I.A.A. (unconfirmed)	
Mercury	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
New Records +B	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Nocturne	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Oceanic	L.P. 750	N.A.B. −16	N.A.B. 500	N.A.B. −16

Label	PRE-1955 Bass Turnover (c/s)	PRE-1955 Roll-off (dB at 10,000 c/s)	POST-1955 Bass Turnover (c/s)	POST-1955 Roll-off (dB at 10,000 c/s)
Overtone	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Oxford	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
L'Oiseau Lyre ..	N.A.B. 500	−10.5	R.I.A.A. 500	R.I.A.A. −13.7
Period	N.A.B. 500	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Philharmonia ..	A.E.S. 400	A.E.S. −12	A.E.S. 400	A.E.S. −12
Pacific Jazz ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Polymusic.. ..	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
Rachmaninoff Society ..	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
R.C.A. Victor ..	800	−10	ORTHO 500	ORTHO −13.7
Remington ..	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
Renaissance ..	L.P. 750	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Riverside −B ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Stradivari	L.P. 750	N.A.B. −16	N.A.B. 500	N.A.B. −16
Technicord ..	800	A.E.S. −12	(Not revealed)	
Tops (see note 1)..	L.P. 750	N.A.B. −16	(Not revealed—see note.)	
Telefunken ..	A.E.S. 400	−0	(Not known)	
Tempo	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
Transradio ..	N.A.B. 500	N.A.B. −16	N.A.B. 500	N.A.B. −16
Urania +B (old)..	L.P. 750	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Urania (pre '55) ..	A.E.S. 400	A.E.S. −12	R.I.A.A. 500	R.I.A.A. −13.7
Vanguard +B ..	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Vox (see note 2) ..	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7
Westminster (see note 2)	L.P. 750	N.A.B. −16	R.I.A.A. 500	R.I.A.A. −13.7

+B=These records need up to a quarter turn of Bass beyond the flat position.

Binaural records—useless unless you have the correct equipment—have no treble boost on the inside band, which should be played without any roll-off.

Note 1
Tops is a label which it is believed is being marketed in the U.K. under another title.

Note 2
Some Westminster records are mastered from early Nixa tapes, some of which may have been A.E.S. 400 A.E.S.—12, all sleeves are marked accordingly.

Some Vox were also made N.A.B. 500 N.A.B. 16, these are not generally marked. L.P. setting on these records will produce excessive bass.

satisfactory results can be obtained by the following method, in spite of what I have already said about juggling with the bass and treble controls. For playing an R.I.A.A. disc in an L.P. position, bring bass and treble up about three to four points from the flat position. For playing an R.I.A.A. disc at the A.E.S. position reduce bass and treble by about the same amount. If you're the type who plays his amplifier with bass and treble full over to maximum, and there are many thousands who do, then neither I nor anyone else can help you.

Finally, some words of warning. The word Hi-Fi on a record label is purely co-incidental and has little or nothing to do with its surface noise ratio, the quality of the recording or the performance. That goes for most parts of the world as well as the U.S.A. You have to face up to this fact when buying records from the U.S.A. in the price range of $1.98 to $2.75. However, many of the $3.98 upwards are excellent representations of the recording engineers' technique. But, to the musically educated Hi-Fi enthusiastic, a rare disc is often a disappointment because the playing is bad, the intonation imperfect, the tempo irregular or unorthodox, or the balance downright ridiculous. Some of the most expensive albums are a wonderful investment and will not be bettered anywhere. Unfortunately true Hi-Fi and a good performance seldom seem to go hand in hand. There is also the fact that few of us can agree on what is a good string tone on a record. Some like it overfull and rich and others thin and reedy. (Take time off sometimes and attend a few orchestral rehearsals, and you will begin to realise how wrong you are, how defective is your hearing, and how highly coloured your imagination when you come to re-create music on your Hi-Fi.)

RTTY In Theory and Practice

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

PART 6—Machine Incompatability

NEW AMATEUR R.T.T.Y. OPERATORS MAY be surprised to find that incompatability exists between different machines, although they may be British Creed Models. This incompatability (that between the Type 3 and Type 7 being of particular importance) arises primarily because the Type 3 machine prints on a continuous length of paper tape, whilst the Type 7 produces a page copy. This means that when the Type 7 machine reaches the end of a line, two keys must be depressed, first that for "Carriage Return" to send the carriage back to the starting position for the commencement of the next line, and second the "Line Feed" to turn the paper roller up one line to prevent overprinting. Clearly, on the Type 3, neither of these functions mean anything. If an operator, using a Type 7 is sending to a station using a Type 3, all that will happen when the carriage return and line feed keys are operated is that the signs -/ will appear on the Type 3 copy. Although the Type 3 operator, if he is new to r.t.t.y., may wonder what this means, it will not interfere with the intelligibility of the message. However, when the circuit runs the other way and Type 3 transmission is being received on Type 7, things begin to go wrong. The Type 7 eventually reaches the end of its line, and in the absence of "carriage-return" continues to print all subsequent letters, one on top of the other at the right hand edge of the paper—the copy being completely lost. The Type 3 operator must, therefore, when sending to a Type 7 machine remember at the end of every 68 characters (i.e. one line of page copy) to send -/ in order to carry out the carriage return and line feed functions. In practice it is usual to use two carriage returns, to allow time for a rather complex mechanical movement (though this is strictly only needed on auto working), so that the end of line characters become --/.

