

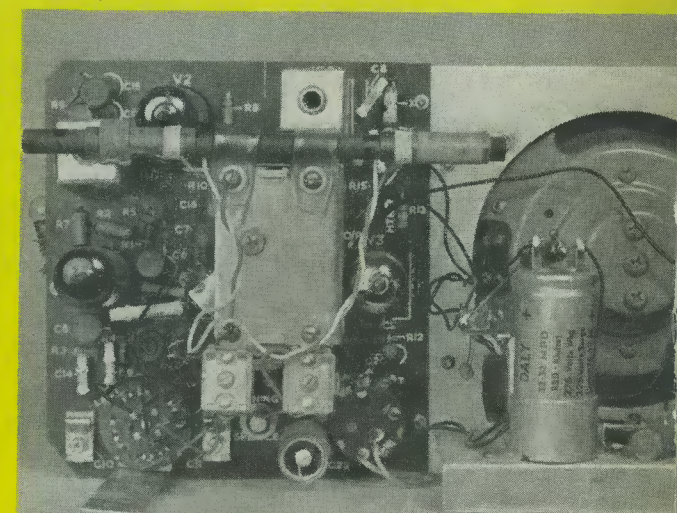


The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

CONTENTS INCLUDE

ELECTRONIC METRONOME
CONVERTING WAVEMETER
D NO. 1 FOR A.C. OPERATION
MINIATURE POCKET
RECEIVER
SERVICING BY NEON
VOLUME LEVEL INDICATORS
SIMPLE INTER-COM SYSTEM
VARIABLE VOLTAGE POWER
UNIT
GUITAR AMPLIFIER WITH
VIBRATO
GETTING STARTED ON
2-METRES, PART 3.



A printed circuit superhet

DATA Publications

ONE SHILLING AND NINEPENCE

VOLUME 14

NUMBER 11

CONTESSA Combined Portable and Car Radio



6 TRANSISTOR MEDIUM AND LONG WAVE SUPERHET TERRIFIC SENSITIVITY UNBEATABLE IN PERFORMANCE AND APPEARANCE

- SPECIFICATION**
- 425mV Push-Pull Output
 - 6 "Top-Grade" Ediswan Transistors
 - New Type Printed Circuit with all Components marked
 - Full Medium & Long Wave Tuning
 - High "Q" Internal Ferrite Aerial
 - Car Radio Adaption and AVC
 - Slow Motion Fingertip Tuning with Station Names
 - "Hi-Fi" Quality Speaker
 - Attractive Rexine Covered Cabinet. RED/WHITE or BLUE/WHITE

TOTAL COST OF ALL PARTS

£10.19.6 P.P. 3/6

★ NO EXTRAS TO BUY ★

PRICE REDUCTION!

Now even better value for money

Transistor 750mW Push-Pull Amplifier

(Over 1 watt peak output)

- 1st Grade Mullard Transistors OC71, OC81D, 2-OC81.
- 9V battery operated
- Output to 3 ohms speaker
- Printed Circuit 4" x 2 1/2" with Metal Heat Sink.

Ideal for Record Player, Intercomm. Baby Alarm for Tuners, etc., etc.

- Fully Guaranteed

69/6

P.P. 1/6



BUILT AND TESTED

RANGER 3



Size 4 1/2 x 3 x 1 1/2

- No External Aerial or Earth

3-TRANSISTOR and 2-DIODES PERSONAL POCKET RADIO with 5 stages giving clear reception on medium wave, amateur top band and shipping. Only first grade components used throughout. Amazing results.

ALL COMPONENTS

79/6 P.P. 1/6

★ NO EXTRAS TO BUY ★
Everything Supplied

- Easy to follow instructions with pictorial layouts

- Reception of Radio Luxembourg guaranteed (most areas).

Free Instrs. & Price List on request. Easy to build

- After Sales Service, Guaranteed Success

6-TRANSISTOR RADIO

Fidelity
"CORONET"



6-TRANSISTOR MEDIUM & LONG WAVE POCKET RADIO

- Size 2 1/2" x 4 1/2" x 1 1/2"
- Quality Push-Pull Speaker Output
- Guaranteed for 12 months
- Phone and Tape Sockets

ALL BRITISH DESIGN AND CONSTRUCTION

9 1/2 gns Reg. Post 2/6 Incl. Battery

TRANSISTOR 27Mc/s MODEL CONTROL RECEIVERS

Three new designs, all 2 1/2 x 2 x 1 in. Single Channel 59/6 p.p. 1/6. 3-Channel Reed Type 59/6 p.p. 1/6 and Single Channel Relayless 72/6 p.p. 1/6.

FREE DIAGRAMS AND PRICES ON REQUEST

PLEASE
TURN PAGE

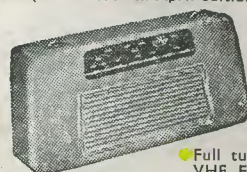
Henry's Radio Ltd 5 HARROW RD. LONDON W2

Dept. C.6. Opposite Edgware Road Tube Station. PADrington 1008/9 Open Monday to Sat. 9-6, Thurs. 1 o'clock

★ COMPLETE LIST OF DO-IT-YOURSELF UNITS ON REQUEST ★

'PW' ROADFARER

(as described in April edition of Practical Wireless)



Parts as specified

£16.19.6 P.P. 3/6

All components sold separately. List on request

A.M. and F.M. 7-transistor mains/battery portable in attractive moulded case. Slow motion tuning; telescopic aerial; 7" x 4" speaker; Ferrite aerial, etc.

- Full tuning medium wave and VHF F.M. for clear reception of all programmes anywhere in the country

- 500mW push-pull output with Mains or Battery supply built in. Printed Circuit—SEVEN TRANSISTORS

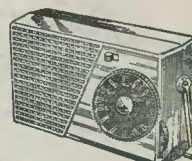
FULLY ILLUSTRATED BUILDING INSTRUCTIONS

'PW' 6-Transistor

MEDIUM AND LONG WAVE POCKET SUPERHET

(as described Nov. P.W.)

- A sensitive pocket superhet with 150mW push-pull output on 2 1/2" speaker. Uses 6 first grade Mullard transistors and printed circuit. Moulded cabinet



Size 5 1/2" x 3" x 1 1/2"

- All parts sold separately. Send for list. Illustrated Building Plans, 1/6 plus post. ALL PARTS REQUIRED

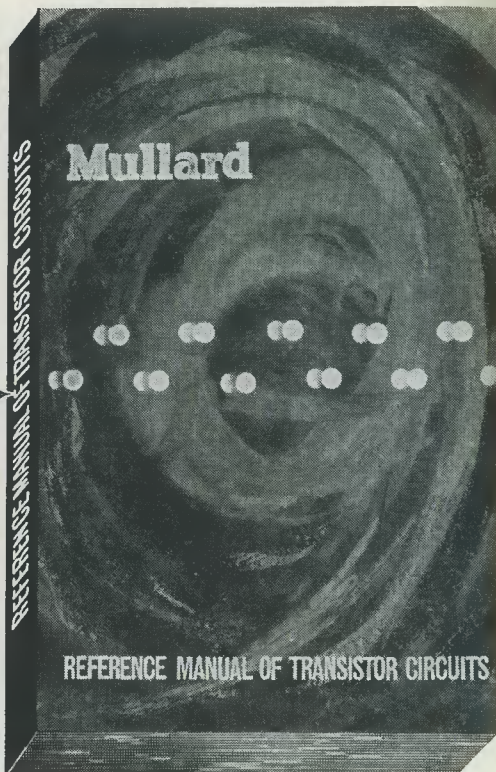
£8.19.6

★ No Extras To Buy—Everything Supplied ★

- Telephone Pick-up Amplifier with induction coil. 4 transistor. Ideal for busy office, no more "holding on." £5.10.0. P.P. 2/6. Uses 400mW Mullard Amplifier

- Portable 4-transistor Baby-Alarm as previously advertised. But now with 400mW output on 5" speaker. Can be used up to 200 yards. £5.10.0. P.P. 2/6. Including battery and microphone. Battery life 3 to 4 months used every day.

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



This new manual of transistor circuitry has been prepared by Mullard engineers, as an up-to-date and readable volume which will be of use and interest to technicians, service engineers, junior designers and electronics students. It has a page size of $8\frac{1}{2}'' \times 5\frac{1}{2}''$ and describes more than 60 circuits—over 30 are made generally available for the first time—including both domestic and industrial applications.

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

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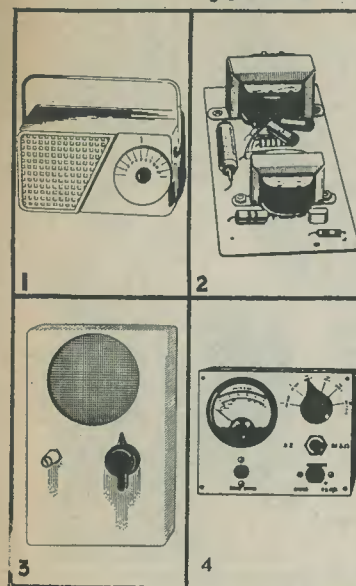
Get your copy of the Mullard "Reference Manual of Transistor Circuits" today from your radio dealer, or order direct from Mullard Ltd. (postage and packing 1s. Od. extra in U.K.).

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MVM17

CHECK with these BARGAINS



1. 3-Transistor Pocket Radio with Miniature Speaker, Ferrite Rod and 2 Germanium Diodes. The only 3-transistor radio available at the price. Build it in one evening! Tunable over M/L waves. Complete with easy-to-follow instructions and all components (less batteries obtainable anywhere 10d.). 27/6. P. & P. 2/-. (All parts available separately.)

2. Push-Pull Output Stage inclusive of transistors with input and output transformers to match 3 ohms speech coil, suitable for use with the POCKET RADIO. Kit of parts, including transistors, 19/6. P. & P. 1/6. Wiring diagram 1/6, FREE with kit.

3. 3-Transistor Super Pocket Radio with Miniature Speaker. Plus Germanium Diode and Printed Circuit. Size $3\frac{1}{2}'' \times 4'' \times \frac{1}{4}''$. Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over Medium and Long waves. **To build yourself** 39/6. P. & P. 1/6. Circuit diagram 1/6, FREE with kit. All parts of items 1 and 3 sold separately.

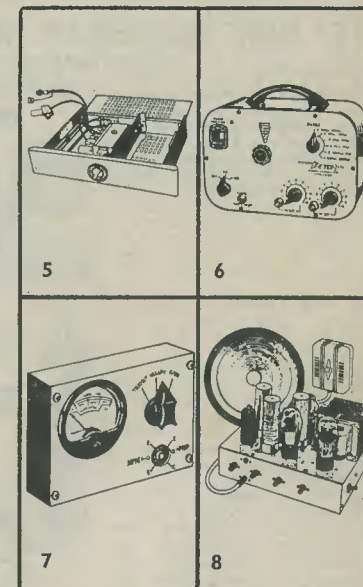
4. A.C./D.C. Pocket Multi-Meter Kit. 2" moving coilmeter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistor and rectifier, 19/6. P. & P. 1/6. Wiring diagram 1/6, FREE with kit.

5. Channel Tuner. Will tune to all Band I and Band III stations. Complete with PCC84 and PCF80 valves (in series) I.F. 16-19 or 33-38. Can be modified as an aerial converter (instructions supplied), 32/6, plus 3/6 P. & P. Heater Transformer to suit above, 200-250V, 6/-, plus 1/6 P. & P.

6. Signal Generators. Cash £6.19.6 or 25/- deposit and 6 monthly payments of 21/6. P. & P. 5/-. Coverage 100 kc/s to 100 Mc/s on fundamentals and 100 Mc/s to 200 Mc/s on harmonics. Case $10'' \times 6\frac{1}{2}'' \times 5\frac{1}{2}''$. Three miniature valves and Metal Rectifier. A.C. mains 200/250V. Internal modulation of 400 c.p.s. to a depth of 30%; Modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch, variable A.F. output, Magic eye as output indicator. Accuracy $\pm 2\%$.

7. Transistor Tester. For both P.N.P. and N.P.N. transistors incorporating moving coil meter. In metal case $4\frac{1}{2}'' \times 3\frac{1}{2}'' \times 1\frac{1}{2}''$. Scale marked in gain and leakage. 19/6. P. & P. 2/6.

8. 5 Valve Amplifier. Ideal for small halls. High power—high quality. 200/250 A.C. 2 inputs, mike and gram, bass and treble lifts. For use with Std./L.P. Records. Two would be suitable for stereophonic. Ideal P.A. system, £3.19.6. P. & P. 6/6. CRYSTAL MIKE to suit, 15/-, P. & P. 1/6. 8" P.M. SPEAKER to suit, 12/6. P. & P. 1/6.



**RADIO & TV
COMPONENTS (Acton) LTD**

**23d HIGH STREET, ACTON
LONDON, W.3.**

ALL ENQUIRIES S.A.E.
GOODS NOT DESPATCHED OUTSIDE U.K.

JUNE 1961

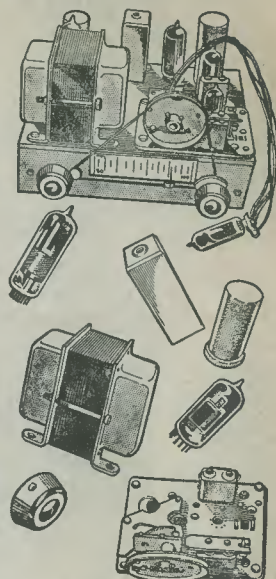
801

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 . . . HARVERSON'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.

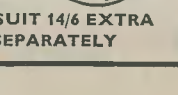
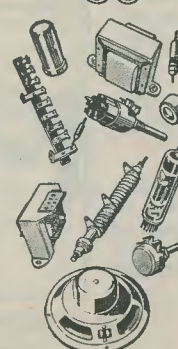
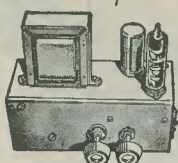
★ A UCL 82 valve provides a triode output stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size, 7" x 3½" x 6½" high).

★ Modern circuitry design, good quality O.P. transformer (to match 3Ω) keep hum and distortion to a low level.

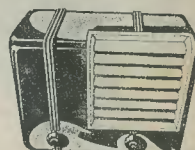
★ The controls, volume on-off, and tone, are complete with attractive cream and gold knobs

★ 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.



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, far 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

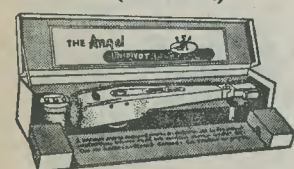
HARVERSON SURPLUS CO. LTD

MONAURAL AMPLIFIER



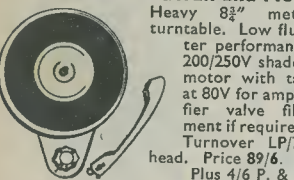
This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass, Treble and Volume on remote panel. Elegant Knobs. **OUR PRICE** one month only £4.16.6 plus P. & P. 3/6

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.



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
RC 121/40 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) 3½" per sec., simple control, uses 5½" 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

SPECIAL OFFER

DON'T MISS THIS

MULLARD OC76 10/6
MATCHED PAIR £10.0

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/-

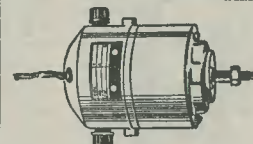


F.M. TUNER HEAD

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 (3½" 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/-

COSSOR 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. 1/9. **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 →

83 HIGH STREET, MERTON S.W.19 CHERRYWOOD 3985/6/7

HARVERSON'S SUPER STEREO KIT

The product of a renowned maker, this stereo amplifier is composed of "ready-built" units, only requiring interconnection. This system has the advantage of being adaptable to fit any cabinet. Each unit is made from first-grade components, and valves used (ECL82, EZ80 range) are genuine Mullard. The comprehensive instructions supplied make the simple interconnection of units easy even for the novice.

The kit comprises . . .

TWO MIDGET AMPLIFIERS each of 3W output, good reproduction from both your stereo or monaural records. Both amplifiers complete with well-designed O.P. transformers providing perfect matching 3-75Ω speakers, and have remote bass, treble and volume controls. Size 5" x 2½" x 3" high (each amplifier).

CONTROL UNIT, is a flying panel with three 2-gang pots, enabling the bass, treble and volume controls of each amplifier to be conveniently positioned. Supplied with attractive cream and gold knobs.

SEPARATE POWER PACK with valve rectifier, midget size (5" x 2" x 3½" high).

ISOLATED MAINS TRANSFORMER of robust construction may be mounted independently.

VOLTAGE SELECTION PANEL. Fitted with the "valve base" type of mains i/p selector and a channel output socket.

ONE SPEAKER, a quality 5" speaker. (Note: The 2nd speaker may be purchased from us for 14/6 extra).

CREAM DOUBLE PUSH BUTTON SWITCH of neat design gives positive on/off switching.

INDICATOR LIGHT. Provides visual indication of equipment operating and is complete with gold-finished escutcheon

E.M.I. 4 SPEED STEREO PLAYER

To suit the above
Plus 5/- carr.

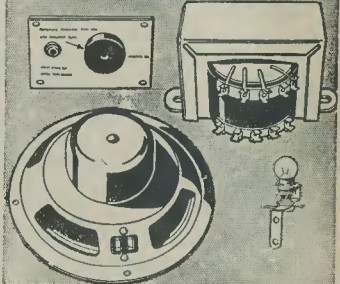
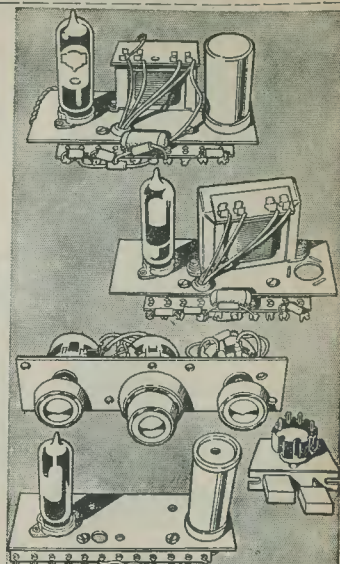
£6.12.6

59/6

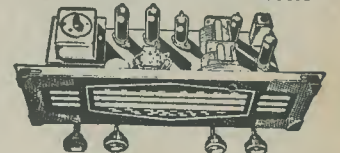
Plus 6/6 p. & p.

GUARANTEED VALVES ★ NEW and BOXED ★ PROMPT

AC/P4	7/-	EF22	8/-	HL41	3/3	PZ30	18/6	UCL82	15/6
AC5PENDD	25/9	EF37	14/-	K40N	8/6	PEN25	5/6	UCL83	11/6
AC6PEN	6/-	EF39	5/3	KLL32	8/-	PEN46	6/6	UF41	8/6
ATP4	3/3	EF40	13/6	KT2	4/6	PEN45DD	8/-	UF85	8/6
AZ1	9/3	EF41	9/3	KT24	4/6	PEN44	14/6	UF89	8/6
AZ31	11/2	EF42	10/3	KT32	9/3	PM12M	7/6	UL44	25/-
B36	14/-	EF50	3/9	KT33C	8/-	QP21	4/6	UL46	25/-
CB131	22/9	EF50SYL	6/6	KT36	28/-	R16	25/-	UL84	8/6
CCH35	22/9	EF55	9/3	KT55	10/3	SP41	2/9	UU6	18/6
CL33	18/-	EF80	7/-	KT61	9/6	SP61	2/9	UY8	25/-
CY31	15/9	EF85	7/-	KT63	7/-	SP4/5	9/9	UYIN	11/9
DAF96	8/6	EF86	11/6	KT66	16/-	SP4/7	9/9	UY21	11/9
DF96	8/6	EF89	8/-	KT88	21/-	T41	22/-	UY41	7/-
DH63	11/6	EF91	5/6	KTW61	6/-	TDD13C	7/-	UY85	6/6
DH101	11/6	EF91(BVA)	5/6	KTW63	7/-	TH233	17/6	VP13C	3/3
DK96	8/6	EL32	8/6	MH41	6/6	TP22	7/6	VP23	6/-
DL96	8/6	EL32	4/3	ML4	8/-	U14	8/-	VP41	8/-
EA50	1/3	EL33	13/-	MS4B	16/-	U16	11/9	VP133	14/-
EABC80	8/6	EL38	24/6	MSP4/5	7/-	U17	11/9	W21	11/9
EAF42	9/6	EL14	9/6	MSP4/7	7/-	U22	7/6	W76	7/-
EB34	1/9	EL42	9/6	N37	18/6	U25	13/-	W77	8/-
EB41	8/-	EL81	15/6	N78	18/6	U26	11/9	X41C	16/9
EBC33	6/3	EL84	8/6	N339	28/-	U37	25/-	Y63	8/6
FBC41	8/9	EM84	8/9	OZ4	5/-	U45	14/-	Z21	9/9
EBF80	9/-	EM80	9/3	P61	3/3	U50	7/6	Z309	7/-
EBF89	9/-	EM81	9/6	PCC84	8/6	U76	7/6	Z359	7/-
EBL21	22/-	EY51	9/3	PCF80	9/-	U91	10/6	1A3	3/-
EBL31	22/-	EY86	9/3	PCF82	11/9	U339	11/9	1A5GT	5/6
EC31	7/-	EZ40	7/-	PCL82	11/6	U403	15/6	1A7GT	11/9
FCC81	7/6	EZ41	7/-	PCL83	13/6	U404	10/6	1C2	11/-
FCC82	7/6	EZ80	6/6	PL36	14/6	U801	28/-	1C5GT	11/9
ECC83	8/6	EZ81	6/6	PL38	16/6	UABC80	9/6	1D5	11/9
ECC84	9/3	EZ90	7/-	PL81	11/9	UAF42	8/9	1D6	11/9
ECC85	9/-	FE13	6/-	PL82	8/-	UBC41	8/6	1H5GT	10/-
ECF80	11/3	FW4/500	9/3	PL83	11/9	UBF80	8/9	1L4	6/-
ECF82	12/3	GZ32	11/-	PX25	11/9	UCC84	10/6	1LD5	3/-
ECH42	9/-	H30	4/6	PY80	7/6	UCC85	10/6	1N5	9/9
ECH81	8/6	H63	9/3	PY81	8/-	UCF80	15/6	1R5	7/-
ECL80	9/3	HL23DD	8/-	PY82	6/6	UCH42	9/9	1S4	9/9
ECL82	9/9	HL22	6/-	PY83	8/-	UCH81	9/9	1S5	6/-



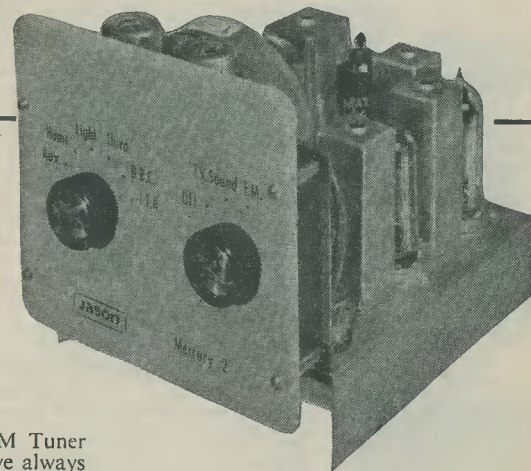
A.M. RADIOGRAM CHASSIS



A chassis of distinction, by a famous maker. Covering Long, Med. & Short Waves, plus gram position, this chassis (Size 15½" x 7" x 6½" high) incorporates the latest circuitry, using fully delayed A.V.C., and negative feedback. Controls: Tone, Vol.-On/Off, W/Change (L.M.S. & Gram), Tuning. Tapped input 200-250V. A.C. only. An attractive brown and gold illuminated dial with matching knobs, make this one of the most handsome, in addition to being one of the best performing chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads etc. OUR PRICE ONLY £9.19.6 plus 4/6 post & packing

BUILD A TUNER

Many models
Well-presented
designs



Tuner Kits

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

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- JTV/2K**—Self-powered switched FM/TV sound £14.19.0
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These highly dependable instruments are supplied in kit form for building oscillators, audio-generators, crystal-controlled calibrators, wobblers, etc. Excellent instructional literature is included with each model. Details on request.

JASON ELECTRONIC DESIGNS LIMITED

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The World-famous 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 (£32.0 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 (£11.10) making a total cost for the equipment of **£14.13.0**.

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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. 150 W. input. **£81.10.0**

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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**

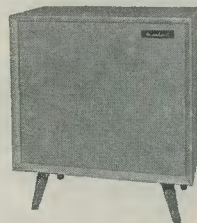


RSW-1

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

In the forefront of design with 4 piezo-electric transistors, 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°. Uses 10 transistors. **£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**.



The "GLOUCESTER"
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TAPE RECORDING/REPLAY AMPLIFIERS. Stereo (TA-S) **£23.6.0**. Mono (TA-IM) **£18.2.6**

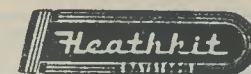
R.F. SIGNAL GENERATOR, Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£11.18.0**

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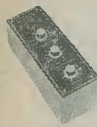


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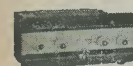
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O-12U



DC-1U



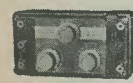
S-33



DX-40U



AG-9U



UJR-1



MA-12

5" OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/cm, 3 c/s to over 5 Mc/s. Rise time, 0.08 µsecs or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. **£36.10.0**

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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**

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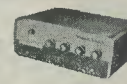
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OS-1



V-7A



S-88



SSU-1



UXR-1



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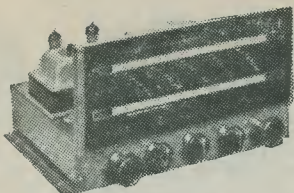
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★ Full VHF Band (87-108 Mc/s and Medium Band, 187-570M. ★ 7 Valves ★ 5 Watts Output ★ 15dB Negative Feedback ★ Separate wide range Bass and Treble Controls ★ 2 Compensated Pick-up Inputs ★ Frequency Response 30-22,000 c.p.s. ± 2 dB ★ Tape Record and Playback Facilities ★ Continental Reception of Good Programme Value ★ For 3. 7 $\frac{1}{2}$ and 15 ohm speakers. Send S.A.E. for leaflet

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Acos 73 Hi-Fi Pick-up for LP, and/or 78, 7", 10" and 12" records. Silent motor heavy turntable, auto stop.

Special offer £6.50 post free

Stereo/Monaural £6.19.6

BUILD THIS REPRODUCER BARGAIN SPECIAL SINGLE PLAYER KIT

B.S.R. TU9 4-speed Gram-Pick-up Unit £4.5.0
Handsome portable case 13" x 11" x 6 $\frac{1}{2}$ " £2.5.0
Ready built 3-watt, printed circuit, amplifier with two valves and speaker £3.12.6

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I.F. TRANSFORMERS 7/6 pair

465 kc/s slug tuning miniature can 1 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ ". High Q and good band width. By Pye Radio. Data sheet supplied.

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5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
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6B8	5/-	12A6	7/6	ECL82	10/6	PL81	12/6
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6BH6	9/6	12AU7	8/-	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/-	EF50	5/6	PY81	9/6
6D6	6/-	12BE6	8/6	EF80	8/-	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/6	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
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DK96, DF96, DAF96, DL96, 8/6 each or 30/- set

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

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5 watt 25 ohms-10,000 ohms 2/-
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15 watt 12.5 k Ω -50 k Ω 10W, 3/3

WIRE-WOUND POTS 3W Lab. Colvren, etc. Pre-set min. TV type. Standard size Pots, 2 1/2". Knurled slotted knob. Spindle, high grade. All values, 100 ohms to 50k, 3/- each, 30k, 50k, 4/-, 6/6; 100k, 7/6. Ditto 1/2W Carbon Track V/W EXT. SPEAKER CONTROL 10 Ω , 3/-.

