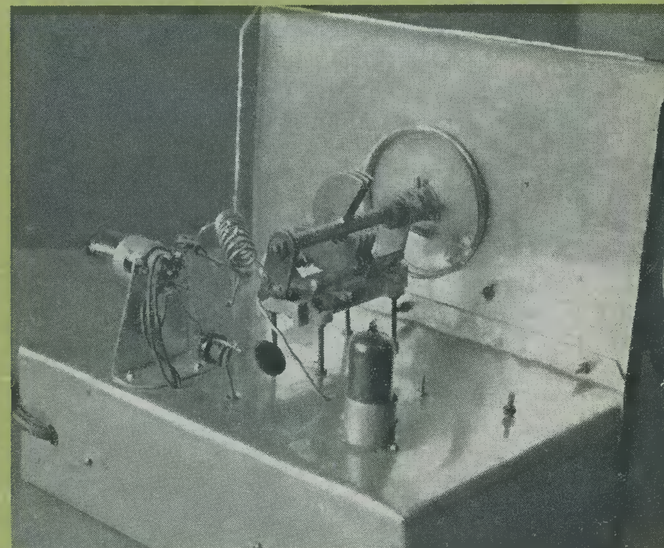
MAY 1961

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

CONTENTS INCLUDE



BAND I - III Signal Generator

DATA Publications

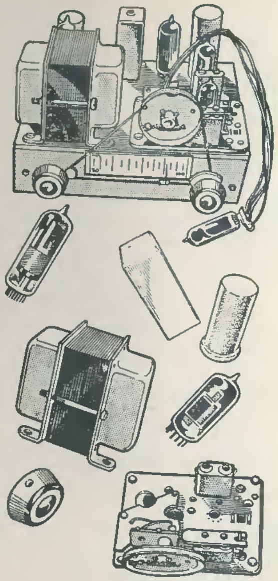
ONE SHILLING AND NINEPENCE

VOLUME 14

NUMBER 10

HARVERSON SURPLUS CO., LTD

HARVERSON'S F.M. TUNER KIT



At last a quality F.M. Tuner Kit at a price you can afford. Just look at these fine features, which are usually associated with equipment at twice the price!

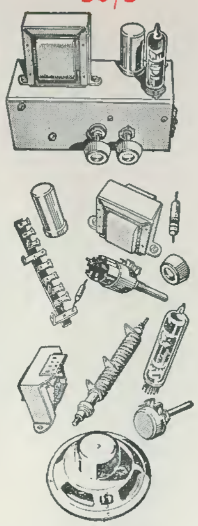
★ Philips F.M. Tuning Head ★ Guaranteed Non-drift ★ Permeability Tuning ★ Frequency coverage 88-100 Mc/s ★ OA81 Balanced Diode Output ★ Two I.F. Stages and Discriminator ★ E.M.84 Magic Eye ★ Self powered, using a good quality, mains transformer and valve rectifier ★ Valves used ECC85, two EF80's, EM84 (Magic Eye) and EZ80 (rectifier) ★ Fully drilled chassis ★ Everything supplied, down to the last nut and bolt ★ Size of completed tuner 8″ x 6″ x 5½″ ★ All parts sold separately

Note: To show the chassis more clearly the attractive 8″ x 3″ black and gold dial supplied with this kit, is not shown in the illustration.

£4.19.6
Plus 8/6 P.P. & Ins.

YET MORE HARVERSON AMPLIFIER SCOOPS

Introducing . . . **HAVERSON'S MONAURAL AMPLIFIER KIT 39/6**

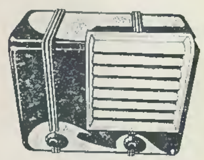


In response to numerous requests from delighted purchasers of our "SUPER STEREO KIT" we have produced a "MONAURAL AMPLIFIER" on similar lines.
★ A UCL 82 valve provides a triode amplifying stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size, 7″ x 3¼″ x 6¼″ high).
★ Modern circuitry design, good quality O.P. transformer (to match 3Ω) keep hum and distortion to a low level.
★ The controls, volume on-off, and tone, are complete with attractive cream and gold knobs
★ The amplifier has a built-in fully smoothed power supply, using a good quality mains transformer (A.C. mains only) and metal rectifier.
★ All you need is supplied including easy to follow instructions which guarantee good results for the beginner and expert. All components, leads, chassis, valve, knobs, etc., are first grade items by prominent manufacturers.

OUR PRICE 39/6
Plus 4/6 Post and Packing.

5″ LOUDSPEAKER TO SUIT 14/6 EXTRA
ALL PARTS SOLD SEPARATELY

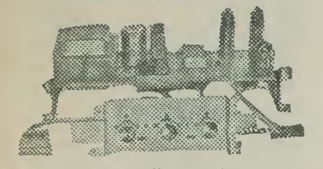
READY BUILT AMPLIFIER 21/-



Owing to a fortunate purchase, we are able to supply these amplifiers at a fraction of the price normal for comparable equipment. Although not new, these units are in good condition, and represent a first class buy. Originally made for a relay wireless company, they are built to strict specifications by a prominent maker.
BASICALLY EACH UNIT COMPRISES . . .
R.F. AMPLIFIER, using a 10F3 valve, all contained in a screening box.
AUDIO AMPLIFIER, employing a 10P14 valve, and giving a good reproduction at 3 watts.
POWER PACK both the R.F. and the Audio amplifier are fed by a common internal fully smoothed power supply. This is provided by a tapped mains dropper (input 200/250 volts AC/DC), and a U404 rectifier valve.
INPUTS. Inputs are supplied for AC/DC mains, crystal pick-up, and six pre-set channels.
SPEAKER. A good quality 15Ω permanent magnet 8″ round speaker is fitted.
CABINET. All the above are housed in an attractive brown bakelite case, with cream speaker slats. (Case size 14″ x 11½″ x 6″).
The applications to which these amplifiers can be put are limitless, for apart from the obvious use as a gram amplifier (2 can be used for stereo) they can be adapted for countless other uses, e.g. baby alarms, inter-coms, guitar amplifiers, etc.
OUR PRICE, including valves
ONLY **21/-** plus 6/6 post & insurance

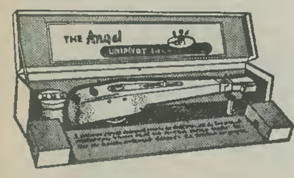
HARVERSON SURPLUS CO. LTD

MONAURAL AMPLIFIER



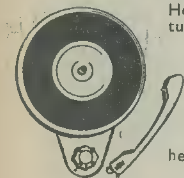
This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass, Treble and Volume on remote panel. Elegant Knobs. OUR PRICE one month only **£4.16.6** plus P. & P. 3/6

THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)



A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at **£4.10.0** Plus P. & P. 5/–

E.M.I. 4-SPEED PLAYER and P.U.



Heavy 8¾″ metal turntable. Low flutter performance 200/250V shaded motor with tap at 80V for amplifier valve filament if required. Turnover LP/78 head. Price **89/6**. Plus 4/6 P. & P.

AUTOCHANGERS

GARRARD

RC 98 Mk.4H	4-speed changer	**£16.10.0**
RC 120/D Mk.2	4-speed changer	**£9. 0. 0**
RC 120 Mk.4D	4-speed changer	**£9. 0. 0**
RC 120 Mk.4H	4-speed changer	**£9. 0. 0**
RC 121 Mk.1	4-speed changer	**£11.0. 6**
RC 121 Mk.4H	4-speed changer	**£11.0. 6**
RC121/40 Mk.2	4-speed changer	**£11.0. 6**

B.S.R.

Monarch UA8 4-speed changer	**£6.19.6**
TU8 4-speed single player less pick up	**£2.10. 0**
UA14 Stereo Changer	**£9. 5. 0**

NOTE: Any of the above with Stereo Cartridge and Fittings, **16/–** *extra. Carriage and Ins. on each of above 5/– extra.*

TAPE DECKS

LATEST B.S.R. MONARDECK (single speed) 3¾″ per sec., simple control, uses 5¾″ spools ... **£7. 5. 0.** plus 5/6 carriage and insurance (tapes extra).
TRUVOX MARK III TAPE DECK. New and Boxed **£10.6.6** Plus 6/– carr. and ins. (tapes extra).

STEREO AMPLIFIER *Complete with 2 Speakers*

This is a compact amplifier embodying the latest features and giving a high standard of reproduction, with ample volume. Supplied complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc., and two specially selected 3Ω matched loudspeakers. Few only at such a low price. Don't risk disappointment. Order now. **£5.10.0** Plus 4/6 P. & P.

SUPERHET CHASSIS. A modern 4 valve AC/DC chassis incorporating a printed circuit, and ferrite rod aerial. Although not completely built, all the main components are ready mounted, and comprehensive instructions are supplied to enable anyone to make the few connections necessary. Supplied complete with knobs, dial, valves (UCH81, UBF89, UCL83, UY85) etc. Nothing else to buy! **Only £4.19.6** P.&P. 3/6

TRANSISTOR BARGAINS—ALL FIRST GRADE

OC71 ...	8/–
OC72...	12/–
OC72 Matched Pair...	25/–
OC45 Green Spot ...	15/–
OC45 Blue Spot ...	15/–
OC44...	15/6
OA41 Diode ...	3/6

Postage on all above 6d.

SPECIAL OFFER
DON'T MISS THIS
MULLARD OC76 10/6
MATCHED PAIR £1.0.0
Post and packing 6d.

G.E.C. FIRST GRADE TRANSISTORS
Set comprising one 874 mixer, two 873 I.F.s, one GET 114 driver, two GET 113 matched output, and diode **£1.18.6**, post 1/–

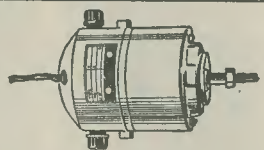
F.M. TUNER HEAD

A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) **14/6** plus 1/9 P. & P. Valve 8/6 extra

PAIR OF MOTORS

A pair of new miniature motors (3¼″ x 3″ x 1½″) Can be run in parallel from 115V AC, or in series from 200/250V AC. Ideal tape motors, models etc., **35/–** per pair. P. & P. 2/9

1/6 H.P. MOTOR



140 watt (approx. 1/6 H.P.). Series wound, 220/250V 50 cycle motor. Off load 14,000 rev/min. On load 8,500 rev/min. Ideal small saw, sewing machine etc., post free. **30/–**

COSSAR C.R.T. SNIP

108K 10-inch. New and boxed. **15/–** plus 6/– P. & P.
75K 10-inch. New and boxed. **15/–** plus 6/– P. & P.
ION TRAP MAGNETS. To suit above, **2/9.** P. & P. 3d.
MAZDA CRM 172—Not a Regun. Picture tested—12 months' Guarantee. **£3.17.6** 12/6 P. & P.

SWITCHED ATTENUATOR

Audio to V.H.F. in four steps of 20 dB ±0.02 dB up to 300 Mc/s. Cost £5.10.0. OUR PRICE **£2.19.6** Plus 1/– P. & P.

CONDENSER/RESISTOR PARCEL
50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor. P. & P. 1/–. **ONLY 10/–**

MIDGET I.F. TRANS & COILS

A Pair of midget 465 kc/s I.F. transformers, plus LW and MW coils. PRICE **10/–** per set. P. & P. 1/9. Set of I.F. transformers for transistor superhet. **12/6.** P. & P. 1/9

SLOW MOTION TUNERS

500-500 Twin gang condensers with geared slow motion drive. **3/6** ea. **36/–** per doz. P. & P. 6d.

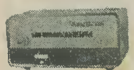
WIRE WOUND POTS

12 Wire Wound Colvern Pots—all different values **10/6**, P. & P. 9d.

PLEASE TURN OVER FOR ADDRESS AND MORE SPECIAL BARGAINS →

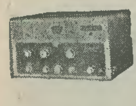
The World-famous Heathkit range of equipment

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 (£11.11.0) making a total cost for the equipment of £14.13.0.

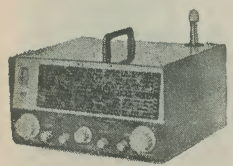
AMATEUR TRANSMITTER Model DX-100U



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. **£81.10.0**

4-WAVE TRANSISTORISED PORTABLE RECEIVER, Model RSW-1

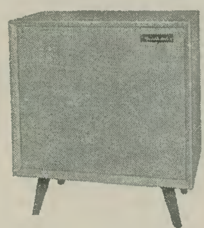
This possesses Medium, Trawler and two Short-wave bands and is mid-way between the domestic broadcasting and professional general communications receiver. Ideal and inexpensive for those who wish to listen to world broadcasts, shipping and aviation communications, etc. It is not the set to buy if you wish only to enjoy domestic broadcasting. In a handsome solid leather case, it has retractable whip aerial and socket for car radio use. **£21.18.6**



THE "MOHICAN" GENERAL COVERAGE RECEIVER
Model GC-1U

In the forefront of design with 4 piezo-electric transfilters, variable tuned B.F.O. and Zener diode stabiliser, this is an excellent fully transistorised portable or fixed station receiver for both "Ham" and Short wave listeners. Other features include printed circuit boards, telescopic whip antenna, tuning meter and large slide-rule dial of approximately 70". **£38.15.0**

THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15½" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£21.19.0**



THE "COTSWOLD"

HI-FI EQUIPMENT CABINETS

Range now available to suit vastly differing needs and all left in white for finishing to personal taste. Will house Record Player, F.M. Tuner, Amplifier and, in some models, also your Tape Deck. The "GLOUCESTER" cabinet is illustrated below.

Send for details of whole range. Prices from **£11.5.6 to £17.18.6.**

RECENT ADDITIONS TO THE RANGE

TAPE RECORDING/REPLAY AMPLIFIERS. Stereo (TA-IS) £23.6.0. Mono (TA-IM) £18.2.6

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. **£11.18.0**

GRID DIP METER, Model GD-IU. £10.9.6. Transistorised version, Model XGD-1. **£10.8.6**

★ **In THE FOREFRONT OF GENERAL COVERAGE RECEIVER DESIGN.** The fully transistorised Model GC-IU, with 4 piezo-electric transfilters will be available shortly **£38.15.0**

The "GLOUCESTER" (open)

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

DAYSTROM LTD DEPT. RC5 GLOUCESTER ENGLAND

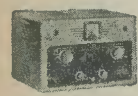
Easily-built Equipment Heathkit of excellent quality

at much lower cost

O-12U

DC-1U

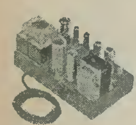
S-33



DX-40U

AG-9U

UJR-1



MA-12

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. **£36.10.0**

2¾" PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5" x 8" x 14". Wt. 10½lb. **£19.10.0**

DECADE CAPACITANCE BOX: DC 1U. Provides capacity values from 100 mmf to 0.111 mfd in 100 mmf steps. Ideal for experimental, development and design work. **£6.5.6**

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

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn. at 2½ watts per channel. **£12.8.6**

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. **£26.12.6**

"HAM" TRANSMITTER: DX-40U. 75W CW; 60W pk. c/c phone; 40W into Aerial. **£32.10.0**

HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono in average room (left "in the white"). Legs £1.1.0 extra. **£10.15.6**

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies attenuation. **£19.19.6**

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

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

SINGLE CHANNEL 12 WATT HI-FI AMPLIFIER: MA-12. Idea for stereo conversions, etc. Generous auxiliary power provided. **£10.19.6**

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

(Following models not illustrated)

CAPACITANCE/RESISTANCE BRIDGE: C-3U. Measures capacity 10pF to 1,000µF. Resistance 100Ω to 5MΩ; Pwr. factor. **£8.6.6**

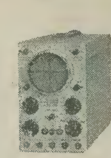
VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. **£11.2.0**

AUDIO WATTMETER: AW-1U. Up to 25W continuous, 50W intermittent. **£14.14.0**

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

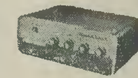
ELECTRONIC SWITCH: S-3U. This extremely useful device extends your single-beam "scope" for double-beam uses. **£10.15.6**

DIRECT READING CAPACITANCE METER: CM-1U. Full-scale ranges of 0–100 mmf, 1,000 mmf, 0.01 mfd and 0.1 mfd. **£14.15.0**



OS-1

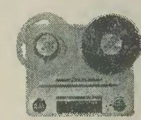
V-7A



S-88

SSU-1

UXR-1



"STUDIO"

Money Saving "Packaged Deals" of Complete Stereo Equipment from £43.19.0

All prices include free delivery in U.K. Deferred terms available on orders above £10

★ **SEND THIS COUPON NOW FOR FURTHER INFORMATION**

(Please write in BLOCK CAPITALS)

NAME ....

ADDRESS ....

Without obligation please send me (Tick here)

BRITISH HEATHKIT CATALOGUE ....

FULL DETAILS OF MODEL(S) ....

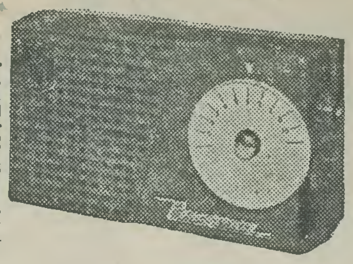
DAYSTROM LTD DEPT. RC5 GLOUCESTER . ENGLAND

A member of the Daystrom Group, manufacturers of the WORLD'S LARGEST-SELLING ELECTRONIC KITS

TRANSISTOR POCKET RADIOS

MOST EFFICIENT R.F. CIRCUIT

Circuit comprises 2 h.f. transistors reflexed to equal 4 stages. Permanent germanium diode and high gain a.f. output stage, fitted with miniature speaker, proper tuning condenser, volume control and in case (less monogram), completely portable. No aerial or earth required. Pocket 3 uses 2 transistors and 1 diode, 37/6. Pocket 4 uses 3 transistors and 1 diode, 42/6. Pocket 5 uses 4 transistors, diode and feedback, 55/–, post & ins. 2/6



★ **Results proved in all areas. Components guaranteed for 12 months.**

★ **Plans free with parts, or separately 1/6.**

More details S.A.E.

Transistors for R.F., F.M., T.V. and U.H.F.

Frequencies quoted are approx. cut-off.

SB 078	15-20 Mc/s	8/6
SB 305	20-30 Mc/s	9/–
SB 231R	40-50 Mc/s	15/–
AMERICAN 2N1727	100-150 Mc/s	15/–
AMERICAN 2N1728	100-150 Mc/s	12/6
AMERICAN T1832	1000-1300 Mc/s	25/–
AMERICAN T1833	1000-1300 Mc/s	25/–

Read these testimonials

THE ORIGINALS MAY BE SEEN AT THIS OFFICE

Mr. S. Rigby-Jones, South Molton, N. Devon.—"I was delighted to receive my Pocket 4 Transistor set. After I assembled and tested it I was amazed such a small receiver had such good reception."

Mr. E. Balcombe, Manchester.—"I have constructed your Pocket 4 Loudspeaker radio and am delighted with its performance and appearance. For the cost I consider it excellent."

Mr. R. Belt, Newcastle-on-Tyne.—"I have built your Pocket 5 Transistor set. I am very pleased with it."

Mr. A. J. Simmonds, Welling, Kent.—"I purchased from you a week ago the Pocket 4 Transistor Kit. I put it together last night in 1½ hours. On switching on the set, I was right on Radio Luxemburg. I must say thank you, because not only has the set a very attractive appearance, it also behaves fantastically."

ELECTRONIC PRECISION EQUIPMENT LTD

★ Orders received by post are despatched from our warehouse, **Dept. 34, 66 Grove Road, Eastbourne,** and to save time, please post your order to this address. Please include enough for postage. Callers, however, should use one of the following addresses:

Electronics (M.P.) Ltd.
520 High Street North
Manor Park, E.12

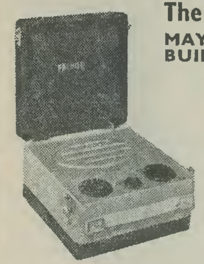
Electronics (Ruislip) Ltd.
42-46 Windmill Hill
Ruislip, Mddx.

Electronics (Croydon) Ltd.
266 London Road
Croydon

Electronics (Finsbury Park) Ltd.
29 Stroud Green Road
Finsbury Park, N.4

Premier RADIO

23 TOTTENHAM COURT ROAD LONDON W1 *Telephone* MUSeum 3451/2
and **309 EDGWARE ROAD LONDON W2** *Telephone* PADdington 6963



The "Petite" PORTABLE

MAY BE BUILT FOR £7.0.0 plus 3/– P. & P.

Batteries extra

HT 10/– (Type B126) or equivalent.

LT 1/6 (Type AD35) or equivalent.

★ Size only 8″ x 8″ x 4½″.

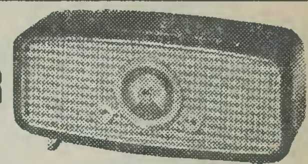
★ Instruction book 1/6.

Battery Eliminator, available in component form price 37/6 plus 2/– P. & P.

Why not convert your battery portable to mains operation with the **COSSOR MU2 BATTERY ELIMINATOR?**

This Eliminator is completely assembled and supplied with 4ft of Mains Lead and Torpedo Type of On/Off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for such receivers as the Cossor 543, 551 and 552 or receivers operating on 1.4V L.T. and 90V H.T. for use on 200–250V A.C. mains. Size: L.T. Unit 3″ x 2¾″ x 1⅜″, H.T. Unit 4″ x 2¾″ x 2″. Original price 3 gns. OUR PRICE for a limited period only, 39/6 plus 2/– P. & P.

THE SUPER 60



6-Transistor BATTERY RECEIVER MAY BE BUILT FOR £9.15.0
plus 4/6 P. & P.
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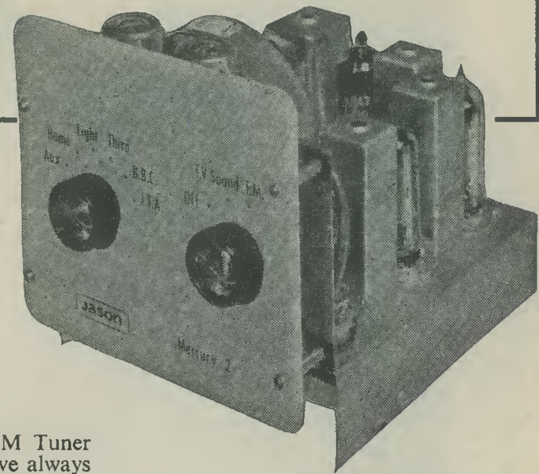

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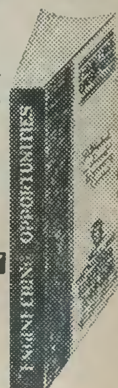

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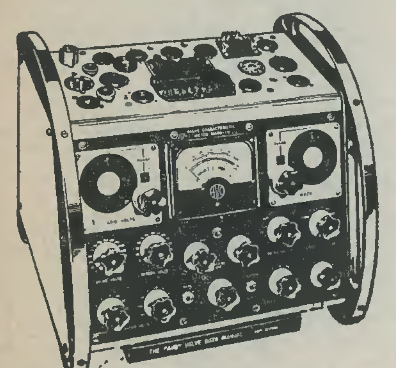

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Suggested Circuits

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. 126
A Transistorised Proximity Detector

This month's circuit is for a transistorised proximity detector; that is, a device which enables external circuits to be switched on or off whenever a remote electrode is approached by the body or the hand. Proximity detectors have a number of useful applications and lend themselves especially well to shop presentations and exhibition displays, wherein their ability to be actuated by members of the public offers a considerable attraction. Other and more serious applications may readily suggest themselves to the reader.

The construction of the proximity detector described in this article should raise few difficulties. Setting up after completion requires a little care but the process is not difficult in itself. A meter capable of measuring the current flowing through the relay coil (or the voltage dropped across it) is necessary, and this point is discussed later. In the event of the oscillator not functioning correctly, it will prove helpful to have a Medium wave broadcast receiver available in order to carry out a simple check on circuit operation.

The Circuit

The circuit accompanies this article and it will be noted that a "proximity plate" is connected, via C_1, to the oscillator tuned circuit L_1C_2. When the proximity plate is approached by the body, hand or any mass having a relatively high capacity to earth, the total capacity across L_1 increases, resulting in a drop in oscillator frequency. L_1 is the tuned winding of coil L_1L_2. Coupling winding L_2 connects to the base of transistor TR_1, and feedback from the collector of this transistor is applied, via C_4, to L_1. The components employed in the TR_1 circuit have values which enable reliable oscillations to be given over a wide range of tuning capacity.

The oscillatory voltage across L_1 is fed, via C_3 and the tuned circuit C_8L_3, to the OA79 shunt diode. C_8L_3 are tuned to the same frequency as that at which TR_1 oscillates when the proximity plate is not approached. In consequence these two components offer a high impedance, and cause a low rectified voltage to appear on the upper terminal of the diode. If the proximity plate is approached the oscillator frequency drops, whereupon C_8L_3 offer a decreased impedance. The rectified voltage across the OA79 diode increases accordingly.

The rectified voltage on the upper terminal of the OA79 is negative with respect to chassis, and it is applied via R_6 to the d.c. amplifier transistor TR_2. The collector of TR_2 shares a common tap, in the potentiometer $R_7R_8R_9$, with the base of TR_3. When minimum rectified voltage is provided by the OA79, TR_2 draws a low current through R_7 and R_8, thereby allowing a relatively high current to flow into the base of TR_3. The latter passes a high collector current in consequence, and causes the relay to energise. If the rectified voltage from the OA79 increases, so also does the collector current drawn by TR_2, with the result that less current flows into the base of TR_3. Thus, when the rectified voltage on the upper terminal of the OA79 rises, the collector current of TR_3 drops. Should the rectified voltage from the OA79 rise sufficiently, the drop in TR_3 collector current allows the relay to de-energise.

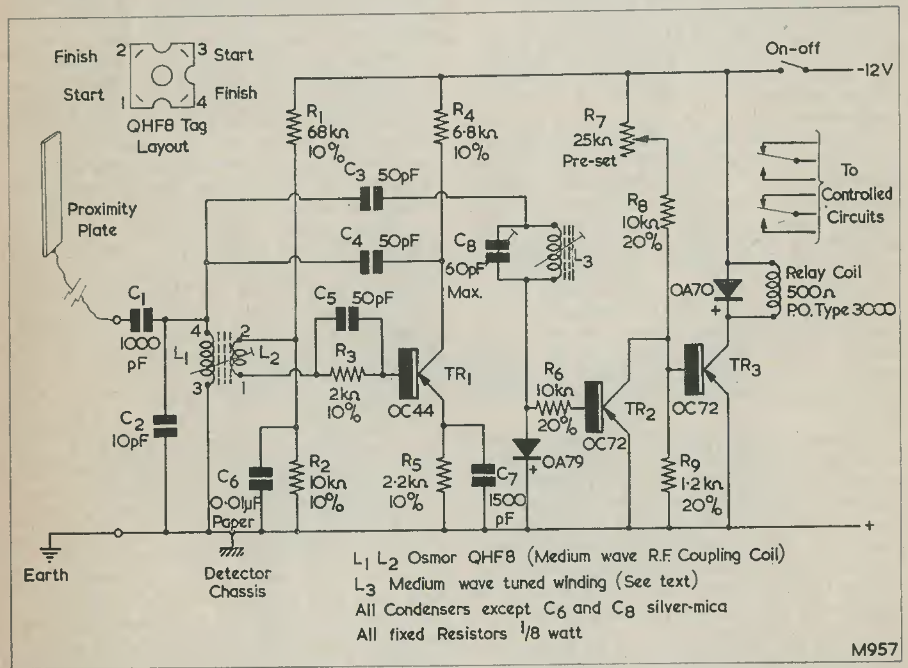
The overall operation of the circuit may be summed up in the following manner. When the proximity plate is not approached, C_8L_3 are at oscillator frequency and minimum rectified voltage is given by the OA79. This corresponds to minimum collector current in TR_2 and maximum collector current in TR_3. The relay is, in consequence, energised. When the proximity plate is approached, oscillator frequency drops, causing the rectified voltage given by the OA79 to rise, the collector current of TR_2 to increase, and the collector current of TR_3 to drop. The relay then de-energises.

Design Features

There are some features in the design which require a little further explanation.

Since the varying capacity to earth given by the proximity plate as it is approached will not be large, it is desirable to keep fixed capacities across the oscillator tuned winding, L_1, to a minimum. In the circuit, a 10pF fixed condenser is connected across L_1, this value being the minimum required to ensure reliable oscillation when the proximity plate is connected to the unit by a yard or less of thin unscreened wire. If the capacity to earth of the proximity plate and its connecting wire is liable to be of the order of 10 to 20pF, C_2 may be deleted. Screened wiring to the proximity plate (with the outer conductor connected to chassis) is best avoided unless the self-capacity between inner and outer conductors can be kept to a value around 15pF. The most desirable installation would employ a short unscreened lead, the detector unit being mounted close to the proximity plate. Since the unit can be made with quite small overall dimensions, such an installation should cause little inconvenience in practice. It is advisable to bear in mind, also, the fact that the capacity to earth of a thin connecting wire will be less than that of a thick wire, and that a thin connecting wire should, therefore, be used. Another argument against a long lead to the proximity plate is that this may cause excessive radiation at oscillator frequency, causing possible interference with neighbouring receivers.

In order to increase sensitivity, the chassis of the proximity detector should be connected to earth, or to any adjacent large metal area. The series condenser C_1 is merely an isolating component, and prevents any damage due to high voltages being accidentally applied between the proximity plate and the chassis.



The coil specified in the oscillator circuit (L_1L_2) is a readily available Medium wave r.f. coupling type. The component values specified in this part of the circuit are applicable to this coil only; other coil types will almost certainly require alternative component values. It may be found necessary to modify the value of C_7 in the circuit after construction has been completed, and this point is discussed later when the setting up process is described.

The coil used in the L_3 position may be a high-Q Medium wave tuned winding having an adjustable iron dust core. In the prototype the writer employed the tuned winding of a second Osmor QHF8 coil (no connections being made to the coupling winding) and this proved to be entirely satisfactory. "Aerial coils" having a large number of turns on the coupling winding should not, however, be used, as the high-inductance coupling winding may have undesirable absorption effects on the tuned winding.

The diode specified for the OA79 position is not a critical component, and most alternative crystal diodes should function equally well in its place. Rather the same comment applies to the OC72 shown in the TR_2 position. Most general purpose a.f. transistors would probably function equally well in its place, although they may require alterations in the values of R_6 or R_8.

The variable resistor R_7 maintains TR_3 on its correct operating point without bottoming, and contributes to the overall sensitivity of the proximity detector. It is a pre-set component.

The circuit around TR_3 is designed to allow this transistor to control the robust relay specified in an efficient manner, and the constructor is strongly recommended to employ a relay of the correct type. That specified is a Post Office type 3,000 unit with a coil resistance of 500Ω. With two contact sets, this relay operates very reliably at an energising current of 20mA. More than two contact sets should not be used, as energising current would become excessive in consequence. Under no circumstances should a relay having a coil resistance less than 500Ω be used.[1]

Although not essential, it would be preferable to clamp the OC72 in the TR_3 position to a heat sink, the latter having the minimum dimensions of $1\frac{1}{2}$ in. square. To ensure, also, that TR_3 is not operated too close to its maximum dissipation figure (and to provide reliable relay operation) the power supply voltage should be reasonably well regulated, a desirable figure being better than ± 2 volts on 12 volts.

The OA70 connected across the relay coil prevents the formation of high reverse voltages across the relay coil. Such voltages would otherwise appear if the energising current were suddenly reduced in value. It is essential to connect the OA70 with correct polarity, or damage to TR_3 may result.

