VALVE & SERVICE REFERENCE MANUAL

Mullard

ABACS · CHARTS · VALVE DATA · CIRCUITS
CALCULATIONS · REFERENCE DATA

PRICE FIVE SHILLINGS

VALVE
&
SERVICE
REFERENCE MANUAL

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Mullard

MULLARD ELECTRONIC PRODUCTS LIMITED
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PREFACE

The MULLARD VALVE AND SERVICE GUIDE has been compiled to meet the particular needs of the Service Engineer and the Advanced Amateur. To this end, the maximum amount of information on valve performance under working conditions has been included.

The contents are so arranged that performance data on any valve can be quickly found under the appropriate heading. At the same time the book is lavishly cross-indexed to give instant information on such matters as base connections, base types and heater characteristics.

In view of the extension of the activities of the Service Engineer to cover maintenance of industrial electronic equipment, oscilloscope tubes, flash tubes, neon stabilisers, photocells and thyratrons have been included.

Data on preferred valves are grouped under headings covering different valve applications, and typical circuits have been inserted where necessary. If a valve is suitable for more than one application, complete data is given under each relevant heading. Every endeavour has been made to include all normal applications, but if additional information is required it can be obtained by applying to Mullard Electronic Products Ltd., Technical Service Department (Valve Division), Century House, Shaftesbury Avenue, London, W.C.2.

Abridged tabulated information on " maintenance " types, together with comprehensive substitution tables and lists of equivalents follow the data on preferred valves.

The conventional symbols have been used throughout and for convenience in reference a list of these symbols is provided on a linen fold-out, which can be consulted side-by-side with the data pages.

Circuits for a variety of apparatus including receivers, amplifiers and power packs, are given in Section 12, and general technical data, including abacs, tabulated information and formula will be found at the end of the book.

CONTENTS

GENERAL INDEX TO VALVE TYPES

In this section every valve included in this Manual is listed in alpha-numerical order. The figures in brackets refer to the base connection diagrams in Section 8, pp. 159 to 165.

VALVE APPLICATION INDEX

In this section all valves in the preferred ranges are listed under headings describing their normal applications.

Valves which are suitable for more than one type of application are included under all appropriate headings. Thus, the EF37 is listed as a R.F. pentode and also as an A.F. voltage amplifying pentode.

Filament or heater ratings and other abridged information is also given.

1. R.F. PENTODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DF70	0.625	0.025	Sub-miniature. Sharp cut-off ...	18
DF33	1.4	0.05	Variable-μ	17
DF91	1.4	0.05	do.	18
KF35	2.0	0.05	do.	27
EF22	6.3	0.2	do.	20
EF37	6.3	0.2	Low microphony. Sharp cut-off	21-65-72
EF39	6.3	0.2	Variable-μ	22
EF41	6.3	0.2	do.	23
EF92	6.3	0.2	Miniature. Variable-μ	27
EF50	6.3	0.3	Short-wave. Sharp cut-off ...	24
EF54	6.3	0.3	V.H.F. Sharp cut-off	25
EF91	6.3	0.3	Miniature. Sharp cut-off	26-37
EF42	6.3	0.33	High slope. Sharp cut-off ...	23
UF41	12.6	0.1	Variable-μ.	28-74
UF42	21.0	0.1	High slope. Sharp cut-off	29

2. R.F. PENTODES WITH DIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DAF91	1.4	0.05	Single diode. Sharp cut-off	17-47-71
EAF41	6.3	0.2	do. do. Variable-μ ...	19-48
EAF42	6.3	0.2	do. do. do. ...	20-48-65
UAF42	12.6	0.1	do. do. do. ...	28-52-73

3. FREQUENCY CHANGERS

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DK32	1.4	0.05	Heptode. Variable-μ	31
DK91	1.4	0.05	do. do.	32
KK32	2.0	0.13	Octode. Variable-μ	40
KCF30	2.0	0.2	Triode-Pentode. Variable-μ ...	39
EK32	6.3	0.2	Octode. Variable-μ	38
ECH42	6.3	0.225	Triode-Hexode. Variable-μ ...	36
EAC91	6.3	0.3	V.H.F. Diode-Triode	32-55
ECH35	6.3	0.3	Triode-Hexode. Variable-μ ...	35
EF91	6.3	0.3	R.F. Pentode mixer at 45 $M_{c/s}$ ...	37-26
ECH21	6.3	0.33	Triode-Hexode. Variable-μ ...	33-147
CCH35	7.0	0.2	do. do. ...	31
UCH42	14.0	0.1	do. do. ...	42
UCH21	20.0	0.1	do. do. ...	41

4. SINGLE AND DOUBLE DIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EA50	6.3	0.15	Miniature. Single diode	48
EB34	6.3	0.2	Double diode. Separate cathodes	49
EB41	6.3	0.3	do. do. do. do.	49
EB91	6.3	0.3	Miniature double diode. Separate cathodes	49
UB41	19.0	0.1	Double diode. Separate cathodes	52

5. VOLTAGE AMPLIFYING TRIODES AND DOUBLE TRIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EC31	6.3	0.65	Low impedance single triode ...	58
ECC33	6.3	0.4	Double triode. Separate cathodes	59
ECC35	6.3	0.4	do. do. do. do.	61
ECC91	6.3	0.45	Miniature double triode. Common cathode	63-115
ECC40	6.3	0.6	Double triode. Separate cathodes	62
ECC31	6.3	0.95	do. do. Common cathode	58
ECC32	6.3	0.95	do. do. Separate cathodes	58
ECC34	6.3	0.95	Low impedance double triode. Separate cathodes	60

6. VOLTAGE AMPLIFYING TRIODES WITH DIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DAC32	1.4	0.05	Single diode...	47-55
KBC32	2.0	0.05	Double diode	51-64
EBC33	6.3	0.2	do. do.	50-56
EBC41	6.3	0.2	do. do.	50-56
EAC91	6.3	0.3	Single diode...	55
UBC41	14.0	0.1	Double diode	53-64

7. VOLTAGE AMPLIFYING PENTODES AS TRIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EAF42	6.3	0.2	... ...	65
EF37	6.3	0.2	... ...	65

8. OUTPUT TRIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EC31	6.3	0.65	Low impedance	67
DO30	4.0	2.0	do. do.	67

9. OUTPUT PENTODES AS TRIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EL32	6.3	0.2	... ...	69
EL33	6.3	0.9	... ...	70
EL37	6.3	1.4	... ...	70
CL33	33.0	0.2	... ...	69

10. A.F. VOLTAGE AMPLIFYING PENTODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EF37	6.3	0.2	... ...	72
EF40	6.3	0.2	... ...	73
UF41	12.6	0.1	... ...	74

Type	V_h or V_f (V)	I_h or I_f (A)		Pages

11. VOLTAGE AMPLIFYING PENTODES WITH DIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DAF91	1.4	0.05	Single diode	47-71
UAF42	12.6	0.1	do. do.	52-73

12. OUTPUT PENTODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
DL71	1.25	0.025	Sub-miniature	78
DL72	1.25	0.025	do.	79
DL35	1.4	0.1	... ...	77
DL33	1.4 / 2.8	0.1 / 0.05	... ...	77
DL92	1.4 / 2.8	0.1 / 0.05	Miniature	79
DL93	1.4 / 2.8	0.2 / 0.1	do.	80-131
DL94	1.4 / 2.8	0.1 / 0.05	do.	81
KL35	2.0	0.15	... ...	94
KLL32	2.0	0.3	Double pentode	94
EL91	6.3	0.2	4-watt miniature	93
EL42	6.3	0.2	6-watt for car radio	91
EL32	6.3	0.2	8-watt	85
EL41	6.3	0.7	9-watt	91
EL33	6.3	0.9	9-watt	86
EL35	6.3	1.35	18-watt	87
EL31	6.3	1.4	25-watt	84
EL37	6.3	1.4	25-watt	88
EL38	6.3	1.4	25-watt. Line time base output valve. A.C. television receivers	90
PL33	19.0	0.3	9-watt.	95
PL38	30.0	0.3	25-watt. Line time base output valve. D.C./A.C. television receivers ...	96
CL33	33.0	0.2	9-watt	76
UL41	45.0	0.1	9-watt	98

Wattage shown refers to anode dissipation (p_a. max.).

13. OUTPUT PENTODES WITH DIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EBL21	6.3	0.8	11-watt. Double diode	51-82
EBL31	6.3	1.5	9-watt. do. do.	51-83
CBL31	44.0	0.2	9-watt. do. do.	47-75
UBL21	55.0	0.1	11-watt. do. do.	53-97

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14. RECTIFIERS

Type	V_h or V_f (V)	I_h or I_f (A)				Pages
HVR2	4.0	0.65	I.H.	H.W.	High voltage ...	105
AZ31	4.0	1.1	D.H.	F.W.	2×500 V 60 mA	99
FW4–500	4.0	3.0	I.H.	F.W.	2×500 V 250 mA	103
GZ32	5.0	2.0	I.H.	F.W.	2×350 V 250 mA	104
EY51	6.3	0.08	I.H.	H.W.	High voltage. Miniature ...	100
EY91	6.3	0.42	I.H.	H.W.	250 V 75 mA Miniature ...	101
EZ41	6.3	0.4	I.H.	F.W.	2×250 V 60 mA	103
EZ35	6.3	0.6	I.H.	F.W.	2×325 V 70 mA	102
EZ40	6.3	0.6	I.H.	F.W.	2×350 V 90 mA	102
PY31	17.0	0.3	I.H.	H.W.	250 V 125 mA	105
CY31	20.0	0.2	I.H.	H.W.	250 V 120 mA	99
UY41	31.0	0.1	I.H.	H.W.	250 V 90 mA	108
UY21	50.0	0.1	I.H.	H.W.	250 V 140 mA	107
PZ30	52.0	0.3	I.H.	F.W.	2×240 V 400 mA	106

I.H. = Indirectly Heated. For D.C./A.C. television receivers.
D.H. = Directly Heated.
F.W. = Full-wave. H.W. = Half-wave.

15. ELECTRON BEAM INDICATORS

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EM34	6.3	0.2	Twin beam	109
UM34	12.6	0.1	do. do.	109

16. V.H.F. TRIODES

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
EC53	6.3	0.25	Low power oscillator	111
EC91	6.3	0.3	Grounded grid	112
EC52	6.3	0.43	Low power oscillator	111

17. TRANSMITTING VALVES AND MERCURY VAPOUR RECTIFIERS

Type	V_h or V_f (V)	I_h or I_f (A)		Pages
ME1001	6.3	0.4	Disc seal triode	115
ECC91	6.3	0.45	2×1.5-watt double triode... ...	115-63
TY2–125	6.3	5.4	135-watt U.H.F. triode... ...	116
QVO4–7	6.3	0.6	7.5-watt beam tetrode... ...	117
QVO5–25	6.3	0.9	25-watt beam tetrode... ...	119
QY2–100	10.0	5.0	100-watt beam tetrode... ...	121
QY3–125	5.0	6.5	125-watt R.F. tetrode	123
QQVO4–20	6.3 / 12.6	1.6 / 0.8	2×10-watt double beam tetrode ...	124
QQVO6–40	2×6.3	2×1.25	2×20-watt double tetrode ...	127
QQVO7–40	6.3 / 12.6	2.5 / 1.25	2×20-watt double tetrode ...	128
QQZO4–15	6.3	0.65	2×8-watt double tetrode ...	130
DL93	1.4 / 2.8	0.2 / 0.1	Miniature R.F. power amplifier ...	131-80
RG1–240A	4.0	2.7	1,250 mA mercury vapour rectifier	131
RG3–250	2.5	5.0	1.0 A mercury vapour rectifier ...	132

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Type	V_h or V_f (V)	I_h or I_f (A)		Pages
18. NEON STABILISING TUBES				
4687 & 4687A	90–110 V	20–40 mA	... ...	135
7475	90–110 V	4– 8 mA	... ...	135
85A1	83– 86 V	4.5 mA	... ...	136
19. OSCILLOSCOPE AND PICTURE TUBES				
ECR30	4.0	1.0	3 ins dia. Oscilloscope. Green screen	137
ECR35	4.0	1.0	3½ ins. dia. do. do. do.	137
ECR35P	4.0	1.0	do. do. Blue do.	137
ECR60	4.0	1.0	6 ins. dia. do. Green screen	138
MW22–7	6.3	0.6	9 ins. dia. Picture Tube ...	139
MW22–14 } MW22–14C }	6.3	0.3	9 ins. dia. do. do.	139
MW31–14C	6.3	0.3	12 ins. dia. do. do.	140
20. GAS-FILLED TRIODES AND TETRODES				
EN31	6.3	1.3	Thyratron	141
1267	—	—	Cold cathode triode	141
2D21	6.3	0.6	Tetrode for relay purposes ...	142
21. PHOTOGRAPHIC FLASH TUBES				
LSD2 ...	... ...		56 joules	143
LSD3 } LSD3A }	... ...		100 do.	143
LSD4 ...	... ...		400 do.	143
LSD7 ...	... ...		200 do.	143
22. PHOTO CELLS				
20AV ...	... ...	...	... ...	146
20CG ...	... ...	...	... ...	146
20CV ...	... ...	...	... ...	146
90AV ...	... ...	...	... ...	146
90CG ...	... ...	...	... ...	146
90CV ...	... ...	...	... ...	146

VALVE TYPE NOMENCLATURE

I. RECEIVING VALVES

The type nomenclature for Mullard Receiving Valves generally consists of two or three letters followed by two figures. These symbols provide information concerning the principal uses of the valves, the heater or filament rating, and the type of base, according to the following code :—

The first letter indicates the filament or heater voltage or current :

A—4.0 V filament
C—200 mA heater
D—1.2 V to 1.5 V filament
E—6.3 V heater
G—5.0 V heater
K—2.0 V filament
P—300 mA heater
U—100 mA heater

The second and subsequent letters indicate the general class of valve :

A—single diode
B—double diode
C—triode
D—output triode
E—tetrode
F—Voltage amplifying pentode
H—Hexode
K—Heptode or octode
L—output pentode
M—electron beam indicator
N—gas triode
*P—secondary emission valve
W—half-wave gas-filled rectifier
X—full-wave gas-filled rectifier
Y—half-wave rectifier
Z—full-wave rectifier

*Used as a third letter only.

Note : Two of the above letters may be combined, e.g., BC—double diode triode.

The first figure indicates the type of base :

2—B8G (Loctal) base
—Octal base
4—B8A base
5—B9G and other special bases
7—Sub-miniature construction
9—B7G base

The second figure indicates the order of development, and serves to distinguish between two or more valves of the same type but of different performance ratings.

Example : ECH35	E	C	H	3	5
	6.3 V heater	triode	hexode	octal base	fifth development

VALVE TYPE NOMENCLATURE

2. TRANSMITTING VALVES

The type nomenclature for valves included in the Transmitting and Industrial range consists of two or more letters followed by two sets of figures. These symbols provide information concerning the principal uses and power ratings of the valves, according to the following code. It is pointed out, however, that in a very few instances, it has not been possible to adhere strictly to this code.

The first letter indicates the general class of valve :

M—Triode suitable for use as a low frequency power valve in amplifiers, or as a modulator in transmitting equipment.
P—R.F. power pentode
Q—R.F. power tetrode
T—R.F. power triode
R—Rectifier

Note : For valves having dual systems, the code letters for both systems are used—e.g., " QQ " denotes a double tetrode.