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Ditto 350-0-350 22/6
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MIDGET. 220V 45mA, 6.3V 2A 15/6
SMALL. 220-0-220V 50mA, 6.3V 2A 17/6
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Ditto 1.4, 2, 3, 4, 5, 6.3V 1 1/2A 8/6
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CRYSTAL MIKE INSERT by Acos 6/6
Precision engineered. Size only 1 1/2" x 1 1/2" x 1 1/2"
ACOS CRYSTAL MIKE 40 25/-

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40 CIRCUITS FOR GERMANIUM DIODES, 3/-.

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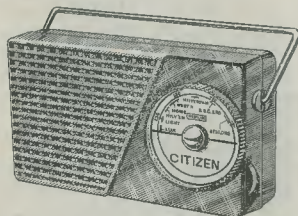
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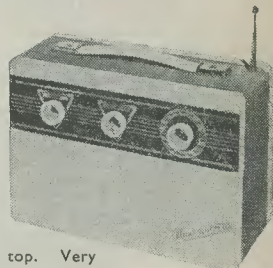
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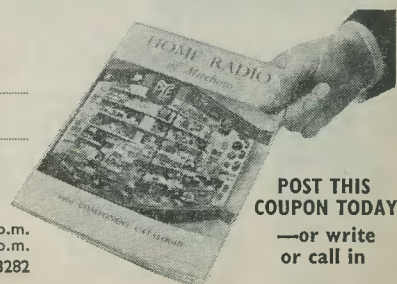
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give optimum audible pulse amplitude from the speaker.

Points of Design

The particular transformer specified for the T_1 position is chosen for several reasons. Firstly, it is of small size and has interleaved laminations, thereby enabling early saturation to be achieved. Secondly, it happens to have a convenient combination of winding ratios, as well as a tertiary winding for low-impedance pulse output.¹ Thirdly, it is readily available through home-constructor channels.

The speaker transformer in the T_2 position may be any conventional component having a ratio around 40:1. This ratio was found to give best results during experimental work with the prototype. The use of transformers having ratios other than 40:1 should not upset oscillator functioning (provided that the impedance presented to the oscillator is greater than $2k\Omega$) but may cause a drop in the audible volume of the pulses.

The upper plate of condenser C_1 receives a positive charge during the pulse, and it might be felt that a reversed voltage (with respect to its polarity) could appear across it in consequence. This point was checked in the prototype by returning the lower plate of the condenser to a point which was positive of chassis. Such a connection caused no noticeable alteration to oscillator functioning and it was decided to leave the lower plate connected to chassis, as shown in the diagram.

Owing to variations in transistors, transformers and in condensers employed in the C_1 position, no value is quoted for resistor R_2 . The simple procedure needed to determine the value required here is described when the setting-up process is discussed.

With the prototype, R_1 offered a range slightly in excess of 10 pulses per second to 0.3 pulse per second. A wider range may be achieved by increasing the value of this component. Control of pulse repetition frequency tends to be cramped at the upper end of the track of R_1 and it might prove helpful to employ a log potentiometer here.

The circuit will similarly function as a blocking oscillator if R_2 is returned to the negative supply rail instead of to the transistor collector. However, with this method of connection the pulse tends to be less sharp. It is possible that connecting R_2 to the collector damps winding 1-2 of transformer T_1 , thereby preventing the formation of excessive ringing voltages at the end of the conduction pulse.

The prototype was found capable of

¹ The particular transformer type specified has been previously employed in a very neat a.f. oscillator design. See D. J. French, GRAD.I.E.E.: "A Transistor Audio Signal Generator"; *The Radio Constructor*, August 1959.

operating reliably with an applied supply potential as low as 1.5 volts; and a lowered supply potential could be used, if desired, should the oscillator not be intended to drive the loudspeaker directly. Supply potentials above 12 volts should not be used.

Setting-up

After the oscillator has been constructed it needs to be set-up. A meter capable of reading 5mA should be inserted in the negative supply lead to monitor collector current whilst this process is being carried out. The oscillator may be coupled to an audio amplifier in the manner discussed above, or to a loudspeaker as shown in the diagram. A resistor having a value of some $100k\Omega$ may be temporarily fitted in the R_2 position. R_1 should be adjusted to insert maximum resistance.

Since the collector of the transistor connects to the negative supply rail via a load having a low resistive value, it might be advisable to commence by increasing the supply voltage in small steps up to the full voltage, checking meter current at each step. Between pulses, collector current should be very low; certainly less than 0.5mA at 12 volts.

Pulses will be evident in the form of a "click" from the associated loudspeaker and a kick in the meter needle. Using the temporary value for R_2 just mentioned the pulses may be very widely spaced in time. R_2 should be carefully advanced, whereupon pulse repetition frequency should increase. A value for R_1 is then found which causes the desired maximum pulse repetition frequency to be achieved when R_1 inserts minimum resistance. Too low a value in R_2 should be avoided as this may cause the transistor to pass excessive current. The value required for R_2 in the prototype was $10k\Omega$.

If a directly-coupled speaker is employed, as in the circuit diagram, care should be taken to avoid accidentally short-circuiting either of the speaker transformer windings during setting up and subsequent use of the oscillator. A short-circuit here can cause the transistor to pass high surge currents. For a similar reason, care should be taken to prevent short-circuits across any of the three windings of transformer T_1 .

Results with the Prototype

When the prototype was finalised it was connected up, as shown in the circuit diagram, to a reasonably sensitive speaker mounted on a baffle. The resulting audio pulses were at an adequate level for most purposes.

Between pulses the current drawn by the prototype at 12 volts was 0.15mA. The peak current drawn during pulses was not measured.

IN YOUR WORKSHOP



This month Smithy the Serviceman and his able assistant, Dick, discuss the problems of measuring transistor potentials with relatively low resistance voltmeters, and of carrying out amateur transistor servicing without professional equipment

"YOU KNOW, SMITHY," BEGAN DICK, settling himself more comfortably on his stool. "It's easy enough for you and I to fix transistor radios in the Workshop here..."

Dick's voice trailed off into silence as he sought the words to express his thoughts.

"Yes?" prompted Smithy.

"Well," continued Dick, "what I mean is that we're lucky here because we've got all sorts of test equipment on hand. We've got really high resistance testmeters as well as modulated signal gennies and things like that. But there are lots of people who, I'm quite certain, try to fix transistor radios with nothing more complicated than a 1,000 ohm per volt testmeter and a screwdriver! How can they, for instance, measure the voltages on the transistor itself?"

"It is a little harder," agreed Smithy, "if you haven't got all the bits and pieces."

"And there are also," Dick carried on, warming to his subject, "chaps who knock up simple t.r.f. receivers with surplus transistors and things like that. How do they trouble-shoot their sets after they've built them?"

Smithy sipped reflectively at his tea and pondered for a moment. Both he and his assistant were in a comfortably lazy mood. There was a momentary lull in the pressure of receivers coming in for repair and Smithy had decreed that an elongated tea-break would not be at all out of place.

The Approach to Transistors

"Well," said Smithy after a moment. "Before saying anything else, I think I should point out that, apart from test equipment,

we have a considerable advantage over the chaps who only play around with transistors once in a while. In our case we've had lots of experience with transistors, and experience is worth a very great deal. Experimenters who encounter transistors only occasionally tend to be far more circumspect about them than you or I would be."

"That's true enough," agreed Dick. "Transistors tend to be a little disconcerting when you encounter them for the first time."

"Which is due," repeated Smithy, "to their unfamiliarity. If you cast your mind back to the first valve set you ever played with you may remember that your approach was probably just as cautious as when you attacked your first transistor set."

"I don't think I can remember back as far as my first valve set."

Smithy looked at his assistant's youthful face and sighed.

"O.K., old man," he said. "I shan't over-tax your memory! Another point is that there is, to the novice, a certain air of mystery about transistors and they tend, by sympathetic magic, to acquire an imaginary ability to introduce faults which are similarly mysterious."

"By sympathetic what?" asked Dick.

"By sympathetic magic," repeated Smithy calmly. "It's a psychological process of rationalisation whereby a thing is accredited with attributes belonging to something else with which it has an illusory association."

"I'm sorry I asked," said Dick. "Let's get back to transistors!"

"Right-ho," said Smithy. "Now the first thing to remember about transistors is that, provided you treat them right, they can be

considered as being as reliable as resistors. This is especially true of the transistors employed in manufactured receivers and of branded transistors bought by the home constructor."

"What do you mean by treating transistors right?"

"A transistor," pronounced the Serviceman, "is a robust component which is only normally damaged by excessive heat, or by excessive voltage or current. So far as excessive heat is concerned you can avoid this by the simple process of using heat shunts on the lead-out wires whenever you solder or unsolder them."

"I sometimes wonder," remarked Dick, "whether using heat shunts isn't being just a little *ultra-cautious*."

"You're quite wrong there," said Smithy. "I know that there's a school of thought which considers that heat shunts are 'fussy' but I, personally, don't subscribe to it. It doesn't take a moment to clip on a heat shunt, and it can spare you a lot of distress afterwards. I would go further, indeed, and say that the heat shunt shouldn't be removed until the point to which the transistor lead-out wire is connected has cooled off after soldering. The actual joint may include a relatively large mass of solder and other metals, and this can retain quite a lot of heat after the soldering iron has been removed. The joint may dissipate much of this heat up the lead-out wire into the transistor if the heat shunt is removed too early."

"Well," said Dick doggedly. "I know that I've soldered transistors into circuit without heat shunts on several occasions in the past, and they don't seem to have suffered in any way."

"You've been lucky," said Smithy. "What probably happened was that you were able to solder the joint quickly. Also, the joint may have had a small mass so that it retained little heat, and this could have been combined with long lead-out wires."

"What you say," admitted Dick reflectively, "could be true."

"Look," continued Smithy. "I'll tell you a little story! Some time ago I had to prepare a little exhibition gadget which included a 0-1mA meter fitted with a series resistor which would cause it to read 10 volts full scale."

"I see," broke in Dick. "The resistor required would need a value of—let me see—10kΩ minus the resistance of the meter."

"That's right," agreed Smithy. "Also, the power it would have to dissipate at f.s.d. would be just short of 10 volts times 1mA, which is 10mW. I went through a stock of 10kΩ ½ watt 20% resistors I happened to have on hand and I soon found one which had a value near enough for my require-

ments. I then soldered it into circuit. Believe it or not, but, when I checked the meter immediately afterwards, I found that the resistor had gone up to 11kΩ! I had to find another resistor of the right value and solder it in with heat shunts before I could get the meter circuit to work properly."

"Well, I'm dashed," said Dick. "Heat shunts on an ordinary resistor!"

"That story has a moral," remarked the Serviceman. "Normally, I wouldn't have noticed the increase in value if I'd put the resistor into a set; it only showed up in this case because it was in an actual meter circuit. Also, I wouldn't like to guarantee that my resistors weren't pretty old stock. Nevertheless the point is that, if you can shift the value of a common-or-garden resistor by soldering you may be similarly able to shift the characteristics of a transistor. And the shift in the transistor would be much less easy to detect than the shift in the resistor."

"I'm convinced!" chuckled Dick. "It's heat shunts for all transistors from now on! What about the second point you raised just now, that of preventing excess current or voltage?"

Transistor Operating Conditions

Smithy looked pointedly at his empty cup. Taking the hint, Dick picked it up and replenished it.

"It's a bit strong, isn't it?" complained the Serviceman.

Dick took back the cup and added a little milk. Smithy regarded its contents without complete favour, but he condescended to sip it experimentally.

"You're getting," remarked Dick, "as bad as Andy Capp."

"Who's Andy Capp?"

Dick stared at Smithy in astonishment. "It would take," he said, after a moment, "too long to explain here. But one thing I can tell you is that Andy Capp's very fussy about his cup of tea. He likes to have it exactly right with the handle positioned in the exact place for picking up."

Smithy looked interested.

"I like people who know precisely what they want," he remarked. "A few more people like this Andy Capp chap in the world, and it would be a much better place!"

"Let's get back to transistors," said Dick hurriedly. "What about excess current and voltage?"

"Oh yes," remarked Smithy, forgetting his tea for the moment. "Now so far as we're concerned, practically all the transistors likely to be encountered in this country at the time being are p.n.p. types. And, when they're used as amplifiers, they're nearly always connected up in the earthed emitter manner with stabilising components. (Fig. 1.)

What happens here is that the negative bias supply for the base is obtained from the fixed potentiometer across the h.t. lines, and the resistor in the emitter circuit prevents the appearance of too much base-emitter voltage."

"I know what you mean," said Dick. "If emitter-collector current increases due to thermal runaway conditions, more current flows through the resistor and more voltage drops across it. The result is that the bias voltage between base and emitter drops, thereby counteracting the runaway effect."

"You've got it," confirmed Smithy. "In commercial receiver circuits it's usual for the collector load to consist of an i.f. or a.f. transformer winding having a very low d.c. resistance. In consequence the transistor is potentially capable of passing quite a high current. It could pass such a current if you accidentally short-circuited the base to the h.t. negative line, whereupon the only component limiting transistor current would be the emitter resistor. The transistor might well be damaged in consequence. An equally dire result could be given if you accidentally short-circuited the emitter resistor. In this case the bias between base and emitter would increase, and the only current limiting component in the emitter-collector circuit would be provided by the very low resistance of the collector load. Also, if the h.t. potential is fairly high, say about 10 volts or more, you might exceed the maximum collector-emitter voltage of the transistor."

"It looks as though these are two important points to bear in mind."

"They are. But there are less severe cases you have to guard against. If, for instance, you're taking voltage readings with a fairly low resistance meter, you should always ensure that the resistance of the voltmeter doesn't cause excess current to flow in the transistor. A good approach is to try to take readings in such a manner that the testmeter resistance reduces transistor current."

Using a 1,000 ohm per Volt Meter

"Ah," said Dick. "That's the situation I referred to at the beginning of this session: how do you read transistor voltages with a 1,000 ohm per volt meter?"

"Fair enough," said Smithy. "Now a 1,000 ohm per volt meter is similar to the meter in that little story about the resistor which shifted in value. It consists of a basic 1mA movement with series resistors. When switched to 1 volt the resistance across the prods is 1kΩ, when switched to 10 volts the resistance is 10kΩ, and so on. Furthermore it represents what, particularly in amateur circles, is considered to be quite a sensitive and expensive instrument. Unfortunately, due to the low voltages encountered in

transistor circuits, a 1,000 ohm per volt meter is not ideal for measuring voltages on the transistor itself."

Smithy drank absently from his cup and replaced it on the bench.

"Let's take a practical example from a commercially made receiver," he continued. "Let's assume we have an i.f. transistor connected as an earthed emitter amplifier. (Fig. 2 (a).) The applied h.t. potential is 7.5 volts and there is negligible voltage drop in the i.f. transformer windings. There is no a.g.c. applied to this particular stage and, if we were to measure the voltages on the transistor with a very high resistance instrument, we would find that the voltage on the base would be slightly less than what the fixed potentiometer would supply if no current were drawn from it. Let's say 1.4 volts. The emitter voltage could well be 1.25 volts, and the collector voltage would be the 7.5 volts of the supply because there is no volts drop worth talking about in the i.f. transformer. All these voltages are, of course, with respect to the h.t. positive line."

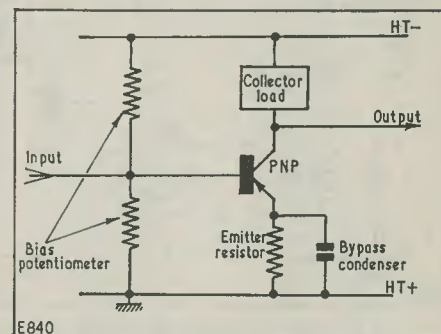


Fig. 1. A p.n.p. earthed emitter amplifier, with stabilising components

"Could you measure them with a 1,000 ohm per volt meter?"

"Not accurately," replied Smithy. "Let's take the emitter voltage first. In our present case this is 1.25 volts, as dropped across a 1kΩ resistor. Now, if our meter were switched to, say, a 2 volt range and were applied between emitter and chassis (Fig. 2 (b)) we would be shunting the existing 1kΩ resistor with another of 2kΩ. What we are actually doing, therefore, is to effectively reduce the emitter resistor to two-thirds of its correct value. Obviously, the reading we would get would not be representative of working conditions, and we could cause quite a sizeable increase in transistor current. This latter is not really a desirable test procedure. There is also a very slight risk

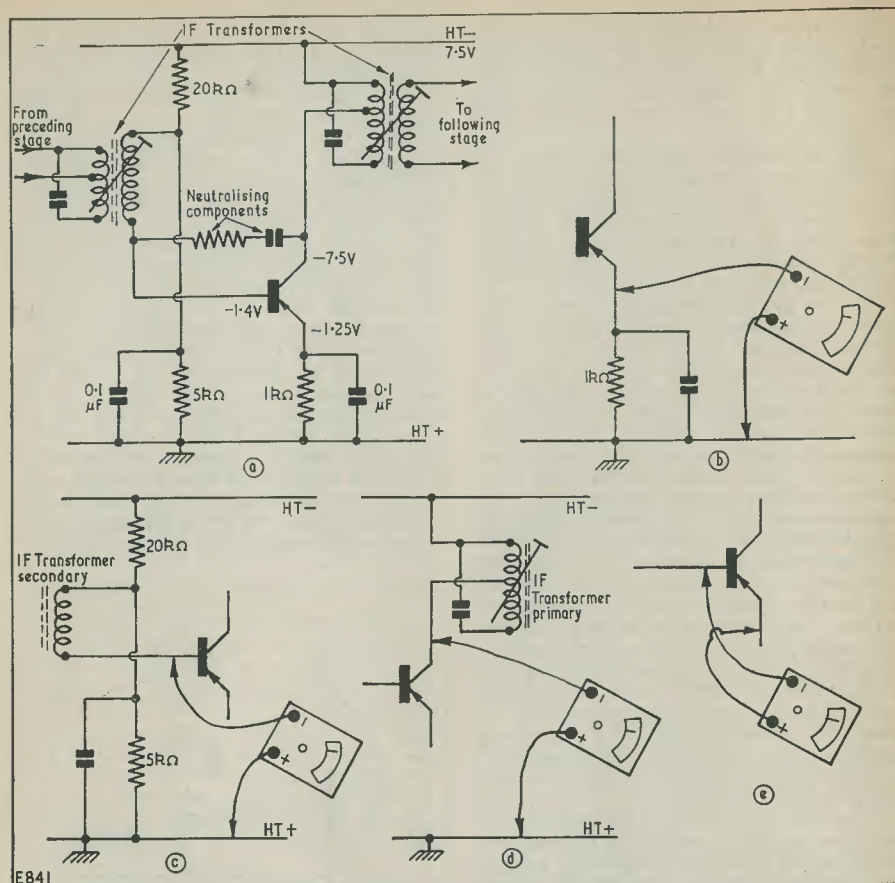


Fig. 2 (a). A typical i.f. amplifier employing an earthed emitter p.n.p. transistor. Bias is applied to the base via the secondary of the first i.f. transformer, which has negligible resistance. The resistor values shown are to the nearest round number to facilitate explanation, and the voltages are relative to chassis. The neutralising components would, typically, have values around $3.9k\Omega$ and $18pF$. (b). When measuring the voltage at the emitter of the transistor of (a), the testmeter should have a resistance much higher than that of the emitter resistor if accurate readings are to be obtained. Too low a meter resistance could, also, seriously increase transistor current. (c). Unless the testmeter has a resistance which is high in proportion to the resistors in the bias potentiometer, it will give a low reading when applied to the transistor base. (d). When the collector load is an i.f. transformer winding, or a similar component, a low-resistance meter gives an accurate indication of collector voltage. (e). Measuring the base-emitter voltage. Care must be taken to avoid connecting the meter between base and collector.

of increasing collector-emitter voltage above the maximum value in circuits having high h.t. voltages."

"What about switching the testmeter to, say, a 10 volt range?"

"That would be much more acceptable," replied Smithy, "because, in this case, the shunt resistance added across the $1k\Omega$ resistor would be $10k\Omega$. The modified value of the emitter resistor would then be ten-

elevenths of its original value and this shouldn't cause an excessive increase in transistor current or collector-emitter voltage. Also, the reading you'd get would be pretty accurate, partly because emitter-follower action in the transistor tends to cause a reasonably constant voltage to appear on its base, despite small changes in emitter resistance. There is a basic snag in this test, incidentally, which I'll have to come back to later."

"Fair enough," said Dick. "How about measuring the voltage on the base?"

"Let's try it and see what happens!" said Smithy. (Fig. 2 (c).) "In our example the true voltage is 1.4 and it consists of the voltage provided by the potentiometer minus the small extra voltage dropped in the upper resistor due to transistor base current. We can ignore the latter for the moment. If, with our testmeter switched to a 10 volt range, we applied it between the h.t. positive rail and the transistor base our potentiometer would have a $20k\Omega$ resistor in the upper section and a resistor in the lower section given by a 5 and $10k\Omega$ resistor in parallel; that is, $3.3k\Omega$. So we'd get a reading", Smithy scribbled some figures on the pad on his bench, "of some 1.06 volts. Which is, as you can see, a long way from the correct figure. On the other hand the test causes a decrease in transistor current and is not undesirable on that account. There is the further point, however, that, if adding the testmeter causes too high a drop in base voltage, the emitter voltage may drop sufficiently low in sympathy to cause maximum collector-emitter voltage to be exceeded in sets with high h.t. voltage."

"What about using a higher voltage range on the meter, so that the resistance between its prods is higher?"

"In our example," said Smithy, "you'd have to go up to some 50 volts or so, whereupon the reading you'd get would cause such a small movement in the needle that it wouldn't be much use to you anyway."

"How about reading first between base and h.t. positive and then between base and h.t. negative, and averaging out the two readings?"

"That", said Smithy severely, "would be a naughty thing to do! Apart from the fact that there wouldn't be any simple relationship between the two figures, connecting the meter between the base and h.t. negative could increase transistor current by a large amount and this is an undesirable practice. If the meter were on the 10 volt range the upper part of the potentiometer in our example would drop from $20k\Omega$ to $6.6k\Omega$, and the resultant increase in bias current would be quite high."

"What about checking collector voltage?"

"That's quite easy," said Smithy. "Just

apply your testmeter between h.t. positive and the collector. (Fig. 2 (d).) When you have a low resistance load you've bound to get quite an accurate reading with your 1,000 ohm per volt meter. If the load happens to be a resistor you should choose a voltage range which gives the meter as high a resistance as possible so that the reading you get is not excessively below the correct one. Testing between h.t. positive and the collector cannot harm the transistor because it only reduces collector voltage."

"It seems to me," said Dick rather helplessly, "as though a 1,000 ohm per volt meter isn't all that marvellous for testing transistor voltages, after all!"

Smithy chuckled.

"I must admit", he said, "that I have painted rather a gloomy picture. But that was only because I wanted to emphasise the risks and shortcomings. Now I'm going to look on the cheerful side for a change!"

"Let's return to our original i.f. amplifier. To start off with, we know that we won't do the transistor any harm by connecting our meter between the h.t. positive line and the collector. If we interpret the reading we get correctly then we will know whether h.t. negative is getting to the collector. We can next check between the h.t. positive line and base. Because of the effects just discussed we would get a low reading around 1.06 volts. Nevertheless, this reading tells us that a negative voltage of some sort is getting to the base of the transistor, even if we don't know its magnitude. So that the upper resistor, at any rate, hasn't gone open-circuit; which is some comfort!"

"Finally we can check the voltage between h.t. positive and the emitter, taking care to ensure that the meter resistance is much higher than the emitter resistor. The emitter reading can tell us a lot, because it gives us an idea of the collector-emitter current."

Dick remembered something.

"You said just now that there's a basic snag in measuring the emitter voltage."

"That snag", said Smithy, "is because, due to emitter-follower action, you may still get a reasonable reading at the emitter if the emitter resistor has shifted seriously off value. You can make certain that this particular snag isn't in evidence by switching the receiver off and measuring the value of the emitter resistor with the 1,000 ohm per volt testmeter set to ohms. The ohms-range energising battery should not be higher than 1.5 volts and the receiver must be switched off or you may inject some dirty voltages into the circuit whilst it's working. There's no need to disconnect the resistor provided that the receiver uses conventional junction transistors and the path between the base and both h.t. lines has a total resistance of some

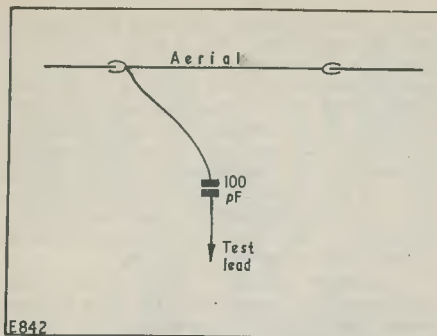


Fig. 3. A long aerial offers a useful source of Medium and Long wave signals in the absence of a signal generator

3k Ω or more. You should try the ohmmeter leads either way round in case the base-emitter junction of the transistor acts as a rectifier, whereupon the higher resistance reading is the correct one."

"Well, it all seems pretty clear," said Dick. "I think that the tests you've just described should enable most transistor faults to be located."

"They should help," said Smithy, "but if I were doing a stage-by-stage test I'd check all the voltages first before measuring emitter resistor values. As a guide to the emitter voltages you're liable to meet, incidentally, I think I should add that the emitter current for the average i.f. stage is usually around 1mA or so. In an a.f. driver stage it would normally be around 3 to 4mA. There's another test you can carry out as well, by the way, but you've got to be very careful whilst doing it."

"What's that?"

"You can check the voltage between base and emitter," replied Smithy. "If the transistor is working correctly, you should get something like 0.1 to 0.15 volts between base and emitter, the important thing being that the base is negative. (Fig. 2 (e).) If you switch your 1,000 ohm per volt testmeter to the 10 volt range and apply it to the base and emitter, you may just be able to see the needle move to indicate the presence of this voltage. If meter deflection is in the correct direction you can be pretty certain that the transistor is amplifying. Also the test is not undesirable, because adding the meter can only reduce transistor bias current. However, don't accidentally connect your meter between base and collector or you may wreck the transistor. This is a test that calls for a clear head and a steady hand! Hullo, my cup's empty!"

Transistor T.R.F.'s

Obediently, Dick got up and carried Smithy's cup to the teapot.

"You'd better put a bit more water in," commanded Smithy.

Dutifully, Dick emptied the contents of the Workshop kettle into the teapot.

"That's too much," said Smithy fussily. "You're drowning it!"

Muttering quietly to himself, Dick brought Smithy's cup to him and placed it on his bench, whereupon the Serviceman picked it up and drank with great satisfaction.

"Now what about servicing miniature home constructed t.r.f. sets, and things like that?" asked Dick, returning to his original subject.

"I haven't had as much experience with those as I have with commercially made sets," replied Smithy, "although pretty much the same rules apply, of course. Some of these sets have low h.t. potentials of the order of 3 volts, and the voltage readings you're likely to get with a 1,000 ohm per volt meter become less as a result."

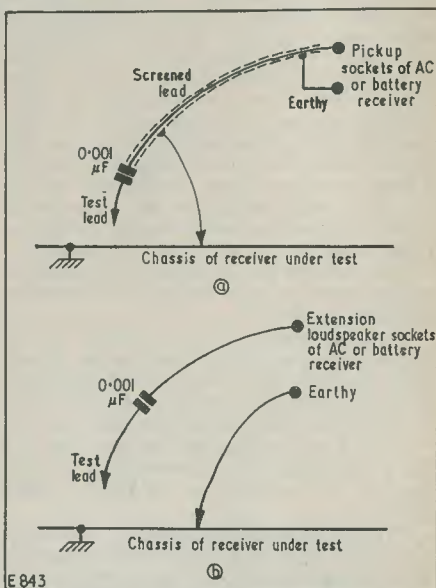


Fig. 4 (a). It is possible to use the a.f. amplifier of a radio receiver as an a.f. tracer by connecting to the pickup sockets as shown here

(b). A source of a.f. for signal injection is available at the extension loudspeaker terminals of a receiver. The internal speaker should be muted by replacing it with a resistor having the same value as its impedance

"Many of the people", said Dick, "who make these sets haven't got signal gennies or signal tracers for fault finding, you know."