Another serious incompatability exists in regard to the letter-figure shifts. On the Type 3, operation of the "figure space" produces a space and ensures that all the following characters will be in figures. Operation of the "letter space" likewise produces a space, and ensures that all following characters will be in letters. On the Type 7 it is quite different, there being only one space bar, and it simply makes a space, having no effect whatever on the shifts. There are, however, two keys marked "Ltrs" and "Figs", which, when depressed, ensure that all following characters come out in letters or figures as the case may be. They do not produce a space in the typing. The corresponding keys for Types 7 and 3 are as follows. The figure space on the 3 works the "figs" on the 7. The letter space on the 3 works the space bar on the 7. The * key on the 3 works the "Ltrs" on the 7. All these keys do, of course, work the other way round as well—i.e. from 7 to 3. An example will show the type of difficulty which can arise. Suppose my call (G3BST) is transmitted from Type 3 to Type 7. Simply typing G figure space 3 letter space B S T, it will be received on the Type 7 as G figs 3 space ? ' 5. If on the other hand, the call is sent from Type 7 to Type 3, as G figs 3 ltrs B. S T, it will print on the Type 3 as G figure space 3 * ? ' 5. All rather confusing. To avoid this mix up, a Type 3 operator, when returning from figures to letters, must send both the letter space and the * key, while the Type 7 operator when returning from figures to letters must send ltrs space.

When working on mixed circuits using different types of printer it is quite a good idea to use the letter and figure shifts as little as possible and spell out any numbers necessary—e.g. G Three B S T. It is also a good idea for Type 3 operators to follow the carriage-return line-feed signals with the * key, to ensure that the Type 7 machines are kept in the letters case, otherwise, if a stray signal puts them into figures they will stay that way until a definite letters signal is received. This cannot happen with the Type 3 since every normal space returns the machine to letters.

Additional incompatabilities exist in the punctuation signals, but for most amateur work these are of no importance. However, when sending on Type 3 to Type 7, try to avoid accidentally sending the character "D" when in "Figures", since this may actuate an "answer-back" mechanism on a Type 7 (where fitted) and prevent reception for a few seconds.

For guidance, the entire list of equivalent signals is published herewith.

Keyboard comparison chart for Creed Type 7 and 3 Teleprinters

Letters		Figures	
Type 7	Type 3	Type 7	Type 3
A	A	—	:
B	B	?	?
C	C	:	(
D	D	Who are you?	2
E	E	3	3
F	F	%	1/
G	G	@	3/
H	H	£	5/
I	I	8	8
J	J	Bell	7/
K	K	(	9/
L	L	)	+
M	M	.	,
N	N	,	—
O	O	9	9
P	P	0 (Nought)	0 (Nought)
Q	Q	1	1
R	R	4	4
S	S	'	'
T	T	5	5
U	U	7	7
V	V	=	)
W	W	2	2
X	X	/	£
Y	Y	6	6
Z	Z	+	.
Carriage Return	—	Carriage Return	=
Line Feed	/	Line Feed	/
Letters	*	Letters	*
Figures	Figure Space	Figures	Figure Space
Space	Letter Space	Space	Letter Space

S.T.C. Triple Crystal Units

Standard Telephones and Cables Ltd. have now issued leaflet MQ/104 Ed. 1, giving details of their triple crystal units type 4434 for f.m. receivers. (The introduction of these units was reported in the London Audio Fair review in our June issue). These crystal units control the local oscillator frequency of f.m. receivers, thereby enabling switched station selection to be achieved with complete freedom from drift.

Each crystal unit contains three separate crystals mounted in a B7G-based glass envelope. The 5th overtone of each crystal is 10.7 Mc/s below the frequency of a selected f.m. transmitter and the three crystals in a particular unit correspond to a particular B.B.C. transmitter. Thus, the triple crystal unit type 4434/A provides local oscillator frequencies for the Light, Third and Home programmes radiated from Wrotham. Other units, with different suffix letters, correspond to the frequencies of other transmitters. The list price of a triple crystal unit is £3 15s. each.

radio topics

BY RECORDER

ONE OF THE MOST IMPORTANT ASPECTS OF radio, and one which to my mind cannot be too frequently emphasised, is that of safety precautions. Many of us tend to take chances when working on electronic gear, and a periodic reminder that such behaviour is dangerous is definitely worth making.

The biggest danger in electronic work is, of course, that resulting from electric shock. Occasionally, engineers and experimenters boast of the shocks they have received in the past and from which they have, obviously, successfully recovered. Such boasting is, surely, misplaced; apart from the fact that it may give the more uninitiated listener the feeling that shocks are a bit of a lark, it also brands the boaster as being over careless. After all, it's only mugs who get shocks.

The Results of Shock

How serious can the results of shock be? This depends on a number of factors which include the state of health of the recipient, the area of contact to the electrodes which cause the shock, the voltage across the electrodes and the current available. If the recipient is lucky he is liable to get a mild shaking; if he is unlucky he may be killed by the shock.

A typical instance of how carelessness can cause shock came to my ears some years ago. A man was working on a corrugated iron roof with an electric drill, the lead of which was not terminated by a proper plug. Instead, the lead ends were pushed into the holes of the mains socket and secured with matchsticks. Either there was a short in the drill and the earth wire pulled out of the socket or, worse, the earth lead was accidentally inserted into the live socket hole. Whatever the cause the outcome was disastrous. The man was electrocuted by the mains voltage between the drill case, held firmly in his hand, and the effective earth provided by the corrugated iron roof.

An unlikely story? There are plenty more to be found. It's a very instructive experience to keep a watch on the local newspaper and see how many deaths due to electrocution are reported in a year. Such deaths do not find their way into the national daily papers but they are fully covered locally. Nearly always you will find that the deaths are caused through electrocution due to the mains, the recipient having touched a live mains point whilst being in contact with earth. Occasionally, potentially dangerous equipment, such as electric fires and a.c./d.c. radios are taken into bathrooms, where accidental contact with earth could hardly be more probable. One only needs a little imagination to visualise a fault condition which may cause accidental contact also with the live side of the mains via the equipment—whereupon the story becomes complete. Some engineers may scoff at the idea of playing around with mains electrical equipment in the bathroom. How often, however, do you find such engineers handling electrical equipment without proper safeguards whilst standing on concrete with damp shoes! Such a situation is nearly as dangerous.