The second letter indicates the type of cathode :

X—Directly heated. Tungsten filament.
Y—Directly heated. Thoriated Tungsten filament.
*Z—Directly heated. Oxide-coated filament.
V—Indirectly heated. Oxide-coated cathode.

* For mercury-vapour rectifiers, all of which have oxide-coated filaments, the letter " G " is used in place of " Z ", to avoid confusion with high vacuum rectifiers.

The third letter. Valves having silica envelopes are distinguished by the letter " S " following the second letter of the type nomenclature.

The first group of numbers, immediately following the letters shows the approximate anode voltage in kilovolts :

Thus, 05 represents 0.5 KV = 500 V.
1 represents 1 KV = 1,000 V.
2 represents 2 KV = 2,000 V.

The second group of figures varies in significance according to the type and size of the valve :

(*a*) For L.F. and R.F. power valves up to 5 KW dissipation, the figures indicate the maximum permissible anode dissipation in watts ;

(*b*) For larger water-cooled valves the figures indicate the output in kilowatts—the anode dissipation of such valves is not usually an important limiting factor ;

(*c*) For all types of rectifiers the figures indicate the maximum rectified output current in milli-amperes per valve.

Examples :

QY2–100 —R.F. power tetrode with thoriated tungsten filament. Rated to work at 2,000 V and to dissipate 100 watts continuously.

QQV07–40 —Twin beam-tetrode with indirectly-heated oxide-coated cathode. Rated to work at 750 V and to dissipate 40 watts continuously (20 watts at each anode).

TX12–20W —R.F. power triode, water-cooled, with tungsten filament. Rated to work at 12,000 V and for an output of 20 KW.

RG3–250 —Mercury-vapour rectifier rated to work at 3,000 V and to give a maximum rectified output of 250 mA.

GENERAL OPERATIONAL RECOMMENDATIONS

I. VACUUM VALVES

Interpretation of Data

The principal characteristics quoted for each valve in this book are normally those corresponding to a value of anode current representing typical operating conditions. The control grid voltage given for this anode current is approximate only, the anode current being taken as the standard.

The values given are the mean values of measurements made on a large number of valves.

Where the "equivalent noise resistance" (R_{eq}) is quoted, this is the value of a resistance which, if introduced into the grid circuit of a perfectly noiseless valve, would produce noise of the same level as that of the shot and partition noise occurring in the actual valve.

The values of input damping resistance represent the extent to which a parallel tuned circuit would be damped by the valve at the stated frequency.

Limiting Values

The operating maxima quoted on individual data sheets should on no account be exceeded. The following general limitations should also be observed, and should be interpreted in conjunction with British Standard Specification No. 1106, "Code of Practice on the Use of Radio Valves in Equipment", upon which these notes have, in part, been based.

Where reference is made to a particular electrode, it should also be considered as referring to an electrode performing a similar function in a more complex valve

Filament

(a) *Valves with 2-volt Filaments*

The filament voltage should be maintained between $\pm$ 7 per cent. of the rated value. If, however, some variation of the valve characteristics is acceptable, the filament voltage limits may be extended to $\pm$ 10 per cent.

(b) *Valves with 1.4-volt Filaments*

(i) *Dry-battery Operation.* Valves with 1.4-volt filaments are designed to be operated from a dry-cell battery with a rated terminal voltage of 1.5 V. In no circumstances should the voltage across any 1.4-volt section of filament exceed 1.6 V. If these valves are operated with their filaments in series from dry batteries with a higher terminal voltage, shunting resistors may be required to ensure the correct voltage across individual 1.4-volt filaments.

(ii) *Accumulator or Mains Operation.* When valves with 1.4-volt filaments are operated from an accumulator or from a mains supply unit, the voltage drop across each 1.4-volt section of filament of valves with rated filament current should have a nominal value of 1.3 V and should be maintained between 1.25 V and 1.4 V at normal line voltage, that is to say at voltages equivalent to 2 volts per cell for accumulators or to nominal line voltage for supply mains. If the filaments are operated in series, shunting resistors may be required to ensure the correct voltage across individual 1.4-volt filaments.

(c) *Thoriated Tungsten Filaments*

With thoriated tungsten and oxide-coated filaments, temporary variations of filament voltage due to mains fluctuations and so forth are permissible provided they do not exceed $\pm$ 5 per cent.; but any permanent deviation from the published figures will definitely reduce the life of the valve. With this type of filament under-running may result in more serious damage than over-running.

Heater (indirectly-heated valves)

Heater voltages should be maintained within $\pm$ 7 per cent. of the rated values. Under-running the heater may cause as much damage to a valve as over-running. Where it is permissible to operate heaters in series, this is clearly stated in the data. When heaters are so operated the heater current should be maintained within $\pm$ 5 per cent. of the rated value.

Cathode

Cathode voltages, with respect to earth, should be kept as low as possible. Maximum values for specific valves are indicated in the data.

In order to avoid hum and instability, the heater-cathode path should not be included either in the A.F. or the R.F. circuit. This precaution is particularly important where the signal level is low.

Disintegration of the cathode coating may occur in both indrectly-heated and directly-heated rectifiers if the total resistance in series with the anode is less than that specified in the data for the particular valve. The value of the resistance depends upon the effective resistance, R_t, due to the transformer.

$$R_t = R_s + n^2R_p$$

where :

R_s = Resistance of the transformer secondary in anode circuit.
R_p = Resistance of the transformer primary.
n = Primary to secondary ratio in half-wave circuits or primary to half secondary ratio in full-wave circuits.

If the resistance R_t is less than the minimum specified value for the series resistance, an additional series resistance must be included.

The maximum cathode-to-heater voltage specified for a particular valve is intended to be the D.C. value or the peak A.C. value. This point should receive particular attention in inverse feed-back circuits in which the cathode bias resistor is not decoupled.

Control Grid

The resistance in series with the control grid must be kept as low as possible, and should in no circumstances exceed the maximum value quoted in the data. Care should be taken when selecting valves for use as oscillators or for other circuit conditions where appreciable grid current is drawn, to ensure that the maximum grid ratings are not exceeded.

f grid bias is provided by grid rectification, precautions should be taken to ensure that the valve ratings will not be exceeded in the event of loss of drive. Normally this risk is avoided by providing a certain amount of cathode bias.

Screen Grid

In circuits where large anode voltage swing occurs, care should be taken that the maximum screen-grid dissipation is not exceeded.
The method of feeding the screen grid will have a considerable effect on the cross-modulation characteristics of valves designed for operation over a large A.V.C. range. Recommendations in this connection are given in the data for individual valves.

Suppressor Grid

Suppressor grids should be maintained at cathode potential, except in applications for which conditions involving the application of voltage to the suppressor grid are quoted in data.
For applications where it is desired to employ the secondary emission characteristic of a valve, it should be noted that this characteristic may vary considerably between valve and valve, and the circuit design should not be critical in this respect. On account of this variability, the use of this characteristic is in general not recommended.

Mounting

Care should be taken when mounting in a horizontal position indirectly-heated valves having high mutual conductance and directly-heated valves having long filaments to ensure that the major axis of the first grid or the plane of the filament is vertical. The direction of this plane is indicated in the data of all valves to which this recommendation applies.
Valves not falling within this category may be mounted in any position.

Ventilation

Adequate ventilation for the dissipation of heat must be provided, particularly for power valves and rectifiers.

General

Valves should not be operated without a D.C. connection between each electrode and the cathode. Any apparent advantage to be gained by so doing may be neutralised by secondary emission from the electrode concerned.

2. MERCURY VAPOUR RECTIFIERS

Filament Supply

(*a*) When a mercury vapour rectifier is first installed, and before it is put into service, the valve should be run for at least half an hour at its normal filament voltage but without H.T., in order to vaporise any mercury which may have been deposited on the anode or cathode during transit. This precaution should also be taken before putting into service a mercury vapour rectifier which has been out of use or in store for any considerable period.

(*b*) When starting up the equipment at any time. the filament must be allowed to attain full working temperature and the condensed mercury temperature

must be within the prescribed limits, before the anode supply is switched on. Unless otherwise stated, this requires a delay of at least one minute and considerably longer if the ambient temperature is appreciably less than the prescribed condensed mercury temperature. The delay is preferably obtained by an automatic switch.

Neglect of either precautions (*a*) or (*b*) may result in immediate and irreparable damage to the valve.

(*c*) It is very important that the filament voltage is accurately adjusted to the correct value. A permanent deviation greater than 2 per cent. may result in a considerable reduction in the life of the valve. Temporary fluctuations, not exceeding 5 per cent., will not appreciably affect the life of the valve.

(*d*) To ensure maximum life from a directly heated valve, it is advisable that the filament supply should be $90\% \pm 30\%$ out of phase with the anode supply.

Mounting and Cooling

Mercury vapour rectifiers must always be mounted vertically with the cathode connections at the lower end.

Any increase of temperature above the specified value reduces the safe peak inverse voltage of the valve.

Free circulation of air must be provided and if any form of screening box is employed it must have suitable openings at top and bottom for ventilation. It is preferable, however, to use expanded metal or close wire mesh for the screen.

The figures for the condensed mercury temperatures specified in the data should be taken as the limiting conditions, since this is the factor which determines both the safe peak inverse voltage and the life of the cathode. The ambient temperature is given only for guidance in equipment not using forced air cooling.

Screening and R.F. Filter Circuits

(*a*) In order to prevent ionisation of the mercury vapour (and consequent flash-over) due to strong R.F. fields, it may be necessary to enclose the rectifiers in a separate earthed screening box. For the same reason R.F. filters should be employed to prevent high-frequency current being passed back to the rectifiers, by way of the H.T. supply leads or other wiring.

(*b*) High-frequency disturbances, usually due to oscillation in the transformer windings, are often produced by mercury vapour rectifiers, and may cause interference in receiving apparatus situated near the rectifier unit. Small R.F. chokes or resistors in the anode leads will generally reduce the interference, and screening as recommended in paragraph (*a*) above may also be adopted, with R.F. filters in all leads emerging from the screen.

Short Circuit Protection

To prevent damage to the rectifier in the event of a short circuit on the D.C. side, it is advisable to include a fuse of suitable rating in the anode circuit of each rectifier.

Smoothing Circuits

In order to limit the peak anode current in a rectifier it is necessary that a choke, having the specified minimum inductance, should precede the first smoothing capacitor.

To ensure good voltage regulation on fluctuating loads, the value of C should be suitable for the maximum current to be taken and the value of L should be large enough to give uninterrupted current at minimum load.

The output voltages quoted in the data refer to ideal conditions and in practice allowance must be made for voltage losses in the choke and transformer. When rectifier circuits are designed to provide maximum output voltage at a specified load, the permissible peak inverse voltage will be exceeded if the load current is decreased.

DAF 91

Miniature single diode pentode with sharp cut-off characteristics

For diode characteristics see Section C, page 47

For A.F. applications see Section F, page 71

FILAMENT

V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CAPACITANCES

c_{a-g1}	0.2	μμF
c_{in}	2.2	μμF
c_{out}	2.4	μμF

OPERATING CONDITIONS

V_a	45.0	67.5	V
V_{g2}	45.0	67.5	V
V_{g1}	0	0	V
I_a	0.75	1.6	mA
I_{g2}	0.2	0.4	mA
g_m	490	625	μA/V
r_a	0.6	0.6 M Ω approx.	

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	90	V
V_{g1} max.	0	V
I_k max.	4.5	mA

BASE : B7G (40) **DIMENSIONS** : L=55 mm D=19 mm

DF 33

R.F. pentode with variable-μ characteristics

FILAMENT

V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CAPACITANCES

c_{a-g1}	<0.007	μμF
c_{in}	3.8	μμF
c_{out}	9.5	μμF

OPERATING CONDITIONS

V_a	90	90	V
V_{g2}	90	90	V
V_{g1}	–4.0	0	V
I_a	—	1.2	mA
I_{g2}	—	0.3	mA
g_m	5.0	750	μA/V
r_a	—	1.5	M Ω

LIMITING VALUES

V_a max.	110	V
V_{g2} max.	110	V

BASE : Octal (67) **DIMENSIONS** : L=102 mm D=30 mm

DF 70

Sub-miniature pentode with sharp cut-off characteristics

FILAMENT
V_f 0.625 V I_f 25 mA Suitable for D.C. operation only

CAPACITANCES
Measured without external screen

c_{a-g1}	<0.5	μμF
c_{in}	1.6	μμF
c_{out}	2.4	μμF

OPERATING CONDITIONS

V_a	20	30	45	V
V_{g2}	20	30	45	V
V_{g1}	0	0	0	V
I_a	220	375	630	μA
I_{g2}	70	125	200	μA
g_m	170	220	240	μA/V
r_a	1.0	0.5	0.4	MΩ approx.

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	500	μA

BASE : Wire-in (16)

DIMENSIONS : L =29.5 mm plus 32 mm leads
D=10.1 mm

DF 91

Miniature R.F. pentode with variable-μ characteristics

FILAMENT
V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CAPACITANCES

c_{a-g1}	<0.01	μμF
c_{in}	3.6	μμF
c_{out}	7.5	μμF

OPERATING CONDITIONS

V_a	45	67.5	90	90	V
V_{g2}	45	67.5	45	67.5	V
V_{g1}	0	0	0	0	V
I_a	1.7	3.4	1.8	3.5	mA
I_{g2}	0.7	1.5	0.65	1.4	mA
g_m	700	875	750	900	μA/V
V_{g1} (g_m=10 μA/V)	−10	−16	−10	−16	V
r_a	0.35	0.25	0.8	0.5	MΩ
R_{g2}	—	—	68	15	KΩ

DF 91 (contd.)

LIMITING VALUES

V_a max.	90	V
$V_{g2(b)}$ max.	90	V
V_{g2} max.	67.5	V
V_{g1} max.	0	V
I_k max.	5.5	mA

BASE : B7G (38) **DIMENSIONS** : L=55 mm D=19 mm

EAF 41

Single diode pentode

Preliminary data

HEATER
V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{a-g1}	<0.002	μμF
c_{out}	7	μμF
c_{in}	4	μμF

For diode characteristics see Section C, page 48

OPERATING CONDITIONS
As R.F. or I.F. amplifier

V_a	250		V
R_{g2}	95		KΩ
R_k	300		Ω
V_{g1}	−2	−40	V
I_a	5	—	mA
I_{g2}	1.6	—	mA
g_m	1,800	18	μA/V
r_a	1.2	>10	MΩ
$\mu_{(g1-g2)}$	17	—	
R_{eq}	9	—	KΩ

LIMITING VALUES
Pentode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. (I_a<2.5 mA)	300	V
V_{g2} max. (I_a=5.0 mA)	125	V
p_{g2} max.	0.3	W
I_k max.	10	mA
R_{g1-k} max.	3	MΩ
V_{h-k} max.	50	V

BASE : B8A (121) **DIMENSIONS** : L=60 mm D=22 mm

EAF 42 Single diode pentode with variable-μ characteristics

For diode characteristics see Section C, page 48

For operation as A.F. voltage-amplifying triode, see Section D2, page 65

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

Pentode Section only

c_{a-g1}	<0.002	μμF
c_{out}	5	μμF
c_{in}	4	μμF

OPERATING CONDITIONS

V_b	170	200	250	250	V
R_{g2}	82	82	82	120	KΩ
V_{g2}	72	85	105	85	V
R_k	330	330	330	330	Ω
V_{g1}	−1.7	−2.0	−2.5	−2	V
I_a	4.15	5.0	6.35	5.0	mA
I_{g2}	1.2	1.4	1.75	1.4	mA
g_m	1.9	2.0	2.15	2.0	mA/V
r_a	>1	>1	>1	>1	MΩ
*V_{g1} (1/50 g_m)	−24	−28	−34.5	−34.5	V
**V_{g1} (1/100 g_m)	−28	−33	−40.5	−40.5	V
R_{eq}	5.5	6.0	6.5	6.0	KΩ

*For 50–1 drop in mutual conductance
**For 100–1 drop in mutual conductance

LIMITING VALUES

Pentode Section only

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	0.3	W
I_k max.	10	mA
R_{g1-k} max.	3	MΩ
V_{h-k} max.	50	V

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

EF 22 R.F. pentode with variable-μ characteristics

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{a-g1}	<0.002	μμF
c_{in}	5.5	μμF
c_{out}	6.4	μμF

EF 22 (contd.)