Construction and Setting Up

Construction should raise few problems provided that a reasonably careful layout is followed. The stages should be positioned on the chassis in "logical" order, i.e. with the relay at the opposite end of the chassis to the proximity plate terminal. Care should be taken to see that no inductive coupling exists between L_1L_2 and L_3. If there is no screening between them, these two coils should be mounted some distance apart with their axes at right angles to each other. Stray wiring capacities across L_1 should be kept to a minimum.

After the unit has been completed it needs to be set up. For this process a meter capable of reading 25mA has to be inserted in series with the negative h.t. supply to the relay coil. An alternative method of measuring relay coil current consists of connecting a high resistance voltmeter across the coil, its readings then being converted to current figures. Thus, to take an example, a reading of 10 volts across the 500Ω relay coil would indicate a current flow of 20mA.

Having ascertained that all connections are correctly made, R_7 should be set approximately in mid-position, and the core in L_1L_2 adjusted to provide maximum coupling between the tuned and coupling windings. The proximity plate and its lead should next be connected, these being kept in a position where they cannot be accidentally approached. The power supply should be at its nominal 12 volts. (Since TR_3 operates with a low resistance collector load, some constructors may prefer to initially raise the power supply voltage from a low figure after switching on, this ensuring that incorrect connections do not cause this transistor to pass an excessive collector current.) The unit may now be switched on.

Unless the tuned circuit C_8L_3 happens to be at, or close to, oscillator frequency, the current flowing through the relay coil should be negligibly low, certainly less than 0.25mA. C_8 should now be adjusted until a rise in relay coil current is seen. As soon as this has been observed C_8 should be adjusted for optimum relay coil current, R_7 being set such that this is around 16mA. When C_8 has been finally adjusted, R_7 may be advanced to bring relay coil current up to 20mA. During the setting up process care should be taken to ensure that relay coil current does not rise above 23mA. The unit may now be checked by bringing the hand close to the proximity plate. When it is sufficiently close, relay coil current should drop to a negligible value, causing the relay to de-energise. The relay will energise again when the hand is taken away.

With the prototype it was found that the final setting of C_8 was rather sharp, and that this setting was a little difficult to obtain because the trimmer was close to maximum capacity. If the same difficulty is experienced by the constructor it might prove helpful to connect a silver-mica condenser of some 30 to 50pF across the trimmer, thereby bringing its final setting close to minimum value. Alternatively, final tuning of C_8L_3 could be carried out by adjusting the core of the coil.

If, after completion of the unit, it is felt that oscillator operation is unreliable this may be checked by coupling the oscillator to a Medium wave broadcast receiver Adequate coupling would be provided by holding a wire from the receiver aerial socket close to L_1L_2. It should be possible to obtain clean heterodynes at the high frequency end of the Medium wave band with stations close to oscillator frequency, the latter being varied if necessary by moving the hand relative to the proximity plate. (This test is preferably carried out in the evening or at night, when stations can be received at all points of the Medium wave band.) Should the oscillator cause a loud hiss to be heard in the receiver it is squegging, this effect being cleared by reducing the value of C_7. The purpose of the receiver test is to ensure that squegging does not occur.

Results with the Prototype

The proximity plate employed with the prototype consisted of a flat metal sheet measuring 6in by 8in. When the hand was brought within 2in of this plate, relay coil current dropped from 20mA to a negligible value. When an insulating material having a dielectric constant greater than that of air was interposed between the proximity plate and the hand it was found possible to increase the distance between the two. Two bound volumes of *The Radio Constructor* (total thickness $3\frac{1}{4}$ in) were placed on the plate. When the hand was laid on top of these volumes relay current dropped once more from 20mA to a negligible value.

It will be noted that, in both the instances just given, reference is made to the relay coil current dropping to a negligible value. Such a current is obviously much less than the de-energising current for the relay, but the fact that the results are presented in this manner emphasises the de-energising reliability of the circuit.

The total current drawn by the prototype for an applied h.t. voltage of 12 was 21.7mA when the proximity plate was not approached, and 1.7mA when it was.

[1] A suitable relay, fitted with two sets of change-over contacts, is available from H. L. Smith & Co. Ltd., 287 Edgware Road, London, W.2.

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

Peto Scott "Trophy-8" Receiver.—G. Boote, 20 Forest Row, Stevenage, Herts, wishes to obtain the circuit of this communications receiver.

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R1392D and E Receiver.—J. F. Gateley, 25 Ebers Road, Mapperley Park, Nottingham, would like to borrow, purchase, or receive information where to obtain the manual for this set.

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CR100/B28 Communication Receiver.—J. F. Dowden, 15 Wheatlands Road, Upper Tooting, London, S.W.17, needs to obtain the manual and also any details available on adding an "S" meter.

Pye Receiver.—N. F. Cass, 60 Briardale Road, Liverpool 18, enquires if any reader can identify his set. Approximately 18in high, square dial, tuning indicator, 4 wavebands (Long, Medium and 2 Short waves). Valve line-up: A80A, VP4A, TDD4, A50N, A70C, 1W4/350.

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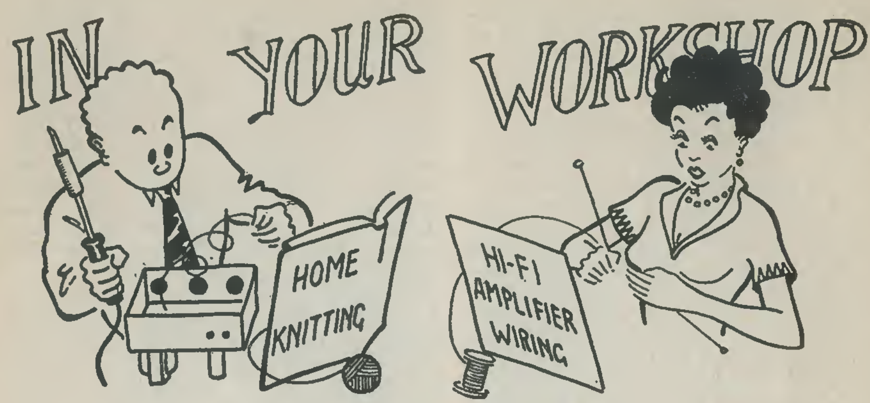
Collaro Mk. IV Transcriptor.—J. D. Booth, 45 Loughborough Road, Mountsorrel, Loughborough, Leics, would be interested to hear from any reader who has converted to stereo and, in particular, ideas for using both tracks simultaneously to achieve this.



This month Smithy the Serviceman and his able assistant Dick do a little overtime and discuss the latest hints received from readers

"... *And the next 'Tonight' will be tomorrow night. Good night!*"

Cliff Michelmore faded from the screen and Smithy settled himself even more comfortably in his armchair. It had been an irritating day, and his evening's relaxation was all the more welcome in consequence.

The picture on his receiver rolled up once as it changed to a young lady with an elaborate and precarious coiffure who proceeded to extol the merits of the *Radio Times*. Smithy listened with half an ear only as his mind meandered dreamily on the problems faced by B.B.C. engineers in maintaining unbroken frame lock from one programme source to the next. The young lady was replaced (without, Smithy observed with satisfaction, any further picture rolling) by a newsreader bringing the latest tidings of the world's violence, murder and mayhem to the cosy atmosphere of Smithy's fireplace. There was a film sequence in the short news bulletin, and Smithy leaned forward eagerly to compare its definition with that of the live studio signal.

Completely absorbed, Smithy was enjoying his evening's television entertainment in his own peculiar way.

Back to Work

"Damn!"

The sudden ejaculation burst from Smithy's lips just after the news bulletin came to an end and the screen indicated the time as 7.30. He stood up irately and snapped off the receiver. Within a few minutes he was in his car, driving bad-temperedly back to the Workshop.

Smithy's choler was not eased, when, on approaching the Workshop, he found that the atmosphere was rocked by Elvis Presley's "Lonely Man" reproduced at a sadly overloaded single-ended three watts, together with a violent percussion accompaniment which could only have been given by one of the long-suffering Workshop soldering irons being beaten against the even more long-suffering Workshop kettle. Smithy fought his way in, then slammed the door behind him with a resounding bang.

There was a sudden crash as the startled Dick turned round and dropped his implements. After one glance at Smithy's apoplectic expression he hastily switched off the record-player on his bench. The echoes died gradually away.

"Corluvaduck," gasped Smithy's assistant. "You didn't half give me a start! What are you doing here at this time of night, anyway?"

"I could well", fumed Smithy, "ask you that myself."

"I'm doing a bit of homework," said Dick. "You've always told me that an excellent way of learning servicing is to build your own sets, and that's just what I'm doing now. In", he added virtuously, "my spare time, too."

Smithy looked at Dick's bench and noticed the neat five-valve chassis which his assistant indicated. Dick had obviously devoted a considerable amount of time to its construction, and he had taken great care with its layout and wiring.

"Well," Smithy remarked grudgingly, walking over to his own bench and pulling out a television chassis. "I won't say that what you're doing isn't a good thing."

The Serviceman connected the television chassis to the mains and an aerial and switched it on.

"What is your set going to be when it's finished?" he continued. "Also, may I ask why its construction necessitates your bashing the life out of valuable Workshop equipment?"

"The set", said Dick, "is going to be a Long, Medium and Short wave superhet. "Because I suddenly remembered that I'd promised the set by tomorrow, and I don't want to let the customer down."

Smithy changed channels disgustedly.

"There you are," he continued, "a perfect picture on both channels!"

"Do I presume", said Dick, "that the set has an intermittent?"

"It has an intermittent," confirmed Smithy flatly. "It would have! Oh, well, I suppose I can't do worse than sit down for a bit and see if the fault shows up."

More Hints

Smithy flopped down dejectedly, and Dick decided to inject a little light into the Serviceman's sombre thoughts.

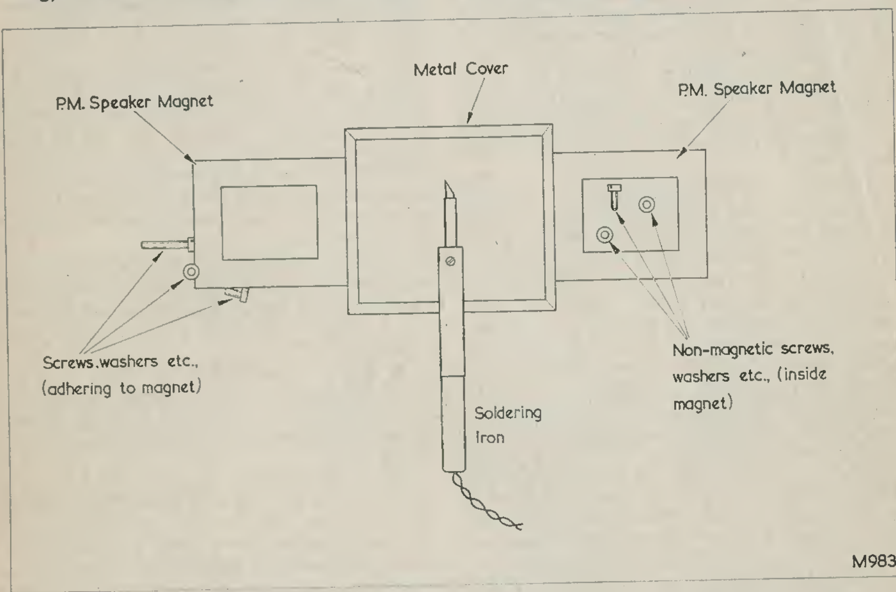


Fig. 1. An assembly which offers the combined functions of a weighted soldering iron rest and a holder for small ferrous and non-ferrous nuts and bolts

As for the music—well, I've been coming round each evening for the last three weeks or so, and it gets a bit lonely in here on your own. I just thought I'd bring round a few records tonight for company."

Smithy nodded absently as the receiver on his bench warmed into life. A picture appeared on its screen accompanied by sound at good quality from its loudspeaker.

"That picture", he remarked bitterly, changing the subject abruptly, "is what I should be looking at in the comfort of my own home!"

"Then why've you come round to look at it here?"

"Talking about records," he remarked artlessly, "if you put all Elvis Presley's records on top of each other, do you know what you'd get?"

"No," replied Smithy unguardedly. "What would you get?"

"You would get", grinned Dick, "a very tall column with a hole going right down the middle."

Despite himself, Smithy chuckled.

"O.K.", he laughed. "Well, it looks as though I have to spend the next hour or so in the Workshop waiting for that set to go wrong. So there's no point in my being grumpy about it."

A thought suddenly struck him, and he brightened considerably.

"Do you know, we haven't had a session on hints and tips for quite a while," he continued, going to a drawer. "How about us having one now?"

"That'd be fine."

Smithy produced a pile of letters.

"I've got a jolly good selection this time," he remarked, choosing a letter. "Here's the first, and it really includes two hints.[1] 'Obtain a couple of square type magnets from old p.m. speakers, together with a metal cover such as is used on the bottom of tuner units, and assemble as shown in the diagram. (Fig. 1.) Position this on the back of the bench and put all set-fixing screws etc., on to the magnets, where they remain safely out of the way. At the same time the weight of the magnets keeps the soldering iron stand in position. The stand is, of course, the tuner unit cover. When disassembling sets you merely throw screws in the direction of the magnets, whereupon they stick there, ready for re-use'."

"That's neat," remarked Dick. "I've used Ferroxdure focus magnet rings for screws in the past but you can't, of course, put those into a complete assembly such as this."

"Quite so," said Smithy. "Now, the second hint in this letter has to do with preventing scratches on cabinets. You can, of course, use pieces of felt on the bench to avoid this sort of thing, but you have to watch out for blobs of solder, which don't shake easily off the felt. A better plan is to use rubber or plastic door mats. The type required are smooth underneath so that the chassis or cabinet can be swivelled round easily whilst, on the top, they have small sunken square 'wells' which are about $\frac{1}{4}$in deep or more. The blobs of solder, and any other debris, fall into these depressions, and no damage can occur to the cabinet resting on top."

"That's neat, too," commented Dick.

"Isn't it? Now, here's another tip.[2] The letter says: '. . . if a d.c. source is used to test the continuity of tape recorder heads they may become magnetised. A simple way of overcoming this problem is to check continuity with the aid of a.f., as obtained from the extension loudspeaker sockets of a radio. Just connect up the head in series with a pair of high resistance phones and operation of the phones will confirm if the head is open circuit or not.' "

"Isn't there a risk here of still magnetising the head if you break the test connection during a half-cycle of loud a.f.?"

"There might just possibly be," admitted Smithy. "So I think I should add that it might be preferable if the a.f. were obtained from the extension speaker sockets of a mains receiver. After checking the head you could then switch the receiver off. The electrolytics in the set would cause the a.f. to taper off in amplitude, and you could then break your test connection to the head."

"Nothing like being cautious," grinned Dick.

"There isn't, indeed," said Smithy, selecting another letter. "This time we have an idea which is really ingenious.[3] It employs the plastic outer covering from coaxial cable, together with any blown cartridge fuse-links which happen to be lying around. The first application for the covering is to use a length of it, in company with a standard $1\frac{1}{4}$in fuse, as an extension spindle coupler. (Fig. 2 (*a*).) The coax sleeve is simply pushed over the $\frac{1}{4}$in spindle, whereupon the grip it provides is tight enough for all normal components except switches. You could stick a knob on the metalwork of the fuse if you liked by making the latter stick out a bit, or you could adjust the control by gripping the sleeve itself.

"Another application for this fuse and plastic sleeve idea has to do with those little printed circuit pots with integral screwdriver slots. (Fig. 2 (*b*).) Do you know the type I mean?"

"I know," said Dick, a little bitterly. "Sometimes they're hidden in the undergrowth, and you short out half the works when you try to adjust them from the back of the set!"

"You speak for yourself," commented Smithy primly. "In any case, this present idea could be used to overcome this trouble. You tin the pivot disc around the screwdriver slot of the pot, and solder a small 5 x 20mm cartridge fuse to it. You then slip a bit of coaxial outer sleeve over the use, pop another fuse in at the other end and, hey presto, you've got an extension coupler!" (Fig. 2 (*c*).)

"Well, I'm dashed," remarked Dick. "That's ingenious."

"I think", said Smithy, "I should add a little word of warning here, though. These little pre-set pots are fairly fragile and you want to do the soldering fairly quickly in case they become faulty or seize up. There are, also, several makes and designs, and new designs are presumably introduced from time to time. So you should check, before soldering, that the pivot disc *does* go round with the slider!"

[1] Contributed by R. Mansell, Redditch, Worcs.

[2] Contributed by J. A. Maltby, Northampton.

[3] Contributed by A. Thorndyke, Bush Hill Park, Enfield, Middlesex.

Dick's Hint

"I've just thought", broke in Dick, "of a little hint of my own."

"What's that?"

"It's nothing really," said Dick modestly. "Just two unusual applications for diagonal wire nippers. If, for instance, you're trying to loosen a screw whose nut is in an awkward corner and which keeps turning, it is often a good idea to apply the nippers to two opposite flats of the nut. The nipper cutting edges bite into the flats and hold the nut still even if it is a really tight fit on the screw. This tip applies especially to those nuts which don't fit nicely into standard spanners."

"What's the other application?"

"Diagonal nippers", stated Dick, "are jolly good for cutting big toe nails, too."

"Charming," commented Smithy.

There was silence for a moment.

"Oh well," said Dick eventually. "Perhaps that's not such a good idea after all."

"Not to worry," replied Smithy, looking through his letters. "Now let's see what else we have here! Ah, this next hint is for a test prod.[4] We've had test prods rather like this one before, but the present idea is so simple that it's well worth passing on. It's based on an ordinary ball-point pen having a long transparent plastic body. After the ink has run out you remove the brass piece holding the ball-point from the bottom with a pair of pliers. The removal has to be done rather carefully, by the way, because the tapered end of the plastic body tends to be brittle. The polythene tube ink reservoir comes out with the brass part and this is next removed, after which the brass piece is cleaned free of ink with carbon tet.

"All you do now is to fill the hole left by the polythene tube with solder, then solder into that hole an insulated flexible test lead and re-assemble. (Fig. 3.) Piece of cake, isn't it?"

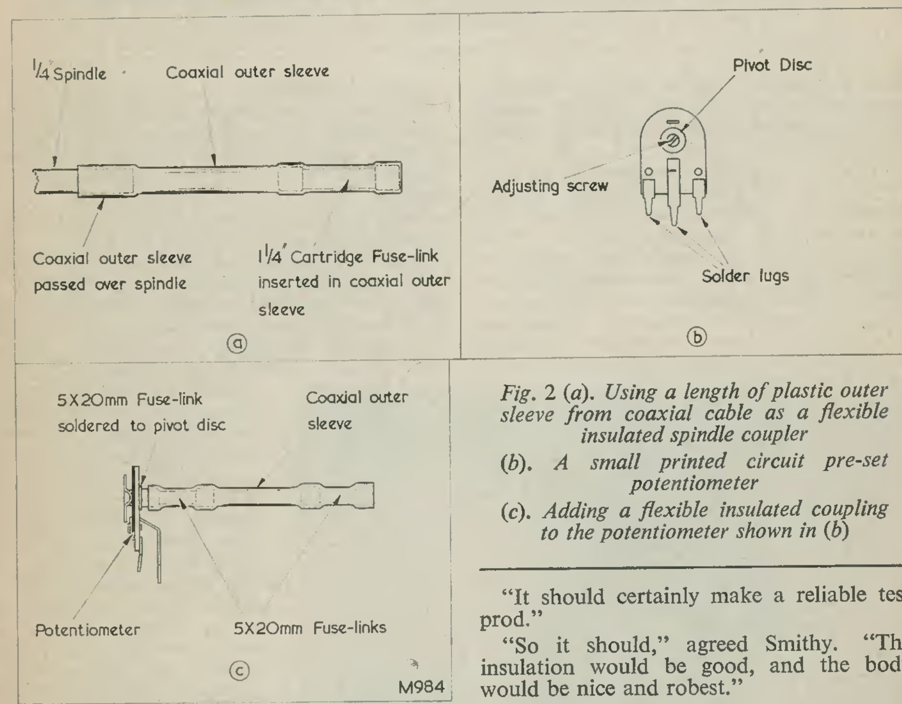


Fig. 2 (*a*). *Using a length of plastic outer sleeve from coaxial cable as a flexible insulated spindle coupler*

(*b*). *A small printed circuit pre-set potentiometer*

(*c*). *Adding a flexible insulated coupling to the potentiometer shown in* (*b*)

"It should certainly make a reliable test prod."

"So it should," agreed Smithy. "The insulation would be good, and the body would be nice and robest."

"Any more ideas?"

"There's an excellent one here," said Smithy, picking up another letter. "This one describes a screened jack socket.[5] 'When making up extension leads for a microphone it is usually necessary to have a screened jack socket. These are often difficult to get and are expensive. The small, screw-topped cans in which 35mm film is sold make excellent screening cans. A hole is made in the lid to take the threaded bush of the socket, whilst a second hole in the base of the can is fitted with a grommet for the cable. The socket

[4] Contributed by B. W. Hollinshead, Abingdon, Berks.

[5] Contributed by P. R. Travers.

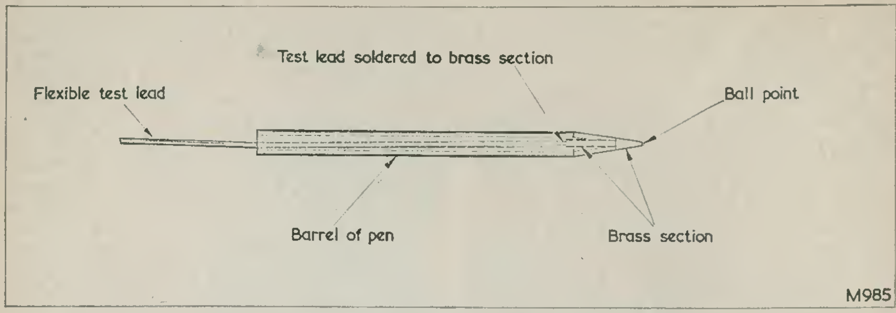


Fig. 3. A reliable and robust test prod may be easily constructed from an exhausted ball-point pen

must be mounted slightly off centre to allow room for the tags to fit into the can.' Look, here are a couple of photographs illustrating the construction."

Dick examined the photographs carefully.

"Now here", continued Smithy, "is yet another tip.[6] 'When I have a small quantity of screws, bolts, tags, grommets, etc., to be stored for fairly immediate use'," read the Serviceman, "'I sort them out into the compartments formed in the sheets of dimpled pasteboard in which eggs are stored, and stock these on top of each other in a drawer. In damp weather three drops of oil in each dimpled section soon saturates the whole board without impairing its rigidity.'"

"I like that," remarked Dick. "We can't move for egg containers at home."

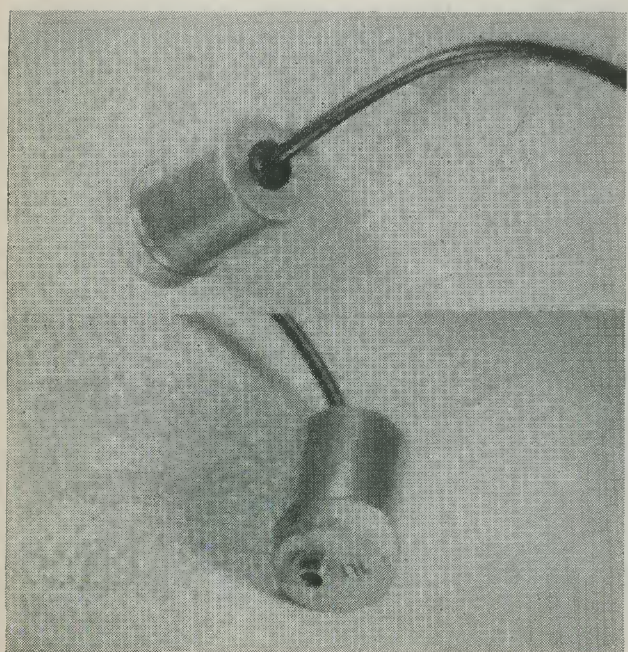
Smithy looked thoughtful.

"I suppose you *could* use egg containers also," he remarked musingly, "for sticking on the walls of, say, an anechoic room."

"Not with *my* family, you couldn't," said Dick promptly. "Although it would be contemporary, I suppose. Anyway, what *is* an anechoic room?"

"It's a room without echoes," explained Smithy, "which is normally used for testing speakers or microphones. But perhaps that's a bit advanced for our present line of country. What I was pondering about, rather, was ways and means of killing reverberation in amateur tape recording studios and places like that. You could, for instance, kill the echo from a flat wall by covering it with egg containers, the 'spikes' pointing away from the wall."

[6] Contributed by J. Anderson, Bramhall, Cheshire.



Two views of a simple and inexpensive screened jack socket

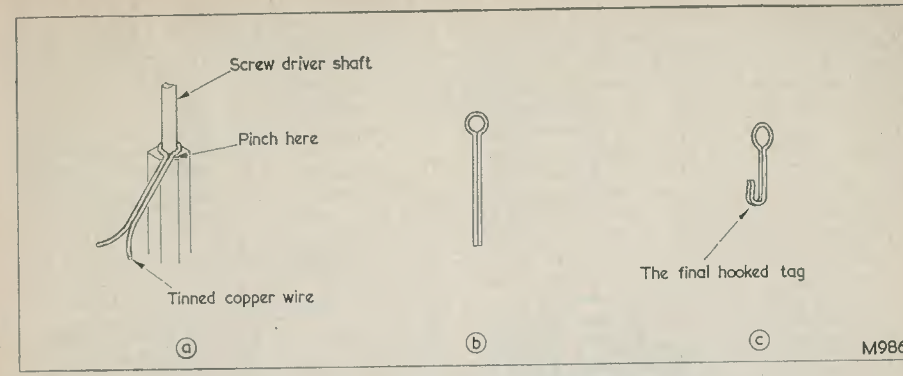


Fig. 4. Successive stages in the formation of a simple solder tag

Dick looked supremely unimpressed.

"It was just a thought," said Smithy hastily. "Anyway, I'll now carry on to the last hint, or pair of hints, rather, for this particular sesh.[7] I'll read what the letter says. 'Finding oneself in a situation with no available solder tags, the following wrinkle will get one out of a jam and produces a neat job. A short length of tinned copper wire is passed around a slender screwdriver shaft and pinched up with sharp-nosed pliers to form a loop. The two free ends are kept close and solder run down to secure them together and tin the surface. The ends are then cut fairly short and bent back to form a hook. The "tag" so formed can be mounted under its nut and bolt and the connecting wires passed into the hooked end, which is then pinched tight. The application of solder makes a final firm joint.'" (Fig. 4.)

Smithy paused for a moment.

"That's the first hint of the pair," he continued. "The second goes like this. 'Caught without a brass slug when I wanted to raise the frequency range of a coil wound on a $\frac{3}{8}$in Aladdin former, I struck upon the following idea after searching for a large enough bolt with the correct thread. I always keep the sawn-off shanks of potentiometers, and a $\frac{1}{4}$in rod will just slip down loosely inside the threaded tube of this size of former. A bit of brass shank was selected and about 1in cut off. (Fig. 5.) After making a slot at each end to take a screwdriver, a single layer of adhesive tape was stuck round the rod so that the slight overlap would be pressed down by clockwise rotation. This core was found to work beautifully, and could subsequently be screwed down or up quite easily, at the same time having ample friction to stay put when correctly set.'"

"And very good, too," commented Dick.

[7] Contributed by M. J. Dunn, Ilfracombe, Devon.

"*All* the hints have been good," said Smithy, "and I think that this has been one of the best sessions we've had for quite a little while. I hardly need to add that we're always interested in hearing about new gadgets, servicing dodges, and any other bright ideas; and that we always like to pass them on."[8]

Intermittent TV

Smithy turned round and glared balefully at the television receiver on his bench. Serenely, it continued to present a perfect picture.

The Serviceman sighed. It seemed he would have to wait a little while yet for the fault to appear. He diverted his attention to Dick's home constructed receiver.

"Well," he remarked, "you seem to have made quite a nice job of that set you're building."

Dick beamed.

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

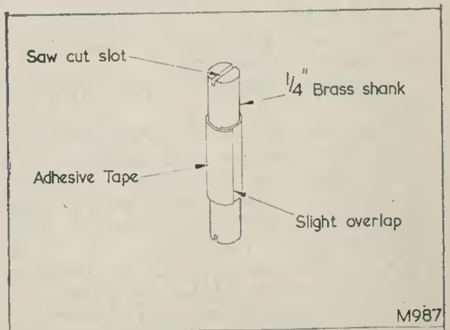


Fig. 5. A brass slug suitable for use with $\frac{3}{8}$in threaded formers

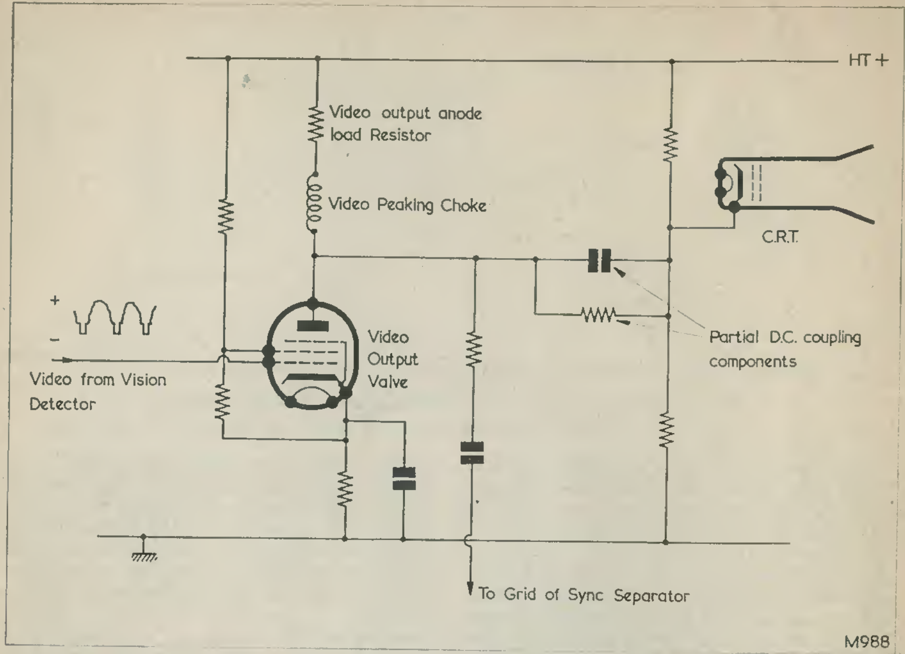


Fig. 6. A typical video output stage illustrating the peaking choke fault located by Smithy

"I *did* take a little care over it," he said. "I decided I'd make everything as neat and tidy as I possibly could so that the completed job would show the touch of the master craftsman!"

"There's nothing like being modest," said Smithy.

"Last night", confided Dick, "I soldered in the very last resistor. Unfortunately, it was so late that I didn't have time to try the set out. I was just warming up to start checking it tonight when you burst in."

"Warming up?"

"With just a little music. One needs to create the mood, you know."

A suspicion suddenly crossed Smithy's mind.

"Where did you get the components?"

Dick looked a little uncomfortable.

"Oh, *those*," he said quickly. "Why, I found a small stock of parts lying around, and it gave me everything I wanted. Even the valves and the two-gang."

Smithy was just opening his mouth to reply when he noticed that the picture had disappeared from the screen of the television receiver on his bench. Forgetting everything else he rushed over and examined it.