In all the instances I have referred to up to now I have cited accidental shock from the mains. I have done this because the mains is the worst domestic electrical killer of them all. A shock from the e.h.t. system of a t.v. receiver is no laughing matter and may be similarly dangerous, but here, at least, the regulation is poor. With the mains there is 200 volts plus, with a source impedance of well-nigh zero ohms, and a current capability as great as the household fuses will stand. So far as the experimenter and engineer are concerned the mains may still constitute the greatest danger. This is because, in this day of a.c./d.c. sound and television receivers, he is the person most likely to play around with large metal chassis which are *purposely* connected to one side of the mains. Nothing could be more natural than for someone working on a sound or t.v. receiver to reach over and pick up an earthed object whilst his other hand rests on the chassis. And that may well be curtains.

The above is not intended to give the impression that the mains supply is the only source of dangerous shock. It is, however, the cause of shock which tends to be most frequently ignored because of familiarity. Other sources of high voltage—h.t. lines and the like—should be similarly avoided.

Precautions at the Bench

Are there any safety precautions which can be taken against shock hazard whilst working at the bench?

There are a few commonsense rules which can be applied. The first of these is that accidental contact with earth should be avoided at all times. If the floor is concrete, tiled, or stone, lay down good quality linoleum or, better still, rubber flooring. Use a *wooden* stool. Some engineers prefer to keep things like soldering irons "floating", so that there is no risk of making accidental earth contact when they pick them up. However, this brings me to my second point which is that, ideally, all the electrical equipment on the bench should be earthed and any uncovered a.c./d.c. chassis be made "floating" by being supplied through isolating mains transformers. I appreciate that mains isolating transformers are not often used, but they represent the most obvious and sensible safeguard if shock is to be avoided. A third precaution against shock hazard consists of mounting a switch, either in the live mains lead or, preferably, in both live and neutral leads, in an accessible position on the front of the bench. This switch should control *all* electrical outlets and equipment on the bench. Should a shock occur the mains may then be completely disconnected by its use. Fourthly, it is a good plan to form the habit of touching only *one* piece of metal (test clip, chassis, aerial plug, etc.) at any single time. A shock has to be applied via *two* electrodes, and this easily acquired habit may save a lot of grief at a later date. And, fifthly, never, *never*, use "matchstick connections" to a mains socket. Not only can these cause the earth connection to be broken to a particular appliance (as may have occurred in the electric drill episode mentioned earlier) but they may also result in an a.c./d.c. chassis which is supposedly connected to the neutral side of the mains to become effectively connected to the live side. If, whilst such a chassis is switched on, the neutral lead pulls out of the socket, the chassis becomes live via the valve heaters and dropper. So always use the correct plugs; good and reliable types are available very cheaply at the chain stores.

A further point which may be of assistance should you get a serious shock is this: if you can't let go and can't switch off the current, a possible way of breaking the circuit may be to bring the two electrodes causing the shock together and blow the fuses. This isn't always possible, of course, but it's worth remembering.

And, don't forget: it's only mugs who get shocks.

Definition

Turning to a lighter subject, I am offering no prizes to the reader who understands the following definition first go. Or, come to that, third or fourth go.

"*Recording characteristic.* The recording characteristic of a disc recording chain is the curve of recorded velocity versus frequency obtained when recording various frequencies with fixed voltage levels applied to that point in the chain where the normal signal has the frequency characteristic that it is desired subsequently to reproduce."

This definition is taken from British Standard 1928:1960, "Gramophone Records and Reproducing Equipment". Try *that* on your hi-fi!

Talking about definitions there is a good description, which has been current for some time, that defines certain t.v. tuner unit cascodes which gradually lose some 4 to 8dB of life in their first few hours of existence. Tuner unit factory inspectors, gazing sadly at their diminished wobbulator traces, have christened such valves "sinkers". (Shades of N.A.A.F.I. wads!)

Also there is the case of a certain make and model of television receiver whose series heater resistor is soldered direct to the vertically mounted printed circuit board. After a time the heat dissipated by the resistor causes the solder holding its tags to the copper foil to melt, and the resistor becomes detached and falls to the bottom of the cabinet. I understand that these particular resistors are known in the trade as—wait for it—"droppers".

On the Ball

Electrolube Limited have always been on the ball ever since their now very well known contact cleaning fluid was first introduced. Those who haven't tried Electrolube for crackling and arcing contacts can be assured that it really is the goods. It is the most effective switch cleaning fluid, electrically, that I have ever enountered.

Electrolube has now become available in a pocket dispenser which has approximately the same dimensions as a fountain pen. The dispenser is fitted, indeed, with a clip similar to that of a fountain pen, enabling it to be clipped in the pocket. When the cap of the dispenser is removed a three inch nylon "snorkel" is released. This, consisting of a thin, narrow bore flexible tube, may be pulled out and applied to the contact to be cleaned. A little pressure on the body of the dispenser then causes one or more drops of the fluid to be expelled at the end of the "snorkel". When the cap is returned to the dispenser the "snorkel" is pushed home and sealed, thereby preventing undue leakage in the pocket.

The reservoir of the dispenser can be refilled when empty. However, it should last a long time in normal use as only a few drops of the fluid are required for most applications. The dispensers are available in two types. The green cap type contains a fluid which cleans and lubricates all contacts, and is that which would be used most frequently in radio work. The red cap type contains a fluid which is especially designed to clear arcing contacts.

Electronic Music

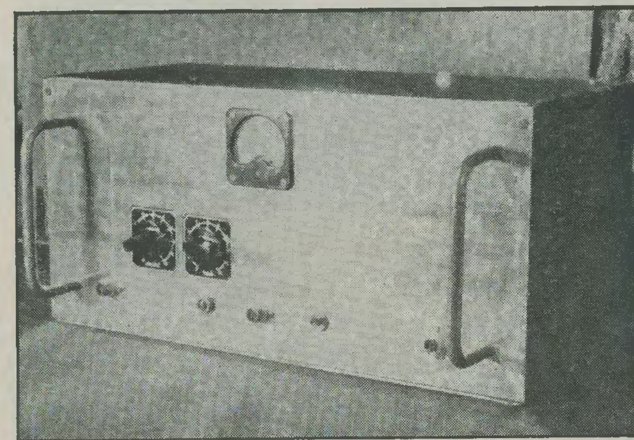
To judge from the reactions of the critics, the recent "first night" of electronic music at the London Proms was not an unqualified success. It would seem that the audience was neither hostile nor madly enthusiastic. The music originally planned, Stockhausen's *Gesang der Jünglinge,* was not performed because, incredible as it may appear, a tape deck capable of playing a four-track tape could not be obtained. A much less complex two-track composition, Berio's *Perspectives,* was presented in its place.