"I see," said Smithy thoughtfully. "Still, there's lots of simple things that can be brought into use in their stead. One of the cheapest signal generators for Medium and Long waves I know of is a good aerial! If you have a nice long aerial you can always apply it to the r.f. circuits via a 100pF condenser (Fig. 3) and this should inject quite a large amount of the local station's signal. A television down-lead often makes a good aerial. If you have an ordinary radio handy, coupling to the pickup sockets via, say, a 0.001 μ F condenser gives you an a.f. amplifier which you can use for a.f. tracing. (Fig. 4 (a).) Or, again, you can obtain a source of a.f., once more via a 0.001 μ F condenser, from the extension speaker sockets. (Fig. 4 (b).) The radio used should be a battery or a.c. only model, as there would be a risk of injecting a.c. voltages into the transistors if an a.c./d.c. receiver with a live chassis were used. Another extremely useful aid is a pair of phones with 2,000 Ω earpieces. These can be used for tracing a.f. voltages (Fig. 5 (a)) or r.f. voltages (Fig. 5 (b)). Provided the room in which you're working is quiet, it's surprising how well you can hear really tiny a.f. voltages with a pair of high resistance phones."

Tempus Fugit

The Serviceman fell silent for a moment.

"How's the teapot?" he asked suddenly, noticing his empty cup.

Dick glanced at the Workshop clock and started.

"I don't think it's worth bothering about," he said. "Do you know, it's only five minutes off our lunch break!"

"In that case", said Smithy firmly, "you'd

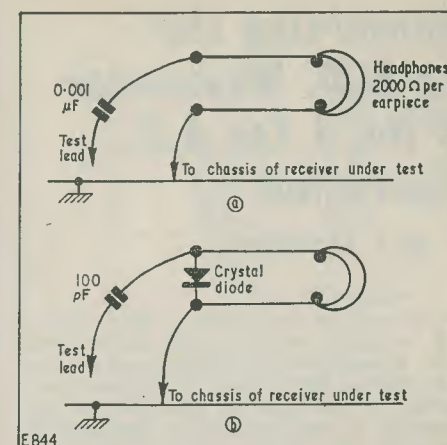


Fig. 5. Quite useful signal tracing may be obtained with a pair of 2,000 Ω headphones. A series 0.001 μ F condenser is required for a.f. tracing (a), and a series 100pF condenser with a shunt diode for r.f. tracing (b). In the second circuit the test leads to the condenser and, thence, to the crystal diode should be kept short

better make a fresh pot. I like a nice cup of tea at the middle of the day!"

"Right you are," said Dick cheerfully. "To change the subject, I wonder if you feel in the mood to talk about gated a.g.c. systems."

"Certainly," said Smithy, watching his assistant fill the kettle. "Don't forget to swill the pot out well! And I think we'll have just a few more tea-leaves this time, and you ought to get the pot really warm beforehand, too. Now, in television a.g.c. systems . . ."

Ballistic Missile Early Warning System

Belling & Lee have been engaged by Sir Alexander Gibb & Partners, consulting engineers, on behalf of the Air Ministry, to assist in the design and implementation of r.f. shielding and interference suppression on the B.M.E.W.S. project at Fylingdales Moor. This installation is to form part of the United States chain of early warning stations, with a range of 3,000 miles, capable of detecting high-trajectory missiles approaching over north polar routes.

The purpose of the shielding is two-fold, to protect operating personnel from the extremely high r.f. radiated power which will be used, and to ensure interference free conditions of working for all the varied electronic equipment, including the computers, etc., to be housed there. It therefore involves every section of the extensive system of buildings which is being erected, and will necessitate the permanent residence on site of a "Belling-Lee" team of engineers throughout the entire programme of construction. Courtesy Belling & Lee Ltd.

Converting the ex-W.D. Wavemeter D No. 1 for A.C. Operation

By J. Anderson

THE EX-W.D. WAVEMETER D NO. 1 IS NOW available on the surplus market, and is being used by an increasing number of amateurs on account of its simplicity, versatility, and ease of operation, to say nothing of the remarkable flexibility it possesses in the face of even the most sweeping adaptations and conversions.

It is equipped to provide marker frequencies at 1 Mc and 50 kc/s points from about 1.3 Mc/s to 8 Mc/s continuous, and generally has a large enough supply of harmonics to go very much higher than this, especially if external amplification is used. In addition, it will provide frequency measurements to an accuracy of 0.5 kc or better inside the indicated ranges, and is equipped with full instructions for setting transmitter frequencies, reading receiver frequencies, and checking the tuning accuracy of all types of sets. Circuitry, repairs, and fault tracing are described in detail in the pamphlet supplied, as is the theory of the instrument; the case housing a spare valve, vibrator, and dial bulbs in addition to the actual set. It is very light in weight, strong, and eminently suitable for amateur use.

However, many people are dissuaded from buying this wavemeter because it requires a source of six volts at a direct current of six

amps; this, whilst no doubt useful to the mobile amateur, was a source of some inconvenience to the author, who accordingly set out to convert the unit as described below.

Conversion Details

Many amateurs will have a source of six volts at the amperage stated available from a spare winding on a power pack transformer, or will even be able to tap it from the heater supply of their transmitter. Such a voltage will be a.c., however, which at first sight might not seem usable. Nevertheless the a.c. supply can be employed by taking advantage of the following simple alteration, which the author used for some years in a military installation with no detrimental effects to the unit. Remove the working vibrator, which will be found in the rear left-hand corner looking from the front panel, and connect *either* (but not both) of the two small holes in the base socket to the large hole which is connected to the chassis, the best and simplest method being the use of two wander plugs and two inches of insulated wire. This modification has the effect of applying the a.c. supply direct to the sub-chassis step-up transformer instead of mechanically turning d.c. to a.c. in the first instance. Also, the vibrator can be replaced at will for mobile use on a d.c. supply whenever this is required.

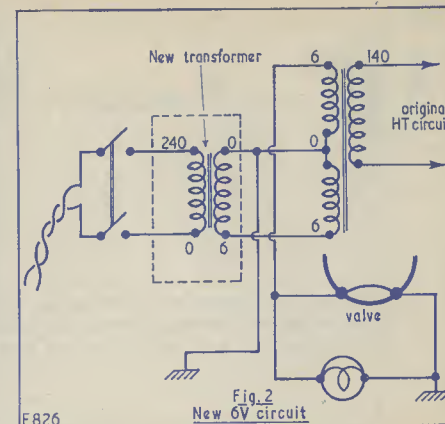
An alternative modification consists of converting the wavemeter to mains operation entirely.

The wavemeter h.t. requirements are of the order of 140 volts at 150mA, and it may be difficult to find a small mains transformer with a secondary voltage of 140. The cheapest way to effect a conversion, and perhaps the best even though it does require another transformer, is to purchase a small trans-

former at four or five amps to domestic bells. This will cost a few shillings and will give excellent results; overheating is negligible and the author's unit has functioned well and accurately for over a year without attention.

Disconnect the wires to the working vibrator holder, trace them to their sources, and remove them completely, together with the holder. Remove the connections to the working valveholder, making a careful note of them first, and move the holder one space to the right; that is, to the point occupied by the spare valve in the original unit. (See Fig. 1.) Reconnect the holder, taking care that the wires are on the same pins as before. There should now be a clear space of about 4in by 1½in in the rear left-hand corner of the chassis, which will prove adequate for the installation of a small transformer as described above. Behind the crystal there is a large ceramic condenser mounted vertically; a screen of thin metal sheeting can be fitted on the same bolts as those holding this condenser, the screen appearing between the crystal stage and the proposed transformer space thereby providing screening between the r.f. and power supply stages. It may be possible to attach the transformer to the screen, but it will more probably be necessary to drill two small mounting holes on the actual chassis.

A new double pole switch must be fitted to the front panel in place of the present low-voltage switch, the mains lead connected to it, and thence to the additional transformer. The six volt secondary leads are taken to the original step-up transformer under the chassis, and connected to the terminal marked "0" and one of the terminals marked "6". The dial lamp and valve



heater obtain their supply from the "0" terminal and the other "6" terminal, as shown in Fig. 2. The wavemeter will now work from a 240V a.c. supply, drawing about 10 watts (although this depends on the type of transformer used) and very little hum, if any, will be noticeable.

The large electrolytic condenser below the chassis on the right-hand side, as well as the small choke next to the original power switch, are connected in the vibrator circuit and accordingly will no longer be required; neither will the small condenser fitted in parallel with the above mentioned choke. The removal of these components will somewhat reduce the weight of the unit and thus compensate the addition of the new transformer.

HIGH POWER SHORT WAVE TRANSMITTERS FOR B.B.C.

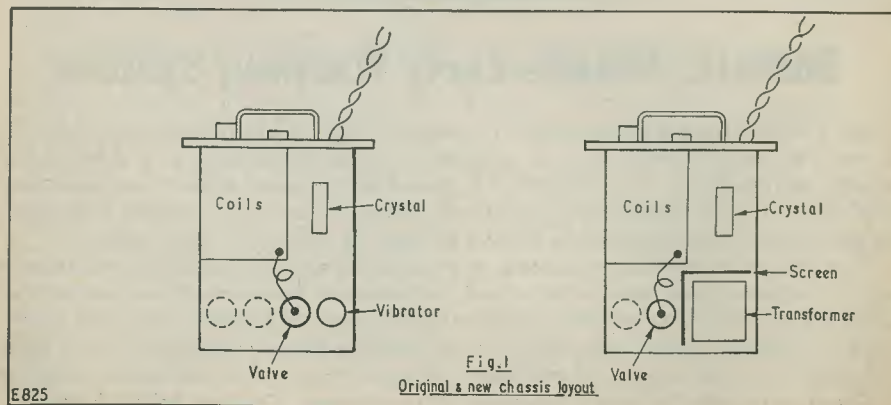
A further contract for two 100 kW twin-channel high frequency sound broadcasting transmitters, valued at approximately £160,000, has been placed with Marconi's by the British Broadcasting Corporation.

These equipments are a departure from conventional design in that the penultimate and final r.f. amplifier valves and those of the modulator are vapour-cooled. The transmitters are scheduled for installation at the B.B.C. External Services station at Daventry, for which two of the same type are already on order. A further two of somewhat similar design have recently been installed at the B.B.C.'s Rampisham (Dorset) station, making a total of six in all.

Vapour-cooling is a system whereby the heat generated by the valves is transferred to water-jackets surrounding them. The resultant steam is taken by convection to a condenser which converts it once more to water for return by gravity feed to the water-jackets.

The ability to effect a speedy changeover from one frequency to another is a highly desirable feature for high-frequency broadcasting services, and this aspect has received especial attention in the design of the new equipments by the provision of two r.f. amplifiers per transmitter. These are contained in separate cubicles on either side of a common modulator, which is switchable to either. With the r.f. amplifiers set up on alternative frequencies a changeover can be made virtually instantaneously by switching the modulator output to the standby amplifier.

The vapour-cooled valves used are manufactured by the English Electric Valve Company.



"5.49" — A Miniature Pocket Receiver —

By D. L. Gibson, C3JDG

This article describes the construction of a very small transistor receiver which provides complete coverage of the Medium wave band. The unusual name, "5.49", derives from the fact that the author uses it daily on the 5.49 from St. Pancras!

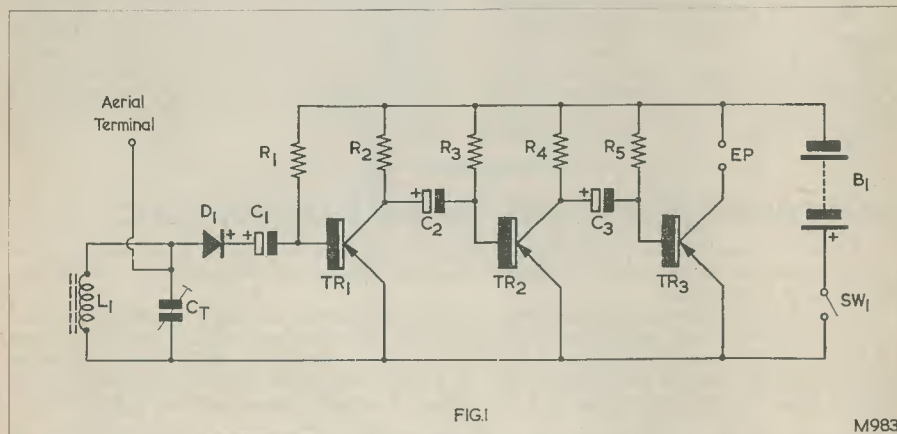
MANY DESIGNS FOR TINY, CHEAP AND easily constructed transistor receivers have appeared from time to time, some being of the straightforward T.R.F. variety and others consisting of more complex reflex circuits, super regens and superhets, etc. However, none of these seemed to fit the bill for a truly "pocket" receiver, this being mostly on account of size. The final choice of circuit employed by the writer was governed by the following

factors: cost, simplicity, ease of construction, easily obtainable components, and compactness.

Circuit Features

Cost in the present design is kept to a low figure by using red spot transistors and a minimum number of components.

Simplicity is adhered to throughout by eliminating all unnecessary frills and using straightforward circuitry.



Components List

- | | |
|--|--|
| L ₁ Coil (Teletron FRM-MW) | R ₂ , R ₄ 470kΩ ½ watt 4.7kΩ! |
| C _T Trimmer 500pF (Cylcon TT13) | TR ₁ , TR ₂ , TR ₃ Red Spot |
| D ₁ Crystal diode (Mullard OA71 or equivalent) | B ₁ Two Mercury cells in series. Mallory RM400 (Arthur Gray Ltd.) |
| C ₁ , C ₂ , C ₃ 2μF—6V wkg. | EP Crystal deaf aid earpiece or earphone(s) |
| R ₁ , R ₃ , R ₅ 1MΩ ½ watt | SW ₁ See text |

Ease of construction is assured by the use of a small sub-chassis which can be wired and soldered prior to its insertion in the case.

Easily obtainable components are used throughout.

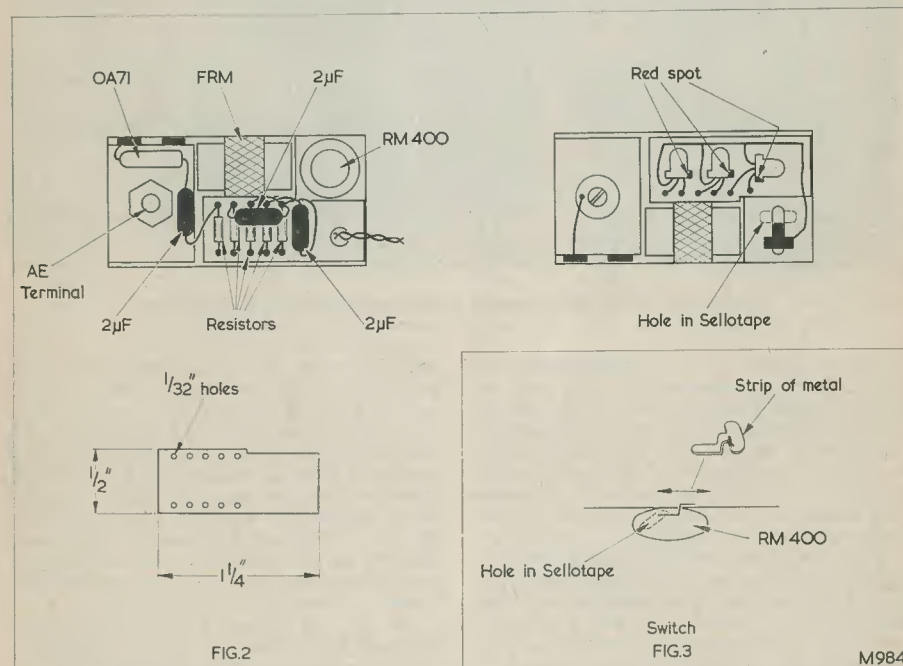
Finally, compactness is important since previous sets carried in the inside jacket pocket gave rise to many an odd glance from fellow travellers on the 5.49 from St. Pancras. A comfortable journey is now enjoyed by the writer since the dimensions of the present receiver are only 2 x 1 x ½ in, and it is quite inconspicuous. It is possible to reduce the size of the set even further but ease of construction suffers if this line of thought is pursued.

should be the aim. Two cells were used in the original and provided the best compromise.

Construction

The plastic case in which the receiver is built has the dimensions given above and originally held antibiotic cough lozenges. Constructional details are given in Fig. 2.

The trimmer terminals must be cut short to allow it to fit into the space allotted and a connection must be soldered from one terminal to the brass ring or washer on the adjustable side. This connection allows the trimmer bush to be used as an aerial terminal. The square Paxolin tagboard on the coil

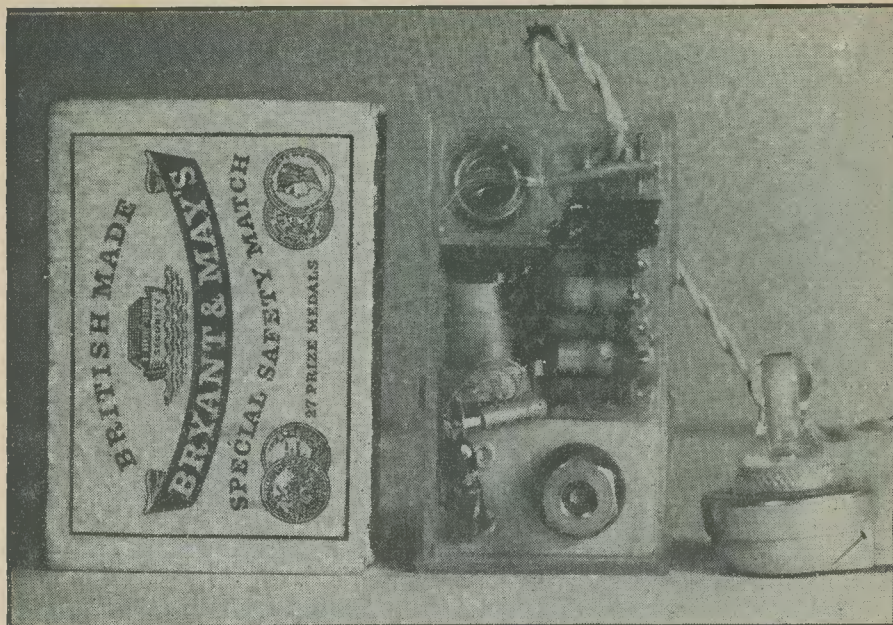


The circuit is based on a design previously issued in *The Radio Constructor*¹, this having been modified to enable the size to be reduced. The design (see Fig. 1) is the acme of simplicity consisting of a tuned circuit L₁, C₁, followed by a crystal diode and three stages of amplification. Power is derived from midget Mallory cells, each cell providing 1.3 volts approximately. There is room in the case for up to three cells, the higher voltage giving greater gain. Unfortunately background hiss rises with increased h.t., therefore a happy medium

must be removed leaving the coil wires "floating" and the ferrite rod pruned down to ½ in to form a snug fit in the case. It should be pointed out that the ferrite rod is very brittle and that it is advisable to provide a foam rubber cushion to prevent any pieces which may fall to the floor from breaking further. L₁, C_T, and the diode are now soldered and may be fitted into the case, further attention then being focused on the sub-chassis.

If all wires are tinned first the amplifier section is fairly simple, the connections then requiring only a touch of the iron. Be warned! The writer failed in this during his

¹ "A Real Miniature", J. M. E. Smith, June 1960.



The completed "5.49" miniature receiver constructed by the author.

first attempt and the result was a sticky little pool of Perspex-encrusted $\frac{1}{2}$ watt resistors. The sub-chassis is cut from thin Perspex or Paxolin and $\frac{1}{8}$ in holes drilled to accommodate the resistors as marked. The $2\mu\text{F}$ condensers are fitted with sleeving over them to prevent shorting—a layer of Sellotape will suffice, this enabling them to be tucked away where space permits.

The transistors are wired last and are soldered directly into the circuit using their own leads, a heat shunt being a necessity. The switch is home made and although a two-way sub-miniature of minute size is commercially available, economy caused the home-brewed switch to gain preference. A small slot in the bottom of the case and a tiny strip of metal cut to shape is quite efficient. A small piece of Sellotape with a hole in the middle is stuck to the bottom

of the battery. When the strip of metal is passed across the Sellotape it arrives at the hole and makes contact.

It will be noted, from the components list, that earphones or a crystal earpiece may be employed with the receiver; and it might be thought that the use of a crystal earpiece would not allow a d.c. circuit to the collector of TR_3 . In practice, however, the crystal earpiece works perfectly on its own and no noticeable improvement is given by shunting it with a resistor.

On test, the receiver gave excellent results on both the Home and Light programmes with an aerial some 2ft 9in long. The two h.t. cells provided 2.6V approximately, these cells lasting about 10–12 weeks using the receiver one hour per day. The set works particularly well on the St. Pancras to St. Albans train journey.

NEXT MONTH . . .

Constructor's Oscilloscope. "Sure-Fire" 2-Metre Transmitter. Phase-Shift Audio Oscillator.

Servicing By Neon

Simple Tests with Low-cost Equipment

By M. D. ROBERTS

THE FOLLOWING TESTS MAY BE MADE WITH the aid of an extremely simple piece of test equipment consisting of a neon bulb in series with a resistor. (See Fig. 1.) The bulb and resistor can be mounted in a simple box, from which the two insulated test leads may protrude.

In his own neon tester the writer employed a standard 200V $\frac{1}{2}$ watt neon manufactured by Cryselco. However, most other neons capable of triggering at 150 volts should cope. The resistor may be a $500\text{k}\Omega$ $\frac{1}{2}$ watt component.

Testing Condensers

Connect the positive lead of the test unit to the h.t. positive rail of the equipment being worked on, and connect the negative lead of the unit to the condenser being checked. The free lead of the condenser should then be connected to chassis.

If a condenser has a value of approximately $0.002\mu\text{F}$ or more, the neon will flash at the instant of connection as the condenser charges. Should the neon remain illuminated or flash intermittently afterwards, the condenser is leaky. Condensers having capacities too low to cause the initial flash may still be tested for leakage, up to $15\text{M}\Omega$ or so, leakage being indicated by steady illumination of the neon.

Should there be no initial flash for con-

densers having values above $0.002\mu\text{F}$ (or the minimum capacity necessary to cause the particular neon employed to strike) such condensers may be considered open-circuit.

The tester cannot be employed with electrolytic condensers as the polarising current will cause a steady illumination in the neon.

Testing Valves for Leakage

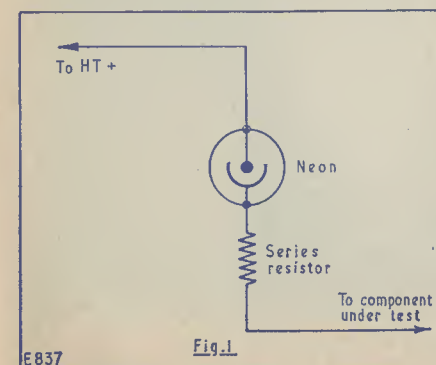
Leakage between electrodes in a valve of up to $15\text{M}\Omega$ may be checked as shown in Fig. 2. The valve should be plugged into a spare holder to whose tags the negative lead from the tester and a test lead from the negative source of h.t. supply are applied. Leakage is indicated by a glow in the neon.

Chassis Isolation

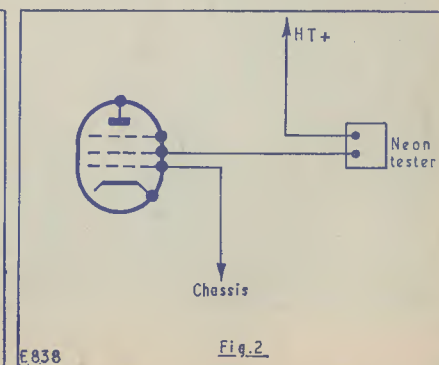
For this test the negative lead of the tester is connected to a reliable earth and the positive lead to the chassis being checked. If the chassis is "live" the neon glows.

Presence of A.C. or D.C.

The presence of a.c. or d.c. voltages above the striking value of the neon are indicated by the fact that it glows when the test unit is coupled to such voltages. The tester may then be employed to trace discontinuities in h.t. supply rails, or in the a.c. circuits of a.c./d.c. receivers.



E837



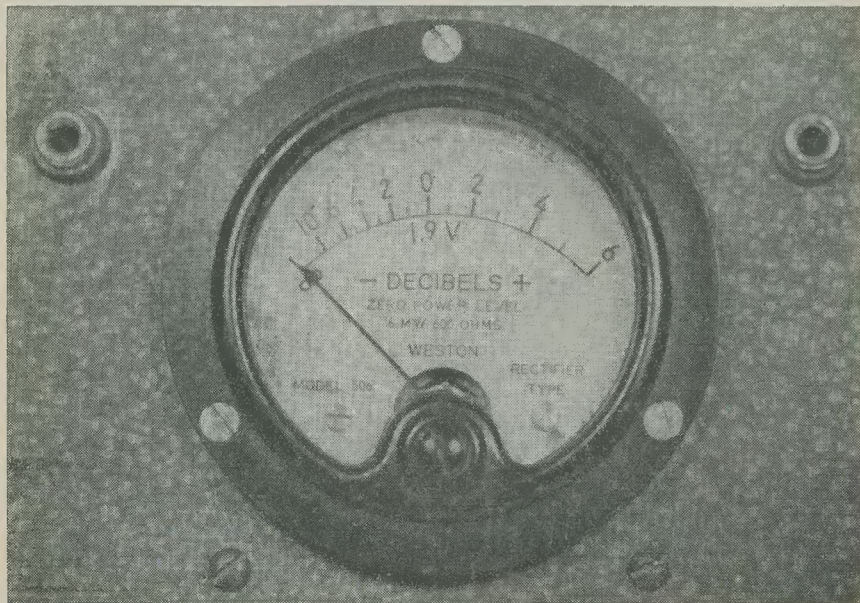
E838

Volume Level Indicators

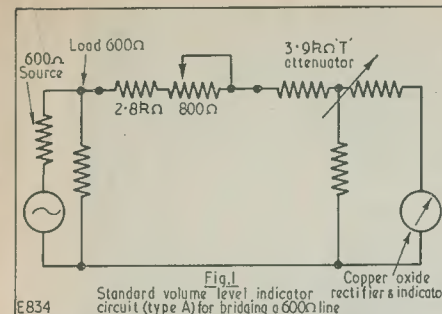
By F. C. JUDD, A.Inst.E.

THE VOLUME LEVEL OF AN AUDIO SIGNAL at any particular point in a broadcasting system is normally measured by means of an instrument called a "Volume Indicator". Such an instrument generally consists of a sensitive high resistance voltmeter of the copper oxide type, an associated "T" type attenuator for extending the range of the meter to higher readings, and a variable resistor which is an accessory for calibrating the instrument. The meter scale is marked in a logarithmic fashion and superimposed on this is a percentage scale. Two types of scales are provided, an "A" type which emphasises the VU (Volume Unit) readings and a "B" type in which the percentage readings are more prominent.