"It's happened," he called out joyfully. "That intermittent's come on!"

Dick turned round interestedly and looked at the set, which now displayed a faint blank raster. The sound channel continued to be heard from the speaker. Smithy switched channels to make certain that a transmitter fault on one channel had not caused the loss of vision. There was sound, but no picture on both channels.

"The time bases," remarked Dick, looking at the raster, "are still running."

"Indeed they are," confirmed Smithy. "I'm in a hurry tonight, and so I'm going to do a few quick short-cuts. The first thing I notice is that the line output transformer whistle sounds a bit low in frequency to my ears."

Dick had long suspected that some mysterious process, akin to Natural Selection, had caused Smithy to be born with ears having an extra chamber sharply resonant at 10,125 c/s. He accepted the Serviceman's statement without protest.

"I'm now", continued Smithy, "pulling out the aerial plug to see what happens. As even your untutored ear will tell you, there is not the slightest change in the note of the whistle. Nor is there when I pop the aerial back again. This set has direct, instead of flywheel, sync and this check means that not only do we have no video getting to the tube but it's doubtful if we have any going to the sync separator either. If there *had* been a change in note as I disconnected the aerial or when I re-connected it we could have assumed that video was getting to the separator."

Smithy reached over for his testmeter.

"Right!" he said briskly. "Now we've still got sound, so we can assume that the tuner is O.K. Therefore, the fault most probably lies in the vision i.f. strip or the video amplifier; that is, at some point in the vision chain between the tuner output and the sync separator input."

"The latter being the same as the anode of the video output valve?" proffered Dick.

"That's pretty well the size of it," confirmed Smithy. "A little judicious voltage prodding along the i.f. stages seems now to be indicated. Here's the first i.f. valve. There's a volt or so on its cathode and plenty on its screen-grid and anode. So things look pretty reasonable here. Let's try i.f. valve No. 2. This gives us the same story: a volt or two on the cathode and plenty on the screen and anode. So we'll forget these two stages for the time being."

"Dash it all," protested Dick, "you're making some pretty risky assumptions, aren't you?"

"Not at this stage," replied Smithy. "I'm just doing quick checks for obvious things; and there's nothing quicker than voltage prodding with a testmeter. If I don't find anything obviously wrong then, of course, I shall *have* to start digging a bit deeper. The video output valve is the next stage within the field of operations. Hallo, what's this?"

"What have you found?"

"Cathode voltage is down to about a volt," replied the Serviceman, "which means that the valve isn't drawing a lot of current and its cathode potential is maintained by the usual fixed resistor potentiometer you have across the h.t. supply. Or, that no positive-going signal is being applied to its grid. The screen voltage is a bit low and —oh, here we are!—the anode voltage is down to about 15 volts."

Smithy settled himself a little more comfortably at his bench.

"We're on the home run now, Dick lad" he remarked. "If you look at the service sheet for this set you'll find that the anode couples up to h.t. positive via a peaking choke and a series resistor, and that there's also a partial d.c. coupling to the tube. (Fig. 6.) It could well be that the anode resistor or choke has given up the struggle and that we're still getting a bit of h.t. on the anode via the partial d.c. coupling. The anode gives me 15 volts, and when I apply my test prod to the junction of the peaking choke and the resistor, I get no less than the full 200 volts given on the h.t. positive rail."

"Which means," said Dick, "that the peaking choke has gone decidedly up the wall."

"Nothing less," confirmed Smithy. "Before I go tonight I'll pop in another choke just to make certain I've cleared the fault. Then I'll box up the set first thing in the morning."

"I'll put in the new choke for you, if you like," volunteered Dick. "It won't take me a moment."

"O.K.", said Smithy. "Many thanks."

That Problem

Smithy watched as Dick replaced the choke.

"I've had quite a few video peaking chokes go open recently," he said. "There seems to be a mild plague of them these days."

"The trouble with most peaking chokes", commented Dick, as he wielded the soldering iron, "is that they're often covered all over

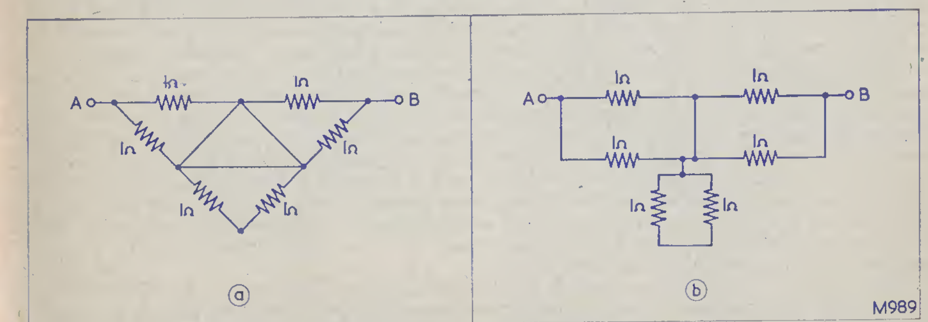


Fig. 7 (a). Smithy's simple problem, published in last month's issue. What is the resistance between terminals A and B? (b) If the circuit is re-arranged it will be seen that the resistance between the terminals is 1Ω with wax or bitumen, and you can't see the joints between the coil wire and the lead-outs."

"That's true enough," said Smithy. "If the factory makes a cold joint between the coil wire and the lead-out wire it may be ages before the fault finally shows up in the field."

"By the way," said Dick. "I solved that little problem of yours. You know, the one with the six 1Ω resistors in the triangular pattern." (Fig. 7 (*a*).)

"What did you make the resistance between the two terminals?"

"One ohm."

"That's right," said Smithy. "I told you it was easy! If you redraw the circuit you find that the bottom two resistors are really shorted out (Fig. 7 (*b*)), and what you have left are two 1Ω resistors in parallel, which are connected in series with another two 1Ω resistors in parallel. Total resistance between the terminals is, therefore, 1Ω."

Dick's Receiver

By now Dick had completed the replacement of the video choke and he switched on the receiver. It worked perfectly.

"I'll just check that video output anode voltage before finalising," said Smithy, moving towards the set and picking up his test prods, "just in case there *is* any excess current flowing through the choke. Ah, the anode's reading 150 volts, so I think we're pretty safe now. I'll also check the video output valve in the morning, as it's had a pretty heavy pasting in regard to screen dissipation because of that open anode circuit. And now I'm going home!"

"I think I'll pack up, too," said Dick. "It's getting later than I thought. I'll put off trying out my set till tomorrow night."

He handed Smithy the open-circuit video choke.

"Thanks," remarked Smithy. "I've got a special box for components like this."

The Serviceman rummaged on the floor under his bench and produced a large cardboard box full of components. As he nonchalantly dropped the video choke into it, Dick regarded him with horror.

"*What* did you say that box was for?"

"Duffy components," replied Smithy. "Components which have gone wrong without any visible indication. I put them in this box to keep them safely out of the way."

"Aren't there *any* serviceable parts in that box?"

"Not one," replied Smithy, cheerfully. "They're all open-circuit or high-value resistors, leaky or shorted condensers, valves with inter-electrode shorts, and all manner of things like that. There's not a working component in the lot."

Dick sat down and gazed in anguish at his receiver.

"Ye gods," he wailed. "I've spent three weeks in making that set. And every single component I've used came out of that blasted box!"

Book Review . . .

International Transistor Data Manual. 147 pages, 7 in x 9½ in. Compiled and published by AVO Ltd. Editor: C. E. Bull. Price 35s.

Transistors are going through rather the same phase, so far as standardisation is concerned, as occurred with valves in the years before the last war. This fact is brought home in the *International Transistor Data Manual*, which provides data on approximately 3,000 types, and which lists no less than 53 different transistor lead-out wire layouts. A rather sad commentary on the present lack of standardisation is given by colour codings: some transistors, for instance, employ blue for collector and red for emitter, whilst others reverse this code.

The book under review covers transistors from 90 manufacturers and distributors in America, Japan, Australia and East and West Europe including, of course, Britain. Also listed are transistors having Services CV specifications. Transistors are listed in strict numerical/alphabetic order and are then detailed under the following headings: Manufacturer, Type (p.n.p. or n.p.n.), Connection Layout, V_{ce} (at which I'_{co} and β should be measured), I'_{co} (typical and maximum), I_b, I_c, β (typical and maximum), Typical Noise, and Maximum Ratings (V_{ce}, I_c, and P_c). One or more of these parameters may be omitted for a particular transistor when they are not applicable or cannot be reliably quoted. A column for Remarks, which may be employed by the reader, is also included.

The manual is intended for use with the AVO Transistor Analyser, but the information is provided in such a manner that it is readily available for general use. An especially pleasing and commendable aspect is the extremely clear layout employed. The transistors are listed in groups of five down the page, whereupon the eye is able to follow a particular horizontal line of characteristics without strain.

J.R.D.

UNDERSTANDING TELEVISION

PART 40

By **W. G. MORLEY**

The fortieth, and last, in a series of articles which, starting from first principles, describes the basic theory and practice of television

In last month's issue we introduced the subject of television aerials, and showed how the basic dipole aerial, in its simple or folded form, provides the basis of current television aerial arrays. We briefly covered the most common "outdoor" aerials employed in the U.K.; and we shall now carry on to "indoor" aerials.

Practical "Indoor" Aerials

In localities where television signals are received at good strength it is possible to achieve adequate reception with the use of "indoor" aerials. A number of special designs are commercially available for Band I, and these will first be considered.

Fig. 242 (*a*) illustrates an inverted-V aerial, which has the advantage that it may be mounted high up in a house immediately underneath the roof itself. The two members of the inverted-V aerial constitute a dipole, and the fact that they are at an angle to each other makes the aerial capable of receiving signals having either horizontal or vertical polarisation. A typical horizontal polar diagram for an inverted-V aerial is shown in Fig. 242 (*b*). As may be seen, there is a sharp reduction in sensitivity at right angles to the aerial, and advantage may be taken of this fact if it is desired to reduce the strength of an unwanted signal arriving at the aerial from a different direction to that of the transmitter.

Fig. 242 (*c*) illustrates a V aerial which is capable of being mounted on the joists of a loft. The horizontal polar diagram of this aerial is the same as for the inverted-V, but it cannot, of course, be mounted in quite as high a position in the house.

Another aerial, suitable for mounting to the joists of a loft is the inverted-T, as shown in Fig. 242 (*d*). With this aerial, one of the feeder wires connects to the vertical member, whilst the other connects to the junction of the two horizontal members. The inverted-T aerial is rather similar to the quarter wave aerial shown in Fig. 234 (*a*)[1]—but the conducting surface below the vertical member is not continuous, since it consists of the two metal rods only. The inverted-T aerial tends to have slight directional properties.

An aerial suitable for mounting against any vertical non-conducting surface in a house is shown in Fig. 242 (*e*). The upper member of this aerial is a rod, whilst the lower member is flexible. Both members are approximately a quarter wavelength long, and the whole assembly forms a dipole. The aerial is intended to be mounted such that the upper rod is vertical and extends as high as the available space will allow. The lower member may then be positioned to suit space limitations, it being run vertically down from the centre as far as possible and then turned through a right angle. An alternative to the aerial of Fig. 242 (*e*) could have both upper and lower members flexible.

All the aerials shown in Fig. 242 are intended for Band I reception, and in each case the purpose of the design is to enable the relatively long element lengths required at Band I frequencies to be conveniently contained within the restricted space normally available inside a house. Band III aerials, whose elements are much shorter, can normally be readily installed in a loft or

[1] Published in last month's issue.

similar location; and it is possible to fit a standard Band III array consisting of, say, a dipole, a reflector and a director, inside a house immediately under the roof.

"Indoor" aerials of the type we have been considering have the advantages over "outdoor" aerials that they may be installed cheaply, and that they are not subjected to the weather. On the other hand, receiver signal strength is, of course, lower.

An alternative type of "indoor" aerial is the V, or "rabbit's ears", non-fixed aerial, a typical example being shown in Fig. 243 (*a*). Such aerials are suitable for Band I and Band III, and consist of two rods mounted on an insulated base which may be positioned close to the receiver. The rods in this type of aerial are usually telescopic and they are fixed to the base by universal joints. In consequence, the rods may be extended to any length within their range and positioned at any angle relative to the base, adjustments being made to provide the combination which offers optimum reception conditions. In a simple design the feeder conductors could connect directly to the rods, but it is usual practice to insert series condensers or inductors at the base in order to modify the performance of the aerial. "Rabbit's ears" aerial rods may be fitted directly to the cabinets of portable television receivers, in which case they are adjustable in the same manner as occurs with the separate assembly.

An alternative aerial for portable television receivers is shown in Fig. 243 (*b*). In this case a single vertical element is used. The element functions largely as a quarter wave aerial, the reflecting surface being provided by the chassis of the receiver inside the cabinet. The rod may be telescopic or it may have a fixed length suitable for the channel it is desired to receive. The assembly of Fig. 243 (*b*) causes aerial currents to flow in the receiver chassis acting as the reflecting surface, and it is possible for these to cause undesired couplings to be set up between the r.f. or i.f. stages and the aerial, with consequent risk of instability. When this effect

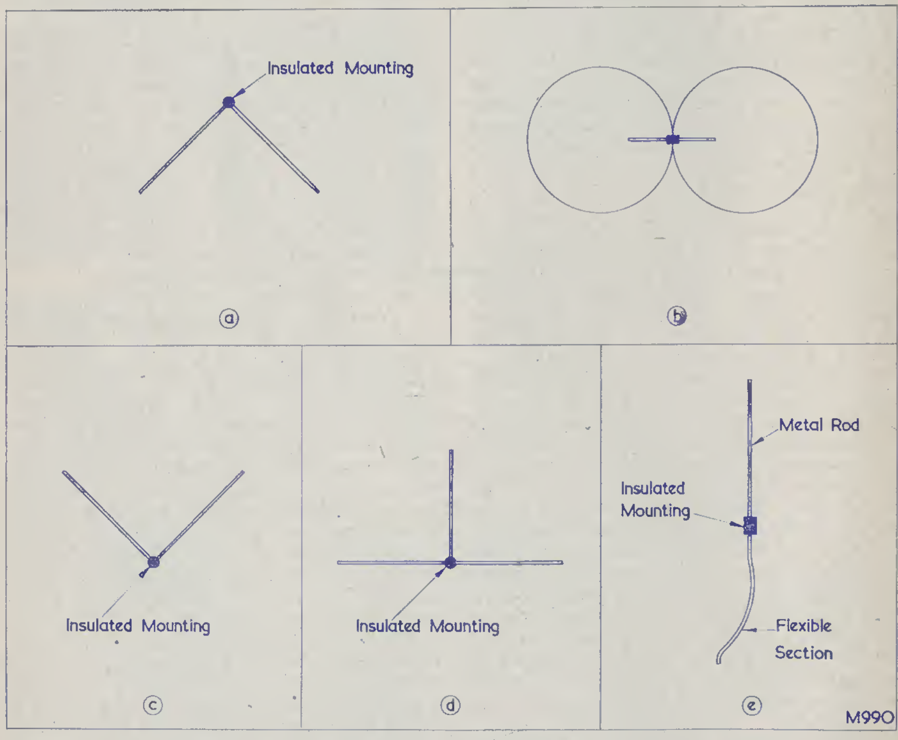


Fig. 242 (a). An inverted-V Band I aerial, suitable for mounting immediately under the roof of a house. (b) The horizontal polar diagram for the inverted-V aerial. (c). A V aerial which may be installed in a loft. (d) An inverted-T aerial which may, similarly, be installed in a loft. (e). An indoor aerial suitable for mounting against a vertical non-conducting surface

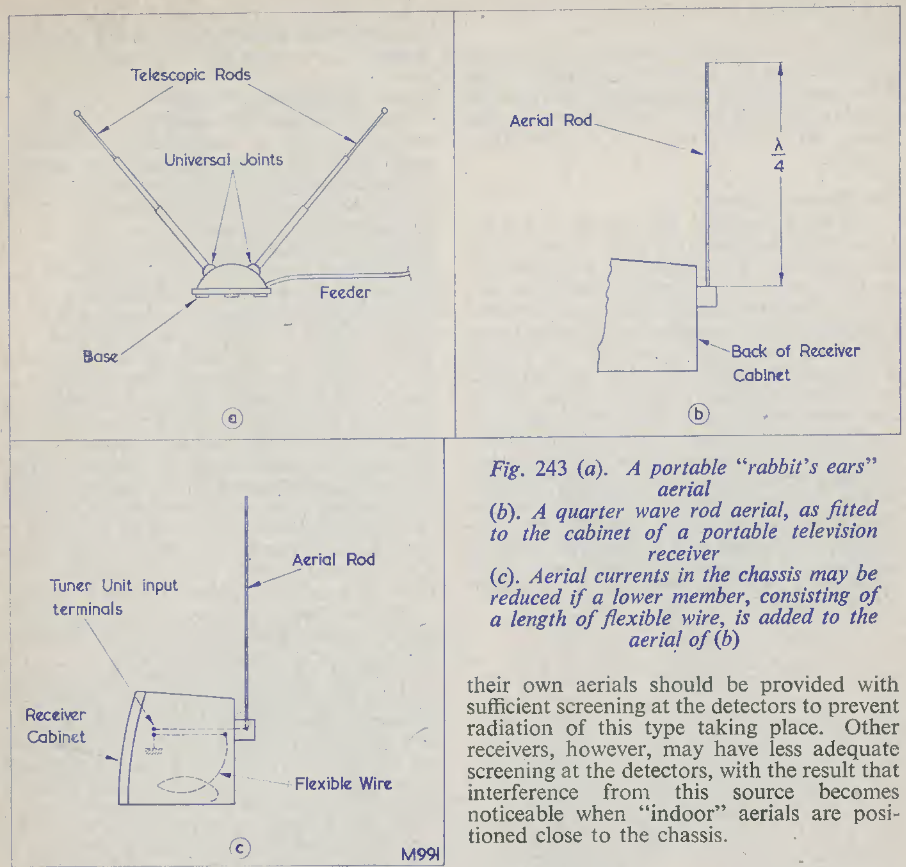


Fig. 243 (a). A portable "rabbit's ears" aerial
(b). A quarter wave rod aerial, as fitted to the cabinet of a portable television receiver
(c). Aerial currents in the chassis may be reduced if a lower member, consisting of a length of flexible wire, is added to the aerial of (b)

is troublesome it may be alleviated by adding a length of insulated cable at the base of the quarter wave element, as in Fig. 243 (*c*). The insulated cable is cut to a suitable length and is disposed around the inside of the cabinet. Since the assembly now resembles a dipole, aerial currents tend to flow more readily in the insulated cable than in the chassis, and the risk of instability is lessened.

The i.f. signals applied to the vision and sound detectors in a television receiver may have high amplitude. Because of this it is possible for these detector circuits to radiate harmonics of the applied intermediate frequencies, and some of these harmonics can appear close to, or inside, Band III channels.[2] Portable receivers intended to function with their own aerials should be provided with sufficient screening at the detectors to prevent radiation of this type taking place. Other receivers, however, may have less adequate screening at the detectors, with the result that interference from this source becomes noticeable when "indoor" aerials are positioned close to the chassis.

Slot Aerials

Slot aerials are sometimes employed for television reception. The basic slot aerial is shown in Fig. 244 (*a*), and it consists of a sheet of conducting material in which a slot is cut having a length approximately equal to half a wavelength. Connection is made to two points at the centre of the slot, the impedance here being of the order of 500Ω Lower impedances are given if the points to which the feeder connects are removed from the centre, as in Fig. 244 (*b*).

Unlike a dipole, the slot has to be horizontal to receive (or transmit) vertically polarised signals, and vertical to receive (or transmit) horizontally polarised signals.

Theoretically the conducting material around the slot should extend for some 0.25 wavelength, but it has been found in practice that the aerial still functions if almost all the conducting material is cut away, leaving the assembly shown in Fig. 244 (*c*). This assembly is described as a "skeleton slot" and

[2] This is especially true of the 5th harmonic of 38.15 Mc/s (the standard British sound i.f.) which, at 190.75 Mc/s, falls between Channels 8 and 9. If the receiver is incorrectly tuned an incorrect i.f. is applied to the sound detector and the resultant 5th harmonic may enter either of these two channels.

it is employed in some Band I–Band III arrays.

Slot aerials having large conducting surface surrounds are not normally employed (apart from experimental applications) in domestic receiver installations. They are useful, and have been employed, for transmitting purposes.

The Bow-tie Aerial

An aerial suitable for use in the u.h.f. (ultra high frequency) Bands IV and V[3] is illustrated in Fig. 245 (*a*). This is the *bow-tie*, or *fan*, aerial and it consists basically of a dipole whose bandwidth has been increased by adopting the characteristic element shape illustrated. The aerial shown in Fig. 245 (*a*) is horizontally polarised. It is usual practice to fit a reflecting surface behind the dipole, this being spaced away from the elements by approximately a quarter wavelength. Sensitivity may be increased by stacking two bow-ties vertically, in the manner illustrated in Fig. 245 (*b*). Since the dimensions of the bow-tie aerial are small, the reflector employed may consist of a continuous conducting surface (or a series of close-spaced parallel rods) without causing the complete assembly to be bulky or unwieldy.

[3] Bands IV and V are 470–582 Mc/s and 606–960 Mc/s respectively.

Signal Reflections—"Ghosts"

Due to the fact that signals at the frequencies employed in television transmissions tend to travel in a straight line, and because of the high modulation frequencies employed, considerable reception difficulties may occur because of reflected signals.

Fig. 246 illustrates a typical example of interference from a reflected signal. In this diagram the receiver aerial picks up a signal direct from the transmitter, together with a signal which has been reflected from an object, such as a steel structure, some distance away. The reflected signal has travelled a greater distance, and it arrives at the receiver aerial a short time after the direct signal. The reflected signal passes through the receiver and is applied to the modulating electrode of the cathode ray tube later, in consequence, than the direct signal. Since the cathode ray tube beam has, during the interval between reception of the direct and reflected signals, been deflected to the right, the reflected signal causes a second image to appear on the right of the direct signal image. The image from the reflected signal is known as a *ghost image*.

Reflected signals are especially troublesome in districts having large steel structures, although reflection can also be given by hills and similar natural formations. Reflected signals can be eradicated by using directional receiving aerials, the latter being rotated such that the source of reflected signal appears at the minimum sensitivity angle of the aerial. An alternative, or complementary, approach is to employ an aerial having a very high forward gain, thereby causing the desired signal to be received at a high level relative to the reflected signal.

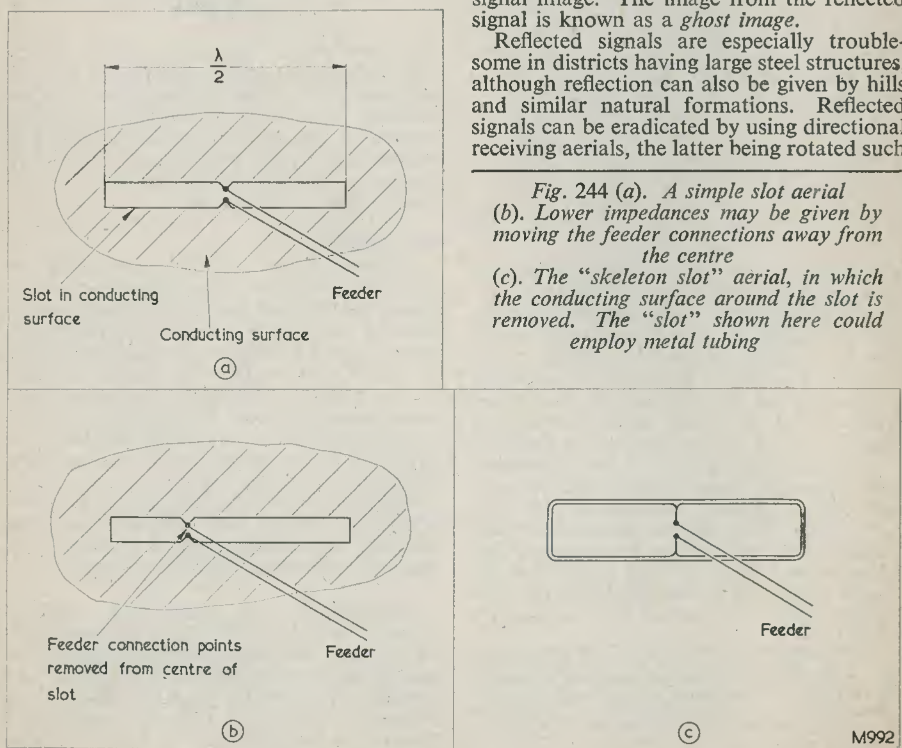


Fig. 244 (a). A simple slot aerial (b). Lower impedances may be given by moving the feeder connections away from the centre (c). The "skeleton slot" aerial, in which the conducting surface around the slot is removed. The "slot" shown here could employ metal tubing

Reflected signals can be troublesome, also, when "indoor" aerials, particularly those of the "rabbit's ears" type or those fitted to portable receivers, are used. The reflections, in this instance, are caused by pipes, wiring and metallic objects in the immediate neighbourhood of the aerial.[4] The reflected signals from objects as close as this suffer only a slight delay, and the ghost images resulting may be only slightly displaced to the right of the desired image. Frequently, the reflected signals may vary in phase relationship with the desired signal at transmitted frequency, in which case heavy attenuation on vision or sound is possible. In instances of this nature, it is usual to move the aerial around the room experimentally until a location offering best reception conditions is found.

Feeders

A *feeder*, or *transmission line*, consists basically of two parallel conductors whose function is that of passing a.c. energy to a remote point with minimum loss. The theory of feeders is complex, but the following simplified explanation should be of assistance so far as television receiver applications are concerned.

Fig. 247 (*a*) illustrates two parallel wires connected to an a.c. generator. The wires form a feeder, and they terminate at a remote point which is shown here as being unconnected.

In Fig. 247 (*b*) we consider the instance when the a.c. generator is applying peak

[4] Reflections may be given, even, by people close to the aerial.

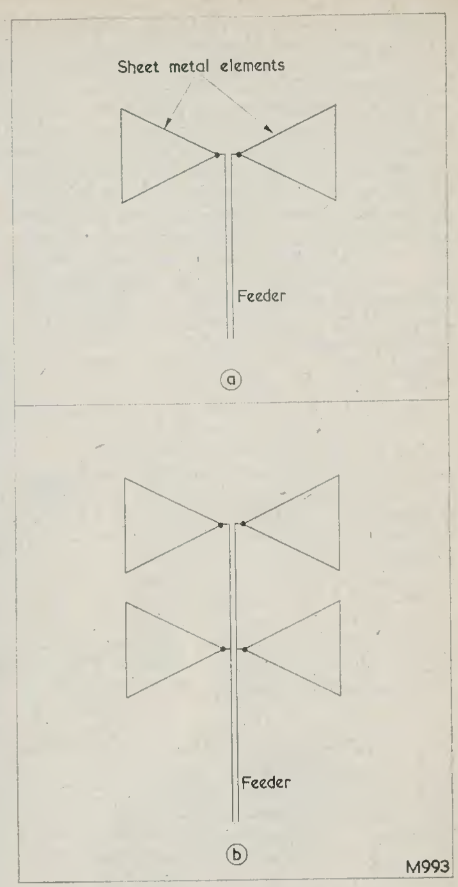
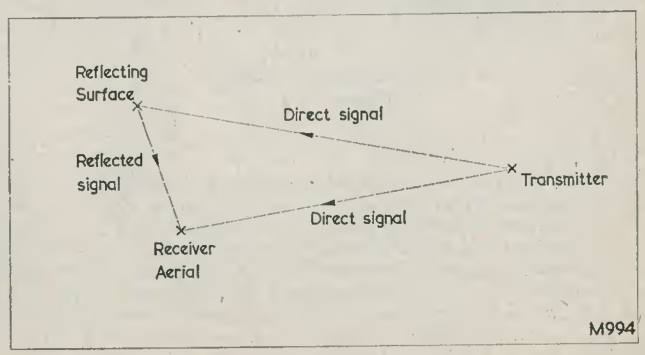
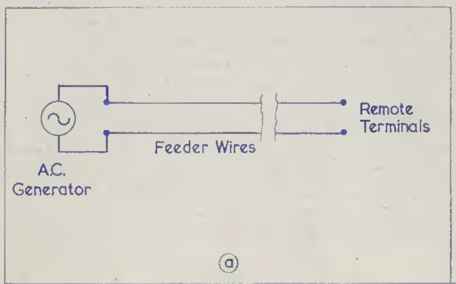


Fig. 245 (a). A bow-tie dipole, as used for u.h.f. reception (b). Increased sensitivity can be given by stacking two bow-tie dipoles vertically. The aerial shown here, and in (a) is horizontally polarised

Fig. 246. How "ghost images" are formed. The receiver aerial picks up two signals from the transmitter, one direct and one reflected. The reflected signal arrives later than the direct signal and causes a "ghost image" to appear on the receiver screen to the right of the desired image



voltage to the feeder. This peak voltage does not appear instantaneously along all points of the feeder. Instead, it causes lines of electrostatic force to appear between the wires immediately connected to the input terminals. These lines of electrostatic force repel each other, with the result that those which are formed first travel along the feeder to be followed by further lines of force which have similarly, in their turn, been repelled from the input terminals. During the time in which it provides peak voltage the a.c. generator can be considered as continually forming lines of electrostatic force at the wires immediately connected to the input terminals.



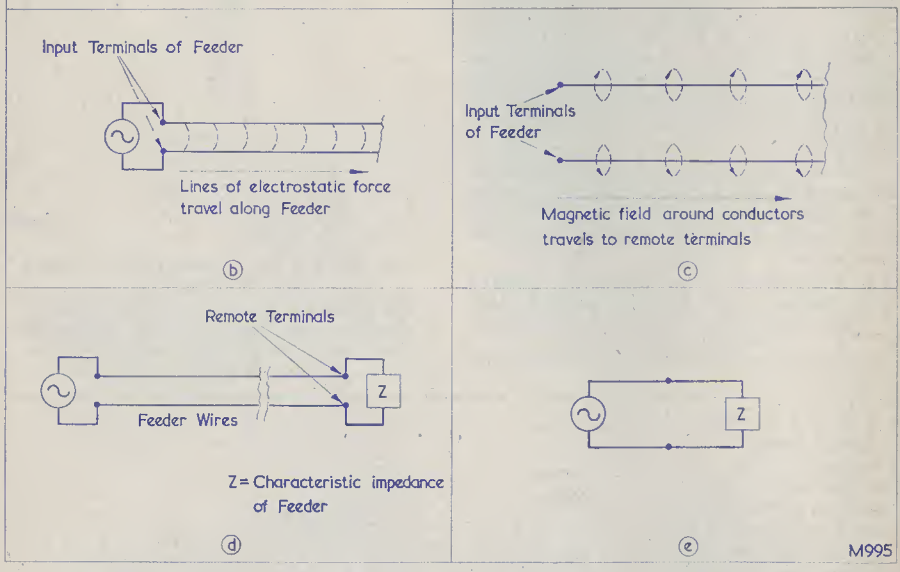


Fig. 247 (a). An a.c. generator coupled to the two wires of a feeder. (b). The generator causes lines of electrostatic force to appear between the wires of the feeder, these travelling towards the remote terminals. (c). Lines of magnetic force appear around the wires of the feeder and these, also, travel to the remote terminals. (d). In this diagram the remote terminals are correctly terminated, and no reflections take place. (e). When correctly matched, the length of feeder becomes unimportant (ignoring losses due to feeder wire resistance, etc.); the feeder of (d) could, therefore, be completely removed without changing circuit operation

The period during which the generator provides peak voltage is very short (in fact, it is infinitesimal) and the voltage at the feeder input terminals commences to drop as the a.c. cycle proceeds. This results in the same effect as before: there is a continuous generation of lines of electrostatic force between the wires at the input terminals and, due to their mutual repulsion, these are caused to travel along the feeder. The magnitude of the lines of electrostatic force travelling along the feeder corresponds to the applied potential of the generator. When some time has passed, the voltage from the a.c. generator becomes zero, after which it changes polarity. The lines of electrostatic force generated between the wires at the input terminals now have opposite polarity but, due to their mutual repulsion, they are still caused to travel along the feeder as before.