OPERATING CONDITIONS

V_a	250	250	250	V
V_{g3}	0	0	0	V
R_{g2}	82	82	82	KΩ
R_k	330	330	330	Ω
V_{g1}	−2.5	−46	−58	V
V_{g2}	100	—	250	V
I_a	6	—	—	mA
I_{g2}	1.7	—	—	mA
g_m	2,200	22	4.5	μA/V
r_a	1.2	>10	>10	MΩ
μ_{g1-g2}	17	—	—	
R_{eq}	6.2	—	—	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} (I_a <3.0 mA) max.	300	V
V_{g2} (I_a = 6.0 mA) max.	125	V
p_{g2}	0.3	W
I_k max.	10	mA

BASE : B8G (86) **DIMENSIONS** : L=91 mm D=29 mm

EF 37 Low-microphony pentode with sharp cut-off characteristics

For characteristics as triode see Section D2, page 65

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised Bulb

CAPACITANCES

For operation as A.F. pentode voltage amplifier see Section F, page 72

c_{a-g1}	<0.02	μμF
c_{in}	5.5	μμF
c_{out}	8.5	μμF

OPERATING CONDITIONS

V_a	100	200	250	V
V_{g2}	100	100	100	V
I_a	3	3	3	mA
V_{g1}	−2	−2	−2	V
I_{g2}	0.8	0.8	0.8	mA
μ	1,800	3,600	4,500	
g_m	1.8	1.8	1.8	mA/V
r_a	1.0	2.0	2.5	MΩ

EF 37 (contd.)

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	125	V
p_{g2} max.	0.3	W
I_k max.	6	mA
V_{h-k} max.	100	V

BASE : Octal (72) **DIMENSIONS** : L=100 mm D=32 mm

EF 39

R.F. pentode with variable-μ characteristics

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised bulb

CAPACITANCES

c_{a-g1}	<0.003	μμF
c_{in}	5.5	μμF
c_{out}	7.2	μμF

OPERATING CONDITIONS

V_a	200	200	250	250	V
R_{g2}	68	68	82	82	KΩ
V_{g2}	100	200	100	250	V
V_{g3}	0	0	0	0	V
V_{g1}	-2.5	-39	-2.5	-49	V
I_a	6.0	—	6.0	—	mA
I_{g2}	1.7	—	1.7	—	mA
g_m	2.2	0.0055	2.2	0.0045	mA/V
r_a	0.9	>10	1.25	>10	MΩ
R_k	330	330	330	330	Ω

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. (I_a=6 mA)	125	V
V_{g2} max. (I_a=3 mA)	300	V
p_{g2} max.	0.3	W
I_k max.	10	mA

BASE : Octal (72) **DIMENSIONS** : L=100 mm D=32 mm

EF 41

R.F. pentode with variable-μ characteristics

Preliminary data

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{a-g1}	<0.002	μμF
c_{in}	5	μμF
c_{out}	8	μμF

OPERATING CONDITIONS

As R.F. or I.F. amplifier

$V_a=V_b$		250		V
R_{g2}		90		KΩ
R_k		325		Ω
V_{g1}	-2.5		-39	V
I_a	6.0		—	mA
I_{g2}	1.7		—	mA
g_m	2,200		22	μA/V
r_a	1		>10	MΩ
μ_{g1-g2}	18		—	
R_{eq}	7.4		—	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. (I_a=<3 mA)	300	V
V_{g2} max. (I_a= 6 mA)	125	V
p_{g2} max.	0.3	W
I_k max.	10	mA
R_{g1-k} max.	3	MΩ
V_{h-k} max.	50	V

BASE : B8A (96) **DIMENSIONS** : L=60 mm D=22 mm

EF 42

High slope R.F. pentode with sharp cut-off characteristics

Preliminary data

HEATER

V_h 6.3 V I_h 0.33 A Suitable for A.C. mains operation

CAPACITANCES

c_{a-g1}	<0.005	μμF
c_{in}	9.5	μμF
c_{out}	4.5	μμF

EF 42 (contd.)

OPERATING CONDITIONS

V_a	250	V
V_{g2}	250	V
V_{g1}	–2	V
I_a	10	mA
I_{g2}	2.3	mA
g_m	9.5	mA/V
r_a	0.44	MΩ
V_{g1} (for I_a cut-off)	–60	V
R_{eq}	750	Ω
Input Damping (at 50 Mcs)	5	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	0.7	W
I_k max.	13	mA

BASE : B8A (95) **DIMENSIONS** : L=60 mm D=22 mm

EF 50

Short-wave R.F. pentode with sharp cut-off characteristics

HEATER

V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

Valve cold

c_{a-g1}	<0.007	μμF
c_{g1-g2}	2.4	μμF
c_{in}	8.3	μμF
c_{out}	5.2	μμF

DAMPING

At 50 Mc/s wavelength (I_a=10 mA)

Input	4,000	Ω
Output	50,000	Ω

OPERATING CONDITIONS

Control by Grid No. 3

V_a	250	250	V
V_{g2}	250	250	V
V_{g1}	–2	–2	V
V_{g3}	0	–54	V
I_a	10	—	mA
I_{g2}	3	—	mA
g_m	6.5	0.45	mA/V
r_a	1	—	MΩ
μ (g_1/g_2)	75	—	
R_{eq}	1,400	—	Ω
R_k	150	150	Ω

EF 50 (contd.)

OPERATING CONDITIONS

Control by Grids 1 and 3

V_a	250	250	V
V_{g2}	250	250	V
V_{g3}	–30	–55.5	V
I_a	10	—	mA
I_{g2}	5.5	—	mA
g_m	5.2	0.52	mA/V
r_a	0.1	—	MΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	3	W
I_k max.	15	mA
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
w_{g2} max.	1.7	W
p_{g1} max. (I_{g1}=0.3 μA)	–1.3	V
V_{g3} max. (I_{g3}=0.3 μA)	–1.3	V
R_{g1-k} max.	3	MΩ
V_{h-k} max.	100	V

BASE : B9G (90) **DIMENSIONS** : L=78 mm D=34 mm

EF 54

V.H.F. pentode with sharp cut-off characteristics

HEATER

V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{a-g1}	<0.02	μμF
c_{g1-g2}	2.2	μμF
c_{in}	6.2	μμF
c_{out}	4.9	μμF

OPERATING CONDITIONS

V_a	250	V
V_{g2}	250	V
V_{g1}	–1.7	V
R_k	150	Ω
I_a	10	mA
I_{g2}	1.45	mA
g_m	7.7	mA/V
r_a	0.5	MΩ
μ_{g1-g2}	80	
R_{eq}	700	Ω
Input damping (50 Mc/s)	10,000	Ω

EF 54 (contd.)

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	3	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	1.7	W
I_k max.	15	mA
V_{h-k} max.	100	V
Max. operating frequency	250	Mc/s

BASE : B9G (91) **DIMENSIONS** : L=78 mm D=34 mm

EF 91

Miniature R.F. pentode with sharp cut-off characteristics

HEATER

V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

For operation as Frequency Changer see Section B, page 37

CAPACITANCES

c_{a-g1}	<0.008	µµF
c_{in}	7.0	µµF
c_{out}	2.0	µµF

OPERATING CONDITIONS

V_a	250	V
V_{g2}	250	V
V_{g3}	0	V
V_{g1}	−2.0	V
I_a	10	mA
I_{g2}	2.55	mA
g_m	7.6	mA/V
r_a	1.0	MΩ
μ_{g1-g2}	70	
R_{eq}	1,200	Ω
Input Damping (at 40 Mc/s)	5,000	Ω

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	0.65	W
I_k max.	15	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	50	V

BASE : B7G (74) **DIMENSIONS** : L=55 mm D=19 mm

EF 92

Miniature R.F. pentode with variable-µ characteristics

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

Measured with close fitting metal can and shielded socket

c_{a-g1}	0.004	µµF
c_{in}	4.5	µµF
c_{out}	7.0	µµF

OPERATING CONDITIONS

V_a	250	250		V
V_{g2}	150	200		V
V_{g1}	−0.65	−2.5	−28	V
I_a	8.0	8.0	—	mA
I_{g2}	2.0	2.1	—	mA
g_m	2.5	2.5	0.005	mA/V

LIMITING VALUES

$V_{a(b)}$ max.	300	V
V_a max.	250	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	300	V
V_{g2} max.	250	V
p_{g2} max.	0.6	W
Max. operating frequency	160	Mc/s

BASE : B7G (74) **DIMENSIONS** : L=55 mm D=19 mm

KF 35

R.F. pentode with variable-µ characteristics

HEATER

V_f 2.0 V I_f 0.05 A Suitable for D.C. operation only

Metallised bulb

CAPACITANCES

c_{a-g1}	<0.1	µµF
c_{in}	8.0	µµF
c_{out}	10.0	µµF

OPERATING CONDITIONS

V_a		120			120		V
V_{g2}		60			120		V
V_{g1}	−1.5	−2.0	−9.5	−3.0	−5.5	−17.0	V
g_m	1,080	800	10	1,500	600	10	µA/V
I_a	1.45	1.0	—	3.8	1.1	—	mA
I_{g2}	0.5	0.35	—	1.0	0.4	—	mA

LIMITING VALUES

V_a max. 150 V V_{g2} max. 150 V

BASE : Octal (68) **DIMENSIONS** : L=97 mm D=33 mm

UAF 42 R.F. diode pentode with variable-μ characteristics

For diode characteristics see Section C, page 52

For operation as A.F. amplifier see Section F, page 73

HEATER

V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

Pentode Section only

c_{a-g1}	0.002	μμF
c_{out}	5.0	μμF
c_{in}	4.0	μμF

OPERATING CONDITIONS

V_b	100	170	200	250	250	V
R_{g2}	82	82	82	82	120	KΩ
V_{g2}	47	72	85	105	85	V
R_k	330	330	330	330	330	Ω
I_a	2.25	4.15	5.0	6.35	5.0	mA
I_{g2}	0.65	1.2	1.4	1.75	1.4	mA
g_m	1.65	1.9	2.0	2.15	2.0	mA/V
r_a	>1	>1	>1	>1	>1	MΩ
*V_{g1}	−14	−24	−28	−34.5	−34.5	V
**V_{g1}	−16.5	−28	−33	−40.5	−40.5	V
R_{eq}	5.0	5.5	6.0	6.5	6.0	KΩ

*For 50 : 1 reduction in mutual conductance
**For 100 : 1 reduction in mutual conductance

LIMITING VALUES

Pentode Section only

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	0.3	W
I_k max.	10	mA
*R_{g3-k} max.	3.0	MΩ
R_{g1-k} max.	3.0	MΩ
V_{h-k} max.	150	V

*For V_{g3} not exceeding +10 V_{pk}

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

UF 41 R.F. pentode with variable-μ characteristics

Preliminary data

For operation as A.F. amplifier see Section F, page 74

HEATER

V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{a-g1}	<0.002	μμF
c_{out}	8.0	μμF
c_{in}	4.7	μμF

UF 41 (contd.)

OPERATING CONDITIONS

$V_a=V_b$	100		170		V
R_{g2}	40		40		KΩ
R_k	325		325		Ω
V_{g1}	−1.4	−17	−2.5	−28	V
I_a	3.3	—	6.0	—	mA
I_{g2}	1.0	—	1.75	—	mA
g_m	1,900	19	2,200	22	μA/V
r_a	0.8	>10	1	>10	MΩ
μ_{g1-g2}	18	—	18	—	
R_{eq}	5.5	—	6.5	—	KΩ

$V_a=V_b$	200		V
R_{g2}	40		KΩ
R_k	325		Ω
V_{g1}	−3	−34	V
I_a	7.2	—	mA
I_{g2}	2.1	—	mA
g_m	2,300	23	μA/V
r_a	1	>10	MΩ
μ_{g1-g2}	18	—	
R_{eq}	7.0	—	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. (I_a<4 mA)	250	V
V_{g2} max. (I_a=7.2 mA)	150	V
p_{g2} max.	0.3	W
I_k max.	10	mA
R_{g1-k} max.	3	MΩ
V_{h-k} max.	150	V

BASE : B8A (96) **DIMENSIONS** : L=60 mm D=22 mm

UF 42 High slope R.F. pentode for D.C./A.C. television receivers

Preliminary data

HEATER

V_h 21 V I_h 0.1 A

CAPACITANCES

c_{a-g1}	<0.005	μμF
c_{in}	9.5	μμF
c_{out}	4.5	μμF

UF 42 (contd.)

OPERATING CONDITIONS

$V_a = V_{g2}$	170	V
I_a	10	mA
V_{g1}	−2	V
I_{g2}	2.8	mA
R_k	750	Ω
g_m	8.5	mA/V
V_{g1} ($I_a = 10\mu A$)	−48	V approx.