I am quite certain that the champions of electronic music will not be put out in the slightest by the lukewarm reaction of the Prom audience, as this music is finding continually increasing applications in other fields. Up to now, electronic music has been employed very effectively as background music both in films and in television plays. If the rumours I hear are correct, it may well find its way shortly into the jingles which accompany television advertisements. In the last case the attraction is, unhappily, largely economic. The cost of hiring musicians to play short jingles is high, and it would be cheaper to use electronic music instead.

There is, at present, no formal structure to which electronic music must conform, and it is therefore very much in the experimental stage. Doubtless, it will gradually produce its own idiom, and it will be especially interesting to watch developments in the next few years. It shouldn't be forgotten that all of us have been listening to *keyed* electronic music for a long time now, such music being provided by the familiar electronic organ!

HIGH QUALITY MODULATOR FOR THE AMATEUR TRANSMITTER

by **David Noble, G3MAW** and **David M. Pratt, G3KEP**



A Conventional Design for Inputs up to 50 watts

GENERALLY speaking, telephony is more popular than c.w. among British radio amateurs. This being so, with the new licences now being issued the number of telephony stations on the amateur bands increases rapidly. It is important, therefore, that every amateur operator takes all possible precautions to ensure that his transmitter is operating correctly, is not overmodulating, and that speech quality is pleasant to the listener. If due attention is not paid to modulation it may mean that valuable space on the amateur bands is unnecessarily wasted, and that other stations may lose contacts. It would be of some advantage if *all* radio amateurs aimed at getting their modulation and speech quality just a little better than that of the nearest local call sign.

The modulator to be described was originally designed to anode and screen-grid modulate a power amplifier running up to 50 watts input. It is, however, mainly used for a 160 metre 10 watt transmitter,[1] and as only 5 watts of audio power are required to modulate a 10 watt p.a. input power, and the modulator has a maximum output of 25 watts, the gain control is turned well down.

Circuit

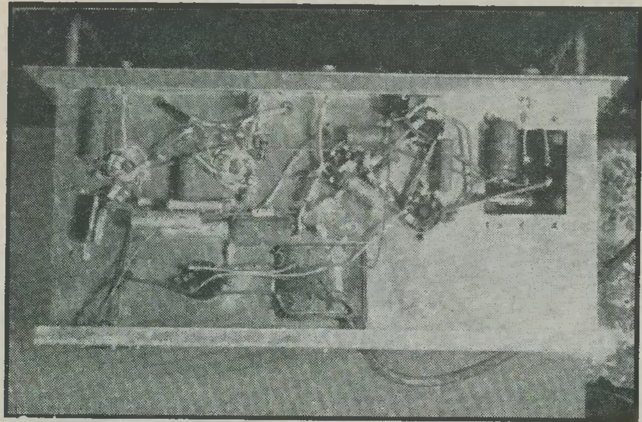
In the first two stages EF50 (VR91) valves are used as voltage amplifiers, the second being strapped as a triode. The reason for the choice of this type of valve was that it has its own screening can, and that it is cheap. The gain control is a simple potentiometer between the first two stages, and the tone control is a simple top-cut circuit between V_2 and the phase-splitter, V_3. The phase-splitter is a 6SL7 in a conventional paraphase circuit which feeds the push-pull output stage. A coaxial socket is connected to the grid of the 6SL7, and high level inputs may be fed to this socket. This facility was originally intended for a 1,000 c/s phase-shift oscillator used for m.c.w. during slow morse transmissions, and it proved to be an invaluable refinement as it did not necessitate changing over the microphone and oscillator plugs before and after verbal announcements.

It is important that several of the components in the phase-splitter and output section be accurately matched. These are the two anode load resistors R_{11}, R_{12}; the two blocking condensers C_{11}, C_{12}; the grid resistors R_{15}, R_{16}; and the grid stoppers R_{17}, R_{18}. Although the actual values themselves are not very critical, the pairs of components, except for R_{17} and R_{18}, should be matched to within 2%. R_{17} and R_{18} are matched to within 5%. Of the matched pair R_{15} and R_{16}, R_{15} should, preferably, have the higher value.

Output Stage

The output stage employs two 6L6's operated in class AB1. A common screen-grid resistor is used, and is calculated for the screen current at zero signal level. The

[1] "A Transmitter Circuit for 160 Metres", David Noble, G3MAW, and David M. Pratt, G3KEP, *The Radio Constructor*, August, 1959.



Underside view of G3KEP's and G3MAW's modulator

condenser C_{13} ensures that the screen voltage remains constant when the current increases as the signal voltage is applied.

It will be seen from the photographs and from the circuit diagram that a meter is included in the anode circuit of the output stage. This has been included in order that a check can be made on the modulator supply current.

The output valves used in this circuit have an anode to anode load impedance of 9,000 ohms. This is the same load as that required by the transmitter[1]. (The p.a. conditions being 300 volts at 33mA giving an input power of 10 watts and a load impedance of 9,000 ohms.) As the impedance of the modulator is equal, in this case, to that of the transmitter power amplifier, a modulation transformer with a turns ratio of 1 to 1 is employed. In the prototype a Collins modulation transformer was used. This has the correct ratio and is available quite cheaply on the surplus market. Multi-ratio types such as the Woden UM1, etc., may, however, also be used.

The output of the modulation transformer is fed to an insulated Belling-Lee coaxial socket; this component was substituted for the original jack socket which was found to arc on modulation peaks. One other feature which is not normally found in designs of this nature is the switch $S_{1(a)}$ and $_{(b)}$. This is a toggle switch of the single-pole changeover variety. It is wired in such a manner that, when the h.t. supply to the modulator is switched off, the secondary of the modulation transformer is shorted. This enables c.w. to be used without removing the modulator connection from the transmitter.

