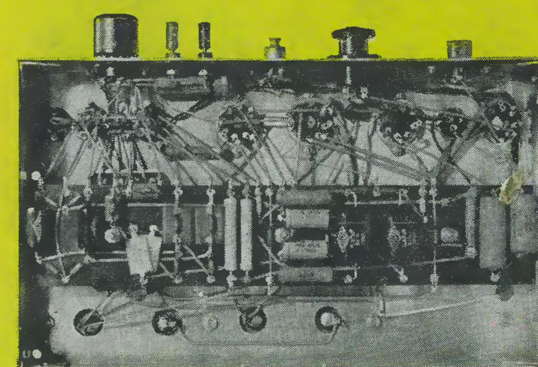
CONVERTING THE BC-348

VOLUME 14
NUMBER 7
FEBRUARY
1961

The RADIO Constructor

TWENTY WATT AMPLIFIER

A Cooper-Smith Design

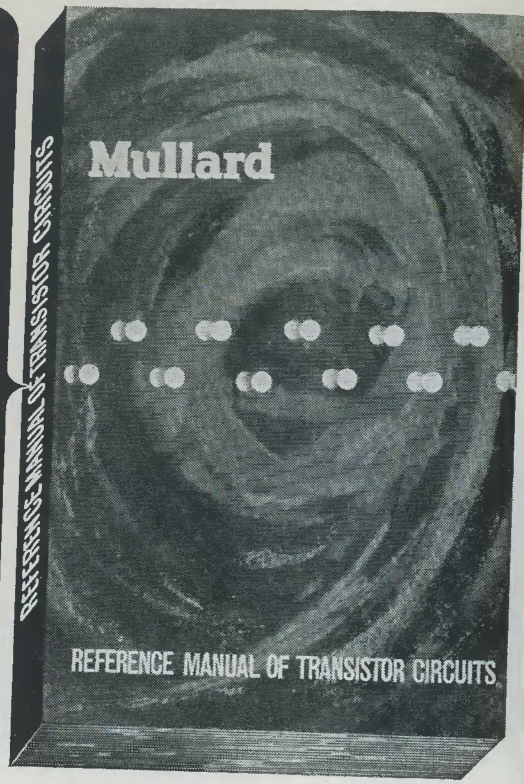


Described by W. Holmes

Included in this issue
AN AUDIO FREQUENCY OSCILLATOR
AN IRON SAVER
A SIMPLE WIRED BENCH
AUTOMATIC LOCATION AERIAL BRACKET
TESTING CONDENSERS
MODERN CERAMIC CONDENSERS

DATA Publications 1/9

over 30 new circuits are in the **Mullard** REFERENCE MANUAL OF TRANSISTOR CIRCUITS



This new manual of transistor circuitry has been prepared by Mullard engineers, as an up-to-date and readable volume which will be of use and interest to technicians, service engineers, junior designers and electronics students.

It has a page size of 8½″ x 5½″ and decribes more than 60 circuits—over 30 are made generally available for the first time—including both domestic and industrial applications.

308 PAGES · 241 DIAGRAMS · U.K. PRICE 12s. 6d.

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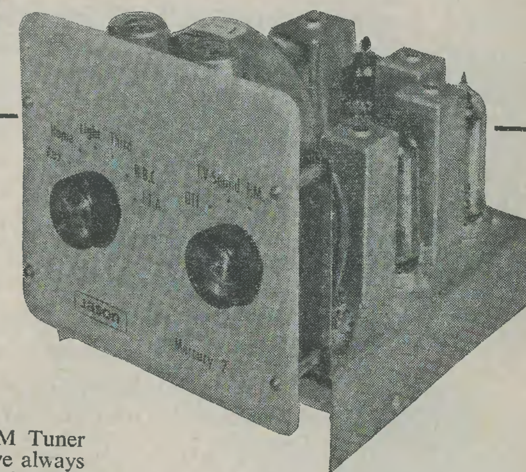
MVM17

BUILD A TUNER Jason



Many models Well-presented designs

From the time of the first Jason FM Tuner (FMT.1) the company's activities have always been closely associated with tuner design and production. Jason were first to produce a stable switched FM tuner for reception of B.B.C. transmissions. Jason next pioneered tuners (FM and AM) in various forms which matched with Jason Mono and Stereo Amplifiers, and both ready-built and constructional kits were made available. Yet another outstanding success has been achieved with the introduction of simple-to-operate switched tuners to receive both FM and TV sound transmissions, the latter facility finding ready welcome among both tape recorder and hi-fi enthusiasts. Jason Tuners (which are available from all leading stockists) offer a wide choice of models designed to meet present-day listening requirements and are a delight to build. Full descriptive literature on request.

Tuner Kits

(Valves extra except on Mercury II and JTV/2K Kits with which 2 valves are included)

FMT/1—The original Jason chassis tuner	**£5.19.0**
FMT/2—As above but in shelf mounting case	**£8.15.0**
FMT/3—Variable FM with AFC control (in case)	**£9.19.0**
JTV/2K—Self-powered switched FM/TV sound	**£14.19.0**
Mercury II—Switched FM/TV sound chassis	**£10.14.0**
Everest 7 Transistor Portable	**£15.18.9**

JASON TEST EQUIPMENT IN KIT FORM

These highly dependable instruments are supplied in kit form for building oscilloscopes, audio-generators, crystal-controlled calibrators, wobbulators, etc. Excellent instructional literature is included with each model. Details on request.

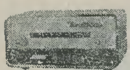
JASON ELECTRONIC DESIGNS LIMITED

3-4(E) GREAT CHAPEL ST. OXFORD ST. LONDON W1 *Telephone GERrard 0273/4*

The World-famous Heathkit range of equipment

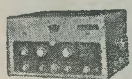
For the Discerning who require the Best Performance at Minimum Price

HI-FI FM TUNER



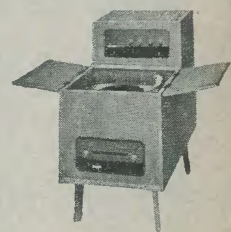
This model is available as two units which, for your convenience, are sold separately. They comprise an R.F. Tuner Unit, Model FMT-4U (£3.2.0 including Purchase Tax) with I.F. output of 10.7 Mc/s, and an Amplifier Unit complete with attractively styled cabinet, also power supply and valves. Model FMA-4U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

AMATEUR TRANSMITTER Model DX-100U



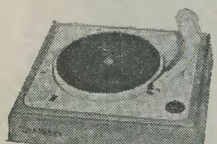
This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160–10 metres. Self-contained, including power supply, Modulator and V.F.O. **£78.10.0**

THE "CHEPSTOW"



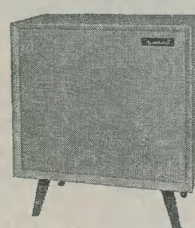
This cabinet has specially been developed for those who require to house their equipment in as small a floor area as possible. Overall dimensions are 35″ x 18″ x 33″ high.
It will accommodate Record Player, FM Tuner, Stereo Amplifier and where a Stereo Control Unit is used, one or more power amplifiers as well. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Left in the white, veneered for finishing to personal taste. **£10.10.0**

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** Heavy Turntable **£15.0.0.**

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



THE "COTSWOLD"

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

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

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

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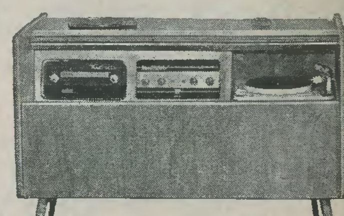
TAPE RECORDING/REPLAY AMPLIFIERS. · Stereo (TA-IS) **£22.4.0.** Mono (TA-IM) **£16.14.0**

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

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

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



The "GLOUCESTER" (open)

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

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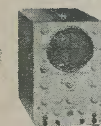
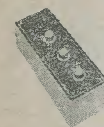
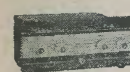


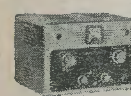
O-12U



DC-1U



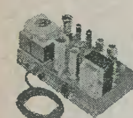
S-33



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**
2¾″ PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5″ x 8″ x 14″. Wt. 10½lb. **£18.19.6**
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VALVE VOLTMETER: V-7A. The world's largest-selling VVM. Measures volts to 1,500 (DC & RMS) and 4,000 pk. to pk.; resistance 0.1Ω to 1,000MΩ DC. Sensitivity: 7,333,333 ohms per volt. **£13.0.0**
HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn. at 2½ watts per channel. **£11.8.0**
HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl. Many special features. **£25.5.6**
"HAM" TRANSMITTER: DX-40U. 75W CW; 60W pk. c/c phone; 40W into Aerial. **£29.10.0**
HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono in average room (left "in the white"). Legs £1.7.0 extra. **£10.5.6**
AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies attenuation. **£19.3.0**
JUNIOR TRANSISTOR RADIO: UJR-1. Youngsters are not excluded from our kit programme. This special single transistor set is an excellent introduction to radio and an instructive present. **£2.16.6**
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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**
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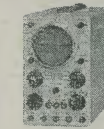
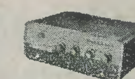
AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V AC. 10 c/s to 400 kc/s. **£13.18.6**
ELECTRONIC SWITCH: S-3U. This extremely useful device extends your single-beam "scope" for double-beam uses. **£9.18.6**
DIRECT READING CAPACITANCE METER: CM-1U. Full-scale ranges of 0–100 mmf, 1,000 mmf, 0.01 mfd and 0.1 mfd. **£14.10.0**

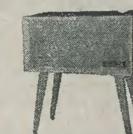


OS-1

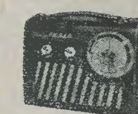
V-7A



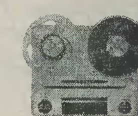
S-88



SSU-1



UXR-1



"STUDIO"

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FULL DETAILS OF MODEL(S) ....

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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. Special offer **£6.19.6** post free

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

or **£9.9.0** complete kit post free

I.F. TRANSFORMERS 7/6 pair

465 kc/s slug tuning miniature can 2½" x 1" x 1". High Q and good band width. By Pye Radio. Data sheet supplied.

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New boxed VALVES 90-day Guarantee

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

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

B.B.C. Pocket Transistor. M.W. and L.W. Radio Kit **32/6**. Phones **7/6** or deaf aid earpiece **12/6**.

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For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied. **Type A.** Low leakage windings. **Optional 25% and 50%** boost on secondary: 2V, or 4V, or 6.3V, or 10.3V, or 13.3V, with mains primaries, **12/6. Our Latest Superior Product. Mains Input Type A2. High quality low capacity 10-15pF. Optional boost 25%, 50%, 75%, 16/6** each. **Type B.** Mains input. Low capacity. Multi output 2, 4, 6.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. **21/–** each.

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

WIRE-WOUND RESISTORS

5 watt	25 ohms–10,000 ohms	1/3
10 watt		1/6
15 watt	12.5 kΩ–50 kΩ 10W, 3/3	2/–

WIRE-WOUND POTS Pre-set min. TV type. Knurled slotted knob. All values 10 ohms to 25k, 3/– each, 30k, 50k, **4/–**. Ditto ¼W Carbon Track 30k to 2 Meg. **3/–**.

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

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STANDARD 250–0–250, 80mA, 6.3V tapped 4V 4A, Rectifier 6.3V 1A, tapped 5V 2A and 4V 2A	22/6
Ditto 350–0–350	22/6
MINIATURE. 200V 20mA, 6.3V 1A	10/6
MIDGET. 220V 45mA, 6.3V 2A	15/6
SMALL. 220–0–220V 50mA, 6.3V 2A	17/6
STANDARD. 250–0–250 65mA, 6.3V 3.5A	17/6
HEATER TRANS. 6.3V 1½A **7/6.** 3A	10/6
Ditto 1.4, 2, 3, 4, 5, 6.3V 1½A	8/6
Mullard "510" Osram "912" 300/0/300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V	38/6
General Purpose Low Voltage. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V at 2A	22/6
Auto. Trans. 150W, 0, 10, 120, 200, 230, 250V	22/6

O/P TRANSFORMERS. Heavy duty 50mA, **4/6.** Multi-ratio push-pull, **7/6.** Miniature 3V4, etc., **4/6.** Small pentode, **4/6.** Hygrade push-pull 10 watts, **15/6.** Goodmans heavy duty 10/20W 6k or 8k c.t., **30/–.**

L.F. CHOKES 15/10H 60/65mA, **5/–**; 10H, 85mA, **10/6**; 10H 120mA, **12/6**; 10H 150mA, **14/–**.

CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ⅞" x 3/16"
ACOS CRYSTAL MIKE 39–1 35/–, MIKE 40 25/–

ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d** 0.3" **FORMERS** 5937 or 8 and cans TV1 or 2, ¾" sq. x 2¼" or ⅜" sq x 1½", **2/–** with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3.**
REMPLOY INSTRUMENT IRON, 230V 25W, **17/6.**
MAINS DROPPERS. 3" x 1½". With adj. sliders, 0.3A, 1,000 ohms, **4/3**; 0.2A 1,000 ohms, **4/3.**
LINE CORD. 0.3A 60 ohms per foot, 0.2A 100 ohms per foot, 2-way, **6d.** per foot; 3-way **7d.** per foot.
MIKE TRANS. 50:1, **3/9**; 100:1, potted, **10/6.**
LOUDSPEAKERS. P.M. 3 ohm. 5" Rola, **17/6**; 6" x 4" Rola, **18/–**; 4" Hi-Fi Tweeter, **25/–**; 8" Plessey, **19/6**; 6½" Goodmans, **18/6**; 10" R.A., **30/–**; 12" Plessey, **30/–**; 10" x 6" R.A., **27/6**; 12" Baker 15W 3 ohm or 15 ohm models, **90/–**; Stentorian HF1012 10", **95/–.**
CRYSTAL DIODES. G.E.C., **2/–**; GEX34, **4/–.**
40 CIRCUITS FOR GERMANIUM DIODES, 3/–.
H.R. HEADPHONES 4,000 ohms, brand new, **15/–** pr.
SWITCH CLEANER FLUID, squirt spout, **4/3** tin.
TWIN GANG CONDENSERS. 365pF, miniature. 1⅜" x 1½" x 1⅜", **10/–**; 0.0005 standard with trimmers, **9/–**; less trimmers, **8/–**; midget, **7/6**; 50pF single, **2/6.**
SHORT WAVE Single 75pF, 100pF, 160pF, **5/6** each.
TUNING AND REACTION CONDENSERS. 100pF, 300pF, 500pF, **3/6** each, solid dielectric.

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

Volume Controls

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

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

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

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Suggested Circuits

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

No. 123.
Reducing Television Warm Up Time

An annoying feature of domestic television viewing is the long period of time which elapses between switching on the television receiver and the appearance of a picture on the screen. The warm up time of television receivers varies for different makes and models; it may be some three-quarters of a minute in one instance or as long as a minute and a half in another.

It is possible in some cases to shorten the warm up time of a television receiver, and this month's article describes a very simple modification, for receivers operating from a.c. mains, which may effect a reduction of around ten to twenty seconds. For reasons which are explained later, several important tests have to be made before the modification can be finalised and, for this reason, the writer feels that it should only be attempted by constructors who are conversant with television theory and practice. The modification should *not* be made without carrying out the tests.

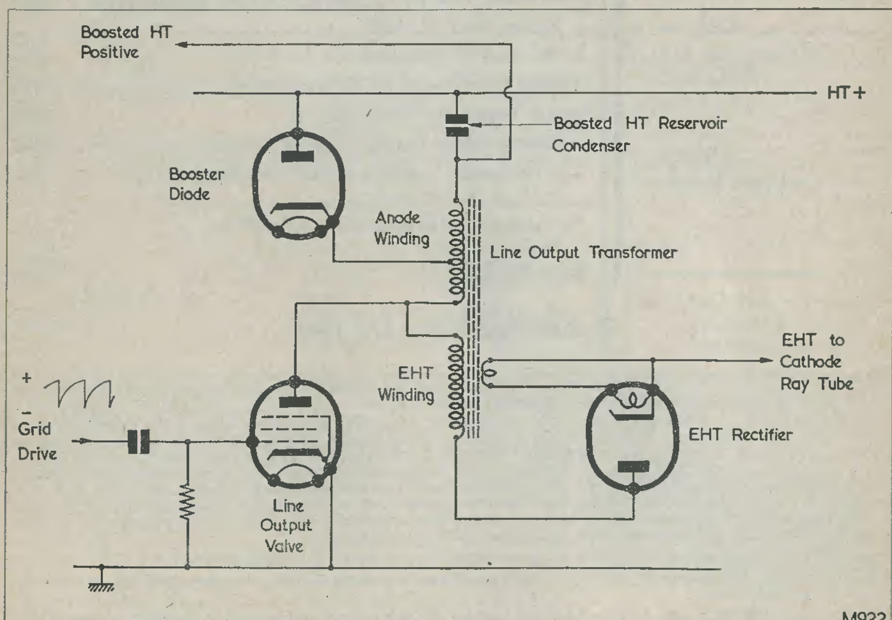


Fig. 1. A typical line output stage, showing the functions performed by the booster diode, the line output valve, and the e.h.t. rectifier. The line deflector coils would normally tap into the anode winding

Television Receiver Warming Up

When a cold[1] television receiver is switched on, the mains supply is applied to its heater chain via a series resistor and a thermistor. The latter offers initially a high value of resistance which drops as the thermistor warms up. Thermistor warm up may take an appreciable time, and the heaters reach operating temperature at a later period than would occur were the thermistor not in circuit. After a time the cathodes of all valves except the booster diode and the e.h.t. rectifier reach emitting temperature. The operating valves include the h.t. rectifier (assuming this is a valve) whereupon the signal-handling stages commence to function, as also do the frame time base and the line sawtooth generator.[2] A similar state of affairs would occur if the h.t. rectifier were a metal or silicon component, the only difference in this case being that h.t. would be present immediately after switching on.

One of the two valves not yet warmed up is the booster diode. Because high voltages appear between the cathode and heater of valves designed for this function, booster diode cathode-heater spacing is much greater than that of a conventional valve; with the result that it has a longer warm up time. As is shown in Fig. 1, the booster diode allows the passage of h.t. current to the anode of the line output valve. The line output stage cannot, therefore, function until the booster diode has reached operating temperature.

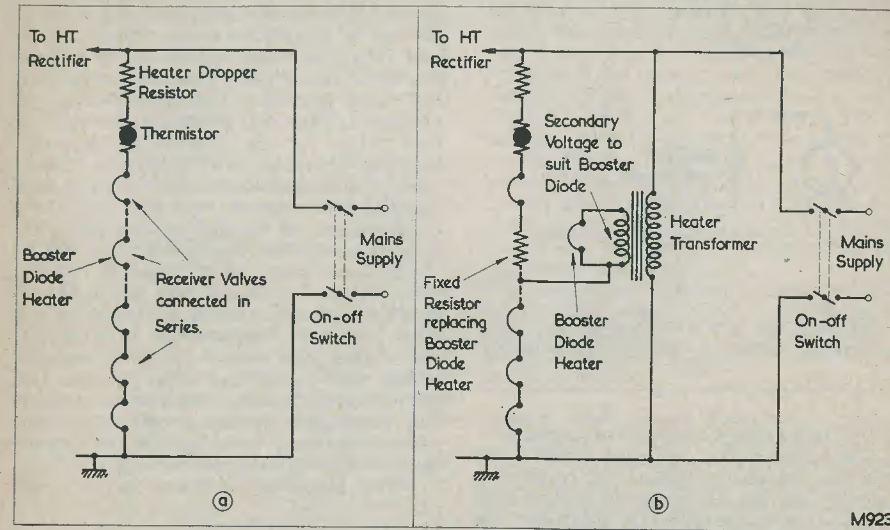


Fig. 2 (a). The receiver heater circuit before modification
(b). Illustrating the manner in which the booster diode is heated by a separate mains transformer after modification

Once the line output stage commences to operate, a heater supply becomes available for the e.h.t. rectifier. It is only when this last valve has warmed up sufficiently to allow an e.h.t. voltage to be applied to the cathode ray tube that a picture is eventually resolved.

The Modification

The modification suggested this month is illustrated in Fig. 2. Fig. 2 (*a*) shows a booster diode heater connected in conventional manner in the heater chain of a television receiver. Fig. 2 (*b*) illustrates the circuit after modification. In this diagram the booster diode heater is taken out of the chain, being replaced by a fixed resistor of equal resistance (and with a sufficiently high wattage rating). The booster diode heater is then connected to the secondary of a heater transformer, the primary of which is connected to the receiver mains input after the on-off switch. To retain approximately the same heater-cathode potential as existed before the modification, one side of the booster diode heater is connected to one side

[1] The term "cold", as applied to a receiver or a valve in this article, infers that the receiver or valve has been previously switched off for at least twenty minutes.

[2] This assumes that the line output stage is not part of the line sawtooth generator.

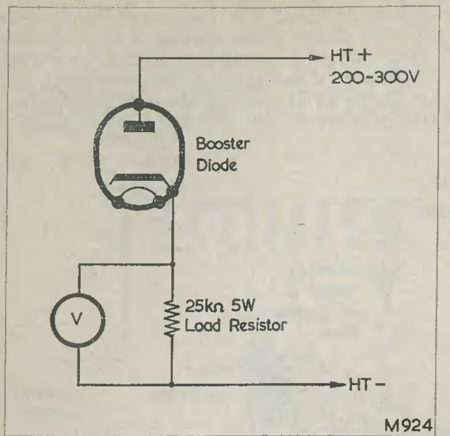


Fig. 3. The test set-up employed for checking warm up time of the booster diode

of the fixed resistor which takes its place.

The heater circuit now functions in the following manner. When the receiver is switched on, the a.c. mains is applied both to the heater chain and to the primary of the heater transformer. The heaters in the chain commence to warm up, their temperature rising slowly at first because of the series thermistor. The booster diode, on the other hand, has a full heater voltage applied to it as soon as the receiver is switched on, with the result that it commences to warm up without the time delay introduced by the thermistor. When the line output valve reaches operating temperature the booster diode may already be functioning. The booster diode may, alternatively, reach operating temperature after the line output valve; but this will still be at an earlier time than occurs in the unmodified circuit.

As may be seen, the time advantage given by the modification is that the booster diode does not undergo the delay imposed on the other valves of the receiver by the thermistor.

Precautions and Tests

The usefulness of the modification will vary according to the make and type of receiver, and the first step to be taken consists of ensuring in advance what saving in warm up time is to be expected with the particular receiver being modified. The latter, in its unmodified state, should be switched on from cold with a meter (to be discussed later) monitoring the drive voltage on the grid of the line output valve, and another meter monitoring the voltage on the boosted h.t. line. The periods elapsing between the moment of switching on, the appearance of grid drive to the line output valve, and the appearance of boosted h.t. voltage, should then be noted. The booster diode should next be connected up in a temporary test set-up as shown in Fig. 3. In this diagram the booster diode heater is connected to the heater transformer intended for use in the modification, a load resistor and voltmeter being inserted in its cathode circuit to check when emitting temperature has been reached. The heater supply is applied to the cold booster diode and the time taken for the cathode to reach full emission (as indicated by the test voltmeter across the load resistor) noted. If this period is significantly shorter than that needed for the formation of boosted h.t. voltage in the previous test, then the modification will be worthwhile. However, it should be borne in mind when evaluating the usefulness of modification that, should the booster diode reach operating temperature in a shorter period than that needed for the appearance of line output grid drive in the previous test, the line output stage in the modified receiver will commence operating only after drive voltage appears, even though the booster diode is already fully warmed up.

If this initial test indicates that a worth-

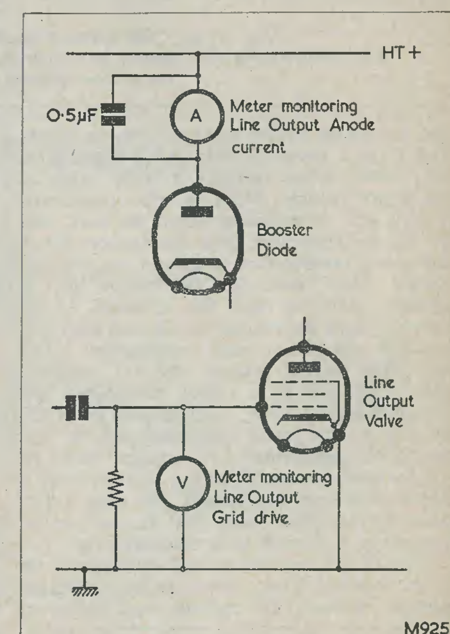


Fig. 4. Connecting up test instruments for checking the modification. The meters employed are discussed in the text

while saving in warm up time is given by supplying the booster diode from the heater transformer, a final important check has to be carried out. This check is needed to ensure that, at no time during the warm up period, does the instance arise where both the line output valve and the booster diode achieve full operating temperature before a drive voltage appears on the line output grid. The risk of such a condition occurring is somewhat remote but it has nevertheless to be guarded against, since the condition could cause excess current to flow in the line output anode circuit.

The receiver should be temporarily put into the modified condition and a meter connected, as before, to monitor the drive to the line output grid. Also, an ammeter, shunted by a 0.5μF condenser, should be inserted between the h.t. positive rail and the anode of the booster diode to monitor line output anode current. The testing circuit arrangement is illustrated in Fig. 4. The receiver should then be switched on from cold. If line output anode current reaches its normal running value *after* the appearance of full grid drive voltage, the test may be considered satisfactory. Should line output anode current exceed its normal value during this test the receiver should, of course, be switched off at once. The test should next be repeated for different switching-on states of the receiver. These would be given by switching on immediately after switching off, switching on one minute after switching off, and switching on some three to four minutes after switching off.[3]

Testing Requirements

As was observed at the beginning of this article, it is advised that the modification be carried out only by constructors who are conversant with television theory and practice. It will be noted also that the test equipment required for the modification checks is a little more specialised than is usually the case with articles in this series.

The voltmeter employed for monitoring the drive to the line output grid should be an a.c. valve voltmeter or a d.c. valve voltmeter with a suitable thermionic rectifier. The instrument used has merely to indicate the presence of grid drive voltage, without loading the grid circuit of the line output valve. If available, an oscilloscope may be employed.

The voltmeter needed to measure the boost voltage in the initial test, and the voltage across the load resistor in the set-up of Fig. 3, can be any high-resistance testmeter switched to the requisite voltage range. The test load of Fig. 3 is intended to draw some 10mA of current, and the h.t. supply may be obtained from any convenient source. Ideally, the test load should draw a current around 100mA (as would be passed by the booster diode in the receiver) but this may prove inconvenient. Use of the 10mA load should give sufficiently accurate indications for present purposes.

The ammeter connected in series with the booster diode anode (Fig. 4) should have a full-scale deflection of 150mA or more. A testmeter switched to a suitable current range would cope here.

Booster Diode Heater Voltage

The booster diodes employed in normal series heater circuits are liable to have non-standard heater voltages, and difficulty may be experienced in obtaining heater transformers with suitable secondary voltages. This problem could, in some cases, be overcome by fitting in the modified receiver a 6.3 volt equivalent of the original booster diode, this course allowing the use of a standard heater transformer. Only *exact* 6.3 volt equivalents of the original diode should be employed.

The heater transformer used in the modification should, of course, have adequate insulation between primary and secondary windings in order to prevent incorrect voltages being applied to the other valves in the heater chain.

[3] It should be pointed out that these last requirements are somewhat rigorous. Incorrect operation of the line output stage for a short period is possible in a number of receivers (without the modification discussed here) if they are switched on again soon after being switched off.

BRITISH SOUND RECORDING ASSOCIATION

A lecture will be given on Friday, 17th February, 1961, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, at 7.15 p.m. on "Organ Pipes and Reeds", by Henry Willis, F.R.S.A. The lecture will deal with the theory of speech, the methods of construction and voicing; a demonstration of the representative pipes of differing tonal quality, with another demonstration of voicing a pipe and a reed. The lecture will be followed by a discussion.