The standard volume indicator as in Fig. 1 utilises a d.c. instrument and copper oxide rectifier. Arranged for bridging across a line it has an impedance of about $7.5k\Omega$ measured with a sine voltage. Of this impedance about $3.6k\Omega$ is provided external to the meter for the purpose of securing the required dynamic characteristics. These characteristics are such that if a 1,000 cycle sine voltage having an amplitude which would give a steady reading of 100 on the voltage scale is suddenly applied, the pointer will reach 99 in 0.3 seconds and then over-swing the 100 mark by at least 1.0% but not more than 1.5%. The frequency response of the instrument must be such that it does not depart from its 1,000 cycle reading by more



Weston unit calibrated between -10 and +6dB



than 0.5dB between 25 and 16,000 c.p.s.

The standard volume indicator is calibrated to read zero VU when it is connected to a 600Ω resistance in which is flowing 1 milli-watt of sine wave power at 1,000 c.p.s. or n VU when the calibrating power is n dB above 1 milli-watt. (See VU meter illustrated herewith.)

Volume Units

The Volume Unit (abbreviated VU) is used to express the level of a complex wave in terms of decibels above or below a reference volume as defined in the previous paragraph. Volume units should never be used to indicate the level of a steady sine wave signal. The latter should always be referred to in terms of dBm.¹

Decibel Meters

A decibel meter is usually a rectifier type of instrument calibrated in decibels with zero dB somewhere near the centre of the scale. (See illustration of Weston unit.) Generally, it is also marked to indicate the reference level and line impedance. Decibel meters are often provided with attenuators to extend the range and are sometimes referred to as "power level" indicators.

Other Types of Audio Level Indicators

The meter is, of course, the commonest

¹ dBm indicates power expressed in decibels with zero dB = 1mW.

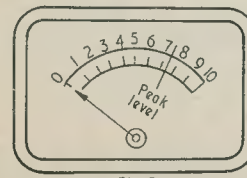
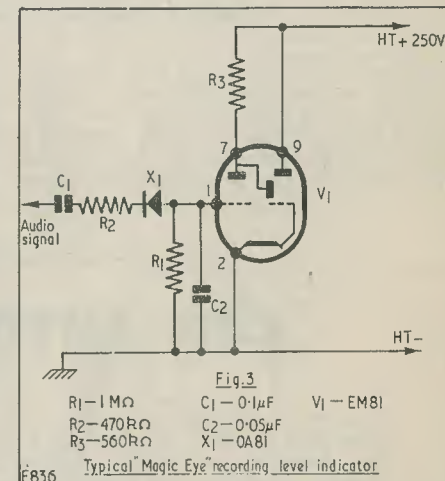


Fig. 2
Peak level indicator as fitted to domestic & semi-professional recorders

type of indicator and many better class tape recorders and recording amplifiers are fitted with them. Studio recorders utilise the calibrated VU meter source since here, accurate indication of power level is required. For domestic and semi-professional equipment a rectifier type meter or a meter operated from a separate valve circuit is sufficiently accurate for most purposes. Such a meter can be calibrated with a mark merely to indicate a maximum recording level. Some are arranged to give instantaneous indication of peaks whilst others employ a time constant in the meter circuit and show an average of the peaks of a complex waveform. Calibration is generally linear from 0 to 10 or some other convenient set of numbers. (See Fig. 2.)

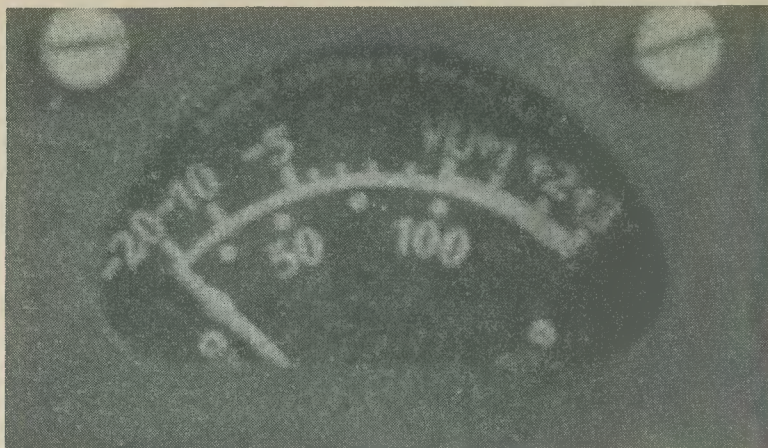
An even simpler type of indicator and one fitted to the majority of domestic recorders is the so-called "Magic Eye" indicator which is in effect a miniature cathode ray tube.



When negative voltage is applied to its grid the "eye" appears to close. The grid of the "Magic Eye" derives its control voltage from the recording amplifier, so that varying signals will cause the "eye" to close by an amount depending on the level of the signals. The "Magic Eye" indicator normally shows instantaneous peak levels only, i.e., it becomes fully closed when a maximum signal is present. A typical "Magic Eye" circuit is given in Fig. 3.

Neon Lamp Indicators

These were fitted to many earlier recorders and are still used on some of the cheaper models of today. A low voltage neon lamp is connected across the output circuit of the



The VU (Volume Unit) Meter referred to in the text

recording amplifier or to an auxiliary amplifier used to boost the audio voltage. Circuitry is so arranged that peak level signals cause the neon to strike; although a time constant is sometimes used in the circuit to show average peaks, whereby the

neon stays alight for longer periods, making it less difficult to ascertain the required level. Two neons are sometimes used, one to indicate an average level and one which glows only when the level is high enough to cause distortion.

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

S.T.C. Communications Rx 3-EL-19N.—D. M. Pratt G3KEP, 30 Lyndale Road, Bingley, Yorks, wishes to obtain a handbook or any circuit information on this receiver.

Ferguson Radio 203U, Advance Signal Generator type C2 Model D.—R. Low, 45 Millar Road, Saltcoats, Ayrshire, Scotland, wishes to obtain circuits or any information relating to the above units.

R1155 Receiver.—R. Holmes, 135 Seaview Road, Wallasey, Cheshire, wishes to obtain, for a relation in N. Borneo, details for conversion of this receiver to mains operation; also addition of an output stage.

RT-7/APN-1 Unit.—Nils Hansson, Box 3017, Gavle 3, Sweden, wishes to obtain conversion details for operation over the 420 Mc/s band.

Halliercrafters S28 Receiver.—A. Wooldridge, 38 Stannard Road, The Avenues, Norwich, would like to borrow or purchase manual or circuit for this receiver.

Ex-R.A.F. Type 13A Oscilloscope.—A. D. Bramall, 57 Fernhurst Road, Wheatley Hills, Doncaster, has tried in vain to obtain a copy of the Air Ministry publication A.P. 2897 AF, Volume I which deals with this equipment. Purchase preferred.

National Senior HRO Receiver.—R. D. Andrews, "Green Acre", Leckhampton Hill, Nr. Cheltenham, Glos, is in urgent need of the handbook for this model W receiver—or any information leading to the procurement of same.

SOME MONTHS AGO THE WRITER WAS ASKED to design and build an inter-com system for an amateur theatre. The problem was to provide the stage manager with a central master station from which he could speak to two dressing rooms, a spotlight control room, and the box office, either individually or in any combination; and to allow any of these slave stations to call the stage manager at any time. All unwanted stations were to be cut out of circuit when the stage manager was talking to any selected station or combination of selected stations. The need for economy was inevitable and, as two of the slave stations were at the remote end of the building, wiring between positions had to be kept as simple as possible.

Master Switching

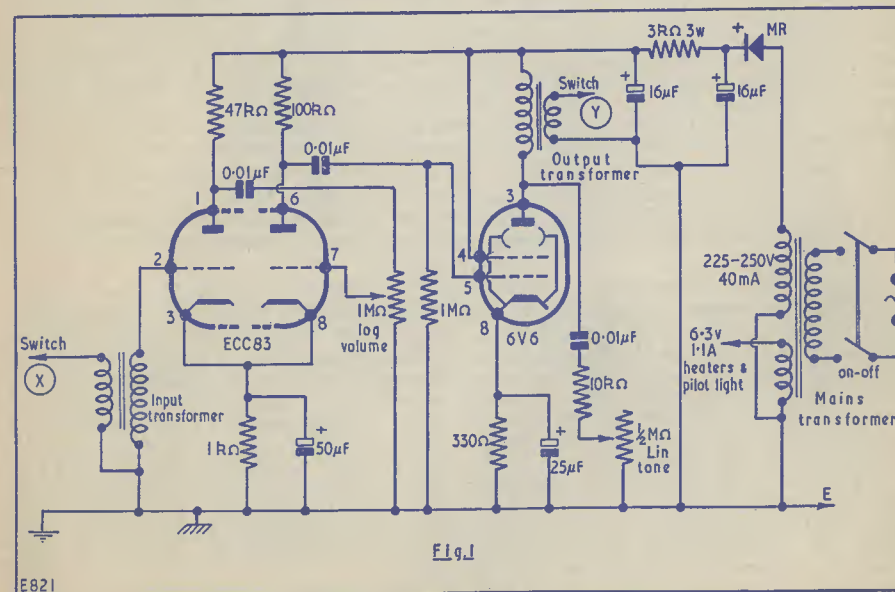
The need for economy and simple wiring was met by keeping all the switching at the master position, each extension simply consisting of a five inch speaker, mounted on a small baffle, which also acted as a microphone. The switching is so arranged that all four slave positions are permanently connected for speech. Thus anyone at any slave station can immediately call the stage manager merely by speaking into the microphone/loudspeaker and identifying itself. The stage manager then moves the talk/listen switch for the appropriate extension to "talk" and can reply instantly. This

A Simple Inter-com System

by P. R. TRAVERS

method of operation avoids any need for a signalling system or for switches at the remote extensions, and it is only necessary to run a twisted pair of leads to each station. Microphone and output transformers are built into the amplifier so that all external leads are at low impedance and, despite long cable runs (25 yds to the two remote station) hum has not been troublesome.¹ If the stage

¹ It would be advisable to keep the extension leads well clear of any unscreened mains wiring. If hum should occur, despite this precaution, its effect could be reduced by lowering the value of either or both of the 0.01μF coupling condensers in the amplifier. Such a reduction in value, provided it is not too great, should not seriously affect speech volume or intelligibility.—Ed.



The circuit of the inter-com amplifier

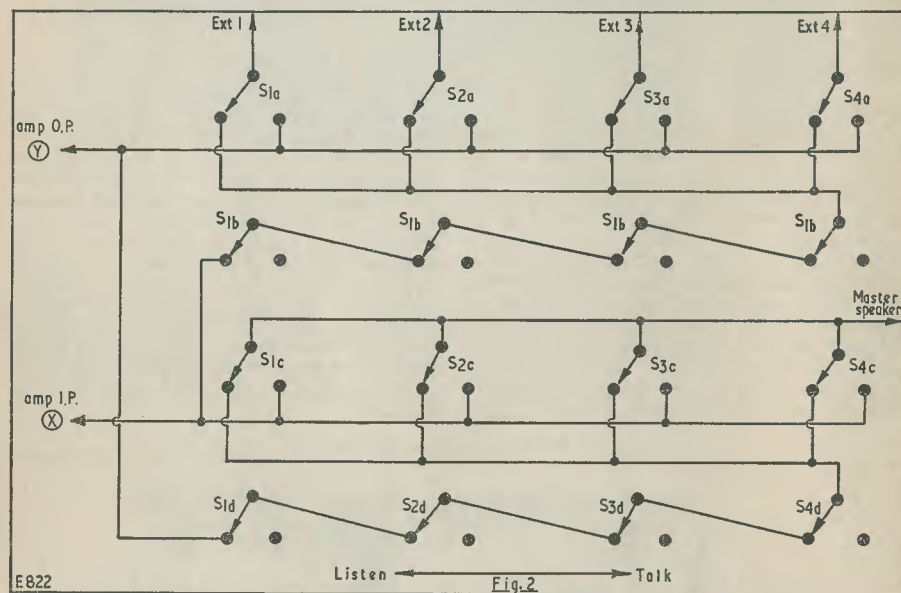
manager wishes to initiate a call he has only to move the switch of the required extension or extensions to "talk" and call up. He then returns the switch to the "listen" position and waits for a reply. Spring loaded switches biased to remain in the "listen" position would be ideal, but as simple four-pole changeover switches were to hand these were used.

The Amplifier

The amplifier is a very simple affair and could be built to any suitable circuit. In fact two voltage amplifier stages were used with

station had to be switched from "listen" to "talk". After much thought and the use of considerable quantities of scrap paper in making diagrams, the system shown in Fig. 2 was tried and has proved completely satisfactory. It also allows further extensions to be added (there are two more dressing rooms that are used occasionally) merely by adding further four-pole changeover switches for each fresh extension.

The "a" contacts switch the extension speakers from "talk" to "listen"; the "b" contacts break the circuit to the remaining speakers, thus ensuring privacy; the "c"



The talk/listen switching installed at the amplifier. All switches with the same suffix number are ganged. Thus, S_{1(a)}, S_{1(b)}, S_{1(c)} and S_{1(d)} form a four-pole two-way switch. Not shown in the diagram are earth leads (coupled to the amplifier chassis) which provide the remaining connection to all extension speakers and the master speaker

a single beam tetrode output. The circuit used is shown in Fig. 1. No originality is claimed for the circuit which was built up from available components. Both the input and output transformers are standard pentode output transformers and are mounted on the amplifier chassis so that all external leads are at low impedance.

The only complicated part of the apparatus was the switching system and this had to allow any one extension to be switched from "talk" to "listen" whilst the remaining extensions were cut out of circuit, or to allow two or more extensions to be switched simultaneously. At the same time the master

contacts switch the master speaker from "listen" to "talk"; whilst the "d" contacts break the circuit from the master speaker to the amplifier output. Extensions can be switched individually or two or three at a time. The four switches are mounted on the main amplifier cabinet near the master speaker and a multiple terminal block is fitted to the back of the cabinet for the extension speaker leads. It should be noted that the switch diagram shows only the signal leads; each speaker also requires an earth lead.

The complete system has proved to be flexible and reliable.

Book Reviews

THE MORSE CODE FOR RADIO AMATEURS. Second Edition. By Margaret Mills, G3ACC. 24 pages, 7½ in x 9½ in. Published by the Radio Society of Great Britain. Price 1s. 6d. net.

From time to time one hears the suggestion that radio communication, by means of the morse code, is on the way out. Such comment is quite unjustified by the facts, this being pointed out in the foreword to this book.

The method advocated by the author for acquiring a working knowledge of the morse code is that of presenting a number of exercises which, if followed through in sequence, will bring the learner steadily to a reasonable standard of proficiency. Other useful advice is included, a circuit of a suitable code oscillator being of great value.

The *Morse Code for Radio Amateurs* is available direct from R.S.G.B. Bookshop, 30 Little Russell Street, London, W.C.1.

LEARNING MORSE. Thirteenth Edition. By H. F. Smith. 20 pages, 7½ in x 4½ in. Published for Wireless World by Iliffe Books Ltd. Price 1s. 6d. net (1s. 10d. by post).

This useful booklet, written by H. F. Smith—formerly editor of *Wireless World*—contains some excellent illustrations showing how to hold the morse key correctly and there is also some good advice on the technique of keying. A circuit and constructional details of a transistorised morse practice oscillator add to the interest of this publication. The "Q" Code is set out in some detail and there are numbers of code practice groups given with some specially devised rhythmic groups for practice purposes. This should prove a very useful little publication for those wishing to master the art of morse code telegraphic communication.

THE RADIO AMATEUR'S HANDBOOK. 38th Edition. 6½ in x 9½ in. Published by the American Radio Relay League. Price in U.K., 32s. 6d. net.

It is with pleasure that we review once again a further edition of this "standard manual of amateur radio communication"—to quote from the front cover. For those who already have several of the past editions on their bookshelves, this latest edition will bring them right up to date with the latest trends in amateur radio. Much new material has been added to the existing chapters, notably those dealing with H.F. Transmitters and Keying and Break-in. A design for a Self-contained All-Band Electronic T.R. Switch has been added and an A.M. Modulation Meter incorporating two magic-eye tubes caught the writer's attention. A Crystal Controlled Converter for 1,296 Mc/s is an addition to the VHF Receiver section and a V.T.V.M. R.F. Probe Unit has been included in the Measurements chapter. A new Monimatch unit is also described.

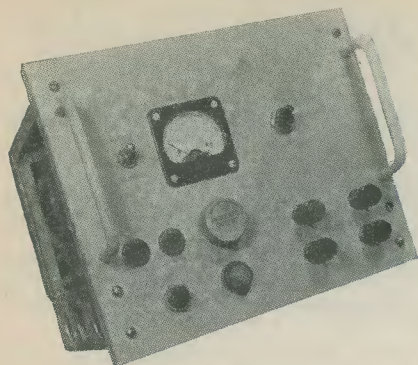
Newcomers to amateur radio are advised to look upon this publication as an essential part of their library, the fact that it is now in the 38th edition speaking for itself.

HIGH FIDELITY SOUND ENGINEERING. By Norman H. Crowhurst. 328 pages, 5½ in x 8½ in. Published by George Newnes Ltd. Price 50s. net.

Norman H. Crowhurst is extremely well known on both sides of the Atlantic by reason of his authoritative articles and books on high fidelity engineering. In this book Mr. Crowhurst covers all aspects of the subject with a style which is very clear and economic. The book is well illustrated.

Aspects covered range from the basic requirements of amplifying systems to oscillators, sound generators and test equipment. The approach is at all times that of an engineer who is fully conversant, both in theory and in practical experience, with his subject. The book discusses transistor applications as well as valve circuits, and it assumes a knowledge of fundamental electronics only. Mathematical discussions are not included in the main text but are gathered together in a separate section at the end of the book.

We would recommend *High Fidelity Sound Engineering* to the audio enthusiast, not only as a publication which may be read for its interest alone but also as a textbook capable of being a source of long-term reference.



A VARIABLE VOLTAGE POWER UNIT

by H. S. THORPE

A POWER UNIT WAS REQUIRED TO supply an output voltage between approximately 50 and 300 volts at 50mA for experimental work on radio control equipment. The power unit described in this article will meet these requirements, giving an output voltage variable from 40 to 300 volts at 50mA. If desired, the

unit can be modified for a higher output current, this being limited only by the transformer and rectifier ratings, and by the maximum dissipation (anode + screen) of the series valve or valves.

The Circuit

The complete circuit diagram is shown

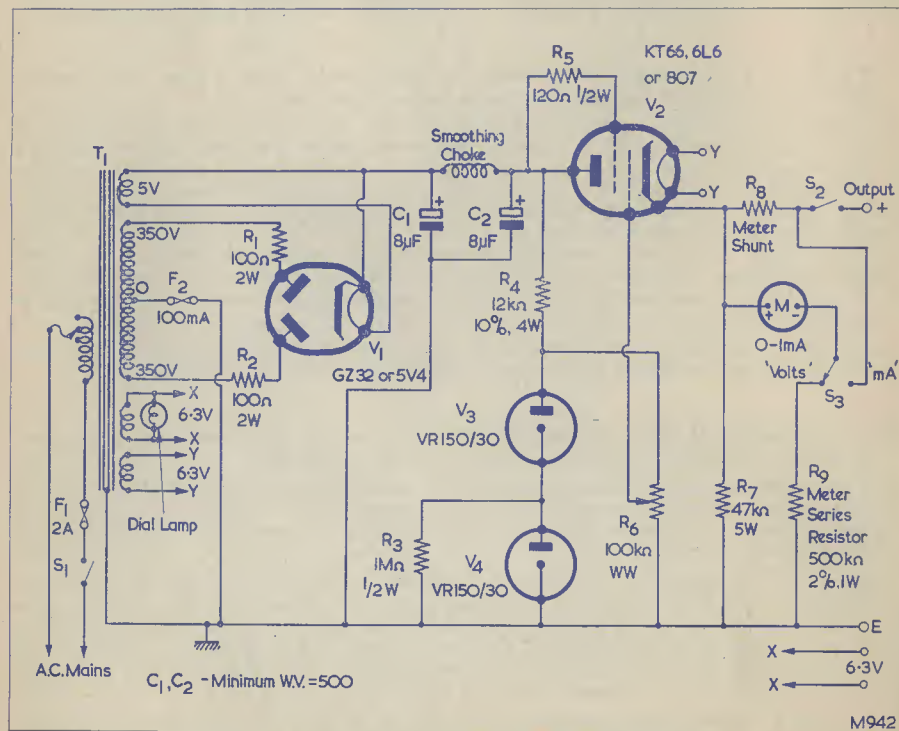


Fig. 1. The circuit of the power unit

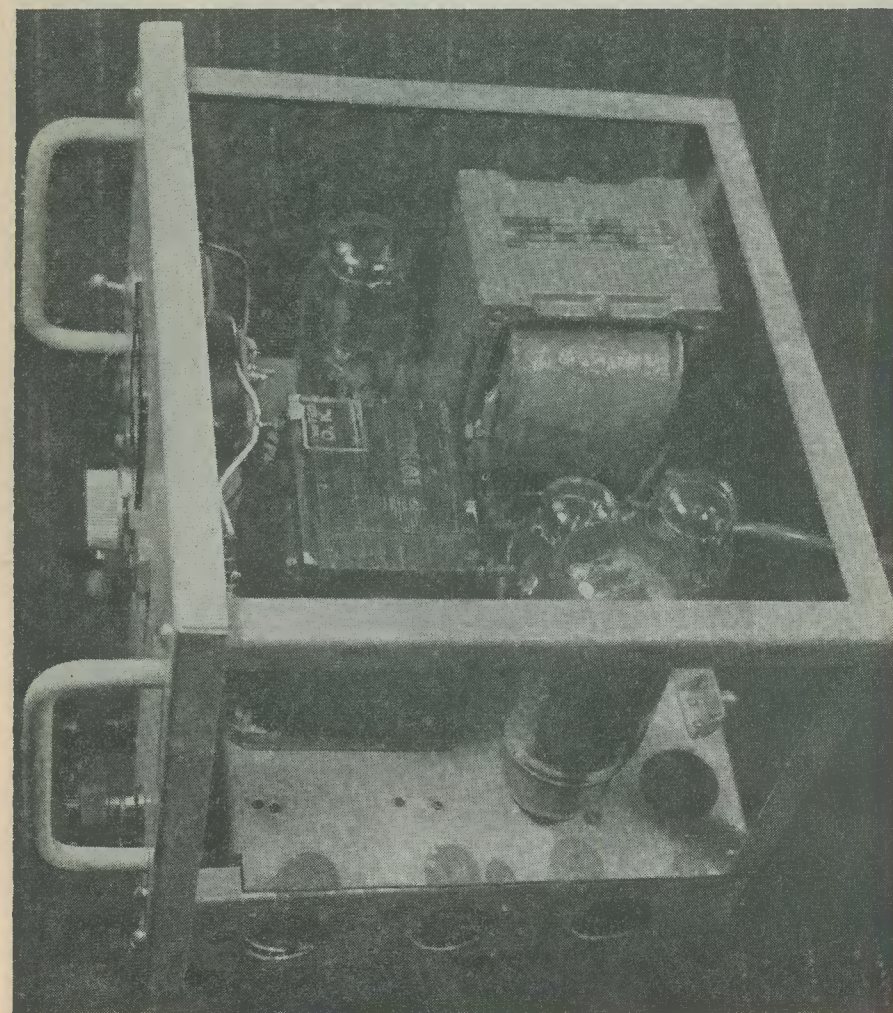
in Fig. 1, a normal condenser input filter being used. The condensers can be electrolytic or paper, having a working voltage at least as high, and preferably somewhat higher, than the peak voltage rating of the transformer secondary. In this case, where the transformer secondary delivers 350 volts each side of the centre-tap, the minimum safe condenser rating is 350×1.41 or 493 volts. 500 w.v., or preferably 600 w.v., condensers should, therefore, be used.

The rectifier valve V_1 can be of any type to suit the transformer used. It should, preferably, be an indirectly heated type.

Suitable rectifiers are the 5V4 or GZ32.

The smoothing choke employed should have a minimum current rating of 75mA. That employed in the writer's unit had a d.c. resistance of approximately 100Ω.

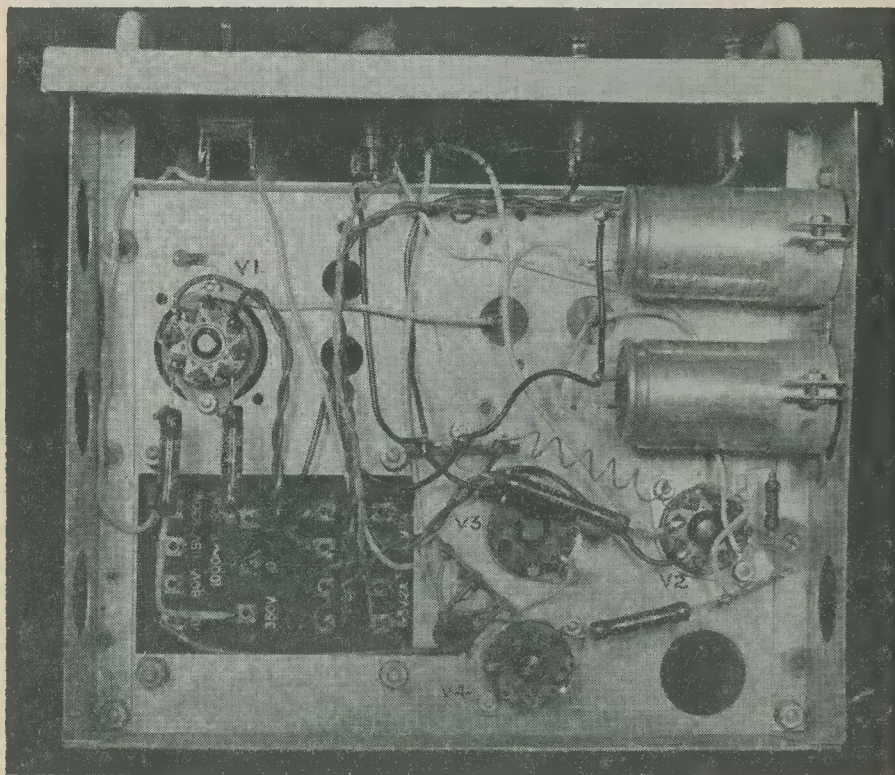
The series valve, or valves, can be a high current rated type such as the KT66, 6L6 or 807. Only one is shown in Fig. 1, but if an output current greater than 50mA is required (and the transformer and rectifier can supply it) further valves can be paralled with V_2 , each screen grid being fed via its own 120Ω resistor. Valve base connections are shown in Fig. 2.



Top view of the unit

The grid voltage of the series valve V_2 is supplied from a $100k\Omega$ wire-wound potentiometer which is connected across the 300 volts provided by the two VR150/30 regulator valves V_3 and V_4 . These regulator valves are connected, in series with a limiting resistor, across the voltage available at the filter output. This voltage must be higher than the striking potential of the regulators in series, the striking potential being some 25% higher than the operating potential. The stabiliser load, in this case the $100k\Omega$ potentiometer, is connected in parallel

was 460 volts, with the result that the series resistor should be capable of dropping 160 volts (460 minus the 300 volts developed across the two regulators) at 13mA. These figures give a calculated value for the series resistance of $12,300\Omega$ with a dissipation of 2.08W; and the nearest 10% preferred value of $12k\Omega$, with a wattage rating of 4W, was employed in the unit. Under fully loaded conditions, the filter output voltage is 420, and under minimum load conditions it is 500 volts. These output voltages cause currents of 10 and 16.6mA



Showing the components mounted below the chassis

with the valves. The maximum and minimum currents quoted for the VR150/30 are 40 and 5mA respectively; and a suitable stabilising current, when the filter output voltage is in the centre of its range, would be 10mA. This, plus the 3mA which flows through the $100k\Omega$ potentiometer, causes the current which flows through the series resistor R_4 to be 13mA. In the prototype, the centre of the filter output voltage range

respectively to flow through the series resistor. Thus, under all conditions, the regulator current is well within its maximum and minimum operating limits.

The function of the $1M\Omega$ resistor R_3 , connected across the lower stabiliser, is that of increasing striking efficiency.