LIMITING VALUES

V_a max.	300	V
V_{g2} max.	300	V
p_a max.	2.5	W
p_{g2} max.	0.7	W
I_k max.	13	mA

BASE : B8A (95) **DIMENSIONS** : L=60 mm D=22 mm

CCH 35

Triode hexode with variable-μ characteristics

HEATER

V_h 7.0 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised bulb

For operating data see Type ECH35, page 35. Except for the heater voltage and current, the ECH35 and the CCH35 are identical

DK 32

Heptode with variable-μ characteristics

FILAMENT

V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

Metallised bulb

CAPACITANCES

c_{a-g4}	<0.5 μμF	c_{g4-all}	7.0 μμF
c_{out}	10.0 μμF	c_{g1-g4}	<0.2 μμF

OPERATING CONDITIONS

(See Fig. 1, page 43)

V_a	90	90	V
V_{g3+g5}	45	45	V
V_{g2}	90	90	V
V_{g4}	0	−3	V
I_a	0.6	—	mA
I_{g3+g5}	0.7	—	mA
I_{g2}	1.2	—	mA
I_{g1}	35	—	μA
I_k	2.5	—	mA
R_{g1}	200	200	K Ω
r_a	0.6	—	M Ω
g_c	250	5.0	μA/V

Characteristics of Oscillator Section ($V_{osc}=0$)

V_a	90	V
V_{g3+g5}	45	V
V_{g4}	0	V
V_{g2}	90	V
V_{g1}	0	V
g_m	550	μA/V

LIMITING VALUES

V_a max.	110	V
$V_{g3+g5(b)}$ max.	110	V
V_{g3+g5} max.	60	V
V_{g2} max.	110	V
$I_{k(o)}$ max.	4	mA
R_{g4} min.	1	M Ω

BASE : Octal (77) **DIMENSIONS** : L=102 mm D=30 mm

DK 91 — Miniature heptode with variable-μ characteristics

FILAMENT
V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CAPACITANCES

c_{g3-all}	7.0	μμF
c_{a-all}	7.5	μμF
c_{g1-all}	3.8	μμF

OPERATING CONDITIONS
(See Figs. 2 and 3, pages 43 and 44)

V_a	45	67.5	90	90	V
V_{g2+g4}	45	67.5	45	67.5	V
V_{g3}	0	0	0	0	V
R_{g1}	0.1	0.1	0.1	0.1	MΩ
r_a	0.6	0.5	0.8	0.6	MΩ
g_c	235	280	250	300	μA/V
V_{g3} (g_c=5 μA/V)	−9	−14	−9	−14	V
I_a	0.7	1.4	0.8	1.6	mA
I_{g2+g4}	1.9	3.2	1.9	3.2	mA
I_{g1}	150	250	150	250	μA
I_{ktot}	2.75	5.0	2.75	5.0	mA

Characteristics of Oscillator Section

$V_{g1}=V_{g3}$	0	V
$V_{g2}=V_{g4}=V_a$	67.5	V
$g_{m(g1-g2+g4+a)}$	1.4	mA/V

LIMITING VALUES

V_a max.	90	V
$V_{g2+g4\,(b)}$ max.	90	V
V_{g2+g4} max.	67.5	V
V_{g3} max.	0	V
I_{ko} max.	5.5	mA

BASE : B7G (41) **DIMENSIONS** : L=55 mm D=19 mm

EAC 91 — Miniature diode triode frequency changer for use up to 300 M/cs

For operation as voltage-amplifying triode see Section D1, page 55

HEATER
V_h 6.3 V I_h 0.3 A

CAPACITANCES

c_{g-k}	1.7 μμF		c_{at-ad}	0.4	μμF
c_{a-k}	0.4 μμF		c_{ad-kd}	1.5	μμF
c_{at-g}	1.6 μμF		c_{kt-kd}	0.4	μμF
c_{g-ad}	<0.1 μμF				

EAC 91 (contd.)

CHARACTERISTICS
Triode Section

V_a	200	V
I_a	7.5	mA
V_g	−2.8	V
g_m	2.8	mA/V
u	36	
r_a	12.8	KΩ

OPERATING CONDITIONS
For circuit see Fig. 5, page 44

Coil data :

L1	Turns	3.5	
	Coil diameter	10	mm
	Coil length	7	mm
	Diameter of wire	1	mm
L2	Dust cored, to tune to intermediate frequency		
L3, L4	Dependent upon signal frequency		

LIMITING VALUES

Triode Section :	V_a max.	250	V
	p_a max.	2	W
	I_k max.	10	mA
	V_{h-k} max.	50	V
Diode Section :	V_a max.	50	V
	I_a max.	5	mA
Max. operating frequency as frequency changer		300	Mc/s
Limiting frequency of oscillation		600	Mc/s

BASE : B7G (36) **DIMENSIONS** : L=54 mm D=19 mm

ECH 21 — Triode heptode with variable-μ characteristics

For application as phase invertor and as combined I.F. and A.F. amplifier see Section Q, pages 147 and 148

HEATER
V_h 6.3 V I_h 0.33 A Suitable A.C. operation only

CAPACITANCES

Heptode Section			Triode Section		
c_{in}	6.8	μμF	c_{g-k}	3.2	μμF
c_{out}	9.5	μμF	c_{a-k}	2.0	μμF
c_{a-g1}	<0.002	μμF	c_{a-g}	1.1	μμF
c_{g3-all}	8.0	μμF			

ECH 21 (contd.)

OPERATING CONDITIONS

Heptode Section as Mixer (See Fig. 4, Page 44)

$V_a = V_b$	250	250	V
R_{g2+g4}	22	22	KΩ
R_k	150	150	Ω
R_{gt-k}	47	47	KΩ
I_{g3+gt}	190	190	μA
V_{g1}	−2	−24.5	V
V_{g2+g4}	100	250	V
I_a	3	—	mA
$I_{g2\cdot g4}$	6.2	—	mA
r_a	1.4	>3.0	MΩ
g_c	750	7.5	μA/V
R_{eq}	55	—	KΩ

Triode Section as R.F. oscillator

V_b	250	V
R_{at}	22	KΩ
R_{gt-k}	47	KΩ
I_{gt+g3}	190	μA
I_a	4.5	mA
g_m (effective)	0.55	mA/V

Characteristics of Triode Section

V_a	100	V
V_g	0	V
I_a	12	mA
g_m	3.2	mA/V
μ	21	

LIMITING VALUES

Heptode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.5	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} (I_a=3 mA)	100	V
V_{g2+g4} (I_a= <1 mA)	300	V
p_{g2+g4} max.	1	W
I_k max.	15	mA
R_{g1-k} max.	3	MΩ

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	175	V
p_a max.	0.8	W
V_{g1} max. (I_{g1}= +0.3 μA)	−1.3	V
R_{g-k} max.	3.0	MΩ

BASE : B8G (88) **DIMENSIONS :** L=77 mm D=32 mm

ECH 35

Triode hexode with variable-μ characteristics

HEATER

V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

Metallised bulb

CAPACITANCES

c_{gt-g1} <0.3 μμF

Hexode Section			Triode Section		
c_{in}	5.0	μμF	c_{g-k}	9.0	μμF
c_{out}	10.0	μμF	c_{a-k}	3.0	μμF
c_{a-g1}	< 0.003	μμF	c_{a-g1}	1.6	μμF

OPERATING CONDITIONS

Hexode Section

(*a*) With Fixed Screen Voltage

V_a		250		V
V_{g2+g4}		100		V
R_k		220		Ω
R_{g3-k}		47		KΩ
I_{g3}		200		μA
V_{g1}	−2	−17	−23	V
I_a	3	—	—	mA
I_{g2+g4}	3	—	—	mA
g_c	650	6.5	1.5	μA/V
r_a	1.3	>5.0	>6.0	MΩ

(*b*) With screen grid fed from a potentiometer (Fig. 6, page 45)

$V_a = V_b$		250		V
R_1		22		KΩ
R_2		33		KΩ
R_k		220		KΩ
R_{g1}		47		KΩ
I_{g3}		200		μA
V_{g1}	−2	−23.5	−31	V
V_{g2+g4}	100	—	145	V
I_{ah}	3	—	—	V
I_{g2+g4}	3	—	—	mA
g_c	650	6.5	1.5	μA/V
r_a	1.3	>3.0	>4.0	MΩ

Triode Section (C = 50 μμF, Fig. 5, page 44)

V_b	100	250	V
R_{at}	—	47	KΩ
I_a (R_{gt}=47 kΩ, I_{gt}=200 μA)	3.3	3.3	mA
I_a (V_{gt}=0 V, V_{osc}=0 V)	10.0	4.5	mA
g_m (V_{gt}=0 V, V_{osc}=0 V)	2.8	2.2	mA/V
μ (V_{gt}=0 V, V_{osc}=0 V)	24	24	

ECH 35 (contd.)

LIMITING VALUES
Hexode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.2	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} (I_a=4.5 mA)	125	V
V_{g2+g4} (I_a=<0.5 mA)	200	V
p_{g2+g4} max.	0.6	W
I_k max.	15	mA
R_{g1-k} max.	3	MΩ
V_{h-k}	100	V

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	100	V
p_a max.	1.5	W
V_{gt} max. (I_{gt}= +0.3 μA)	-1.3	V
R_{gt-k} max.	100	KΩ

BASE : Octal (82) **DIMENSIONS** : L=113 mm D=36 mm

ECH 42 Triode hexode with variable-μ characteristics

HEATER
V_h 6.3 V I_h 0.225 A Suitable for A.C. operation

CAPACITANCES
Hexode Section

c_{g1h-at} <0.1 μμF	$c_{g1-h+k+g2+g4+skirt}$	4.0	μμF
c_{g1h-gt} <0.3 μμF	$c_{a-h+k+g2+g4+skirt}$	9.2	μμF
	c_{a-g1}	<0.05	μμF

Triode Section

$c_{gt-h+k+g2+g4+skirt}$	6.4	μμF
$c_{at-h+k+g2+g4+skirt}$	2.7	μμF
c_{at-gt}	1.5	μμF

OPERATING CONDITIONS
For circuits see Fig. 6, page 45
Hexode Section

$V_a=V_b$		250		V
R_1		27		KΩ
R_2		27		KΩ
R_k		220		Ω
R_{g3+gt}		47		KΩ
I_{g3+gt}		200		μA
V_{g1}	-2.0	-19	-23.5	V
I_a	3.15	0.21	0.1	mA
I_{g2+g4}	3.15	0.15	0.085	mA
V_{g2+g4}	83	123	124	V
g_c	690	13.8	6.9	μA/V
r_a	1.0	7.0	9.0	MΩ
R_{eq}	62	—	—	KΩ

ECH 42 (contd.)

Triode Section

V_b	250	V
R_{at}	33	KΩ
I_a	4.3	mA
R_{gt+g3}	47	KΩ
I_{gt+g3}	200	μA
V_{osc} r.m.s.	10	V

The effective mutual conductance under the above conditions is approximately 0.5 mA/V

CHARACTERISTICS
Triode Section

V_a	100	V
V_{g1}	0	V
I_a	10	mA
g_m	2.8	mA/V
μ	19	

LIMITING VALUES
Hexode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.0	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max.	125	V
p_{g2+g4} max.	0.4	W
I_k max.	10.0	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	150	V

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	175	V
p_a max.	0.9	W
I_k max.	5.5	mA
V_{g1} max. (I_{g1}= +0.3 μA)	-1.3	V
R_{gt-k} max.	3.0	MΩ

BASE : B8A (94) **DIMENSIONS** : L=60 mm D=22 mm

EF 91 Miniature R.F. pentode with sharp cut-off characteristics

For operation as voltage amplifier, see Section A, page 26

HEATER
V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{in}	7.0	μμF
c_{out}	2.0	μμF
c_{a-g1}	<0.008	μμF

EF 91 (contd.)

OPERATING CONDITIONS

As Mixer at 45 Mc/s (See Fig. 8, page 46)

V_b	250	V
R_k	470	Ω
I_a (V_{osc} = 0 V)	4.4	mA
I_a (V_{osc} = 2.25 V)	5.5	mA
I_{g1}	0.5	μA
g_c	3.0	mA/V
R_{g1-k}	1.0	MΩ
Equivalent Noise Resistance	6.5	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	0.65	V
I_k max.	15	mA
V_{g1} (I_{g1} = 0.3 μA)	–1.3	V
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	50	V

BASE : B7G (74) **DIMENSIONS** : L=54 mm D=19 mm

EK 32

Octode with variable-μ characteristics

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised bulb

CAPACITANCES

c_{in}	9.0 μμF	c_{a-g4}	<0.1 μμF
c_{out}	10.5 μμF	c_{g1-all}	6.0 μμF
		c_{g2-all}	5.0 μμF

OPERATING CONDITIONS

(See Fig. 7, page 45)

	Medium and Long Wave		Short Wave	
V_a	250	250	250	V
V_{g2}	200	200	200	V
V_{g3+g5}	50	80	80	V
V_{g4}	–2	–4	–4	V
R_1	22	22	22	KΩ
R_2	6.8	15	12	KΩ
R_k	470	430	560	Ω
R_{g1-k}	47	15	47	KΩ
R_{g2}	22	10	12	KΩ
V_{osc} r.m.s.	15	5	9	V
I_{g1}	300	275	200	μA
I_a	1.0	2.3	1.7	mA
I_a (V_{g4}=–25V)	<0.015			mA
I_{g2}	2.5	5.3	4.0	mA
I_{g3+g5}	0.8	1.9	1.3	mA
g_c	0.55	0.65	0.5	mA/V
g_c (V_{g4}=–25V)	<0.002			mA/V
r_a	2.0	0.9	1.4	MΩ
r_a (V_{g4}=–25V)	>10			MΩ

EK 30 (contd.)

LIMITING VALUES

$V_{a(b)}$ max.	550	V	p_{g3+g5} max.	0.3	W
V_a max.	250	V	$V_{g2(b)}$ max.	550	V
p_a max.	1.0	W	V_{g2} max.	225	V
$V_{g3+g5(b)}$ max.	550	V	p_{g2} max.	1.3	W
V_{g3+g5} max.	125	V	I_k max.	12	mA

BASE : Octal (81) **DIMENSIONS** : L=100 mm D=63 mm

KCF 30

Triode pentode with variable-μ characteristics

FILAMENT

V_f 2.0 V I_f 0.2 A Suitable for D.C. operation only

Metallised bulb

CAPACITANCES

Pentode Section		Triode Section	
c_{a-all}	8.0 μμF	c_{a-all} (less c_{gt-at})	3.75 μμF
c_{g-all}	6.5 μμF	c_{g-all} (less c_{gt-at})	9.0 μμF
c_{a-g1}	0.01 μμF	c_{a-g}	2.0 μμF

OPERATING CONDITIONS

V_a	100	120	120	V
V_{g2}	60	60	40	V
V_{g1}	–1.5	–1.5	–0.3	V
I_a	0.53	0.53	0.55	mA
I_{g2}	0.97	0.97	0.95	mA
g_c	250	260	285	μA/V
V_{osc} (p_k) min.	8.0	8.0	8.0	V
V_{g1} (g_c=10 μA/V)	–12.5	–14.0	–14.0	V
*R_{gt-f}	47	47	47	KΩ

*Grid leak returned to f_+

CHARACTERISTICS

Triode Section

V_a	100	V
V_{g1}	0	V
g_m	1.7	mA/V
μ	18	

LIMITING VALUES

Pentode Section			Triode Section		
V_a max.	150	V	V_a max.	150	V
V_{g2} max.	150	V	$I_{a(pk)}$ max.	15	mA

BASE : Octal (15) **DIMENSIONS** : L=110 mm D=33 mm

KK 32 Octode with variable-μ characteristics

FILAMENT

V_f 2.0 V I_f 0.13 A Suitable for D.C. operation only

CAPACITANCES

c_{g1-all}	6.3	μμF
c_{g2-all}	8.5	μμF
c_{g4-all}	9.0	μμF
c_{out}	11.0	μμF

OPERATING CONDITIONS

Medium and Long Wave working

V_a	90	135	V
V_{g2}	90	135	V
V_{g3+g5}	45	45	V
V_{osc} (r.m.s.) approx.	8.5	8.5	V
I_a (V_{g4}= −0.5 V)	0.7	0.7	mA
I_a (V_{g4}=−12 V)	<0.015	0.015	mA
I_{g2}	1.3	2.1	mA
I_{g3+g5}	0.6	0.7	mA
g_c(V_{g4}= −0.5 V)	270	270	μA/V
g_c(V_{g4}=−12 V)	<2	2	μA/V
r_a (V_{g4}= −0.5 V)	2	2.5	MΩ
r_a (V_{g4}=−12 V)	>10	10	MΩ

Short Wave working

V_a	135	V
V_{g2}	135	V
V_{g3+g5}	60	V
V_{osc} (r.m.s.)	6	V
I_a (V_{g4}=−1.5 V)	1.0	mA
I_{g2}	2.3	mA
I_{g3+g5}	1.0	mA
g_c (V_{g4}=−1.5 V)	67	μA/V
r_a (V_{g4}=−1.5 V)	1.7	MΩ

LIMITING VALUES

V_a max.	150	V
p_a max.	0.5	W
V_{g2} max.	150	V
p_{g2} max.	0.6	W
V_{g3+g5} max.	100	V
p_{g3+g5} max.	0.4	W
I_k max.	11	mA
R_{g4-k} max.	2.5	MΩ