Mr. Henry Willis is governing director of the pipe organ makers of that name, being a grandson of the "Father" Henry Willis, founder of the firm in 1845, and one of the most famous organ builders of the nineteenth century. Having been responsible for the building of organs in many countries, perhaps the most famous being the world's largest cathedral organ at Liverpool, Mr. Willis's experience is very comprehensive. It is not surprising, therefore, that he holds strong views on organ construction, particularly voicing, and his lecture should interest all who enjoy listening to the "king of instruments".

In connection with the above lecture, B.S.R.A. members will be able to visit the organ works of Henry Willis and Sons, in London, S.E.1, on Saturday, 18th February, at 10.30 a.m. Invitation tickets for non-members to attend the lecture can be obtained from S. W. Stevens-Stratten, F.R.S.A., Hon. Secretary, "Greenways", 40 Fairfield Way, Ewell, Surrey.

IN YOUR WORKSHOP

This month Smithy the Serviceman and his able assistant, Dick, join forces in an episode which carries a pointed moral

"COUGHS AND SNEEZES", QUOTED DICK, "spread diseases!"

Smithy turned a tortured, watering eye upon his assistant, and opened his mouth preparatory to delivering a crushing retort. Before he could speak, however, his body was shaken by a gargantuan sneeze.

"Bless you," remarked Dick equably. "Indeed, after that one, I should say: bless you *squared!*"

The Serviceman staggered over to the Workshop sink and allowed a little water to flow from the tap into the bottom of a cup. He took a paper packet from a box nearby, opened it, and poured the contents into the cup. After stirring the mixture briskly with a screwdriver he swallowed the draught at one gulp.

"Ah, that's better," he remarked.

"That's the second powder you've taken in half an hour," his assistant reminded him accusingly.

"I can't help that," replied Smithy, a little brusquely. "It's just that I've got a bit of a chill this morning."

Dick raised a disbelieving eyebrow but made no further comment. Besides, he was at a very interesting stage in the repair of the stereo record player on his bench.

Stereo Record Player Fault

The stereo record player was of the more inexpensive type employing a single triode-pentode in each channel. (Fig. 1.) The triodes were voltage amplifiers, appearing in circuit immediately after the pickup, and their output fed into the grids of the pentode sections. A simple balance control, consisting of two ganged potentiometers, varied the relative a.f. levels applied to either output grid.

Before Smithy's attack, Dick had carefully placed the two speakers at either end of his bench and had reproduced a stereo record over the player. Reproduction had been acceptable, but there were occasional fleeting moments of just-perceptible distortion which passed so quickly that Dick had difficulty in identifying or locating them. Dick had decided to fall back on a simple testing device which Smithy had developed in the past for servicing record players of this type.

Smithy's testing device consisted, quite simply, of a three-way single-pole switch and a 1μF paper condenser mounted in a small box from which protruded three flexible test leads. (Fig. 2.) One test lead was intended to connect to the chassis of the equipment under test, and the other two to the grids of the output valves. By suitable manipulation of the switch it was then possible to silence either one output stage or the other, or to leave both unaffected. The silencing of the output stages was achieved by bypassing to chassis via the 1μF condenser the grid selected, the condenser ensuring that the appropriate grid bias arrangements were not upset. The presence of the condenser also allowed the second and third clips to be connected, if desired, to points which carried h.t. potential, such as would be present at the anodes of voltage amplifiers.

Dick quickly clipped the leads of the test unit into the chassis of his record player and selected a monaural test record. He next placed the speakers side by side on the bench and placed the pickup on the record. With the aid of the test unit switch he quickly adjusted the balance control of the record player so that the volume from one channel working on its own was equal to that from the other.

"You know, Smithy", he called out, "this test gadget of yours is jolly useful for checking the balance of stereo record players."

"What's that?"

"I said that your gadget is jolly useful for checking the balance of stereo players. You can click from one channel to the other instantaneously and judge the relative volumes as easy as anything."

"Oh, I see."

There was a noticeable lack of interest in Smithy's voice and, glancing over his shoulder, Dick saw that the Serviceman was gazing disconsolately at a television set, still in its cabinet, which was giving strong symptoms of sound-on-vision. Dick decided that he had enough problems of his own for the time being, and he returned to his record player.

He noted that the correct setting for the balance control was approximately at the centre of its travel, this indicating that both channels were providing the same degree of amplification. He adjusted the test unit

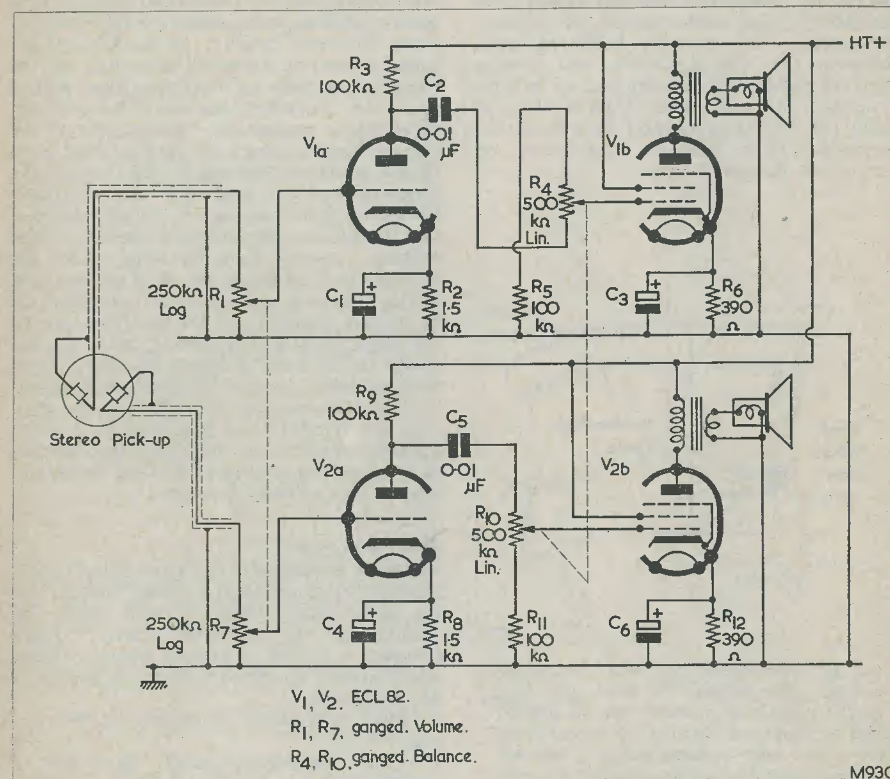


Fig. 1. The basic circuit of the stereo record player serviced by Dick, with negative feedback and tone control circuits omitted. R_4 and R_{10} are ganged such that, as one potentiometer increases the a.f. tapped off its slider, the a.f. tapped off in the other reduces. Component values and valve types are typical, and the cathode bypass condensers have conventional values

switch such that both channels were in operation and let the mono record play on. After a moment, a certain passage in the music caused the appearance of the distortion he had heard previously. He returned the pickup to the point on the record which caused the distortion to appear and allowed the passage to play again. This time he continually flicked the test unit switch back and forth so that each channel was silenced alternately. This process indicated quite definitely that the distortion was coming from the right hand channel and, as he grew more used to its character, Dick felt that he could describe it to himself as a faint but noticeable buzz brought into being on certain low frequency notes.

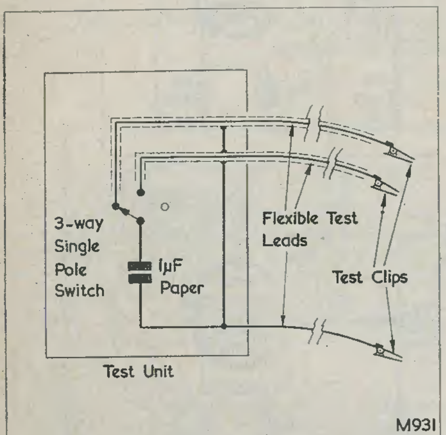


Fig. 2. The simple test unit devised by Smithy. By clipping the lower test lead to the chassis of a stereo record player, and the screened leads to the output grids (or to any other suitable points in the two stereo amplifiers) either channel may be silenced for purposes of comparison or as an aid in fault finding

Dick rested his chin on his hands and pondered for a moment. Since the correct balance control setting was at the centre of its travel it could be assumed that the amplifiers in each channel were working under more or less the same conditions, whereupon Dick decided that the trouble might be more of a mechanical than an electrical nature. The fault would, therefore, be present in either the right hand channel speaker or the right hand section of the pickup. The speaker seemed the better bet and Dick quickly changed the speakers over such that they connected to the opposite channels. Playing once more the passage on the monaural record which caused the distortion to appear, Dick again operated the test unit switch. He was rewarded by the appearance of the distortion, this time, on the left hand channel. The fault was, in consequence, undeniably in the speaker which had previously been connected to the right hand channel.

Jubilantly, Dick switched both channels into operation and advanced the volume control of the record player to full. At this same moment Smithy, in search of his sound-on-vision, turned the sound on his television receiver to maximum also, whereupon the Workshop became filled with an ear-splitting cacophony resulting from the two different sources of music, that from Dick's amplifier teetering all the time on the verge of overload and that from Smithy's television receiver so heavily beyond overload that its raucous output was a travesty of the original. As so often happened under the stimulus of loud noise, the devil entered into Dick's soul and, seizing a heavy screwdriver, he started thumping on his bench in time to the music from his amplifier. Smithy put his hands to his ears to block out the racket; then suddenly changed his mind and plunged his hand desperately into his pocket, producing a handkerchief just in time to catch a sneeze which was so stentorian in character as to blast into relative silence the remaining tumult which filled the room.

Speaker Repair

Deeply impressed, Dick ceased his thumping and switched off the record player. At the same time Smithy turned back the volume on his television receiver. There followed a period of blessed silence, during which Smithy stumbled back to his stool and flopped down.

"Phew, corblimey!" murmured the Serviceman.

"You", remarked Dick, "have got a *cold*."

Smithy ignored him.

"Would you believe it," he said, after a further moment, "even now, I can still see stars!"

"The best place for you," commented Dick severely, "is bed."

"Nonsense," replied Smithy. "There's nothing wrong with me except for a slight chill."

Dick surveyed the Serviceman's flushed face and bloodshot eyes.

"I've read all about people like you in the newspapers," he said sternly. "You're one of those types who insists on going to work with a streaming cold instead of staying at home in bed until you get better again. With the result that not only do you make *yourself* worse but you also give your cold to everyone else as well."

Dick stopped for a second, as a thought suddenly struck him.

"What about *me?*" he continued indignantly, his voice tremulous with self-pity. "Here am I, a defenceless, sensitive lad, who is *plunged* by the necessity to earn a humble crust into a Workshop which is literally *crawling* with strept . . ., strepto . . ."

"Streptococci?" put in Smithy helpfully.

"With strepto—whatever you said," concluded Dick lamely.

"I'm not at all certain," commented Smithy thoughtfully, "that streptococci have anything to do with colds."

"Well, common cold germs then," said Dick, swinging back into the attack. "Also, apart from myself, what about our customers? Do you realise that you have, this morning, sneezed violently into every single bit of equipment that's gone through your hands? This Workshop is now a common cold distribution centre, radiating colds in all directions up to the range of the delivery van, each serviced receiver carrying into our trusting customer's house its deadly complement of vicious infection."

"I have *not* sneezed into all the receivers which have been through my hands," interrupted Smithy hotly.

"The only thing that can break this deadly radiation pattern", continued Dick, now completely carried away, "of which this Workshop, mark you, forms the hub, is for our driver to succumb completely under the concentrated attack of the virulent germs he carries in the back of his van. It is better for one man", finished Dick impressively, "to go to the wall than for countless others to suffer."

But his last words were lost in a gale of laughter from the Serviceman.

"I can't see why you think my regard for other people is so funny," said Dick, hurt.

"Well, it's certainly cheered *me* up, anyway," chuckled Smithy. "I must admit, though, that you're perfectly right, and that the best place for me is bed. I'll just clear up the jobs we've got on hand, and then I'll leave you to look after things on your own for a few days. How's that stereo player of yours going?"

"Very well," said Dick, proudly. "I've located the fault, and all it needs is a new speaker on one of the channels."

"Let's hear it," commanded Smithy.

Obligingly, Dick put the record player through its paces and demonstrated the fleeting distortion contributed by the speaker.

"It doesn't sound too bad to me," remarked Smithy, "although it could, I suppose, be a source of irritation to someone who likes good music. Are you sure that you haven't merely got a bit of cabinet buzz?"

"How can I check for that?"

"Just play the part of the record which allows the distortion to appear and run your hand over the cabinet joints, the speaker mounting, and anything else which could cause a buzz or rattle at a low frequency. Press fairly heavily on each point you check —but not too heavily on things like expanded metal speaker fabrics which may bend—and the buzz will reduce or cease when you've found the right spot."

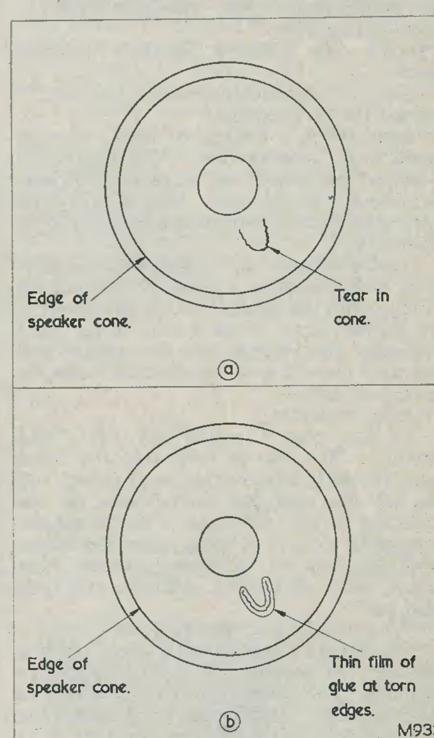


Fig. 3 (a). A small tear in a loudspeaker cone caused an irritating buzz at low frequencies
(b). The tear was repaired by holding the torn piece in position so that the fibres at the torn edges overlapped, a thin film of glue having previously been applied

"That's a good idea," remarked Dick. "I'll try it out."

The loudspeaker cabinet was of simple design, and it did not take Dick long to find that it was not contributing to the distortion.

"Fair enough," remarked Smithy, after Dick had completed his investigation. "Before we finally finish the job let's have a look at the speaker itself."

The obedient Dick removed the speaker

from the cabinet and handed it over to Smithy.

"If the speaker's at fault," continued Smithy, examining it carefully, "we *might* be able to do a simple repair. This particular unit isn't in what you could call the 'professional hi-fi' class, but it is still expensive enough to make it worthwhile seeing if we can do a quick repair before finally deciding on replacement. Ah, here's something. Look at this, Dick!"

Dick's eyes followed Smithy's pointing finger.

"Can you see that small tear in the cone?" queried the Serviceman.

"Just about," confessed Dick, moving round to get a better view. "There's a small V-shaped piece near the edge of the cone, torn along the two sides. (Fig. 3 (*a*).) The sides are about three-eighths of an inch long, I'd reckon."

"That's about it," confirmed Smithy. "The V-shaped piece is virtually mounted on a hinge, with the result that it flaps around in the breeze rather. Feed a note of the right frequency and volume into the speaker and this torn bit will give the buzzing noise we heard just now."

"Is it repairable?"

"In this case I would say yes," said Smithy. "The tear is such that the fibres from the torn bits overlap each other, and it's not too near the corrugations on the periphery or the voice coil. I would suggest you apply a trace of glue along the edges, hold the bits in position between your fingers for a very quick moment, and then let it set."

"What sort of glue should I use?"

"We require a quick-acting glue," replied Smithy, "but not one that sets to a rock-like hardness. The latter might cause the tear to reappear later. What we want is something that sets to a fairly rubbery consistency. I would suggest that a faint trace of Evo-Stik should do the trick. There's a tube of it in the spares cupboard."

Dick soon found the tube of Evo-Stik and he applied it to the speaker cone in the manner Smithy had described. (Fig. 3 (*b*).) As he went over to the sink to wash the glue off his fingers he found that Smithy had preceded him.

"You're surely not taking *another* powder!" protested Dick.

"Good gracious, no," replied the Serviceman. "This is just something to clear the old passages."

Dick waited patiently as, to an accompaniment of loud snorting noises, Smithy squirted the contents of a plastic bottle first up one nostril and then the other. Dick then watched him walk back to his bench and take from a drawer a packet of large and pungent-looking cough lozenges. The Serviceman commenced to suck vigorously.

Mono and Stereo Styli

Dick sniffed suspiciously.

"The place is beginning to smell like a sick bay," he complained.

"Don't be silly," replied Smithy. "I'm just employing one or two commonsense remedies. In fact, they're making me feel better already."

Assuming an expression intended to indicate a state of extreme well-being, the Serviceman lit a cigarette with a flourish. He was immediately assailed by a violent and continuous attack of coughing. Suddenly, a wild look came into his eye and, elbowing Dick out of the way, he rushed over to the sink.

Several minutes later he returned to his seat.

"What on earth happened *then?*" asked Dick.

"I swallowed the cough lozenge," replied Smithy miserably.

The Serviceman picked up his still-glowing cigarette and stubbed it out disgustedly. Suddenly, a thought crossed his mind and, brightening up, he rummaged in the drawer of his bench again.

"What now—fumigation?"

"Nothing of the sort," snapped Smithy, busily applying a match to the jumbo-sized night-light he had just unearthed. "This gadget is designed to give off a delicious germicidal odour which is reminiscent of the forest."

Dick sniffed distrustfully, but made no further comment.

"Well, whilst the glue's setting on that speaker," he remarked, we'd better carry on with fixing that t.v. set of yours."

"Just a minute," said Smithy. "There's one little matter to clear up on the last job first."

"What's that?"

"It's necessary to make the point that it isn't normally good practice to play a monaural record with a stereo pickup. This is because a stylus designed purely for stereo usually has a different tip radius to one intended for mono, and it can cause excessive wear on a mono record. So, when you use a mono record to check for faults in either channel of a stereo player, select one which is not of special value. There is also the fact that tests of this nature often require lowering the pickup down on specific parts of the tracks, and this treatment is hardly the sort of thing you would do to expensive or treasured discs, anyway."

Smithy paused and gave a little experimental cough, followed by a tiny sneeze. His face lit up perceptibly.

Sound-on-Vision

"That forest-smell stuff is doing me good," he remarked, from the clouds.

"If you say so," commented Dick sceptically. "Shall we have a stab at that t.v. on your bench now?"

"O.K.", replied Smithy, equably. "I'll direct operations from here."

Dick carried the receiver over to his own bench, where visibility was better.

"I'll tell you what I've done to date," commented Smithy cheerfully. "As soon as I put the set on I noticed the sound-on-vision effect at once. So far as I could tell, the sound traps in the vision i.f. strip seemed to be working pretty well, and I . . ."

"Wait a minute," interrupted Dick. "You can't just *say* that the sound i.f. traps were working O.K. without even having got the set out of its cabinet!"

"You can get a pretty fair idea with some sets," replied the Serviceman, "although this involves getting used to the performance such sets have. In a number of receivers i.f. response has a very pronounced dip at the sound i.f., this being due to highly selective sound i.f. rejector circuits. (Fig. 4.) For the record, I should add that these rejectors are tuned to the standard British sound i.f. of 38.15 Mc/s, the vision carrier i.f. being at 34.65 Mc/s. If the receiver has sufficiently good focus and resolution, you can often make out a 3.5 Mc/s 'grain' on the screen when the fine tuner is incorrectly adjusted."

"I'm lost," confessed Dick. "To begin with, where does the 3.5 Mc/s come from?"

"It's the difference frequency between sound and vision i.f.s," explained Smithy. "If your fine tuner is adjusted such that the sound i.f. from the mixer gets into the vision i.f. strip at the wrong frequency it can beat with the vision carrier i.f. to give you a 3.5 Mc/s signal. Once you've got used to a particular make and model you can get a fairly good idea of the condition of its sound rejector circuits by slowly adjusting the fine tuner and noticing if the 3.5 Mc/s 'grain' clears sharply as you pass through optimum fine tuning position."

"It sounds rather a complicated sort of test to me," remarked Dick.

"Well, there *is* a certain amount of experience involved," admitted Smithy. "And you have to get used to the performance given by individual makes and models. Quite a few t.v. receivers don't give the effect at all."

"I'll keep my eyes open for it in the future, anyway," Dick said.

"I should," replied Smithy. "But I must add that it's a trick which is only useful if you repair *lots* of t.v.'s. It's not much use if you only fix the odd set now and again. Incidentally, the 3.5 Mc/s 'grain' shows up best against dark backgrounds, and you may have to turn the brilliance up slightly."

"Right," said Dick. "Well, let's assume that you have found the sound i.f. rejector circuits to be O.K. What's the next diagnosis?"

"The obvious one," said Smithy, "of sound-on-vision being caused by acoustic feedback from the speaker to the tuner unit. The sound waves from the speaker cause the oscillator valve elements, or oscillator components, to waggle about and change oscillator frequency in sympathy. The result is frequency modulation of the vision i.f., which causes the picture to jitter whenever the speaker emits a loud sound or a sound on a frequency at which the oscillator valve or components resonate. In severe cases of feedback you may get horizontal bars on the screen, these corresponding to the frequency of the sound emitted by the speaker."

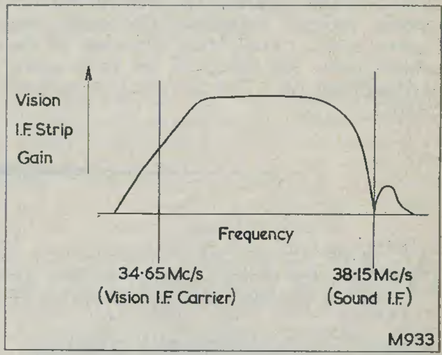


Fig. 4. The vision i.f. strips of some television receivers have very sharply defined dips at the sound i.f., as shown here. The frequencies quoted are the standard British television i.f's

"How does the sound get back to the tuner unit?"

"Via the cabinet or chassis, usually," replied Smithy. "Although, if the oscillator circuits of the tuner are *very* microphonic, feedback through the air itself could also cause the trouble. Things are pretty bad when that happens, though. As an aid to diagnosis, this particular fault is usually much worse on Band III than on Band I because, since the oscillator runs at a higher frequency on Band III, small vibrations in the oscillator valve or components cause a greater variation in oscillator frequency."

"What have you done to date with this particular receiver?"

"Swapped the mixer-oscillator valve, that's all," said Smithy. "Which gave no improvement. After that, I had a slight attack of sneezing, as you may have noticed."

Dick grinned.

"You mean you began to feel 1dB under!"

The Serviceman threw a suspicious glance at his assistant.

"Well, you'd better have a go at the set now," was his only comment.

Dick looked inside the cabinet.

"They've certainly taken care to prevent acoustic feedback in this particular receiver," he announced, "the tuner unit is mounted on grommets."

He next adjusted the channel selector knob.

"Why, that's funny," he remarked, "it feels as though it's binding against something."

He examined the knob further.

"It is definitely binding," he remarked excitedly. "The edge of the knob shaft is pressing against the hole in the cabinet. We'll soon clear that!"

Dick quickly eased the bolts holding the chassis in the cabinet. He then moved the chassis around experimentally until the channel selector knob shaft was clear of the cabinet hole. He tightened the bolts again and switched on. The sound-on-vision had cleared.

Smithy Goes Home

"Well, that's another job done," said Smithy cheerfully. "I wish all these sound-on-vision snags were as easy as that one! You'd better try out that speaker you repaired next. The glue should have set sufficiently by now."

Dick refitted the repaired stereo speaker into its cabinet, and checked it. This also was working perfectly.

"I think that clears up all the outstanding jobs," remarked Smithy happily. "I might as well toddle off home now and pop into bed."

"You're certainly *looking* better," remarked Dick, surveying the Serviceman clinically. "Perhaps the powders and the spray and the cough lozenges and the essence-of-the-forest have done you some good after all."

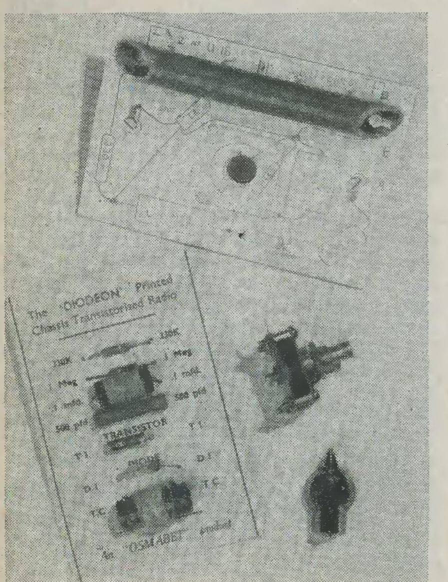
"I'm certain they have," agreed Smithy, as he made for the door.

Left to himself, Dick first set about clearing the debris caused by Smithy's medicines. After he had put away the last item he stood thoughtfully in the centre of the Workshop, surveying the receivers awaiting repair.

Then he sneezed.

A New Type of "Printed Circuit"

A NOVEL METHOD OF SIMPLIFYING KIT CONSTRUCTION IS THE BASIS OF THE "DIODEON" transistor radio. As may be seen from the accompanying photograph, the "chassis" of the Diodeon receiver, consisting of a flat board of insulating material, has printed on it a layout drawing showing the positions and connections of the components employed. These components may then be mounted and soldered at the points indicated by the drawing. Terminals for aerial, earth and phones are available on the reverse side of the board, which has printed on it, also, a simple tuning scale.

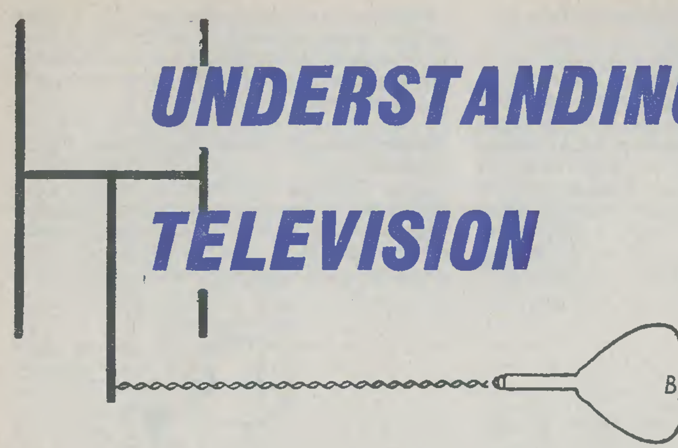


To further ease construction, all components for the receiver are mounted on a card which indicates their value or circuit reference. These values or references correspond to those shown on the board.

The Diodeon transistor radio is an "Osmabet" product. Other units employing the same constructional technique are also available.

UNDERSTANDING TELEVISION

PART 37



By **W. G. MORLEY**

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

IN THE ARTICLE IN THIS SERIES PUBLISHED last month we discussed gated a.g.c. systems of the type employed in British receivers working with positive modulation signals. We saw that these systems derived an a.g.c. voltage which was proportional to blanking level, since this level was the only usable part of the received signal which maintained a sufficiently constant relationship to the strength of the received signal.

We shall now carry on to the a.g.c. system employed in receivers designed for negative modulation signals, following this with an introduction to power supply circuits.

Negative Modulation Sound A.G.C.

Since negative modulation transmissions employ frequency modulated sound, separate a.g.c. systems are not needed in the sound circuits of negative modulation television receivers.

The reasons for this fact are as follows. It is desirable in an f.m. receiving system to prevent any amplitude modulation of the received signal (or any impulsive interference) from being fed to the a.f. stages for subsequent reproduction over the loudspeaker. Suppression of amplitude modulation is normally achieved by means of a limiter stage preceding the discriminator, further suppression being provided at the discriminator itself if the latter is a ratio discriminator.[1] The presence of limiting circuits ensures that the audio frequency passed to the subsequent a.f. amplifier is that which would result from a constant amplitude f.m. signal. Variations in f.m. signal level due to fading, channel-changing, etc., should not therefore result in corresponding changes in a.f. level from the discriminator.