Microphone

Almost any type of crystal microphone may be used with the modulator, and good

Top view of the modulator described in the text

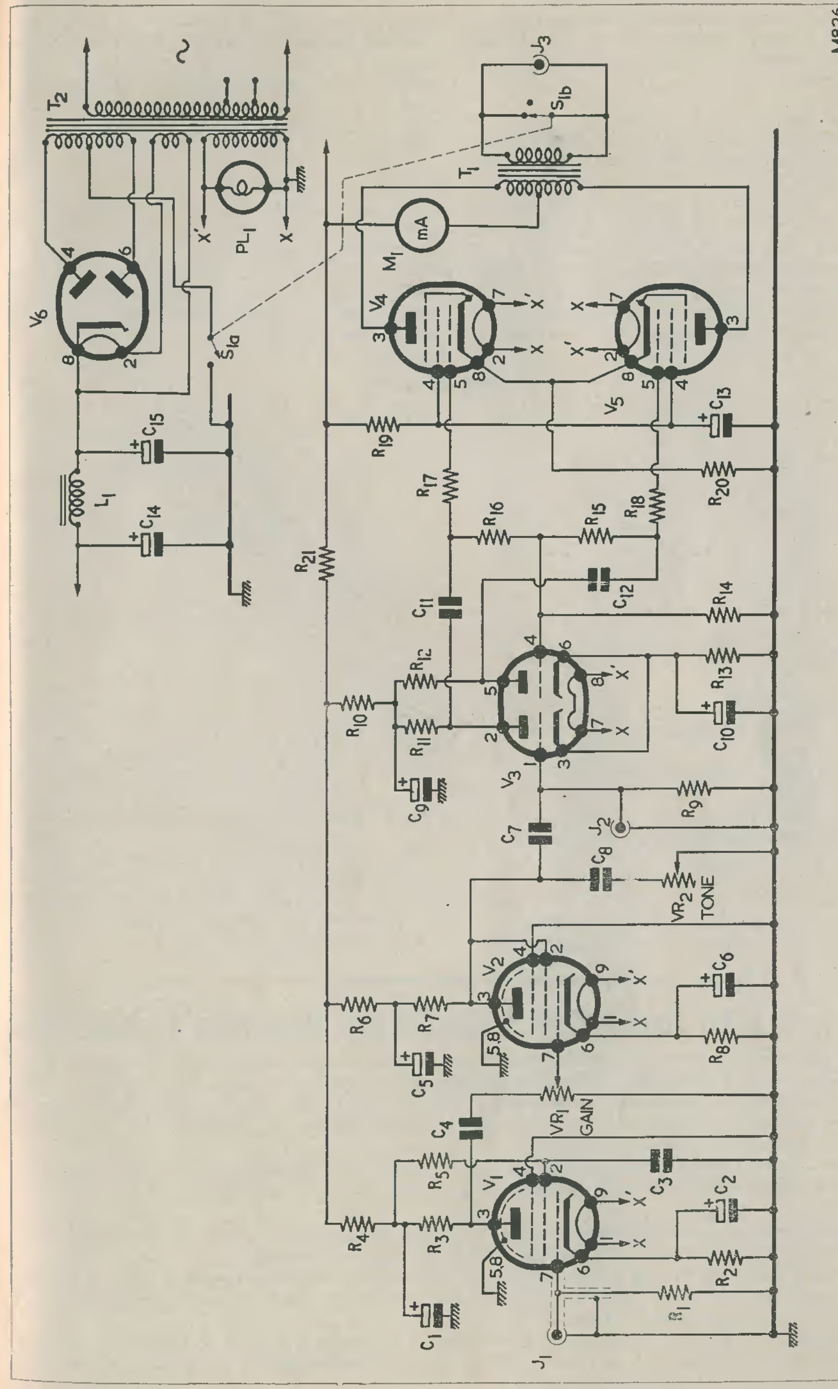


Fig. 1. Circuit diagram of the 25 watt modulator described by G3KEP and G3MAW. The switch S_1 is shown in the "off" position with the secondary of the modulation transformer shorted so that c.w. may be used without disconnecting the modulator

results have been obtained from a variety of different types ranging from "surplus" deaf-aid inserts to the more expensive commercial units.

Construction

The modulator and its power supply were built on to a chassis 7½ x 15¼ x 2in. This conveniently fitted into a TU-unit outer case with a suitable front panel. The external appearance of the modulator was designed to match the transmitter with which it is used.[1] The power supply was mounted along the rear of the chassis, the mains transformer being well away from the modulation transformer and the first stage. The modulation transformer itself is mounted towards the front of the chassis; with the first three valves mounted in line from left to right and the output valves equally spaced on either side. (See photograph of top view.) The modulation transformer is mounted in line with the first valves.

Results

No difficulties were encountered when getting the modulator working. If constructors who decide to make this equipment take the usual precautions with regard to grid wiring, etc., they will find that this general purpose modulator will give extremely satisfactory results

Components List

Resistors (¼ watt unless otherwise stated)

R_1 5.6MΩ
R_2 1.5kΩ
R_3 390kΩ
R_4 82kΩ
R_5 820kΩ
R_6 68kΩ
R_7 220kΩ
R_8 2.2kΩ
R_9 680kΩ
R_{10} 10kΩ
R_{11} 220kΩ } Matched ±2%
R_{12} 220kΩ }
R_{13} 1.5kΩ
R_{14} 220kΩ
R_{15} 220kΩ } Matched ±2%
R_{16} 220kΩ }
R_{17} 10kΩ } Matched ±5%
R_{18} 10kΩ }
R_{19} 18kΩ, 1 watt
R_{20} 250Ω, 6 watts
R_{21} 33kΩ, 2 watts

Condensers

C_1, C_5, C_9 8μF, 350V wkg. electrolytic
C_2, C_6, C_{10} 50μF, 25V wkg. electrolytic
C_3 0.1μF, 400V wkg. paper
C_4, C_7 0.001μF, 400V wkg. paper
C_8 0.01μF, 400V wkg. paper
C_{11}, C_{12} 0.05μF, 400V wkg. paper, matched ±2%
C_{13} 8μF, 500V wkg. electrolytic
C_{14}, C_{15} 50μF, 500V wkg. electrolytic