Accompanying the lines of electrostatic force travelling along the feeder wires are lines of magnetic force formed around the wires of the feeder, as in Fig. 247 (*c*). These increase in magnitude and direction according to the amplitude and polarity of the current given by the generator, and their mutual repulsion causes them to travel along the

wires in the same manner as the lines of electrostatic force between the wires.

If the remote terminals of the feeder are open-circuit the lines of electrostatic force can travel no further. They commence to concentrate, therefore, at the remote end. The increase in density of the lines at this point causes a magnetic field to be built up which generates new lines of electrostatic force. These lines of force, which have the same polarity as those arriving at the remote end, then travel back towards the generator in the same manner as the original lines of force travelled from the generator. If the remote ends of the feeder are short-circuited a different effect takes place. This time the lines of electrostatic force do not concentrate but decrease in density as they cause current to flow in the short-circuiting wire. This current creates a magnetic field which, in its turn, generates an opposing electrostatic field which then travels back towards the generator.

We have now discussed three important features of a feeder. When an a.c. generator is applied to a feeder it causes lines of electrostatic force to *travel along* the feeder rather than cause them to appear *instantaneously* at all points of the feeder. If the remote end of the feeder is open-circuit these lines of force are reflected back, travelling back to the generator with unchanged polarity. If the remote end of the feeder is short-circuited, the lines of electrostatic force are similarly reflected back, this time with reversed polarity.

The last two points obviously represent undesirable conditions if we wish to pass energy along the feeder without any losses. In either instance all the energy fed into the feeder is reflected back to the generator from the remote end. Since the two extreme conditions at the remote end—open-circuit (infinite impedance termination) or short-circuit (zero impedance termination)—cause reflection to occur by different means, it might be expected that terminating the feeder at the remote end with an impedance between these two extremes would prevent reflection taking place. This is, indeed, the case, and if the feeder is terminated by an impedance (Fig. 247 (*d*)) having the same value as the *characteristic impedance* of the feeder line no reflection whatsoever takes place. What happens in this instance is that all the energy travelling along the feeder wires passes into the terminating impedance, and there are no losses due to reflections back to the generator.

As there are no reflections in a feeder terminated with an impedance equal to its characteristic impedance, the length of the feeder becomes unimportant. So far as the generator is concerned the circuit would, therefore, function in the same manner if the feeder were completely eliminated, as in Fig. 247 (*e*). In both Figs. 247 (*d*) and (*e*) the impedance into which the generator "looks" is the same. For maximum efficiency in either case the output impedance of the generator should be equal to the impedance into which it feeds. So, for maximum efficiency, the generator should have an output impedance equal to the terminating impedance, this being also equal to the characteristic impedance of the feeder.

In television receiving aerial systems, the aerial (which is the generator) is connected via a feeder to the receiver input circuit (which is the terminating impedance). When the aerial impedance, the characteristic impedance of the feeder, and the input impedance of the receiver are all the same, maximum transfer of energy takes place.

The terminating impedance of the feeder is, normally, preferably a resistor, since this causes no phase changes to occur at the remote end. The input circuit of a television receiver cannot employ a physical resistor as the terminating impedance, because of the necessity of transferring the maximum amount of energy into the first tuned circuit. Television input circuits are, in consequence, designed to offer an input impedance which is largely resistive,[5] despite the fact that most of the components employed are condensers or inductors.

Although the length of a correctly terminated feeder has no effect on the impedance presented at either end, this length is still important in practice because of losses from causes other than reflections. Such losses are given mainly by the resistance of the feeder wires, and losses in the insulating medium between the two wires.

Twin Feeder and Coaxial Cable

The characteristic impedance of a feeder increases in proportion to the spacing between the two wires. At the same time the characteristic impedance reduces in proportion to the thickness of the wires themselves.

For domestic television applications it is desirable to employ aerial feeders which offer a reasonable compromise between cost and losses. American practice consists of employing aerial feeders having a characteristic impedance of 300Ω, these consisting of two wires separated by an insulating material, as shown in Fig. 248 (*a*). Such cable is readily capable of being mass produced by simple plastic extrusion methods. This type of feeder is frequently described as *twin feeder* or *ribbon feeder*. When it is desired to keep losses to a very low level, part of the insulation between the wires may be removed, as in Fig. 248 (*b*).

[5] By using step-up transformers or pi networks feeding into the input resistance of the first valve.

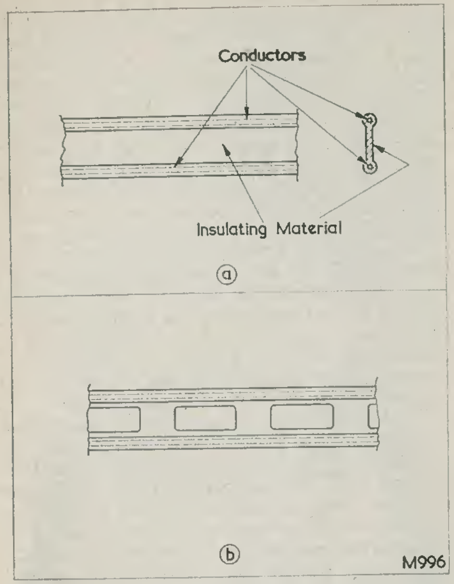


Fig. 248 (a). A typical example of twin feeder
(b). Losses in twin feeder may be reduced by removing some of the insulation between conductors

An alternative type of feeder employs *coaxial cable* or *concentric feeder*. Coaxial cable functions in the same manner as two-wire feeder, but one conductor is now completely enclosed within the other. The inner conductor is kept centrally disposed inside the outer conductor by means of an insulating material. With coaxial cable the characteristic impedance increases in proportion to the inside diameter of the outer conductor, and reduces in proportion to the diameter of the inner conductor. Coaxial cable may be manufactured economically for the standard British television aerial impedance of 75Ω: and such cable can be made by extruding a plastic insulating material (normally polythene) on to the inner conductor, braiding the outer conductor over this, and finally extruding a protective plastic sheath over the outer conductor. Where very low losses are concerned, the insulating material between the conductors can be made such that they are partly air-spaced.

Twin feeder having a characteristic impedance of 80Ω[6] is available, but this is not usually employed in British television installations.[7]

Twin feeders are described as *balanced feeders* because the circuits to which they connect should be balanced about earth. Fig. 249 (*a*) illustrates, in simplified form, a typical example of how a balanced feeder may be coupled to the input circuit of a television receiver. Coaxial feeders are described as *unbalanced feeders* because the outer conductor should be connected to earth. A typical method of coupling an unbalanced feeder to a receiver is shown in Fig. 249 (*b*). As may be seen, the outer conductor of the coaxial cable connects directly to the receiver chassis.

Balanced feeder has the disadvantage that it should be kept well away from earthed objects if undue losses are not to occur. In domestic installations this necessitates the use of stand-off insulators when the feeder is routed close to pipes or guttering, etc. Coaxial cable can, however, be run close to earthed objects without serious losses taking place.

[6] Twin feeder having a characteristic impedance below 80Ω is not normally manufactured because the wires have to be positioned too close together to allow reliable insulation.

[7] Such feeder may, however, be used to couple the aerial input socket to the tuner unit *inside* the receiver.

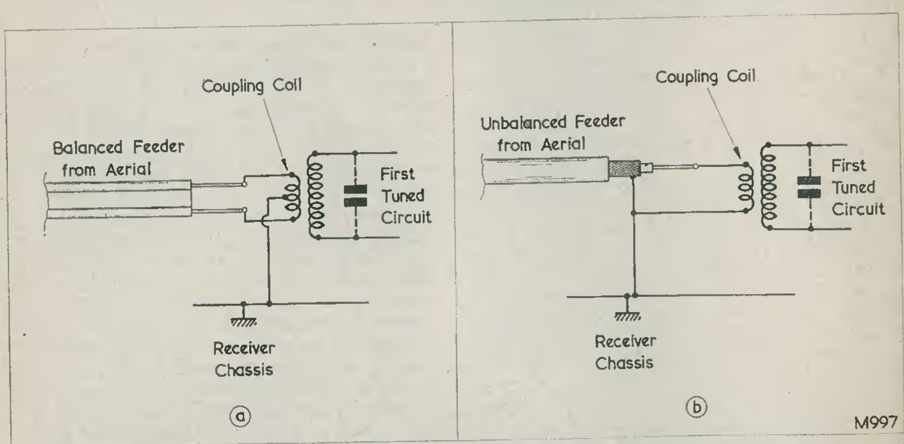


Fig. 249 (a). A simplified diagram, illustrating how balanced feeder is connected to the input circuits of a television receiver. (b). Unbalanced feeder may be connected to the input circuits as shown here

Editor's Note

This article ends our very popular series of articles by W. G. Morley. Our contributor will shortly be commencing a new series under the title "Understanding Radio" and, as in "Understanding Television", he will start from first principles. We regret that recent very heavy pressure of work on our author has prevented the new series from commencing in our next issue, as was stated in *The Radio Constructor* for March.

A matchbox 1mW Amplifier

By S. SMITH

THE ACCOMPANYING DIAGRAM SHOWS THE complete circuit of a subminiature amplifier which, when constructed, was smaller than the battery that powered it. It was designed primarily to reproduce loud music (in headphones) from a very quiet musical instrument (a clavichord); but it has since been used as the output stage of a personal receiver and for tracking low-level audio signals through various circuits.

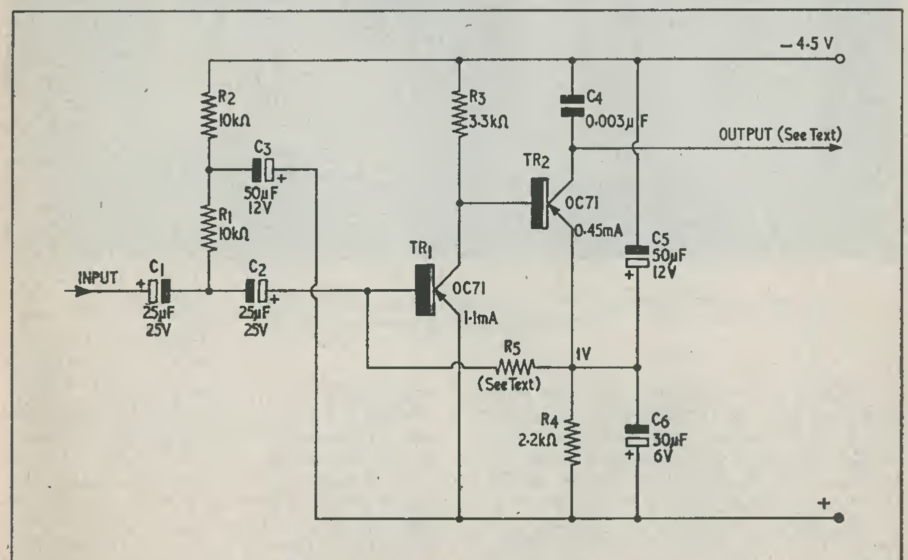
Although it does not pretend to be in the Hi-Fi category (the cut-off frequency of the transistors used is around 10 kc/s only) its quality is not unpleasing and its technical performance is satisfactory. The amplifier was designed on the basis that 1mW output is more than adequate for headphone operation.

Circuit Requirements

The circuit must be stable to cope with variations of temperature, and also simple for the reason that great trouble and expense is not warranted in an amplifier that is not intended to be in the "quality" class.

The power requirement is 4.5V at 1.5mA, i.e. 7mW, which is modest by any standard.

The complete unit comprises five resistors,



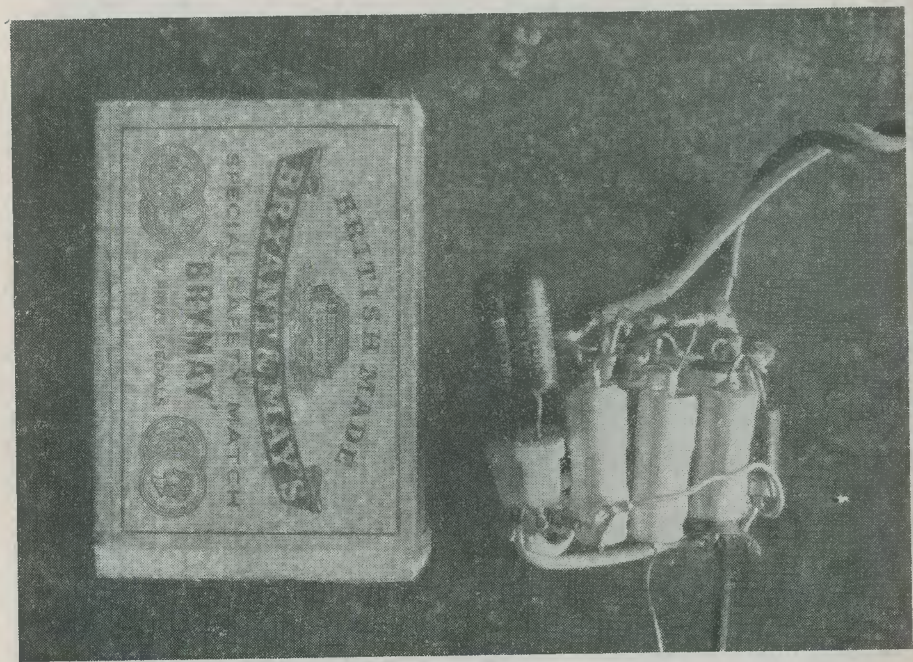
CIRCUIT OF THE MATCHBOX 1mW AMPLIFIER

six condensers and two transistors only. If miniature components are used the whole amplifier may fit into a matchbox, as is shown in the accompanying illustrations.

Circuit Operation

The input is applied via the isolating condensers C_1 and C_2. The junction of these is maintained at the h.t. potential of 4.5V by R_1 and R_2. By this means, should the input be connected accidentally to the h.t. of the preceding stage, or to any lower voltage, the input condenser is not subjected to reversed polarity with resulting damage. The junction of R_1 and R_2 is decoupled from the h.t. negative line with respect to a.c. by

by V volts: the increase in current through R_5 will then be $\frac{V}{\alpha'}$mA. This increase in the base current of TR_1 increases its collector current by $\alpha' \times \frac{V}{\alpha'}mA=$VmA, which causes a potential drop across R_3 of 3.3V volts. This potential drop appears at the emitter of TR_2 by emitter-follower action and so amply corrects the initial assumed potential rise of V volts. Similar reasoning demonstrates the stability of TR_1. In the prototype, R_5 was 33kΩ. The best plan is to replace R_5 during construction by a 100kΩ variable



The completed Matchbox 1mW Amplifier constructed by the author—note the compact method of construction

C_3. The input is in phase with the output and there must be no possibility of feedback along the h.t. line or oscillation may result.

For stabilising purposes the base of TR_1 is biased via R_5 from the emitter of TR_2, the latter being earthed with respect to a.c. by C_6, thereby avoiding a.c. feedback. R_5 should have a value around α' kΩ, where α' is the grounded emitted current gain of TR_1. Assume that the current through TR_2 increases so that it raises the emitter potential

resistor and adjust to give a collector current of 450μA in TR_2, then measure the resistance and subsequently replace by a fixed resistor having the nearest preferred value.

C_4 is necessary to bypass high frequencies which would otherwise enter the output. In the prototype, a value of 0.003μF was sufficient to prevent high frequency attenuation of the signal, but the value was large enough to act as an effective bypass for frequencies which could pass across the

stray capacities between the output and input and so cause oscillation.

No collector load is shown for TR_2. The amplifier was intended for use with high impedance phones (4kΩ a.c.; 3kΩ d.c.) across C_4; but it may be that other constructors will have a different application in mind (e.g., feeding another amplifier in cascade to produce louspeaker output). In such a case, a resistance of 3.3kΩ across C_4 will be a suitable load.

Transistor Currents

Finally, a word about the particular values of current chosen for TR_1 and TR_2. The current of TR_2 cannot be large otherwise it will bottom with a typical load of 3kΩ d.c. when a signal is applied. Nor can it be too small, or the amplification will be low. About 0.5mA is correct.

The current for TR_1 is chosen to be high so that the contribution due to $I'_{c(o)}$ is small, and the stabilising control exercised by R_5 becomes more effective. If the current were very little greater than $I'_{c(o)}$ (e.g., only one or two times greater) the correcting signal from R_5 would apply only to a proportion of the total current (viz. that part in excess of $I'_{c(o)}$) and control would be weaker accordingly. There is no danger of bottoming here because the input signal is very small at this stage.

It will be noticed that some of the electrolytic condensers have high voltage ratings. This is to ensure that their leakage currents are low. For example, if C_3 had a substantial leakage current (as might well be the case with a 6V condenser working at 4.5V) there would be a noticeable voltage drop across R_2, whereby C_1 would be subjected to reverse polarity if the input were connected accidentally to the h.t. Similarly C_1 and C_2 must have very small leakage currents in order not to upset the biasing of TR_1.

Avoiding Arithmetic in Resistor and Condenser Calculations

By J. B. DANCE, M.Sc.

The calculation of the value of two resistors in series or two condensers in parallel does not cause any problems whatsoever, as it is merely necessary to add the values of the individual components in order to find the value of the combination.

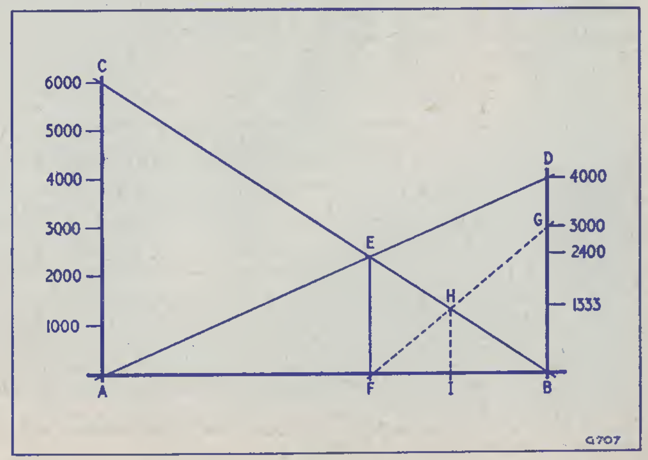
It is well known that the effective resistance, R, of two resistors (R_1 and R_2) in parallel is given by the equation:

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2} \quad (1)$$

and similarly for two condensers in series:

$$\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2} \quad (2)$$

Those readers who dislike the simple arithmetic involved in the use of these equations may be interested in the graphical method of finding the result which is illustrated in the accompanying diagram.



The graphical method used. Dotted lines are required if three components are present

Graphical Method

Let us assume that it is desired to calculate the value of a 6kΩ resistor placed in parallel with a 4kΩ resistor. A line AC should be drawn on a sheet of graph paper so that its length represents, on a suitable scale, the value of one of the resistors. A line AB of any convenient length is then drawn perpendicular to AC. The length of the line BD represents the value of the other resistor on the same scale; it is perpendicular to AB. Lines should then be drawn joining AD and BC so that they cross at E. The height of E above AB (i.e. EF) then represents the value of the parallel resistor combination on the same scale as before. This value can be read off; it is 2,400 ohms in the example chosen.

If the value of three resistors (say, 6kΩ, 4kΩ and 3kΩ) in parallel were required, the value of any two should first be calculated as described and the process repeated using EF and the value of the third resistor on the same scale (GB). The value of the three resistors in parallel is then represented by the length of the line HI and can be read off the scale (it is 1,333 ohms in the example chosen).

The graphical method can also be used in reverse; that is, it can be used to find the value of a resistor which must be placed in parallel with another known resistor so that the combination has a certain desired value. Exactly the same method can be used for two condensers in series.

Pocket Calculator

The graphical method can be employed in a small pocket calculator which is now described.

A rectangular section 11cm by about 8 or 9cm should be cut from a sheet of centimetre graph paper and pasted on a sheet of cardboard very slightly larger than the paper. The scale AC should be drawn 10cm in length near the left hand edge of the graph paper and scale BD, also 10cm in length, near the right hand edge. The points A and B are joined.

It is essential that the lines AD and BC can be moved as desired; they are therefore replaced by a length of fine thread. A piece of the finest thread available, about 15in long, should be passed through a very small hole made at the point A. It should then be taken under the calculator and be brought up through a very small hole at B. A knot should be tied in each end of the thread to prevent it falling back through the holes. It is important that the holes should be made in exactly the correct position.

If the threads from each side are pulled across to the opposite side so that they cut the scales at the values of the resistors or condensers concerned, the answer can be read off as the height of the intersection of the threads from the base line. The threads must be kept taut.

The scales can be multiplied (mentally) by 10 any number of times; the same scale on the calculator may then be used for 1Ω, 1kΩ and 1MΩ. The error should not be more than about 5%.

Use of Slide Rule

Equations (1) and (2) are not especially convenient for those who perform their calculations by means of a slide rule. If, however, the equations are changed into the following forms, it is much easier to use a slide rule to perform the calculations.

$$R=\frac{R_2}{(R_1+R_2)}\times R_1$$

$$C=\frac{C_2}{(C_1+C_2)}\times C_1$$

The value of (R_1+R_2) or (C_1+C_2) is easily found (mentally) and the slide rule is then used for the multiplication and division in the usual way. If three components are present, the value of any two should first be found and the process repeated with the value thus obtained and the third component.

WORLD-WIDE INTEREST IN TRAFFIC RADARS

Marconi's traffic radar—the portable electronic device which measures the speed of passing vehciles—has been ordered for the police forces of fifteen counties in Great Britain. The equipment is now being evaluated by police authorities abroad, and Australia, Canada, South Africa and Singapore are amongst the first countries to try this new apparatus.

In the past two years Marconi's have demonstrated the Portable Electronic Traffic Analyser (known as PETA) to police authorities and local government departments in Portugal, Italy, France, Austria, Belgium, Holland and Switzerland.

The first company in Britain to develop a traffic radar device, Marconi's have received in the last twelve months orders for the apparatus totalling about £14,500. Of those ordered, nearly 60 per cent have already been delivered, chiefly to county and borough police forces but also to local government departments in the U.K. The traffic engineering departments of several universities and technical colleges have also expressed interest. Lancashire Constabulary, who gave the Marconi Company invaluable assistance in evaluating the performance of PETA in the initial stages, have ordered six of these radars. Three have been ordered by the Ministry of Transport, two by the Essex Constabulary and two by Durham Constabulary.

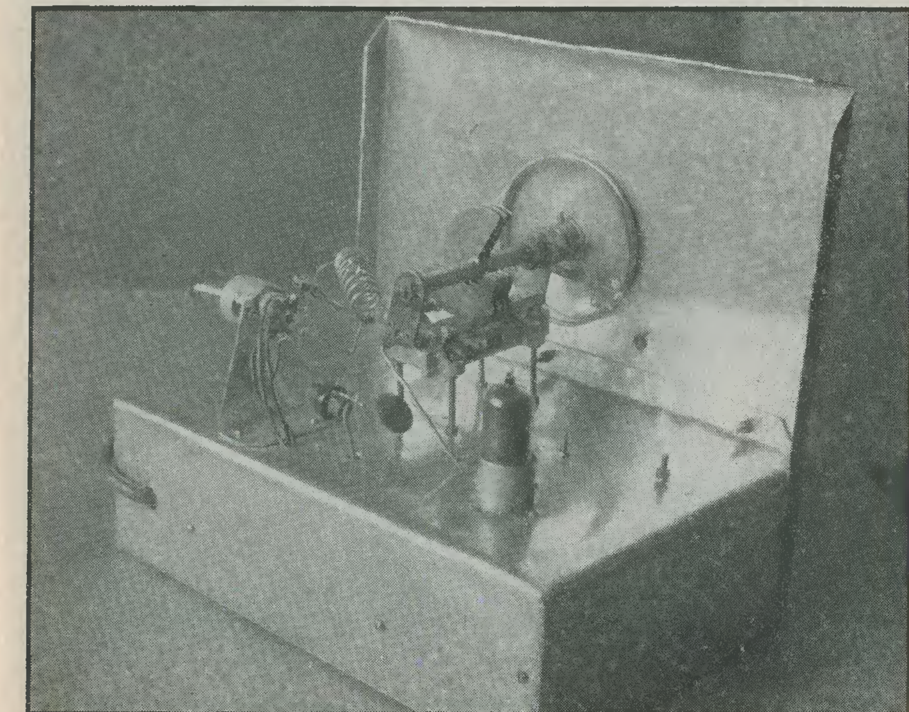
Other counties in England, Scotland and Wales where the analyser is either in use or delivery is due to be made include Suffolk, Hertfordshire, Ayrshire, Monmouthshire, Dorset, Northumberland, Devon, Yorkshire, Berkshire, Renfrewshire, Gloucestershire and Staffordshire.

BAND I – BAND III signal generator

By J. HILLMAN

This signal generator, covering Band I on fundamental and Band III on harmonics, provides a modulated output capable of being heard as a tone from the loudspeaker, or as a pattern on the screen, of a television receiver. It should be pointed out that the tuning condenser, clearly visible in the photographs, is an ex-W.D. component and may not be readily obtainable by some readers. Any other suitable variable condenser having ceramic insulation and a similar maximum capacity may, of course, be employed in its place, although the mounting instructions given here will not then apply. Alternative condensers should take up the same position on the chassis as that used in the prototype.—Editor

This is a simple signal generator, covering Band I and Band III, having a scale of eleven inches and a slow-motion dial so that it can easily be set to the required channel. As may be seen from the circuit diagram of Fig. 8, it incorporates two oscillators, one an electron-coupled oscillator using a 6C4 to give the r.f. signal, and the other an audio frequency oscillator using an EF91 coupled as a triode. The latter



Above-chassis view of the completed Band I-Band III Signal Generator described herewith modulates the r.f. signal and the resultant signal is fed via diode X1 to the output socket. This arrangement gives a series of horizontal lines, eight in number, on the screen of the television receiver being tested and, also, a fairly high note from its speaker. The tuning condenser used was an ex-Government component (10C/3996) having a value of 30pF. The vanes (originally six moving and five fixed) were double-spaced, and some of these were removed until there were three moving and four fixed vanes remaining. The capacity of the modified condenser is approximately 20pF. The h.t. consumption of the unit is 18mA at an h.t. voltage of 350.

Construction

First mark out the front panel, Fig. 4, then cut out and bend up at right angles the ½in edges. Mark out as in Fig. 1, and drill the holes shown. Mark out the chassis, Fig. 5, and cut as shown. Next, bend the edges in the order A, B, C, D, E, F, G. (See photographs of the completed chassis to find direction of bending for individual edges). Drill the edges C and D with an ⅛in drill in the centre, then mark the back edge of the

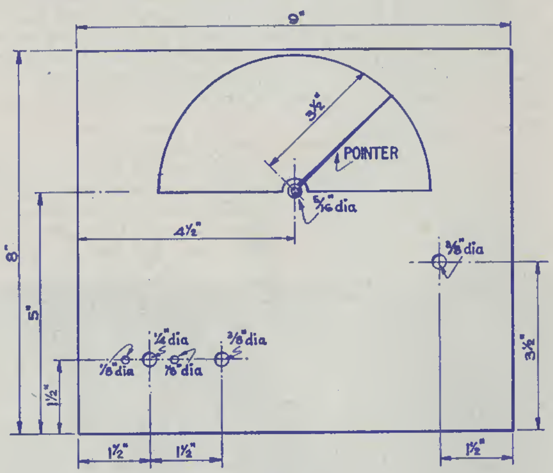


FIG. 1
FRONT PANEL

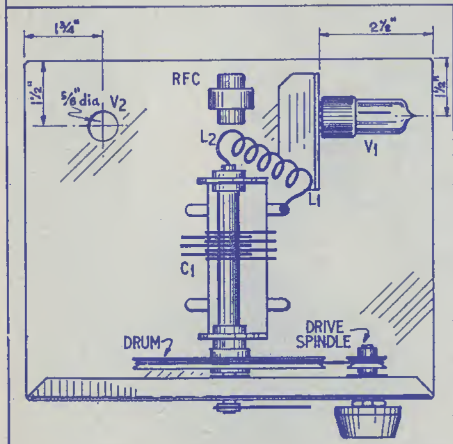


FIG. 2
TOP OF CHASSIS LAYOUT

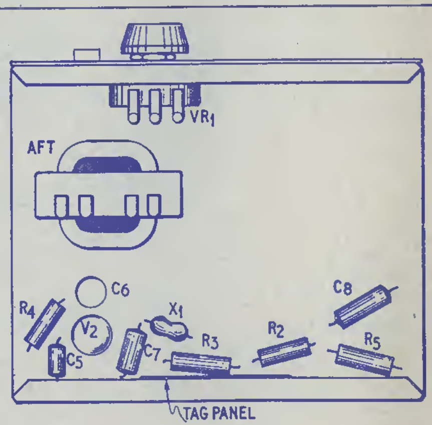
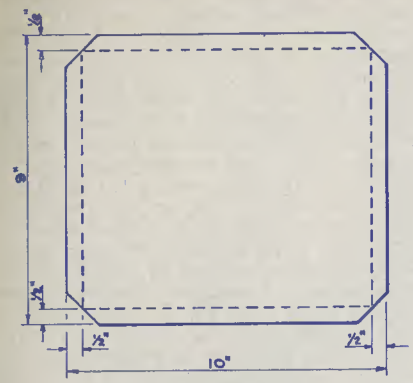
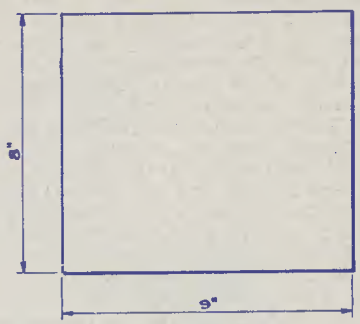


FIG. 3
UNDER CHASSIS LAYOUT

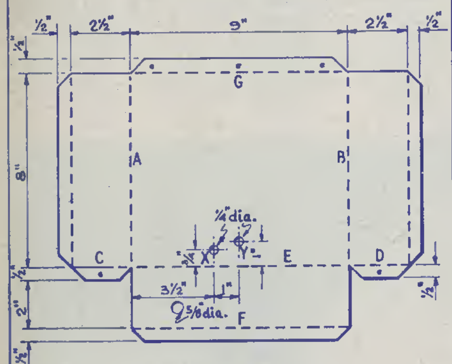
G 702



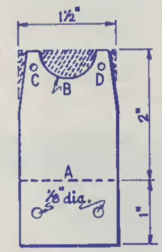
FRONT PANEL
FIG. 4



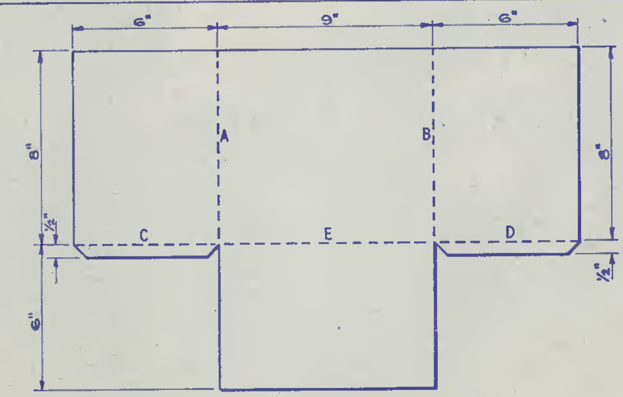
BOTTOM PANEL
FIG. 6



CHASSIS
FIG. 5



VALVE BRACKET
FIG. 9

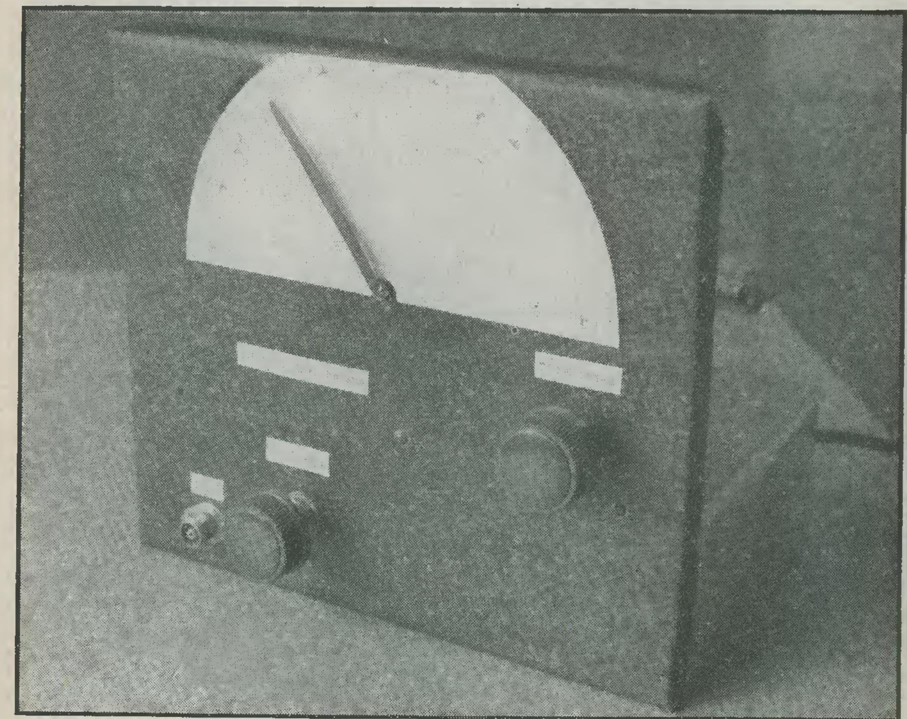


TOP COVER
FIG. 7

G 703

chassis and drill through, finally bolting together with 6BA screws and cuts. Drill the further holes shown in Fig. 5: two ¼in holes on the chassis top for the wires to pass through, and a ⅝in hole for the grommet through which the power supply cable passes at the back of the chassis. Drill three ⅛in holes in the ½in strip G, place the chassis against the front panel, mark off these holes, drill through, and bolt together. At this stage the front panel can be painted with black crackle paint and left to dry. Next mark out the top cover, Fig. 7, and cut out and bend to form in the following order: A, B, C, D, E, drilling the ½in edges with a ⅛in drill and bolting together with 6BA screws. Cut out the bottom panel as shown in Fig. 6. Lastly, mark out the valveholder bracket, Fig. 9, cutting out the rectangular piece first, then bending up at A at right angles. Drill two ⅛in holes as shown. File out the segment marked B so that the B7G valveholder will fit down into it, then drill at C and D to take 6BA screws securing the valveholder in place. Finally taper off the edges as shown.