Despite the existence of limiting circuits it is common, in practical f.m. sound-only receivers, to employ simple a.g.c. systems in order that overloading of the i.f. stages does not occur. In television receivers, design requirements automatically ensure that the signal applied to the sound i.f. stages, or inter-carrier frequency stages,[2] undergoes at least a rudimentary form of automatic gain control. If the sound circuits employ an i.f. amplifier following the tuner unit (and, in some cases, a common vision and sound i.f. amplifier), the vision a.g.c. applied to the tuner unit r.f. amplifier (and the common i.f. amplifier, if applicable) should exert sufficient control to prevent overloading of the sound i.f. stages. Modern receivers employ the intercarrier system (wherein the sound signal is extracted after the vision detector as an f.m. signal whose centre frequency is equivalent to the difference between sound and vision intermediate frequencies), with the result that the inter-carrier signal is subjected to the same degree of automatic gain control as the vision i.f. The combination of limiting action, together with the control offered by the vision a.g.c. circuits, obviates the necessity for a separate sound a.g.c. system in a

[1] The two most commonly encountered f.m. discriminators are phase and ratio discriminators, the latter having an inherent a.m. limiting action. Alternative discriminators, which could also have an inherent limiting action, may be encountered.

[2] F.M. sound circuits, including the intercarrier system, were discussed in "Understanding Television," part 17, June 1959 issue.

negative modulation television receiver.

Negative Modulation Vision A.G.C.

In the negative modulation vision signal, sync pulse tips correspond to maximum transmitter amplitude. It is a relatively simple matter to obtain an a.g.c. voltage which is proportional to sync pulse tip amplitude, and such a voltage will be similarly proportional to received signal strength. This state of affairs differs considerably from that given with positive modulation a.g.c. systems, wherein it is either necessary to employ an a.g.c. voltage which is proportional to mean signal level, or to use complex gating circuits to obtain an a.g.c. voltage which is proportional to blanking level.

Single-Diode Negative Modulation A.G.C. Circuits

Fig. 224 (*a*) illustrates a simple a.g.c. detector for use with a negative modulation signal. The diode is coupled to the secondary of the last vision i.f. transformer in such a manner that a voltage which is negative with respect to chassis appears on the upper plate of condenser C_1. If this condenser and its parallel resistor, R_1, have a time constant equal to the period occupied by some twenty or more lines of picture information, a substantially steady voltage, nearly equal to sync pulse tip amplitude, appears on the upper plate of the condenser. Such a voltage will be proportional to received signal strength and may be employed for automatic gain control.

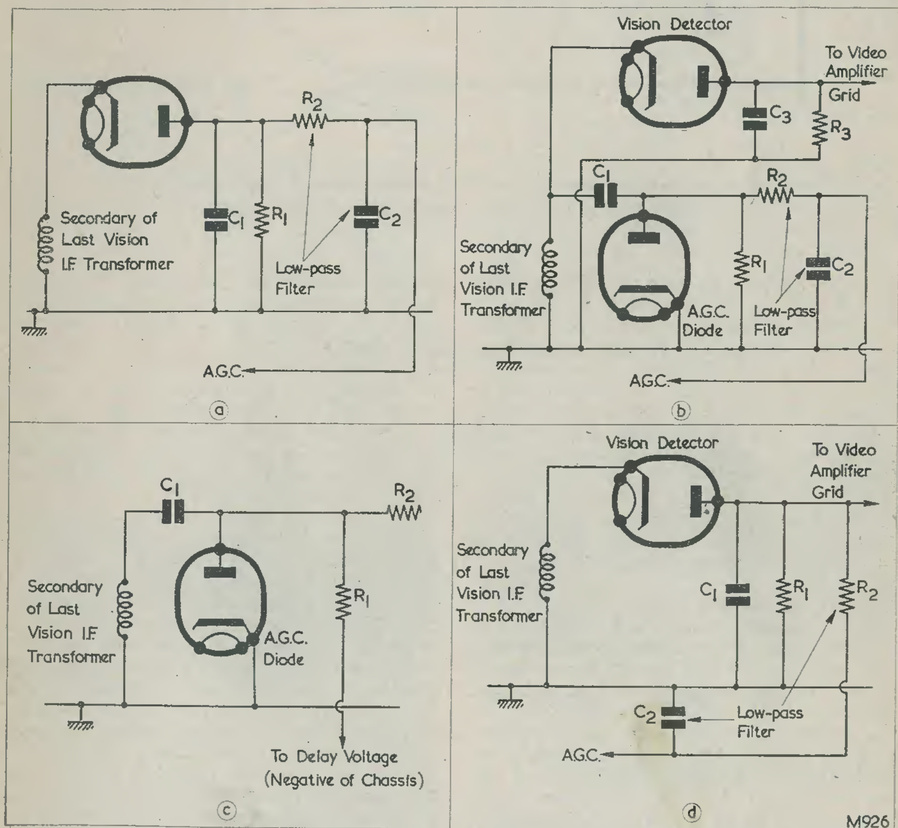


Fig. 224 (a). A single-diode a.g.c. circuit suitable for negative modulation receivers. A negative potential, nearly equal to sync pulse tip level, appears on the upper plate of C_1

(b). An alternative circuit wherein a negative potential, nearly equal to sync pulse tip level, appears on the anode of the a.g.c. diode. The vision detector is included in this diagram

(c). A voltage delay may be added to the a.g.c. circuit of (b) by returning R_1 *to a point which is negative of chassis*

(d). A frequently employed circuit in which an a.g.c. voltage is derived from the vision detector. In this instance, the a.g.c. voltage is proportional to average signal level

An alternative method of connecting the a.g.c. diode, and one which may be more frequently encountered in practical receiver circuits, is illustrated in Fig. 224 (*b*). This diagram shows the vision detector in addition to the a.g.c. diode. A negative voltage, nearly equal to sync pulse tip level, appears on the anode of the a.g.c. diode. Condenser C_1 and R_1 carry out the same functions as did C_1 and R_1 of Fig. 224 (*a*), and their time constant should be similar. (The a.g.c. diode circuit of Fig. 224 (*b*) is merely a rearrangement of the diode components of Fig. 224 (*a*).)

A voltage delay for the circuit of Fig. 224 (*b*) may be obtained by returning R_1 to a point which is negative of chassis, as in Fig. 224 (*c*). The a.g.c. diode will not then conduct, and cause an a.g.c. voltage to be formed, until the signal applied to it has an amplitude greater than the delay voltage. Alternatively, a delay may be obtained by the use of a clamp diode circuit, such as that shown in Fig. 214 (*d*).[3] A clamp diode may similarly be used to provide a delay for the circuit of Fig. 224 (*a*).

If the time constant of the resistor and condenser associated with the a.g.c. diode is very short, the voltage across the condenser will rise when the line sync pulses give way to broad frame pulses, and will fall when the broad frame pulses cease. This is because the broad frame pulses cause maximum signal amplitude to be applied to the a.g.c. diode for a longer period of time than do the line sync pulses. (The effect is largely absent during the equalising pulses which precede and follow the broad frame pulses because, although these occur at twice line pulse frequency, their width is half that of the line pulses.) Should the resultant a.g.c. voltage then be applied direct to the controlled valves the overall receiver gain would fall during the time that frame pulses were transmitted; with the consequence that frame sync pulses would be passed to the sync separator at reduced amplitude and the i.f. stages of the receiver would be modulated at frame frequency. This defect may be overcome by increasing the time constant of the resistor and condenser associated with the a.g.c. diode, or by causing the low-pass filter to which the a.g.c. voltage from the diode is applied to have a relatively long time constant. In practice it is usual to give the resistor and condenser associated with the a.g.c. diode a relatively short time constant (of the order of twenty lines) and the low-pass filter a relatively long time constant (of the order of ten frames or more).

An a.g.c. circuit commonly employed in negative modulation receivers is illustrated in Fig. 224 (*d*). In this diagram a single diode functions both as vision and a.g.c. detector. As with positive modulation receivers, it is common practice for negative modulation receivers to employ a single video amplifier feeding a signal having positive-going sync pulses to the cathode of the cathode ray tube. The signal passed to the grid of the video output valve from the vision detector has, therefore, negative-going sync pulses; whereupon this grid signal, after application to a suitable low-pass filter, can be employed for a.g.c. purposes. The circuit of Fig. 224 (*d*) has the disadvantage that the a.g.c. voltage obtained is not proportional to signal strength but to average signal level. The system becomes subject, therefore, to the same defect as occurs with a positive modulation mean level a.g.c. system, in as much that changes in the brightness of the transmitted scene cause changes in receiver gain. In this instance, however, a reduction in transmitted brightness will cause an *increase* in a.g.c. voltage together with a *reduction* in receiver gain, and *vice versa*.

The a.g.c. circuit of Fig. 224 (*d*) may be delayed by the use of a clamp diode.

If a noise pulse having a level greater than sync pulse tip amplitude is applied to an a.g.c. diode circuit of the type shown in Figs. 224 (*a*) to (*c*) the rectified voltage from the diode may rise nearly to the peak value of the pulse and cause an increased a.g.c. voltage to be passed to the controlled valves. The consequence is that receivers employing an a.g.c. circuit of this type may suffer temporary reductions in gain in the presence of impulsive interference. The effect is less troublesome with the circuit of Fig. 224 (*d*), because the a.g.c. voltage formed here is proportional to average applied level instead of peak applied level. It is occasional practice, in receivers employing peak a.g.c. detectors, as in Figs. 224 (*a*) to (*c*), to provide a pre-set adjustment of the time constant of the associated resistor and condenser. A typical instance would consist of making the resistor a variable component (in series with a fixed resistor to restrict its range). In areas free of interference the variable resistor could then be adjusted to insert maximum resistance into circuit, thereby enabling the a.g.c.

[3] Published in "Understanding Television", part 35 December 1960 issue.

diode to function as a peak detector and to provide an a.g.c. voltage proportional to applied signal level. In areas with heavy impulsive interference, the variable resistor could be adjusted to insert minimum resistance into circuit, whereupon the a.g.c. diode would operate as an average level detector.

Gated Negative Modulation A.G.C. Circuits

The single-diode a.g.c. circuits just discussed suffer from the defects that the associated system has to have a relatively long time constant, and that they are susceptible to impulsive interference. These shortcomings may be largely overcome by the use of gated a.g.c. circuits.[4]

A very commonly employed gated a.g.c. circuit is illustrated, in basic form, in Fig. 225. In this diagram, the control grid of the pentode is connected, via a d.c. coupling, to the anode of the video output valve, the pentode cathode being returned to the h.t. positive supply rail for that anode. The signal at the video output anode has positive-going sync pulses and, provided the video output valve is not cut-off, the pentode grid is always negative of its cathode because of the voltage dropped across the video output anode load. Applied to the anode of the pentode, via C_1, are pulses obtained from the anode winding of the line output transformer, these having a peak potential of some 300 to 500 volts above the h.t. positive rail which feeds the video output valve anode.

When the line sawtooth generator is in synchronism with the incoming signal, the pulses from the line output transformer are applied to the pentode anode at the same time as the sync pulse tips appear at the grid. The pentode then conducts, causing C_1 to receive a charge. Between pulses C_1 discharges into R_2, causing a voltage which is negative of chassis to appear at the upper end of this resistor. If, due to an increase in signal strength, the sync pulse tips on the pentode grid go positive, the pentode draws more current when the line output transformer pulse is applied to its anode. In consequence, C_1 receives a greater charge and the voltage at the upper end of R_2 goes more negative. If signal strength decreases, the sync pulse tips at the pentode grid go negative and the pentode draws less anode current during the pulse from the line output transformer, with the result that C_1 receives a smaller charge. The voltage at the upper end of R_2 goes, therefore, less negative.

It may be seen that the voltage on the

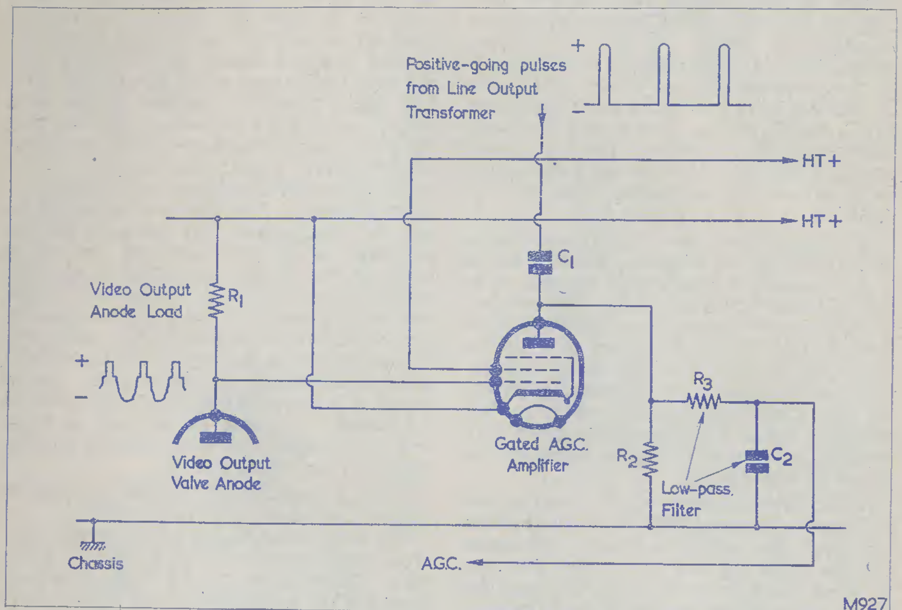


Fig. 225. A gated a.g.c. circuit for use in negative modulation receivers. The pentode screen-grid requires a higher h.t. potential than the pentode cathode

[4] Gated a.g.c. circuits are often described, in American literature, as *keyed* a.g.c. circuits.

upper end of R_2 goes more negative when signal strength increases, and less negative when signal strength decreases. This voltage may in consequence be employed for automatic gain control. It might be noted, incidentally, that the circuit around the pentode functions in much the same manner as does that around the triode a.g.c. amplifier of Fig. 221.[5] A pentode is needed in Fig. 225, instead of a triode, to reduce capacitive coupling between the anode and grid. Such coupling could cause the pulses from the line output transformer to be coupled into the video output anode circuit, whereupon sync separator performance might be adversely affected.

If a delay is required, a suitable clamp diode circuit may be added.

The circuit of Fig. 225 has a number of advantages. Firstly, due to the inherent amplifying action provided by the pentode and the fact that high level signals (from the video output anode) may be applied to it, the gain of the a.g.c. system of which it forms a part is high. Secondly, the a.g.c. voltage obtained, being proportional to sync pulse tip amplitude, is similarly proportional to received signal strength. Thirdly, the circuit is much less liable to be affected by noise pulses than are the simple single-diode circuits of Fig. 224. The pentode does not conduct between pulses from the line output transformer, with the result that the only noise pulses which can affect the system are those which coincide with pulses from the transformer. Fourthly, the circuit does not suffer from paralysis or lock-out. This is because a large video signal suddenly applied to the video output grid causes this valve to become cut-off, with the consequence that the grid of the pentode assumes the same potential as its cathode. Condenser C_1 receives, therefore, a high charge during pulses from the line output transformer and the a.g.c. line goes sufficiently negative to remove the overload. Fifthly, the circuit can be employed in an a.g.c. system having a short time constant because, during equalising and broad frame pulses, the grid of the pentode will still be at sync tip level when the pulse from the line output transformer is applied to the anode. In this instance, however, it would be advisable to change, by means of a differentiating circuit, the pulse from the line output transformer to a spike, so that it occupies a shorter period of time than the half-width equalising pulses. This would then ensure that the pentode grid was at sync pulse tip level throughout the existence of the spike.

The main disadvantages of the circuit of Fig. 225 are that it cannot function correctly until the line sawtooth generator is in synchronism with the received signal, and that, immediately after switching on the receiver, no a.g.c. potential is developed until the booster diode has warmed up and gating pulses are available from the line output

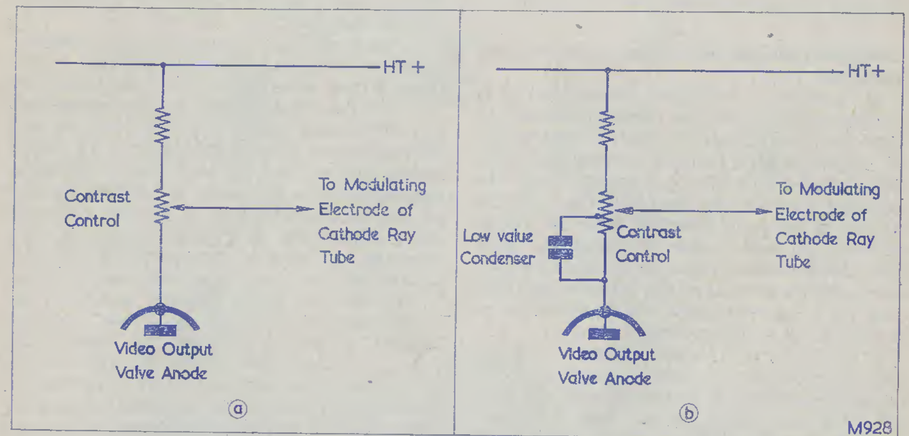


Fig. 226 (a). Illustrating, in basic form, a contrast control circuit in which the control forms part of the video output valve anode load
(b). To prevent attenuation of the higher video frequencies, the circuit of (a) may be modified by adding a low value condenser between a fixed tap and the anode end of the potentiometer track

[5] Published in last month's issue.

transformer. Both these shortcomings seem to be generally tolerated, in American receivers at any rate, even though the second results in a particularly obvious fault known as "warm-up buzz". If, during warm-up, the receiver happens to be tuned to a powerful signal, this is applied at high level to the i.f. stage. Before the appearance of an a.g.c. voltage these stages operate at maximum sensitivity, with the result that overloading takes place and the sound i.f. is heavily modulated by the vision i.f. The consequence is that, until the booster diode warms up and an a.g.c. voltage is formed, a loud buzz at frame frequency can be heard from the loudspeaker. Simple protection circuits or devices to overcome or reduce this effect may be fitted to later receivers.

Contrast Controls in Negative Modulation Receivers

In positive modulation receivers it is normal practice for the contrast control to vary the bias applied to the r.f. and/or the i.f. stages. Such a contrast control is usually incorporated into the a.g.c. system itself. In negative modulation receivers the contrast control is normally inserted *after* the vision detector, in which case it varies the gain provided between the vision detector and the modulating electrode of the cathode ray tube. The a.g.c. system then functions independently of the contrast control.

Contrast control circuits which vary the gain between the vision detector and the modulating electrode of the cathode ray tube fall into two basic types. The first type employs a potentiometer to vary the screen-grid or bias potential of the video amplifier and, thereby, the gain it provides. The second type employs a potentiometer which functions in the same manner with the video signal as does an a.f. volume control with an audio signal. A representative example is illustrated in simplified form in Fig. 226 (*a*), wherein the potentiometer is part of the video output anode load. The video signal tapped off by the slider of the potentiometer is then passed to the modulating electrode of the cathode ray tube. The circuit around the potentiometer, and the component itself, requires care in design to ensure that stray capacities between the slider and chassis do not cause attenuation of the higher video frequencies when the slider is some way removed from the anode end of the track. Sometimes, the possibility of high frequency attenuation is overcome or reduced by connecting a low value condenser (of the order of 50pF) between the anode end of the track and a fixed tap, as in Fig. 226 (*b*).

Power Supply Circuits

Domestic television receivers normally obtain their operating power from the mains supply. In Britain, mains supplies are available at 200 to 250 volts, and are 50 c/s a.c. or d.c. (usually the former). European mains supplies are normally 50 c/s a.c. at voltages of 200 to 250, with lower voltages occurring in some countries. Australian mains supplies are normally 200 to 250 volts 50 c/s a.c., whilst American mains supplies are at 60 c/s a.c. with a nominal voltage of 117.[6]

The purpose of television receiver power circuits is to convert the power available from the mains to an h.t. supply and a heater supply.[7] Other power requirements, such as the boosted h.t. positive supply or potentials negative of chassis for bias or a.g.c. protection devices, are then obtained from the receiver circuits themselves.

In early British receivers it was conventional practice to employ an isolated mains transformer similar to that illustrated in Fig. 227 (*a*). A full-wave h.t. secondary fed a conventional valve rectifier, and heater supplies were obtained from one or more heater secondaries. Later circuit arrangements allowed a reduction in costs by the use of an autotransformer, a typical example being illustrated in Fig. 227 (*b*). In this diagram a voltage of approximately 250 a.c. is applied to a half-wave selenium rectifier to provide h.t., whilst a heater secondary or secondaries is provided as before. A significant difference between the circuit of Fig. 227 (*b*) and that of Fig. 227 (*a*) is that, in the latter, the chassis of the receiver is connected to one side of the mains supply in order that an h.t. negative connection may be made. The chassis is, in consequence, "live", and special precautions have to be taken to prevent shock.

Both the circuits of Figs. 227 (*a*) and (*b*) require that the television receiver be operated from a.c. mains supplies only. They have now been superseded in Britain by the a.c./d.c. type of power supply shown in Fig. 227 (*c*), which has become standard practice for a considerable number of years. In Fig. 227 (*c*) the mains supply is connected directly to chassis and, via one or more resistors, to the anode of a half-wave h.t. rectifier. The heater supply is obtained by wiring all the valve heaters in series, and connecting these to the mains supply via one or more resistors and a thermistor.[8] In Figs. 227 (*a*) and (*b*) varying mains supply

[6] American equipment manufacturers occasionally specify an input voltage of 105–125 volts.

[7] These are known, in American terminology, as the B supply and the A (or "filament") supply respectively.

[8] A thermistor exhibits high resistance when cold and low resistance when warm. It consequently prevents a heavy surge of current through the heaters when the receiver is switched on.

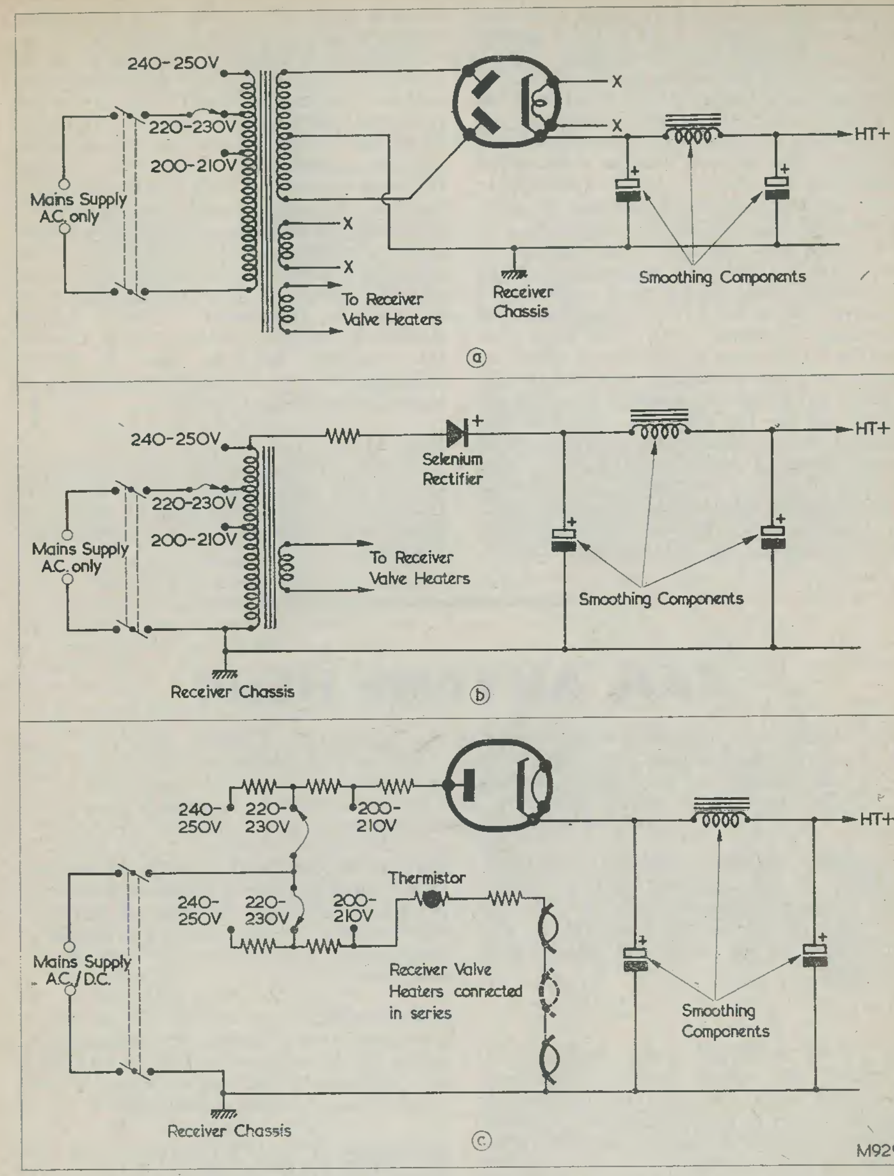


Fig. 227 (a). A mains transformer power supply circuit of the type employed in early British television receivers
(b) A development of the circuit shown in (a), in which an economy is obtained by the use of an autotransformer. The resistor in series with the rectifier is intended to limit the current it passes when it conducts
(c). A power supply circuit of the type employed in current British receivers

voltages are catered for by employing taps in the transformer. In Fig. 227 (*c*) they are catered for by selecting different values of resistance in series with the h.t. rectifier and the heaters. The power supply circuit of Fig. 227 (*c*) is capable of functioning from d.c. mains if the non-chassis lead is connected to the positive supply terminal; the rectifier then merely passes a steady current.

Whilst the power supply circuit of Fig. 227 (*c*) represents standard British practice, it has not been universally accepted elsewhere. It is commonly employed in European receivers, although some models may be encountered employing transformer circuits (possibly to cater for the low mains voltages in some countries). In some parts of Australia it is obligatory that full-wave rectification be employed in television receivers, it being considered that the current drawn on positive half-cycles by a large number of television receivers with half-wave h.t. circuits could have a deleterious effect on public supplies. Australian receivers usually employ a full-wave isolated transformer circuit, as in Fig. 227 (*a*). In America, isolated mains transformer circuits represented standard design practice for a large number of years, "live-chassis" receivers not being generally introduced until around 1955. In the American instance the half-wave rectifier circuit of Fig. 227 (*c*) is not attractive, because the low mains supply voltage available prevents the formation of an adequate h.t. potential. In consequence, American "transformerless" receivers employ *voltage doubling* rectifier circuits (to be discussed later) which allow the formation of an h.t. voltage approximately double that given by a single half-wave rectifier. Voltage doubling circuits can only function with a.c. supplies, and they require that the receiver chassis be connected to one side of the mains. Heater supplies, in receivers of this type, are obtained either by connecting the valve heaters in series, or by supplying them from a separate transformer. Most current American receivers employ voltage doubler h.t. rectifiers, although there is still a tendency to retain autotransformer or isolating transformer circuits.

Next Month

In next month's issue we shall continue to discuss the power supply circuits of the television receiver, covering in detail the basic design requirements of h.t. and heater circuits.

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

Transmitter BC191E, Receiver BC342N, Rectifier RA34F.—Ian M. Hull, 74 Southfield Avenue, Kingswood, Bristol, wishes to buy, beg or borrow the manuals, or any information on the above U.S. Signal Corps equipment.

* * *

G.E.C. "F.M. Plus" Tuner Booklet.—D. Norman, 24 Verney Walk, Southcourt, Aylesbury, Bucks, requires to purchase or borrow a copy of this publication, now out of print, in order to complete modifications to his 912 Plus amplifier.