BASE : Octal (79) **DIMENSIONS :** L=125 mm D=46 mm

Triode heptode with variable-μ characteristics UCH 21

HEATER

V_h 20 V I_h 0.1 A Suitable D.C./A.C. operation

CAPACITANCES

Identical with Type ECH 21, to which refer

For Circuit see Fig. 4, page 44

OPERATING CONDITIONS

Heptode Section as mixer

V_a=V_b		100		200	V
R_{g2+g1}		15		15	KΩ
R_k		150		150	Ω
R_{gt-k}		47		47	KΩ
I_{g3+gt}		95		190	μA
V_{g1}	−1	−14	−2	−28	V
V_{g2+g1}	53	100	100	200	V
I_a	1.5	—	3.5	—	mA
$I_{(g2+g4)}$	3.0	—	6.5	—	mA
g_c	580	5.8	750	7.5	μA/V
r_a	1.0	>10	1.0	>10	MΩ
R_{eq}	40	—	55	—	KΩ

Triode Section as R.F. oscillator

V_b	100	200	V
R_{at}	22	22	KΩ
R_{g3+gt}	47	47	KΩ
I_{g3+gt}	95	190	μA
V_{osc} r.m.s.	4.5	9.0	V
I_a	1.9	4.1	mA
g_m (effective)	0.44	0.45	mA/V

CHARACTERISTICS

Triode Section

V_a	100	V
V_g	0	V
I_a	12	mA
g_m	3.2	mA/V
μ	19	

LIMITING VALUES

Heptode Section			Triode Section		
$V_{a(b)}$ max.	550	V	$V_{a(b)}$ max.	550	V
V_a max.	250	V	V_a max.	175	V
p_a max.	1.5	W	p_a max.	0.5	W
$V_{g2+g4(b)}$ max.	550	V			
V_{g2+g4} max. (I_a=3 mA)	100	V			
V_{g2+g4} max. (I_a=1 mA)	250	V			
p_{g2+g4} max.	1.0	W			
I_k max.	15	mA			

BASE : B8G (88) **DIMENSIONS :** L=96 mm D=32 mm

UCH 42 Triode hexode with variable-μ characteristics

HEATER

V_h 14.0 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

Similar to Type ECH 42, to which please refer

OPERATING CONDITIONS

Hexode Section (see Fig. 6, page 45)

$V_a = V_b$		100		V
R_1		18		KΩ
R_2		27		KΩ
R_k		220		Ω
R_{gt+g3}		47		KΩ
I_{gt+g3}		100		μA
V_{g2+g4}	41	59	59.5	V
V_{g1}	−1.0	−9.5	−11.5	V
I_a	1.2	0.07	0.04	mA
I_{g2+g4}	1.75	0.09	0.055	mA
g_c	520	10.4	5.2	μA/V
r_a	0.85	7.0	9.0	MΩ
R_{eq}	36	—	—	KΩ
$V_a = V_b$		170		V
R_1		18		KΩ
R_2		27		KΩ
R_k		220		Ω
R_{gt+g3}		47		KΩ
I_{gt+g3}		170		μA
V_{g2+g4}	71	100	101	V
V_{g1}	−1.7	−16	−19	V
I_a	2.5	0.15	0.08	mA
I_{g2+g4}	2.85	0.14	0.09	mA
g_c	610	12.2	6.1	μA/V
r_a	1.1	9.0	>10	MΩ
R_{eq}	55	—	—	KΩ
$V_a = V_b$		200		V
R_1		18		KΩ
R_2		27		KΩ
R_k		220		Ω
R_{gt+g3}		47		KΩ
I_{gt+g3}		200		μA
V_{g2+g4}	84	118	119	V
V_{g1}	−2.0	−18	−22	V
I_a	3.2	0.21	0.11	mA
I_{g2+g4}	3.35	0.17	0.1	mA
g_c	690	13.8	6.9	μA/V
r_a	1.25	8.0	>10	MΩ
R_{eq}	64	—	—	KΩ

UCH 42 (contd.)

Triode Section

V_b	100	170	200	V
R_{at}	22	22	22	KΩ
I_a	2.0	3.5	4.2	mA
R_{gt+g3}	47	47	47	KΩ
I_{gt+g3}	100	170	200	μA
V_{osc} r.m.s.	4.7	8.0	9.4	V approx.

The effective mutual conductance of the triode section under the above conditions is approximately 0.5 mA/V

LIMITING VALUES

Heptode Section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	0.8	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max.	125	V
p_{g2+g4} max.	0.3	W
I_k max.	10	mA
V_{h-k} max.	150	V

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	175	V
p_a max.	0.9	W
V_{gt} max. (I_{gt}=0.3 μA)	−1.3	V
I_k max.	5.5	mA

BASE : B8A (94) **DIMENSIONS** : L=60 mm D=22 mm

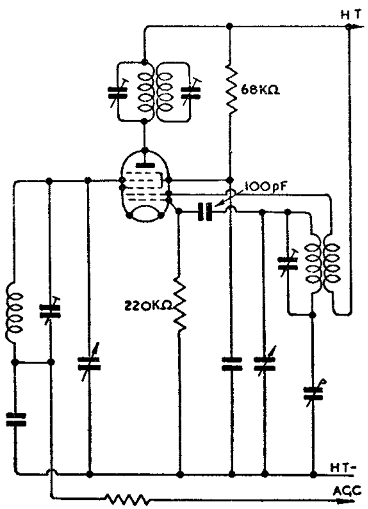


Fig. 1

Battery-operated Frequency Changer Circuit using DK32 Heptode

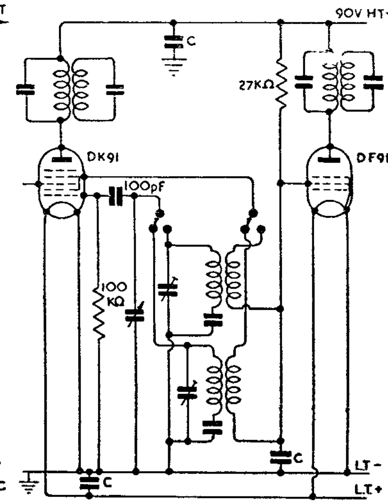


Fig. 2

Medium and Long Wave Battery-operated Frequency Changer Circuit using DK91 Heptode

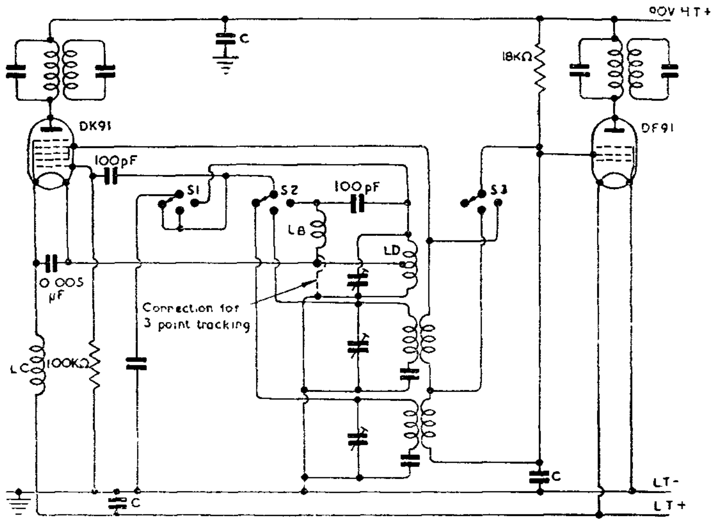


Fig. 3. *All-wave Battery-operated Frequency Changer using DK91 Heptode*

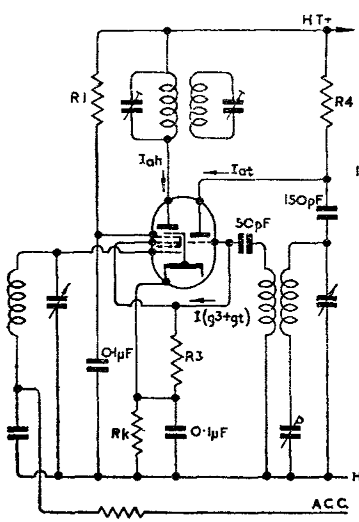


Fig. 4. *A.C. Mains-operated Frequency Changer using ECH21 or UCH21 Triode-Hexode*

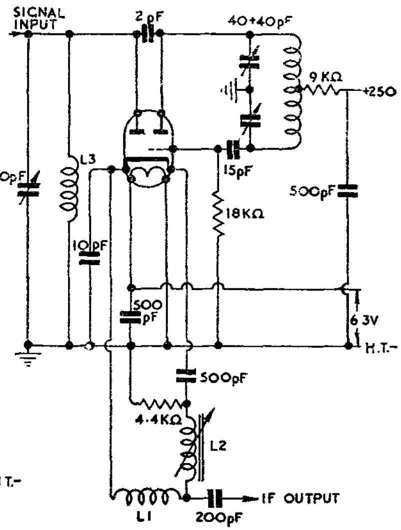


Fig. 5. *U.H.F. Mains-operated Frequency Changer using EAC91 Diode-Triode*

VALUE DATA PREFERRED TYPES 5
FREQUENCY CHANGERS B

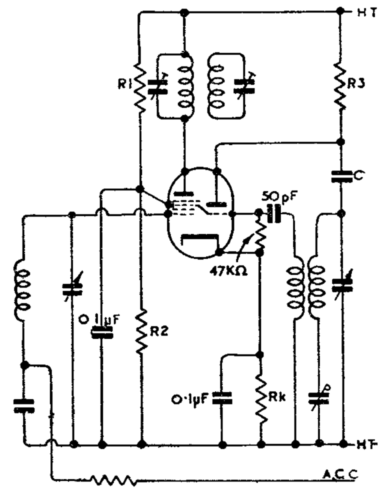


Fig. 6. *A.C. Mains-operated Frequency Changer using CCH35, ECH35, ECH42 or UCH42 Triode-Hexode*

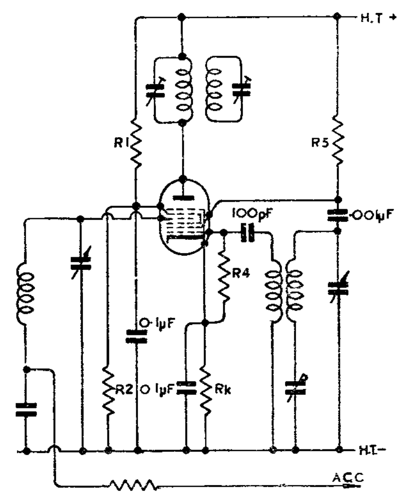


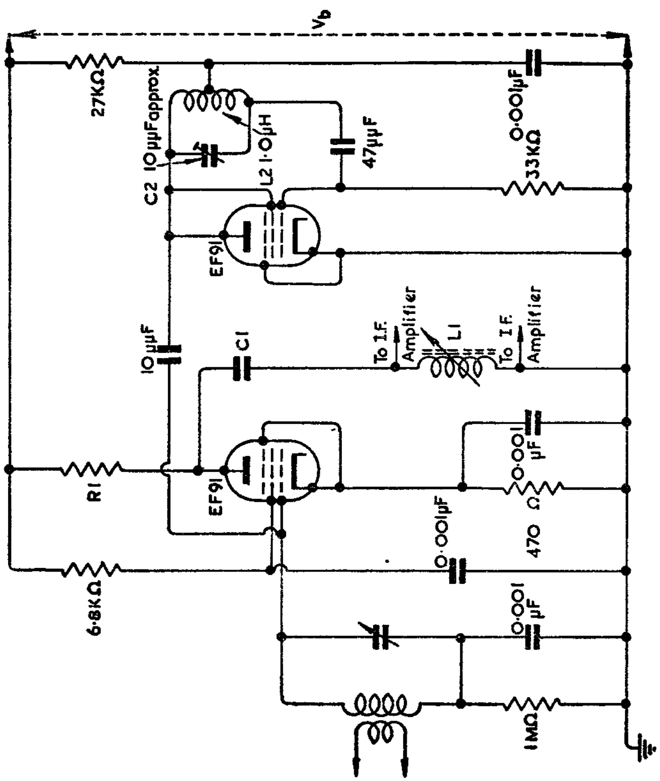
Fig. 7. *Mains - operated Frequency Changer using EK32 Octode*

Fig. 8.

A.C. Mains-operated Frequency Changer using two EF91 Pentodes, one as Mixer and one as Oscillator

The first I.F. circuit consists of L1, C1 and R1, L1 being designed to resonate at 13 Mc/s

The Oscillator circuit, formed by L2 and C2 resonates at 32 Mc/s



CBL 31

Double diode output pentode

HEATER
V_h 44.0 V I_h 0.2 A Suitable for D.C./A.C. operation

Bulb part metallised over diode section

CAPACITANCES

c_{ad-k} (each section)	3.5	µµF
$c_{ad'-ad2}$	<0.5	µµF

LIMITING VALUES

$V_{ad'}$ max.	200	V
$V_{ad''}$ max.	200	V
$I_{ad'}$ max.	0.8	mA
$I_{ad''}$ max.	0.8	mA
$V_{ad'}$ max. ($I_{ad1}=+0.3$ µA)	-1.3	V
$V_{ad''}$ max. ($I_{ad2}=+0.3$ µA)	-1.3	V

BASE : Octal (75) **DIMENSIONS** : L=136 mm D=46 mm

For characteristics of pentode section see Section G, page 75

DAC 32

Single diode triode

FILAMENT
V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CAPACITANCES

c_{ad-f}	3.2	µµF
c_{ad-g}	0.002	µµF
c_{ad-at}	0.2	µµF

The diode anode is located at the negative end of the filament

BASE : Octal (65) **DIMENSIONS** : L=102 mm D=30 mm

For characteristics of triode section see Section D1, page 55

DAF 91

Miniature diode pentode

FILAMENT
V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

LIMITING VALUE
I_{ad} max. 0.25 mA

The diode anode is located at the negative end of the filament

BASE : B7G (40) **DIMENSIONS** : L=55 mm D=19 mm

For characteristics of the pentode section see Section A, page 17

EA 50 Miniature diode

HEATER
V_h 6.3 V I_h 0.15 A Suitable for A.C. mains operation

CAPACITANCE

c_{a-k}	2.1	μμF

LIMITING VALUES

V_a max.	50	V
I_a max.	5.0	mA
V_a max. (I_a=+0.3 μA)	−1.3	V
V_{h-k} max.	50	V

BASE : B3G (141) **DIMENSIONS** : L=49 mm D=12 mm

EAF 41 Single diode R.F. pentode

For characteristics of pentode section see Section A, page 19

HEATER
V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{ad-k}	3.8	μμF
c_{ad-h}	<0.02	μμF
c_{ad-a}	<0.15	μμF

LIMITING VALUES

$v_{ad\ pk}$ max.	200	V
I_{ad} max.	0.8	mA
V_{ad} max. (I_{ad}=+0.3 μA)	−1.3	V
V_{h-k} max.	50	V

BASE : B8A (121) **DIMENSIONS** : L=60 mm D=22 mm

EAF 42 Single diode pentode

Preliminary data

For characteristics of pentode section see Section A, page 20

For operation as AF voltage amplifying triode see Section D2 page 65

HEATER
V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{ad-k}	3.8	μμF
c_{ad-g1}	<0.0015	μμF
c_{ad-a}	<0.15	μμF

LIMITING VALUES

v_{ad} pk. max.	200	V
I_{ad} max.	0.8	mA
V_{ad} max. (I_{ad}=+0.3 μA)	−1.3	V
V_{h-k} max.	50	V

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

EB 34 Double diode (separate cathodes). Internally screened and screened between sections

HEATER
V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised bulb

CAPACITANCES

c_{ad-k} (each section)	4.5	μμF
$c_{ad'-ad''}$	0.5	μμF

LIMITING VALUES

$V_{ad'}$ max.	200	V
$V_{ad''}$ max.	200	V
$I_{ad'}$ max.	0.8	mA
$I_{ad''}$ max.	0.8	mA
$V_{h-k'}$ max.	75	V
$V_{h-k''}$ max.	75	V
$V_{ad'}$ max. ($I_{ad'}$=+0.3 μA)	−1.3	V
$V_{ad''}$ max. ($I_{ad''}$=+0.3 μA)	−1.3	V
$V_{k'-k''}$ max.	50	V

BASE : Octal 58 **DIMENSIONS** : L=82 mm D=36 mm

EB 41 Double diode (separate cathodes). Internally screened and screened between sections

HEATER
V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

$c_{ad'-ad''}$	<0.03	μμF
c_{k-all} (each section)	4.0	μμF
c_{ad-k} (each section)	0.01	μμF

LIMITING VALUES
Each section

V_{ad} max.	150	V
I_{ad} max.	9	mA
i_{ad} pk. max.	54	mA
V_{h-k} max.	300	V
V_{ad} (I_{ad}=+0.3 μA)	−1.3	V

BASE : B8A (92) **DIMENSIONS** : L=60 mm D=22 mm

EB 91 Miniature double diode (separate cathodes). Internally screened between sections

HEATER
V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{ad-k} (each section)	3.0	μμF
$c_{k-ad+h+s}$ (each section)	3.4	μμF
$c_{ad''-ad''}$	<0.026	μμF

EB91 (contd.)