The meter circuit shown in Fig. 1 is relatively self-explanatory. When S_3 is switched to "Volts", R_9 is connected in

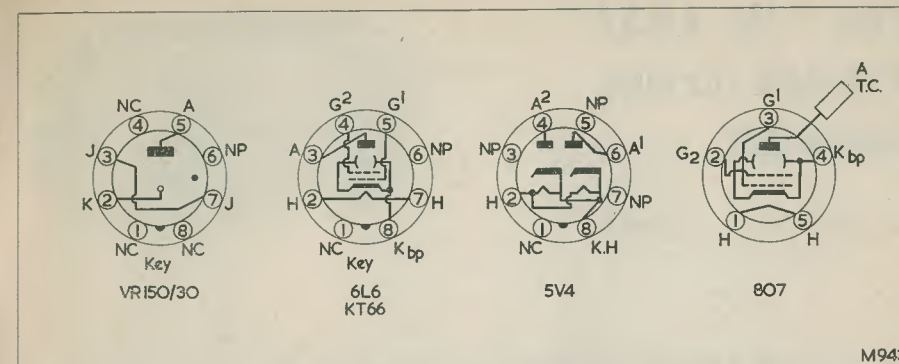


Fig. 2. Base connections for the valves referred to in the text. The GZ32 has a single cathode, but its pin functions are the same as for the 5V4. Apart from the 807, which has a five pin UX base, all valves are octal types

series with the meter, thereby causing it to indicate the output voltage provided by the unit. The $500k\Omega$ figure specified in the diagram for R_9 causes the meter to read 500 volts at full-scale deflection. A value for the shunt resistance R_8 is not specified, as this will depend upon the resistance of the meter. R_8 may be calculated from the following:

$$R \text{ (Shunt)} = \frac{R_m}{N-1}$$

Where R_m is the internal resistance of the meter and N the ratio of the currents for full-scale deflection. If the 0-1mA meter of Fig. 1 has an internal resistance of 60Ω and it is intended to cause it to read 50mA f.s.d., then

$$R \text{ (Shunt)} = \frac{60}{50-1} = 1.224\Omega$$

It is, of course, possible to employ meters

having full-scale deflections other than 1mA provided that the f.s.d. current is not excessive. With such meters alternative values for R_9 will be required.

Construction

The front panel layout is shown herewith. Panel-Signs could be used to advantage on this equipment.

The underside of the chassis is shown herewith. It will be noticed that the rectifier valve is kept away from V_3 and V_4 , and that the wire-wound resistors are supported in the wiring. As the mains transformer used was surplus, it was necessary to use an available 7 volt winding for the series valve V_2 , and drop the voltage to 6.3 volts. The spiral of resistance wire used for this purpose is clearly visible.

A further illustration shows the layout of the chassis deck, the rectifier being next to the mains transformer, the two VR150/30 regulators being away from the main source of heat.

NEW MULLARD EDUCATIONAL FILMSTRIP "The History of Television"

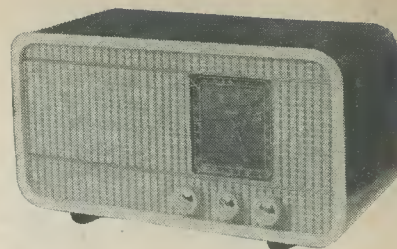
A new filmstrip, "The History of Television", has been added to the range of colour filmstrips introduced by the Mullard Educational Service. It is complementary to an earlier release "The History of Radio", and deals with the history of picture transmission from the middle nineteenth century to the present, explaining fundamental principles showing the significance of technical developments.

Its simple approach makes this filmstrip suitable for use in Secondary Modern Schools, and the lower forms in Grammar Schools; or in senior classes where science is taught as a general knowledge subject, rather than one for examination.

The filmstrip comprises 28 frames and is immediately available from the distributors, Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, Victoria Street, London, S.W.1., price 25/- a copy including comprehensive teaching notes.

The "DE LUXE" Printed Circuit Superhet

Described by E. GOVIER



THE "DE LUXE" PRINTED CIRCUIT SUPERHET receiver, about to be described, has been especially designed and developed for construction by the home hobbyist. Constructed around a TCC printed circuit board and the latest type miniature valves, it features simplicity in construction, high sensitivity and reliability, and pre-aligned i.f. transformers. Intended for use on a.c. mains 200-250V supply, the design includes three valves, one germanium diode and a contact cooled selenium rectifier unit. It also features a built-in dual wave ferrite rod aerial which provides two advantages—discrimination against interference due to its high Q and directional properties, and portability because of the elimination of external aerial and earth connections.

Circuit

From Fig. 1 it will be seen that three valves, ECH81 triode heptode frequency changer (V_1), EF85 variable-mu pentode intermediate frequency stage (V_2), and ECL80 triode pentode, first audio and output stage (V_3), are included. A germanium diode provides detection and a.g.c.

L_1, L_2 the dual wave ferrite rod assembly is tuned by C_1 (500pF) and trimmers C_3, C_4 (40pF), signals are then fed to the control grid of V_1 (ECH81) via C_5 (100pF), R_1 (100k Ω) providing the grid return to the a.g.c. line. R_2 (33k Ω) drops the h.t. voltage to the screen grid with C_6 (0.05 μ F) providing decoupling. R_3 (220 Ω), decoupled by C_8 (0.05 μ F), together provide cathode bias. The grid leak for the oscillator section is R_4

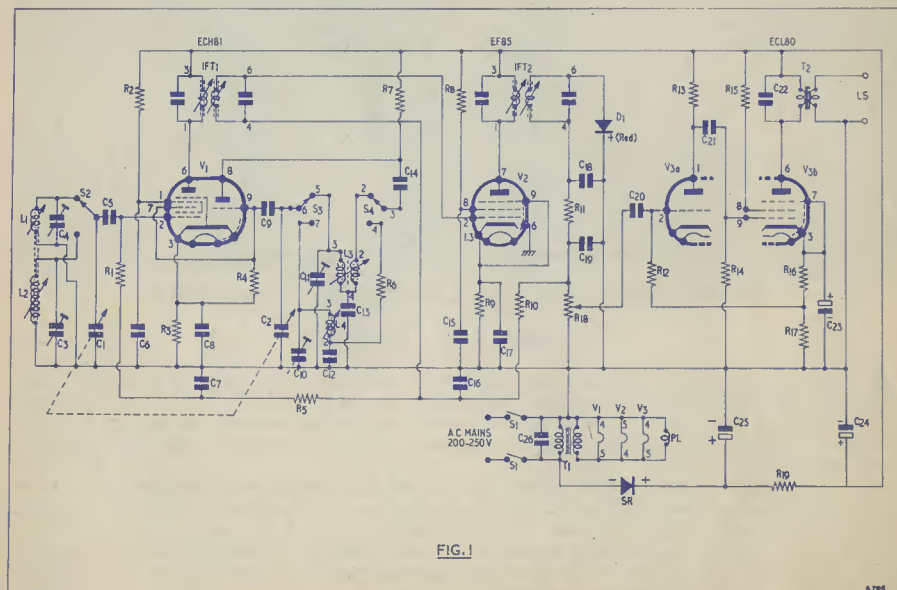


FIG. 1

Components List

Resistors

R ₁	100k Ω $\frac{1}{2}$ watt
R ₂	33k Ω $\frac{1}{2}$ watt
R ₃	220 Ω $\frac{1}{2}$ watt
R ₄	47k Ω $\frac{1}{2}$ watt
R ₅	100k Ω $\frac{1}{2}$ watt
R ₆	5.6k Ω $\frac{1}{2}$ watt
R ₇	33k Ω $\frac{1}{2}$ watt
R ₈	68k Ω $\frac{1}{2}$ watt
R ₉	680 Ω $\frac{1}{2}$ watt
R ₁₀	2.2M Ω $\frac{1}{2}$ watt
R ₁₁	47k Ω $\frac{1}{2}$ watt
R ₁₂	470k Ω $\frac{1}{2}$ watt
R ₁₃	220k Ω $\frac{1}{2}$ watt
R ₁₄	470k Ω $\frac{1}{2}$ watt
R ₁₅	1k Ω $\frac{1}{2}$ watt
R ₁₆	220 Ω $\frac{1}{2}$ watt
R ₁₇	220 Ω $\frac{1}{2}$ watt
R ₁₈	500k Ω potentiometer with switch
R ₁₉	1k Ω 5 watt wirewound

Valves

V ₁	ECH81
V ₂	EF85
V _{3a,b}	ECL80

Output Transformer

T ₂	11k Ω -3 Ω (Clyne Radio Ltd.)
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Miscellaneous

4-pole, 2-way wavechange switch
Germanium diode
3 Ω speaker
IFT ₁ , IFT ₂ 472 kc/s (Clyne Radio Ltd.)
Printed circuit board (Clyne Radio Ltd.)
Cabinet, knobs (Clyne Radio Ltd.)
Power unit chassis (Clyne Radio Ltd.)
Nuts, bolts, wire, etc. (Clyne Radio Ltd.)

Condensers

C ₁	500pF variable
C ₂	500pF variable
C ₃	40pF trimmer
C ₄	40pF trimmer
C ₅	100pF, ceramic, 20%
C ₆	0.05 μ F, paper, 350 w.v.
C ₇	0.05 μ F, paper, 350 w.v.
C ₈	0.05 μ F, paper, 350 w.v.
C ₉	100pF, ceramic, 20%
C ₁₀	40pF trimmer
C ₁₁	100pF trimmer
C ₁₂	150pF, ceramic, 20%
C ₁₃	470pF, silver mica, 20%
C ₁₄	100pF, ceramic, 20%
C ₁₅	0.05 μ F, paper, 350 w.v.
C ₁₆	0.05 μ F, paper, 350 w.v.
C ₁₇	0.05 μ F, paper, 350 w.v.
C ₁₈	100pF, ceramic, 20%
C ₁₉	100pF, ceramic, 20%
C ₂₀	0.005 μ F, paper, 350 w.v.
C ₂₁	0.005 μ F, paper, 350 w.v.
C ₂₂	0.001 μ F, paper, 250 w.v.
C ₂₃	250 μ F, electrolytic, 12 w.v.
C ₂₄	32 μ F, electrolytic, 275 w.v.
C ₂₅	32 μ F, electrolytic, 275 w.v.
C ₂₆	0.01 μ F, paper, 500 w.v.

Selenium Rectifier

250V, 50mA

Coils

L _{1, L₂}	Ferrite assembly (Clyne Radio Ltd.)
L _{3, L₄}	(Clyne Radio Ltd.)

Mains Transformer

T ₁	6.3V at 1.5A (Clyne Radio Ltd.)
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(47k Ω), the lower end of which is returned directly to cathode. C_9 (100pF), the oscillator grid coupling condenser, feeds the oscillator voltage to the triode grid (pin 9). Due to the grid current action via R_4 , automatic bias results thus providing optimum oscillator voltage. The oscillator tuning condenser is C_2 (500pF).

S_3, S_4 , which are ganged with S_2 , select the appropriate coil for either Medium or Long wave operation, L_3 (Medium wave) and L_4 (Long wave) are the oscillator coils whilst C_{11} (100pF) and C_{10} (40pF) are the trimmers. The Medium wave tracking or padding condenser is C_{13} (470pF) whilst that for the

Long wave is C_{12} (150pF). The resistor R_6 (5.6k Ω) is the oscillator limiting resistor on the Long wave position. C_7, C_{16} (0.05 μ F), R_5 (100k Ω), R_{10} (2.2M Ω) respectively are the a.g.c. line decoupling components.

The intermediate frequency signal, appearing at the anode of V_1 (pin 6), is selected by the i.f. transformer (IFT₁) primary winding, this being tuned to 472 kc/s. The tuned secondary winding of this transformer feeds the i.f. signal to the control grid of V_2 (EF85). The lower end of this winding connects with the a.g.c. line in order to provide control of gain.

The resistor R_8 (68k Ω) functions as an h.t.

dropping resistor to the screen grid of the i.f. stage (V_2) and is decoupled by C_{15} ($0.05\mu\text{F}$). Fixed bias is supplied by R_9 (680Ω), this being decoupled by C_{17} ($0.05\mu\text{F}$). Amplified i.f. signals appearing at the anode (pin 7) of V_2 are fed to the tuned primary winding of IFT_2 .

Signals from the secondary winding of IFT_2 are then fed directly to the germanium diode (D_1) which provides detection and the a.g.c. voltage. The necessary i.f. filtering is provided by C_{18}, C_{19} (100pF), and R_{11} ($47\text{k}\Omega$). The volume control R_{18} ($500\text{k}\Omega$) forms part of the diode load across which the detected audio signal appears. R_{10} ($2.2\text{M}\Omega$) is part of the a.g.c. filter network which prevents audio and i.f. signals being fed back to the i.f. or frequency changer stages. Only the d.c. component exists on the a.g.c. line.

Audio signals to the control grid of V_{3a} (pin 2) are fed via C_{20} ($0.005\mu\text{F}$), this condenser preventing the d.c. component that exists across R_{18} from biasing V_{3a} . The grid leak R_{12} ($470\text{k}\Omega$) is returned to the junction of R_{16}, R_{17} (220Ω).

Amplified audio signals at the anode (pin 1) of V_{3a} appear across the load resistor R_{13} ($220\text{k}\Omega$) and are fed, via C_{21} ($0.005\mu\text{F}$), to the control grid (pin 9) of V_{3b} . In this instance, the grid leak R_{14} ($470\text{k}\Omega$) is taken to chassis and therefore the full bias developed across the cathode resistors R_{16} and

R_{17} (220Ω) is applied to the control grid. C_{23} ($250\mu\text{F}$ electrolytic) provides adequate decoupling in the cathode circuit. R_{15} ($1\text{k}\Omega$) is the screen grid limiting resistor.

The output transformer T_2 provides the correct matching between the output stage and the speaker, C_{22} ($0.001\mu\text{F}$) being included for tone correction purposes. The main h.t. line smoothing components are C_{24} and C_{25} ($32\mu\text{F} + 32\mu\text{F}$) and R_{19} ($1\text{k}\Omega$).

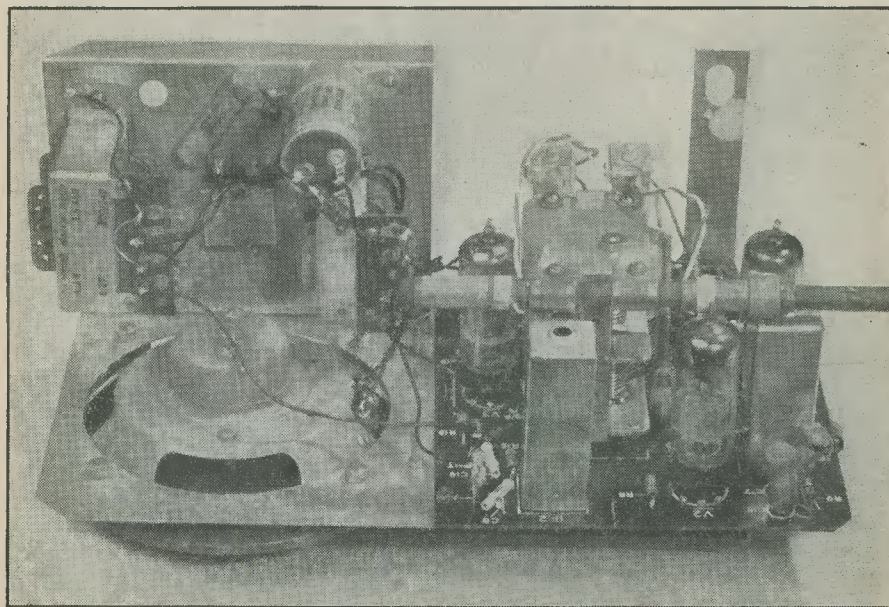
A contact cooled selenium rectifier unit (SR) provides half-wave rectification of the applied mains voltage. The heater transformer T_1 supplies the current to the valve heaters and the pilot bulb. C_{26} ($0.01\mu\text{F}$) is the anti-modulation hum condenser. A double-pole mains switch, S_1, S_2 , completely isolates the chassis from the a.c. mains supply when switched to the off position.

Assembly

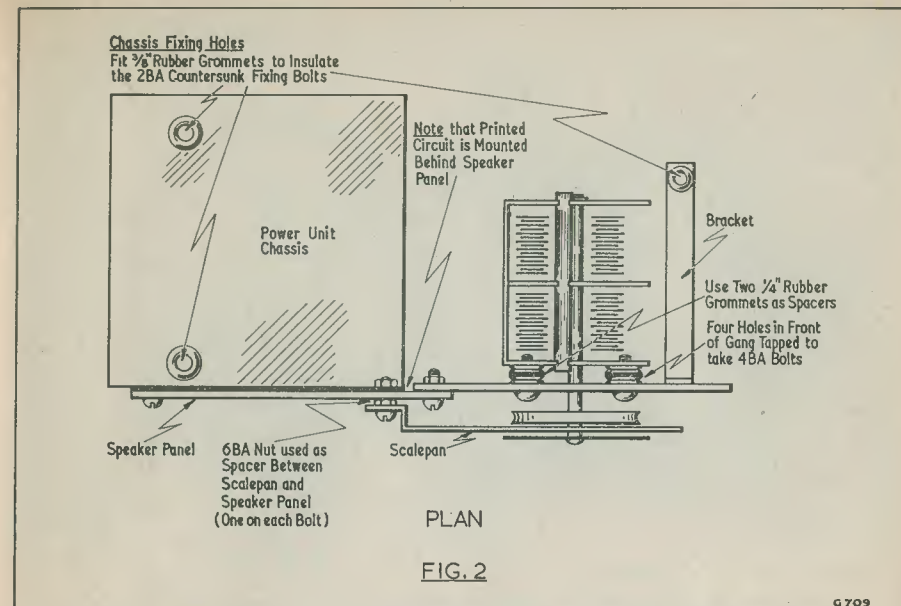
Commence with the printed circuit board. All components are fitted from the printed white side, the printing being classified as the "legend". All wire lead-outs should be cleaned if necessary, pushed through the appropriate holes and then soldered on the copper side, any excess wire then being cut off. For beginner readers, the colour code of the resistors is given within the brackets.

Assemble in the following order:

1. Looking at the printed side of the board, mount the three valveholders. Push



Showing clearly the power unit chassis on the right and the method of mounting the ferrite rod aerial assembly



firmly through the board and solder all connections including the centre spigots. It may be necessary to bend the valveholder pins outwards slightly in order to align them with the punched holes in the printed circuit board.

2. Starting at the top of the board, fit R_9 (680Ω blue, grey, brown). C_{15} and C_{17} ($0.05\mu\text{F}$) should both be mounted in a vertical position, these condensers having one end marked by a ring—this end is fitted to the earth of the printed circuit.

3. Fit R_8 ($68\text{k}\Omega$ blue, grey, orange) and C_{18} (100pF ceramic).

4. Next, solder into position the germanium diode D_1 , the red end being in the position indicated in Fig. 1.

5. Connect into circuit R_{11} ($47\text{k}\Omega$ yellow, violet, orange) and C_{19} (100pF ceramic).

6. Deal next with R_{15} ($1\text{k}\Omega$ brown, black, red) and R_{13} ($220\text{k}\Omega$ red, red, yellow).

7. On the left-hand side of the board, adjacent to IFT_1 , mount and solder into position R_{10} ($2.2\text{M}\Omega$ red, red, green) R_1 and R_5 ($100\text{k}\Omega$ brown, black, yellow).

8. Connect into circuit C_6, C_7 and C_{16} ($0.05\mu\text{F}$); both C_6 and C_{16} being mounted in the vertical position.

9. Fit both R_2 and R_7 ($33\text{k}\Omega$ orange, orange, orange).

10. Having proceeded thus far, deal next with C_5 (100pF ceramic).

11. Trim the leads of C_{12} (150pF) to about $\frac{3}{16}$ in in length, fit sleeving on each lead and then solder into position.

12. Mount and solder C_8 ($0.05\mu\text{F}$) in the vertical position.

13. Connect into circuit the two resistors R_3 (220Ω red, red, brown) and R_4 ($47\text{k}\Omega$ yellow, violet, orange).

14. Solder into circuit the condenser C_{14} (100pF).

15. The legend "lead" is marked twice on the printed circuit board adjacent to the wavechange switch. Wire covered with sleeving is next fitted, in both instances, between the points so indicated.

16. Fit and solder C_9 (100pF).

17. Deal next with the resistor R_6 ($5.6\text{k}\Omega$ green, blue, red) and the condenser C_{13} (470pF silver mica).

18. Connect into circuit the two resistors R_{16} and R_{17} (220Ω red, red, brown).

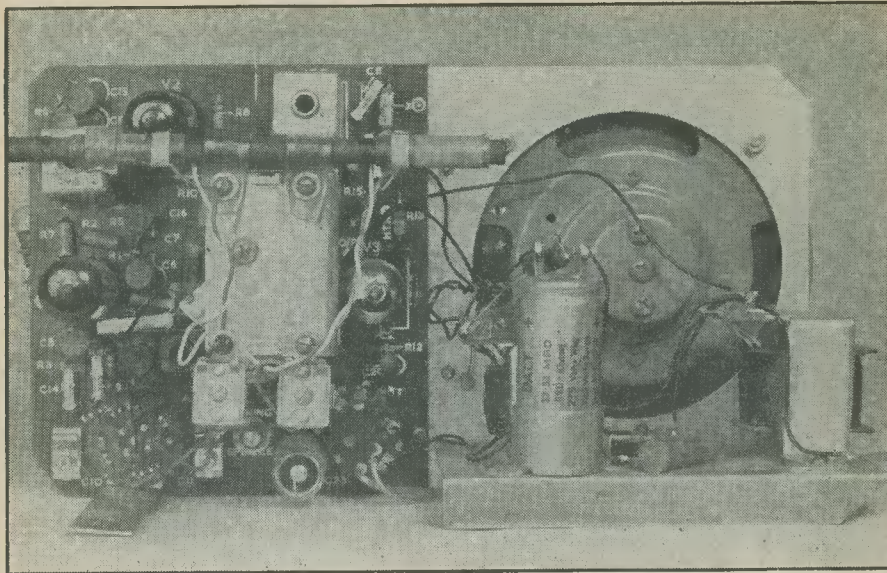
19. Obtain R_{14} ($470\text{k}\Omega$ yellow, violet, yellow) and solder into position.

20. Connect into position C_{21} ($0.005\mu\text{F}$) and R_{12} ($470\text{k}\Omega$ yellow, violet, yellow), also C_{20} ($0.005\mu\text{F}$).

21. The drive spindle should now be fitted where indicated on the board with the spindle and fixing nut on the copper side of the board. Tighten the nut securely.

22. Using sleeving, fit "lead" adjacent to V_3 valveholder as marked on the board.

23. Mount C_{10} (40pF) and C_{11} (100pF) printed circuit trimmers. The difference between these two trimmers can be recognised by the fact that C_{11} has an extra copper plate, whereas C_{10} is fitted with all brass plates.



Rear view of the receiver showing the output transformer and power stage on the right and the printed circuit board on the left. Note particularly the method of mounting the various condensers—the “legend” designations being clearly visible

24. Adjacent to these two trimmers and the wavechange switch (see Fig. 5) are the numbers 2, 3, 4, 5, 6 and 7 marked on the printed circuit board. Tinned copper wires each about 2 in in length, are now fitted in each of these holes for connection to the wavechange switch, this being fitted in the

next operation. Sleeving should be fitted over these wires before finally soldering to the wavechange switch.

25. The “bracket”, as shown in both the plan and side views of the chassis, (see Figs. 2 and 3) is now fitted between the wavechange switch and the printed circuit board.

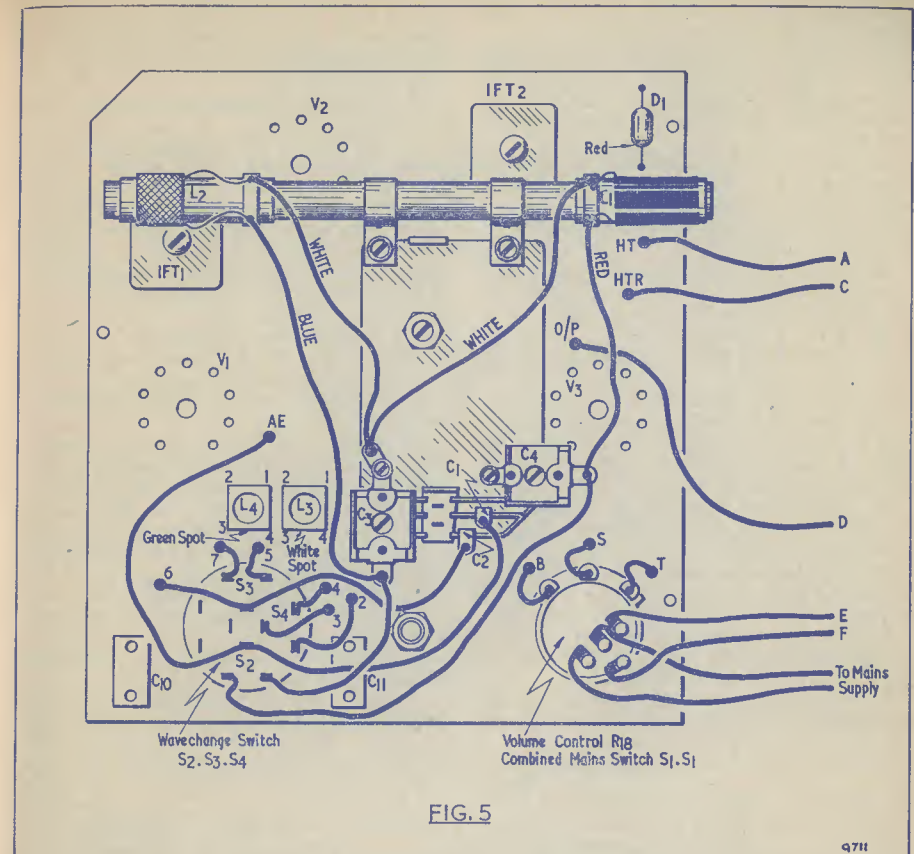


FIG. 5

Q711

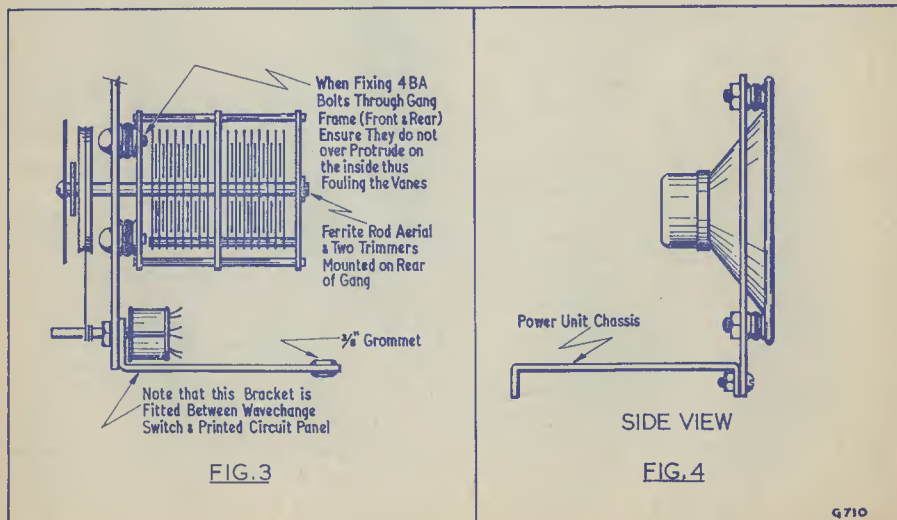


FIG. 3

SIDE VIEW

FIG. 4

Q710

Remove nuts and washers from the wavechange switch spindle. Replace one nut, securing it fully home, then fit the bracket over its bush and insert the wavechange switch through the printed circuit board. Fit a washer and nut and tighten securely. The extra nut is fitted in order to space the wavechange switch away from the board. Ensure that no components come into contact with the switch.