* * *

Guildford 2-Metre Enthusiasts.—G. C. Miller, VE3DPT/G3ONG, 36 Lime Grove, Bellfield, Guildford, Surrey, recently arrived from Canada, has Gonset equipment set up for 144–148 Mc/s working and would like to contact any local amateurs working on these frequencies.

Receiver RU-19.—A. J. E. Hill, 24 Fellowes Way, Stevenage, Herts, wishes to borrow or purchase the circuit diagram of this U.S. Navy receiver. Also interested in details of modifications for amateur "Top Band" reception.

* * *

Sylvania C.R.T. type 5NP1.—D. B. Hulse, 5 Industry Street, Norden, Rochdale, Lancs, would like to include this tube in a cathode ray oscilloscope but has no data or base connections—can any reader help?

* * *

RT-34/APS-13 and RT-7/APN-1.—R. K. Lloyd, Box 1164, Lusaka, North Rhodesia, Central Africa, would like to obtain the circuit diagrams and any other information with reference to these units.

* * *

Heathkit Amateur Transmitter DX100U.—P. Woollard, 10 Brookside, Glapthorne, nr. Peterborough, Northants, would like to obtain the loan of circuit and technical details for a period of about one week.

Converting the BC-348

by P. MEREDITH

(Despite the considerable amount of time which has elapsed since surplus electronic equipment first appeared on the amateur market, readers still show a very keen interest in conversion details for the more commonly met receivers and test equipment. In this article our contributor discusses the conversion of the BC-348 receiver to amateur use. The conversion of other items of surplus equipment will be covered from time to time.—Editor.)

THE EDITOR OF *The Radio Constructor* has, over the past few years, received many requests from readers for conversion details for ex-W.D. receivers and other electronic equipment. Such requests are typical of the vigorous interest currently in existence, this having been maintained in spite of the period of time that has elapsed since surplus equipment was first offered for sale. I have had some experience in modifying quite a few surplus units for experimental, amateur or domestic use; and the Editor has, in consequence, asked me to contribute a number of articles, to be published from time to time, describing such conversions. The present article discusses the modification of the BC-348 in order that it may be operated as a mains powered communications receiver.

The BC-348 Receiver

The BC-348 is an American aircraft a.m. receiver intended for operation from 24–28 volt aircraft batteries (negative terminal earthed). It covers 200 to 500 kc/s and 1,500 kc/s to 18 Mc/s. Its main attraction, therefore, is as a Short-wave receiver.

Before passing on to conversion details it will be helpful to quickly discuss the receiver in its unmodified state. The description which follows refers to the basic BC-348 and should be applicable to all models (distinguished by different suffix letters), available on the British surplus market.

The main controls available on the BC-348 are as follows: tuning condenser, band selector switch, combined on-off and a.v.c.–m.v.c. switch, b.f.o. switch, crystal filter switch, volume control, and dial light dimmer control. An aerial alignment control may also be fitted. The volume control consists of two ganged potentiometers, one acting as a conventional a.f. volume control in the grid circuit of the output valve, and the other as an r.f. volume control varying the bias on the cathodes of the two r.f. valves and the first and second i.f. valves. When the main switch is in the m.v.c. (manual volume control) position, the grid of the a.f. output valve is taken to the top end of the a.f. potentiometer track instead of its slider, with the result that the a.f. circuits operate at full gain and control of receiver volume is achieved entirely with the r.f. potentiometer. When the main switch is in the a.v.c. position, the r.f. potentiometer slider is taken to chassis via a low value resistor, the output valve grid being returned to the slider of the a.f. potentiometer. Thus, on a.v.c., the i.f. and r.f. stages function with minimum cathode bias, and volume control is achieved entirely with the a.f. potentiometer.

The valve line-up in most BC-348 models likely to be encountered is as follows: 1st r.f., VT117 (6SK7 metal); 2nd r.f., VT117 (6SK7 metal); mixer, VT150 (6SA7 metal); 1st i.f., VT117 (6SK7 metal); 2nd i.f., VT117 (6SK7 metal); 3rd i.f., VT116 (6SJ7 metal); 2nd detector, a.v.c. diode, and b.f.o. triode, VT233 (6SR7) metal; a.f. amplifier and output, VT152 (6K6GT). Earlier receivers had the following line-up: 1st r.f., VT86 (6K7 metal); 2nd r.f., VT86 (6K7 metal); mixer, VT91 (6J7 metal); separate oscillator VT65 (6C5 metal); h.t. voltage regulator for the oscillator; 1st i.f., VT86 (6K7 metal); 2nd i.f. and b.f.o. triode, VT70 (6F7 metal); 3rd i.f., a.g.c. and a.f. diode, VT93 (6B8 metal); a.f. amplifier and output, VT48 (41).[1] In the first, 6SK7, line-up the crystal filter appears between the first and second i.f. stages, whilst in the earlier, 6K7, line-up the crystal filter is between the mixer and the first i.f. stage. The 6K6GT (octal base) has the same characteristics as the 41 (6-pin UX base). A receiver having a line-up of the types just described would be expected to give a very good account of itself; and such, indeed, is the case with the BC-348. This receiver is extremely sensitive and selective.

In the design and layout of the BC-348

[1] Variations such as 6K6GT instead of 41 in the second line-up may perhaps be encountered, but circuit functions should remain unaltered.

considerable emphasis has been placed on ruggedness and reliability, and the cliché "built like a battleship" definitely applies. The BC-348 is not, however, a receiver in which all components are easily accessible, and this may be something of a deterrent to those wishing to modify the design. This point is taken into account in the conversion details given later.

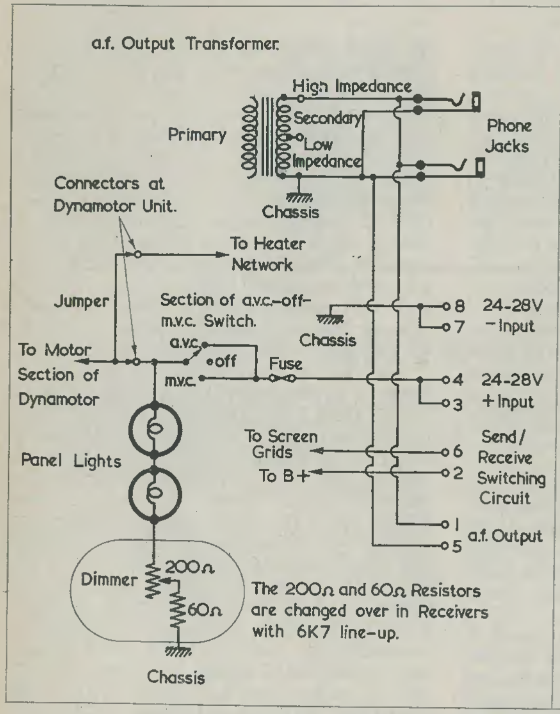
External Connections

There are three sets of connections to the receiver.

Of these the first set consist of antenna and ground terminals mounted on the front panel. The antenna terminal connects to the arm of the first band-selector switch wafer and, thence, to the appropriate aerial coils. The ground terminal connects direct to chassis.

The second set of connections consist of two a.f. output jacks of conventional design. These are wired in parallel and connect to the secondary of the a.f. output transformer. The jacks do not incorporate any switching circuits actuated by the insertion of a jack plug.

The third set of connections is to an 8-way plug at the rear of the receiver. The services provided by the pins of this plug are shown in Fig. 1. It will be seen, in this diagram, that the 24–28 volt aircraft supply is fed to four pins, these consisting of pins 8 and 7 joined together (and thence to chassis) for the negative connection, and pins 3 and 4 joined together for the positive connection. From pins 3 and 4 the positive supply passes through a fuse, the a.v.c.–off–m.v.c. switch, a connector between the main receiver and the dynamotor unit, and is finally applied to the motor section of the dynamotor. Also, via a jumper on the dynamotor unit, it connects back into the receiver to supply the heaters. The secondary of the a.f. output transformer couples to pins 1 and 5, pin 5 being at chassis potential. It will be noted that pins 1 and 5 are in parallel with the two output jacks referred to in the preceding paragraph and that they connect across the complete secondary winding of the output transformer. This method of connection provides a high impedance output. A low impedance output is available by connecting the non-earthy output lead to the tap in the



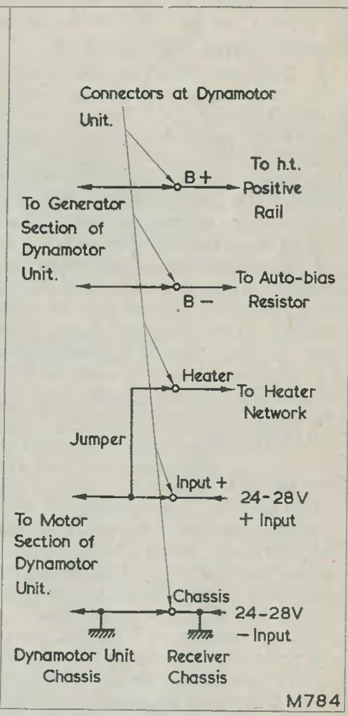


Fig. 1 (left). The receiver circuits immediately connected to the 8-way plug. Fig. 2 (right). The circuits around the dynamotor unit terminals

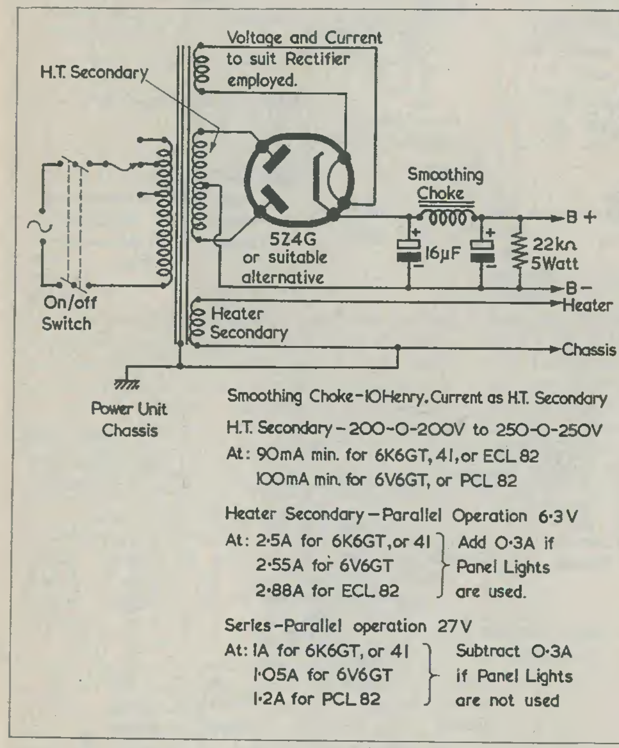
secondary winding. (Incidentally, I have not personally encountered a BC-348 wired up for low impedance output.)

Pin 2 connects to B+ (h.t. positive) while pin 6, via various dropping resistors, is connected to the screen-grids of the r.f. and first and second i.f. valves, and to the anode circuit of the b.f.o. Pins 2 and 6 were originally intended for connection to a send-receive switch or relay. When the circuit between them is opened the receiver is muted, thereby enabling the associated transmitter to be operated. Pins 2 and 6 must be connected together if the receiver is to function.

Power Supplies

Having paid attention to the main features of the receiver we now continue with details of conversion. These apply to receivers having either the 6SK7 or the 6K7 line-up.

H.T. power in the unmodified receiver is obtained from the generator section of the dynamotor unit. For mains operation the dynamotor unit is not required, and it should be removed from the chassis. The dynamotor unit connects into five terminals on the receiver chassis which should be clearly marked with their functions, as in Fig. 2. It is to these terminals, mainly, that the output of the mains power unit will connect. If the chassis terminals are not clearly marked, or if any doubt as to their function exists, they may be identified with the aid of an ohmmeter. The B+ (h.t. positive) terminal connects directly to pin 2 of the 8-way plug and to that end of the a.f. output transformer primary which is remote from the output valve anode. Zero resistance should be obtained between either of these points and the B+ terminal. The B– (h.t. negative) terminal connects to chassis via an auto-bias resistor having a value around 50Ω. The negative connection to the heater network is made via chassis, and this is covered by a single terminal which is obviously at chassis potential. The remaining two terminals will be the two 24–28 volt positive terminals which were "jumpered"



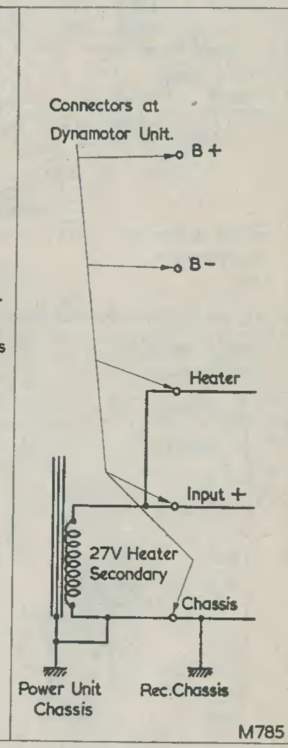


Fig. 3 (left). A suitable mains power unit for the BC-348. Fig. 4 (right). How a 27 volt a.c. heater supply may be connected to the dynamotor terminals over in the dynamotor unit. One of these will be the 24–28 volt input terminal, and this will show zero resistance to pins 3 and 4 of the 8-way plug (assuming a serviceable input fuse), or a varying resistance to chassis as the panel light dimmer is operated (assuming serviceable bulbs). The other terminal will be that which connects to the heater network. This will show a change of resistance to chassis if any valve is removed from its socket.

later.) H.T. voltages above 250 are inadvisable, in my opinion, as the fractionally increased gain and output power which result are outweighed by the risk of broken down decoupling condensers or failure of the output valve (if this is retained). I would certainly suggest that the top limit for h.t. voltage be set at 260 when, with the receiver on m.v.c., volume is set to minimum. The h.t. supply will need to be reasonably well regulated by virtue of varying current

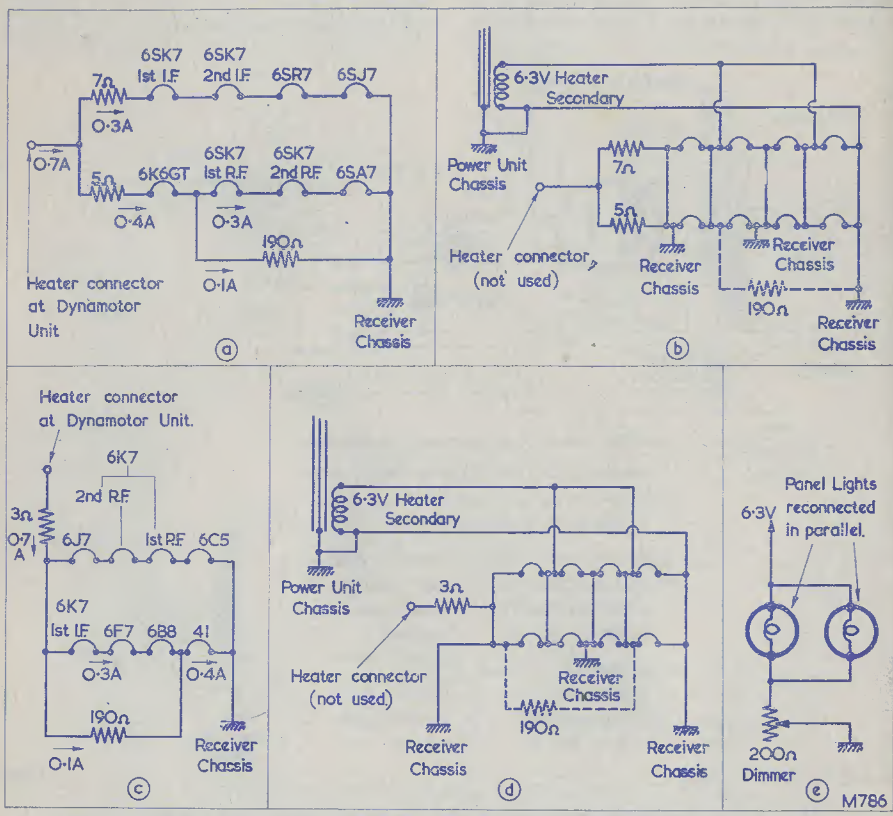


Fig. 5 (a) The heater network in receivers employing the 6SK7 line-up. (b) The 6SK7 network may be converted to 6.3 volt operation by the additional wiring shown here. (c) Heater network for the 6K7 line-up. (d) Modifying the 6K7 network for 6.3 volt working. (e) If desired, the panel lights may be run from the 6.3 volt supply in the manner shown here

Having identified the various terminals to which the dynamotor unit connects, we next consider a suitable form of mains power unit. The receiver will work comfortably with an h.t. supply of 200 to 250 volts at a current, assuming no modification to the a.f. circuits, of 80mA minimum. (The question of modification to the a.f. stages is discussed

demands, and it would be advantageous to fit a bleeder resistor taking some 10mA or so. A suitable h.t. supply is shown in Fig. 3. The h.t. secondary of the transformer in this diagram is specified as providing a current (for the receiver with unmodified a.f. circuits) of 90mA, as an extra 10mA approximately is consumed by the 22kΩ bleeder resistor.

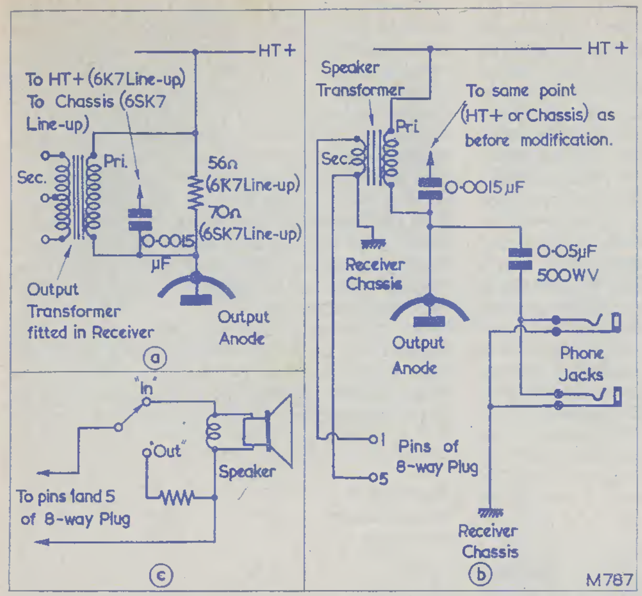


Fig. 6 (a) The output anode circuit in the unmodified receiver. (b) Fitting a speaker transformer. The resistor previously connected across the primary is removed. (c) A speaker silencing switch. The resistor should have a value approximately equal to speech coil impedance

The h.t. rectifier may be any indirectly heated full-wave type suitable for this class of work, such as the 5Z4, GZ30, etc. It is most important to note that the h.t. negative line is *not* at chassis potential. Electrolytic condenser cans must therefore be insulated from chassis, where applicable.

A heater winding is shown on the mains transformer of Fig. 3, but no single voltage is specified. The reason for this is that it is possible to operate the heaters of the converted BC-348 in one of two ways. One method consists of modifying the heater wiring such that all the valve heaters are in parallel, whereupon a 6.3 volt supply at 2.5 amps (ignoring current drawn by the panel lights and assuming unmodified a.f. circuits) becomes necessary. The alternative method of feeding the heaters consists of keeping the wiring in the receiver as it is, and of supplying the existing heater network with 27 volts a.c. at a current of 1 amp (assuming a panel light consumption of 0.3 amp and unmodified a.f. circuitry). In my own opinion this second alternative is easier, because it completely obviates the necessity of altering heater wiring, some of which may be a little inaccessible. I must admit that my judgment may well be biased by the fact that I have been able to obtain specially-wound mains transformers fairly readily when carrying out my own conversions. If the reader is able to obtain a transformer with a 27 volt secondary (or is prepared to string several secondaries in series to obtain this voltage), all that is necessary is to connect one side of the 27 volt supply to chassis, and the other to the 24-28 volt terminals at the dynamotor unit in the manner shown in Fig. 4. All heaters should then light up correctly, as will, also the dial lamps. I have found that this method of operation has caused no trouble whatsoever due to hum injection.

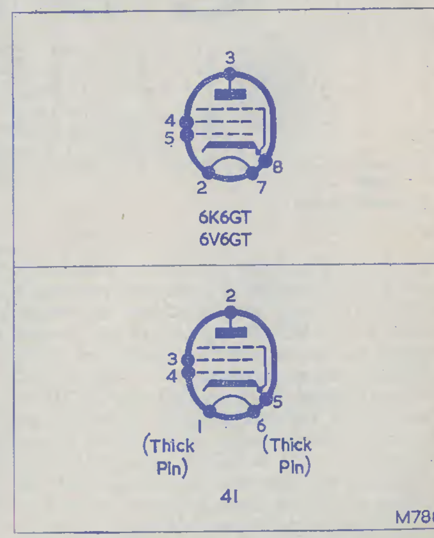


Fig. 7. Base connections to the 6K6GT, 6V6GT and 41

For those who are prepared to change the heaters in the receiver over to parallel operation Fig. 5 (*a*) shows the heater network installed in receivers having the 6SK7 line-up which will have to be modified. As may be seen there are two chains, one of which consumes 0.3 amp, whilst the other consumes 0.4 amps. Apart from the 6K6GT, all valves draw 0.3 amp heater current. The 6K6GT draws 0.4 amps, and the consequent additional 0.1 amp in its chain is bypassed by the 190Ω resistor. If it is intended to convert to 6.3 volt operation the best procedure would consist of making the changes illustrated in Fig. 5 (*b*). In this diagram chassis connections are made at the centre and left-hand end of each chain, the 6.3 volt supply being then fed to the four intermediate points. Fig. 5 (*c*) illustrates the heater network in receivers having the 6K7 line-up, and due to manufacturing changes, and this factor should be borne in mind when carrying out the modifications. It would certainly be wise to check that no short circuits have been accidentally introduced into the wiring before connecting up the 6.3 volt secondary winding. If it is felt worthwhile, the panel lights may be run from the 6.3 volt supply by connecting them up in the manner illustrated in Fig. 5 (*e*). They will not, however, achieve full brilliance and the dimmer will be effective only over part of its range. The additional current drawn by the panel lights is not taken into account in the current figures quoted for 6.3 volt operation.

It may be found possible, with a little squeezing, to fit the mains power unit into the space vacated by the dynamotor unit. This course has the disadvantage that extra heat is dissipated inside the receiver cabinet

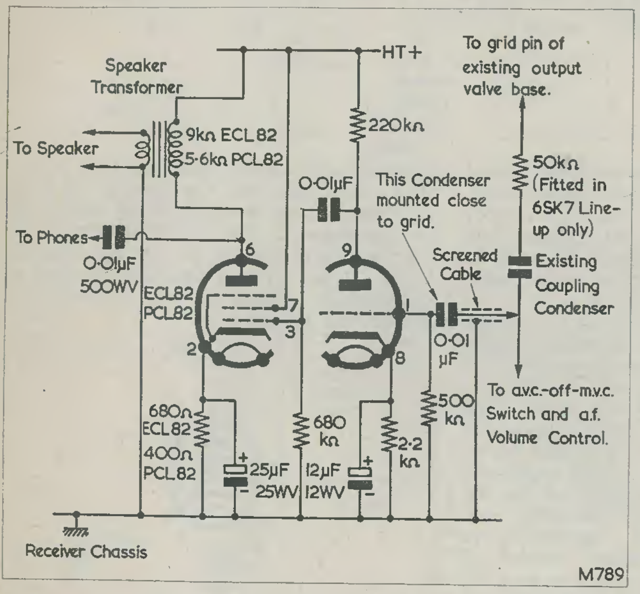


Fig. 8. A simple method of fitting a two-stage a.f. amplifier consists of employing a modern triode-pentode on a separate chassis, as shown here. The existing output valve is removed

Fig. 5 (*d*) illustrates a suitable method of wiring modification. I have not personally carried out any modifications to heater wiring in the BC-348 myself but the process should not be beyond the capabilities of the average home constructor. The 190Ω resistor of Figs. 5 (*a*) and (*c*) may be left in circuit after the modification, if desired, as the extra current drawn by it, at the altered potential of 6.3 volts, is negligible. The writer would like to point out that the circuits of Figs. 5 (*a*) and (*c*) are, to the best of his knowledge, those existing in standard BC-348 receivers. It is possible that there may be variations in individual receivers due

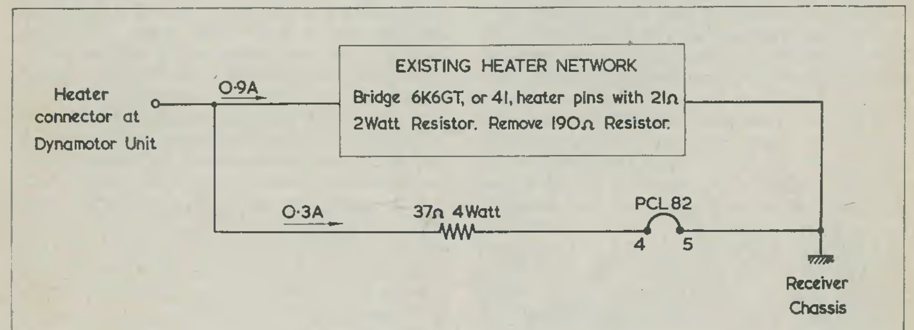
I would suggest that the power unit be mounted externally, h.t. and heater connections to the receiver being made by multi-way cable and perhaps, a suitable plug and socket.

A.F. Circuits

When powered from the mains in the manner just discussed, the BC-348 will drive a loudspeaker at quite reasonable volume. The speaker may be connected to the existing output terminals (assuming that the high impedance tap on the output transformer is employed), via a speaker transformer offering a primary impedance of some 5,000 ohms.

Better results should be given by replacing the output transformer in the receiver with a standard speaker transformer, as demonstrated in Figs. 6 (*a*) and (*b*). In the modified arrangement of Fig. 6 (*b*) the two phone jacks are coupled to the output anode via a 0.05μF 500 w.v. condenser and can, in consequence, accept high impedance phones. At the same time, pins 1 and 5 of the 8-way plug connect direct to the speech coil of the speaker. It is important to note that the secondary of the speaker transformer should always be loaded by a resistor if the speaker is silenced, as the transformer may otherwise be damaged by high a.f. voltages on its primary. The speaker silencing switch of Fig. 6 (*c*) covers this point. As an aid to choosing the requisite speaker transformer it should be noted that the 6K6GT (or 41) is designed to work into an anode load of 7,600Ω and that its anode current will be of the order of 30mA.

be short.[2] Replacements are, also, rather difficult to obtain in this country. In consequence, it is not a bad plan to replace the output valve with a 6V6GT when carrying out the modification to mains operation. The 6V6GT has the same base connections as the 6K6GT and can be plugged into the same holder. It will be necessary, however, to change the base if a 41 is employed in the receiver. Fig. 7 illustrates the base connections for types 6K6GT, 6V6GT and 41. The 6V6GT draws some 10mA more h.t. current than the 6K6GT (or 41), and its heater is rated at 0.45 instead of 0.4 amp. This latter point necessitates an increase in heater current of 0.05 amp in both 6.3 or 27 volt heater supplies. Further, with the 27 volt heater supply, the 190Ω resistor of the 27 volt heater networks in Figs. 5 (*a*) or (*c*) will need to be altered to 130Ω 3 watt, or be shunted by an additional 380Ω 1 watt resistor, to bypass the extra 0.05 amp. A metal 6V6 can



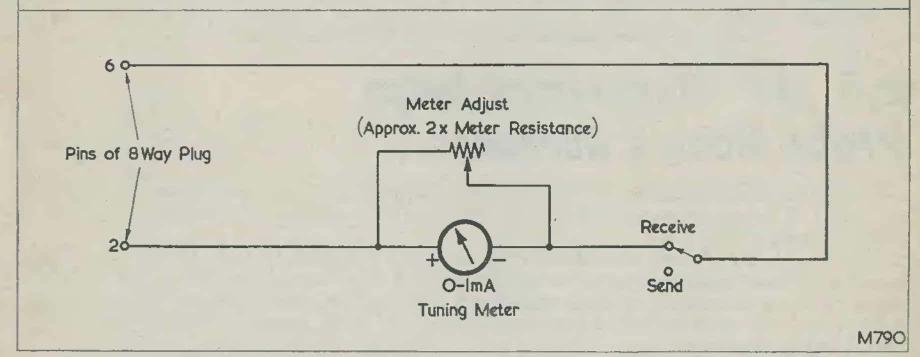


Fig. 9 (above). Wiring a PCL82 into the 27 volt heater network. Fig. 10 (below). A send-receive circuit, incorporating a tuning, or S-meter

My own experience with the 6K6GT as fitted to BC-348 receivers has been rather disappointing, in so far that its life tends to be used instead of a 6V6GT provided that pin 1 of its base (connecting to valve shell) is bonded to chassis. So far as the requisite speaker transformer is concerned, the 6V6GT requires an anode load impedance of 5,000Ω.