LIMITING VALUES

V_{ad} r.m.s. max.	150	V
I_{ad} max.	9	mA
I_{ad} pk. max.	54	mA
V_{ad} max. (I_{ad}=0.3 μA)	−1.3	V
V_{h-k} max.	330	V

BASE : B7G (37) **DIMENSIONS** : L=55 mm D=19 mm

EBC33

Double diode triode

For characteristics of the triode section see Section DI, page 56

HEATER
V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation
Metallised bulb

CAPACITANCES

$c_{ad'-k}$	2.6	μμF
$c_{ad''-k}$	3.2	μμF
$c_{ad'-ad''}$	0.7	μμF

LIMITING VALUES
Each diode

V_{ad} max.	200	V
I_{ad} max.	0.8	mA
V_{h-k} max.	100	V

BASE : Octal (62) **DIMENSIONS** : L=100 mm D=32 mm

EBC41

Double diode triode

For characteristics of triode section see Section DI, page 56

HEATER
V_h 6.3 V I_h 0.225 A Suitable for D.C./A.C. operation

CAPACITANCES

$c_{ad'-ad''}$	<0.15	μμF
$c_{ad'+ad''-at}$	<0.02	μμF
$c_{ad'-gt}$	<0.007	μμF
$c_{ad''-gt}$	<0.02	μμF
$c_{ad''-h}$	<0.05	μμF

LIMITING VALUES

V_{ad} max.	200	V
I_{ad} max.	0.8	mA
V_{h-k} max.	90	V

BASE : B8A (102) **DIMENSIONS** : L=60 mm D=22 mm
(ad′ to pin 4, ad″ to pin 5)

EBL21

Double diode output pentode

For characteristics of pentode section see Section G, page 82

HEATER
V_h 6.3 V I_h 0.8 A Suitable for A.C. mains operation

CAPACITANCES

$c_{ad'-k}$	1.8	μμF
$c_{ad''-k}$	2.0	μμF
$c_{ad'-ad''}$	<0.15	μμF

LIMITING VALUES

$V_{ad'}$ max.	200	V
$V_{ad''}$ max.	200	V
$I_{ad'}$ max.	0.8	mA
$I_{ad''}$ max.	0.8	mA
$V_{ad'}$ max. ($I_{ad'}$ =+0.3 μA)	−1.3	V
$V_{ad''}$ max. ($I_{ad''}$=+0.3 μA)	−1.3	V

BASE : B8G (87) **DIMENSIONS** : L=96 mm D=29 mm
(ad′ to pin 6, ad″ to pin 5)

EBL31

Double diode output pentode. Diodes screened internally

For characteristics of pentode section see Section G, page 83

HEATER
V_h 6.3 V I_h 1.5 A Suitable for A.C. mains operation

CAPACITANCES

$c_{ad'-ad''}$	<0.35	μμF
$c_{ad'-k}$	3.0	μμF
$c_{ad''-k}$	3.6	μμF

LIMITING VALUES

$V_{ad'}$ max.	200	V
$V_{ad''}$ max.	200	V
$I_{ad'}$ max.	0.8	mA
$I_{ad''}$ max.	0.8	mA
$V_{ad'}$ max. ($I_{d'}$=+0.3 μA)	−1.3	V
$V_{ad''}$ max. ($I_{d'}$=+0.3 μA)	−1.3	V

BASE : Octal (75) **DIMENSIONS** : L=136 mm D=46 mm
(ad′ to pin 4, ad″ to pin 5)

KBC32

Double diode triode

For characteristics of triode section see Section DI, page 64

FILAMENT
V_f 2.0 V I_f 0.05 A Suitable for D.C. operation only

KBC32 (contd.)

CAPACITANCES

c_{ad-all} (each section)	2.5	μμF
$c_{ad'-ad''}$	<0.5	μμF
c_{ad-g} (each section)	<0.05	μμF
$c_{ad'-at}$	<0.6	μμF
$c_{ad''-at}$	<0.3	μμF

BASE : Octal (61) **DIMENSIONS** : L=97 mm D=33 mm
(ad′ to pin 4, ad″ to pin 5)

UAF42 R.F. diode pentode with variable-μ characteristics

For characteristics of pentode section see Section A, page 28, and Section F, page 73

HEATER
V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{ad-k}	3.8	μμF
c_{ad-g1}	<0.0015	μμF
c_{ad-h}	<0.02	μμF
c_{ad-a}	<0.15	μμF

LIMITING VALUES

V_{ad} pk. max.	200	V
I_{ad} max.	0.8	mA
V_{ad} max. (I_{ad}=+0.3 μA)	−1.3	V
V_{h-k} max.	150	V

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

UB41 Double diode with separate cathodes

HEATER
V_h 19 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

$c_{ad'}-c_{ad''}$	<0.03	μμF
c_{ad-all} (each section)	4	μμF
c_{ad-k} (each section)	0.01	μμF

LIMITING VALUES
Each section

V_{ad} max.	150	V
I_{ad} max.	9	mA
i_{ad} pk. max.	54	mA
V_{ad} max. (I_{ad}=+0.3 μA)	−1.3	V
V_{h-k} max.	300	V

BASE : B8A (92) **DIMENSIONS** : L=60 mm D=22 mm

Double diode triode UBC41

Preliminary data

HEATER
V_h 14.0 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

For characteristics of triode section see Section D1, page 64

$c_{ad'-ad''}$	<0.15	μμF
$c_{ad'+ad''-at}$	<0.02	μμF
$c_{ad'-g}$	<0.007	μμF
$c_{ad''-g}$	<0.02	μμF
$c_{ad''-h}$	<0.05	μμF

LIMITING VALUES
Each diode section

V_{ad} max.	200	V
I_{ad} max.	0.8	mA
V_{h-k} max.	150	V

BASE : B8A (102) **DIMENSIONS** : L=60 mm D=22 mm
(ad′ to pin 6, ad″ to pin 5)

Double diode output pentode UBL21

For characteristics of pentode section see Section G, page 97

HEATER
V_h 55 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

$c_{ad'-k}$	1.8	μμF
$c_{ad''-k}$	2.0	μμF
$c_{ad'-ad''}$	<0.15	μμF

LIMITING VALUES

$V_{ad'}$ max.	200	V
$V_{ad''}$ max.	200	V
$I_{ad'}$ max.	0.8	mA
$I_{ad''}$ max.	0.8	mA
$V_{ad'}$ max. ($I_{ad'}$=+0.3 μA)	−1.3	V
$V_{ad''}$ max. ($I_{ad''}$=+0.3 μA)	−1.3	V

BASE : B8G (87) **DIMENSIONS** : L=96 mm D=29 mm
(ad′ to pin 6, ad″ to pin 5)

Single diode triode **DAC 32**

FILAMENT
V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

Metallised bulb

For diode characteristics see Section C, page 47

CAPACITANCES

c_{g-k}	1.3	μμF
c_{a-k}	6.0	μμF
c_{a-g}	1.0	μμF

OPERATING CONDITIONS
Triode Section as Class " A " Amplifier

V_a	90	V
V_g	0	V
I_a	0.15	mA
μ	65	
r_a	240	K Ω
g_m	275	μA/V

LIMITING VALUE

V_a max.	110	V

BASE : Octal (65) **DIMENSIONS** : L=102 mm D=30 mm

Miniature diode triode. Primarily designed for use as frequency changer up to 300 M/cs **EAC 91**

HEATER
V_h 6.3 V I_h 0.3 A Suitable for D.C./A.C. operation

For operation as frequency changer see Section B, page 32

CAPACITANCES

c_{g-k}	1.7	μμF
c_{a-k}	0.4	μμF
c_{at-g}	1.6	μμF

CHARACTERISTICS
Triode Section only

V_a	200	V
I_a	7.5	mA
V_g	-2.8	V
g_m	2.8	mA/V
μ	36	
r_a	12.8	K Ω

LIMITING VALUES

V_a max.	250	V
p_a max.	2	W
I_k max.	10	mA
V_{h-k} max.	50	V

BASE : B7G (36) **DIMENSIONS** : L=55 mm D=19 mm

EBC 33 Double diode triode

For diode characteristics see Section C, page 50

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

As Transformer Coupled A.F. Amplifier

V_a	100	200	250	V
I_a	2	4	5	mA
V_g	–2.1	–4.3	–5.5	V
μ	30	30	30	
g_m	1.6	2.0	2.0	mA/V
r_a	19	15	15	KΩ

OPERATING CONDITIONS

As resistance coupled A.F. amplifier

V_b (V)	R_a (KΩ)	I_a (mA)	R_k (KΩ)	V_{out}/V_{in}	V_{out}* (V)	D_{tot} (%)	R_{g1}** KΩ
300	47	2.8	1.2	19.5	45	5.8	150
250	47	2.3	1.2	19.0	34	5.5	150
200	47	1.8	1.2	18.5	26	5.2	150
100	47	0.5	4.7	13.0	8	10.0	150
300	100	1.5	2.2	22.0	49	5.2	330
250	100	1.27	2.2	22.0	41	5.2	330
200	100	1.0	2.2	21.5	31	5.0	330
100	100	0.32	6.8	16.5	14	10.0	330
300	220	0.83	3.9	23.5	52	4.8	680
250	220	0.69	3.9	23.5	41	4.6	680
200	220	0.53	3.9	23.0	31	4.5	680
100	220	0.2	10	19.0	20	10.0	680

*V_{out}=Output voltage at start of I_g or D_{tot}=10%
**R_{g1}=Grid resistance of *following* valve

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.5	W
I_k max.	10	mA
R_{g1-k} max. (Self bias)	3	MΩ
R_{g1-k} max. (Fixed bias)	1	MΩ
V_{h-k} max.	100	V

BASE : Octode (62) **DIMENSIONS** : L=100 mm D=32 mm

EBC 41 Double diode triode

Preliminary data
For diode characteristics see Section C, page 50

HEATER

V_h 6.3 V I_h 0.225 A Suitable for D.C./A.C. operation

CHARACTERISTICS

V_a	250	V
I_a	1.0	mA
V_g	–3.0	V
μ	70	
g_m	1.3	mA/V
r_a	54	KΩ

EBC 41 (contd.)

OPERATING CONDITIONS

As resistance coupled A.F. amplifier (with cathode bias)

V_b (V)	R_a (KΩ)	I_a (mA)	R_k (KΩ)	V_{out}/V_{in}	V_{out} (V_{rms}) (D_{tot} 5%)	V_{out} (V_{rms}) (D_{tot} 10%)	R_{g1}* (KΩ)
400	100	1.35	2.2	43.5	35.5	62.5	330
350	100	1.18	2.2	43	30.5	54	330
300	100	1.0	2.2	42.5	25.5	46	330
250	100	0.85	2.2	42	21	38	330
200	100	0.7	2.2	41	16	28.5	330
150	100	0.5	2.2	40	12	19.5	330
100	100	0.28	3.3	33.5	6	10.5	330
400	220	0.76	3.9	48	40	74.5	680
350	220	0.67	3.9	47.5	34.5	64	680
300	220	0.56	3.9	47	27	54	680
250	220	0.48	3.9	46.5	24.5	44.5	680
200	220	0.4	3.9	46	19	34	680
150	220	0.32	3.9	44	16.5	24	680
100	220	0.18	5.6	38	8	13.5	680

*R_{g1}=Grid resistance of *following* valve

OPERATING CONDITIONS

As resistance coupled A.F. amplifier** (with grid-current bias)

V_b (V)	R_a (KΩ)	I_a (mA)	V_{out}/V_{in}	V_{out} (V_{rms}) (D_{tot} 2.5%)	V_{out} (V_{rms}) (D_{tot} 5%)	R_{g1+}* (KΩ)
400	100	2.4	56.5	33	51	330
350	100	2.0	55	27	43	330
300	100	1.95	53.5	22	35	330
250	100	1.3	51	17	27	330
200	100	0.95	48.5	12	19	330
150	100	0.6	44	7	11	330
100	100	0.3	35.5	3	5	330
400	220	1.3	62.5	34	55.5	680
350	220	1.1	61.5	29	47	680
300	220	0.9	59.5	23	38	680
250	220	0.7	57.5	17	29.5	680
200	220	0.5	54	12.5	21	680
150	220	0.33	49	8	14	680
100	220	0.18	40	4	7	680

**Measured with grid resistance of 20M Ω and signal source impedance Z_s=0. The distortion figures quoted hold good for valves of Z_s not exceeding 0.2 M Ω. At this value of Z_s the gain will be reduced by 10%.
*R_{g1}=Grid resistance of *following* valve.

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1	W
R_{g-k} max. (cathode bias)	3.0	MΩ
V_{h-k} max.	90	V

BASE: Octal (102) **DIMENSIONS**: L=60 mm D=22 mm

EC 31

Triode, low impedance, for use as voltage amplifier or low power output valve

For operation as output triode see Section E1, page 67

HEATER

V_h 6.3 V I_h 0.65 A Suitable for A.C. mains operation

OPERATING CONDITIONS

As R.C. amplifier

$V_{a(b)}$	250	350	450	550	V
R_a	82	100	120	150	KΩ
$V_{in\ (r\ m\ s)}$	5.8	9.0	11.5	13.0	V
I_a	1.6	2.0	2.3	2.5	mA
R_k	8.2	8.2	8.2	8.2	KΩ
$\frac{V_{out}}{V_{in}}$	7.2	6.5	7.0	7.4	

LIMITING VALUES

V_a max.	250	V
p_a max.	5	W
I_k max.	30	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	50	V
V_g (I_g=1.0 μA)	–0.4 to –0.8	V

BASE: Octal (60) **DIMENSIONS:** L=124 mm D=48 mm

ECC 31
ECC 32

Double triodes. The ECC 32 and the ECC 31 are identical except that the ECC 32 has separate cathodes

HEATER

V_h 6.3 V I_h 0.95 A Suitable for A.C. mains operation

CAPACITANCES

$c_{a'-a''}$	0.8	μμF
c_{a-g} (each section)	4.3	μμF
c_{g-k} (each section)	4.3	μμF
c_{a-k} (each section)	2.0	μμF

CHARACTERISTICS

Each section

V_a	250	V
V_g	–4.6	V
I_a	6.0	mA
g_m	2.3	mA/V
μ	32	
r_a	14	KΩ

ECC31
ECC32
(contd.)