Miscellaneous

VR_1 500kΩ potentiometer, log track
VR_2 250kΩ potentiometer, lin. track
V_1, V_2 EF50 (VR91)
V_3 6SL7-GT
V_4, V_5 6L6
V_6 GZ34
M_1 0–100mA meter
PL_1 6.5 volt, 0.3 amp pilot lamp
J_1, J_2 Belling-Lee coaxial socket, type L604/S
J_3 Belling-Lee insulated coaxial socket, type L.603.
T_1 Modulation transformer—see text
T_2 Mains transformer 350–0–350V, 200mA, 6.3V, 2A and 6.3V, 4A
L_1 10 henry, 200mA choke
S_1 Toggle switch—changeover

Brian Rix to Open the 1960 Radio Hobbies Exhibition

Brian Rix, stage, screen and t.v. laughter-maker and now B.B.C. impresario, will appear in an unfamiliar role when he opens the Radio Hobbies Exhibition in London on 23rd November, 1960.

Mr. Rix has a special interest in this show for amateur radio and television enthusiasts, as it is the annual rendezvous for members of the Radio Society of Great Britain and for all amateur radio enthusiasts.

Known on the Short waves by the call sign G2DQU, Mr. Rix obtained his amateur radio licence in 1938 and was soon conversing with fellow radio enthusiasts in all countries throughout the world.

In speech and morse code they discussed technical and personal topics in the friendly way for which the international amateur radio fraternity is well known.

Although he is known to millions through the record-breaking farces at the Whitehall Theatre and on television, he also has this more individual means of communications at his command and is a member of the R.S.G.B.

The show will be held at the Royal Horticultural Society's Old Hall, Westminster. It will display all types of receiving and transmitting radio and television equipment, together with test gear, components and accessories.

A small Ad. in The Radio Constructor

by **J. BLAND**

FROM PAST EXPERIENCE, I HAD LITTLE faith in the response that a "small ad" would bring. Consequently, the response to my "small ad" in *The Radio Constructor* caught me "on-the-hop"—that being my reason for writing this article. I propose to deal with the subject in three sections: preparation, packing the parcels, and the various ways of sending them.

The first thing is to decide the prices of the various items for sale, and whether postage is to be included in this price. Remember that a valve may be sent by post for about 7½d., while the average mains transformer will cost 1s. 6d., or more.

Next, clearly write out the advertisement and send it to the Advertising Manager. Do not sacrifice clarity for the sake of a word, or two. The first few words will be printed in block letters, therefore use them to good advantage. Do not start with the words "For Sale". Catch the reader's eye with something like this:

"GREMLIN MAJOR" high fidelity amplifier for sale.

Ask for a stamped addressed envelope for enquiries and, if a reader asks for further details, provide as much of them as possible. It is always a good idea to keep some sort of account sheet, in order that a check may be kept on expenditure.

Keep all letters together, where they may easily be found if required.

As soon as the advertisement has been sent, look around for packing materials, a plentiful supply will be required. Should the goods arrive, even slightly damaged, the inference may be drawn that they were unserviceable before despatch.

Obtain plenty of strong cardboard boxes and corrugated paper. An excellent packing material can be made from newspaper by tearing it into thin narrow strips and crumpling it at the same time.

Always address the package once on the inside and twice on the outside. Add such information as "Registered Post", "C.O.D.", etc. "Fragile—With Care" labels are useful and cost about sixpence per hundred.

There are three ways of sending parcels: by post, by rail, or by road. Parcels up to 15 pounds in weight may be sent by post, there being two rates, letter post and parcel post; dependent, in price, only by the weight of the package, 15lbs costing 3s. 6d. Any parcel may be sent by road or rail, the price depending on distance and weight. A parcel weighing 15lbs being sent 200 miles will cost approximately 5s.

Some readers may ask for the goods to be sent Cash on Delivery. Quote this as an extra. By post, the charge is 1s. 8d. for £10 to be collected; the maximum amount collected being £40, charge 2s. 8d.

British Railways do not offer a C.O.D. service. British Road Services charge 3⅓% up to £7 10s. collected, minimum charge 4d., and for £10 to be collected the charge is about 5s. The sequence of events is as follows: The carrier will deliver the parcel, and hand it to the customer in exchange for the cash, the C.O.D. charge then being deducted and the balance forwarded to the consigner of the parcel. If the carrier is to accept a cheque, the parcel must be marked "Take cheque" (or "T/C"), failing this the carrier will only accept cash. British Road Services require the parcel to be marked "C.O.D." together with the amount, plus "Take Cheque", is required. They also require an invoice and a receipt (the latter being stamped if over £2) fixed in an envelope to the outside of the parcel. In any event this is advisable when the parcel is despatched C.O.D.

Should there be more than one parcel in any consignment, mark each one "Parcel 1—Lot of 3", and so on.

It is also a good idea, where large and expensive components or equipment are being despatched, to insure the parcels. Insurance companies require the submitting of a "proposal" stating the value of the items, a description of them, and one or two other details; they will then quote a premium.

Goods sent by British Railways are automatically covered, however, by the company's policy up to £25 in value, the same applies to British Road Services, up to a maximum of £10 in value.

Parcels sent by General Post are not insured when travelling in this country, but, since the value is easily proved, they can be protected by registration. A charge of 1s. covers articles of value up to £10; 1s. 3d. up to £60, and so on.

To conclude, the writer has added a sample "small ad" (entirely fictitious, of course!)

"THE JUGGERNAUT" Super high fidelity 20+20 watt stereo radiogram for sale, £40. Also Valves EXBC25, Z8V57, BEN51, 5s. each; Zens crystal microphone, £3; etc., etc.—s.a.e. for details. Prices plus 9d. p. and p. for orders under £1. C.O.D. and insurance extra.—Soap, 57 Devonport Way, Farthingsworth, Lincolnshire.