[2] The same remark could, presumably, apply to the 41.

It will be found that the coupling condenser to the grid of the output valve in the receiver has rather a low value (0.001 to 0.0015μF). Bass response will be improved if this is replaced, or shunted, with a 0.01μF unit.

An Additional A.F. Valve

The BC-348 receivers converted by myself have always exhibited adequate, although not excessive, a.f. gain. It is quite possible that some readers may prefer to insert a triode between the second detector and the output valve, thereby making the a.f. circuitry consistent with that given in conventional communications receivers. There are a number of obvious ways in which such a modification may be carried out, but I feel that the simplest consists of fitting a two-stage amplifier on its own small chassis into the space previously occupied by the dynamotor. Such an amplifier can employ a modern triode-pentode of the type now common in television and radio receivers.

A typical example is illustrated in Fig. 8. The two-stage amplifier shown here employs an ECL82 or PCL82 triode-pentode, and obtains its drive via a 0.01μF condenser coupled to that terminal of the receiver output valve grid coupling condenser which is remote from grid. The 6K6GT (or 41) is now discarded. This method of operation has the advantage of obviating modifications to the auto-bias circuits in the receiver. The ECL82 has a heater voltage of 6.3 at a current of 0.78 amp and it should be used with parallel heater arrangements. The total parallel heater current will then become 2.88 amps (an increase of 0.38 amps over the figure applicable with the 6K6GT). There is no significant change in h.t. current requirements. The ECL82 should feed into an anode load impedance of 9kΩ.

If the original 27 volt heater wiring is retained, the extra amplifier may employ a PCL82. This has the same base connections as the ECL82, and its heater voltage is 16 at 300mA. The heater supply may then be modified in the manner shown in Fig. 9, whereupon the heater current requirement at 27 volts becomes 1.2 amps. H.T. consumption with the PCL82 increases by approximately 10mA, and its anode load impedance should be 5.6kΩ.

Send-Receive Switching and Tuning Meter

As was mentioned above, the receiver may be disabled by opening the circuit between pins 2 and 6 of the 8-way plug. These two pins can, in consequence, be wired to a send-receive switch.

Since the current drawn by the screen-grids fed via pin 6 vary with a.g.c. voltage it becomes possible to connect a tuning meter, or S-meter, to them. A suitable circuit, which includes a send-receive switch, is shown in Fig. 10. If there is evidence of current surges in the meter when the send-receive switch is closed, it may be protected by connecting a condenser of some 2μF or so in parallel with it. It may be possible, especially with receivers employing the 6K7 layout, to employ a meter less sensitive than the 0–1mA unit shown in Fig. 10. This point may readily be checked with a testmeter before selecting a particular meter.

2.5 MW Magnetron Helps Probe Moon's Surface

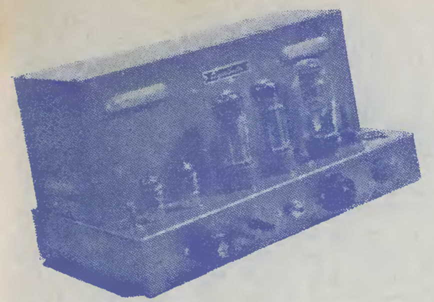
In a letter to *Nature* recently, Mr. V. A. Hughes, of the Royal Radar Establishment at Malvern, gave news of recent investigations carried out into the roughness of the moon's surface as a radar reflector.

From the results of these experiments the assumption is made that the surface has vertical irregularities which are greater than a wavelength and a horizontal scale which is considerably larger. The angular scattering properties of the lunar surface were measured at a wavelength of 10cm by a 45ft radio telescope, the radar transmitter being powered by an English Electric 2.5MW M543 magnetron.

This is one of the long anode magnetrons currently being produced by the English Electric Valve Co. Ltd., capable of delivering a very high mean power. Under typical operating conditions the mean power is 3.75kW at 300 p.p.s., with a pulse length of 5 μsec.

In this experiment a pulse length of 5 μsec., corresponding to a range resolution of 0.75 km, was used, and since the area of the lunar surface illuminated by the pulse at any one time is constant, the angular scattering law may be obtained by converting the distance travelled by the pulse after first contact with the moon to angle of incidence of the surface.

The law of scattering derived by Mr. Hughes is consistent with scattering from a rough surface which has irregularities much greater than a wavelength and a horizontal scale about twenty times the vertical deviations.



The Cooper-Smith MAGNUM

20 Watt Power Amplifier

Part 1

Described by W. HOLMES

The Cooper-Smith 20 watt power Amplifier provides a true high fidelity output at high power. It is an instrument which is ideal for high grade sound reinforcement and public address systems, and it can also fulfil applications in the domestic field. In the latter case, the amplifier would normally be operated below its rated output, the fact that it has a considerable degree of undistorted power in reserve ensuring that transients and the like are reproduced truthfully without approaching overload at any time.

The photograph at the head of this article clearly illustrates the clean and well planned layout of the amplifier. An under-chassis illustration is also shown, and it will be seen from this that component layout has the same neatness, and exhibits the same care in design, as has been evident in previous equipments in the Cooper-Smith series.

Amplifier Features

The amplifier is designed to operate in conjunction with the Cooper-Smith Mk. II Control Unit,* although other pre-amplifiers could be used instead if they meet input requirements. Power supply sockets are available both for the pre-amplifier and for a radio tuner unit. There is also an outlet which may be used for supplying mains voltage to a gram motor or to any similar ancillary equipment. On-off switching for the power amplifier is achieved at the Control Unit, and the pre-amplifier socket carries the necessary wiring for this facility.

A special feature of the amplifier is given by the output transformer. This component is of heavy construction and employs C-cores instead of normal laminations to keep leakage inductances to a minimum. The transformer is coupled to the output valves in an ultra-linear circuit. Output impedances at 3.8, 8.5 and 15.2 ohms are available, these being selected by fitting individual plugs into a special 9-way matching socket. The plugs are identified by the output impedance they provide and they are wired internally such that appropriate combinations of the output transformer secondary windings are presented to the two loudspeaker terminals. The plugs also carry components which enter the negative feedback loop, these components ensuring that feedback at the correct level is achieved whatever output impedance is selected.

Especial attention has been paid in the design of the amplifier to the prevention of hum. A centre-tapped 6.3 volt secondary on the mains transformer supplies the heaters of the first two valves in the amplifier circuit, and is available for use by the pre-amplifier and radio tuner unit as well. Main h.t. smoothing is carried out with paper, and not electrolytic, condensers. Fuses are provided both in the mains input and in the h.t. supply circuit.

The technical specification for the amplifier is as follows:

Output: 20 watts nominal, 30 watts maximum.

Distortion: 0.1% at full output.

Input Sensitivity: 650mV referred to 29.3 watts.

Frequency Response: 30–30,000 c/s ± 0.5 dB.

Feedback: 26dB.

Noise Level: −80dB referred to 29.3 watts.

Output Impedance: 3.8, 8.5 or 15.2 ohms.

Output: EL 34's, ultra-linear.

Size: 14in x 8¼in x 7¾in.

Weight: 26lb.

* The Cooper-Smith Mk. II Control Unit, J. Cooper, *The Radio Constructor*, February 1958.

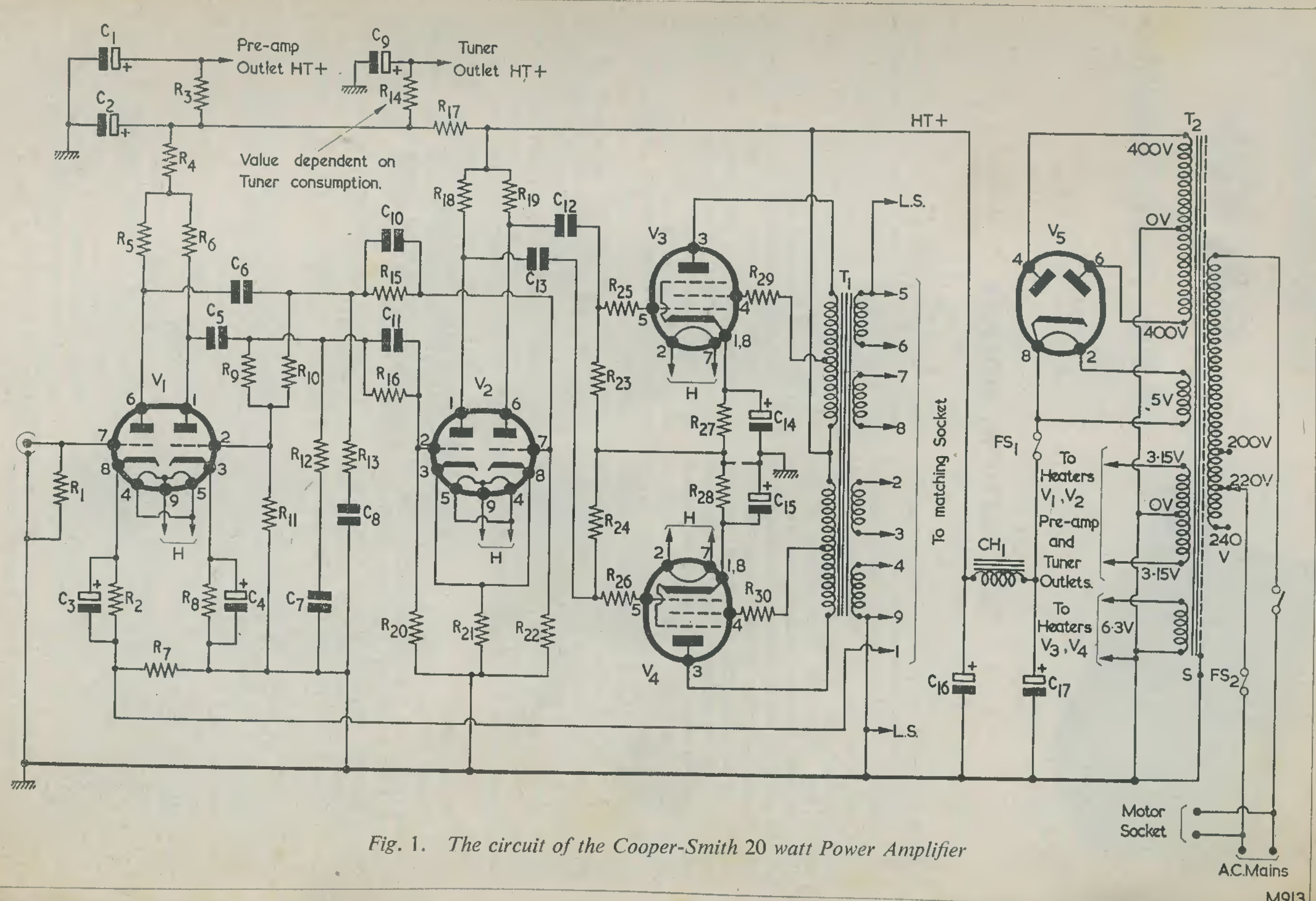


Fig. 1. *The circuit of the Cooper-Smith 20 watt Power Amplifier*

The Amplifier Circuit

The circuit of the amplifier appears in Fig. 1. In this diagram the input signal is applied to the left hand triode of V_1 (12AX7). The two triodes of V_1 are employed in a "floating paraphase" circuit, a.f. voltages of opposite phase appearing at the anodes. In the "floating paraphase" circuit the grid of the right hand triode of V_1 taps into the junction of R_9 and R_{10}. The value of R_9 is slightly greater than R_{10}, with the result that the grid receives a small proportion of the a.f. voltage on the anode of the left hand triode, the necessary phase reversal then taking place in the right hand triode itself. The circuit is self balancing, with the consequence that the a.f. voltages on the anodes are of equal amplitude.

The a.f. on the anodes of V_1 are fed, by way of the frequency correcting components R_{12}, R_{13}, R_{15}, R_{16}, and C_7, C_8, C_{10}, C_{11},

Components List

(Set out for easy reference to Fig. 1)

Resistors

(All 10% ½ watt high stability unless otherwise specified.)

R_1	1MΩ
R_2	3.9kΩ
R_3	68kΩ
R_4	22kΩ
R_5	220kΩ
R_6	220kΩ
R_7	100Ω
R_8	3.3kΩ
R_9	1.2MΩ
R_{10}, R_{11}	1MΩ, matched 2%
R_{12}	10kΩ
R_{13}	10kΩ
R_{14}	Value dependent on tuner h.t. consumption
R_{15}, R_{16}	4.7MΩ, matched 2%
R_{17}	68kΩ, 1 watt
R_{18}, R_{19}	47kΩ, matched 2%
R_{20}	470kΩ
R_{21}	680Ω, 1 watt
R_{22}	470kΩ
R_{23}, R_{24}	220kΩ, matched 2%
R_{25}	10kΩ
R_{26}	10kΩ
R_{27}, R_{28}	470Ω, matched 3%, 3 watt wire wound
R_{29}	1.2kΩ
R_{30}	1.2kΩ

Condensers

C_1	16μF 450 W.V. elec.
C_2	8μF 450 W.V. elec.
C_3	50μF 12 W.V. elec.
C_4	50μF 12 W.V. elec.
C_5	0.25μF 500 W.V. paper
C_6	0.25μF 500 W.V. paper
C_7	470pF mica
C_8	470pF mica
C_9	8μF 450 W.V. elec.
C_{10}	5,000pF mica
C_{11}	5,000pF mica
C_{12}	0.47μF 500 W.V. paper
C_{13}	0.47μF 500 W.V. paper
C_{14}	50μF 50 W.V. elec.
C_{15}	50μF 50 W.V. elec.
C_{16}	7 or 8μF 500 W.V. paper
C_{17}	7 or 8μF 500 W.V. paper

Valves

V_1	12AX7/ECC83
V_2	12AU7/ECC82
V_3	EL34
V_4	EL34
V_5	GZ32

Miscellaneous

(All available from H. L. Smith & Co. Ltd.)

T_1	Output transformer. C-core, ultra-linear, 6.6kΩ anode-to-anode, tapped at 43%, 4-section secondary
T_2	Mains transformer. 400–0–400 volt 200mA h.t., 6.3 volt 3.5A centre-tapped heater, 6.3 volt 4A heater, 4 volt 3A heater

CH_1 Choke. 12H, 200mA
Input plug and socket, coaxial
Speaker plugs and sockets
Power plug and socket, pre-amplifier, International Octal

Power plug and socket, tuner unit, 5-way
Mains input plug and socket
Motor plug and socket
2 valveholders, B9A
3 valveholders, International Octal
Speaker matching socket
Speaker matching plug. 15.2 ohm or 8.5 ohm or 3.8 ohm

Mains selection panel and 2A fuse
H.T. fuse and holder, 250mA
Group board and fixing screws
Chassis, cover and base-plate
Screws, nuts, wire, sleeving, etc.

to the grids of V_2 (12AU7). The triodes of V_2 amplify the a.f. voltages independently, but they share a common unbypassed cathode bias resistor in order to reduce the effects of any unbalance in the applied signals, or in the triodes themselves.

The two outputs from V_2 are fed, via C_{12} and C_{13} and the stoppers R_{25} and R_{26}, to the grids of the output pentodes V_3 and V_4. These two valves are EL34s and they function in an ultra-linear circuit, their screen-grids being returned to taps in the primary winding of the output transformer. The secondary windings of the output transformer connect

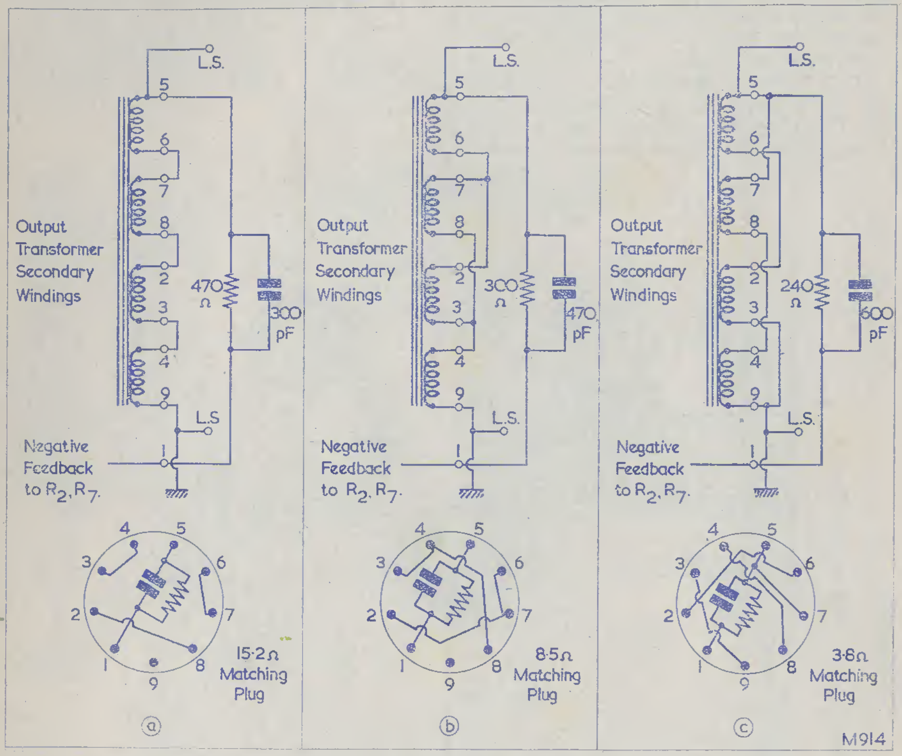


Fig. 2. The different manners in which the output transformer secondary windings are interconnected by the matching plugs. The 15.2 *ohm matching circuit is shown in* (*a*), *the* 8.5 *ohm circuit in* (*b*), *and the* 3.8 *ohm circuit in* (*c*)

to the 9-way matching socket, the required output impedance being selected by choice of the appropriate plug. Each of the output impedance matching plugs contains a resistor and parallel condenser which couples pin 5 of the matching socket to pin 1. As will be shown shortly (when the matching circuit is considered in greater detail) the matching plug then allows a negative feedback voltage to be applied from the output transformer secondary to the cathode circuit of the left hand triode of V_1.

In the power supply section the mains input is applied to the Motor Socket and, via fuse FS_2 and the on-off switch, to the primary of the mains transformer. The Motor Socket is permanently connected to the mains supply and is not controlled by the amplifier on-off switch. This is to allow the motor to be switched off independently by its own control or mechanism, thereby obviating the possibility of the formation of "flats" on its drive wheel. The on-off switch shown in Fig. 1 is, in practice, intended to be mounted in the pre-amplifier (a suitable switch is already available in the Cooper-Smith Mk. II Control Unit) and the appropriate wiring is, in consequence, coupled to the pre-amplifier socket on the power amplifier chassis. Fuse FS_2 is incorporated in the bridging link of the mains voltage selection panel.

The 400–0–400 volt secondary of the mains transformer connects to the rectifier

V_5. This is a GZ32 and the rectified voltage on its cathode is applied, via fuse FS_1, to the smoothing circuit given by paper condensers C_{16} and C_{17}, and the heavy duty smoothing choke CH_1. The smoothed voltage is supplied direct to the anode and screen-grid circuits of V_2, V_3 and V_4, and it is decoupled, by R_{17} and C_2, for the anode circuits of V_1. This decoupled supply is further filtered, by R_3, C_1, and R_{14}, C_9, for use by the pre-amplifier and tuner units respectively.

The Loudspeaker Matching Circuit

As was pointed out earlier, the three output impedances available from the amplifier are obtained by fitting appropriate plugs into the 9-way impedance matching socket. The manner in which these plugs select the desired impedance is illustrated in Fig. 2.

Fig. 2 (*a*) shows the internal wiring of the 15.2 ohm plug, together with the resultant output transformer secondary connections. As may be seen, the plug causes all four secondary windings to be connected in series. Fig. 2 (*b*) gives the internal wiring and the resultant secondary connections effected by the 8.5 ohm plug. In this instance the two centre windings are connected in parallel, this parallel combination being in series with the two outside windings. In Fig. 2 (*c*) the 3.8 ohm plug, and the consequent secondary winding connections, are shown. This time the top and third windings are connected in series, as are the second and fourth windings. These two series combinations are then paralleled for application to the loudspeaker terminals. Fig. 2 clearly illustrates the fact that the different output impedances are obtained with optimum utilisation of the four secondary windings.

The negative feedback circuit is completed, in each plug, by the parallel resistor and condenser connected between pins 5 and 1. For 15.2 ohm operation these have values of 470 ohm and 300pF, for 8.5 ohm operation values of 300 ohm and 470pF, and for 3.8 ohm operation values of 240 ohm and 600pF. Thus, the plugs automatically ensure that correct feedback is achieved, despite the varying a.f. voltages appearing at the loudspeaker terminals for different impedance connections.

If the amplifier is obtained in kit form, a 15.2 ohm plug is normally supplied unless alternative impedances are specified.

Pre-amplifier and Tuner Connections

The connections to the pre-amplifier and tuner unit sockets are illustrated in Fig. 3.

Fig. 3 (*a*) shows the International Octal 8-way pre-amplifier socket connections. Pins 2 and 7 carry the 6.3 volt heater supply, pin 3 provides the chassis connection and pin 6 the h.t. positive supply, via R_3. Pin 4 connects to the mains input and pin 5 to the mains transformer. Pins 4 and 5 have, therefore, to be bridged for the mains input to be applied to the power supply transformer. Such bridging is effected by the on-off switch in the pre-amplifier specified for use with the amplifier.

It should be pointed out that Cooper-Smith Mk. II Control Units may have a.f. output plugs different from the type required for the present amplifier. If this is the case, such plugs may be easily replaced by the type

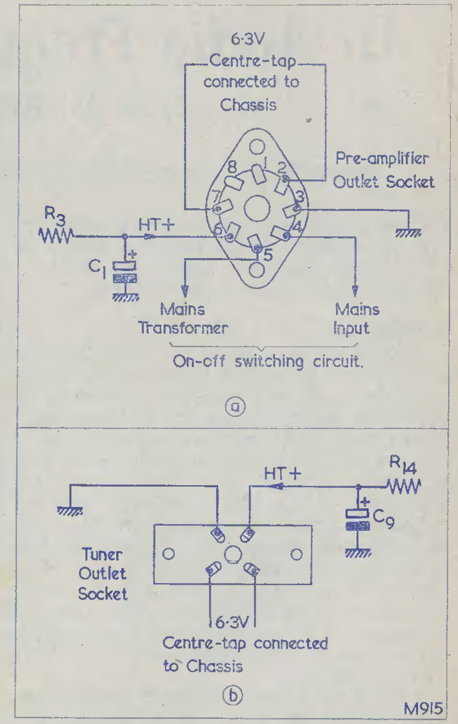


Fig. 3. The connections to (*a*), *the pre-amplifier socket and* (*b*) *the tuner unit outlet socket. In both cases, the diagram gives a rear view of the socket*

needed here; and a suitable plug is specified in the components list.

A 5-way socket is employed for the tuner unit, and this is wired as shown in Fig. 3 (*b*). The services provided here are an h.t. positive supply via R_{14}, chassis, and a 6.3V heater supply.

The heater current available for both pre-amplifier and radio tuner unit is 2.9A. The heater consumption of the Mk. II Control Unit is 0.5A, with the result that, if this pre-amplifier is employed, 2.4A is available for the tuner unit. *It is important to note that the heater supply for both tuner unit and pre-amplifier is taken from a heater winding whose centre-tap is connected to the power amplifier chassis. If the pre-amplifier or tuner unit has one side of its heater supply connected to chassis, such a connection must be broken before coupling to the power amplifier, or damage to the mains transformer or wiring will result.*

The h.t. current available for both pre-amplifier and tuner unit is of the order of 40mA. A value for the series resistor, R_{14}, is not specified, as this will vary according to the current and voltage requirements of the tuner unit.

(To be continued)

An Audio Frequency Oscillator

By A. G. BOOTH, B.Sc.

This article describes an original design for a transistor Wien bridge a.f. oscillator

THIS DEVICE WAS DESIGNED TO MEET THE need for a cheap portable source of audio frequency signal, suitable for efficient checking of sound amplifiers.

Specification

The frequency range is approximately from 40 c/s to 40 kc/s in three ranges. Three transistors are used and the amplitude of oscillation is controlled by a thermistor. There is a variable output attenuator.

Since the thermistor allows less than 2% amplitude change with any change in frequency setting, the attenuator may be calibrated directly in output p.d. The rate of amplitude change with temperature rise is about −1% per Centigrade degree. The maximum available output p.d. is preset internally by potentiometer VR_1, and is adjustable to about 1.5 volts r.m.s. on open circuit, which corresponds to 0.75 volt into a 1kΩ load.

At switch on, the thermistor takes about three seconds to reach the stable running temperature. Frequency drift at a constant dial setting is extremely small, but the frequency changes with temperature rise at a little less than −1% per Centigrade degree.

The power supply is three EverReady 4.5 volts pocket lamp batteries type 1289 with brass strip connections. The life of these is about 200 hours running time, since the total battery current is 7mA.

The harmonic content, chiefly second, in the output waveform is about 3% with VR_2 at minimum resistance, falling to only 0.3% with VR_2 at maximum resistance.

Principle of Operation

The oscillator section, comprising transistors TR_1 and TR_2, uses a Wien bridge for frequency control. The more familiar thermionic Wien bridge oscillator commonly uses the network shown in Fig. 1 for frequency control; the basis for this oscillator is the network shown in Fig. 2. Here the resistors are a two bank potentiometer, VR_2, and the pair of condensers is selected by switch S_2.

The signal at TR_2 collector passes through the resistance/capacity frequency selecting network to the base of TR_1. The resulting signal at TR_1 collector is applied to the base of TR_2; this maintains the original signal at TR_2 collector.

In the absence of the thermistor H_1, the loop gain of this system would be much greater than unity. The presence of excessive signal amplitude at TR_1 collector brings about an increase in the heating effect in the thermistor; the resulting increased conductivity of H_1 applies degeneration to TR_1 until the loop gain falls sufficiently to just maintain oscillation, that is, unity. Insufficient signal amplitude at TR_1 collector allows the thermistor to cool; this increases the loop gain in order that the required amplitude shall be recovered.

The part of the signal at TR_2 emitter which appears at the slider of VR_1 is amplified by TR_3. The high impedance of TR_3 collector circuit provides the effect of a current generator applied between the slider and one end of VR_3; because of this, the output impedance is very nearly constant for all settings of VR_3.

Resistor R_1 completes the direct coupled loop incorporating TR_1, TR_2 and TR_3. This direct coupling serves to maintain correct levels of direct current and potential in the system.