OPERATING CONDITIONS

As R.C. coupled amplifier

V_b (V)	R_a (KΩ)	I_a (mA)	R_k (KΩ)	$\frac{V_{out}}{V_{in}}$	V_{out}* (V)	D_{tot} (%)	R_{g1}** (KΩ)
400	47	3.9	1.2	21	67	3.7	150
350	47	3.4	1.2	20.5	57	3.6	150
300	47	2.9	1.2	20	48	3.5	150
250	47	2.4	1.2	19.5	37	3.4	150
200	47	1.9	1.2	19.5	26	3.2	150
400	100	2.1	2.7	25	81	3.0	330
350	100	1.8	2.2	25	69	2.9	330
300	100	1.6	2.2	24.5	54	2.8	330
250	100	1.3	2.2	24.5	44	2.6	330
200	100	1.05	2.2	24	32	2.4	330
400	220	1.1	3.9	27.5	81	2.3	680
350	220	0.95	3.9	27.5	68	2.2	680
300	220	0.85	3.9	27	56	2.2	680
250	220	0.7	3.9	27	45	2.1	680
200	220	0.55	3.9	26.5	34	2.0	680

*V_{out}=Output voltage at start of I_{g1} or at D_{tot}=10%
**R_{g1}=Grid resistance of *following* valve

LIMITING VALUES

V_a max.	300	V
p_a max.	5	W
I_k max.	2×25	mA
R_{g1-k} max.	1.5	MΩ
V_{h-k} max.	50	V

BASES: ECC 31—Octal (63)
ECC 32—Octal (64)

DIMENSIONS: L=106 mm D=46 mm

ECC 33

Double triode with separate cathodes

Preliminary data

HEATER

V_h 6.3 V I_h 0.4 A Triode heaters series connected

CAPACITANCES

$c_{a'-a''}$	0.75	μμF
c_{a-g} (each section)	2.5	μμF
c_{g-k} (each section)	3.5	μμF
$c_{a'-k'}$	1.2	μμF
$c_{a''-k''}$	1.5	μμF

g′, a′, k′–pins 1, 2 & 3
g,″ a,″ k″–pins 4, 5 & 6

ECC 33 (contd.)

CHARACTERISTICS

Each section

V_a	250	V
V_g	−4.0	V
I_a	9.0	mA
g_m	3.6	mA/V
μ	35	
r_a	9,700	Ω

OPERATING CONDITIONS

As R.C. coupled A.F. amplifier

V_b (V)	R_a (KΩ)	I_a (mA)	R_k (KΩ)	V_{out}/V_{in}	V_{out}* (V)	D_{tot} (%)	R_{g1}** (KΩ)
400	47	4.0	1.2	25.5	74	6.1	150
350	47	3.5	1.2	25	62.5	5.9	150
300	47	3.0	1.2	25	50	5.6	150
250	47	2.5	1.2	25	41	5.6	150
200	47	2.0	1.2	24.5	30.5	5.3	150
400	100	2.05	2.2	28	78.5	5.7	330
350	100	1.8	2.2	27.5	66.5	5.6	330
300	100	1.55	2.2	27	54.5	5.6	330
250	100	1.3	2.2	27	43	5.4	330
200	100	1.05	2.2	26.5	32	5.2	330
400	220	1.1	3.9	28	74.5	5.1	680
350	220	0.98	3.9	28	63	5.0	680
300	220	0.83	3.9	28	51	5.0	680
250	220	0.7	3.9	27.5	41	4.8	680
200	220	0.53	3.9	27	30.5	4.8	680

*Output voltage at start of I_{g1}. At output voltages lower than those shown, the distortion is approximately proportional to the voltage

**Grid resistance of the *following* valve

LIMITING VALUES

Each section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
I_k max.	20	mA
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	100	V

BASE : Octal (64) **DIMENSIONS** : L=82 mm D=33 mm

ECC 34

Double triode, low impedance, with separate cathodes

HEATER

V_h 6.3 V I_h 0.95 A Suitable for A.C. mains operation

ECC 34 (contd.)

CAPACITANCES

Each section

$c_{a'-a''}$	0.48	µµF
c_{a-g}	4.0	µµF
c_{g-k}	3.5	µµF
c_{a-k}	1.8	µµF

OPERATING CONDITIONS

V_a	250	V
I_a	10	mA
V_g	−16	V
g_m	2.2	mA/V
r_a	5.2	KΩ
μ	11.5	

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	3.25	W
I_k max.	2×25	mA
V_{h-k} max.	50	V
R_{g1-k} max.	2.0	MΩ

BASE : Octal (64) **DIMENSIONS** : L=106 mm D=46 mm

ECC 35

Double triode with separate cathodes

HEATER

V_h 6.3 V I_h 0.4 A Suitable for A.C. mains operation

CAPACITANCES

$c_{a'-a''}$	0.75	µµF
$c_{a'-g'}$	2.5	µµF
$c_{g'-k'}$	3.0	µµF
$c_{a'-k'}$	1.0	µµF
$c_{a''-g''}$	3.0	µµF
$c_{g''-k''}$	3.0	µµF
$c_{a''-k''}$	1.3	µµF

g′, a′, k′-pins 1, 2, 3
g″, a″, k″-pins 4, 5, 6

CHARACTERISTICS

V_a	250	V
V_g	−2.5	V
I_a	2.3	mA
g_m	2.0	mA/V
μ	68	
r_a	34	KΩ

ECC 35 (contd.)

OPERATING CONDITIONS

As R.C. coupled A.F. amplifier

V_b (V)	R_a (K Ω)	I_a (mA)	R_k (K Ω)	V_{out}/V_{in}	V_{out}* (V)	V_{out}† (V)	D_{tot} (%)	R_{g1}** (K Ω)
400	100	1.3	2.7	40.5	37.5	66.2	10	330
350	100	1.1	2.7	40.5	32.2	57.0	10	330
300	100	1.0	2.7	40	28	48.7	10	330
250	100	0.8	2.7	40	23.2	41.1	10	330
200	100	0.65	2.7	39.5	18.7	28.5	8	330
400	220	0.73	4.7	46	44	80	10	680
350	220	0.63	4.7	45.5	38	69.3	10	680
300	220	0.53	4.7	45.5	32.5	59	10	680
250	220	0.45	4.7	45	27	43	8.5	680
200	220	0.38	4.7	45	21.5	33.6	8.2	680

*At D_{tot}=5%
†At D_{tot}=10% or start of I_g
**Grid resistance of *following* valve

LIMITING VALUES

Each section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.5	W
I_k max.	8.0	mA
R_{g-k} max.	1.5	M Ω
V_{h-k} max.	90	V

BASE: Octal (64) **DIMENSIONS:** L=83 mm D=33 mm

ECC 40 Double triode with separate cathodes

Preliminary data

HEATER

V_h 6.3 V I_h 0.6 A Suitable for A.C. mains operation

CAPACITANCES

Each section

c_{g-k}	2.9	μμF
c_{a-k}	1.0	μμF
c_{a-g}	2.65	μμF

CHARACTERISTICS

Each section

V_a	250	V
V_{g1}	–5.5	V
I_a	6	mA
g_m	2.7	mA/V
r_a	11	K Ω
μ	30	

ECC 40 (contd.)

OPERATING CONDITIONS

As R.C. coupled A.F. amplifier

V_b (V)	R_a (K Ω)	R_k (K Ω)	V_{out}/V_{in}	V_{out} (V_{rms})	D_{tot} (V)	R_{g1}* (K Ω)
250	100	2,000	24	30	1.8	500
250	200	2,000	26	18	1.2	500

*R_{g1}-Grid resistance of *following* valve

LIMITING VALUES

Each section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.5	W
I_k max.	10	mA
V_g (I_g=+0.3 μA)	–1.3	V
R_{g-k} max.	1	M Ω
V_{h-k} max.	175	V

BASE: B8A (110) **DIMENSIONS:** L=67 mm D=22 mm

ECC 91 Miniature double triode

For use in transmitters see Section K, page 115

HEATER

V_h 6.3 V I_h 0.45 A Suitable for A.C. mains operation

CAPACITANCES

Each section

c_{a-g}	1.6	μμF
c_{g-k}	2.2	μμF
c_{a-k}	0.4	μμF

CHARACTERISTICS

Each section

V_a	100	V
I_a	8.5	mA
R_k	50	Ω*
g_m	5.3	mA/V
μ	38	
r_a	7.1	K Ω

*Value for both sections working under specified conditions

LIMITING VALUES

V_a max.	300	V
p_a max.	2×1.5	W
V_g max.	–40	V
I_g max.	2×8	mA
V_{h-k} max.	100	V
R_{g-k} max. (self bias)	0.5	M Ω

BASE: Octal (80) **DIMENSIONS:** L=55 mm D=19 mm

Double diode triode

KBC 32

For diode characteristics see Section C, page 51

FILAMENT

V_f 2.0 V I_f 0.05 A Suitable for D.C. operation only

Metallised bulb

CAPACITANCES

c_{out}	7.0	μμF
c_{in}	1.9	μμF
c_{a-g}	3.1	μμF

CHARACTERISTICS

V_a	100	V
V_g	0	V
I_a	2.4	mA
g_m	1.2	mA/V
μ	25	
r_a	21	KΩ

TYPICAL OPERATING CONDITIONS

As R.C. coupled A.F. amplifier

$V_{a(b)}$	120	120	V
R_a	47	100	KΩ
V_g	−1.5	−0.9	V
I_a	0.6	0.5	mA

LIMITING VALUE

V_a max.	150	V

BASE : Octal (61) **DIMENSIONS** : L=110 mm D=33 mm

UBC 41 Double diode triode

Preliminary data

For diode characteristics see Section C, page 53

HEATER

V_h 14.0 V I_h 0.1 A Suitable for D.C./A.C. operation

CHARACTERISTICS

V_a	170	V
V_g	−1.6	V
I_a	1.5	mA
μ	70	
g_m	1.65	mA/V
r_a	42	KΩ

OPERATING CONDITIONS

For resistance capacity coupled amplifier data see Type EBC 41, pages 56 and 57

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1	W
V_{g1} max. (I_{g1}=+0.3 μA)	−1.3	V
R_{g-k} max. (cathode bias)	3	MΩ
V_{h-k} max.	150	V

BASE : B8A (102) **DIMENSIONS** : L=60 mm D=22 mm

Diode pentode operated as triode with screen connected to anode

EAF 42

For operation as pentode see Section A, page 20

For diode characteristics see Section C, page 48

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

At V_b=250 V R_a=100 KΩ R_k=680 Ω

$-V_{g1}$ (V)	I_a (mA)	V_{out}/V_{in}	D_{tot}(%) (V_{out}= 3 V_{rms})	D_{tot}(%) (V_{out}= 5 V_{rms})	D_{tot}(%) (V_{out}= 8 V_{rms})
0	2.0	15	0.9	1.1	1.2
5	1.5	8.5	1.1	1.6	2.4
10	1.17	6	1.1	1.6	2.4
15	0.90	5	1.1	1.6	2.4
20	0.68	4	1.2	1.7	2.6

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

R.F. pentode operated as triode with screen connected to anode and suppressor to cathode

EF 37

For operation as R.F. pentode see Section A, page 21

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

Metallised bulb

OPERATING CONDITIONS

For operation as A.F. pentode Voltage amplifier see Section F, page 72

V_a	150	V
V_{g1}	−3	V
I_a	6	mA
μ	28	
g_m	2.8	mA/V
r_a	10	KΩ

BASE : Octal (72) **DIMENSIONS** : L=100 mm D=32 mm

Low impedance triode

EC 31

HEATER

V_h 6.3 V I_h 0.65 A Suitable for A.C. mains operation

For operation as voltage amplifier see Section D, page 58

OPERATING CONDITIONS

As output valve (Class " A ")

V_a	250	V
V_g	−16	V
I_a	20	mA
R_k	800	Ω
g_m	3.2	mA/V
μ	10.5	
r_a	3.3	KΩ
R_a	10	KΩ
$V_{in(rms)}$	9.1	V
P_{out} ($D_{tot}=5\%$)	0.5	W

LIMITING VALUES

V_a max.	250	V
p_a max.	5	V
I_k max.	30	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	50	V
V_g ($I_g=1.0$ μA)	−0.4 to −0.8	V

BASE : Octal (60) **DIMENSIONS** : L=124 mm D=48 mm

Low impedance triode

DO 30

FILAMENT

V_f 4.0 V I_f 2.0 A approx.

CHARACTERISTICS

V_a	100	V
V_g	0	V
μ	4	
r_a	580	Ω
g_m	6.9	mA/V

OPERATING CONDITIONS

As Single Class " A " amplifier

V_a	400	500	V
V_g	−102	−134	V
I_{ao}	62.5	60	mA
R_a	4.5	6.0	KΩ
P_{out}	8	11	W

DO 30 (contd.)

OPERATING CONDITIONS—(contd.)