Place the valveholder bracket on the chassis as illustrated in Fig. 2 and drill and bolt up with 6BA screws. Also cut out the ⅝in hole for V_2 valveholder, and drill 6BA clear holes on either side for securing that valveholder. Next take the variable condenser and, with its vanes fully meshed, make a saw cut parallel to the straight edges of the moving vanes across the end of the spindle. Place the condenser so that its spindle just projects through the panel and mark out four points on the chassis to correspond with the holes in the base of the condenser. Drill ⅛in holes at these points. Using suitable lengths of 6BA studding and nuts, mount the condenser, first putting on the dial drum. (See Fig. 2.) Mark and cut out of white paper the scale (Fig. 11) and glue in place as in Fig. 1. Mark and cut out of tin-plate or brass the pointer (Fig. 10) and solder into the slot already cut in the condenser spindle. Now mount the drive spindle and adjust the drive cord and spring such that the drive spindle turns the pointer smoothly from one end of the dial to the other. Mount the coaxial socket and potentiometer VR_1 on the front panel, and the valveholders on the chassis. A tag panel



Front-panel view of the Band I-Band III Signal Generator

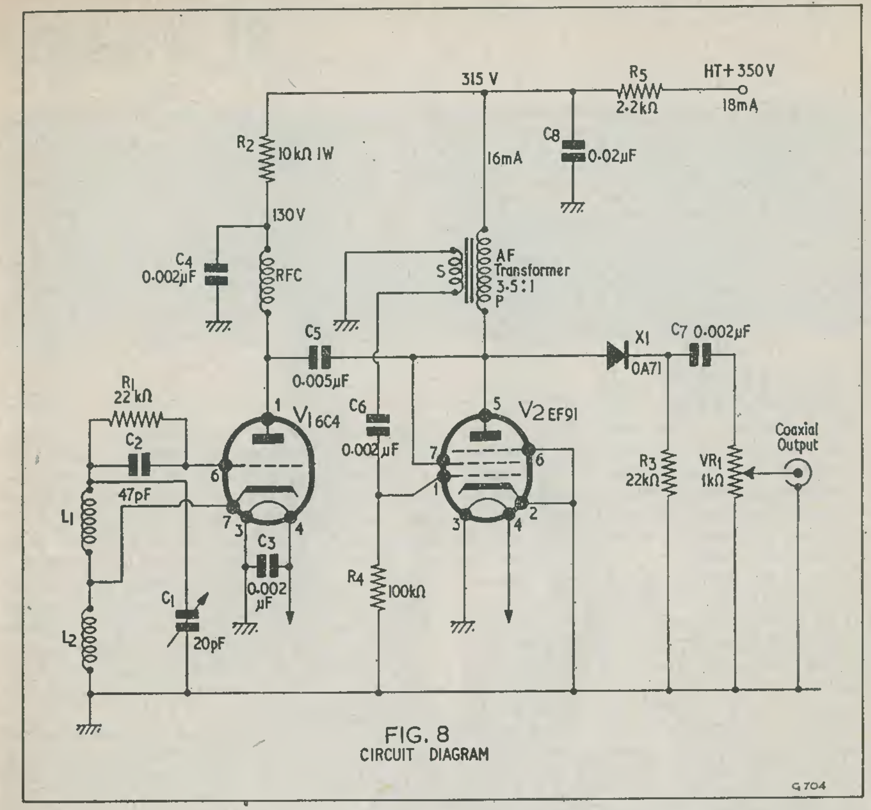


FIG. 8
CIRCUIT DIAGRAM

Components List

Resistors. (All ¼ watt unless otherwise specified.)

R_1	22kΩ
R_2	10kΩ, 1 watt
R_3	22kΩ
R_4	100kΩ
R_5	2.2kΩ, 1 watt
VR_1	1kΩ, potentiometer

Inductors

L_1,L_2	14 turns of 16 s.w.g. tinned copper wire tapped at 5 turns from earthy end. (See text.)
R.F.C.	60 turns of 36 s.w.g. enamelled wire pile-wound on ¼in diameter former

A.F. Transformer. Elstone, type LF36

Condensers. (All ceramic unless otherwise stated.)

C_1	20pF max. variable. (See text.)
C_2	47pF
C_3	0.002μF
C_4	0.002μF
C_5	0.005μF
C_6	0.002μF, paper
C_7	0.002μF
C_8	0.02μF, paper

Valves

V_1	6C4
V_2	EF91

Diode

X_1	OA71 or equivalent

1961 International Audio Festival

We regret that owing to pressure on space, our report on the above Festival has been held over until the next issue.

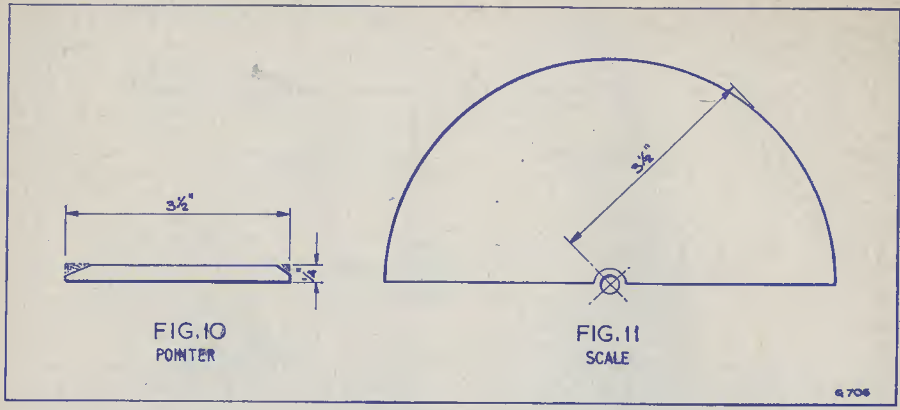


FIG. 10 POINTER

FIG. 11 SCALE

is next mounted on the inside back of the chassis and the a.f. transformer near the valveholders on the underside of the chassis, as shown in the component layout of Fig. 3. Care should be taken, when drilling holes for these new components, to avoid damage to parts already fitted. The r.f. choke is mounted in the wiring on top of the chassis as is L_1, L_2, C_2, C_3, C_4 and R_1. The coil is made by winding fourteen turns of 16 s.w.g. tinned copper wire around a ⅜in former, then removing the coil from the former and spacing the turns roughly twice the diameter of the wire. No special precautions are necessary in wiring up, except in the tuned circuit of V_1 where 20 s.w.g. tinned copper wire should be used to connect the coil to the tuning condenser and to pins 6 and 7 of the valveholder. The heater wires and the anode wire are brought up through the hole marked "X" in Fig. 5, whilst the wire to the junction of the r.f. choke and C_4 comes up through hole "Y". Power supplies are fed via three flexible p.v.c. leads.

Testing

Having completed the wiring, the unit has to be tested.

Connect the output of the signal generator to the aerial socket of a television receiver switched to Channel 1 and swing C_1. A fairly high-pitched whistle should be heard as C_1 tunes through the sound channel, and a pattern should appear on the screen when it tunes to the vision channel. Should no pattern appear, switch the receiver to Channel 2. If this results in a pattern with C_1 fully meshed then the coil inductance is too low and the turns should be brought closer together. If this process still does not give enough inductance, the coil should be re-wound with an extra turn. If no pattern can be obtained on any channel then alter the cathode tap to six turns from the chassis end and try again.

Having got a pattern on Channel 1, adjust the spacing of the coil turns until the sound channel appears at a near-maximum capacity setting of C_1, then tune from Channel 1 to Channel 5. The latter should appear near the minimum capacity position. Next switch the receiver to Channel 9 and check that a pattern appears below Channel 5 on the signal generator scale. Finally, check other channels on Bands I and III to ensure that the generator has the range required.

Calibration of the scale may be finally carried out against a television receiver on both Bands. Should the output from the signal generator be too great on Band I, the coaxial lead from the generator may be removed from the receiver socket and a simple resistive attenuator inserted in series.

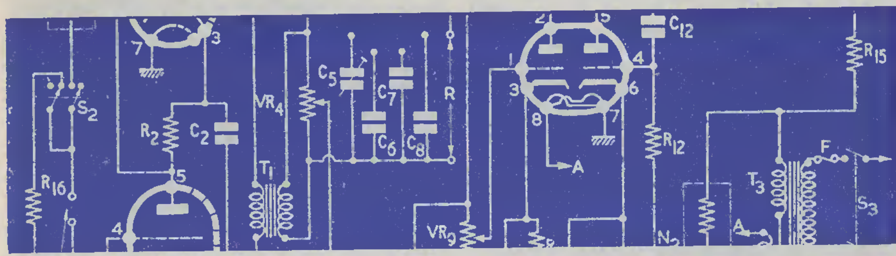
British Equipment for German Airfields

Among orders announced at the Leipzig Fair by the Government of the German Democratic Republic was one for £40,000 which was awarded to Pye Telecommunications Limited of Cambridge.

The equipment to be supplied includes an Instrument Landing System (I.L.S.) for Dresden International Airport and the latest v.h.f. ground-to-air communications equipment for Schoenefeldt airfield and the East German area.

The Pye I.L.S. gives highly accurate guidance to an aircraft on approach to landing due to the use of a directional localiser and stabilised glide path. It is rapidly achieving world-wide application, having already been supplied to airfields in Geneva, Hong Kong, Canada, Nairobi, Belgian Congo, Persian Gulf, Russia, Hungary, Yugoslavia, and Britain.

WHAT'S IN A DESIGN?



By W. E. THOMPSON, A.M.I.P.R.E.

In this mainly theoretical article, the author describes a method of designing the C-R values in an audio oscillator to provide not only the required scales but also to ensure that these are linear.—Editor.

Although it cannot be expected that every reader of technical journals is sufficiently experienced to develop his own circuit designs, there must be many who have attempted it themselves with varying degrees of success. Many others have most likely failed to achieve their objective, possibly due to insufficient technical knowledge, or perhaps overlooking certain features that a particular design might reveal to a more appreciative mind.

This article does not presume to teach basic design principles which could be applied to any problem that might arise in developing an item of equipment; it does, however, deal with one aspect of designing a piece of apparatus with the object of showing what can be behind an article in a technical journal.

A short study here of a typical circuit configuration can give an insight to some of these matters. At the same time it can

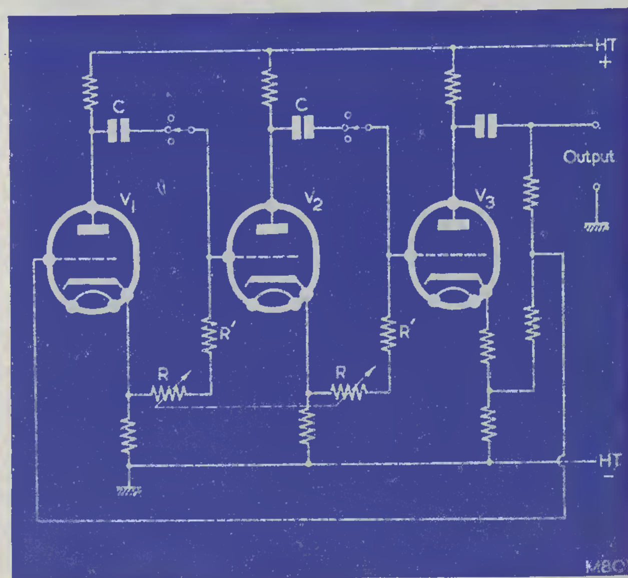


Fig. 1. Basic circuit of the 20 c/s–20kc/s audio oscillator, the design of which is discussed in the text particularly with reference to the values of C, R and R'

provide some interesting exercises in deriving circuit values, and the reasons which sometimes necessitate the use of a certain specification for a component. Design does not end at a circuit on paper; the end product quite often involves more thought than making up a suitable circuit. The mechanical design of an instrument may well require considerable modification of original thoughts in order to achieve certain functions in the finished apparatus.

A typical example could be the simple basic circuit for an audio oscillator shown in Fig. 1. We shall look more than casually into the innocent appearance of the frequency-determining components, C, R and R′.

Now, this circuit could be made to generate audio frequencies ranging from a fraction of a cycle per second (c/s) to several hundred kilocycles per second (kc/s) by suitable design. However, let us assume that we wish to prepare a design to cover a general purpose range of 20 c/s to 20 kc/s.

The frequency of oscillation is determined by the values allotted to condenser C and resistance R. It is possible, of course, to cover the whole range in a single sweep of a control if C is a fixed value and R is made variable, but the calibrated scale of R would then become very cramped, making it difficult to read and uncertain in setting if reasonable accuracy of tuning is to be achieved. The reason is not hard to find, for the resonant frequency is given by the formula:

$$f = \frac{10^6}{2\pi CR}$$

where f = frequency in c/s
C = capacitance in μF
R = resistance in Ω

$$2\pi = 6.28 \text{ (or } \frac{100}{16} \text{ approx.)}$$

(It can be mentioned here that this approximated value for 2π introduces only about 0.5% error—certainly accurate enough for slide-rule calculations.)

To make calculation somewhat easier, give a value of 0.16μF to C, and our formula becomes:

$$f = \frac{10^6}{100/16 \times 0.16 \times R}$$

$$= \frac{10^6}{R}$$

$$\text{so } R = \frac{10^6}{f}$$

By inserting the values of 20 and 20,000 for f, we now find that R must have a maximum resistance of 50kΩ and a minimum resistance of 50Ω. The whole range of frequencies is thus covered in 49.95kΩ of the 50kΩ total. Only 50Ω, or 1/1000th part of the resistance is not used.

If we insert other values of frequency in the formula and plot the results on a linear scale, a graph or calibration chart, Fig. 2, can be obtained, which shows what the scale divisions on the variable resistor would look like. It is not a very impressive picture!

Fig. 2 has been drawn to represent the resistance element of the 50kΩ potentiometer opened out to a straight line. A standard wire-wound potentiometer has an element about 4in long, so our scale is a fairly close representation of the frequency/resistance ratio. It would be most disappointing to find out this sort of thing *after* the instrument had been built—far better to see the snags in the design stage!

We can note several undesirable features of the scale. Its practical usefulness does not go much beyond 200 c/s, for at higher frequencies the setting accuracy becomes increasingly unreliable. Even between 100 and 200 c/s it is very poor, and altogether it is not a lot of use. The range of frequencies from 2 kc/s to 20 kc/s has virtually disappeared, for here we have crammed 18 kc/s into no more than 1/25th of an inch. It would be quite impossible to set up a frequency on such a ridiculous scale for, say, 10 kc/s. Clearly there are some problems to solve, and this is where the designer would put on his thinking cap.

The first thing to consider is the *ratio* of maximum to minimum frequency covered by the variable resistance R. In the required design it is 20,000/20 or 1,000:1, and our calculations have shown that this is an impossibly high ratio to cover with a single sweep of the variable resistance R. If the ratio can be smaller, we can expect to get better accuracy, but to do this we cannot use a single condenser; we shall have to use other values in addition to break up the frequency coverage into several ranges.

If we reduce the max/min frequency ratio to 10, we shall need three ranges for complete coverage, i.e. 20,000/2,000, 2,000/200, and 200/20. We can cover this last one with the 0.16μF condenser previously chosen. As the formula for frequency is $f = 10^6/2\pi CR$, the capacity is proportional to $10^6/2\pi fR$. We have allotted a value for R which we retain, so C is clearly inversely proportional to the frequency. Now our required frequency ratios are to be 1:10-100, so the condensers will be the inverse of this, or 100:10:1. Their values will therefore be 0.16μF, 0.016μF and 0.0016μF.

Our scale for these three ranges would be the same as that shown in Fig. 2 except that there would be no markings beyond the 200 c/s mark. Beyond this frequency we would switch to the next range of 200 c/s to 2 kc/s, so the same scale will do for all three ranges. Only one range need be calibrated if the condensers are accurately matched with each other in the ratio 100:10:1 for then the other ranges would automatically coincide.

We now have a part of the variable resistance at the right hand end unused, so we might try to make use of it and open out our scale a little. This is where the resistance R′ in Fig. 1 comes into the picture. As it is in series with the variable resistance R, it will set a limit to the minimum resistance obtained when R itself is zero, that is, at the high frequency end of the scale. For a high frequency f'' the formula given earlier will therefore become:

$$f'' = \frac{10^6}{2\pi CR'}$$

and for a low frequency f' it will be:

$$f' = \frac{10^6}{2\pi C(R+R')}$$

The frequency ratio f_r is thus:

$$f_r = \frac{f''}{f'} = \frac{\dfrac{10^6}{2\pi CR'}}{\dfrac{10^6}{2\pi C(R+R')}}$$

$$= \frac{10^6}{2\pi CR'} \times \frac{2\pi C(R+R')}{10^6}$$

$$= \frac{R+R'}{R'}$$

As we are now considering a value of 10 for f_r we can find that:

$$10 = \frac{R+R'}{R'}$$

$$\text{so } R' = \frac{R}{9}$$

Since our value for R is 50kΩ, R′ will be 5.6kΩ to the nearest standard value. Our highest frequency on the first range will now be:

$$f'' = \frac{10^6}{5.6 \times 10^3}$$

$$= 180 \text{ c/s}$$

For the lowest frequency on this range, R and R′ in series produce a frequency ratio of 10, so it will be 1/10th of the high frequency, or 18 c/s. As this range is lower at both ends than the 20 to 200 c/s required, we can correct it by altering the value of C by a small amount. From the formula $f = 10^6/2\pi CR'$ we find, by rearranging, that C needs to be 0.143μF for this range. The other two condensers will therefore now be 0.0143μF and 0.00143μF. The scale shape for the variable resistance R will now appear as shown in Fig. 3.

If we now examine the scale shapes of Figs. 2 and 3, we can notice that up to about 60 c/s the scales are fairly open; above this frequency they get more and more cramped as the frequency increases. Now 3 times 60 is nearly 200, and 1/3rd of 60 is our lowest frequency of 20 c/s. If the multiplier for 60 was a little more than 3, it would be 200 exactly—in fact, 200/60 = 3.33.

Suppose now we divide each range into two, in the ratio 3.3:1—what effect will this have? Starting at 20 c/s as the lowest frequency, the high frequency will be 20×3.3 = 66 c/s, and multiplying this again by 3.3 gives 225 c/s. Therefore, if we lower the top frequency in each case by a small amount, keeping the frequency ratio at 3.3:1 would also lower the lowest frequencies. Trying 64 c/s, we find 64×3.3 = 212 c/s, and 64/3.3 = 19.4 c/s. It looks, therefore, as if there is something to be gained by dividing the frequency coverage into six ranges instead of three.

Suppose we look into the case where f_r is 3.3:1. From the formula found previously:

$$f_r = 3.3 = \frac{R+R'}{R'}$$

$$\text{so } R = 3.3R' - R'$$

$$= 2.3R'$$

Rearranging this to solve for R′ and inserting the value of R, we have:

$$R' = \frac{R}{2.3}$$

$$= \frac{5 \times 10^4}{2.3}$$

= 22kΩ to the nearest standard value.

Now applying the formula for the high frequency:

$$f'' = \frac{10^6}{100/16 \times C \times R'}$$

$$= \frac{1.6 \times 10^5}{C \times 2.2 \times 10^4}$$

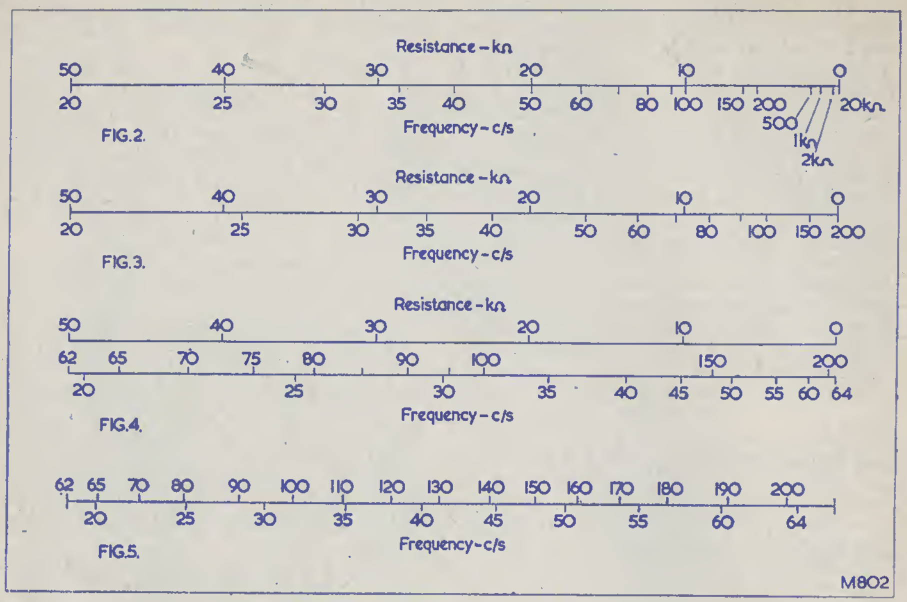
$$= \frac{16}{2.2C}$$

$$= \frac{7.27}{C}$$

$$\text{therefore } C = \frac{7.27}{f''}$$

$$= \frac{7.27}{64}$$

$$= 0.112\mu F$$



Verifying for the low frequency:

$$f' = \frac{1.6\times 10^5}{C\times 7.2\times 10^4}$$

$$= \frac{16}{7.2C}$$

$$= \frac{2.2}{C}$$

$$= \frac{2.2}{0.112}$$

$= 19.4$ c/s, as predicted.

Having found the values for the first range, the values of C for the *third* and *fifth* ranges must be such that the three condensers are in the ratio 100:10:1. Those for the two latter ranges will therefore be 0.0112μF and 0.00112μF.

Turning now to the *second* range, since we shall have to calibrate another scale for it we can with advantage drop the frequencies slightly in order to obtain a small overlap of the ranges. If, instead of 64 to 212 c/s we drop to 62 c/s for the low frequency, the high frequency becomes $62\times 3.3=205$ c/s. For these limits of frequency we find that for C we require a value of 0.0355μF. So, for the *fourth* and *sixth* ranges, C will be 0.00355μF and 0.000355μF (or 355pF) respectively.

Our frequency coverage in six ranges for each value of C can be tabulated thus:

Frequency		*Capacity*
19.4–64 c/s	..	0.112μF
62–205 c/s	..	0.0355μF
194–640 c/s	..	0.0112μF
620–2,050 c/s	..	0.00355μF
1.94–6.4 kc/s	..	0.00112μF
6.2–20.5 kc/s	..	355pF

Up to this point we have considered only one of the two frequency determining networks C–R–R′ but both the networks associated with V_1 and$_2$ V will clearly have to be of similar characteristics to ensure that both stages tune to the same resonant frequencies. The individual components must therefore be matched pairs, and to make both networks tune in step the variable control R must be a twin-gang unit.

So far as values of components are concerned, there is no more we need do, and we have at the same time suitably arranged for the two calibrations to be contained within the limits of travel of the tuning control, as is shown in Fig. 4. However, our work is not yet finished, for there is still room for improvement in the shape, or law, of the calibrations. It is never particularly easy to interpolate readings on a non-linear scale unless there is a large number of graduations, thus reducing the possibility of errors. Even so, if the spacings of the graduations vary continuously over the whole scale, as they do in Figs. 2, 3 and 4, their irregularity will always be the cause for uncertainty in one's mind.

One has only to compare, say, reading between divisions on a slide rule (which has a logarithmic law) and the same operation on an ordinary foot rule (whose divisions follow a linear law). It is fairly easy to read fractions of divisions on the foot rule, simply because the eye can subdivide them evenly more accurately; with the slide rule, however, a certain amount of judgment, acquired with experience, is necessary to secure commensurate accuracy of interpolation. Similarly, with scale markings on a test instrument's calibration, the more evenly divided they are, the more accurately they can be read. Consequently, if we can make our tuning scale for the audio oscillator more evenly divided, so much the better.

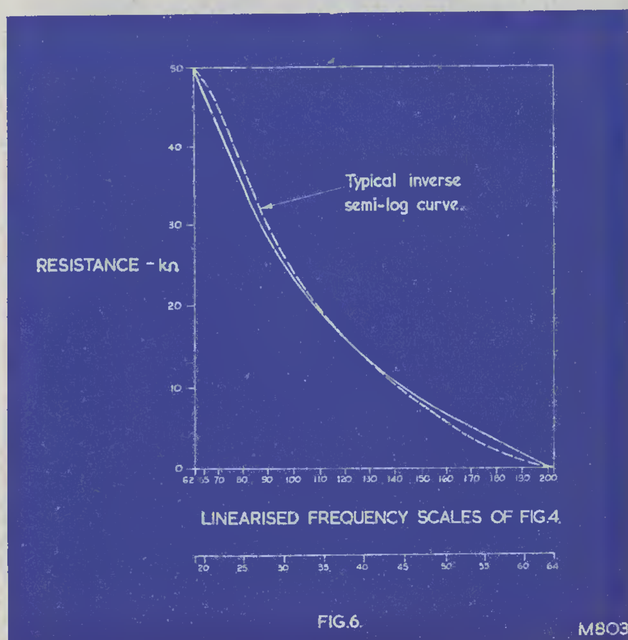
The scales of Figs. 2, 3 and 4 have the linear law of the resistance element shown with them for comparison with the non-linear law of the frequency characteristic. If a potentiometer with a suitably graded element is substituted, it could be possible largely to reverse this order of things; let us, therefore, consider a means of doing this.

For the three scales so far considered it is seen that in all cases the resistance is at its *maximum* value when it is turned to its fully anti-clockwise position, where the frequency is low. Variable resistors, or potentiometers, are more often used so that the resistance is at its *minimum* value at this position (e.g. the volume control of a radio receiver), and the resistance becomes greater as the control is turned in a clockwise direction. We require the opposite of this in our case, so a potentiometer with an *inverse* action is necessary, that is, resistance decreasing with clockwise rotation of the control.

In addition, we have to compensate the non-linear frequency characteristic, and to do this it is necessary to get some idea of the frequency/resistance relationship when the frequency scale is linearised in order to see to which law the resistance element will need to be graded. Such a curve is shown by the full line in Fig. 6. The two frequency scales of Fig. 4 have been shown in Fig. 6 as linear scales on the X-axis for the graph. For each value of frequency the *proportion* of the total resistance of R at that point has been calculated, and plotted against the value of resistance so found on the Y-axis, so producing the curve shown. It is easier now to see that if we are to obtain a linear frequency scale, the resistance element of R would have to be graded to a law similar to that of the full-line curve.

The dotted curve represents the law of a resistance element having an inverse semi-log grading. The curves are almost the same shape; their resemblance to each other is so close that little error is introduced by adopting the dotted curve in place of the full-line one. From these two curves it is possible to predict the scale shape of a control having an inverse semi-log grading, and the result is shown in Fig. 5. It is apparent that the divisions are fairly evenly spaced, and certainly more "linear" than those in Fig. 4.