Condenser C_8 provides a decoupling path

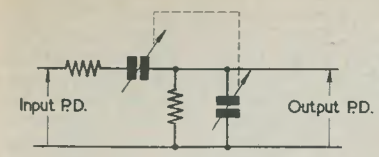


FIG.1.
Potential operated Wien Network

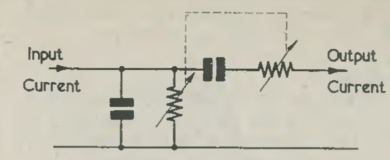


FIG.2.
Current operated Wien Network

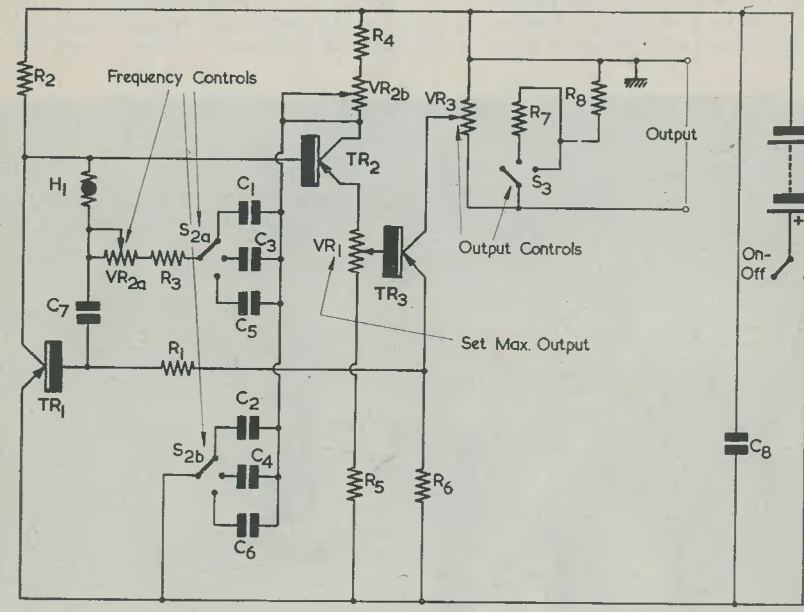


FIG.3.
Complete Circuit of the Oscillator.

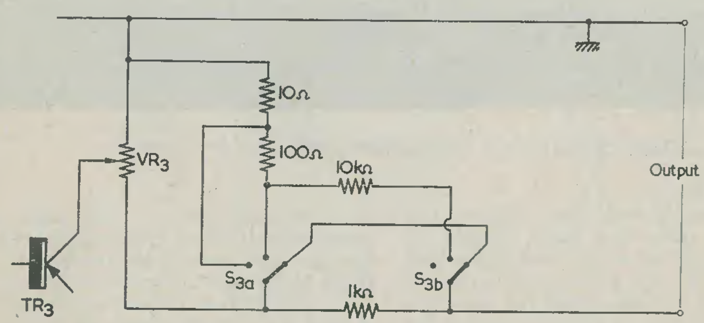


FIG.4.
Alternative Attenuator with constant output impedance.

M900

for the alternating currents when the battery resistance becomes appreciable. This effect lengthens the useful life of the battery.

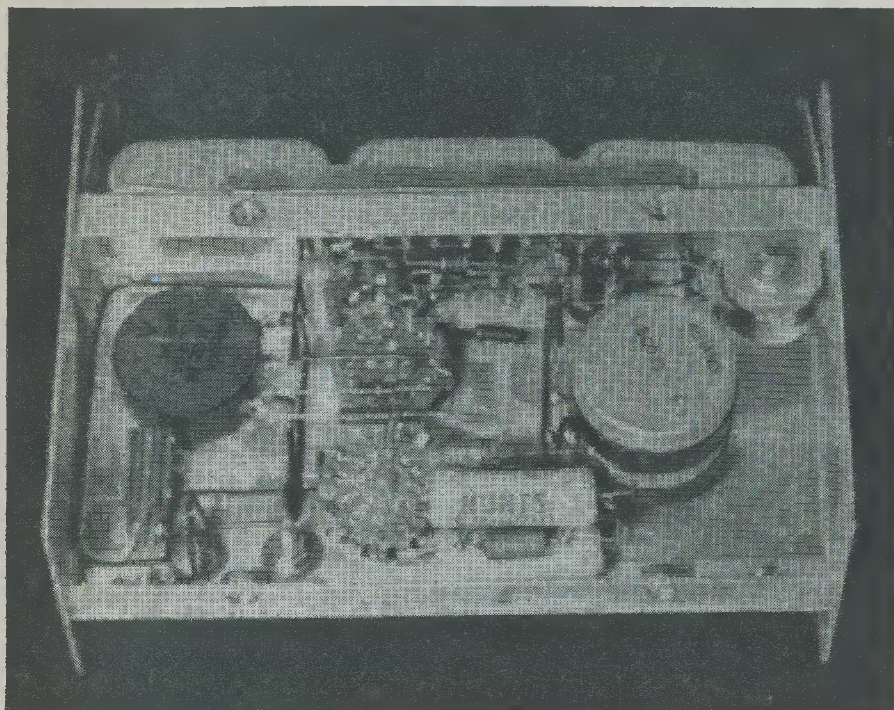
Construction

The major part of the work of construction concerns making the box; nevertheless it is designed for construction with simple tools, and has no awkward sheet bending. There is a division forming two compartments, one for the batteries, the other for the circuit. The controls are recessed in order that the box will lay quite flat on any of its faces.

The first part of the construction is to make the plain rectangular end plates, each with four countersunk rivet holes. The material for these end plates should be strong; 16 s.w.g. brass was used in the unit shown, but 10 s.w.g. aluminium would presumably be suitable. Next the $\frac{1}{2}$in x $\frac{1}{2}$in L-section bars can be riveted between the end plates with $\frac{1}{8}$in aluminium rivets. The remaining sheeting can be quite thin, say 20 s.w.g. The control panel is simply a flat plate fixed to the L-section bars with similar $\frac{1}{8}$in rivets. The sheet forming the division has a single bend, and covers the top and front of the battery compartment; it is riveted to the L bars. The removable back cover has two parallel bends to form a channel section. It is removed in the under-chassis photograph so that the hank bushes which fix it to the L bars may be seen. The hank bushes shown are 2BA, but 4BA would probably be more suitable.

The bottoms of the three batteries can be seen in this illustration. The brass strip connectors are bent outwards to lay one each side of each battery. Adjacent batteries make contact by means of these strips, the end strips making contact with brass plates mounted on Paxolin insulating boards. The Paxolin insulators can be seen in the photograph at the ends of the row of batteries.

The top edge of the battery compartment is lined with a further piece of Paxolin, and the batteries are held against this by the aluminium strip visible along the bottoms of the batteries. There is no need to clamp the batteries since the back cover stops them



Under-chassis view of the Oscillator constructed by the author

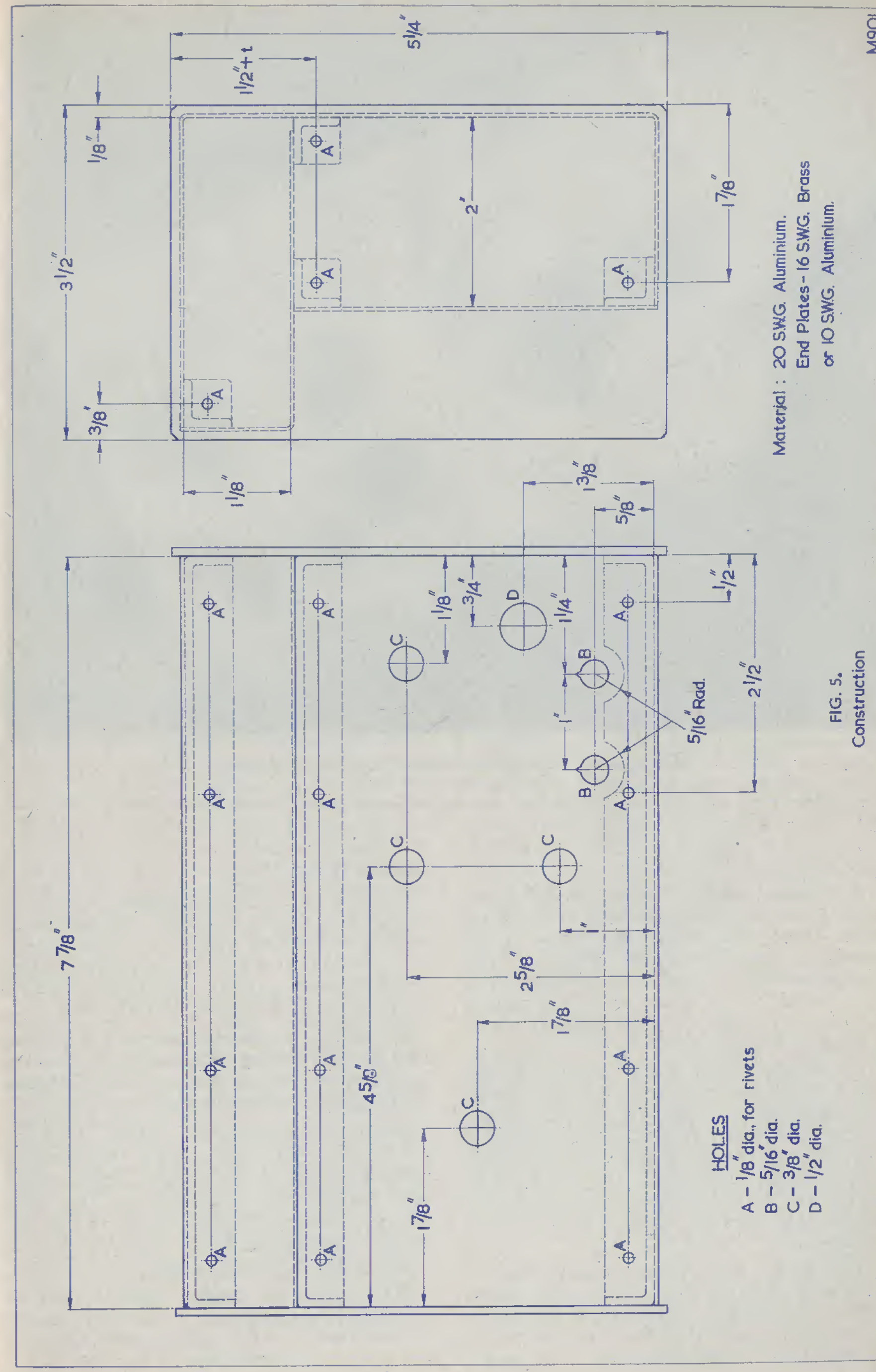
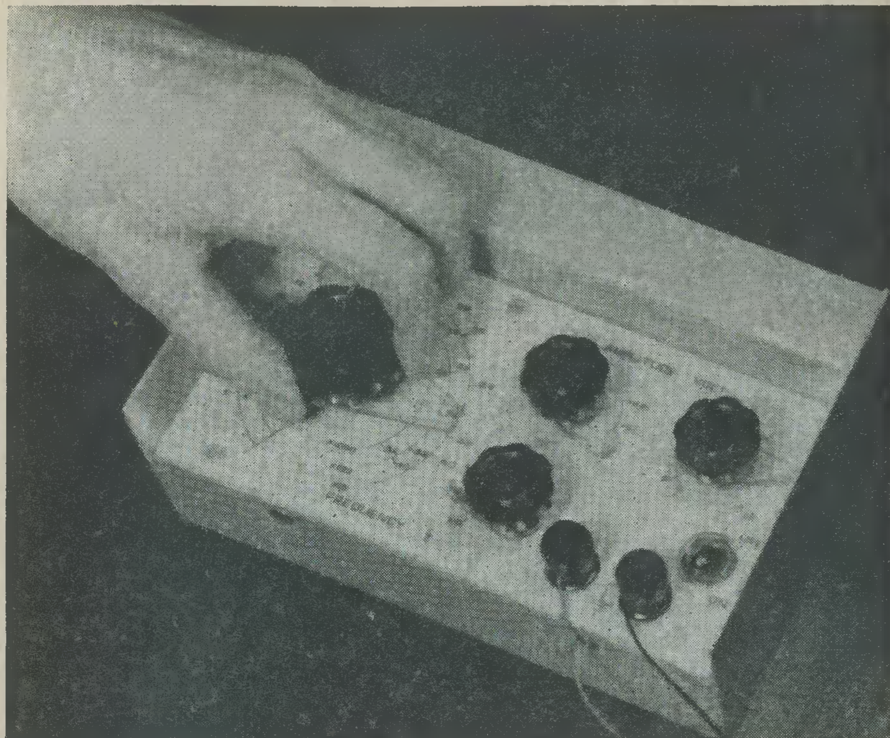


FIG. 5. Construction



Front panel view of the Audio Frequency Oscillator

from falling out.

The control panel is faced with a Perspex sheet, ⅛in thick. The calibration is drawn on white paper and sandwiched between the aluminium panel and the Perspex. The control pointers are also of Perspex. The front panel of the instrument is coloured though the photograph does not, of course, show this.

The wiring layout is not critical. It was found necessary to make a distinct electric connection between the box and the circuit, since without such a connection the frequency was liable to change slightly when the box was touched; the choice of the negative battery line as chassis connection was merely because it is common with one of the output terminals.

Most of the small components are carried on a group board, to be seen in the under-chassis illustration at the back of the circuit compartment. The thermistor is mounted in the centre of this group board.

General Notes

Though a somewhat larger maximum output p.d. could be useful, the associated penalty in terms of cost did not seem justifiable. Modification of the buffer stage TR_3 to incorporate a more powerful transistor, could yield the larger output if required.

To arrange a constant output impedance, 1kΩ, for any setting of the attenuator switch S_3, the circuit of Fig. 4 may be used in place of the simple attenuator shown in Fig. 3.

It may be desirable to add a condenser, 0.1μF or 1μF, in series with the "live" output terminal to act as isolation of direct potentials between the generator and the load circuit; a resulting disadvantage is that the output impedance would be raised, and would become frequency sensitive.

If desired, the output control may be calibrated logarithmically in decibels; to achieve this it may be an advantage to use a semi-log potentiometer for VR_3.

Components List

Resistors (all ⅛ watt)
R_1 180kΩ
R_2 5.6kΩ
R_3 100Ω
R_4 150Ω
R_5 820Ω
R_6 680Ω
R_7 100Ω 2%
R_8 10Ω 2%
VR_1 1kΩ linear
VR_{2a}—1.5kΩ } 2 bank, inverse semi-log,
VR_{2b}—1.5kΩ } Reliance type TW/1
VR_3 Linear

Transistors
TR_1 Mullard OC44
TR_2 Mullard OC44
TR_3 Mullard OC44

Condensers
C_1 2μF paper
C_2 2μF paper
C_3 0.2μF paper
C_4 0.2μF paper
C_5 0.02μF paper
C_6 0.02μF paper
C_7 8μF electrolytic 15WV
C_8 100μF electrolytic 15WV

Switches
S_1 Single pole, single throw
S_{2a}, S_{2b} }—2 pole, 3 way, yaxley
S_3 Single pole, 3 way, yaxley

Thermistor
"Stantel" type R24 (Standard Telephones & Cables Ltd.)

Modern Ceramic Condensers

by J. B. DANCE, M.Sc.

MUCH RESEARCH HAS RECENTLY BEEN carried out on new ceramic dielectrics and on methods of using them in condenser manufacture. An extremely wide range of ceramic condensers is already available in the smaller capacity values (up to about 20,000pF) and it appears highly probable that ceramics will replace paper condensers in almost all miniature equipment when they become more readily available in the larger capacity values. Ceramic condensers may be divided into two main types, namely the "ordinary" type and the "Hi-K" type.

Ordinary Ceramics

Ordinary ceramic condensers (i.e. those which do not have a "Hi-K" dielectric) are made in values ranging from about 1pF to several hundred pF. The usual d.c. working voltage is 500, but certain special types are manufactured with working voltages of several kilovolts. They have a low power factor (about 0.002) and a high insulation resistance (about 10,000MΩ), so the leakage is low. They are somewhat inferior to silver mica condensers when great stability of capacity value is required. Ceramic condensers can, however, be obtained with either positive or negative temperature coefficients and are therefore useful in certain high frequency oscillator circuits, because frequency drift with change of temperature can be minimised by using the correct proportions of capacity with positive and negative temperature coefficients. The construction is usually tubular with wire ends, the temperature coefficient often being marked on the case (e.g. N750 signifies that the condenser has a negative temperature coefficient of 750 parts per million per degree Centigrade, whilst PO30 means a positive coefficient of 30 parts per million per degree Centigrade). They can also be obtained with zero temperature coefficient (marked NPO). Some types are colour coded according to either the British or American system; the colour code not only signifies the capacity value, but also the temperature coefficient and tolerance.

"Hi-K" Ceramics

The capacity of a condenser increases with increasing area of the electrodes (or foils) and with increasing dielectric constant (or permittivity) of the material between the electrodes, but decreases as the distance between the electrodes is increased. A miniature condenser of moderate or large capacity value must therefore either employ a dielectric of high permittivity or have closely spaced electrodes or both. Limitations are imposed on the closeness of the electrode spacing because condensers which have thin dielectrics have a small working voltage.

Mica has a permittivity of about 6, but certain "Hi-K" ceramics (such as barium titanate) have a permittivity of over 1,000.

This is due to their "ferroelectric" properties—a name which is derived by analogy with the familiar magnetic phenomenon known as "ferromagnetism". Such ceramics can therefore be used in the manufacture of condensers which, for a given value of capacity, are much smaller in size than those using mica or paper as the dielectric. These ceramic condensers are normally made in values ranging from about 50pF to 20,000pF, and the usual working voltage is 300 d.c. The power factor is not very good and the temperature coefficient is not usually quoted. They are especially useful for decoupling and are made in tubular, small disc and feed-through types. A typical 1,000pF condenser may be encased in a tube $\frac{3}{4}$in long and $\frac{1}{4}$in in diameter.

Modern Miniaturisation

Ceramic materials with permittivities of up to 6,000 are now being used in the manufacture of condensers. Such ceramics are very brittle and impossible to handle when in the very thin sections (less than 0.005in thick) required for the manufacture of miniature condensers. Special techniques have recently been developed in America to overcome such difficulties; the very thin ceramic dielectric is actually made on one of the electrodes.

One method commences with a number of thin ceramic rods (about 0.03in diameter) which are coated—very thinly—with metal. A very thin film of the dielectric is placed on top of the metal and finally another layer of metal. A number of these rods may be bunched together in a honeycomb structure and placed inside a ceramic tube. The inner metal coatings are all joined together at one end to a wire and the other connection is made to the outer metal deposits. The length of the rods depends on the capacity required. The smaller the diameter of the rods, the greater the capacity/volume ratio, but it is not possible to work with rods which are very thin. This method of manufacture enables 1,000pF condensers to be made in a tube less than $\frac{1}{10}$in diameter and $\frac{1}{3}$in long, whilst a 0.1μF can be made in a tube $\frac{1}{3}$in in diameter and $\frac{3}{4}$in long. These "Cerafil" condensers will be invaluable in space research where a minimum of weight and volume are essential. A rather better technique is now available for capacity values above 0.1μF.*

Condensers of large value are best made by rolling the dielectric between two metal foils. Until recently, however, it has not been possible to produce rolled ceramic condensers owing to the non-flexibility of the dielectric. "Cerol" condensers are produced by rolling an extremely thin film of a material which will form the dielectric when heated between two very thin pieces of a precious metal.* The complete roll is then heated so that the ceramic dielectric is formed and the structure becomes sealed and rigid. The thickness of the ceramic dielectric controls the working voltage. "Cerol" condensers with a working voltage of 100 volts d.c. and a capacity of 0.1μF have been made with a size of only 0.2in diameter by 0.65in in length. A 1μF condenser provided by this method would be about 0.4in in diameter and 0.75in in length. It is expected that these sizes will be at least halved in the very near future.

* "Cerafil" and "Cerol" condensers were developed by Aerovox, in their High-Q Division.

DANISH WORLD PUBLICATION FIFTEEN YEARS OLD

World Radio-Television Handbook's 15th edition now available

World Radio Handbook—WRH—is known to all broadcasting circles the world over as an invaluable handbook for the promotion of co-operation between listeners and broadcasters, thus furthering understanding between the peoples of the world. With its edition this year this international handbook is celebrating its fifteenth anniversary, and in this connection has received appreciative messages from broadcasting and other organisations all over the world—not forgetting the United Nations.

The new, extended edition now available is the only publication in the world that furnishes complete and up-to-date information about all the radio and television stations in the world. *WRH* is a radio and television reference book, by the help of which listeners can, without difficulty, listen at any time to the station they want, and identify any station they may pick up by chance. The book also contains information about the addresses, principals, programmes, broadcasting hours, pause signals, advertising, etc., of all stations—in a word, it contains all information of interest concerning radio and television. In addition there are interesting photographs from many countries, practical articles about listening on all wavelengths, maps, tables and many other features.

Compared with earlier editions, the contents of the present number of *WRH* are quite new. The rapid development in the spheres of broadcasting and television means that information changes from year to year and a large number of new stations annually come into existence.

WRH is published by World Publications (Publisher O. Lund-Johansen), Lindorffsalle 1, Hellerup, Denmark, and can be ordered through booksellers.

AN IRON SAVER

by

E. G. GWILLIAN, G3HLZ

Many constructors will no doubt have had the same annoying experiences as the writer when intermittently using an electric soldering iron. One either has to keep switching it on and off, or leave it on for perhaps three or four hours whilst only needing it a few times. In the first case there is often a maddening wait for it to warm up, or trying to use it before the correct temperature is attained. The alternative usually means overheating, and, of course, shortened life of both the element and bit. Resting the iron on a metal "heat sink" is not very successful; nor is an instant-heating iron always the answer (even if one can afford it!), and, anyway, there must be many thousands of the ordinary type in use.

The writer therefore decided that some form of switched series resistor was the best solution. It had to be simple, safe, cheap, adaptable, and within easy reach of the working position on the bench. The ordinary lighting bulb is ideal for this sort of job, and the gadget described, after long usage, has proved indispensable. The diagrams show how extremely simple it is, and there could be so many variations that anyone making it can modify it according to his own needs and junk-box contents. Fig. 1 illustrates the circuit used by the writer. For a 25 watt instrument iron, a 25 or 40 watt bulb has generally been used although it is easy enough to try various sizes, a higher wattage giving a higher "idling" voltage to the iron and *vice versa*. Incidentally, the difference between the actual and rated consumption of bulbs can be quite considerable.

The shorting switch is normally "off" and the bulb glows dimly. When the iron is about to be used the switch is closed, thus shorting out the bulb whereupon the iron attains full heat very quickly, the time depending on the size of the bulb used. The dim glow serves as a useful reminder that the iron is only "ticking over".

Although the writer has not found it necessary, series-parallel switching, as shown in Fig. 2, may be preferred by some constructors, as this would give a full glow for "full on", and a dim glow for "idling".

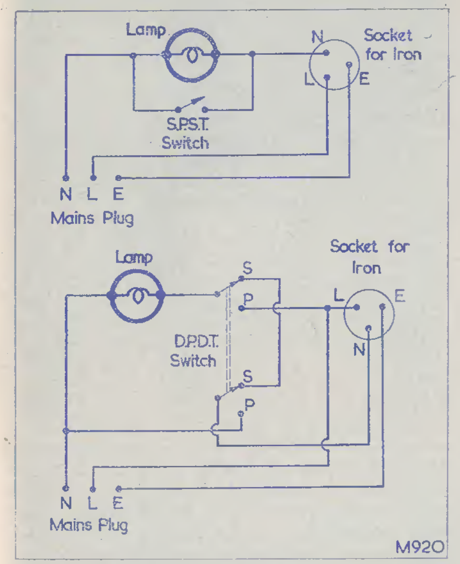


Fig. 1 (above). The circuit employed by the writer

Fig. 2 (below). An alternative method of wiring the "iron-saver". When the switch is in position "S" the lamp is in series with the iron. In position "P" the mains supply is connected directly to the iron and the lamp glows at full brilliance

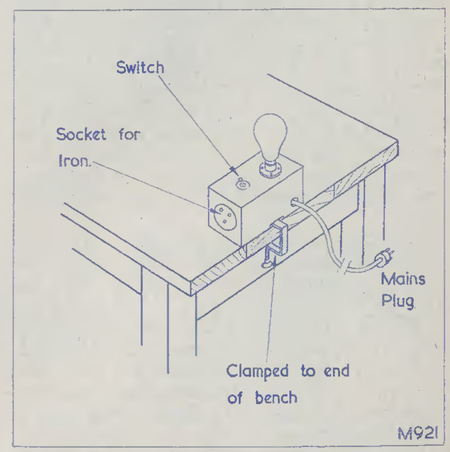


Fig. 3. A possible method of mounting the "iron-saver"

Conversion of 1.4 Volt Superhet to Low Consumption Valves

by J. B. HALL

Editor's Note.—This short article describes a reader's experiences in converting a portable receiver from 50mA filament to 25mA filament valves, and the remarks apply to a receiver employing parallel-connected filaments running from a single 1.4 volt cell.

The modifications should, on no account, be attempted on receivers in which the valve filaments are connected in series or in series-parallel because they may cause one or more filaments to burn out. Receivers which should not be modified are mains/battery types and receivers whose filament supply voltage is greater than that provided by a single 1.4 *volt cell.*

THE SET IN QUESTION WAS A CONVENTIONAL superhet employing the line-up: 1R5, 1T4, 1S5 and 3S4. By using the "96" series valves, the existing set and components and a minor amount of work, a considerable saving on both h.t. and l.t. batteries was realised. The reading for l.t. before alteration was 1.4 volt 240mA.

A set of low consumption valves was ordered through one of the advertisers in *The Radio Constructor*, the cost being 35s. 9d., including postage. These valves are DK96, DF96, DAF96 and DL96.

Each stage was altered and checked with a meter separately, as some constructors for reasons of economy may wish to change one valve at a time. The greatest saving is made with the output stage. This was the 3S4 and the valve base requires slight modification to suit the DL96. Filament and anode connections remain unchanged but the connections to pins 3 and 6 are changed over. The l.t. current on completion of the modification to this stage was reduced to 200mA. Some adjustment to the value of the auto-bias resistor is required but more about this later.

Working backwards, the next stage was the diode and first a.f. 1S5. This was directly changed to the DAF96. The l.t. current was now 170mA.

The i.f. amplifier was also changed directly from IT4 to DF96. L.T. now read 155mA[1]

Finally, the frequency-changer 1R5 was replaced by the DK96. This required alteration to the valve base wiring, pin 5 changing from chassis to h.t. positive.[2] Note that on some sets pin 5 is directly earthed to chassis and connection is made to the spigot and pin 1. Make certain such connections remain at chassis potential after the modifications. On completion of the modification, l.t. consumption was, as expected, 125mA, some 50% of the current drain when using the original valves.

Biassing the output value calls for some comment. Usually the value of auto-bias resistor with a 3S4 is between 680 and 1,000Ω, and for the DL96 between 470 and 560Ω.

Valve Equivalents

3S4	N17	1P10	DL92
3V4	N19	1P11	DL94
1S5	ZD17	1FD9	DAF91
IT4	W17	1F3	DF91
1R5	X17	1C1	DK91
1AC6	X18	1C2	DK92
1AB6		1C3	DK96
1AJ4		1F1	DF96
1AH5		1FD1	DAF96
1P1		3C4	DL96

With the receiver finally modified and an auto-bias resistor of 560Ω, h.t. current consumption was 12mA at 70 volts. This was considered too high. It was found possible to increase the auto-bias resistor in this particular receiver to 1,500Ω without the onset of distortion. The total current consumption then became 6.5mA.

The above relates to changing the valve line-up 1R5, 1T4, 1S5 and 3S4. If the line-up DK92, DF91, DAF91 and DL94 is employed in the receiver, this may be changed to "96" series valves with no alteration other than that of changing the value of the auto-bias resistor.[3]

The final touch to the above set was the re-alignment of the i.f. transformers although, throughout the modifications, the local station came in at good volume.

The substitution in both the a.f. stages should require alteration of the anode loads but in actual practice no change was made and the valves operated quite normally with the existing loads.

[1] For a 90 volt h.t. supply the series screen-grid resistor (to pin 3 of the DF96) should have a value of 39kΩ or more. No screen-grid series resistor is necessary for operation from a 67.5 volt supply.