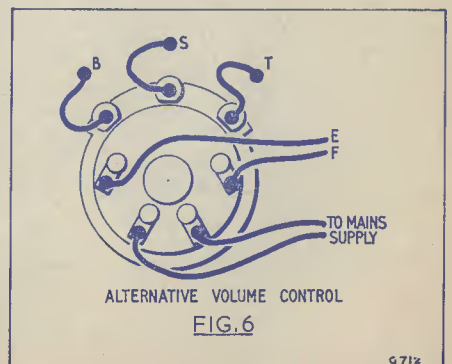
26. Connect points 2, 3, 4, 5, 6 and 7 to the wavechange switch as shown in Fig. 5.

27. A $\frac{1}{2}$ in rubber grommet is now fitted to the rear hole in the bracket (see Fig. 2). The position of this grommet can be adjusted, the hole being elongated.

28. The twin ganged condenser C_1C_2 should now be mounted into position. A 4BA solder tag is fitted under the head of each mounting bolt (4BA x $\frac{1}{2}$ in) each tag then being soldered directly to the copper foil of the board. This effectively earths the ganged condenser frame. Two $\frac{1}{2}$ in rubber

grommets on each bolt are used as spacers (see Fig. 2), adjusting the bolts so that the grommets are compressed.

29. Next, mount the trimmers C_3C_4 on the rear of the ganged condenser C_1C_2 using



ALTERNATIVE VOLUME CONTROL

FIG. 6

Q712

4BA x $\frac{1}{4}$ in bolts. A 4BA solder tag is fitted under C_3 where shown in Fig. 5.

30. Mount IFT₁ (1660) and IFT₂ (1661). These IFTs are marked and the numbers on the bases should coincide with those on the printed circuit board, viz., 1-3-4-6. Solder into circuit.

31. The Medium wave oscillator coil L_3 (white coil) and the Long wave oscillator coil L_4 (green coil) should both be mounted, noting the colour spot as indicated in Fig. 5. Solder all connections.

32. With reference to Fig. 5, the following connections should now be made. Wire C_1 tag to S_2 and the point marked "AE".

33. Wire C_3 trimmer tag to S_2 .

34. Connect C_4 trimmer tag to S_2 and C_2 tag to S_3 .

35. Next, fit and connect C_{23} (250 μ F, 12 w.v. electrolytic). This condenser has red (+) and black (-) ends. Mount vertically with the red and black connections in the appropriate holes as marked.

36. Three wires should now be fitted to the holes marked B-S-T respectively adjacent to the on/off volume control R_{18} . Fit the volume control and connect leads B-S-T as shown in Fig. 5. Leads A-C-D-E-F (Fig. 5) are now also soldered into circuit. (Note that Fig. 6 shows an alternative volume control.)

This completes the wiring of this side of the printed circuit board at present.

37. Dealing next with the reverse side of the board (copper side), the drive drum

should now be fitted, see Fig. 7. Fit the drum as far back as possible, just clearing the heads of the four 4BA ganged condenser fixing bolts (Fig. 2).

38. Fit the drive spring and the nylon cord drive. (Fig. 7.)

39. The pilot bulb is now fitted to the holder and mounted on the earthy edge of the copper foil shown in Fig. 7 using a 6BA x $\frac{1}{4}$ in bolt and nut. A lead is taken from the bulb holder tag to pin 5 on V_1 valveholder. Ensure that the bulb holder is mounted upright in order to avoid the bracket shorting to other live portions of the copper foil.

Power Unit Chassis Assembly

Refer to Fig. 8. All leads in the power unit are insulated with sleeving.

40. First, fit two $\frac{3}{8}$ in rubber grommets as indicated.

41. The contact cooled selenium rectifier unit SR should next be fitted using 6BA x $\frac{1}{4}$ in bolts and nuts. Note polarity markings.

42. Mount into position the 6.3V heater transformer T_1 using 4BA x $\frac{1}{4}$ in bolts and nuts, fitting a 4BA solder tag under one bolt where indicated in Fig. 8.

43. Using 6BA x $\frac{1}{4}$ in bolts and nuts, mount T_2 into position, a solder tag being fitted where shown.

44. Solder into position C_{22} (0.001 μ F) across the two outer tags of T_2 .

45. Next, the combined electrolytic condensers $C_{24}C_{25}$ are mounted, using 4BA x $\frac{1}{4}$ in

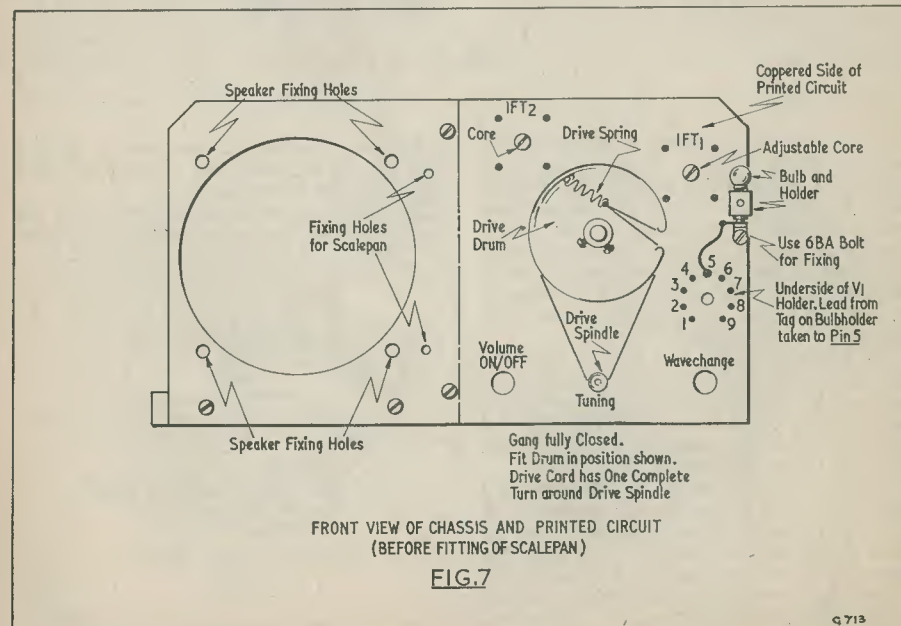


FIG. 7

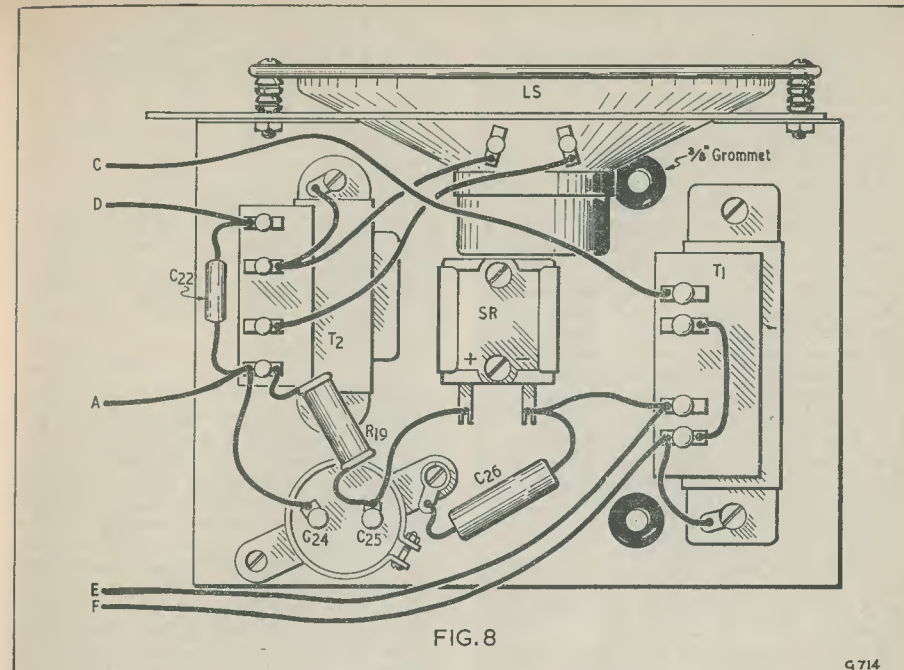


FIG. 8

bolts and nuts. A 4BA solder tag should also be fitted as shown. A 4BA x $\frac{1}{4}$ in bolt and nut should be used for the clamp. Mount the clamp so that it does not overhang the chassis.

46. Solder into circuit the 5 watt wire-wound resistor R_{19} (1k Ω 5 watt).

47. Connect C_{26} (0.01 μ F 500 w.v.) between the negative tag of the contact cooled rectifier SR and the adjacent 4BA solder tag.

48. Join the tag of C_{24} to the end tag of T_2 (see Fig. 8).

49. Join the tag of C_{25} to the positive tag of the rectifier SR.

50. A lead is now taken from the negative tag of SR to the tag shown on T_1 .

51. Solder together, by means of a short length of wire, the two tags shown on T_1 carrying on to the earthing solder tag.

52. With reference to Fig. 7, it will be seen that the speaker panel has one corner removed. This should be noted during the following operation.

53. Secure the speaker panel to the printed circuit board using 6BA x $\frac{1}{4}$ in bolts and nuts. Refer to Fig. 2.

54. Mount the 5in speaker on the panel using 4BA x $\frac{1}{4}$ in bolts with two $\frac{1}{2}$ in grommets as spacers on each of the four bolts. (See Figs. 4 and 8.) Tighten the nuts to compress the grommets slightly. A further 4BA nut,

used as a locknut, may be fitted on each bolt. 55. Join the assembled power unit chassis to the speaker panel using 6BA x $\frac{1}{4}$ in bolts. (See Fig. 4.)

56. Connect two leads from LS (Fig. 8) to T_2 . Earth one of these tags (T_2) to the adjacent earth tag.

57. Join leads A-C-D-E and F from the printed circuit board to the power unit assembly as shown in Fig. 8.

58. Connect the mains leads to the volume control switch as shown in Fig. 5 or Fig. 6 (alternative types of volume controls).

59. Mount into position the ferrite rod with the coils L_1 and L_2 in the positions indicated in Fig. 5. The two punched lengths of plastic strip are folded around the ferrite rod. Use 4BA x $\frac{1}{4}$ in bolts with a 4BA washer under each head (see Fig. 5) in order to clamp the strips into position.

60. The four coloured leads from the coils L_1L_2 should now be connected into circuit as shown in Fig. 5.

61. Insert the three valves into their respective holders, V_1 ECH81, V_2 EF85, and V_3 ECL80.

This completes the receiver assembly and wiring.

Testing and Alignment

The following tests should be carried out

before connecting the receiver to the a.c. mains supply.

First ensure that no wires or components are short circuiting to each other and also that no short circuits exist on the h.t.+ line to chassis. Using an ohm-meter, the h.t.+ to chassis resistance should be found to be in excess of 1MΩ. Allow sufficient time for the ohm-meter to settle. C₂₄C₂₅ will charge during this test and the meter pointer will initially "kick" towards zero resistance. Scrutinise the copper side of the printed board for superfluous blobs of solder, removing any that may be found. Connect the receiver to the a.c. mains supply. Remember that this chassis is connected to one side of the mains—care should therefore be exercised when handling the chassis.

Approximately some twenty seconds after switching on, the valve heaters will glow at full temperature and a faint hum will be heard from the speaker. On adjustment to the volume and tuning controls it should be possible to receive some stations. The i.f. transformers are pre-aligned in order to facilitate final setting-up.

Check that the leads to the ferrite rod aerial and the output lead D from T₂ are kept well apart otherwise instability may result.

For those who have a modulated signal generator the alignment frequencies are as follows:

IF 472 kc/s: Adjust cores in IFT₁ and

IFT₂ for maximum audio output.

LW 2,000M (150 kc/s): Adjust L₄ core (oscillator) for maximum signal. Adjust L₂ for maximum output by sliding along ferrite rod.

1,000M (300 kc/s): Adjust C₁₀ (oscillator) for maximum signal. Adjust C₃ for maximum output.

Repeat the above.

MW 500M (600 kc/s): Adjust L₃ core (oscillator) for maximum signal. Adjust L₁ for maximum output by sliding along the ferrite rod.

200M (1,500 kc/s): Adjust C₁₁ (oscillator) for maximum signal. Adjust C₄ for maximum output.

Repeat the above.

Final Tests

Fit the scalepan using 6BA x ½in bolts and 6BA nuts as spacers. (See Fig. 2.)

Fit the pointer to the variable condenser spindle using a 6BA x ½in brass bolt. With the condenser vanes fully meshed, the pointer should be in the horizontal position.

To install the receiver in the cabinet, countersunk 2BA bolts are used, these being fitted from the underside of the cabinet through the ½in grommets with a washer under each nut. Four self-tapping screws should be used to secure into position the cabinet backing.

Fit the control knobs to the three spindles and the receiver is complete.

D.C. TEST VOLTAGE READINGS

20,000 ohm/volt Testmeter (measured between chassis and the following points)

Tuned to no signal. Volume control to max.

Pin	1	2	3	4	5	6	7	8	9
V ₁ Holder	100V	—	2.3V	—	6.3V a.c.	245V	—	100V	—
V ₂ ..	6.5V	—	6.5V	6.3V a.c.	—	—	245V	180V	6.5V
V ₃ ..	85V	—	9V	—	6.3V a.c.	240V	9V	245V	—
+ Tag on SR 300V d.c.					— Tag on SR 250V a.c.				

A Constructor Visits

The 1961 International Audio Festival and the Heathkit Exhibition

THE 1961 INTERNATIONAL AUDIO FESTIVAL and Fair was opened on 6th April at London's Russell Hotel, which now appears to be the permanent London home for this event. The Festival continues to advance, and this year 70 exhibitors, nearly a dozen of whom were of overseas origin, participated.

Tape Recorders

Tape recorders provided a high proportion of the exhibits. In the larger class of recorder could be found the Multimusic "Reflectograph", Model A (2 tracks) and Model B (4 tracks), this having two speeds (each separately equalised) together with the ability to monitor the tape whilst actually recording. Another recorder in the larger class was the Grundig stereo model TK60. This instrument has two speakers fitted on either side of a central container holding the deck and electronics. These speakers may be unclipped and placed in any desired position. Newly introduced by Ampex Electronics Ltd. is their Universal series 351. The series is similar to previous models with the exception that a multi-voltage input tapping is provided, enabling the recorder to be operated from practically any known a.c. supply, plus the availability of NAB/CCIR equalisation in the amplifier section.

The Fi-Cord transistorised tape recorder represents what was probably the smallest instrument at the Festival. This unit, measuring only 9½ x 5 x 2½in, provides playback as well as recording facilities and has a frequency response within ±3dB of 50 to 12,000 c/s. The design is largely unaltered from last year and it is interesting to note that six models have been purchased by Armand & Michaela Denis.

Many recorders falling in the small, but not miniature, category were also transistorised. The Butoba recorder, for instance, employs seven transistors together with a DM71 level indicator, and may be operated from batteries or mains. It may also be operated from a 6 volt car battery. The Butoba stand showed the recorder coupled to a film projector, the tape leaving the tape deck and passing over a capstan on the projector before returning to the heads.

A neat transistorised recorder is the Minivox "C". This employs three motors, one of which is for fast rewind. A DM70 indicator shows volume level, and the unit is completely battery powered, battery life

being 100 hours. There are two speeds, and monitoring facilities together with the ability to mix microphone and radio are also provided. Audio output is 600mW. An interesting technical feature of this recorder is the use of permanent magnet instead of oscillator erasure. Two ring-shaped magnets with segments of approximately 0.04in cut-away are used, the poles appearing on either side of the cut-away segment. The tape to be erased passes over the gap of the first magnet, their relative positioning being similar to that of tape and a head, and the full magnetic field is applied to the tape. It then passes over the second magnet, which is offset such that the gap is away from the tape. The first magnet gives erasure, leaving a level of noise on the tape. The second magnet removes the noise. Minivox point out that this erasure system gives excellent results and that, although it was introduced several years ago, it has not up to now been given due prominence in the technical press.

The new Garrard Magazine Tape Deck was exhibited at the Festival. The magazine for this tape deck holds two spools and can be simply dropped into position on the deck, whereupon the tape is automatically positioned at the heads and the spools couple up to the appropriate spindles. The magazine may be fitted to the deck either side up, thereby allowing both tape tracks to be used. The tape deck also takes conventional spools up to 4in in diameter.

A new innovation at the Festival was a combined tape recorder and record reproducer exhibited by the Wyndor Recording Company. Within a compass which was hardly larger than that of their standard "Victor" model, Wyndor provided an additional pickup and record support. The capabilities of this combination are somewhat impressive in the avoidance of interdependence. Both tape and gram may run at the same time, the first at 3½ or 7½ i.p.s., and the second at 45 or 33 r.p.m. The provision of two separate amplifiers enables stereo to be recorded or reproduced. Alternatively, gram can be fed through one channel and tape through the other, and it is possible also to record on one tape track and play back on the other at the same time! Gram reproduction may be either mono or stereo.

Sony, of Japan, exhibited a range of tape recorders varying from the Model 101, for domestic use, to the No. 521 unit. This latter is a two or four-track stereo recorder with built-in speakers. Two level indicators, one for each channel, are incorporated, and these are calibrated to zero dB at 10dB below saturation. One of the Sony recorders, No. 362, has a built-in three transistor superhet radio tuner.

Microphones and Pickups

Standard Telephones & Cables introduced two new microphones. One of these, the 4106, is a moving coil high grade studio instrument with a cardioid polar response and a frequency range from 30 c/s to 12 kc/s. The other microphone, the 4108, is a condenser type having an extended response from 30 c/s to 15 kc/s with an accurately maintained cardioid response. This microphone has a transistor and valve head amplifier built in.

Lustraphone showed, amongst other products, their new Stereo-Ribbon Microphone, Model VR/65NS. This is based on the same design principles as the previous Model VR/65, the only difference being that phase switching and other mechanical features are omitted, thereby reducing cost.

Introduced this year by A.K.G. is their C60 Cardioid Condenser Microphone, which has been developed to offer light weight and small dimensions in company with high reproduction quality. The response is nearly flat from some 30 c/s to 15 kc/s, and a single valve head amplifier is incorporated.

Considerable interest was shown in the Parabolic Reflector exhibited by Grampian Reproducers Ltd. This reflector is intended for use with a microphone, whereupon it concentrates signals from a single sound source. When fitted with a microphone at its focal point the reflector resembles a radar dish in appearance. The diameter of the reflector is 24in, and its depth is 5in. "Sighting" on the source of sound is provided by a hole in the reflector which is lined up with a fixed point on the microphone holder. Tests have shown that, over a frequency range of 500 to 5,000 c/s, the reflector can provide an increase in sensitivity of 14dB.

Described as a "Wireless Microphone", is the Sony model CR-4. This comprises a pocket three transistor f.m. transmitter coupled by a flexible lead to a small moving coil microphone, together with a receiver. The latter is an 8 valve superhet and the two units work together over the band 27.12 Mc/s $\pm$ 250 kc/s. The wireless microphone is especially useful in the entertainment field, since it may be carried about by performers without trailing leads. Amongst other users, Sony state that it is ideally suited for private investigators.

Cosmocord Ltd. have introduced a new pickup, the Acostereo 81. This has a ceramic cartridge and, since it is consequently immune to the effects of humidity, is capable of being used anywhere in the world. Full details were not available at the Festival but the following points may be stated. The stylus is coupled to bender elements, these being mounted at 45° to the horizontal. Cross-talk is of the order of 25dB at 1 kc/s. Tracking pressure is approximately 5 grs.

The Acos Hi-Light pickup assembly, which has previously been made in mono only is now available in both mono and stereo. The main feature of the Hi-Light is the negligible stylus wear, it being stated that the pickup plays records at downward forces within the elastic limit of the record material.

Loudspeakers

H. J. Leak & Co. Ltd. describe the invention of their new "Sandwich" full range loudspeaker as "the greatest advance in moving coil loudspeaker design since Rice-Kellogg invented the moving coil loudspeaker in 1925." The Leak speaker is a 13in unit which employs a $\frac{3}{8}$ in thick cone of sandwich construction that is stated to be 200 times stiffer than any other cone produced. The new Leak cone, having immense stiffness for no greater weight than a standard cone, obviates flexing at large amplitudes and break-up distortion. The Sandwich speaker, together with a 3in unit and a cross-over network, is fitted in an enclosure measuring only 26 x 15 x 12in to provide a complete reproducer.

Also new at this year's Festival was the "Airedale" free-standing speaker assembly exhibited by Wharfedale. This is the latest version of the Wharfedale omni-directional three speaker Corner System and it can be positioned in a corner or along a wall. Three speakers are employed, a 3in treble, an 8in mid-range, and a high-flux 15in unit for bass. The latter is fitted with a "roll" surround, another new innovation. The "roll" surround has a U-shaped cross-section. Cabinet resonance is avoided by loading the larger panels with ceramic tiles. The unit measures 39 x 28 $\frac{1}{2}$ x 14in and its total weight exceeds $\frac{3}{4}$ cwt.

A further innovation was the Grampian HL12 Cabinet Loudspeaker whose dimensions are 33in high by 15in wide and 16in deep. This employs a folded horn having an effective length of over 6ft, careful design enabling this to be contained within the cabinet. The speaker employed is the Grampian 1255/15 high flux 12in unit.

Amplifiers

Prominent among high fidelity amplifiers were those in the Jason range. The Jason J2-10 Mk. III stereo amplifier was exhibited, and this has been designed with an eye on possible future developments. Power output per section is 12 watts, and response is within 1dB from 30 c/s to 10 kc/s, with a greatly extended response above. The first stages have d.c. valve heating. The Jason J10 Mono Amplifier was also shown, this offering its full 10 watts output with less than 0.1% distortion for an input of 12mV.

Lowther introduced a new 5 watt direct

coupled transistor amplifier, this being intended for use with the Lowther high efficiency horn-loaded speaker system. Direct coupling is used throughout and the output transistors are OC22s. There is no output transformer, the output transistors coupling directly to the speaker. Input sensitivity is of the order of 1 volt for full output and input source impedance should preferably be 4.7k Ω or greater.

Other Exhibits

Mullard exhibited both their "World Series" of audio valves and their range of audio transistors. An item of special interest was the newly released AC107 low noise transistor, this being intended for use in a.f. amplifier input stages. On the valve side, another new addition was the ECL86, a triode-pentode having an output of 4 watts and a sensitivity three times greater than that of the ECL82. Also available were the Mullard publications *Circuits for Audio Amplifiers* and *Reference Manual of Transistor Circuits*. The former discusses the theory and practice of high fidelity mono and stereo reproduction, and gives details of 12 circuits designed around Mullard valves. The *Reference Manual of Transistor Circuits* has six chapters on audio circuitry.

An interesting newcomer to the high fidelity component field is the toroidal transformer manufactured by Aveley Electric Ltd. This transformer has its windings arranged on an unbroken circular core, with the consequence that leakage inductances are reduced to a negligible value. Leakage

inductance is lower than with C-cores, and a figure of 1% is claimed. Toroidal transformers lend themselves especially well to output transformer applications because of this low leakage inductance. Since the external field is at a low level these components offer advantages, also, as mains transformers. Aveley Electric Ltd., in company with Dynaco, Inc., are producing a range of wide band power amplifiers employing toroidal mains and output transformers.

The Heathkit Exhibition

This year Daystrom Ltd. held their separate exhibition at the Grand Hotel, Southampton Row, close to the Russell Hotel. Exhibits shown were taken from the wide range of Heathkits now available.

A newly released exhibit was the Heathkit Audio Sine-Square Wave Generator Model AO-IU. This unit covers 20 c/s to 200 kc/s in four ranges, with choice of sine or square waves (the latter up to 50 kc/s). Output voltage is 10 volts maximum, and distortion is less than 0.6%. Another very new addition to the range is the "Malvern" Hi-Fi Equipment Cabinet which is capable of housing a complete high fidelity system, including a tape deck and full sized transcription motor board. Also shown was the TA-IC, -IM and -IS range of tape amplifier units, these consisting of combined tape record/replay amplifiers capable of being coupled direct to a tape deck. The TA-IM is a mono kit which can be modified for stereo by the TA-IC kit. The TA-IS is a stereo kit.

A Guitar Amplifier with Vibrato

A cheap but
comprehensive guitar
amplifier

By J. G. Ransome

THE BASIC ESSENTIALS OF A GOOD GUITAR amplifier are high output, portability and, if possible, cheapness. These considerations were borne in mind when this unit was constructed. The unit consists of the amplifier proper and a variable frequency variable depth, vibrato circuit. In all, only four valves (including the h.t. rectifier) are used, all other components being kept to a minimum.

Vibrato Unit

The vibrato unit centres around a phase-shift oscillator consisting of the pentode

section of an ECF82 and associated circuitry. The phase-shift components C_1 , C_2 , C_3 , R_1 , R_2 and R_3 , are chosen to give a vibrato frequency of about five cycles per second. R_3 is made variable in order that the vibrato frequency may, to some extent, be altered. Should the vibrato frequency chosen prove to be either too low or high, the values of the fixed resistors may be changed. By increasing the value of these two resistors a lower frequency will be obtained; by decreasing their value the opposite effect will result. It will probably be found that the vibrato unit will not function at very high or very low

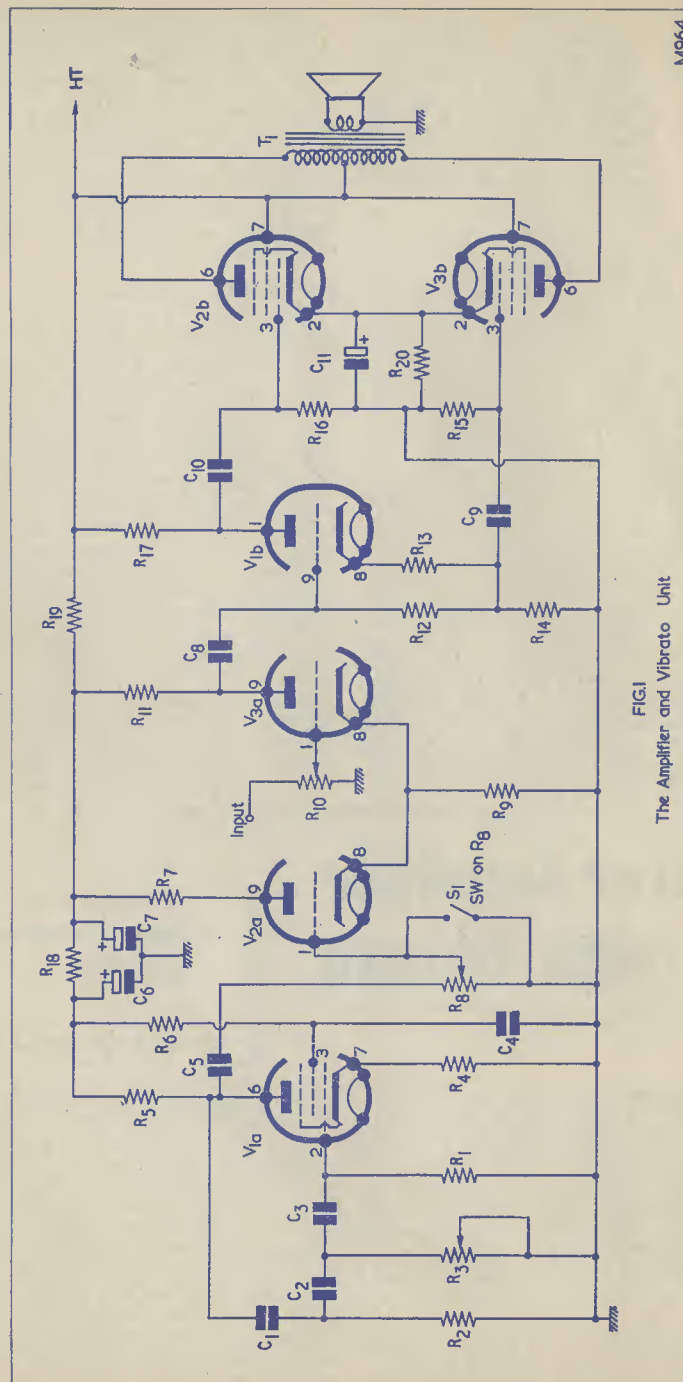


FIG.1
The Amplifier and Vibrato Unit

M964

settings of R_3 but, with a little experimenting, this should not prove a disadvantage.