It is not possible to make a wire-wound resistance element with a perfectly smooth curve (at least, not at reasonable cost), but a close approach to it is obtained by winding the element in several section. This accounts for the slight divergencies at the extremes of rotation, and the effect can be seen in Fig. 5, for the spacings are a little wider at the ends compared to those near the centre. Even so, the better linearity is so marked that to set up, say, 155 c/s on the scale of Fig. 5 is



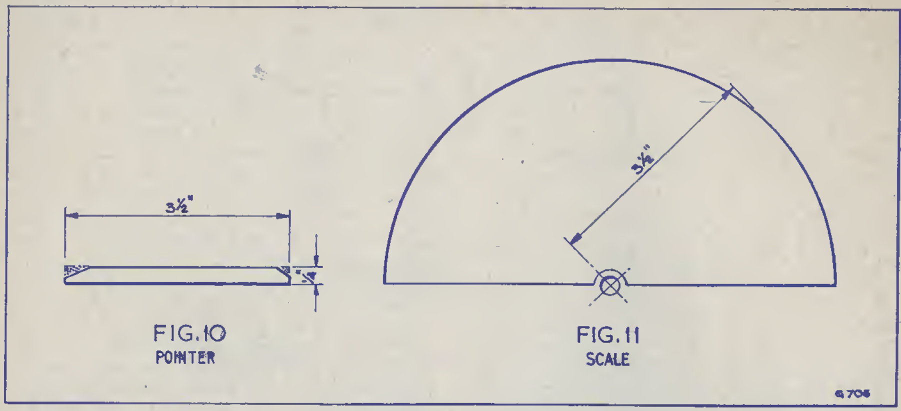


FIG. 10
POINTER

FIG. 11
SCALE

is next mounted on the inside back of the chassis and the a.f. transformer near the valveholders on the underside of the chassis, as shown in the component layout of Fig. 3. Care should be taken, when drilling holes for these new components, to avoid damage to parts already fitted. The r.f. choke is mounted in the wiring on top of the chassis as is L_1, L_2, C_2, C_3, C_4 and R_1. The coil is made by winding fourteen turns of 16 s.w.g. tinned copper wire around a ⅜in former, then removing the coil from the former and spacing the turns roughly twice the diameter of the wire No special precautions are necessary in wiring up, except in the tuned circuit of V_1 where 20 s.w.g. tinned copper wire should be used to connect the coil to the tuning condenser and to pins 6 and 7 of the valveholder The heater wires and the anode wire are brought up through the hole marked "X" in Fig. 5, whilst the wire to the junction of the r.f. choke and C_4 comes up through hole "Y" Power supplies are fed via three flexible p.v.c. leads.

Testing

Having completed the wiring, the unit has to be tested.

Connect the output of the signal generator to the aerial socket of a television receiver switched to Channel 1 and swing C_1. A fairly high-pitched whistle should be heard as C_1 tunes through the sound channel, and a pattern should appear on the screen when it tunes to the vision channel. Should no pattern appear, switch the receiver to Channel 2. If this results in a pattern with C_1 fully meshed then the coil inductance is too low and the turns should be brought closer together. If this process still does not give enough inductance, the coil should be re-wound with an extra turn. If no pattern can be obtained on any channel then alter the cathode tap to six turns from the chassis end and try again.

Having got a pattern on Channel 1, adjust the spacing of the coil turns until the sound channel appears at a near-maximum capacity setting of C_1, then tune from Channel 1 to Channel 5. The latter should appear near the minimum capacity position. Next switch the receiver to Channel 9 and check that a pattern appears below Channel 5 on the signal generator scale. Finally, check other channels on Bands I and III to ensure that the generator has the range required.

Calibration of the scale may be finally carried out against a television receiver on both Bands. Should the output from the signal generator be too great on Band I, the coaxial lead from the generator may be removed from the receiver socket and a simple resistive attenuator inserted in series.

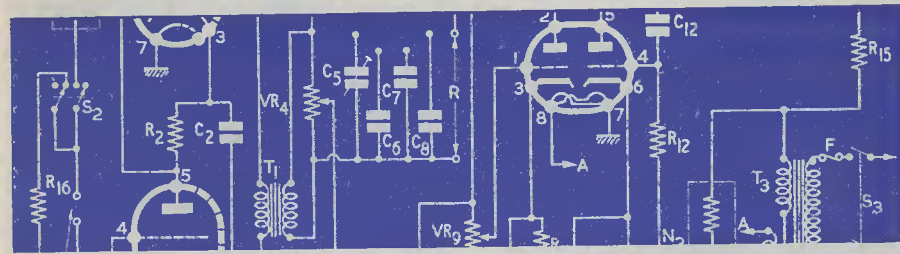
British Equipment for German Airfields

Among orders announced at the Leipzig Fair by the Government of the German Democratic Republic was one for £40,000 which was awarded to Pye Telecommunications Limited of Cambridge.

The equipment to be supplied includes an Instrument Landing System (I.L.S.) for Dresden International Airport and the latest v.h.f. ground-to-air communications equipment for Schoenefeldt airfield and the East German area.

The Pye I.L.S. gives highly accurate guidance to an aircraft on approach to landing due to the use of a directional localiser and stabilised glide path. It is rapidly achieving world-wide application, having already been supplied to airfields in Geneva, Hong Kong, Canada, Nairobi, Belgian Congo, Persian Gulf, Russia, Hungary, Yugoslavia, and Britain.

WHAT'S IN



A DESIGN ?

By W. E. THOMPSON, A.M.I.P.R.E.

In this mainly theoretical article, the author describes a method of designing the C-R values in an audio oscillator to provide not only the required scales but also to ensure that these are linear.—Editor.

Although it cannot be expected that every reader of technical journals is sufficiently experienced to develop his own circuit designs, there must be many who have attempted it themselves with varying degrees of success. Many others have most likely failed to achieve their objective, possibly due to insufficient technical knowledge, or perhaps overlooking certain features that a particular design might reveal to a more appreciative mind.

This article does not presume to teach basic design principles which could be applied to any problem that might arise in developing an item of equipment; it does, however, deal with one aspect of designing a piece of apparatus with the object of showing what can be behind an article in a technical journal.

A short study here of a typical circuit configuration can give an insight to some of these matters. At the same time it can

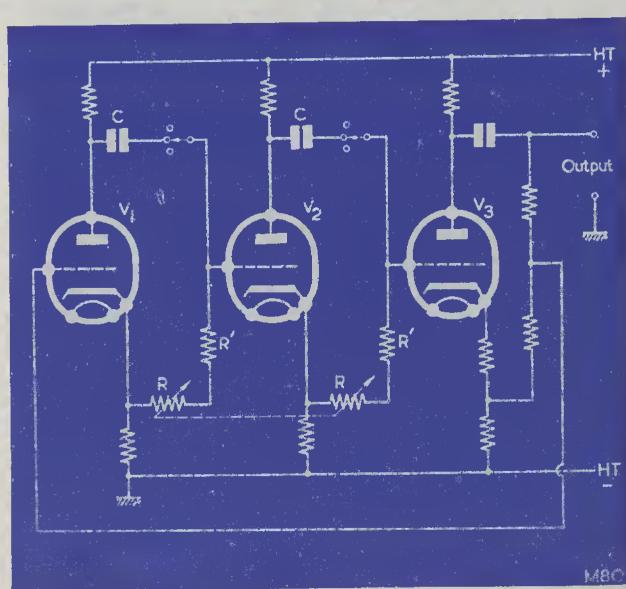


Fig. 1. Basic circuit of the 20 c/s–20kc/s audio oscillator, the design of which is discussed in the text particularly with reference to the values of C, R and R'

provide some interesting exercises in deriving circuit values, and the reasons which sometimes necessitate the use of a certain specification for a component. Design does not end at a circuit on paper; the end product quite often involves more thought than making up a suitable circuit. The mechanical design of an instrument may well require considerable modification of original thoughts in order to achieve certain functions in the finished apparatus.

A typical example could be the simple basic circuit for an audio oscillator shown in Fig. 1. We shall look more than casually into the innocent appearance of the frequency-determining components, C, R and R′.

Now, this circuit could be made to generate audio frequencies ranging from a fraction of a cycle per second (c/s) to several hundred kilocycles per second (kc/s) by suitable design. However, let us assume that we wish to prepare a design to cover a general purpose range of 20 c/s to 20 kc/s.

The frequency of oscillation is determined by the values allotted to condenser C and resistance R. It is possible, of course, to cover the whole range in a single sweep of a control if C is a fixed value and R is made variable, but the calibrated scale of R would then become very cramped, making it difficult to read and uncertain in setting if reasonable accuracy of tuning is to be achieved. The reason is not hard to find, for the resonant frequency is given by the formula:

$$f=\frac{10^6}{2\pi CR}$$

where f = frequency in c/s
C = capacitance in μF
R = resistance in Ω

$$2\pi=6.28 \text{ (or } \frac{100}{16} \text{ approx.)}$$

(It can be mentioned here that this approximated value for 2π introduces only about 0.5% error—certainly accurate enough for slide-rule calculations.)

To make calculation somewhat easier, give a value of 0.16μF to C, and our formula becomes:

$$f=\frac{10^6}{100/16\times0.16\times R}$$

$$=\frac{10^6}{R}$$

$$\text{so } R=\frac{10^6}{f}$$

By inserting the values of 20 and 20,000 for f, we now find that R must have a maximum resistance of 50kΩ and a minimum resistance of 50Ω. The whole range of frequencies is thus covered in 49.95kΩ of the 50kΩ total. Only 50Ω, or 1/1000th part of the resistance is not used.

If we insert other values of frequency in the formula and plot the results on a linear scale, a graph or calibration chart, Fig. 2, can be obtained, which shows what the scale divisions on the variable resistor would look like. It is not a very impressive picture!

Fig. 2 has been drawn to represent the resistance element of the 50kΩ potentiometer opened out to a straight line. A standard wire-wound potentiometer has an element about 4in long, so our scale is a fairly close representation of the frequency/resistance ratio. It would be most disappointing to find out this sort of thing *after* the instrument had been built—far better to see the snags in the design stage!

We can note several undesirable features of the scale. Its practical usefulness does not go much beyond 200 c/s, for at higher frequencies the setting accuracy becomes increasingly unreliable. Even between 100 and 200 c/s it is very poor, and altogether it is not a lot of use. The range of frequencies from 2 kc/s to 20 kc/s has virtually disappeared, for here we have crammed 18 kc/s into no more than 1/25th of an inch. It would be quite impossible to set up a frequency on such a ridiculous scale for, say, 10 kc/s. Clearly there are some problems to solve, and this is where the designer would put on his thinking cap.

The first thing to consider is the *ratio* of maximum to minimum frequency covered by the variable resistance R. In the required design it is 20,000/20 or 1,000:1, and our calculations have shown that this is an impossibly high ratio to cover with a single sweep of the variable resistance R. If the ratio can be smaller, we can expect to get better accuracy, but to do this we cannot use a single condenser; we shall have to use other values in addition to break up the frequency coverage into several ranges.

If we reduce the max/min frequency ratio to 10, we shall need three ranges for complete coverage, i.e. 20,000/2,000, 2,000/200, and 200/20. We can cover this last one with the 0.16μF condenser previously chosen. As the formula for frequency is $f=10^6/2\pi CR$, the capacity is proportional to $10^6/2\pi fR$. We have allotted a value for R which we retain, so C is clearly inversely proportional to the frequency. Now our required frequency ratios are to be 1:10-100, so the condensers will be the inverse of this, or 100:10:1. Their values will therefore be 0.16μF, 0.016μF and 0.0016μF.

Our scale for these three ranges would be the same as that shown in Fig. 2 except that there would be no markings beyond the 200 c/s mark. Beyond this frequency we would switch to the next range of 200 c/s to 2 kc/s, so the same scale will do for all three ranges. Only one range need be calibrated if the condensers are accurately matched with each other in the ratio 100:10:1 for then the other ranges would automatically coincide.

We now have a part of the variable resistance at the right hand end unused, so we might try to make use of it and open out our scale a little. This is where the resistance R′ in Fig. 1 comes into the picture. As it is in series with the variable resistance R, it will set a limit to the minimum resistance obtained when R itself is zero, that is, at the high frequency end of the scale. For a high frequency f'' the formula given earlier will therefore become:

$$f''=\frac{10^6}{2\pi CR'}$$

and for a low frequency f' it will be:

$$f'=\frac{10^6}{2\pi C(R+R')}$$

The frequency ratio f_r is thus:

$$f_r=\frac{f''}{f'}=\frac{\dfrac{10^6}{2\pi CR'}}{\dfrac{10^6}{2\pi C(R+R')}}$$

$$=\frac{10^6}{2\pi CR'}\times\frac{2\pi C(R+R')}{10^6}$$

$$=\frac{R+R'}{R'}$$

As we are now considering a value of 10 for f_r we can find that:

$$10=\frac{R+R'}{R'}$$

$$\text{so } R'=\frac{R}{9}$$

Since our value for R is 50kΩ, R′ will be 5.6kΩ to the nearest standard value. Our highest frequency on the first range will now be:

$$f''=\frac{10^6}{5.6\times10^3}$$

$$=180 \text{ c/s}$$

For the lowest frequency on this range, R and R′ in series produce a frequency ratio of 10, so it will be 1/10th of the high frequency, or 18 c/s. As this range is lower at both ends than the 20 to 200 c/s required, we can correct it by altering the value of C by a small amount. From the formula $f=10^6/2\pi CR'$ we find, by rearranging, that C needs to be 0.143μF for this range. The other two condensers will therefore now be 0.0143μF and 0.00143μF. The scale shape for the variable resistance R will now appear as shown in Fig. 3.

If we now examine the scale shapes of Figs. 2 and 3, we can notice that up to about 60 c/s the scales are fairly open; above this frequency they get more and more cramped as the frequency increases. Now 3 times 60 is nearly 200, and 1/3rd of 60 is our lowest frequency of 20 c/s. If the multiplier for 60 was a little more than 3, it would be 200 exactly—in fact, 200/60=3.33.

Suppose now we divide each range into two, in the ratio 3.3:1—what effect will this have? Starting at 20 c/s as the lowest frequency, the high frequency will be $20\times3.3=66$ c/s, and multiplying this again by 3.3 gives 225 c/s. Therefore, if we lower the top frequency in each case by a small amount, keeping the frequency ratio at 3.3:1 would also lower the lowest frequencies. Trying 64 c/s, we find $64\times3.3=212$ c/s, and $64/3.3=19.4$ c/s. It looks, therefore, as if there is something to be gained by dividing the frequency coverage into six ranges instead of three.

Suppose we look into the case where f_r is 3.3:1. From the formula found previously:

$$f_r=3.3=\frac{R+R'}{R'}$$

$$\text{so } R=3.3R'-R'$$

$$=2.3R'$$

Rearranging this to solve for R′ and inserting the value of R, we have:

$$R'=\frac{R}{2.3}$$

$$=\frac{5\times10^4}{2.3}$$

$$=22\text{k}\Omega \text{ to the nearest standard value.}$$

Now applying the formula for the high frequency:

$$f''=\frac{10^6}{100/16\times C\times R'}$$

$$=\frac{1.6\times10^5}{C\times2.2\times10^4}$$

$$=\frac{16}{2.2C}$$

$$=\frac{7.27}{C}$$

$$\text{therefore } C=\frac{7.27}{f''}$$

$$=\frac{7.27}{64}$$

$$=0.112\mu F$$

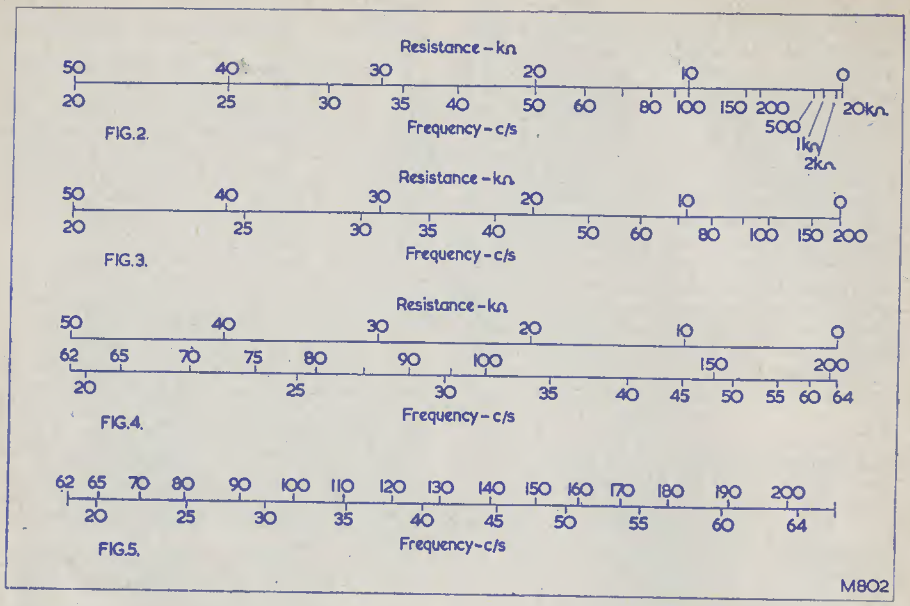


FIG.2. FIG.3. FIG.4. FIG.5.

Verifying for the low frequency:

$$f' = \frac{1.6 \times 10^5}{C \times 7.2 \times 10^4}$$

$$= \frac{16}{7.2C}$$

$$= \frac{2.2}{C}$$

$$= \frac{2.2}{0.112}$$

$= 19.4$ c/s, as predicted.

Having found the values for the first range, the values of C for the *third* and *fifth* ranges must be such that the three condensers are in the ratio 100:10:1. Those for the two latter ranges will therefore be 0.0112μF and 0.00112μF.

Turning now to the *second* range, since we shall have to calibrate another scale for it we can with advantage drop the frequencies slightly in order to obtain a small overlap of the ranges. If, instead of 64 to 212 c/s we drop to 62 c/s for the low frequency, the high frequency becomes $62 \times 3.3 = 205$ c/s. For these limits of frequency we find that for C we require a value of 0.0355μF. So, for the *fourth* and *sixth* ranges, C will be 0.00355μF and 0.000355μF (or 355pF) respectively.

Our frequency coverage in six ranges for each value of C can be tabulated thus:

Frequency		*Capacity*
19.4–64 c/s	..	0.112μF
62–205 c/s	..	0.0355μF
194–640 c/s	..	0.0112μF
620–2,050 c/s	..	0.00355μF
1.94–6.4 kc/s	..	0.00112μF
6.2–20.5 kc/s	..	355pF

Up to this point we have considered only one of the two frequency determining networks C–R–R′ but both the networks associated with V_1 and$_2$ V will clearly have to be of similar characteristics to ensure that both stages tune to the same resonant frequencies. The individual components must therefore be matched pairs, and to make both networks tune in step the variable control R must be a twin-gang unit.

So far as values of components are concerned, there is no more we need do, and we have at the same time suitably arranged for the two calibrations to be contained within the limits of travel of the tuning control, as is shown in Fig. 4. However, our work is not yet finished, for there is still room for improvement in the shape, or law, of the calibrations. It is never particularly easy to interpolate readings on a non-linear scale unless there is a large number of graduations, thus reducing the possibility of errors. Even so, if the spacings of the graduations vary continuously over the whole scale, as they do in Figs. 2, 3 and 4, their irregularity will always be the cause for uncertainty in one's mind.

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The scales of Figs. 2, 3 and 4 have the linear law of the resistance element shown with them for comparison with the non-linear law of the frequency characteristic. If a potentiometer with a suitably graded element is substituted, it could be possible largely to reverse this order of things; let us, therefore, consider a means of doing this.

For the three scales so far considered it is seen that in all cases the resistance is at its *maximum* value when it is turned to its fully anti-clockwise position, where the frequency is low. Variable resistors, or potentiometers, are more often used so that the resistance is at its *minimum* value at this position (e.g. the volume control of a radio receiver), and the resistance becomes greater as the control is turned in a clockwise direction. We require the opposite of this in our case, so a potentiometer with an *inverse* action is necessary, that is, resistance decreasing with clockwise rotation of the control.

In addition, we have to compensate the non-linear frequency characteristic, and to do this it is necessary to get some idea of the frequency/resistance relationship when the frequency scale is linearised in order to see to which law the resistance element will need to be graded. Such a curve is shown by the full line in Fig. 6. The two frequency scales of Fig. 4 have been shown in Fig. 6 as linear scales on the X-axis for the graph. For each value of frequency the *proportion* of the total resistance of R at that point has been calculated, and plotted against the value of resistance so found on the Y-axis, so producing the curve shown. It is easier now to see that if we are to obtain a linear frequency scale, the resistance element of R would have to be graded to a law similar to that of the full-line curve.

The dotted curve represents the law of a resistance element having an inverse semi-log grading. The curves are almost the same shape; their resemblance to each other is so close that little error is introduced by adopting the dotted curve in place of the full-line one. From these two curves it is possible to predict the scale shape of a control having an inverse semi-log grading, and the result is shown in Fig. 5. It is apparent that the divisions are fairly evenly spaced, and certainly more "linear" than those in Fig. 4.

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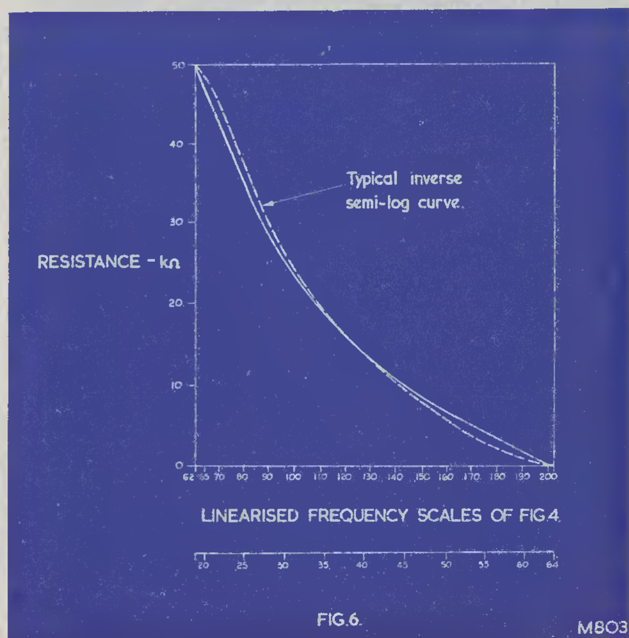


FIG.6.

obviously much easier than doing the same thing on a scale like that of Fig. 4. In this latter case it would be more guesswork than anything else.

Gathering together the information obtained, we can now say that for Fig. 1 the following specifications should apply to the frequency-determining components:

(*a*) Condensers C for the six ranges to have values as set out in tabular form earlier. Pairs of condensers for each range to be matched as closely as possible.

(*b*) Resistors R′ to be 22kΩ each, 2% tolerance, and matched to 2% or better. Half-watt rating is more than adequate.

(*c*) Resistors R to be a 50kΩ+50kΩ twin-gang potentiometer with inverse semi-log grading.

Some remarks concerning these components would not be out of place. Tolerances for paper condensers being fairly wide, it would be better to select lower values than those specified, and make up the differences with mica or silver-mica condensers. Silver-micas to 1% tolerance can be bought fairly cheaply in a wide range of values. Resistors R′ can consist of small close tolerance items which are readily obtainable in the Lab range. They cost 1s. 6d. for 2% tolerance, or 2s. 6d. for 1%, the range covering all values in the usual 5% tolerance values from 100Ω to 10mΩ.

The twin-gang potentiometer for R is not to be confused with a couple of cheap volume controls. This component should be a good one, and certainly the best that one can afford. As a standard value it is likely to be a stock item at the maker's works, though few radio shops would be likely to stock it "on-the-shelf". Made to fairly close electrical and mechanical tolerances, it is not exactly cheap to buy, a standard sized component 1½in in diameter being in the region of 25s. to 30s. A larger one, say up to 3in diameter, would provide far greater accuracy, but is likely to cost about £3 or more.

If you have had enough patience still to be with us, and can understand what we have been talking about, you will see by now that the opening remarks in this article have a ring of truth about them. If you had not realised this sort of thing before it may have surprised you to find that a couple of resistors and a condenser could cause so much trouble. However, we have at least shown how foundations are laid for a design which could be more creditable as an end product, cleared of the snags usually resulting from hastily stringing together components which, though they may be on hand, are not entirely suitable. It is this sort of work which so often lies concealed in an article, not because the author is gloating over his "cleverness" or is deliberately being cagey, but because he wishes to present the best arrangement he can devise without having to explain every little detail. Although this present article has sought to elucidate such points, it nevertheless conceals a lot in itself! For instance, none of the calculations necessary to plot the scales and curves given in the Figs. 2 to 6 have been given; to have done so would have made the article many times longer.

When next you see a particular component specified for a design, don't harbour dark suspicions that the author (and possibly the editor!) is hand-in-glove with certain manufacturers, "plugging" their commodities or boosting their sales for them. More often than not there's good sound reasoning behind it all, and may be far more hard work has gone into it than many people might imagine. And none of this is a "puff" for writers in this journal or any other—it is a statement of fact.

In this short treatise we have dealt with only one aspect of the circuit, as we set out to do. But this is only part of it; the circuit as a whole design could involve one in quite a lot more work to produce the finished instrument, and the article describing it, as no doubt you now well appreciate. Anyway, let's hope you do!

Acknowledgments

The circuit of Fig. 1 is based upon an audio oscillator described by W. Fraser, B.Sc.(Eng.), A.M.I.E.E., in the May 1956 issue of *Electronic Engineering*. The curve of the inverse semi-log variable resistance in Fig. 6 is taken from curves shown in the catalogue of Messrs. Reliance Manufacturing Co. (Southwark) Ltd.

I.T.A. WIDENS VIEWING AREA IN SCOTLAND

The Independent Television Authority has placed an order with Pye Telecommunications Limited of Cambridge for the supply and installation of a television re-transmission link in North-East Scotland.

The Authority is setting up new television broadcasting stations, to cover the area, at Durris in Kincardineshire and at Mounteagle in Ross and Cromarty. Durris will eventually receive programmes by Post Office link, but this will not be available for some months after the opening of the Mounteagle station. The Postmaster-General has therefore authorised the use of this re-transmission link between Durris and Mounteagle.

The broadcast programmes from Durris will be picked up by v.h.f. receivers at Pikey Hill, a high site near Elgin. From these receivers the programmes will be re-transmitted by Pye microwave equipment, working in the 7,000 Mc/s band, to Mounteagle—a distance of 36 miles.

Pye Telecommunications Limited will supply and install all of the equipment of the link. The microwave transmitters and receivers will be type PTC M1000G which is designed for monochrome or colour television signals, with accompanying sound, using any of the standard systems—405, 525 or 625 lines.

A PICKUP CONTROL

by J. DAY

With certain types of manual record-playing decks there is no method of lowering the pickup on to the disc. Attempting to do this by hand can often be a tricky operation, and it may cause damage to the record or the pickup.

The device described in this article overcomes this problem in an extremely simple and inexpensive manner. The original was made in a couple of hours, and is at present being used with a Garrard 4HF deck.

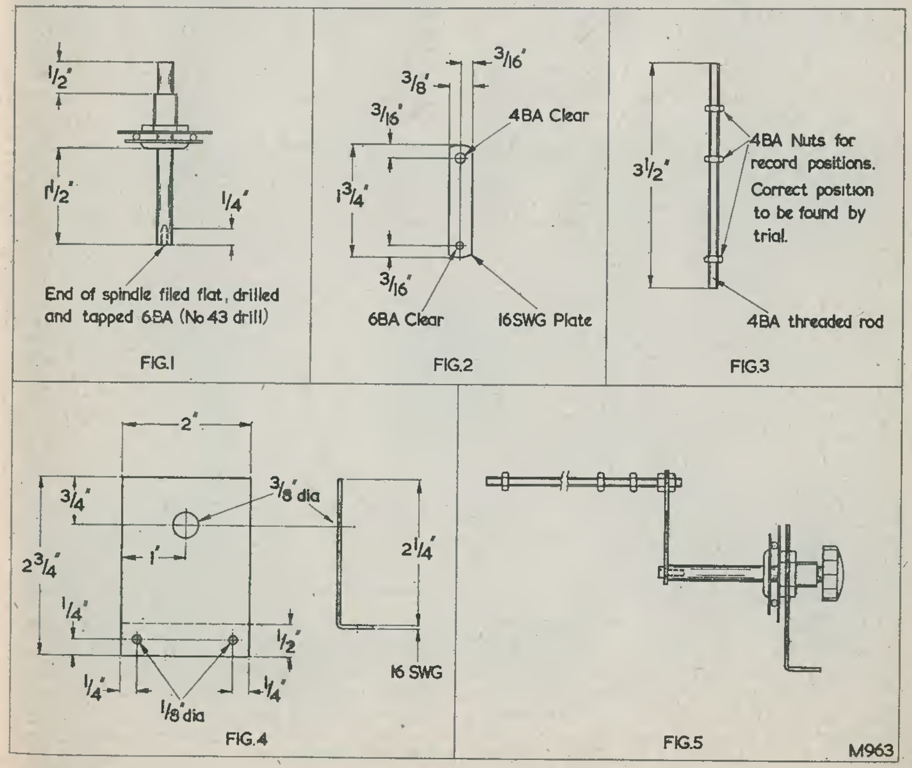
The Lowering Device

The main requirement for the device is an old wafer switch. The Paxolin switch wafers, together with the studding and spacers securing them, are removed. The next process consists of filing the end of the spindle flat ,as shown in Fig. 1. The flat spindle end is then drilled and tapped 6BA to a depth of ¼in, as illustrated.

The next requirement is a piece of 16 s.w.g. metal, cut out and drilled as shown in Fig. 2. Aluminium was employed in the original although any other suitable material may be used. The 16 s.w.g. metal plate is secured with a 6BA screw to the tapped end of the spindle. At the same time, a length of 4BA studding (Fig. 3) is fitted to the remaining hole in the plate. The method of assembling these parts is made clear in the final assembly shown in Fig. 5.

It is next necessary to make a mounting bracket for the lowering device. Suitable dimensions for such a bracket are given in Fig. 4. Once again, 16 s.w.g. metal is specified.

The modified switch is now fitted to the ⅜in diameter hole in the bracket, as illustrated in Fig. 5. The complete assembly is then mounted on the gram motor board adjacent to the pickup, with the 4BA threaded rod protruding under the pickup



arm. A suitable knob should be fitted to the switch spindle.

Three nuts should now be fitted to the threaded rod in positions corresponding to the start of 7in, 10in and 12in records. The positions of the nuts has to be found by experiment. Self-locking nuts or plain nuts locked with varnish should be used.

In operation, the pickup is placed on the 4BA studding and is moved across to one of the three positions taken up by the nuts. The switch movement is then rotated in a clockwise direction, whereupon the pickup lowers itself on to the record.

Stops on the switch movement were not found necessary with the original. They could, nevertheless, be added if desired, and would provide an added refinement.

A USEFUL HEAT SHUNT

By **T. S. Williamson**

When soldering transistors or other semi-conductors into circuit it is always advisable to apply a heat shunt to the lead-out wire between the solder joint and the body of the semi-conductor. The heat shunt conducts away heat travelling up the lead-out wire and thereby prevents damage to the semi-conductor.

One method of applying a heat shunt consists of holding the lead-out wire with a pair of long nosed pliers whilst the joint is being soldered (and until it has afterwards cooled). This has the disadvantage that the pliers have to be held whilst the soldering operation is in process—a requirement that can sometimes be difficult to carry out. The heat shunt described here overcomes this difficulty, as it may be clipped firmly to the lead-out wire and removed later at any convenient time.

The basic part of the heat shunt is an ordinary crocodile clip with the first few teeth in both jaws removed, as in Fig. 1. Two metal pieces are then cut from 1/8in copper to the shape and dimensions given in Fig. 2. These two pieces are finally fitted and soldered to the crocodile clip as illustrated in Fig. 3, which shows the completed heat shunt. It will be noted that the method of assembly ensures that the inside edges of the copper pieces provide a positive contact to the lead-out wire to which they are clipped, and that there is a relatively heavy mass of copper to conduct away the heat.