[2] Pin 5 of the DK96 should be connected directly to h.t. positive only when a 67.5 volt h.t. battery is employed. With a 90 volt h.t. battery a resistor of 120kΩ should be connected in series, and pin 5 by-passed to chassis via a 0.02µF condenser.

[3] Provided that the points covered by footnotes 1 and 2 are observed.

CELLS

By J. G. RANSOME

A reviews of the various types of cell liable to be encountered by the home constructor

WITH THE INCREASING USE OF TRANSISTORS in electronic circuits, emphasis is being laid more and more on apparatus that is both compact and transportable. In order to supply power for such equipment use has to be made of batteries. However, the problem of reconciling compactness with life and efficiency can sometimes be very difficult indeed. It is hoped that this short article may prove to be of some help to the would-be user of both dry and wet cells—as well as a guide to the selection of the right cell for the right job.

The ideal cell should have the following: a high e.m.f., a low internal resistance, a long life, compactness, indefinite "shelf-life" (that is to say, it may be stored indefinitely under no-load conditions without loss of e.m.f.), it should be re-chargeable, it should be capable of being used under any condition of temperature or situation and, last but not least, it should be cheap. In practice, no cell satisfactorily meets more than two or three of these requirements.

Primary Cells

Primary cells are not re-chargeable by normal methods but some types offer compactness, relative cheapness, and a fair length of life.

(A) The Dry Leclanché Cell

The electrolyte in this cell, which is illustrated in Fig. 1, is a mixture of ammonium chloride (sal-ammoniac) and zinc chloride mixed into a paste of flour and water. The depolariser is manganese dioxide. The action of the depolariser is to remove the hydrogen produced in the cell on discharge which otherwise would impair its efficiency. This cell is never really dry because its action depends upon the electrolyte being damp. The true dry cell—the inert cell—is supplied with the electrolyte in a desiccated state and has to be activated by the addition of small amounts of water. The inert cell may be stored indefinitely in the dry state but must be used as soon as possible after the addition of the water. The normal dry cell may be

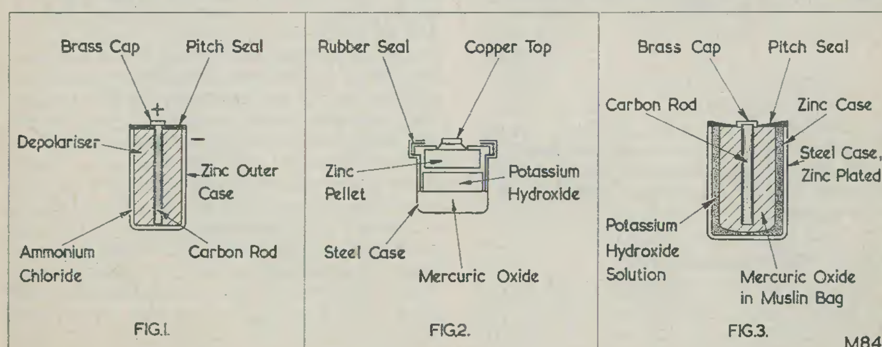


FIG.1. FIG.2. FIG.3.

kept in good condition for many years by refrigeration. Perhaps we may see quick-frozen cells on the market in the near future!

(*B*) *The Mallory Cell* (*Mercury Cell*)

The Mallory cell is shown in Fig. 2, this diagram being simplified for purposes of explanation. The electrolyte is potassium hydroxide (caustic potash) and the depolariser mercuric oxide. The steel case is positive and the cap negative.

(*C*) *The Kalium Cell*

This cell, shown in Fig. 3, is similar in action to the Mercury cell but, by use of different construction techniques, the case is made negative and the cap positive.

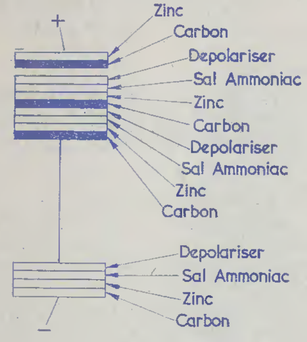


FIG.4.

'Running down' graph of a dry Leclanché Cell.

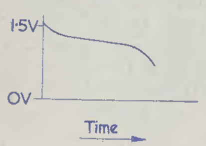


FIG.5.

M846

(*D*) *The Stacked Dry Cell*

The stacked dry cell consists of small flat Leclanché cells mounted above each other as shown in Fig. 4. It provides a high e.m.f. at a low current.

Primary Cell Characteristics

The dry cell of the Leclanché type has an e.m.f. of 1.5 volts when on open circuit. The internal resistance of the cell is approximately 10–20Ω depending upon the size of the cell. The discharge characteristic is shown in Fig. 5.

The Mercury cell has an e.m.f. of 1.34 volts and has a fairly steady high internal resistance. This type of cell will refuse to work below 0° Centigrade, therefore it is not recommended for outdoor applications.

The Kalium cell produces the same e.m.f. as the Mercury cell but shows a rather unusual discharge characteristic. The voltage drops quickly on first load but then rises slowly to a steady state.

Secondary Cells

Secondary cells are those which may be re-charged. The lead-acid and the nickel-iron (Ni-Fe) cells, because of their large size and spillable electrolyte, have little to offer the miniature radio enthusiast. However, for the miniature record player or tape recorder enthusiast, there are two cells in this class which are very suitable, these being as follows:

(1) *Nickel-Cadmium Alkaline Accumulator*

The construction of this type of accumulator is similar to that of the lead-acid type. The positive plate consists of nickel filings pressed into a plate of nickel plated steel, whilst the negative plate is made of cadmium sponge set into a nickel plated steel support. The electrolyte is a 20% solution of potassium hydroxide in water. The e.m.f. is about 1.2 volts and a high rate of discharge may be obtained from quite a small cell.

(2) *Venner Silver-Zinc Accumulator*

The positive plate in this type of cell is made of silver peroxide and the negative plate of spongy zinc. The electrolyte is potassium zincate, the cell giving an e.m.f. about 1.5 volts on load. These are expensive cells to manufacture and the discharge rate is very high. The Venner L1 measures $\frac{5}{16}$ x $1\frac{1}{8}$ x $1\frac{1}{2}$in, weighs just under an ounce, and has a capacity of 1 amp/hour rated on the 20 hour basis.

Use of Cells

The electrolyte in all cells has a negative resistance coefficient. In consequence, the colder the cell the greater its internal resistance and the lower its terminal e.m.f. when delivering current. It is advisable, therefore, to keep your cell cosy when in use. On the other hand, cells in storage should be kept as cool as possible. This has the effect of reducing the local action inside the cell and results in a longer shelf life. Cells are very much like hedgehogs: they are active when their surroundings are warm, they hibernate under cold conditions, and they always fold up on you at the wrong time when they realise they are the centre of attraction!

Testing Condensers

by GILBERT DAVEY

RECENTLY I DECIDED TO TRY BUILDING AN amplifier to a design which was popular some years ago and which used two large output triodes of the PX4 type in the output stage. These two valves were in push-pull and shared a 500Ω resistor in the filament circuit for biasing purposes, as shown in Fig. 1. As always when testing a new circuit I had placed a 50mA meter in the anode lead of one of the PX4s. As soon as I switched on I was extremely puzzled by the behaviour of the pointer. First it swung to the correct reading of 45mA then slowly sank to a steady reading of 10mA. Trying the meter in the other PX4 anode circuit showed a very unhappy state of affairs, the needle trying to swing right off the end of the scale. Hastily switching off, a little thought was given to the problem, and soon the conclusion was reached that the high anode current of one valve was, due to the common bias resistance, causing over-biasing of the other valve and the consequent drop in anode current.

The problem was not quite as simple as that, however, as subsequent investigation proved. The first thing was to discover the reason for the heavy anode current in one valve, and a glance at the circuit soon revealed this. The anode resistors in the leads to the ACHL valves are only 22kΩ so that there is not a great voltage drop across them and at least 150 volts reach the anodes of the valves. Also connected to the anodes of the ACHLs are 0.1μF condensers transferring the audio signals to the grids of the PX4s which, according to the circuit values, should each have 45 volts bias at which the anode current per valve would be 45mA. But, of course, as every reader has seen by now, one of the 0.1μF condensers had completely broken down and that particular PX4 had something like 150–45–105 volts on its grid positive of filament, which was a most unhealthy condition in which to run the valve. Testing the other 0.1μF condenser revealed that it was not 100% satisfactory, so a general review of the condenser stock was decided upon.

As indicated earlier, this amplifier was of an old design and the components used to make it were of the period when it was designed, which meant that the condensers had been in store, unused, for a good number of years. In order to test the stock the workshop power unit was connected up as shown in Fig. 2. Its output being 300 volts, a 6kΩ resistor was connected across it in series with the 50mA meter and a switch, a space being left in this chain across negative to positive for the insertion of the condenser under test. It was found convenient to have a pair of leads with crocodile clip terminations for attaching to the condenser wires or terminals.

Having rigged up this testing arrangement the two condensers in the amplifier were removed and tested. One caused the meter needle to go rapidly over to 50mA indicating a dead short. The other showed an initial leak of 2mA, but the needle gradually crept up to 20mA whereupon the condenser was discarded as useless. Of two dozen condensers of 0.1μF capacity which were in the component box, and which had recently been removed from an elderly receiver, only two were found absolutely perfect and suitable for the amplifier. Four had slight leaks of a couple of mA and could be used for decoupling purposes but, as such leaky types tend to worsen with use, it is preferable to discard them. That was the fate of the rest of my stock, all of which were really in bad shape. It was extremely interesting to watch condensers, which appeared in good order at first, gradually show signs of leaks when left on test, and also of interest to note that the two types which were in first class order were branded with names of top-quality manufacturers.

When testing larger condensers of 1μF or more, the initial "jump" which the meter needle gives is quite in order and only indicates a charging-up surge. In the case of large electrolytics the needle may rise to quite a few mA and then, as the electrolyte "forms", drop slowly to a steady figure of 4 or 5mA. Do not be alarmed if these large electrolytic types maintain a few mA of steady leakage current, it is quite common practice with them and, of course, the larger the capacity of the condenser the greater the leakage. This is a factor which must be taken into account when designing a power pack

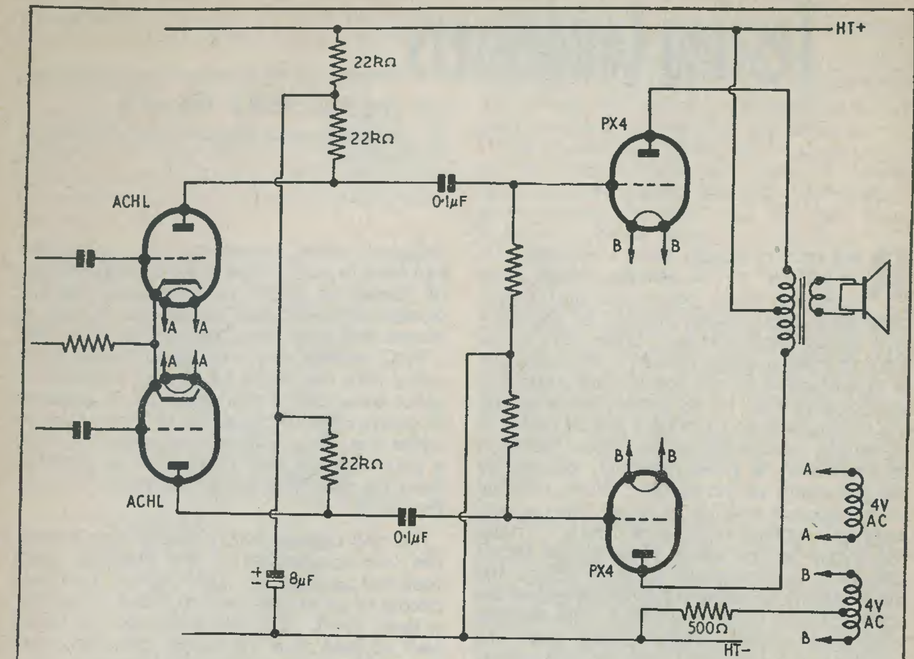


Fig.1

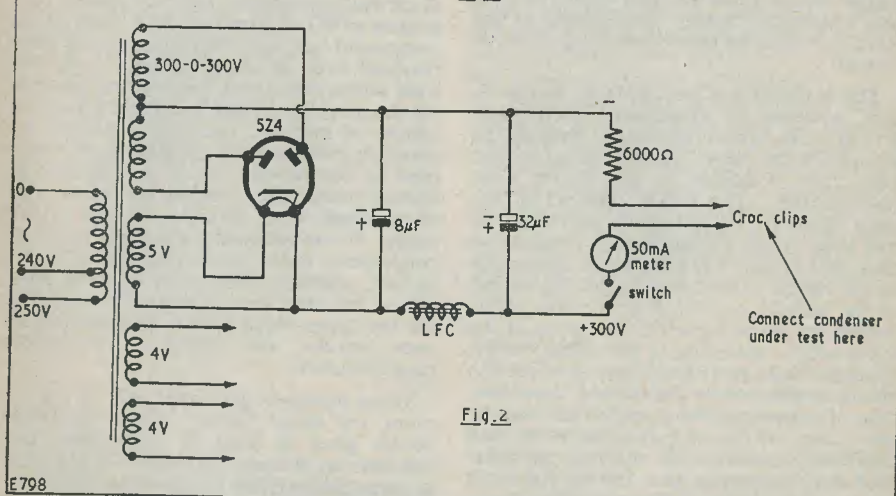


Fig.2

for a large receiver or amplifier embodying a number of high-capacity electrolytic condensers. Large paper condensers should not leak at all but return to normal after the first "charging" jump of the meter needle. The best test for these types is to see how long they hold their charges. One of mine gave quite a lively shock about an hour after test when I picked it up to pack away. The best way to avoid this is to discharge the condenser after testing; although it is said to be bad for the condenser I have always done this by putting a screwdriver across the terminals and enjoying the resulting crackling spark. However, rather than give readers bad advice on this point, I had better advise discharging by holding a resistor of 1,000 ohms or so across the condenser.

In conclusion, I feel that I ought to mention that direct-coupled amplifiers which dispense with inter-valve condensers are specially designed to compensate for the unusual circuit conditions thus involved. There is thus no need for readers who use such amplifiers (as I do myself) to wonder if there is something missing which is likely to cause trouble. All is in order in such cases! It is hoped, however, that those readers who use junk-box condensers, or condensers from old sets or ex-Services equipment, will be encouraged to apply a few tests to them before use and avoid future troubles. The chief point to remember is that the test must be made at a voltage above that at which the condenser will be used. It is no use testing at 4.5 volts from a dry battery with a pair of phones, very likely at that potential the condenser will be perfect.

radio topics

BY RECORDER

The Jabez Gough Loudspeaker Cabinet

There has been a notable amount of newspaper publicity over the last month or two concerning the invention by Mr. Jabez Gough, a Cardiff engineer, of a new loudspeaker cabinet. The first major newspaper story covering this cabinet appeared on the front page of *The Observer* of 27th November, some eight column inches being devoted to the subject under the heading: "Experts Hail a £5 Hi-Fi Cabinet". This was followed by a story twice as long in *The Times* under the heading: "Hi-Fi Unit For Less Than £5". *The Observer* weighed in again on the following Sunday with: "Details Soon on £5 Hi-Fi For Amateurs" on a middle page. The *Western Mail* (published in Cardiff) gave further details, including a simple description of cabinet construction, on 9th December. There has also been a report on the cabinet in a Johannesburg newspaper, and I understand that it has been featured in a local news-magazine programme put out on ITV.

Feeling that a high fidelity loudspeaker cabinet which merited front page presentation in a national Sunday newspaper merited investigation, I contacted Mr. Jabez Gough and examined his cabinet at Cardiff in December.*

The History of the Cabinet

Mr. Jabez Gough is a high fidelity retailer having premises in North Road, Cardiff. He commenced experimenting with his cabinet in the summer of 1960 and, with the help of Professor Frank Landgrebe of the Welsh National School of Medicine, produced a prototype measuring approximately 30in high by 30in wide by 18in deep, and employing two loudspeakers. The results from this encouraged him to work on a second version using a single 8in (7in effective cone diameter) loudspeaker. This second model represents the Gough cabinet principle so far as it has been developed to date. Its outside dimensions are approximately 24in wide, 28in high, and 12in deep, and it has a hinged lid at the top. Mr. Gough has also produced a third cabinet design, this being a scaled-down version of the second model and being fitted with a 5in speaker. The third cabinet design is not considered satisfactory as it stands, and it may either be developed or discarded.

* Just too late, unfortunately, for my report to appear in our January issue.

Cabinet Features

A noteworthy feature of the cabinet is that it is claimed to function with a relatively inexpensive loudspeaker unit. The cabinet demonstrated to me had a loudspeaker unit costing around £5 installed in it, and Mr. Gough states that he can get almost equally good results with a much cheaper speaker costing around £2. It is necessary that the speaker employed be as free from peaks in its frequency response as possible.

Mr. Gough was reluctant to release full technical details on his cabinet because of pending patent rights, but he did allow the following information to be passed on. The single loudspeaker is mounted at the top centre of the cabinet at an angle such that the sound from the front of the cone projects upwards and backwards against the lid. A path is provided from the back of the cone to openings on either side of the speaker, and it appears that a very important aspect of cabinet design lies in the critical degree of mixing between the sound from these openings and the sound from the front of the speaker. The lid, which is hinged at the rear of the cabinet top, is intended to be set at an angle adjudged best by the listener, and it can modify the coupling between the openings and the outside air. In my opinion the lid also serves as a reflector for high frequency sound from the front of the speaker cone.

The construction of the cabinet itself is of a very simple order. The single 8in speaker model shown to me employed ½in plywood throughout for all surfaces. There is no need for wadding or any similar damping material. Theoretically, there is a column of sorts behind the loudspeaker cone and one would think at first sight that this would cause resonance. However, I could detect no resonance whilst listening to sound from the reproducer. For what it was worth I laid my fingertips against the front of the cabinet and could feel a faint vibration for most lower frequencies being handled, but I could detect no undue vibration at any particular frequency. There is no loading on the front of the speaker cone, and there is only that imposed by the "column of sorts" just mentioned on the rear; this fact may help to partly explain the performance of the reproducer.

The cabinet is intended to give an impression of an apparent wide source of sound, and it has been suggested in one newspaper article that a single Gough cabinet in a mono system may go some way towards replacing a stereo system. When I saw him, Mr. Gough stated that he does not subscribe to this view, and he agreed with me on the obvious fact that a single channel system, however widely spaced the sound may be from the reproducer, is manifestly a different thing to a two channel system.

A point which needs enlarging on is the reference to a "£5 hi-fi cabinet". If, as a home-constructor, you wanted to build the single 8in speaker version in the white, you could get the necessary timber for about £2. Fit the £2 8in speaker mentioned above, throw in a few screws, hinges for the lid and so on, and your total expenditure would be less than a fiver. Fit the £5 8in speaker and your expenditure would be £3 more. If the Jabez Gough single 8in reproducer went into production and was sold through retail channels its cost would, I am sure, be well in excess of £5.

The Performance of the Speaker

It is an extremely difficult job to report on the performance of a high fidelity reproducing system because one's impressions are entirely subjective. Nevertheless, Mr. Gough and myself spent a very pleasant three hours putting his cabinet through its paces and I shall do my best to report my reactions as accurately as possible. In some cases I was able to directly compare the Gough reproducer with two others, one retailing at around £25 and the other retailing at around £55.

My first reaction was that the Gough loudspeaker cabinet gave a definite impression of a widely spaced sound source. There was, also, no discontinuity between the bass, middle and treble; the whole frequency range was covered smoothly and uniformly and the feeling that one department was handling high frequencies whilst another department handled low frequencies was entirely absent. Transients were handled excellently. I could detect no colouration due to resonances in the cabinet or its material.

I think that the Gough cabinet had a markedly lower bass response than the two other reproducers. Nevertheless, I preferred the Gough unit for all the orchestral and vocal music to which we listened. Part of the music contained a passage with a plucked double bass. In spite of what I felt to be the lower bass response of the Gough cabinet, I preferred the reproduction it gave on this passage to that provided by either of the other two units. On piano the Gough reproducer was excellent.

One of the tests included a reproduction of pipe organ music, during which a sustained heavy bass note was accompanied by variations in treble. The three reproducers gave quite *different* versions of this music. Working at full volume I felt that the £55 unit handled the sustained bass note best, and I thought I detected overloading, at this note, of the 8in speaker in the Gough reproducer. At lower volume levels the effect was absent. We tried the same music at high volume level on the original prototype cabinet employing two loudspeakers, and I could not then detect the overload.

The above remarks cover the impressions gained by myself whilst listening to the Gough speaker cabinet and, as I stated earlier, have to be qualified by the fact that they cannot be anything else but subjective. There is only one sure way to judge the merit of a reproducer and that consists of listening to it oneself and of forming one's own opinion thereby. The Jabez Gough loudspeaker cabinet, despite its extreme simplicity of design, provides reproduction of a very pleasing quality and it deserves consideration both by the high fidelity enthusiast and by the engineer.

Royal Naval Amateur Radio Society

I have pleasure in passing on an item of news which will be of interest to all readers who are connected with the Royal Navy. The Royal Naval Amateur Radio Society, whose inaugural meeting took place in August of last year, is now expanding in membership as it gets into its stride. The Headquarters Station, G3BZU, is regularly on the air on 40 metres and the Dx bands, and welcomes calls from Naval types. Other society projects, such as QSL cards and morse proficiency runs, etc., are in progress.

Membership of the Society is open to all serving, or past, members of the Royal Navy, Royal Marines, Women's Royal Naval Service, Reserves or Commonwealth Navies. Associate membership is open to civilians who are, or have been, connected with the above Services in any way.

Information is available from the Hon. Sec. of the Society at H.M.S. Mercury, Leydene, Petersfield, Hants.

Tinier and Tinier

Radio components for normal domestic receivers are getting smaller and smaller. A typical example of the trend towards miniaturisation in this field is given by a new range of transistor i.f. transformers introduced by the Wireless Telephone Company (one of the Plessey Group).

These i.f. transformers are available in a set of three, the first two being designed for use in the i.f. stages and the third for use at the detector stage. The first two transformers are double-tuned, the coils being mounted side by side with their axes vertical, whilst the third has a single tuned circuit. Can size has been reduced to $1\frac{1}{16}$ by $\frac{5}{8}$ by $\frac{11}{16}$in high.

The coils are fitted in ferrite cups and are potted in epoxy resin to give optimum mechanical rigidity. The cores employed represent a welcome break from conventional design: instead of being threaded, the cores are plain cylinders affixed to polystyrene threaded sections. The polystyrene sections take the brunt of trimming operations and allow the use of metal-bladed screwdrivers.

The third i.f. transformer has the diode and r.f. bypass condenser already fitted in the can.

The frequency range of the Wireless Telephone Company i.f. transformers is 450–480 kc/s.

Oxford Street Christmas Scene

If, like me, you were in London during the Christmas festivities I have no doubt you saw the half-dozen or so Father Christmases wandering up and down Oxford Street. Each carried a sandwich board arrangement consisting of two boards shaped like Christmas trees to which were fixed samples of receivers made by a well known manufacturer.

Quite a good publicity stunt. But the chaps carrying those boards didn't look the *slightest* bit pleased at being Father Christmas!

Marconi Equipment Assists in Rainmaking Experiment

Unlike certain parts of England these days, rainfall in East Africa only occurs in "the long rains and the short rains", and to stimulate rain the East African Meteorological Department has been conducting experiments with rockets fired into cumulus clouds. In these experiments, Marconi trans/receiver equipment has played its part, linking the "rainmaking" research teams with the Civil Aviation authorities and the Central Forecast office in Nairobi over 100 miles away.

The experiments were begun in 1951 in an attempt to develop rain-making techniques which might save crops from almost total ruin due to lack or lateness of rain in a normally wet season. It was found that well developed cumulus clouds would be induced to give up some of their moisture in the form of rainfall if "seeded" with common salt.

The most recent technique used to seed these clouds has been to fire rockets of various types into them, and trials have been carried out in all three territories—Kenya, Uganda and Tanganyika.

One recent experiment carried out by the East African Meteorological Department was on behalf of the Laikipia Farmers' Association at Rumuriti, just north of the equator, where there are cattle ranches and very marginal rainfall.

Quick communication with the Central Forecast office in Nairobi is necessary on such sorties in order to obtain forecasts of when meteorological conditions for cumulus cloud formations are likely in the area. It is also necessary to obtain clearance from the Civil Aviation authorities before rockets are fired. Radio telephone communication is therefore essential and the East African Meteorological Department have on these experiments used a pair of HSR.21 equipments.

Four HSR.21 equipments are used by the East African Meteorological Department to link up their four main centres in East Africa, i.e. Entebbe Airport, Nairobi Airport (Central Forecast Office), Dar es-Salaam Airport and the Meteorological Department H.Q. in Nairobi.