The output from the phase-shift oscillator is taken to the grid of the triode section of V_2 via C_5 and R_8 . R_8 controls the depth of the vibrato modulation by varying the signal applied to the triode grid. R_8 is also fitted with a switch which closes when R_8 is fully anti-clockwise, short-circuiting the grid of $V_2(a)$ to chassis and cutting the vibrato.¹

$V_2(a)$ is cathode-coupled to the first amplifier stage of the amplifier proper. $V_3(a)$ amplifies the signal appearing across R_{10} (from the guitar) in the normal way and, when the vibrato switch on R_8 is closed, it functions as a straightforward a.f. amplifier.

¹ If difficulty is experienced in obtaining a potentiometer fitted with a switch of this nature, a separate tumbler switch may be fitted to the panel.—Ed.

When the vibrato switch is open, however, $V_2(a)$ amplifies the vibrato signal and draws current through R_9 , causing voltage fluctuations to appear across this resistor at the vibrato frequency. Thus, the cathode of $V_3(a)$ has a fluctuating signal applied to it. This causes the gain of $V_3(a)$ to vary and superimposes the vibrato frequency on the signal applied to its grid.

The Amplifier

The amplifier is a standard push-pull circuit. The triode section of the ECF82 is used as the phase-splitter. The pentode sections of the ECL82 valves are used in a push-pull output circuit. The amplifier is perfectly stable but, should there be any tendency to oscillate, grid stoppers of 2.2k Ω may be inserted in series with the grids of the output valves.

The power supply circuit is shown in Fig. 2.

Where a low impedance pickup is used on the guitar the input should be arranged as in Fig. 3.

Construction

In the original unit the power supply and the amplifier were constructed as separate items but there is no reason why they should not be incorporated on one chassis. The layout and wiring is not critical but signal-carrying leads should be as short as possible.

The amplifier and vibrato unit were constructed on a chassis 4in x 7in x 1½in deep. The chassis is drilled as shown in Fig. 4. No drilling instructions have been given for the positioning of the output transformer or tagboard as this will depend on the size of the component used.

Details of the wiring of the circuit are shown in stages in Figs. 5 to 9. The output

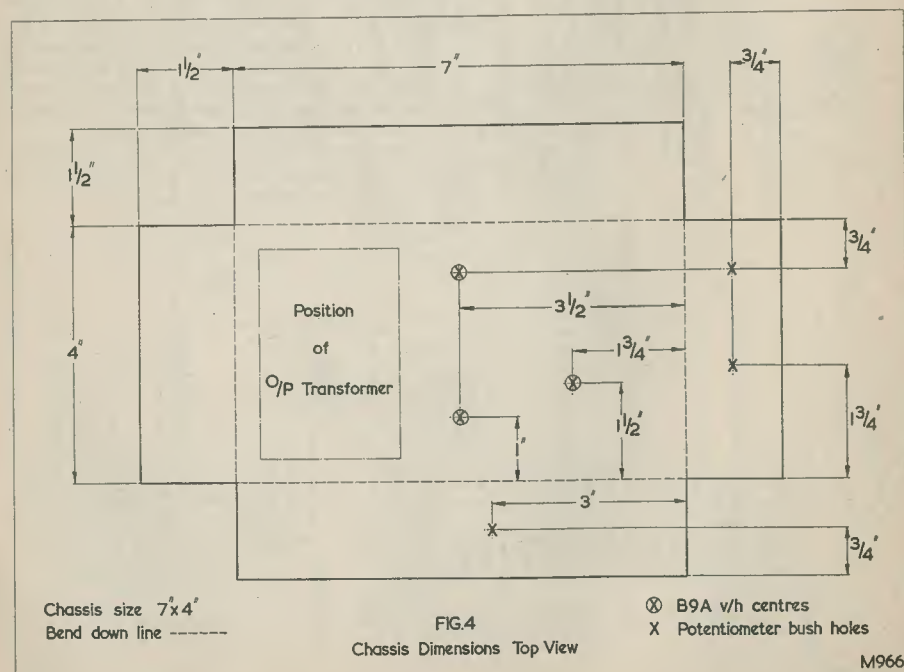
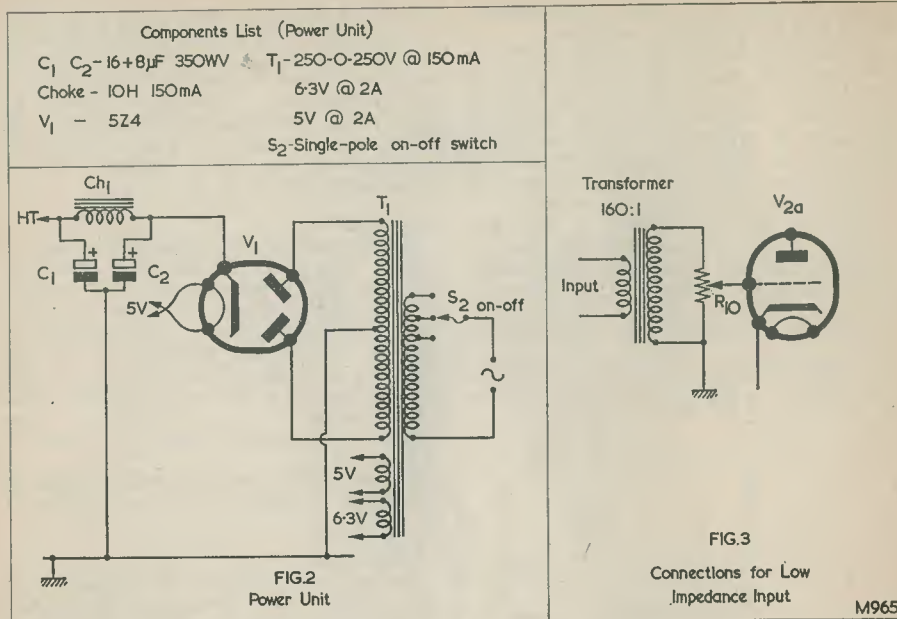
Components List (Set out for easy reference to Fig. 1)

Resistors

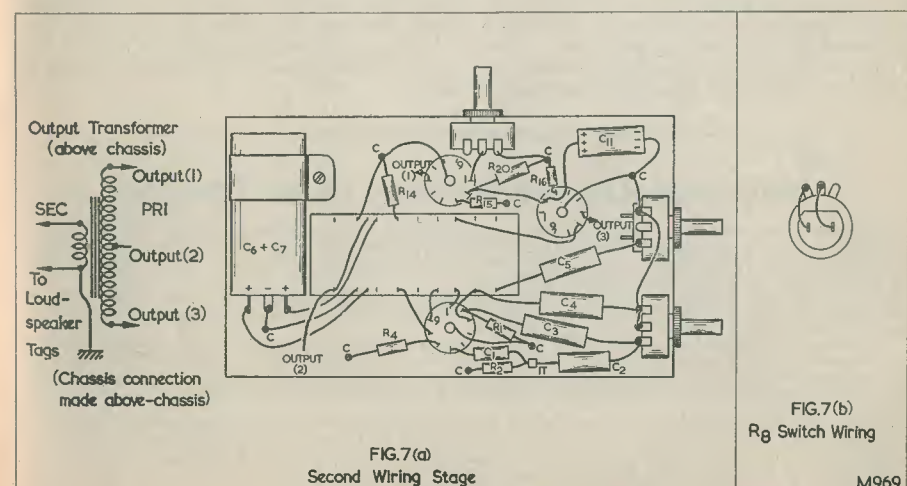
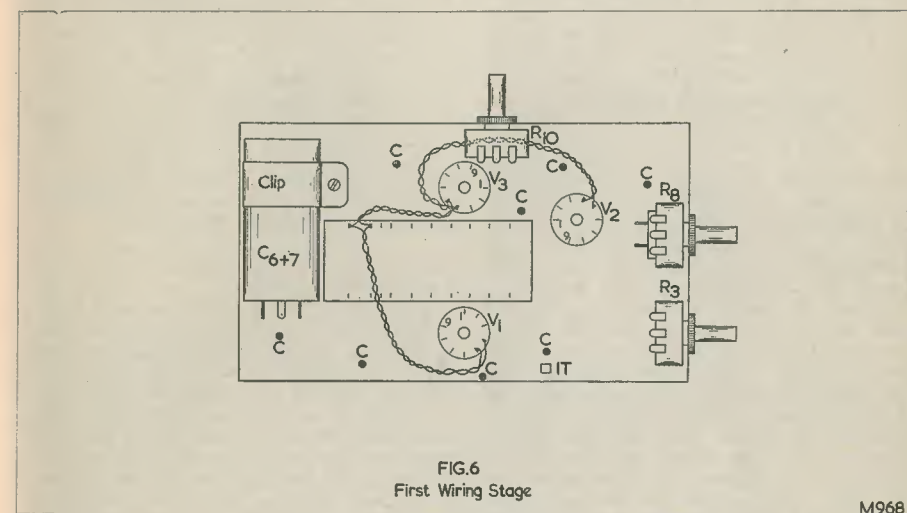
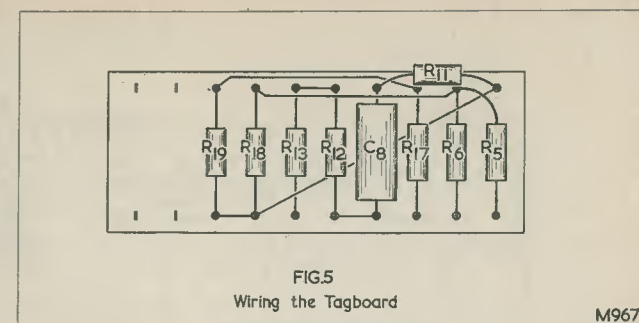
Resistors	Components List	Miscellaneous
R1	150k Ω ½ watt	2 x 10-way tagboard (outside dimensions 1½in x 3¼in approx.)
R2	150k Ω ½ watt	Chassis
R3	250k Ω potentiometer (Linear)	Three B9A valveholders
R4	3k Ω ½ watt	Nuts, bolts, wire, etc.
R5	47k Ω 1 watt	
R6	10k Ω ½ watt	
R7	220k Ω ½ watt	
R8	250k Ω potentiometer (log. with switch S1)	
R9	1k Ω ½ watt	
R10	1M Ω potentiometer (log.)	
R11	220k Ω ½ watt	
R12	1M Ω ½ watt	
R13	3.9k Ω ½ watt	
R14	100k Ω ½ watt $\pm 5\%$	
R15	470k Ω ½ watt $\pm 10\%$	
R16	470k Ω ½ watt $\pm 5\%$	
R17	100k Ω ½ watt	
R18	47k Ω 1 watt	
R19	47k Ω 1 watt	

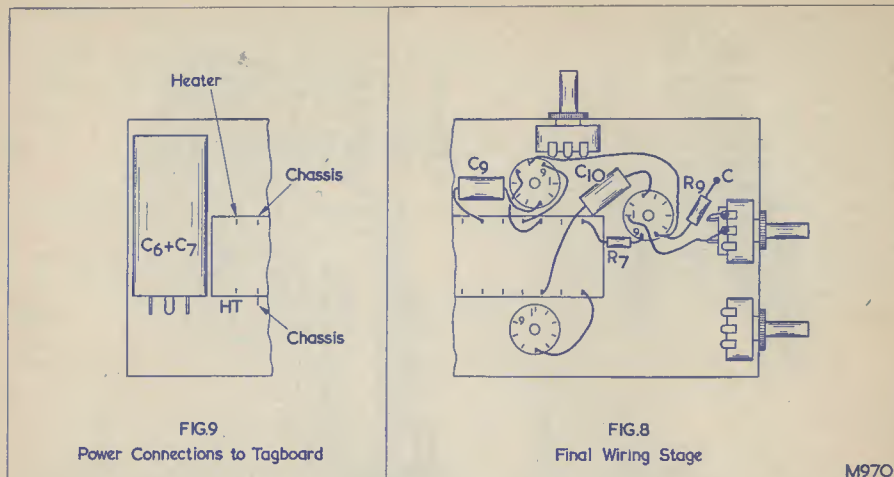
Capacitors

Capacitors	Components List	Miscellaneous
C1	0.1 μ F 350 w.v.	
C2	0.1 μ F 350 w.v.	
C3	0.1 μ F 350 w.v.	
C4	0.1 μ F 350 w.v.	
C5	0.1 μ F 350 w.v.	
C6	8 + 8 μ F electrolytic 350 w.v.	
C7	8 + 8 μ F electrolytic 350 w.v.	
C8	0.1 μ F 350 w.v.	
C9	0.1 μ F 350 w.v.	
C10	0.1 μ F 350 w.v.	
C11	50 μ F electrolytic 50 w.v.	
T1	Push-pull output, 9 watt, 9k Ω anode-to-anode	



transformer, the potentiometers, the valveholders and the electrolytic decoupling condenser (C_6 and C_7) should be mounted first. The tagboard should then be wired in accordance with Fig. 5 and mounted on the chassis, taking care that the body of R_{11} does not make contact with the tags connected to R_6 and R_{17} . If an aluminium





chassis is used, tags will have to be mounted at the points marked "C" in the diagrams. To make contact with the chassis if this is tinned or cadmium-plated, connections to these points may be soldered directly. Next, mount the insulated anchoring tag "IT". Wire up the heater connections. By this stage the amplifier should resemble Fig. 6. The second stage is to wire in the components shown in Fig. 7. The three connections to the output transformer from the underside of the chassis should be made through a suitable hole drilled near the base of the transformer. The wiring of the switch contacts across R_8 are shown separately in Fig. 7 (b). Fig. 8 shows the last stage of the wiring. The power supply connections to the tagboard are shown in Fig. 9. The layout of the power-pack are left to the individual requirements of the constructor. The original amplifier was constructed within the case of a commercial extension loudspeaker

and for this reason a rather untidy layout was adopted in order to accommodate the components of the power section.

Low Impedance Inputs

If the guitar has a low impedance output then a small matching transformer will have to be fitted. It may usually be accommodated under the chassis just over C_{11} . If C_{11} is of a large physical size then the transformer will have to be mounted above the chassis. It is, however, more desirable to place the transformer under the chassis as this prevents instability in the amplifier due to magnetic interaction between this input transformer, the output transformer and the loudspeaker. The high impedance side of the transformer must be connected across the two outer tags of R_{10} . (For high impedance inputs the input is taken direct to the two outer tags of R_{10} .)

Modernisation of Medway River Service

The Conservators of the River Medway have in hand an extensive scheme for the modernisation of the existing Medway service. This will include v.h.f. marine radiotelephone equipment to be supplied by Pye Telecommunications Limited and a Decca Type 32 Harbour Radar with three 16 inch displays; the whole system will be integrated with the Medway Port Operations and Information Service.

Owing to the ever increasing number of tankers calling at the Isle of Grain, and the dry cargo vessels using the river, the annual tonnage of cargo handled in the Medway is fifth highest for ports in this country, excluding British Transport Commission ports.

To meet existing pressing requirements the Conservators of the River Medway introduced an interim scheme, announced in Admiralty Notices to Mariners, which provides a Port Operations and Information Service at Sheerness, with headquarters in the Signal Station at Garrison Point. Pye supplied the r/t equipment for the interim scheme and installed a radiotelephone in the Medway Conservancy Board's craft to enable the Master to maintain contact with Garrison Point.

A Port Operations Building, to be erected on top of Garrison Point Fort, overlooking the approach channel to the River Medway, will house the Pye and Decca equipment now on order and will provide detailed surveillance and navigational information which will ensure the speed and safety of ships using the Medway.

The system will be similar to that supplied by Pye to the Port of London Authority in 1959 and the Hague Convention (1957) International Communication Channels will be employed.

Getting Started on 2-Metres

PART 3

by J. N. WALKER, G5JU

In this third article our contributor deals with the addition of an i.f. and r.f. stage to the single valve converter described last month

THE PREVIOUS ARTICLE DEALT WITH A fairly simple, but efficient, 2-metre converter and, presuming the constructor has had some success with this, there will now be the desire to effect improvements, increase the sensitivity, and make it more suitable for the reception of weak signals. These improvements take the form of (a) additional amplification at the intermediate frequency and (b) additional radio frequency amplification.

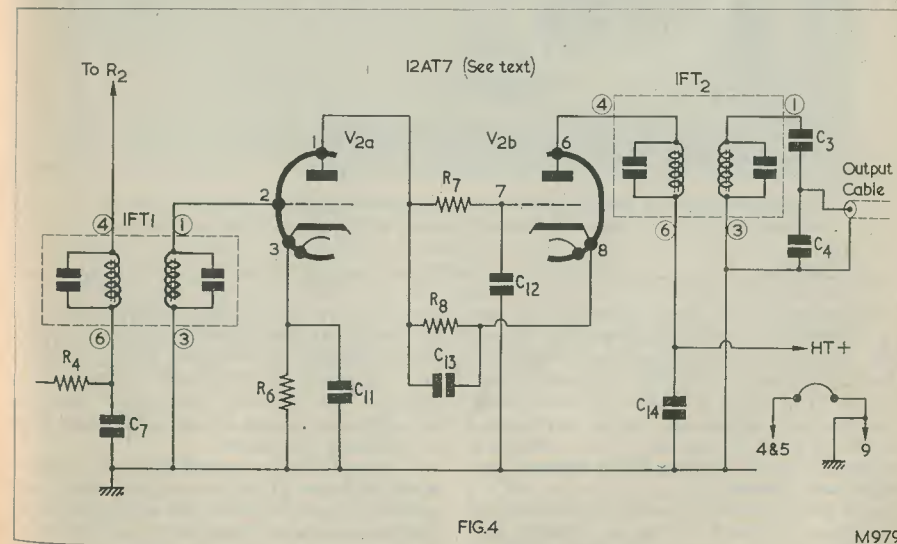
Benefit of I.F. Stage

An intermediate frequency amplifying stage fitted to the converter is termed a head amplifier and two inter-related benefits are thereby obtained. In the first place, the main receiver may have sufficient amplification when dealing with signals received on a good outdoor aerial but be lacking in this respect when accepting the relatively low output direct from the mixer stage in the

converter. Again, with a head amplifier which provides high gain and which is well screened to avoid pick-up of breakthrough signals, a higher wanted signal voltage is transferred to the receiver. The effect of any stray pick-up, possibly on the inter-connecting coaxial cable (and the cable can act as an aerial since the screening is imperfect), or at the receiver end, is then reduced. An incidental advantage brought about by the low noise characteristics of the particular head amplifier to be described is that overall noise is also reduced. In passing, whilst little has so far been said about noise, it is an important factor when weak signal reception is involved, and more will be said on the subject later.

Layout Details

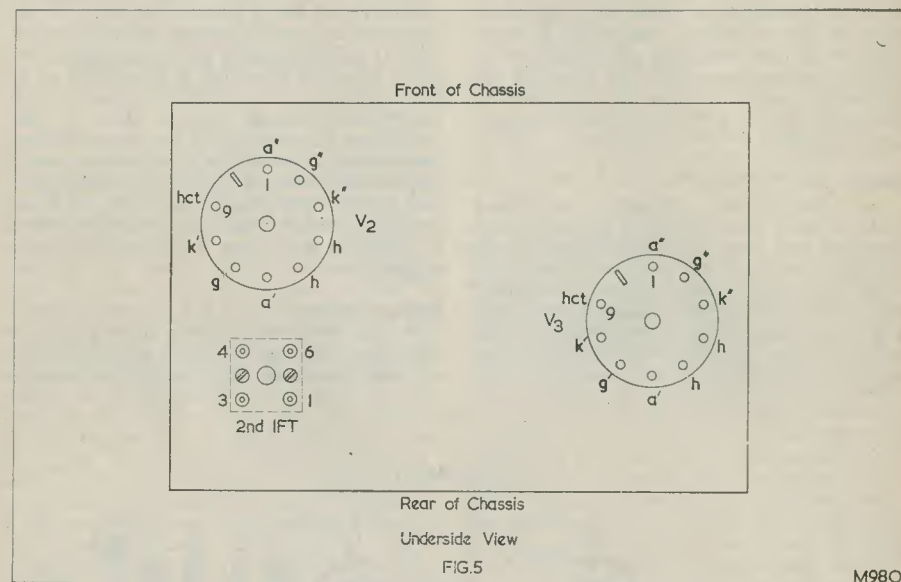
A cascode circuit has been adopted for the additional i.f. stage because it gives high gain with less noise than would result if a pentode



The circuit of the additional i.f. stage

were used; it is largely self-neutralising and therefore inherently stable; and the circuitry is relatively simple. The circuit is given in Fig. 4.

A B9A screened valveholder from V_2 is fitted into the hole designated in Fig. 2 (published in last month's article) and a second i.f. transformer, identical with the first one, fitted in the appropriate position. In both cases, note should be made of the orientation, which is designed to keep lead lengths short and to separate anode and grid connections. Correct orientation for V_2 valveholder and I.F.T.₂ is given in Fig. 5, looking at the underside of the chassis, and with the size of the holders enlarged out of proportion for clarity.



Underside view of chassis illustrating orientation of i.f.t.₂ and V_2 and V_3 valveholders. The valveholders are shown larger than they appear on the actual chassis

The coaxial cable, and of course C_3 and C_4 , now have to be re-sited on the output side of the second transformer and the photographs help to illustrate this and other points. The cable is firmly anchored with a small metal clip to the inside rear apron, removing some of the outer p.v.c. covering to allow a good earthing bond between the screen and chassis.

It is then a matter of wiring up, following the circuit diagram of Fig. 4. In this, the components have been numbered to follow on from those in the single valve circuit.

Similar types of condenser and resistor must be used—these being physically small to take up as little space as possible. Again, all leads should be made short. The lead-out wires from the i.f. transformer bases should also be shortened.

When the stage is finished a quick check should be made, with power applied, to ensure that the valve heater lights up and that h.t. is present at each of the anodes—a full reading at a' (pin 6) and approximately half at a'' (pin 1).

The cores in the i.f. transformers will need adjusting for peak response and the method suggested in the first article can again be followed if more elaborate equipment (e.g. a signal generator) is not available. A short

pick-up wire attached temporarily to pin 4 of the first transformer will enable a breakthrough signal to be heard on the receiver and adjusting the cores will bring up the strength considerably; whereupon receiver gain may be reduced accordingly before final adjustments are made.

It should also be noticed that, whilst much additional gain at the intermediate frequency will have been secured, the noise level will not have increased to any extent. Signals on two metres should show an equivalent improvement and what were weak signals

before should now be noticeably stronger.

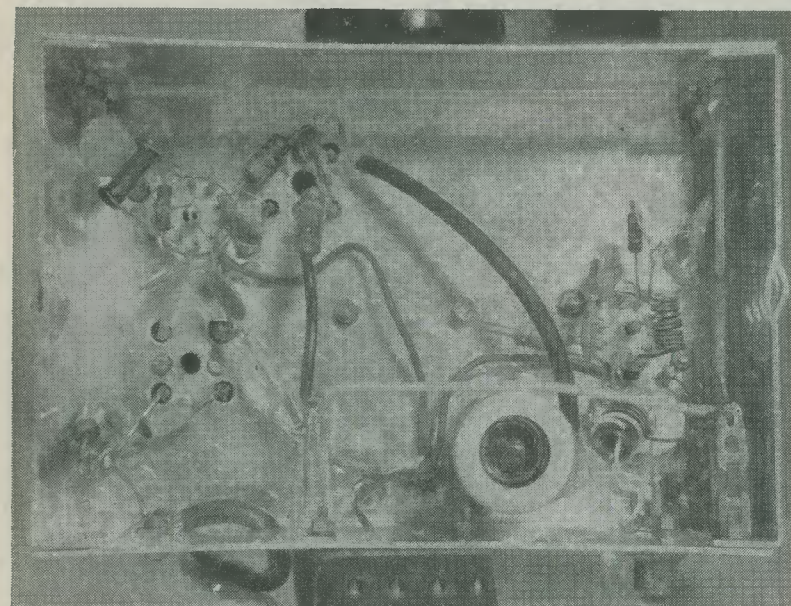
Radio Frequency Stage

Whilst the addition of an r.f. stage is more important than that of an i.f. stage, it has been allowed to take second place in this article because the work involved—and therefore the time required—is greater. Actually, of course, the constructor can choose which stage he adds in the first instance.

Turning to the subject of noise, little could be done in this respect with the simple mixer/oscillator described in the first article, other than to design it to keep the noise level as low as possible.

high frequencies) to ensure that the r.f. stage itself contributes little noise, or the object of having such a stage is not fully secured. For this reason a triode valve is preferable at the frequencies involved to a pentode and, of the various triode circuits available (grounded grid, neutralised push-pull, etc.) there is no doubt the cascode circuit has the major advantages—low noise, inherent stability, and good overall gain, without any fussiness in setting up. In a cascode, the first section acts as a normal grounded cathode amplifier and the second section as a grounded grid amplifier.

The easily obtainable 12AT7 type of valve is again chosen and the details provided here



Underside view of the chassis illustrating the wiring of the additional r.f. and i.f. stages. The single tagstrip which previously anchored the junction of C_3 and C_4 is now moved to the left rear of the chassis, where it carries out the same function. Chassis tags are fitted under all valveholder securing nuts. The coil L_3 is clearly visible over V_3 valveholder, the coil assembly L_1, L_2 appearing between this valveholder and the coaxial socket. Trimmer C_{19} is immediately below L_1, L_2 . An additional single tagstrip is fitted to the inside right hand end of the rear apron and provides an anchoring point for the h.t. positive end of R_{12} . The junction between R_{12} , C_{18} and the lead from L_5 is made close to the hole through which the latter passes

Space does not allow a lengthy explanation, but it may be stated briefly that an r.f. stage is necessary to step up the signal voltage to a level which overcomes the inherent mixer noise and allows weaker signals to be made audible. It is essential (particularly on very

apply to it. Nevertheless there are other valves, of more recent design, which will give still better results, and notes about these are made later.

The circuit of the r.f. stage is given in Fig. 6.

Practical Details

A B9A valveholder for V_3 is mounted in the position indicated in Fig. 2, and given the orientation shown in Fig. 5. A small trimmer condenser, C_{19} , of similar type to C_1 or C_9 , is mounted close to the valveholder underneath the chassis, with the stator connection brought as close as possible to pin 7. Directly across the trimmer are soldered the ends of the coil previously used as the input coil to the grid of $V_{1(a)}$ and now re-labelled L_1 . It will be found that the coupling coil L_2 comes close to the coaxial socket and that only very short connecting leads are now required. Incidentally, it will probably be found necessary to remove the C_1 trimmer to allow fixing holes for C_{19} to be drilled, and it will help if nuts are threaded on the fixing screws of both condensers to act as spacers and hold the trimmers slightly away from the chassis.

consists of ten turns of 20 s.w.g. enamelled wire, wound on the shank of a No. 34 ($\frac{1}{16}$ in) drill and then slipped off. The ends are tailored to fit across the appropriate points.