Sources of Information: General Post Office, Victoria Street, Derby; British Railways, Midland Road Station, Derby; British Road Services, Parcels Depot, St. Mary's Wharf, Derby.

A Constructor visits the ....

1960 NATIONAL RADIO and TELEVISION SHOW and the PYE GROUP EXHIBITION

THE 1960 NATIONAL RADIO SHOW AT EARLS COURT was opened by Dame Flora Robson on the 24th August. The ceremony was marked by Dame Flora pressing a button, whereupon a girl, representing "The Spirit of the Air", danced her way across the stage to a background of electronic music, finally presenting Dame Flora with a bouquet.

This was the 27th Show to be held and it occupied the largest area ever employed. More than 20,000 people attended on the first day. For once, there was no marked stress on any single activity within the industry; all sections, including television, sound reproduction, and transistor equipment, had advances to show and these were presented with equal emphasis.

An innovation was an exhibition of pianos in the Warwick Hall.

Television

Television receivers exhibited at the Show gave evidence of the advantages offered to cabinet designers by the new short-neck 110° cathode ray tubes. Considerable weight was placed in advertising literature on the "slimness" of present cabinets, an example of such "slimness" being provided by the McMichael 17in model M75T, whose cabinet is less than 12in deep. Cabinet presentation was much livelier than in previous years, glossy polyester finishes (on which you can stub out a cigarette) being almost universally employed for wooden surfaces, these being relieved with metal trim or bright washable plastic inlays. Some table models were completely covered in brightly coloured plastic or fabric.

Whilst there were, technically, no startling innovations, there was a general all-round improvement in design together with the introduction of devices calculated to make adjustment easier. Especial attention was paid to servicing requirements. A few firms have reverted to conventional wiring in at least part of their receivers in order to overcome the servicing difficulties stated to exist with printed circuits. The Philco stand demonstrated the advantages given by this firm's "Codenta" manufacturing system, which is aimed entirely at easing the problems of the service engineer. A receiver made to "Codenta" requirements has easy-to-remove individual chassis and assemblies, all of which are colour coded to indicate their function. A "Codenta" receiver may be completely dismantled or assembled in under five minutes.

Much thought has been given to overcoming the difficulties experienced by the lay viewer in changing channels and in adjusting fine tuning. Bush, who introduced "Bush Button" channel selection at the 1958 Show, displayed the tuning units in which these buttons form an integral part. Pressing any button causes a ganged set of slugs to enter the aerial, r.f., and oscillator coils of the tuning unit to a pre-determined amount, thereby selecting the channel required. The buttons also operate a switching mechanism which selects Band I or Band III tuning inductors as applicable. The amount of slug insertion into the appropriate coils is controlled by threaded rods passing through the shafts actuated by the buttons, and an ingenious clutch enables these rods to be rotated by turning the front panel button itself.

Whilst the operation of "Bush Buttons" is not entirely news their application to remote control is. With the Bush remote control arrangement, incorporated in their model T101C and introduced for the first time at the Exhibition, a control box containing a volume control and four buttons is connected to the receiver via a length of wire. Pressing a button on the remote control unit energises a solenoid fitted around the appropriate "Bush Button" shaft in the receiver, and thereby draws that shaft inwards to select the channel required. Since a relatively large force is required to move the shaft, the energising current for the solenoid is obtained from a 300μF condenser charged to full h.t. voltage. When the remote control button is released the condenser recharges up to h.t. voltage via a series resistor ready for the next operation.

Simplified tuning was evident in many other receivers. His Master's Voice receivers had piano-key tuning, small protruding keys being pressed down to select the desired channel. In this instance, pressing down a key causes separate pre-aligned sets of coils to be offered to contacts in the associated tuning unit. H.M.V. also had on display a receiver whose turret tuner could be controlled by a remote control unit not coupled to the main chassis by wiring. When a button on the remote unit is pressed, a short rod is struck which produces a vibration at supersonic frequency. This "sound" is picked up by a microphone on the receiver and causes a motor to turn the turret tuner round to a pre-selected channel. Thus, if Channel 1 and Channel 9 were pre-selected, pressing the button would cause the motor to turn the turret from Channel 1 to Channel 9. Pressing it again would cause it to continue rotating until Channel 1 was selected once more. In addition to channel changing, the device enables the receiver to be switched off by having one of the preselected turret positions on a "dead" channel, such as Channel 7. If the turret is set remotely to the "dead" channel and left there for 15 seconds the receiver switches itself off.

Ultra, in their "Bermuda" series, introduced their "Auto-tuner". The front panel control of the "Auto-tuner" consists of a circle of 12 buttons, each corresponding to a t.v. channel or to a v.h.f. f.m. transmitter. Behind the circle of buttons is a rotating concentric disc bearing "homing" contacts and coupled to an electric motor. The electric motor shaft carries bevel gears which couple, through 90°, to a turret tuner mounted vertically. On pressing a button the electric motor causes the disc behind the buttons to rotate and "home" on to the button depressed, thereby turning the tuner unit turret to the desired position. The design allows accurate indexing of the turret drum, together with pre-set fine tuning at all positions.

In the Alba range, channel selection is achieved by a two-way rocker-arm switch. In this case the two channels available (one on Band I and one on Band III) are selected by a simple switching arrangement. Band I and Band III coils are in series when the switch is set to Band I. Setting the switch to Band III causes the Band I coils to be short circuited. The switch also brings in separate pre-set sensitivity controls on either band.

Ferguson television receivers featured the "Golden Glide" channel selection mechanism. A moulded press-button protrudes through a slotted escutcheon in the top of the cabinet on which are printed the various channel numbers. To select a channel it is merely necessary to press the button, slide it along the slot to the appropriate number, and release it again. This operation causes the rotation of a tuner unit turret inside the cabinet, the action of initially pressing the button releasing the turret indexing spring and providing a free sliding movement for the button. The mechanism also enables pre-set fine tuning to be achieved from the front panel.