A Simple WIRED BENCH

by P. M. GARNER

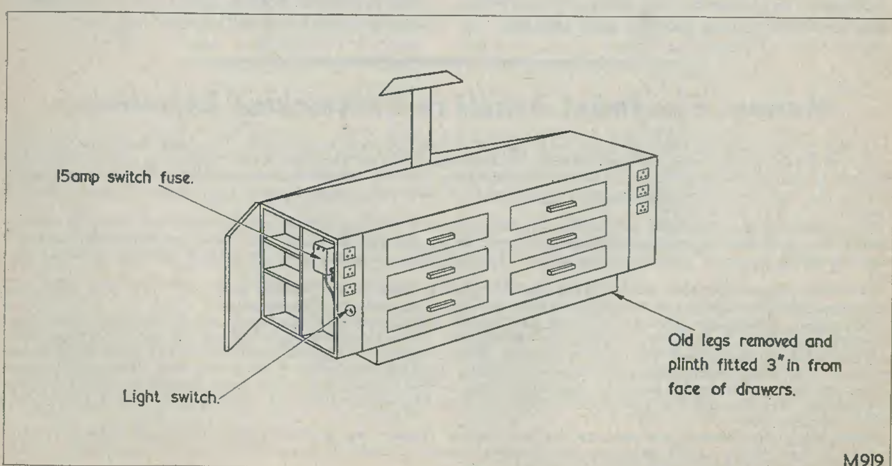
This short article describes the construction of a simple but efficient bench and will be of especial interest to those constructors who have limited working space

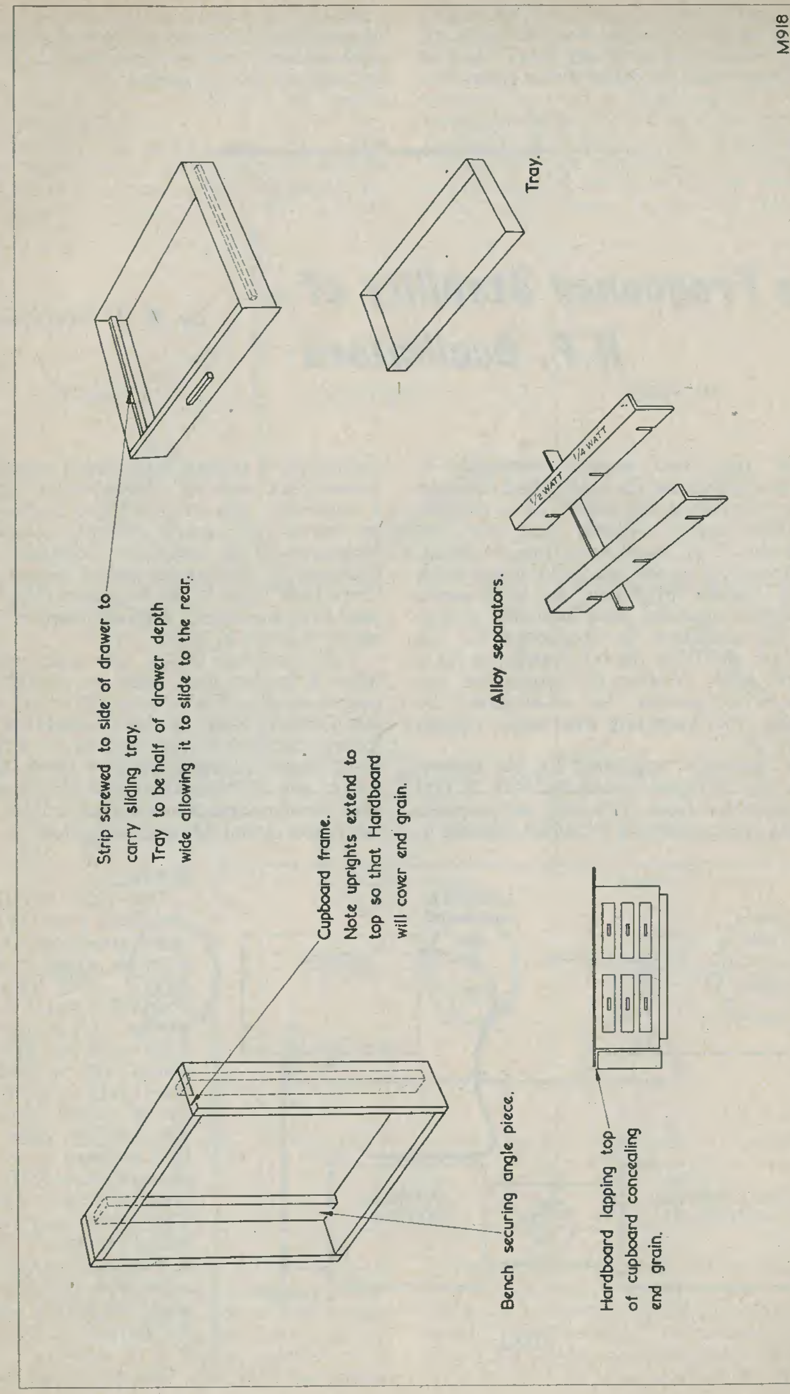
THE USE OF THE KITCHEN TABLE AS A bench presents a problem not only to the home constructor but to other members of the family. Most of us, including the writer, are not in the fortunate position of having a spare room that can be converted into a workshop. After a bit of deep thinking the writer decided to build up an old chest of drawers and to wire sockets and a light directly on to this instead of mounting them on the wall above the bench. These could then be fed from a handy wall socket via a switch fuse mounted on the side of the bench. Three five amp sockets were fixed at each end of the bench so as to avoid a large bundle of leads all going to one place. The bench length was extended by the addition of cupboards at both ends of the basic chest of drawers, each cupboard being about 4in deep. One cupboard housed the switch fuse and was fitted with a lock to prevent children tampering, whilst the other was provided with clips, etc., to hold the various tools. The two top drawers of the chest were fitted with shallow trays suitably partitioned to hold resistors and other small components, strips of flanged alloy being used to make the divisions. The uppermost, horizontal section of the strips was $\frac{3}{8}$in wide so that labels could be fastened on with the use of Sellotape, the Sellotape keeping them clean and secure.

The cupboards were soon made up from some $\frac{7}{8}$in match-boarding after removing the tongue and groove. The doors presented no problem, and consisted of just a light framework which may be faced with either plywood or hardboard to suit the personal taste and pocket. The diagrams accompanying this article are self explanatory and even the most inexperienced of joiners should not suffer any headaches. Once the cupboards are assembled they should be fitted to the ends, care being taken to keep their upper surfaces level so that a sheet of hardboard may be placed overall to provide a good working surface free from cracks and joins.

For the light fitting a length of wood screwed to the back of the bench will serve to provide a fixing; although this may be varied to suit any type of light fitting.

If care is taken with the woodwork and





the whole assembly given a coat of enamel paint, it might even meet with the approval of the female section of the family and be tolerated in a corner of the living room.

Before finishing this brief article, a word of warning: do not forget to feed the bench with a three core flex, thus earthing all the sockets in a proper manner.

The Frequency Stability of R.F. Oscillators

by R. J. Stephenson

Some time ago whilst designing a signal generator the author had occasion to investigate the effects of a variable h.t. supply and a variable load upon the frequency of an oscillating tuned circuit. The theoretical aspects are well known, being treated in many text-books, but there seems to be little practical data available giving, say, the alteration in frequency for an alteration of 10V in the h.t. supply, or for a different load. A series of experiments was therefore conducted to investigate the problem, the operating frequency chosen being 1 Mc.

The equipment employed for the experiments was a signal generator with a dial absolutely free from back-lash and capable of being read accurately for small changes in frequency, a normal a.m. radio receiver, a power pack with an adjustable h.t. supply, a voltmeter, and enough spare components to "mock up" several different oscillators. Measurement of oscillation frequency was obtained by causing the signal generator to "zero-beat" with it, the frequency then being read from the latter. A block diagram of the set-up is given in Fig. 1.

The oscillator under test was supplied from a power pack with a variable h.t. output ranging from 50 to 250 volts. Both the oscillator and the signal generator were loosely coupled to the receiver by fixing a short length of insulated wire to the aerial socket and allowing it to trail on the bench near the signal generator output terminal and the tuned circuit being investigated.

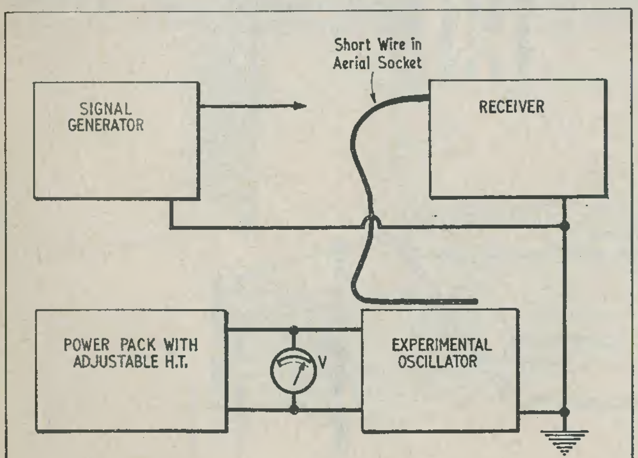


FIG. 1

Results

The first oscillator checked employed a tuned anode circuit, and a triode valve of Ra=3.7kΩ. The frequency obtained was plotted against anode voltage. This valve was then replaced with a triode of Ra=15kΩ and another set of results obtained. The second valve was next replaced by a pentode of Ra=1MΩ and the results again plotted. The three graphs obtained are given in Fig. 2. It should be noted that, when the pentode was used, the supply voltage was fed also to the screen grid.

The next stage was to repeat the whole process with a tuned grid circuit, the graphs obtained being given in Fig. 3. Finally, the process was repeated again, this time using a cathode tap (or "electron-coupled") oscillator, the results being given in Fig. 4.

From Fig. 3 it will be seen that, with a tuned anode circuit and a valve of low Ra (3.7kΩ), the alteration in frequency for change of h.t. voltage of 75–250V is about 9 kc/s, and about 8 kc/s with a valve of medium Ra (15kΩ). When a pentode of high Ra (1MΩ) was used the change in frequency was not only much smaller (2.2 kc/s), but was a decrease in frequency instead of an increase. With a tuned grid stage the changes in frequency were all increases, being 7 kc/s, 5 kc/s, and 1.4 kc/s for Ra=3.7kΩ, 15kΩ, and 1MΩ respectively. With the cathode tap oscillator, the frequency decreased with an increase in h.t. for all values of Ra. The changes were 6 kc/s, 1.6 kc/s and 800 cycles for Ra=3.7kΩ, 15kΩ and 1MΩ respectively.

Generally, the results can be summarised as follows. Of the three circuits tested the tuned anode circuit was the most susceptible to variations in h.t. supply voltage, the tuned grid slightly less so, and the cathode tapped oscillator considerably less susceptible than either. Also, frequency variations decreased as the Ra of the valve increased. It should be noted that, in practice, h.t. voltage would

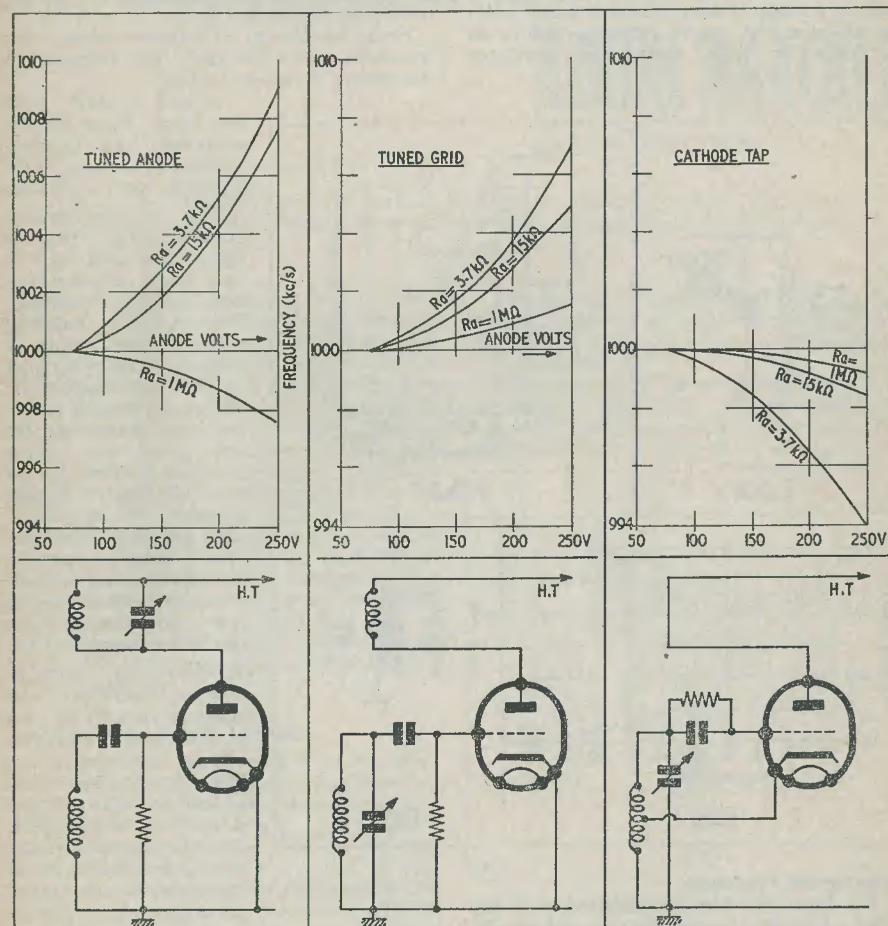


FIG. 2 FIG. 3 FIG. 4

not vary as much as it was made to do in the experiments, but the anode voltage could still, nevertheless, easily swing above and below the nominal supply voltage by quite large amounts under conditions of anode modulation, giving a considerable amount of unwanted frequency modulation. Since a stable oscillator, such as a cathode tapped, high Ra pentode circuit (or electron-coupled oscillator) shows a change of frequency of only about 200 cycles for a 10% change of supply voltage, it does not seem worth while to stabilise the supply voltage, unless an exceptionally high degree of oscillator stability is required.

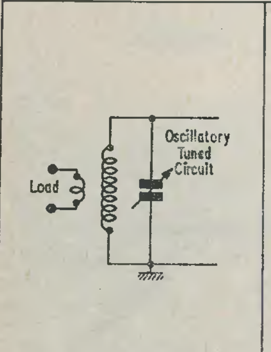


FIG.5

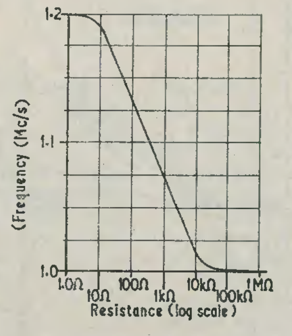


FIG.6

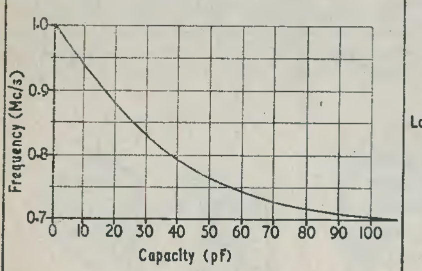


FIG.7

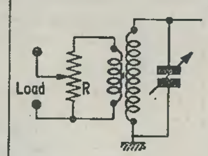


FIG.8

G650

Loading the Oscillator

The next problem investigated was the effect of loading the oscillator tuned circuit. A common method of taking a load from the oscillatory circuit is to provide a separate winding as shown in Fig. 5. A tuned grid oscillator was first investigated. For experimental purposes a coil was wound over the grid coil having one-third the number of turns of the grid coil and tightly coupled to it. It was realised such a coupling coil would have a far bigger effect than a smaller winding, or one loosely coupled, and it was fitted intentionally in order to exaggerate the results. With no load (open circuit) across the load terminals the frequency was adjusted to 1 Mc/s. As a preliminary test to ensure that the circuit was behaving as it should, the load terminals were shorted across. The frequency then increased to 1.2 Mc/s, a frequency change of 200 kc/s. Next, various values of resistance were connected across the load terminals and the results are shown in Fig. 6.

Next, condensers of various values were connected across the load. This reduced the frequency, as shown in Fig. 7.

Inductive loads were not tried, since insufficient inductors of known inductance and self-capacity were available.

The loading experiments were repeated again, this time with a very much smaller coil, very loosely coupled. The reduced coupling reduced the frequency shifts due to varying load to about one-tenth of the values previously given, but even these were far too great to allow accurate calibration of the oscillator tuning condenser if the latter were intended for use in, say, a signal generator. In any case the amount of power available was so low as to be useless without further amplification.

Finally, an electron-coupled oscillator was constructed with the load in the anode. With this circuit, the change in frequency for all values of load was so small that it could not be measured. A slight change in beat note was noticed, but it was impossible to measure the change of frequency with any accuracy.

To draw one or two conclusions from the loading experiments, it seems that the loading must be very light, or the load must have a constant value. This could be obtained by the simple circuit of Fig. 8, where the impedance of the attenuator, R, is very small compared with the impedance of any load likely to be connected across the terminals. In the view of the writer, a much better arrangement would be to take the load from a valve electrode not concerned with the tuned circuit (as in the electron-coupled oscillator) or to use a "buffer" valve between the tuned circuit and the load, or, better still, to use both. It will be seen that, unless great care is taken with loading the circuit, it can have far more serious effects upon the frequency stability than even the most erratic fluctuations in h.t. supply voltage.

An Automatic-Location AERIAL BRACKET

by L. H. BROWN

This article describes an aerial bracket in which ingenious, but simple, principles have been employed to enable an aerial mast to be raised, lowered or rotated from the ground

IT FREQUENTLY HAPPENS THAT AN AERIAL mast may be most conveniently mounted by securing it to the side wall of a house as illustrated in Fig. 1. It will be noted that the mast is secured by two brackets and that, whilst the lower bracket is within easy reach of anyone standing on the ground, the upper bracket must necessarily be mounted as high up the wall as possible in order to achieve maximum stability of the mast and aerial. The fact that the upper bracket is well above ground level causes difficulties if it is desired to raise or lower the mast, or to rotate it. Such operations necessitate the use of long ladders in order that the upper bracket fixing may be loosened, and there is a risk of personal danger whilst handling an inevitably top heavy aerial and mast assembly under such conditions.

An Alternative Upper Bracket

It is possible to dispense with all these inconveniences and hazards by employing an automatically locating upper bracket such as that described in this article. After such a bracket has been initially fitted to the wall there is no need to touch it again, all subsequent handling and fitting of the mast being carried out from ground level.

Top and side views of the automatically locating bracket are shown in Figs. 2 (*a*) and (*b*). As may be seen, the working part of the bracket consists of an arm, pivoted at its centre, and having a "C" socket piece at one end. The latter has an inside diameter which gives sliding clearance to a 2in mast section, its opening permitting access to a 1½in mast section. Two wires fastened to the arm allow it to be pivoted, from ground level, to any desired angle.

The aerial mast employed with the bracket should consist of an upper section having a diameter of 1½in and a lower section having a diameter of 2in.

When the mast is to be fitted to the bracket its upper 1½in section should be placed against the opening of the "C" hole, whereupon it will enter the socket piece as

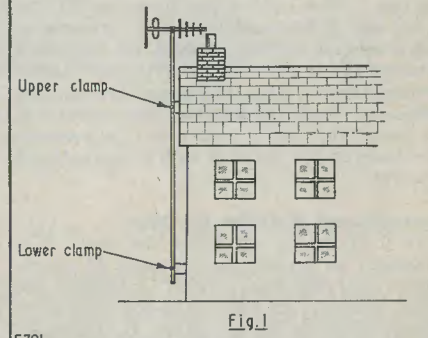


Fig. 1. A typical aerial mast installation

shown in Fig. 3 (*a*). The arm is then kept at right angles to the mast by controlling the wires which are coupled to it, the mast then being raised until it is at the desired height. This will cause the 2in diameter section to appear inside the socket piece, as in Fig. 3 (*b*). The wires from the arm are next left free and the mast allowed to drop slightly. At once the arm will assume the angle shown in Fig. 3 (*c*), whereupon the top left-hand

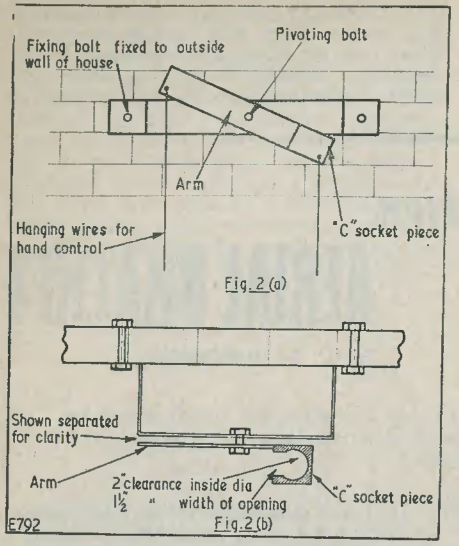


Fig. 2 (a) and (b) Side and top views of the automatically locating bracket.

and bottom right-hand inside edges of the socket piece bite into the mast and prevent it falling further.

The mast is now secured laterally and its entire weight is taken up by the upper bracket. The only force apparent at the lower end of the mast is the slight rotational force caused by the weight of the mast attempting to pivot on the upper bracket pivoting bolt. Once the upper bracket has taken the weight of the mast and aerial it is an extremely simple matter to finally secure the lower end of the mast with a conventional bracket.

Lowering and Rotating the Mast

If it is desired to lower the mast it is necessary to reverse the sequence of operations just described. After loosening the lower bracket, the mast is raised slightly to free it from the socket piece. By means of the hanging wires, the arm is then kept at right angles to the mast whilst the latter, now a sliding fit in the socket-piece, is lowered. When the 1½in section of the mast is in the socket piece, the mast may be lifted out.

To rotate the mast it is merely necessary to raise it slightly so as to free it from the socket piece, rotate it to its new position and allow it to drop again, whereupon the arm automatically takes up the weight once more.

General Points

As may be gathered, the automatically locating bracket is ideal for all mast-borne aerials, whether these be employed for television or v.h.f. reception, or for amateur transmission and reception. Not only does it allow directional arrays to be rotated to

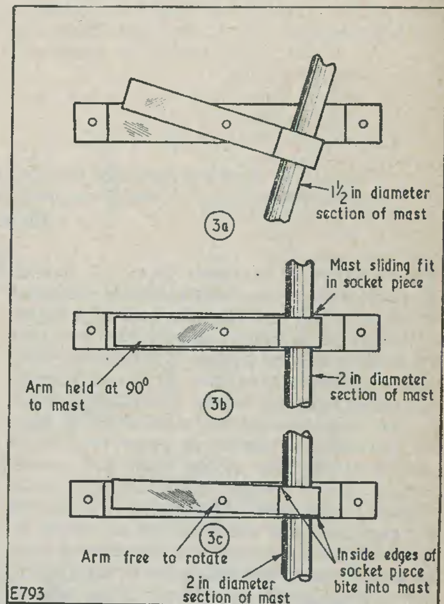


Fig. 3 (a) On initial installation the aerial mast is first dropped into the socket piece (b) The 2in. diameter section of the mast slides freely in the bracket (c) Releasing the arm causes it to rotate slightly and take up the weight of the mast

any desired direction, it also enables the mast to be quickly lowered for maintenance or modification to the aerial.

In the case of the installation employed by the writer all parts, including the lower bracket, were made out of iron by a local ironworker at a cost of 25s. The ironwork should be protected against the weather with, at least, a heavy coat of good paint, galvanising, if possible, is preferable.

NEXT MONTH

Transistorised Test Oscillator
Tackling Car Radio Interference
10-30 Mc/s Aerial Matching Unit

BOOK REVIEWS

THYRATRONS. By C. M. Swenne. 82 pages, 5¾in x 8ain, 68 illustrations, 4 plates. Price 12s. 6d.

The growing importance of electronics in industry has necessitated the design of valves specially for industrial use. Control or switching operations on comparatively large currents or high frequencies are often needed; for these purposes high vacuum valves are less suitable and gas-filled types of various kinds are employed. This book deals with one of these, the thyratron.

The great advantage of a thyratron is its use as a fast switching device: it combines the functions of a pulse-controlled fast switcher and a regulator.

In a simple way construction, operation and electrical characteristics of thyratrons are here explained. Chapters are devoted to the basic circuits of these valves and their application in simple industrial devices, for instance relay circuits, timing circuits, d.c./a.c. converters and automatic circuits, to regulate the speed of electric motors and to stabilise rectifiers: applications in which thyratrons show to full advantage.

This book employs only the most elementary mathematical expressions and operations; it is intended for those who want to get a general impression of one currently rather important field of industrial electronics.

Cleaver-Hume Press Ltd., 31 Wright's Lane, London W.8.

INDUSTRIAL ELECTRONICS APPARATUS: STEPS IN DESIGN AND MAINTENANCE. By P. van der Ploeg. 116 pages, 5¾in x 8ain, 22 illustrations, 33 photographs on art paper. Price 9s. 6d.

Through the fast development of industry fresh fields of applications are discovered almost daily and new construction elements continually widen the scope of industrial electronics in our daily life. The business of ensuring that the equipment is always in efficient working order will remain one of the most important aspects of both construction and general maintenance.

The object of this book is to show both the designer and the service-engineer the extent to which troublefree operation of electronic equipment is dependent on the little things that matter in the design, production, use and maintenance.

The development of a typical item of electronic equipment is traced step by step in a logical classification from the first experiment in the laboratory to the production and subsequent maintenance of the final unit. Throughout the book practical tips and hints are given.

For convenience sake the second part of the book contains some general remarks on the interpretation of tube data with particular reference to gas-filled rectifiers and thyratrons, which are often used in industrial control equipment.

Cleaver-Hume Press Ltd., 31 Wright's Lane, London, W.8.

Practical Transistor Circuits. 52 pages. 80 figures. 7½in x 9¾in. Published by Henry's Radio Ltd. Price 3s. 6d. post free.

Compiled by D. J. French, Grad. I.E.E., *Practical Transistor Circuits No.* 2 is a most useful and practical publication for those interested in transistorised equipment construction. Within the covers are featured some 40 designs each complete with circuit diagram and most having a point-to-point illustration. The contents include such varied designs as A 3-Transistor Hearing Aid, Variable Frequency Oscillator, Sub-Miniature Pocket Transmitter, Transistor Timer, Headlamp Dimmer, Portable Baby Alarm, Telephone Pick-Up Amplifier, Miniature RF, IF, Audio Tracer, 10 Watt Portable Loud Hailer, Light Sensitive Power Switch and Multi-Channel Radio Control Receiver, etc., etc.

This extremely useful and informative book is recommended to our readers and should find a place on every home constructor's book shelf.

Service Valve Equivalents. 2nd Edition. 40 pages. 5½in x 8½in approx. Published by Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. Price 2s. 0d. plus 6d. postage.

Compiled by G. C. Fox, A.M.I.E.E., G3AEX, this second edition includes a large number of new service valve types which have appeared since the previous edition was published. Additional information on the structure or function of each type has been added thus considerably increasing the usefulness of the booklet.

This booklet will undoubtedly meet the need for a source of information on the commercial equivalents and the manufacturers of the numerous CV coded valves, cathode ray tubes and semi-conductor devices now generally available to the radio amateur and home constructor.

Thoroughly recommended to all our readers as a most informative and helpful publication and representing extremely good value at the small cost involved.

R.S.G.B. Amateur Radio Call Book. 1961 Edition. 80 pages. 7¼in x 9¾in. Published by Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. Price 4s. 0d. plus 6d. postage.

The 1961 edition of this well known and indispensable work of reference contains, in addition to the calls, names and addresses of radio amateurs resident within the British Isles and Eire, a complete list of the Societies and Clubs in affiliation with the R.S.G.B., a list of Amateur Radio Prefixes—Prefix Order, a list of Amateur Radio Prefixes—Country Order, Amateur Abbreviations, British Isles Two Metre Band Plan details, R.S.G.B. Contests Diary for 1961, a list of bands available to U.K. Amateurs, Types of Emission details, the Morse Code and Sound Equivalents, and the European Band Plan.

Since the last edition (1960) appeared in November 1959, more than 450 new calls have been issued, more than 100 old calls have been re-issued, upwards of 1,000 changes of address have been recorded and about 250 calls have been cancelled. The latest (1961) edition reflects these additions and changes.

The First One. 14 pages (duplicated) plus cover. 7in x 8in. Published by The K. & M. Printing and Publishing Company, 18 Melville Road, Birmingham 16. Price 1s. 3d. plus 2d. postage.

This booklet, *The First One*, deals with the construction and operation of a mains one valve radio receiver for the Medium and Long waves. Written by James S. Kendall—a well known contributor to the radio press—this publication should prove of interest to the beginner in that the design of the receiver is simple and inexpensive to construct. Complete with circuit diagram, point-to-point wiring and layout drawings, the booklet will be of value to those about to embark on building their first receiver.

CATALOGUE RECEIVED

Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey, have just released the revised third reprint of their Component Catalogue. This year, the catalogue has been brought up to date by means of a supplement and, except for this and the cover, it is identical to that issued after 6th June, 1960. Those readers who purchased their catalogues after this date will, in most cases, automatically receive the supplement, whilst those who obtained an earlier catalogue will, if they send to Home Radio (Mitcham) Ltd. the front cover from the old edition and 9d. postage, receive the latest publication free. In this manner, those who find the catalogue useful will be able to obtain at regular intervals the most up to date copy, the cost being only that of the postage.

Comprising some 128 pages plus art cover, 7¼in by 9¾in (approx.), the catalogue is literally crammed from cover to cover with details of almost every type of electronic component, kits, complete equipments of all types, accessories, etc., complete with type numbers and current prices. Supplied with the sixteen-page supplement and handy book mark, the catalogue is extensively indexed thus making the location of any component or unit an easy matter. This well produced and lavishly illustrated catalogue is available direct from Home Radio (Mitcham) Ltd. at 2s. 0d., plus 9d. postage.

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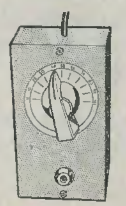

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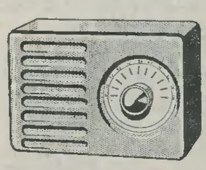

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continued on page 558

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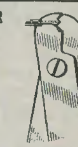

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TRADE *continued from page 557*

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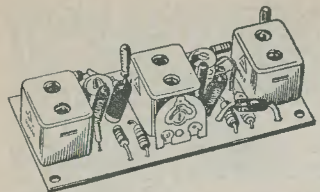

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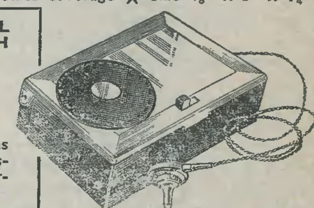

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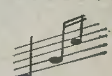

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