A new coil is prepared for the interstage coupling. The grid winding—now labelled L_4 —is identical to the previous input coil (three turns on a $\frac{3}{16}$ in diameter former) but the coupling winding L_5 , of thin p.v.c. covered wire, is increased in this case to $2\frac{1}{2}$ turns, wound around the low potential end of L_4 , with the ends left fairly long. One end goes down through the chassis, with some additional insulation where it passes through, taking the shortest path to pin 1 on the valveholder. The hole through which this wire passes is drilled as close to pin 1 as possible. The other end of L_5 also goes through a hole drilled in the chassis immediately below the coil, and then connects to R_{12} and C_{18} , a single tagstrip being fitted



Top view of the chassis around the r.f. amplifier and mixer. The lead from L_5 which connects to pin 1 of V_3 passes round the left hand side of V_3 screening can. The chassis hole through which it passes is drilled as close as possible to pin 1 of V_3

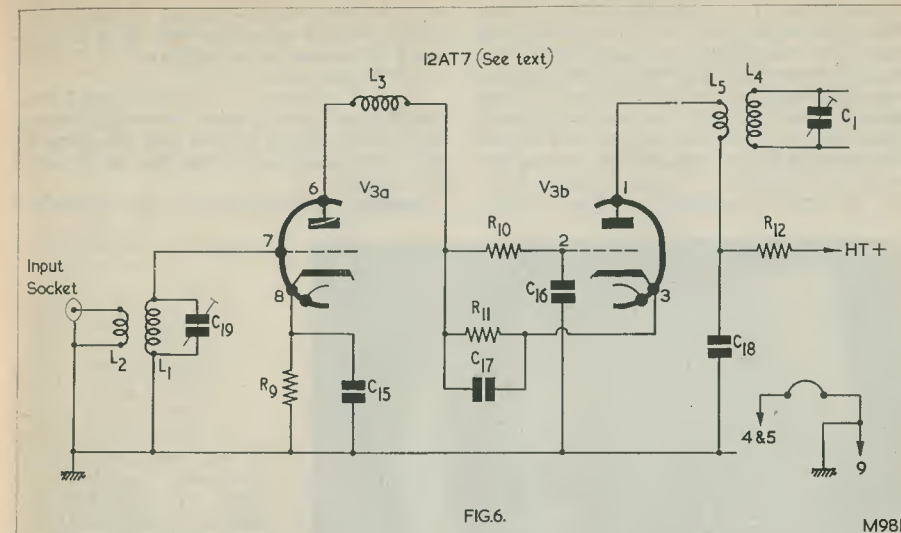
General underside wiring can then be proceeded with, the only precaution being to keep all leads carrying r.f. currents very short.

In this stage, a small coil is added (L_3), the purpose of which is to give a slightly lower noise level, plus a little extra gain. It

to the rear apron to ensure a firm support for the h.t. positive end of R_{12} .

Operation

As before, a preliminary check should be made with power applied, after which it should only be necessary to tune C_1 and C_{19}



The circuit of the additional r.f. stage

to resonance at the centre of the band, that is, 145 Mc/s. To start with, this can be done against the slight increase in noise level which will result, and final adjustment made when a fairly weak signal is available. If the trimmers are of rather large capacity, it is probable that two resonance points will be found. The position of lowest capacity is the correct one—the other will be the image frequency when in fact the circuits will be tuned to around 124 Mc/s.

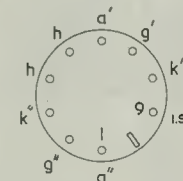
The increase in strength of signals previously heard should now be very obvious. With the complete three valve converter, the constructor can be sure of a really efficient job and results will then be dependent, not so much on his receiving equipment as on the aerial used, on the location, and on conditions.

With the addition of two extra valves, the heater current rises to 0.9A and the h.t. current will be in the region of 16mA. It is necessary for the power supply to be capable of delivering these currents.

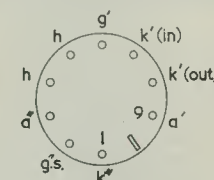
Final Improvements

A further improvement, particularly as regards noise, can be obtained by choosing more modern valves for the V_2 and V_3 positions. The 12AT7/ECC81 has been specified because it is easily obtained and is generally satisfactory in many cases.

Valves which can be recommended are the Brimar 6BQ7A, or the Mullard ECC85, and either of these can well be used in both the



6BQ7A or ECC85



ECC84

FIG. 7

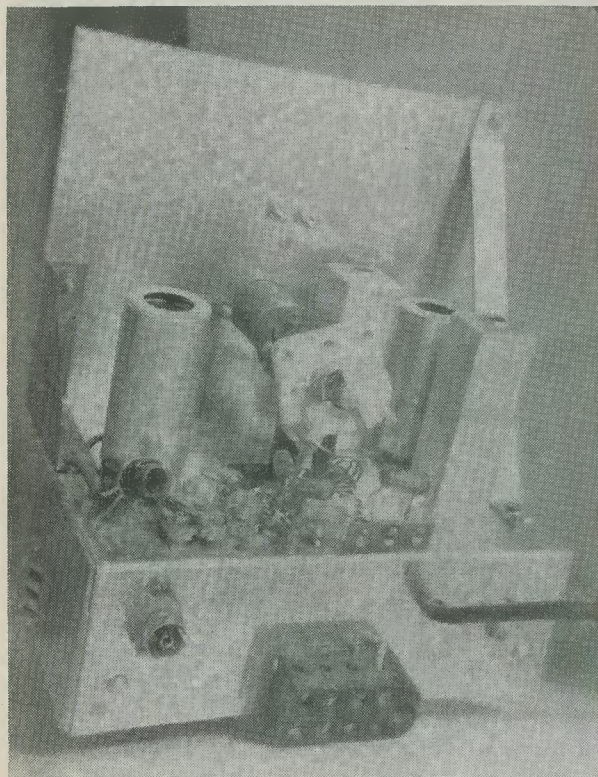
Base connections for alternative valves suitable for the V_2 or V_3 positions. When the ECC84 is used the two cathode pins (7 and 8) should be strapped together

r.f. (V_3) and i.f. (V_2) positions. Fig. 7 gives their pin connections. Minor changes to the valve base wiring are called for. Pins 4 and 5, instead of being connected together, are separated, one being connected to the nearest earth tag and the other remaining connected to the heater supply. Pin 9 now has nothing to do with the heater supply, being an internal screen between the sections, but it remains earthed as before. If this

used for V_3 , which operates at signal frequency. Little advantage will be gained by using it instead of a 6BQ7A or an ECC85 in the V_2 position.

Quite a number of changes would then have to be made to the valveholder wiring, and details of the ECC84 base are given in Fig. 7 to assist those who decide to make the change.

Another point which may be mentioned



A rear view of the converter complete with r.f. and i.f. stages. This illustration shows the position of the chassis hole through which the lead from L_5 to R_{12} , C_{18} passes. Also visible are the front panel strengthening strut and bracket referred to in the text

alteration is made subsequent to putting the converter into use with 12AT7 valves, it will be advisable to adjust the trimmers.

In the mixer stage (V_1), reliance is placed on inter-electrode capacity between the two sections for oscillator injection. With the internal screen between the sections in the 6BQ7A, this capacity is much reduced, for which reason it is not advisable to make any substitution in this stage for the 12AT7.

The reader may also query the use of valves of recent introduction specially designed for cascode operation and having one grid (g'') effectively earthed by being connected internally to the screen. An example is the ECC84 and it could well be

is the i.f. output circuit. The combination of C_3 and C_4 , using the values specified, is suitable for feeding into most general purpose communications receivers, having an input impedance around 400 ohms. However, if the converter is used with a receiver having low impedance input, say 70 to 80 ohms, a more effective transfer will result if C_4 is changed to 200pF. An alternative is to substitute a small trimmer in the C_3 position and experiment to see if any improvement is possible, re-trimming the core setting for each change in the capacity of C_3 .

Panel Rigidity

Although the tuning condenser assembly

itself is firmly mounted, at the frequencies involved the slightest movement of the panel can cause a change in tuning and it has been found that some additional support for the panel is desirable.

As can be seen in the photograph, an angle bracket of 18 s.w.g. aluminium strip, fashioned to fit, has been bolted one end to

the top of the panel, the other to the rear of the chassis, on the side where there is space to spare. On the other side, a small angle piece has been inserted. With these modifications, the whole assembly becomes much more rigid and mechanical stability is improved, with a resultant improvement also in electrical stability. (To be continued)

Components List

Resistors

R_6	100 Ω $\frac{1}{4}$ watt
R_7	220k Ω $\frac{1}{4}$ watt
R_8	100 Ω $\frac{1}{4}$ watt
R_9	100 Ω $\frac{1}{4}$ watt
R_{10}	220k Ω $\frac{1}{4}$ watt
R_{11}	100 Ω $\frac{1}{4}$ watt
R_{12}	220 Ω $\frac{1}{4}$ watt

Miscellaneous

2 Valveholders B9A with centre spigots, skirts and screens
I.F. transformer 10.7 Mc/s Eddystone
Cat. No. 856
Single tagstrip

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C_{12}	0.003 μ F Cascap
C_{13}	0.003 μ F Cascap
C_{14}	0.003 μ F Cascap
C_{15}	0.003 μ F Cascap
C_{16}	0.003 μ F Cascap
C_{17}	0.003 μ F Cascap
C_{18}	0.003 μ F Cascap
C_{19}	Trimmer (see text)

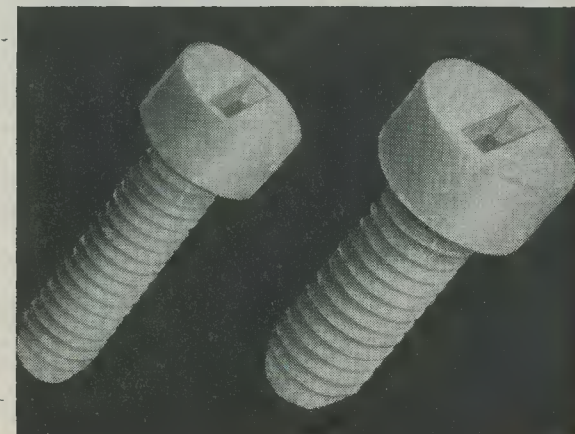
Valves

V_2	12AT7/ECC81 (see text)
V_3	12AT7/ECC81 (see text)

Nylon Screw with New Features

Nylon screws, approximately similar in shape and size to their metal counterparts, are frequently employed in electronic manufacture where they offer, amongst other things, the advantages of electrical insulation and freedom from corrosion. A new nylon screw, introduced by Flora Plastics Ltd., Duke Street House, 415 Oxford Street, W.1., incorporates several very novel features which are the subject of patent application. The screw has a cross-slot

at the head which terminates near the ends. From the centre of this slot, a narrow bore extends into the body of the screw. The screwdriver recommended should have a spigot projecting from the centre of its blade to fit into this central bore, whereupon it acts as a carrier for the screw whilst the hole is being located. Further features are a self-threading action ensuring firm engagement and preventing loosening under vibration, and availability in any colour to match particular presentations.



radio topics

BY RECORDER

EVERY TECHNICALLY MINDED PERSON MUST wince now and again when he encounters what seems to him to be a glaring misuse of a familiar term. I should imagine, for instance, that most of us feel irritated by the increasingly common habit, in lay circles, of referring to transistor radios as "transistors". Indeed, a recent pop song goes so far as to credit its heroine with the especial attribute of possessing a "pocket transistor" (the hero couldn't "resist 'er"). When I first heard this song an unbelievable image arose in my mind of a stiletto-heeled young lady enticing her admirers by waving an OC71 at them. (I understand that no electronic pun is intended in the rhyme for "transistor".)

My own pet annoyance is the description of people using public address systems as "shouting through loudspeakers". This phrase is quite often heard in conversation and occasionally appears in evidence in the courts. We all know the person who uses the Speakers' Corner approach to a microphone—on the assumption that what goes in loudest must come out loudest—but the phrase still doesn't accurately describe even this instance, because the resultant noise from the loudspeaker or loudspeakers is derived from a pair of output valves (normally) and not directly from the orator's vocal cords. The real trouble is, I suppose, that we do not have a single word which can cover the act of speaking into a microphone for reproduction, at amplified level, from a loudspeaker. The only possible verb I can think of to fill this gap at the moment is "to electrociferate". Have readers any ideas?

Using P.A. Systems

Apart from the terms used to describe the act of using a public address system it is a

regrettable fact that, even in these days, such systems are themselves quite often misused. Our broadcasting authorities are not entirely blameless here, and one occasionally encounters a sound or television programme in which audience loudspeakers are turned up so high that quite obvious "singing" takes place. "Singing" is the effect which occurs when the p.a. system is just short of going into oscillation.

Turning fully to the practical side of sound amplification, a basic p.a. system consists of a microphone, an amplifier, and one or more loudspeakers. The person setting up the system has to ensure that the microphone is in a convenient position and that the loudspeakers are so placed that they provide optimum sound for the audience. At the same time he also has to ensure that only a small proportion of the sound from the loudspeakers finds its way back to the microphone. If this last precaution were not observed, and assuming sufficient gain in the amplifier, a positive feedback loop could be set up whereupon the whole system would break into oscillation.

When p.a. systems are employed in small halls, feedback to the microphone may be given by reflections from the walls, and this adds a complicating factor to the process of setting up loudspeakers. It is a good plan to aim loudspeakers directly at the audience, since these good people offer quite good sound absorption! Taking advantage of any hangings in the hall (curtains, decorations, etc.) may also be helpful. Direct feedback from the speaker to the microphone in a hall may often be reduced considerably by taking advantage of the hall's structure. Obviously, loudspeakers should be mounted forward and reasonably well away from the microphone. If pillars or wall buttresses, etc., can

be interposed immediately behind loudspeakers a surprising reduction in feedback can sometimes be realised.

When the combination of feedback from a loudspeaker to the microphone together with amplifier gain is too great oscillation occurs, and the result is an audible howl. If the overall response of the p.a. system (including microphone and loudspeaker) has a pronounced peak at any particular frequency, oscillation will very probably occur at that frequency. This is because it is here that overall gain is greatest. It follows that if the overall p.a. system has a smooth response curve it becomes possible to obtain greater amplification at all frequencies covered before oscillation takes place. When a high quality p.a. system is employed in a small hall the frequency at which oscillation first takes place may be partly governed by standing waves set up in the hall itself.

A hint which I have found useful in the past applies to p.a. amplifiers which are used extensively for microphone work. It is a good plan to fit an amplifier in this category with a pre-set microphone gain potentiometer in addition to the manually operated control. When the loudspeakers and microphone have been set up for optimum results at a particular installation the pre-set gain control may then be set up such that, with the manual gain control at maximum, the system is just free from "singing". When the p.a. system is later brought into use it then becomes impossible to accidentally introduce a feedback howl by setting the manual gain control too high.

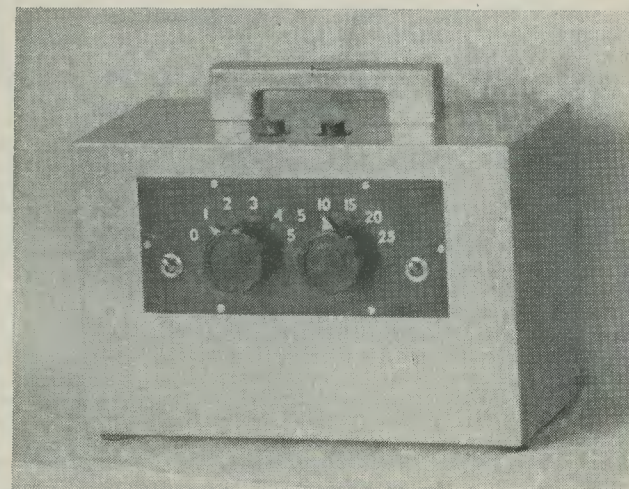
An interesting approach to the problem of acoustic feedback in p.a. systems (particularly when these are used in halls) was described in *Radio-Electronics* last year.¹ The approach consists of shifting all the frequencies in the microphone signal by a small but constant amount. Since the frequency of the sound from the loudspeaker is now shifted from that fed to the microphone, feedback oscillation occurs much less readily. With speech, shifts in frequency of

a few c/s are nearly imperceptible, and shifts of as much as 20 c/s may still be tolerable.

In the system invented by M. R. Schroeder, the author of the *Radio-Electronics* article, a convenient frequency shift could be 5 c/s. The signal frequency may be amplitude modulated on a carrier of, say 20 kc/s, after which the carrier and lower sideband can be removed and the upper sideband demodulated (s.s.b. fashion) by an injected carrier of 19,995 c/s. The result is a shift of 5 c/s. The increased gain possible in the frequency-shift p.a. system is of the order of 6 to 8dB.

Two Letters

G. A. French's "Suggested Circuits" series is, I think, one of the major attractions of this magazine. To produce a brand new circuit every month (and he's been doing it now for well over ten years) represents no mean achievement. This comment is prompted by a letter received recently from Mr. J. Smeed of Ashford, Middlesex, who built the process timer described in "Suggested Circuit No. 78" (published in our



May 1957 issue) and states that "this has been used for many photographic enlargements with every success". A photograph of the timer (taken by Mr. Smeed's son) accompanies this contribution. I thought I would include it here as it looks such a nice, neat job.

Another letter (received a little while ago and held back for lack of space) is from Mr. H. Wright of Doncaster. After he had inserted an entry in our "Can Anyone Help?" column, Mr. Wright received two replies,

¹ M. R. Schroeder (Bell Telephone Laboratories, Inc.), "Stop Feedback In Public Address Systems", *Radio-Electronics*, February, 1960.

one of which corrected several points in his original request. Mr. Wright's letter continues:

"This service you give is certainly a worthwhile one, and I am sure that at least another two people will be looking through the column to see if they can go to someone else's assistance.

"Both the letters I have just mentioned were of a genuine sort, even before I had corresponded, and this sort of experience certainly helps to draw the North and South together."

The essential spirit behind the "Can Anyone Help?" feature is that of mutual help between people engaged in the same hobby and interests. It is pleasant to see this spirit expressed in the practical manner described by our reader.

More TV DX

Mr. I. C. Beckett, of Buckingham, whose long distance television reception results were described in our issue for last November, still continues with the good work. Earlier this year he erected a 5 element horizontally polarised Band I aerial but, up to and including the first two weeks of March, received no Continental transmissions. After the 14th of March, however, the signals started rolling in, and he converted his Philips 1768U receiver (previously modified for negative modulation 625 line signals by reversing the vision detector and reducing the value of the line oscillator grid leak) back to positive modulation. The signals received were Belgian 625 line transmissions on 48.25 Mc/s (vision) and 53.75 Mc/s (sound), these having positive vision modulation and a.m. sound (as opposed to the negative vision modulation and f.m. sound employed in all other 625 line systems). On some days the Belgian signals were received at such strength that contrast had to be turned right back. French 819 line signals (again, positive vision modulation and a.m. sound) were also received but, as Mr. Beckett's line timebase could not be advanced sufficiently high, had to be resolved as two pictures side by side.

My latest news from Mr. Beckett (20th April) is that he has converted his receiver back to negative modulation again, and is receiving strong t.v. signals from West Germany.

I should mention also that, this year, Mr. Beckett has changed the first vision i.f. stage in his receiver from EF80 to EF184. The EF184 is a frame-grid i.f. amplifier having the same pin connections as the EF80 and a gm of some 15mA/V as compared with approximately 7.5 mA/V in the EF80.

News in Brief

The trend towards miniaturisation is carried further with the introduction, by Erie Resistor Ltd., of their type 15 miniature fully-moulded carbon resistor. The type 15 resistor is available from 10Ω to 10MΩ in tolerances of 5, 10 and 20%, and has a wattage rating of 0.1 watt at 70°C. Its dimensions are 0.2in long by 0.095in in diameter.

Noise, especially excessive noise, plays an increasingly important part in modern life. However, it is not always an easy matter to measure noise or to express its intensity in generally acceptable terms. A solution to this problem is available from Advance Components Ltd., who have negotiated to manufacture under licence in this country a Sound Spectrometer designed by Peekel Laboratorium voor Electronica N.V. of Holland. The Advance Sound Spectrometer will be known as type SPM.1. It is small and easily handled, and is available for immediate delivery.

The first wireless distress signal—in those days QOD—to bring about a rescue at sea was sent by John Robinson Binns of Peterborough on 23rd January, 1909. Jack Binns was the Marconi radio operator on the trans-Atlantic liner *Republic* when his ship was rammed in thick fog by the Italian liner *Florida* not far from Sandy Hook. Recognition of his courage and devotion to duty—which resulted in the saving of nearly 2,000 lives—came from both sides of the Atlantic. Jack Binns afterwards settled in the U.S. and progressed to becoming president of the Hazeltine Corporation before his death in 1959 at the age of seventy-five. On 11th April this year medals and citations awarded to Jack Binns in 1909 were handed over to the Peterborough Museum Society by Mr. R. Ferguson, managing director of The Marconi International Marine Communication Company Ltd., acting on behalf of Mrs. Alice Binns of New York.

Why do fewer students elect to read for technological qualifications in this country than in the U.S.A. or Russia? This question, of vital importance in the future technological standing of Britain, is to be investigated by the University of Oxford Department of Education under its director, Mr. A. D. C. Peterson. This research will occupy a period of two years and has been made possible by a grant of £2,500 to the University from Capitol Radio Engineering Institute of Washington through their International Division, C.R.E.I. (London). A preliminary study conference of representatives from schools, colleges of technology and industry has already taken place.

A RADIO TELESCOPE FOR D.S.I.R.

New Instrument on Berkshire Site

A fully-steerable radio telescope is to be built at a site near Crowthorne, Berkshire, by the Ministry of Works for the Radio Research Station of the Department of Scientific and Industrial Research. It is expected to be completed and in operation towards the end of 1963 at an estimated overall cost of £250,000, including buildings, equipment and site services.

The radio telescope, which will have a parabolic aerial about 80 ft. in diameter, is needed by D.S.I.R.'s radio scientists for their work in the space research programme and to study certain other aspects of radio science.

It will have high accuracy and a faster tracking speed than the 250 ft. radio telescope at Jodrell Bank, an essential requirement for following earth satellites and determining orbital data. It will be used to receive weak signals from distant space vehicles transmitting at ultra-high frequencies.

In the field of radio astronomy, an application of the telescope will be a study of radio noise from the sun, including sudden increases in radio emission which are related to disruption in Shortwave communications. Also of interest is the radio noise from planets.

The telescope will be valuable in extending investigations of the properties of the upper and lower atmospheres which are important in both terrestrial and space communications. This feature will assume even greater significance in the next few years when satellites for communications, as well as for research purposes are likely to come into use.

In considering this project for D.S.I.R., the Council for Scientific and Industrial Research were advised by a small sub-committee. Its members were: Professor Sir Bernard Lovell, F.R.S., (Manchester University), Professor Martin Ryle, F.R.S., (Cambridge University) and Dr. J. S. Hey, (the Royal Radar Establishment, Malvern).

COMPREHENSIVE TELEVISION INSTALLATION AT STANDARD-TRIUMPH

New Techniques for Inspection Control

Thirteen Marconi closed circuit television camera channels and associated equipment form an integral part of a new automatic routing system to facilitate the inspection of new car bodies at the Standard-Triumph Motor Company's Works at Coventry. The installation is claimed by Standard-Triumph to be unique and the most advanced in the world in terms of efficiency and rigidity of control.

The cars arrive on conveyor belts from the manufacturing areas into a new extension hall for further inspection. Each of the various types of vehicle is carried in a special skip which incorporates trip devices peculiar to the type it is intended to carry. These trips actuate routing mechanisms on the conveyor belt system to channel the vehicles to their correct destinations in the area quite automatically. Here they undergo a series of stringent inspections after which the "passes" are automatically delivered to other floors while any rejects are diverted along a rectification line for further work to be done on them.

The closed circuit television installation fulfils several functions in the routing and inspection processes, and for these the cameras are installed at strategic points within the area. At a central Control Room, five Marconi 14 in. monitors provide pictures from five cameras mounted in various parts of the body storage area enabling controllers to identify the various types of car bodies passing along the conveyor belts and to keep the Programming Department constantly informed of the current position. Details of the colour and other relevant data are carried in code form on a card attached to each vehicle.

Any of the remaining eight cameras can be switched to the sixth picture monitor thus enabling a controller to keep a close watch on the passage of vehicles at all stages of progress. The use of television enables all supervision to be carried out from a central point, removing the necessity for an operator stationed at every point equipped with an open telephone line to the Programming Dept.

The Marconi installation consists of thirteen camera channels Type BD871 and eight 14 in. picture monitors Type BD879, together with ancillary equipment. The thirteen control units, which form part of the camera channels are contained in a single rack-mounting unit with an oscilloscope for monitoring purposes.

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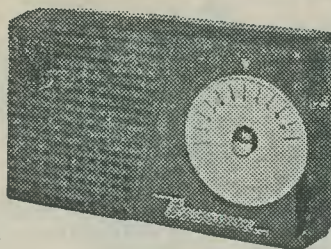
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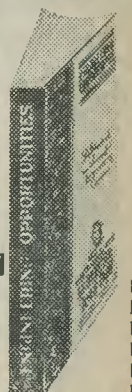
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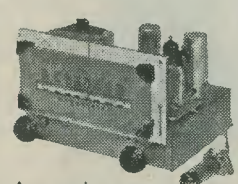
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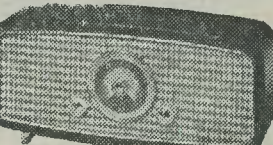
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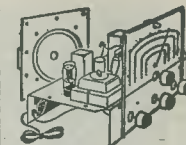
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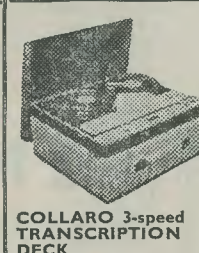
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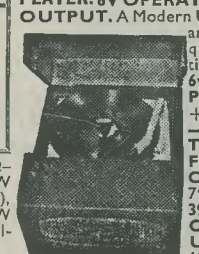
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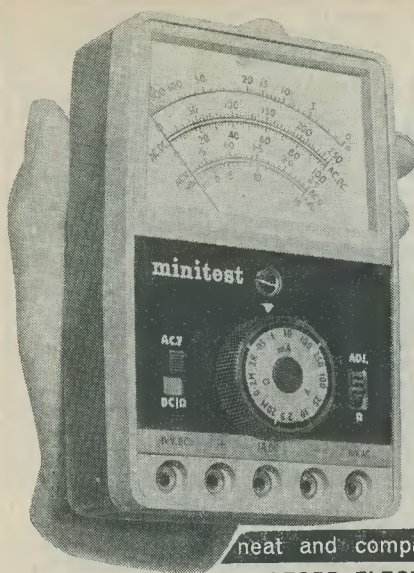
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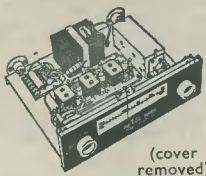
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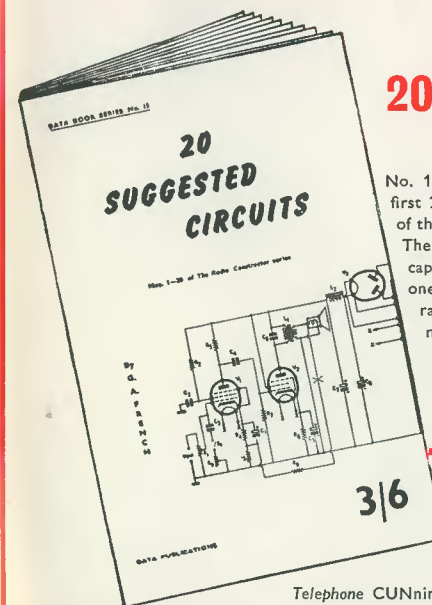
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