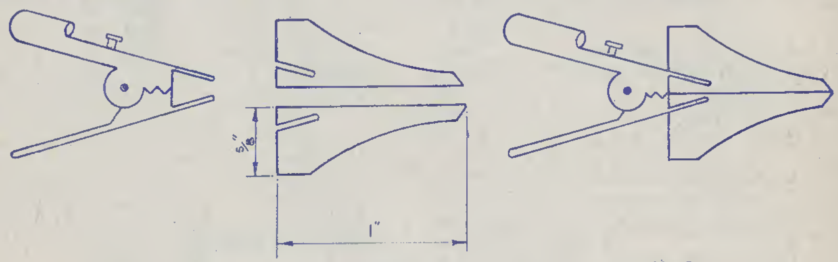


Fig.1 Crocodile clip with first few teeth removed

Fig.2 Material: 1/8" copper 2-off

Fig.3 Finished heat shunt

E823

It is a good plan to make several pairs of heat shunts in this manner, each pair being joined together by 3in of flex. Often, two semi-conductor leads have to be connected to the same point, and the shunts then give each other added mechanical stability.

Getting Started on 2-Metres

PART 2 — A NOVICE 144 Mc/s CONVERTER

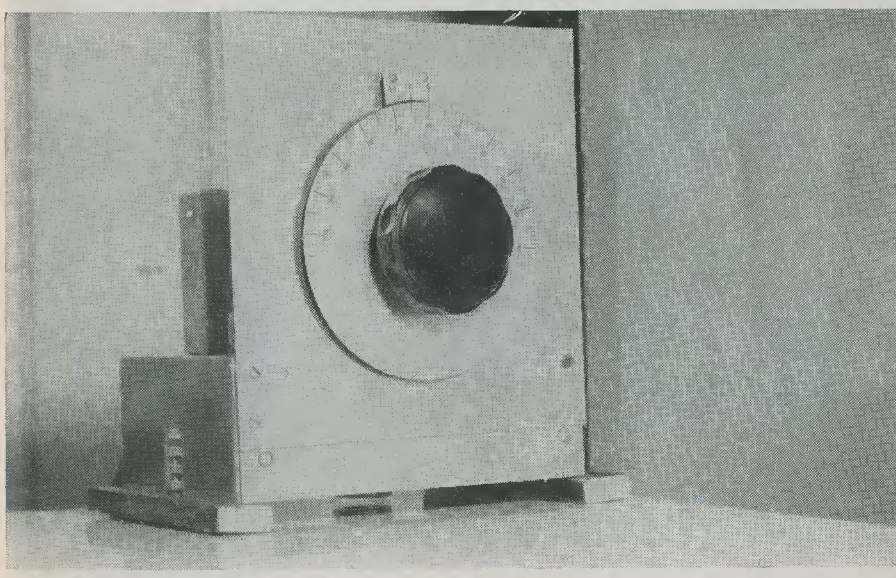
by J. N. WALKER, G5JU

Many amateurs, including the up-and-coming younger generation, would like to "have-a-go" at the two metre band, which holds much of interest for both the listener and the fully fledged licensed transmitter. Constructing suitable equipment, however, can be quite a problem and many will wish to start in a small way, building up to more ambitious and elaborate gear as time goes on.

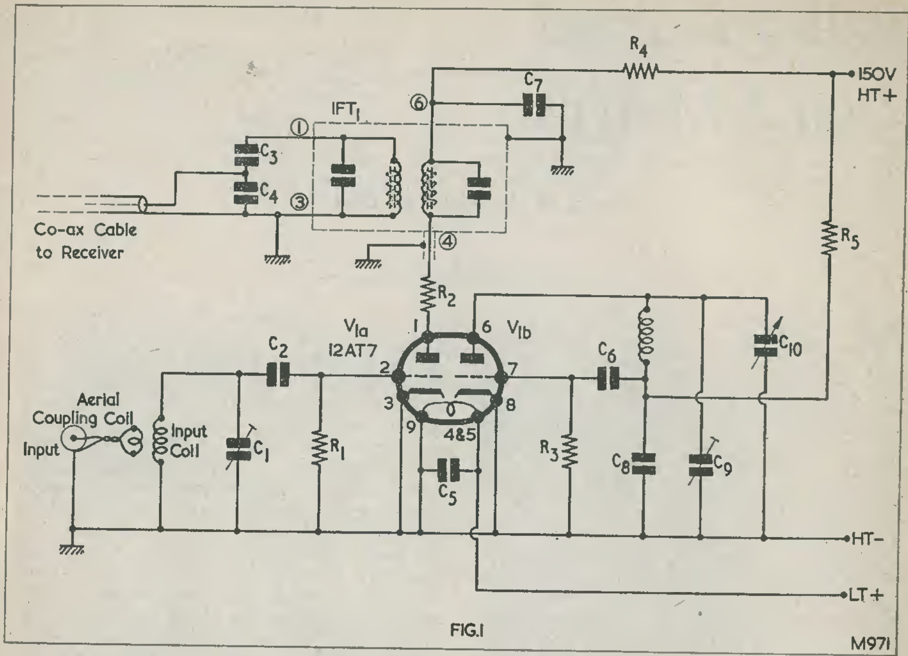
Obviously, a start must be made with equipment for receiving two metre signals. Usually an h.f. receiver of one type or another is available and it is common practice to utilise this as the "back-end" giving amplification at the chosen intermediate frequency, followed by normal detection and audio output. The problem therefore boils down to a converter used in front of the receiver.

Previous articles have been published on quite a number of converters for 144 Mc/s, mostly of complex design—at least as far as newcomers to v.h.f. are concerned. The writer has also seen one or two short articles dealing with fairly simple converters, the construction of these not having been dealt with adequately. In any event, constructing a two metre converter and, what is more, adjusting the tuned circuits—especially the oscillator coverage—is by no means easy, the more information that can be provided the better for all concerned. It is hoped that the present design will considerably help to encourage a greater use of the 144 Mc/s band.

The main feature of the converter design described here is the stage by stage constructional system. One can commence with the essential mixer and oscillator stages and later



Front view of the completed converter



The circuit of thesingle valve 144 Mc/s Converter

Components List

Resistors

R_1	10MΩ ⅛ or ¼ watt
R_2	12Ω ⅛ or ¼ watt
R_3	10kΩ ¼ or ½ watt
R_4	150kΩ ½ watt
R_5	25kΩ ½ watt

Condensers

C_1	Trimmer (see text)
C_2	25pF ceramic or silver mica
C_3	10pF ceramic or silver mica
C_4	100pF ceramic or silver mica
C_5	0.003μF cascap
C_6	50pF ceramic or silver mica
C_7	0.003μF cascap
C_8	50pF ceramic or silver mica
C_9	Trimmer (see text)
C_{10}	Variable (see text) Eddystone Cat. No. 580

Valve

V_1	12AT7 or ECC81

I.F. Transformer

10.7 Mc/s Eddystone Cat No. 856

Miscellaneous

Chassis and panel (H. L. Smith & Co. Ltd.)
Slow motion drive and dial Eddystone Cat. No. 843
Valveholder—B9A, with centre spigot, skirt and screen
Condenser mounting bracket (Eddystone Cat. No. 708)
Flexible coupler (Eddystone Cat. No. 893)
2-way tagstrip
Two single tagstrips
Coaxial socket, plugs, cable, etc.
Aerial coupling coil and input coil assembly (see text)

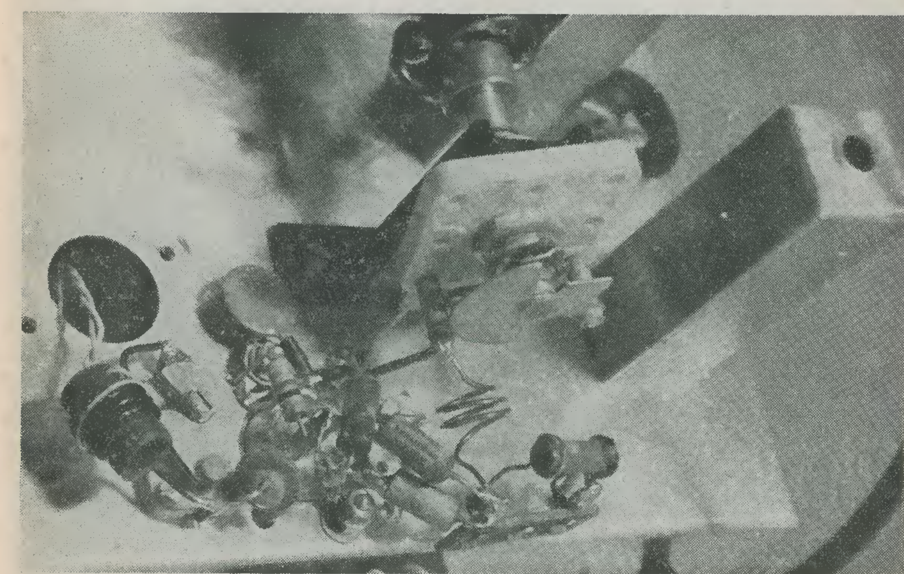
improve the preformance by adding a radio frequency amplifier stage and also an intermediate frequency pre-amplifier. Both of these will of course make a considerable difference, especially where weak distant signals are concerned. The fairly simple one valve converter described here will be found to give worthwhile results, allowing reception of local stations over quite an area. Provided the aerial system used and the location are both good, signals can be received from stations forty miles or more away, this having been the case during tests with the present design.

Basic Design

Only one double triode valve is used, one half as a mixer, the other as a self-running oscillator, its frequency being on the lower side of the signal.

A valve used as a mixer, to function properly, must be operated in a non-linear condition, hence the inclusion in the circuit (Fig. 1) of R_1, which provides a small amount of grid bias (derived from grid current), and of R_4, which reduces the anode voltage to a comparatively low value. The input circuit is tuned to the centre of the band by means of the trimmer condenser, C_1. This part of the circuit could admittedly be simplified by adopting a self-resonant coil but, with the damping caused by the valve loading, the bandwidth would be very high (probably in the region of 10 Mc/s) causing a serious drop in sensitivity. This is a point which appears to be overlooked by many designers, probably because the overall bandwidth is dependent on the characteristics of the h.f. receiver and too great a bandwidth in the earlier stages is not always evident. Some capacity across the input circuit is definitely desirable and this is provided by C_1, this being a trimmer of small physical dimensions and having a maximum capacity of some 12pF.

The anode circuit of the mixer includes an intermediate frequency transformer working on a frequency near 10 Mc/s, which is a good choice for this application. Originally some slight instability was evident, due to a resonance effect in the short length of anode connecting cable, an anode stopper resistor (R_2) is therefore included. An impedance transformation is effected in the secondary circuit, C_3 and C_4 providing a good match



The components around the valveholder. The aerial components are on the left and the oscillator components on the right. Chassis tags are fitted under both valveholder-securing nuts. The oscillator coil connects between the left hand tag of the two-way tagstrip and the stator contact of the variable condenser C_{10}. The oscillator bandset trimmer, C_9, is just visible to the left of this coil. The aerial coupling coil employs the same light-coloured p.v.c. covered wire which is used in the twisted pair to the aerial socket. A short length of thick tinned copper wire connects the moving vanes of the tuning condenser to the adjacent chassis tag into the input of the associated receiver—a method not often seen but perfectly efficient and satisfactory, allowing both tuned windings to be used to advantage.

The oscillator circuit is perhaps a little unusual. It has the advantages of being simple, stable and not unduly difficult to construct and set up. The good stability is due mainly to two factors: (*a*) the feedback to the grid is at a relatively low impedance, and (*b*) the tuned circuit has only the low output capacity of the valve across it instead of the much higher input capacity. Securing the right degree of bandspread is a matter of adjustment between the working capacities of the bandset trimmer C_9 and the tuning condenser C_{10}. Enough injection is provided by coupling within the valve and no separate injection condenser has been found necessary.

Construction

The converter is built on a 4in by 6in aluminium chassis (Fig. 2), to which is attached a 6in square panel (Fig. 3). The larger holes (mainly for valveholders) are indicated in the accompanying drawing and, to make things easier for the intending constructor, this metalwork can be supplied on request (from H. L. Smith & Co. Ltd.) with such holes already cut out. In addition to showing the positions of V_1 and I.F.T.$_1$, Fig. 2 also illustrates the positions of V_2, V_3 and I.F.T.$_2$. At the time being we are concerned only with V_1 and I.F.T.$_1$, the other stages being added later. It should be noted that V_1 valveholder is mounted such that the valve projects underneath the chassis. The orientation for V_1 and I.F.T.$_1$ shown in Fig. 2 should be closely followed.

The reader will probably be aware of the need for very short connecting leads in the tuned circuits of any v.h.f. unit. It is for this reason, and also because it tends to make construction easier, that the valveholder is mounted upside down, with the valve projecting into the under-chassis space.

The arrangement of the components grouped around the valveholder is clearly shown in the photographs. It should be noted that the trimmer condensers C_1 and C_9 are fitted as closely as possible to the valveholder, the "earthy" tag in each case being positioned towards the front of the chassis. With the prototype illustrated two different types of trimmer are shown, either type being suitable for each position. For ease of adjustment, the maximum capacity should preferably be around 12pF but, if this value cannot be obtained, then a maximum value of 20 to 23pF may be substituted. The most likely source of supply is from component specialists such as Home Radio (Mitcham) Ltd.; Southern Radio, Redlynch; or Webbs Radio, London.

The constructor can use any miniature type of small fixed condenser, ceramic or silvered mica. Some of those shown in the photographs are Erie "Ceramicons" (N750), whilst the grid condenser is a Dubilier disc ceramic. Bypass condensers C_5 and C_7 are "Cascap" disc ceramics, which take up little space, allow very short lead lengths and increase efficiency. The centre spigot of the valveholder should be connected to chassis.

A two-way tagstrip is used to support one end of the oscillator coil, R_5, C_6 and C_8. A single tagstrip at I.F.T.$_1$ holds C_3, C_4 and the outgoing coaxial cable while another, mounted on the rear chassis apron, anchors the h.t. connections.

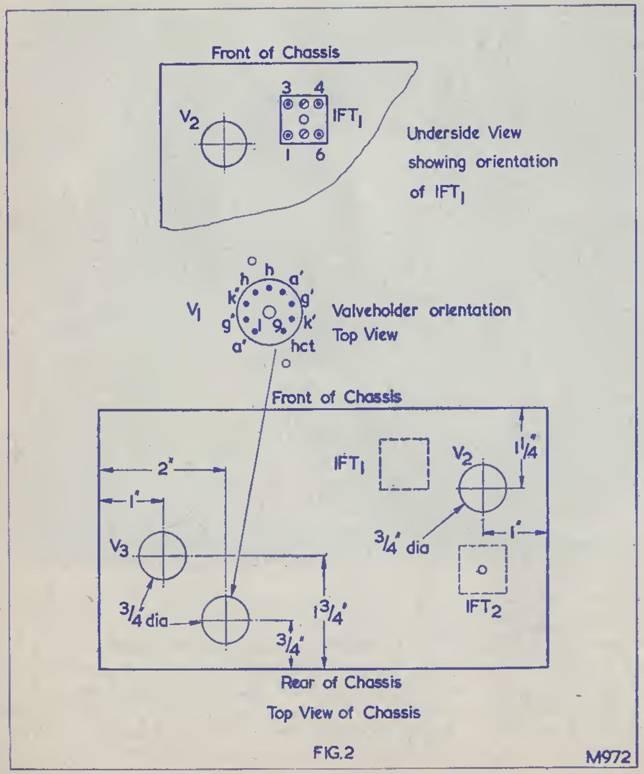
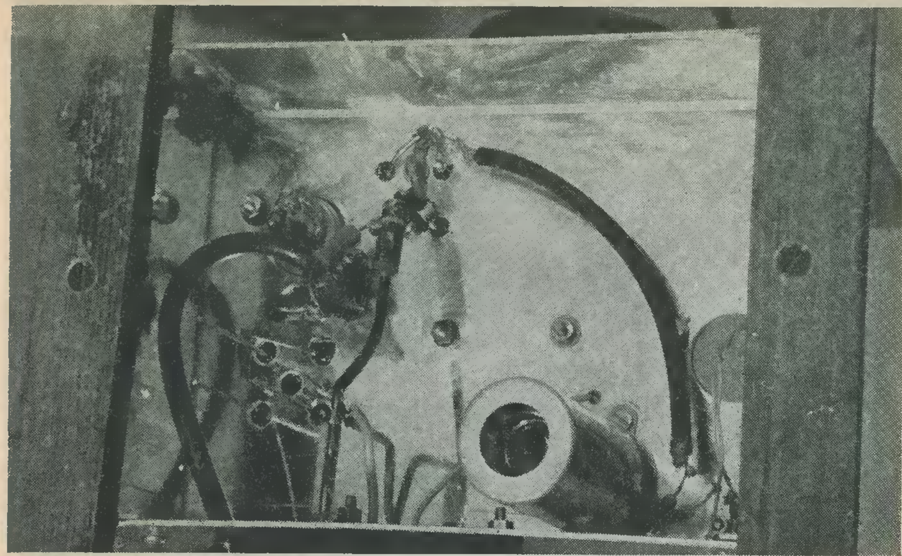


Fig. 2. Top and underside view of the chassis, illustrating the relative positioning of the valveholders and i.f. transformers. At this stage only V_1 and I.F.T.$_1$ are fitted, I.F.T.$_2$ and V_2, V_3 being added later. The valveholder for V_1 is fitted above the chassis so that the valve projects underneath. The orientation shown for this valveholder and I.F.T.$_1$ should be carefully followed



Under-chassis view of the converter. The short coaxial lead from the anode of $V_{1(b)}$ to the i.f. transformer is clearly visible here, R_2 being fitted, under the chassis, at the valveholder end. A single tagstrip, secured to the rear chassis apron, provides an anchoring point for the h.t. positive input lead and for R_4. Condensers C_3 and C_4 appear to the left of R_4, their junction connecting to a second single tagstrip. The twisted pair from the aerial coupling coil may be seen on the right. V_2 valveholder and I.F.T.$_2$ (both unwired) appear in this illustration, and may be ignored at this stage

Coils

The input coil has three turns of 18 s.w.g. enamelled wire, wound slightly spaced on a $\frac{3}{8}$in diameter piece of material cut from the barrel of an empty ballpoint pen. A form of polythene is commonly used for these pens and the barrel can be cut into useful low loss formers for small coils.

The aerial (feeder) coupling coil consists of one and a half turns of thin p.v.c. covered wire wound at the earthy end of the main coil, the leads being twisted together and taken direct to the coaxial socket mounted on the rear drop of the chassis. The grid coil is tailored to fit across the trimmer condenser, to the terminations of which the ends of the coil are soldered.

The oscillator coil has three turns of 20 s.w.g. enamelled wire, wound on a $\frac{3}{8}$in diameter former and then slipped off to become self-supporting. The turns are spaced approximately two wire diameters, the distance between wire ends measuring just one inch. One end of the coil is soldered directly to the stator tag of the tuning condenser, the other to the tagstrip, which should be mounted so that the tag is the right distance (again 1in of course) away.

The Tuning Condenser

The oscillator tuning condenser presents a slight problem. It has to be a single-ended type, of small capacity, say 5pF maximum or even less—a higher maximum resulting in too great a frequency swing. The one actually used, and shown in the photograph, is an Eddystone Cat. No. 580, modified by having the stator and the rotor vanes reduced to one each. This modification is carried out with the aid of a miniature hacksaw, cutting in the blank slots and taking care not to damage the bearing. The No. 580 condenser is fitted with double spaced vanes and has an advantage in that the position of the centre bush can be adjusted to vary the final vane spacing and, therefore, the actual working capacity. This is useful in that the spacing can be increased if the band spread is not sufficient, or *vice versa*. The constructor may have available, or be able to obtain, a condenser of suitable small size and capacity which will adequately serve the purpose.

As can be seen, the tuning condenser is mounted non-symmetrically, to reduce the length of lead between the stator tag and the anode tag on the valveholder. In passing, it may be said that efficiency has been the main object in mind with this converter, rather than attempting to make the unit look "pretty". On lower frequencies it is usually possible to combine good appearance with high efficiency but this is not so easy at frequencies around 150 Mc/s.

Tuning Dial

The front panel is mounted on the chassis by means of four bolts, in such a way that the centre of the hole in the panel is about 1½in above chassis level. A flexible coupler is fitted between the spindle of the slow motion head and that of the tuning condenser, whilst the inclusion of an adjustable bracket allows good alignment. The whole assembly should be set up in position before marking off and drilling the two small holes required for fixing the tuning condenser bracket.

Incidentals

The i.f. transformer is mounted in the position indicated, ensuring ample clearance of the lead-out wires. Lead-out wires marked 1 (grid) and 4 (anode) are cut down to about ¼in, to minimise breakthrough at the intermediate frequency. The connection from lead 4 to the anode is by means of a short length of coaxial cable, the outer screen being earthed at both ends and R_2 being fitted (below the chassis) at the valveholder end. The coaxial cable feeding the signal to the receiver should be of appropriate length and anchored down temporarily—this part of the circuit will be altered when the i.f. stage is added.

Small holes are required, close up to the valveholder, to take leads down through the chassis from the anode (pin 1) and from the heater (pins 4 and 5 together).

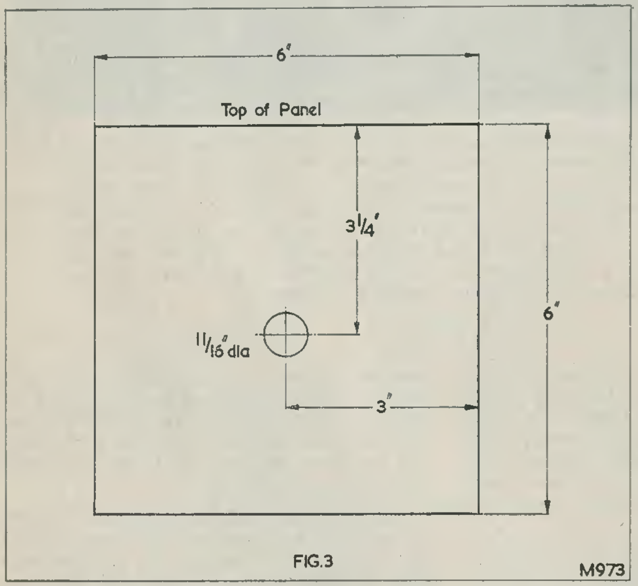


Fig. 3. The front panel

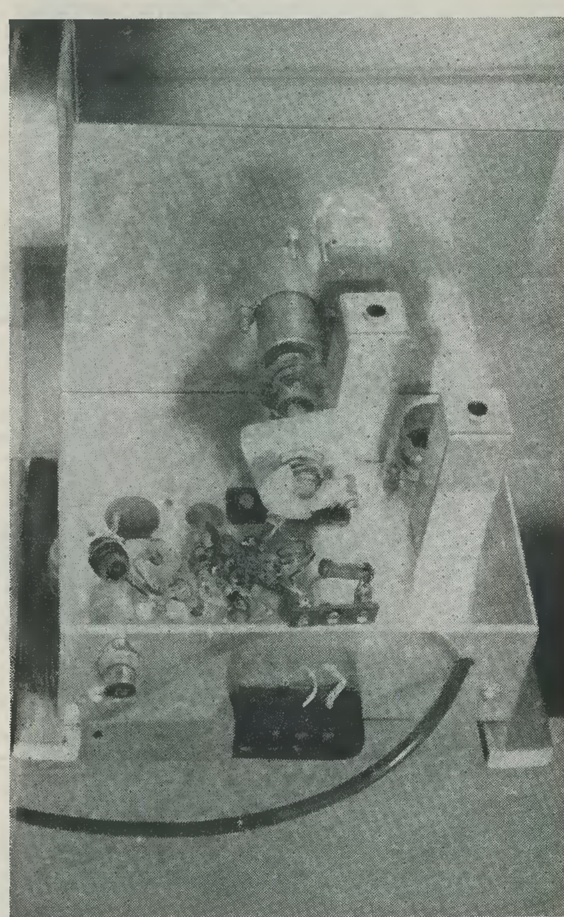
Power Supplies

The power supply requirements are small—the heater taking 0.3 amps at 6.3 volts and the anodes a few mA at 150 volts, preferably stabilised. A higher applied h.t. voltage is not recommended. In many cases, these supplies can be taken from the accompanying receiver. Where this is not possible or advisable, a small power unit, consisting of a television pre-amplifier type transformer and a metal rectifier (plus smoothing components), should be constructed. The manner in which the supplies are fed to the converter is a matter of individual preference—possibly a plug and socket arrangement or a terminal block, the latter having been used in the original design.

Setting Up

The first task, without energising the converter, is to bring both sections of the i.f. transformer into tune. The simplest way of doing this is to clip a short length of pick-up wire to pin 4 on the transformer, having of course connected the far end of the coaxial cable to the receiver. Incidentally, a fully screened connection is desirable at the receiver, to reduce possible breakthrough at the intermediate frequency. A weak signal on about 10.5 Mc/s should be tuned and the cores in the i.f. transformer adjusted for maximum strength of signal.

Next, it will be as well to check that the oscillator stage is actually oscillating. This can be done by taking a reading of the h.t. voltage at the junction of R_5 and C_8 and temporarily bypassing the stator of the tuning condenser to chassis via a ceramic condenser of 1,000pF or more, whereupon the indicated voltage (about 80) should fall with the



Rear view of the single valve converter, showing the variable condenser flexible coupler. In the prototype a terminal block, visible on the rear apron of the chassis, was employed for power connections. Again, V_2 valveholder and I.F.T.$_2$ appear in the illustration, and these are not required in the single valve version of the converter cessation of oscillation. It will be necessary to interpose an r.f. choke between the meter lead and R_5.

With C_{10} at mid-position, the oscillator has to be adjusted to a frequency of 134.5 Mc/s (145 Mc/s less the i.f. of 10.5 Mc/s). Almost certainly the coil/condenser combination specified will permit this and one method is to use a grid-dip meter. Without a frequency measuring instrument of one type or another, it would be as well to try and enlist the aid of a local amateur already using the band. Failing all else, it will be a question of trial and error, listening carefully, and at the most likely times, for local or semi-local signals. It may perhaps be mentioned that signals will be less likely to be missed if the associated receiver has a fairly low degree of selectivity. Once a signal is located, it should be brought to maximum strength by adjustment of C_1. The latter should also bring up noticeably ignition noise from cars provided the location is near a road.

It finally remains to adjust the degree of bandspread, either by alteration of the working value of the tuning condenser, if his is possible, or, alternatively, by increasing the coil inductance (compressing the turns and necessitating, therefore, a reduction in the value of C_9) if the amount of bandspread is too great; the reverse procedure being adopted if it is found that the band occupies too small a portion of the dial.

To Follow

As already mentioned, next month's article will deal with the addition of further stages. The parts list given herewith covers only those components needed for the basic unit and the intending constructor may wish to note that two more B9A valveholders, with skirts and screens, one more similar i.f. transformer, another trimmer condenser and a few more "Cascap" condensers and other components will be required for the additional stages. *(To be continued)*

radio topics

BY RECORDER

SOME FLUTTERING IN THE DOVECOTES HAS been caused during the last few months by the recent announcement that our coinage may change over to a decimal system. In the proposed new system, I presume, the basic unit will be ten shillings and this will be divided into 100 "pennies" or "cents".

There has been quite a little outcry in the readers' columns of the Press over this move, most of the complaints having stemmed from those who feel that the demise of the pound, with its 240 pennies, would represent a sad break with tradition. A smaller quantity of objectors raise the considerably more valid point that our present monetary unit, the pound, has the advantage of being divisible by 2, 3 and 5, whereas the new unit would be divisible by 2 and 5 only. This is quite an argument and it is, in my opinion, the only serious objection which can be made against decimal coinage. I think, nevertheless, that the advantages given by decimal coinage considerably outweigh the single snag of its not possessing 3 as a factor. When, at the urgent invitation of my Income Tax inspector, I find myself forced to add up sums of money, I always curse at having first to add up the pence in steps of 12 and the shillings in steps of 20. (As you can see, pence form a conspicuous part of my income.) How much simpler and less time-wasting such addition would be if the items were all in decimal notation!

Electronic Systems

Living with cumbersome, antiquated systems such as that employed for our monetary units is rather like hitting oneself on the head with a hammer. It isn't until we leave off that we realise how inconvenient we have made things for ourselves. In the electronic world we have, fortunately, grown up with units which possess delightfully simple relationships with each other. Thus, if we have a thousand ohms we can call it a kilohm, and if we have a million ohms we can call it a megohm. The same applies to inductance (henry, millihenry and microhenry), capacity (farad, microfarad and picafarad), and to practically all the other units with which we deal. Just imagine settling down to design a receiver when the basic unit for resistance is a "D-ohm", twelve of which form the next unit, an "S-ohm", and two hundred and forty of which form the largest unit, the "L-ohm"! Assume further that units of capacity are measured in the same way as in the avoirdupois table; so that the minimum unit of capacity is called the "ounce-C", sixteen of which give a "pound-C", and one thousand, seven hundred and ninety-two of which give a "hundredweight-C"! It is only when easy-to-handle units with which we are familiar are subjected to the archaic relationships of our coinage and weights and measures tables that the stupidity of the latter becomes really obvious.

Electronics engineers have been lucky in having units to deal with which are fitted into decimal systems and which have simple relationships with each other. Even so, however, one or two odd units, in the past, have crept in and have, thank goodness, dropped out again. For instance, I remember seeing some condensers during the last war which were employed by the Royal Navy. The values of these condensers were measured, not in microfarads, but in mysterious units called "jars". The Navy has since, I understand, dropped their jars! A particularly fortunate fact which helps to ease electronics calculations is due to radio waves travelling at very nearly the nice round figure of 300 million metres (sorry, 300 megametres!) per second. Because of this the product of wavelength in metres and frequency in c/s is 300,000,000; or 300,000 for metres and kc/s, and 300 for metres and Mc/s.

Funnily enough, the English units for length have not caused a great deal of difficulty so far as electronic engineering is concerned. The reason for this is that most electronic equipment is relatively small in size and can be dimensioned against the basic unit of one inch, lengths shorter than an inch being measured in tenths, hundredths and thousandths of an inch in straightforward decimal fashion Home constructor chassis designs published in this and contemporary magazines frequently quote dimensions in fractions of an inch, but this is only because such chassis are made individually and tolerances do not normally need to be very tight. Mass production metal chassis and piece-parts which have to be tooled up are, on the other hand, almost always dimensioned in decimal sub-divisions of an inch, typical tolerances on dimensions lying between ± 0.005 and ± 0.02 inch. What has happened here, of course, is that the light engineering generally associated with electronics has fallen into a decimal system despite the fact that the basic unit employed is anything but decimal.

As you may gather from what I have just said, I am, for one, all in favour of decimal coinage. I would go further, indeed, and state that I would like to see *all* our measures converted to decimal systems, whether the units concerned are of weight, length, area or volume. The time and effort saved by such a change would be of incalculable value.

The R.A.F. Tape Recording Society

As mentioned last month, I can now pass on further information concerning the Royal Air Force Tape Recording Society, membership of which is open to past and present members of the R.A.F., the W.R.A.F., Princess Mary's R.A.F. Nursing Service, and to personnel of N.A.T.O. and Commonwealth air forces. The Secretary of the Society, Cpl. P. Rogers, is now stationed at Royal Air Force, Khormaksar, Aden. Meanwhile, all queries and letters in this country are being handled by Flt. Lt. L. Jacob, No. 2 M.T. Sqdn., Royal Air Force, Stafford.

Japanese Imports in the U.S.

To hand is an extract from the United States Congressional Record and it highlights some interesting details concerning domestic receiver manufacture in that country in addition to the main point covered, which is the increasingly severe competition currently suffered by American manufacturers of dry batteries due to low price imports from Japan. We can learn some serious lessons from this report, not only as an importer of Japanese goods but also as an exporter, ourselves, to the United States.