McMichael and Sobell both demonstrated automatic contrast controls which counteracted changes in ambient lighting levels, the device being described as "Cat's Eye" and "Electronic Eye" respectively. The light-sensitive unit in each instance is a light dependent resistor whose resistance changes according to the amount of light falling upon it. The light dependent resistor is coupled into the a.g.c. circuit of the receiver and causes contrast to increase when ambient light level increases. A similar device was exhibited by Philips in their "Videomatic" range.

A new introduction from Ferguson was an all-transistor portable t.v. receiver called the "Transvista". This has a 7in screen, weighs 20lb, and has dimensions of 15in by 9¾in x 7¼in. The batteries give four hours of viewing and may be recharged from the mains.

Radio

Transistors have now found their way into v.h.f. f.m. receivers. Transistorised a.m./f.m. receivers were shown by G.E.C., Ferguson, H.M.V., Marconiphone, Philco and Ultra. The H.M.V. model employs nine transistors and four crystal diodes.

The most expensive transistor receiver at the Show was a jewel encrusted portable covered in black suede and studded with 70 real diamonds and other mixed stones, by Roberts' Radio. The price is 2,000 guineas. (Plus 3s. 6d. for the battery!)

Audio Reproduction

Four-track recorders were exhibited by Elizabethan, Sound Tape Recorders, Fidelity and Reflectograph. Since these recorders enable four, instead of two, tracks to be used on a standard ¼in tape, twice the playing time is available. Thus, a 5¾in spool running at 3¾in/sec can give a total playing time of six hours.

Recorders capable of offering stereo recording and playback were shown by Brenell, Elizabethan, Reflectograph and Truvox.

In their 658RG radiogram, Ferguson have introduced a "Reverbersonic" device. It is stated that this provides in effect, a built-in echo giving an acoustic result similar to that in a concert hall. The degree of reverberation can be selected by push buttons.

Constructional Interests

As always, Mullard were well to the fore at the Exhibition. This year they had four stands: the Main Stand, the Dealer Rendezvous, the Set-Makers Reception Room, and the Home Constructor Centre. In addition to these, Mullard also demonstrated their High Speed Valve Tester in the Servicing Display organised by Radio Industry Exhibitions Ltd.

On their Main Stand Mullard presented "Mullardrama", this being part colour film, part display, the latter being strikingly enhanced by ingenious lighting effects. The film, entitled "Then and Now", starred Jon Pertwee in a series of sketches demonstrating the difference between electronic entertainment past and present. The Home Constructor Centre is now a well-known and very welcome feature of the Radio Show, and it enables enthusiasts to consult Mullard engineers and obtain the latest information on Mullard valves and semi-conductors. The Home Constructor Centre was very well attended at this year's Show.

Standard Telephones and Cables Ltd. gave a striking demonstration of the capabilities of their new S.T.C. silicon h.t. rectifiers type FST 1/4. These are intended for use in t.v. receivers. The rectifiers, which have a rated maximum forward current of 500mA, were subjected to a surge of 35A every 5 seconds. This demonstration was to continue throughout the duration of the Show.

The Radio Society of Great Britain catered for a steady stream of visitors at their stand, under the very capable hands of Sylvia of A.R.M.S. fame. Notable amongst the exhibits on the stand was a 33–48 Mc/s wobbulator employing voice-coil modulation, and portable R.A.E.N. equipments.

The Pye Group Exhibition

Pianos moved into Earls Court this year. And Pye moved out.

The three day Pye Group Exhibition was held at the Royal Festival Hall from the 22nd to the 24th of August. The reason for a separate Exhibition was that "it was felt that dealers and public could not get a fair picture of what is being done in the space available at Earls Court". More than 175,000 attended the Exhibition, and it is stated that orders were taken at the rate of about £200,000 per day.

On the domestic television side, by far the most newsworthy exhibit was the Pye transistorised portable fringe receiver, model TT1. This receiver employs 26 transistors, 11 crystal diodes, 3 silicon diodes, and 1 e.h.t. thermionic diode. The c.r.t. is 14in, with 70° deflection, and is aluminised. The dimensions of the case are 13in by 14½in x 17in and the weight is 38lb. The receiver is capable of operating from the following supplies: 200–250 volt a.c. mains, 12 volt car battery with positive earth, or its own internal battery. The battery gives 1½ hours viewing and is automatically recharged when the receiver is connected to the mains supply. Power consumption is stated to be 15 watts.

The TT1 models on view at the Exhibition gave a good account of themselves, providing a picture of good definition and interlace. So far as could be judged in the Festival Hall lighting conditions, brightness level was more than adequate. The receiver is currently in production, it was stated.

Another television exhibit consisted of 19 and 21in cathode ray tubes by Cathodeon. These, the C19/7A and C23/7A respectively, had "squared" corners. No ion trap magnets are required, focus is electrostatic, and the face provides a grey filter.

Pye Telecommunications Ltd. exhibited a remotely controlled t.v. camera. This camera, sited in Westminster, could be operated from a control box in the Festival Hall itself. Control functions available included pan and tilt, wiper and demister, and lens turret change. The system employed is 625 lines with negative modulation.

A popular exhibit at the Festival Hall was "Radio Westminster", a sound transmitting station designed to serve any town in Britain at a cost of £15,000 complete. The station uses two transmitters, a Medium-wave transmitter during daylight hours and a v.h.f. transmitter day and night. The radius of coverage for both transmitters is 10 miles minimum. Programmes are originated locally by the station's own staff or are obtained from tape and disc. It is intended that the Medium wave transmitter be used during daylight hours to give immediate access to vast numbers of Medium wave receivers in homes and in cars, and to close down after sunset to avoid Continental interference.

Since the v.h.f. transmitter is available all the time, the station has two channels during the day. It is suggested, therefore, that the v.h.f. transmitter could be made available for educational and public service broadcasting at daytime.

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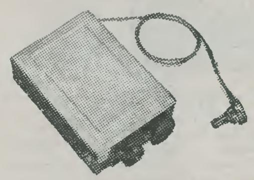

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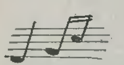

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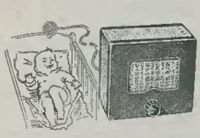

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