A Statement of Facts was printed in the Record, on the instigation of Senator Proxmire (Wisconsin), and this may be summarised as follows:

Seven manufacturers in the U.S. produce virtually all domestic dry batteries, their output including about 120 different radio types to satisfy all customer requirements. Three transistor set types (Nos. 1015, 216 and 226) make up over 50% of the total radio battery sales; and this figure is accounted for by the high incidence of transistor radios in the U.S., such sets outselling valve models in 1960 at a rate of 7 to 1. The battery manufacturers are concerned over the flooding of the United States with imported Japanese transistor radio batteries, and it is pointed out that the imports are the most popular types only.

American production workers in dry battery plants average $2 per hour whilst Japanese production workers receive about 30 cents an hour. It is felt that the import duty on Japanese batteries, at 17.5% is negligible, since it allows Japanese No. 216 batteries to sell, at U.S. port of entry, at about 15 cents, whereas U.S. manufacturers sell No. 216 batteries to distributors for about 70 cents. It is also considered that Japanese imports are of lower quality than the U.S. product due, firstly, to possibly lower quality on manufacture and, secondly, to the delay involved in shipping.

The statement declares that if the trend in Japanese imports is allowed to continue there is a very real danger that the U.S. dry battery industry will lack the capacity to supply military and defence needs in the event of a national emergency; and the following remedial action is proposed:

(*a*) Higher duties be declared on the Japanese imports.

(*b*) The Office of Defence and Civilian Mobilisation be asked to declare transistor radio batteries vital to national security with a recommendation for appropriate action.

(*c*) The Japanese to voluntarily establish annual quotas for transistor battery exports to the U.S.—a course of action which the Japanese took in 1956 regarding textiles, in 1958 regarding transistor radio sets, and in 1961 regarding bicycles.

Heat into Electricity

Also from America comes news of what, so far as is known, is the first commercial use of a thermionic converter. The unit offers a power of 100 watts and is heated by burning propane gas at the base of an insulated chimney. Thermoelectric couples mounted on the chimney turn the heat directly into electricity.

The unit, built by Westinghouse Electric Co. for the Northern Illinois Gas Co. is installed at a remote station where there is no access to electric power lines, and the electricity generated is used to neutralise corrosion causing static electricity which is produced when natural gas passes through pipe lines. The converter also powers meters, valve control, and microwave relay equipment at the station.

Electro-Magnetic Level Crossings

A glimpse of what the future offers on British Railways, as well as on our highways, was evident at the Electrical Engineers Exhibition held at Earls Court on 21st to 25th March.

A new level crossing barrier system, manufactured by Rotax Ltd., was exhibited by the British Transport Commission. The new barrier is automatically operated by track relays, electrical power being supplied by local batteries. Eight seconds before the train arrives at the crossing an electric two-tone gong, mounted on the barrier and audible from 300 yards, sounds as the boom is lowered to stop on-coming traffic. As a safety precaution there is a "Second Train Coming" sign which lights up to warn when a further train is following, this sign being operated automatically also by track relays.

The barrier boom is made of two spruce beams joined together by horizontal cross pieces. These and the tip of the boom carry red electric lights visible in both directions along the road but shielded from the railway track. The booms are covered with red and white bands of reflecting material. A shear pin secures the boom to its carrier so that, in the event of the barrier being hit, little damage will result to the vehicle.

The main reason for introducing the new level crossing is economy, since the keepers for the 4,000 manually operated crossing gates present a wage bill of approximately £1 million a year. So, if enough of the new crossings appear they should equalise out that £24,000 a year we have heard so much about recently!

Cameras for New Italian Television Service

Radio Italiana Televisione (R.A.I.) have placed an order for a further seventeen Mark IV television cameras from Marconi's Wireless Telegraph Company Ltd.

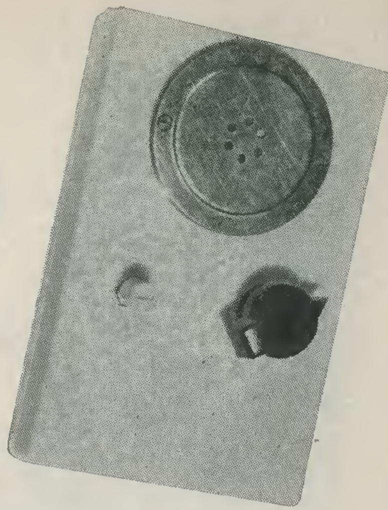
This order follows the successful introduction of the Marconi Mark IV camera in Italy last year when eight channels were delivered to R.A.I. in time for the Olympic Games.

The seventeen new channels now on order from Marconi's will be used to enlarge the existing facilities in R.A.I.'s Rome and Naples studios and will be put into operation in time for Italy's second television service scheduled to commence later this year.

R.A.I. have 103 camera channels now in operation, of which 52 have been supplied by the Marconi Company; most of these are in use at the extremely modern Rome Studio Centre at Piazza Cloudio, and in its associated outside broadcast units.

The "SUPER-3"

(A 3-Transistor Pocket Receiver)



described by **R. A. LANGIS**

THE PERSONAL POCKET RECEIVER ABOUT TO be described is an ideal design from many points of view. First—it can be completely constructed in about an hour or so; second—it is comparatively inexpensive; third—it is completely portable and has "pocketability", its dimensions being only some 3⅛ x 5 x ⅞in; fourth—it has a "speaker" output; fifth—the few components required are mounted on a printed circuit board; and sixth—it may be built with ease by the veriest beginner.

Using two r.f. surface barrier transistors and one a.f. transistor together with a germanium diode, only seven ⅛ watt resistors and seven condensers (plus TC_1) as well as a balanced armature insert and the printed circuit board are required to complete the whole circuit. This, together with the batteries and the case, provides the complete assembly.

Circuit

This is shown in Fig. 1 from which it will be seen that it is a five stage reflex design. The primary winding of the ferrite rod aerial assembly L_1 is tuned by the variable trimmer TC_1. On the Long wave position C_1 is brought into circuit by the 3-pole 3-way Yaxley switch. This functions as the on off control also, as well as bringing C_5 into circuit on the Long wave position. The signal induced in the secondary of L_1 is then applied to the base of transistor TR_1, the amplified r.f. at its collector being passed to the base of TR_2. The resultant further amplified r.f. at the collector of TR_2 is then transformer coupled to the germanium diode D_1 via L_2. D_1 rectifies the signal and passes it, as a.f. back to the base of TR_1. TR_1 and TR_2 now function as a.f. amplifiers, the amplified a.f. signal being fed, via C_7, to the base of the audio transistor TR_3, from the collector of which the audio signal is finally applied to the balanced armature insert.

Construction

Construction of the "Super-3" receiver should commence with modifications to the tuning condenser TC_1. As supplied, this is a standard compression-type trimming condenser. Remove the 6BA adjusting screw completely and replace this with the 1-in 6BA bolt provided. Ensure that this operation is carried out without losing any of the mica leaves and washers that are sandwiched between the metal plates. Screw in the bolt until the condenser plates are firmly compressed. Fit the condenser to the plastic receiver case and then, over the bolt, slide on a washer, a coil-spring and a second washer—in that order (see Fig. 2). Having done this, screw on a 6BA nut until it *just begins* to compress the coil-spring. Using a spanner, hold the 6BA nut in position and screw on the white plastic tuning knob supplied up to the nut, finally tightening the nut against the knob and locking it in position. Providing this operation has been done correctly, it should be possible to obtain about three complete turns of the knob, and this will be found to give an adequate tuning range when the receiver is completed.

Next, the balanced armature speaker unit should be fitted to the receiver case, its

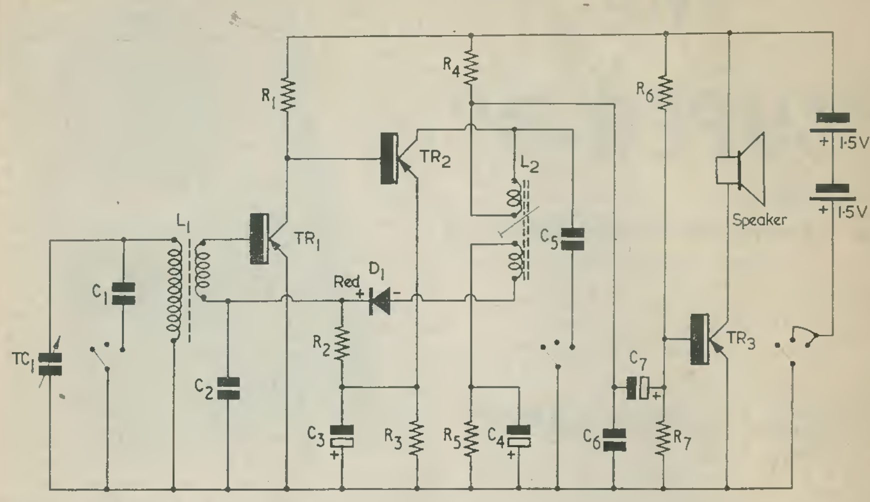


FIG.1
Circuit Diagram

Components List

Resistors

- R_1 2.2kΩ $\frac{1}{8}$ watt
- R_2 4.7kΩ $\frac{1}{8}$ watt
- R_3 680Ω $\frac{1}{8}$ watt
- R_4 1kΩ $\frac{1}{8}$ watt
- R_5 4.7kΩ $\frac{1}{8}$ watt
- R_6 10kΩ $\frac{1}{8}$ watt
- R_7 2.2kΩ $\frac{1}{8}$ watt

Transistors

- TR_1 Surface barrier r.f. type (R & TV Components Ltd.)
- TR_2 Surface barrier r.f. type (R & TV Components Ltd.)
- TR_3 V10/15 (R & TV Components Ltd.)

Condensers

- C_1 1,500pF ceramic
- C_2 0.1μF tubular, 150 w.v.
- C_3 16μF, electrolytic, 6 w.v.
- C_4 2μF, electrolytic, 6 w.v.
- C_5 560pF, ceramic
- C_6 0.1μF, tubular, 150 w.v.
- C_7 2μF, electrolytic, 6 w.v.
- TC_1 250pF variable trimmer

Batteries

Ever Ready U16 (2)

Miscellaneous

Case, 3-way 4-pole switch, balanced armature insert, printed circuit board, ferrite rod aerial assembly, coil L_2, germanium diode, knob, nuts and bolts, etc. (R & TV Components Ltd.)

position being exactly as shown in Fig. 3. Of the four 8BA bolts holding the brass front plate in position, two should be removed and replaced with the two longer 8BA bolts provided. *On no account must the other two remaining bolts be disturbed.* Having firmly screwed in the two longer bolts, the balanced armature unit may now be placed into position on the receiver case and two 8BA nuts used to secure it firmly into position. This completes the assembly of the receiver case for the time being, and it should be placed to one side whilst the remaining components are soldered into circuit on the printed circuit board.

Note that all the following components are fitted such that their bodies appear on the blank side of the printed circuit board,

their connecting wires protruding through the holes provided. The wires which project from the printed side of the board should be cut to a length just sufficient to allow for soldering to the respective copper conductors. The wire ends should be tinned, bent flat upon the board and then soldered using a hot iron applied briefly to the joint. The order of component assembly on the board is as follows:

On/Off Wavechange Switch

This is a 4-pole 3-way component, only three poles of which are used in the present circuit. Having first checked that all the tags are perfectly straight and clean, carefully feed them through the holes in the board (see Fig. 3). The ends of the tags which, after pressing the switch body home, project from the circuit side of the board are then trimmed down to leave about $\frac{1}{8}$in clearance from the board. When all the tags have been so trimmed, their remaining stubs should be lightly pressed outwards on to the board and the appropriate tags soldered. The pressing operation must be done with care, using the plastic handle of a screwdriver or knife as the pressing tool. A sharp metal instrument should, *on no account*, be used—an accidental slip would almost certainly result in damage to the thin copper surface of the printed circuit board. With the switch tags now correctly in place, solder these tags to the copper pattern. Note here that it does not matter which way round this switch is pressed into the circuit board—any section or pole can occupy any position. When soldered it will be noted that one complete section of the switch is not used in the circuit.

R.F. Transformer L_2

This should be fitted to the board next. The orientation of the coil terminal ring must be that shown in Fig. 3, correct orientation being given when the gap in the terminal ring aligns with the pilot hole in the board. The tags of L_2 should be bent over, as in the case of the switch, and then soldered. Some care should be exercised here in order to avoid damage to the extremely fine wires of the coil.

Resistors

Collect together all seven of the resistors and bend their respective lead-out wires at right angles to the component body; then clip off surplus wire and tin the ends before insertion through the respective holes in the board. Before finally soldering, ensure that the resistors are laid flat against the plain side of the board. When positioning the resistors, note that they must be kept clear of the two areas shown in Fig. 3.

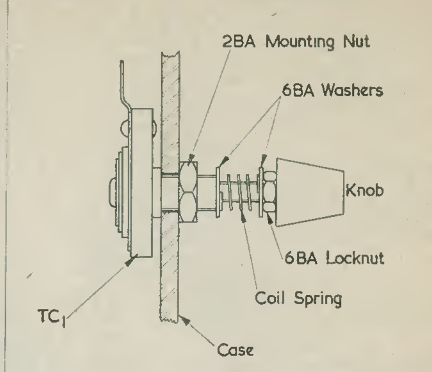


FIG.2
TC_1 Mounting Details

The positions which the resistors occupy are shown in Fig. 3. Resistor identification, together with that of the transistors and germanium diode, is given in Fig. 4.

Condensers

Having soldered all the resistors into circuit, deal next with all the condensers—except, of course, TC_1. Deal with these components in the same manner as was described above for soldering the resistors into circuit. Electrolytic condensers must be connected with due regard to their polarity and this is shown not only in the circuit of Fig. 1 but also in the layout diagram of Fig. 3. In most instances the negative pole of the electrolytic condensers is identified on the case, but where this is not so the metal can of the condenser should be taken as the negative (—) connection—the positive wire being that which enters the condenser through an insulating bush. When positioning the condensers, note again the two clear areas of Fig. 3. Also, mount the electrolytic condensers such that they are clear of the printed circuit board edges; these components must not protrude over the edge of the board.

With a short length of wire, connect the metal body of the switch to the outside edge copper strip which traverses three sides of the printed circuit board. This provides a chassis connection.

Transistors and Germanium Diode

It is most important to carefully study the diagram showing the transistor lead-out connections (Fig. 4) before attempting to fit these components. Note particularly that the r.f. transistor lead-out wires are quite different from those of the a.f. transistor. Should a transistor be connected into circuit incorrectly, immediate damage will almost

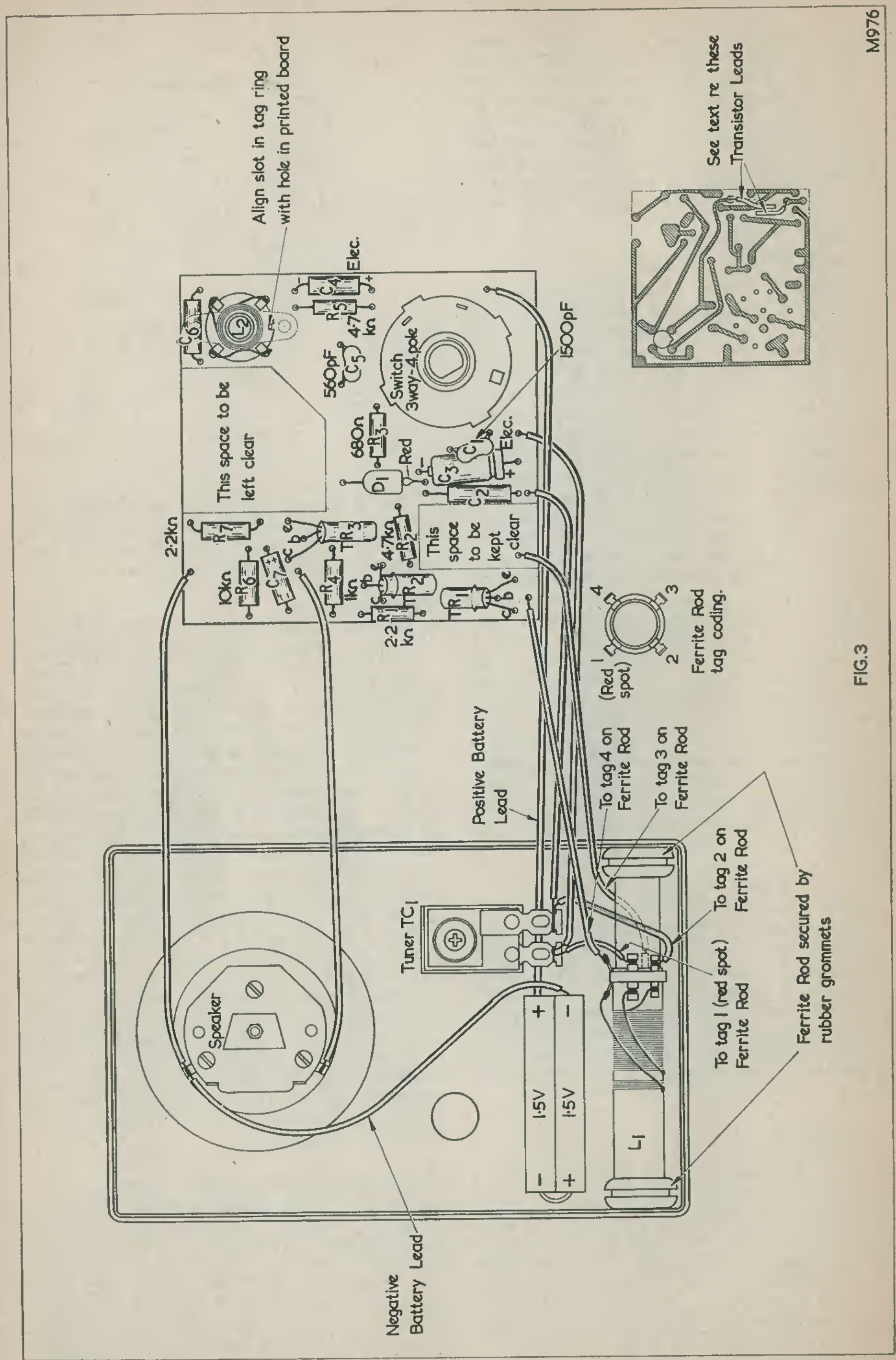


FIG.3

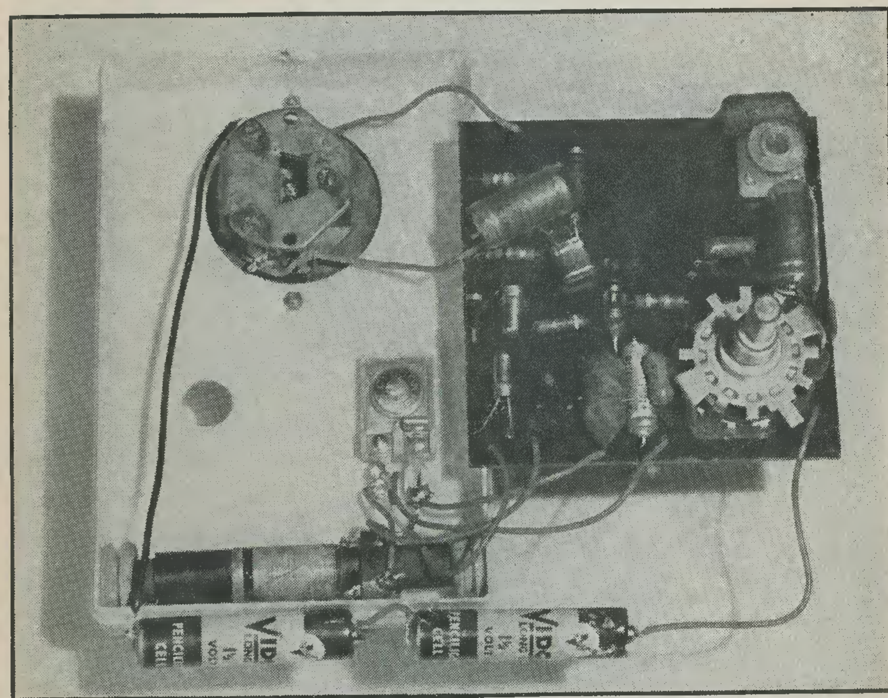
certainly result. For the beginner, it should be mentioned here that damage can also be occasioned to transistors from two other causes when soldering them into position. There is, firstly, damage due to excessive heat from the iron. To avoid this, grip the lead-out wire being soldered with a pair of pliers so that most of the heat is conducted away from the transistor—the application of the iron bit to the joint being made as briefly as possible. The second cause of damage is especially applicable to surface barrier transistors because these transistors can be immediately damaged by any electrostatic or resistive leakage voltages which may exist on the bits of mains-operated soldering irons. The most convenient method of avoiding this risk is to disconnect the iron from the mains during the actual soldering process, re-connecting the iron to maintain its heat before the next soldering operation. The foregoing precautions apply equally to the germanium diode.

Transistor TR_1 should be soldered into position first. After soldering, trim back the emitter and collector lead-out wires only, leaving the base wire projecting from the joint. Next, fit and solder TR_2 and, after soldering, leave its collector lead untrimmed. Details of the use to which these two untrimmed lead-out wires will be put are included in the testing instructions. It should be noted that both TR_1 and TR_2 are surface barrier type transistors.

Transistor TR_3, the a.f. type, should now be soldered into position and all lead-out wires trimmed. Follow this by connecting into circuit the germanium diode and cutting its wire ends to length.

Ferrite Aerial Assembly

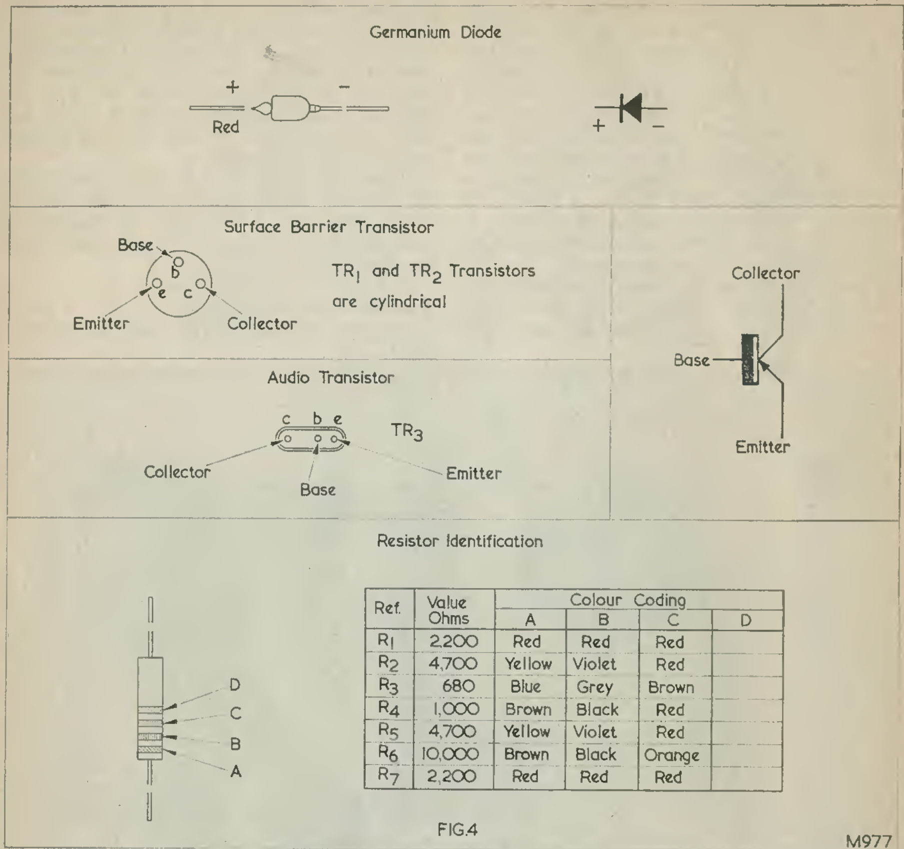
Having completed all the component soldering, the wires connecting to the ferrite rod aerial assembly (L_1), the tuning condenser and the batteries, etc., can be cut to length and soldered into their appropriate positions. As shown in Fig. 3, these wires should be long enough to enable the printed circuit board to be swung away from the case.



The completed "Super-3" transistor receiver. Compare with diagram on opposite page

Testing and Completion

Solder the battery leads to two 1.5V cells



Ref.	Value Ohms	Colour Coding A	B	C	D
R_1	2,200	Red	Red	Red	
R_2	4,700	Yellow	Violet	Red	
R_3	680	Blue	Grey	Brown	
R_4	1,000	Brown	Black	Red	
R_5	4,700	Yellow	Violet	Red	
R_6	10,000	Brown	Black	Orange	
R_7	2,200	Red	Red	Red	

FIG.4

(see Components List) connected in series, carefully observing the polarity of connection (the brass cap being positive). The cells may now be tucked into the case using cotton wool for packing. Insert the printed board assembly into the case by feeding the switch spindle and bush through the aperture on the front of the case. Ensure that the printed circuit components do not foul the sides of the receiver case. Secure into position with the switch nut and washer and tighten firmly. The switch knob should now be fitted to the spindle. Note here that with the switch in position 1 (fully anti-clockwise) the receiver is switched off, in position 2 Medium wave operation is selected and in position 3 Long wave operation is selected.

Over each of the projecting wires of TR_1 and TR_2 slide a length of p.v.c. sleeving, this being slightly longer than the transistor wire so that none of the wire is exposed.

Switch to the Long wave position (fully clockwise) and turn the tuning knob about two turns clockwise. Slowly adjust the position of L_1 along the length of the ferrite rod until the B.B.C. Light programme of 200 kc/s (1,500 metres) is heard. Tune for further volume with the screw core of L_2.

Switch to Medium wave and adjust the tuning control until a station is heard. The two transistor wire extensions, now completely sleeved, should be bent in such a manner as to lie parallel with each other—the effective capacity between them being utilised for regeneration purposes. Next bring these two wires closer together, thereby increasing the effective capacitance between them. As the wires approach each other volume will increase, a point being reached where actual oscillations commence. The presence of oscillations indicates that the wires are too close to each other. When the correct position of the wires has been found, they may be fixed into position with p.v.c. tape or a suitable adhesive. As a final check for correct regeneration the tuning knob

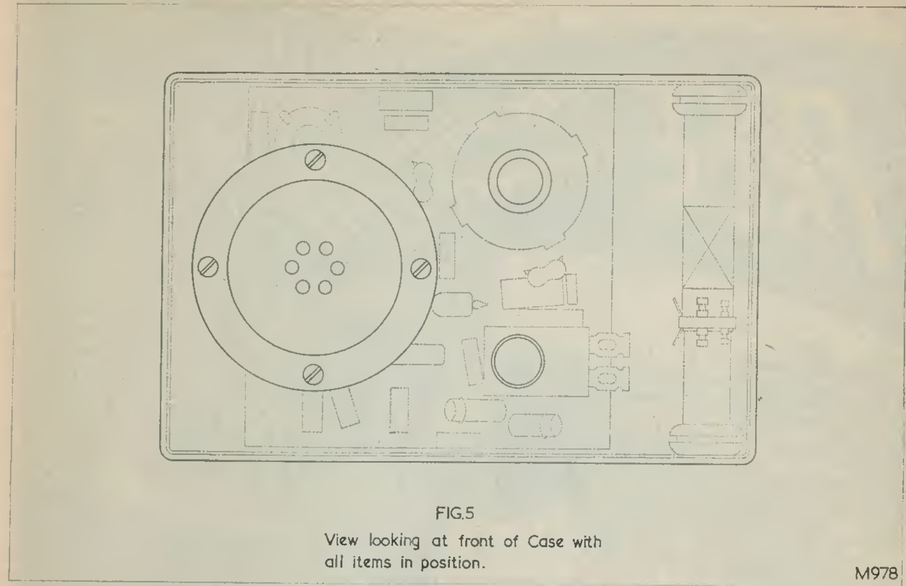


FIG.5
View looking at front of Case with all items in position.

should be rotated over its full range, and it should be possible to receive all stations without oscillation occurring. Having made this final check, the plastic rear cover of the receiver can be snapped into position whereupon the receiver is ready for use.

Operation

The following remarks, with respect to operating the "Super-3", may be found useful.

The ferrite rod aerial will exhibit highly directional properties, maximum reception being obtained when the rod is in a horizontal position and at right angles to the direction from which the transmitted signal emanates. When the rod is pointed directly at a transmitter, reception is at a minimum. The angle over which minimum reception occurs is particularly sharp, and this property may be put to good account in eliminating interference from unwanted stations.

MARCONI COMPANY ACTIVE IN SPACE TECHNOLOGY FIELD

Satellite tracking experiments now being carried out by Marconi's are increasing the company's contribution to space technology research.

Commenting on Marconi's work in this field, Dr. E. Eastwood, Chief of Research, says that although it is no longer space fiction to speak of creating communication channels between Britain and the United States via a repeater satellite, much more intensive research and development by telecommunications engineers is required if this is to be achieved.

Speaking of the "impressive achievements" in rocket technology by the Americans, the Russians, and on a more modest scale by British laboratories, Dr. Eastwood said that telephone, telegraph and television links by satellite were now becoming a certainty.

But much more work requires to be done on propagation and ultra sensitive receiver techniques—two fields in which Marconi's are now actively engaged. The company is also carrying out studies of electronic storage, encoding of information and the provision of electrical power from devices rendered active by the sun's radiation.

"Reliability", said Dr. Eastwood, "is obviously going to be the key word in the new communications system if it is to be economic and bear comparison with the radio and cable circuits of the world".

Components giving a reliability of six years' working, or the equivalent of 50,000 hours, are the aim of Marconi technologists who are engaged on intensive research in this field.

Marconi's are also carrying out comprehensive studies of the ground equipment which would be required to operate in association with an active satellite.

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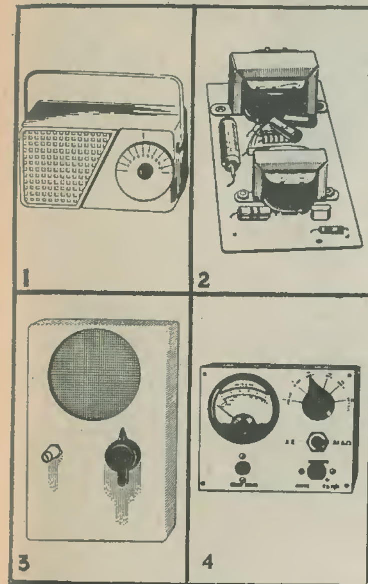

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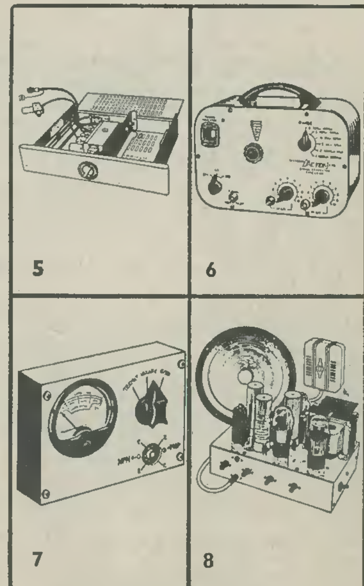

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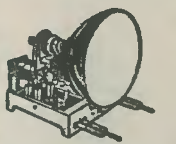

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