As Class "AB 1" push-pull pair

V_a	440	500	V
V_g	−117	−145	V
I_{ao}	57	50	mA
R_{a-a}	2.8	3.4	KΩ
P_{out}	32	45	W

LIMITING VALUES

V_a max.	500	V
p_a max.	30	W

BASE: British 4-pin (3)

DIMENSIONS: L=160 mm D=65.5 mm

CL 33

HEATER

V_h 33.0 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

Screen connected to anode

For operation as pentode *see Section G, page 76*

V_a	200	V
I_a	37.5	mA
V_g	−10	V
g_m	7.5	mA/V
μ	13.5	
r_a	1.8	KΩ
R_k	270	Ω
P_{out}	0.7 W approx.	
$V_{in\ rms}$	6	V
R_a	7	KΩ

LIMITING VALUES

$V_{a(b)}$ max.	400	V
V_a max.	250	V
p_a max.	11	W
I_k max.	70	mA
R_{g1-k} max. (self bias)	1.0	MΩ
V_{h-k} max.	175	V

BASE: Octal (70) **DIMENSIONS**: L=126 mm D=45 mm

EL 32

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

Screen connected to anode

For operation as pentode *see Section G, page 85*

V_a	200	200	250	250	V
V_{g1}	−19	−14	−27	−20	V
I_a	15	30	15	30	mA
g_m	2.1	3.2	1.7	2.6	mA/V
r_a	3.3	2.4	4.1	3.1	KΩ
μ	7	8	7	8	

LIMITING VALUES

$V_{a(b)}$ max.	550	V
$V_{a\ (a+g2)}$ max.	250	V
$p_{a\ (a+g2)}$ max.	9.6	W
I_k max.	45	mA
R_{g1-k} max. (fixed bias)	1	MΩ
R_{g1-k} max. (self bias)	0.6	MΩ
V_{h-k} max.	50	V

BASE: Octal (71) **DIMENSIONS**: L=110 mm D=37 mm

EL 33

For operation as pentode see Section G, page 86

HEATER

V_h 6.3 V I_h 0.9 A Suitable for A.C. mains operation

OPERATING CONDITIONS

Screen connected to anode

V_a	250	V
I_a	20	mA
V_g	−8.5	V
g_m	6.5	mA/V
μ	20	
r_a	3	KΩ
R_k	390	Ω
R_a	7	KΩ
P_{out}	1.1	W
D_{tot}	5	%
$V_{in\ rms}$	5.9	V
$V_{in\ rms}$ (50 mW)	1.1	V

LIMITING VALUES

$V_{a(b)}$ max.	550	V
$V_{a\ (a+g2)}$ max.	250	V
$p_{a\ (a+g2)}$ max.	11.5	W
I_k max.	55	mA
R_{g1-k} max.	1	MΩ

BASE : Octal (70) **DIMENSIONS** : L=126 mm D=46 mm

EL 37

For operation as pentode see Section G, page 88

HEATER

V_h 6.3 V I_h 1.4 A

OPERATING CONDITIONS

As single valve (screen connected to anode by 100 Ω resistor)

V_a	300	400	V
I_a	50	37.5	mA
V_{g1}	−23	−36	V
g_m	6.5	4.5	mA/V
μ	9	9	
r_a	1.4	2	KΩ

As triode connected push-pull pair (self bias)

V_b	350	435	V
V_a	320	400	V
$I_{a\ (o)}$	2×56	2×70	mA
I_a (max. sig.)	2×64	2×80	mA
p_a	2×18	2×28	W
R_k	245	245	Ω
R_{a-a}	4	4	KΩ
$V_{in\ rms}$	2×21.5	2×27.2	V
P_{out}	12.5	20.6	W
D_{tot}	4.1	4.3	%

LIMITING VALUES

Normal applications

V_{a+g2} max.	400	V
p_{a+g2} max.	28	W

BASE : Octal (70) **DIMENSIONS** : L=131 mm D=54 mm

DAF 91

Miniature diode pentode

For operation as R.F. pentode see Section A, page 17

For diode characteristics see Section C, page 47

FILAMENT

V_f 1.4 V I_f 0.05 A Suitable for D.C. operation only

CHARACTERISTICS

V_a	67.5	90	V
V_{g2}	67.5	90	V
V_{g1}	0	0	V
I_a	1.6	2.7	mA
I_{g2}	0.4	0.5	mA
g_m	625	720	µA/V
r_a	0.6	0.5 MΩ approx.	

OPERATING CONDITIONS

As R.C. coupled A F. amplifier (V_{g1} =0V)

V_b	45	45	45	45	45	45	45	45	45	V
R_a	0.27	0.27	0.27	0.47	0.47	0.47	1.0	1.0	1.0	MΩ
I_a	80	80	80	50	50	50	25	25	25	µA
R_{g2}	1.0	1.0	1.0	1.8	1.8	1.8	3.9	3.9	3.9	MΩ
I_{g2}	23.2	23.2	23.2	14.6	14.6	14.6	7.7	7.7	7.7	µA
R_{g1}*	0.47	1.0	4.7	1.0	4.7	10	2.2	4.7	10	MΩ
$V_{out(rms)}$	1.55	1.94	2.25	2.15	2.75	2.85	2.8	3.25	3.5	V
V_{out}/V_{in}	31	38.8	45	43	55	57	56	65	70	
D_{tot}	2.1	1.9	1.2	2.0	1.7	1.6	2.9	2.4	2.0	%
$V_{out(rms)}$ (D_{tot}=5%)	3.95	6.0	7.55	5.0	7.4	7.6	5.6	6.5	6.9	V
V_{out}/V_{in} (D_{tot}=5%)	30.4	35.3	39.7	41.6	49.3	50.6	56	59	62.7	

V_b	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	V
R_a	0.27	0.27	0.27	0.47	0.47	0.47	1.0	1.0	1.0	MΩ
I_a	145	145	145	87	87	87	45	45	45	µA
R_{g2}	1.0	1.0	1.0	1.8	1.8	1.8	3.9	3.9	3.9	MΩ
I_{g2}	41	41	41	25	25	25	13	13	13	µA
R_{g1}*	0.47	1.0	4.7	1.0	4.7	10	2.2	4.7	10	MΩ
$V_{out(rms)}$	4.1	5.0	5.7	5.5	6.8	7.0	7.1	8.2	8.65	V
V_{out}/V_{in}	41	50	57	55	68	70	71	82	86.5	
D_{tot}	1.8	1.3	1.6	1.7	2.0	2.1	2.3	2.5	2.7	%
$V_{out(rms)}$ (D_{tot}=5%)	9.85	12.6	15.2	10.4	13.9	14.8	10.0	12.8	13.4	V
V_{out}/V_{in} (D_{tot}=5%)	37.9	45	50.6	49.6	60.3	61.8	66.8	75.3	78.8	

V_b	90	90	90	90	90	90	90	90	90	V
R_a	0.27	0.27	0.27	0.47	0.47	0.47	1.0	1.0	1.0	MΩ
I_a	220	220	220	130	130	130	65	65	65	µA
R_{g2}	1.0	1.0	1.0	1.8	1.8	1.8	3.9	3.9	3.9	MΩ
I_{g2}	61	61	61	36	36	36	18.7	18.7	18.7	µA
R_{g1}*	0.47	1.0	4.7	1.0	4.7	10	2.2	4.7	10	MΩ
$V_{out(rms)}$	4.9	6.0	6.9	6.65	8.35	8.7	9.0	10.4	11.0	V
V_{out}/V_{in}	49	60	69	66.5	83.5	87	90	104	110	
D_{tot}	0.8	1.4	2.0	1.7	3.1	3.5	3.0	3.3	3.6	%
$V_{out(rms)}$ (D_{tot}=5%)	14.4	17.5	20	16.5	20.3	21.0	15.1	17.4	17.6	V
V_{out}/V_{in} (D_{tot}=5%)	42.4	51.5	58.9	59	72.5	75	84	96.8	103.5	

*Grid resistance of following valve

DAF 91 (contd.)

LIMITING VALUES

V_a max.	90	V
V_{g2} max.	90	V
V_{g1} max.	0	V
I_k max.	4.5	mA

BASE : B7G (40) **DIMENSIONS** : L=55 mm D=19 mm

EF 37 Low microphony A.F. pentode

For operation as R.F. pentode see Section A, page 21

For operation as triode see Section D2, page 65

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

As resistance–coupled A.F. amplifier

V_b (V)	R_a (M Ω)	I_a (mA)*	R_{g2} (M Ω)	I_{g2} (mA)*	R_k (K Ω)	V_{out} (V_{rms})	V_{out}/V_{in}	D_{tot} (%)
300	0.33	0.7	0.82	0.25	3.9	11.2	175	1.4
250	0.33	0.6	0.82	0.2	3.9	8.5	165	1.6
200	0.33	0.45	0.56	0.17	6.8	5.0	130	1.8
100	0.33	0.22	0.56	0.08	6.8	2.4	105	<1.0
300	0.22	1.1	0.39	0.4	3.3	11.2	150	<1.0
250	0.22	0.9	0.39	0.35	3.3	8.5	140	1.3
200	0.22	0.6	0.39	0.23	4.7	5.0	115	1.0
100	0.22	0.3	0.39	0.12	4.7	2.4	100	0.9
300	0.1	1.9	0.27	0.65	1.5	11.2	115	1.0
250	0.1	1.6	0.27	0.5	1.5	8.5	110	1.0
200	0.1	1.2	0.22	0.4	3.3	5.0	95	<1.0
100	0.1	0.6	0.22	0.2	3.3	2.4	85	<1.0

*I_a and I_{g2} measured at zero signal
Note.—Resistance of grid leak of *following* valve=0.7 M Ω

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1	W
I_k max.	6	mA
$V_{g2(b)}$ max.	550	V
V_{g2} max.	125	V
p_{g2} max.	0.3	W
I_{g2} max.	1.4	mA
R_{g1-k} max. (self bias)	3	M Ω
R_{g1-k} max. (fixed bias)	1	M Ω
V_{h-k} max.	100	V

BASE : Octal (72) **DIMENSIONS** : L=100 mm D=32 mm

EF 40 Low microphony A.F. pentode

Preliminary data

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{in}	4.0	μμF
c_{out}	5.5	μμF
c_{a-g1}	0.025	μμF
c_{g1-h}	<0.0015	μμF

CHARACTERISTICS

V_a	250	V
V_{g2}	150	V
V_{g3}	0	V
V_{g1}	–2.0	V
I_a	3.0	mA
I_{g2}	0.9	mA
μ_{g1-g2}	45	
g_m	1.8	mA/V
r_a	3.0	M Ω

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	200	V
p_{g2} max.	0.3	W
I_k max.	6	mA
R_{g1-k} max.	3	M Ω
V_{h-k} max.	100	V

BASE : B8A (109) **DIMENSIONS** : L=60 mm D=22 mm

UAF 42 Diode pentode

For operation as R.F. amplifier see Section A, page 28

For diode characteristics see Section C, page 52

HEATER

V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

As A.F. amplifier

V_b	100	170	V
R_a	0.22	0.22	M Ω
R_{g2}	0.82	0.82	M Ω
R_k	2.7	2.7	K Ω
I_a	0.29	0.5	mA
I_{g2}	0.09	0.17	mA
$V_{out\ rms}$	5.0	8.0	V
V_{out}/V_{in}	75	80	
D_{tot}	1.1	1.2	

UAF 42 (contd.)

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	0.3	W
I_k max.	10	mA
R_{g1-k} max.	3	MΩ
V_{h-k} max.	150	V
R_{g3-k} max.	3	mΩ*

*For V_{g3} not exceeding +10 V pk.

BASE : B8A (93) **DIMENSIONS** : L=60 mm D=22 mm

UF 41

A.F. pentode with variable-μ characteristics

Preliminary data

HEATER

V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES and LIMITING VALUES

For operation as R.F. pentode see Section A, page 28

See Section A, page 000

OPERATING CONDITIONS

As A.F. amplifier

V_b	170	170	100	100	V
R_a	0.2	0.1	0.2	0.1	MΩ
R_{g2}	0.73	0.35	0.73	0.35	MΩ
R_k	2,500	1,300	2,500	1,300	Ω
I_a	0.62	1.16	0.36	0.7	mA
I_{g2}	0.2	0.38	0.12	0.22	mA
V_{out}/V_{in}	84	76	80	75	
$V_{out(rms)}$	8	8	5	5	V
$V_{in(rms)}$	0.094	0.105	0.063	0.067	V
D_{tot}	1.7	2.0	1.3	1.4	%

BASE : B8A (96) **DIMENSIONS** : L=60 mm D=22 mm

CBL 31

Double diode output pentode

FILAMENT

V_h 44 V I_h=0.2 A Suitable for D.C./A.C. operation

For diode characteristics see Section C, page 47

OPERATING CONDITIONS

As Class "A" amplifier

V_a	200	V
V_{g2}	200	V
V_{g1}	−8.5	V
I_a	45	mA
I_{g2}	6	mA
g_m	8	mA/V
r_a	35	KΩ
R_a	4.5	KΩ
$V_{in(rms)}$	5	V
$V_{in(rms)}$ (P_{out}=50 mW)	0.5	V
P_{out}	4	W
D_{tot}	10	%
R_k	167	Ω

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9	W
I_k max.	70	mA
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	2	W
R_{g1-k} (self bias)	1	MΩ
V_{h-k}	125	V

BASE : Octal (75) **DIMENSIONS** : L=136 mm D=46 mm

CL 33 High sensitivity output pentode

For operation as triode see Section E2, page 69

HEATER

V_h 33.0 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

Single valve Class " A "

V_a	200	V
V_{g2}	200	V
V_{g1}	–8.5	V
I_a	45	mA
I_{g2}	6	mA
g_m	8	mA/V
r_a	35	KΩ
μ_{g1-g2}	13.5	
R_a	4.5	KΩ
$V_{in(rms)}$	5.0	V
$V_{in(rms)}$ (P_{out}=50 mW)	0.5	V
P_{out}	4.0	W
D_{tot}	10	%
R_k	180	Ω

OPERATING CONDITIONS

As Class " A " push–pull pair

V_a	200	V
V_{g2}	200	V
R_k	150	Ω
$I_{a(o)}$	2×33	mA
$I_{g2(o)}$	2×5	mA
R_{a-a}	4.5	KΩ
$V_{in(rms)}$	2×5	V
P_{out}	8	W
D_{tot}	1.5	%

LIMITING VALUES

$V_{a(b)}$ max.	400	V
V_a max.	250	V
p_a max.	9	W
I_k max.	70	mA
$V_{g2(b)}$ max.	400	V
V_{g2} max.	250	V
p_{g2} max.	2	W
R_{g1-k} max. (self bias)	1	MΩ
V_{h-k} max.	175	V

BASE : Octal (70) **DIMENSIONS** : L=126 mm D=45 mm

DL 33

Output pentode
Suitable for D.C. operation only

FILAMENT

(*a*) Series : V_f applied across the two filament sections in series, between pins 2 and 7. V_{g1} referred to pin 7
(*b*) Parallel : V_f applied across the two filament sections in parallel, between pin 8 and pins 2 and 7 connected together. V_{g1} referred to pin 8

	Series	*Parallel*	
V_f	2.8	1.4	V
I_f	0.05	0.1	A

OPERATING CONDITIONS

As Class " A " amplifier

Filament Arrangement	*Series*			*Parallel*		
V_a	90	110	85	90	110	V
V_{g2}	90	110	85	90	110	V
V_{g1}	–4.5	–6.6	–5.0	–4.5	–6.6	V
$V_{in(rms)}$	3.2	3.6	3.5	3.2	3.8	V
I_a	8.0	8.5	7.0	9.5	10.0	mA
I_{g2}	1.0	1.1	0.8	1.3	1.4	mA
g_m	2.0	2.0	1.95	2.2	2.2	mA/V
r_a	80	110	70	90	100	KΩ
R_a	8	8	9	8	8	KΩ
P_{out}	230	330	250	270	400	mW
D_{tot}	8.5	8.5	5.5	6.0	6.0	%

LIMITING VALUES

Filament Arrangement	*Series*	*Parallel*	
V_a max.	110	110	V
V_{g2} max.	110	110	V
$I_{k(o)}$ max.	6*	12	mA
R_{g1-f} max.	1.0	1.0	MΩ

*For each 1.4 V section

BASE : Octal (69) **DIMENSIONS**: L=100 mm D=30 mm

DL 35

Output pentode

FILAMENT

V_f 1.4 V I_f 0.1 A Suitable for D.C. operation only

OPERATING CONDITIONS

As Class " A " amplifier

V_a	83	90	V
V_{g2}	83	90	V
V_{g1}	–7.0	–7.5	V
$V_{in(rms)}$	5.0	5.3	V
I_a (max. sig.)	7.3	7.8	mA
I_{ao}	7.0	7.5	mA
I_{g2} (max. sig.)	3.5	3.5	mA
$I_{g2(o)}$	1.6	1.6	mA
r_a	110	115	KΩ approx.
g_m	1.5	1.55	mA/V
R_a	9	8	KΩ
P_{out} (D_{tot}=10%)	200	240	mW

DL 35 (contd.)

LIMITING VALUES

V_a max.	110	V
V_{g2} max.	110	V
I_k max.	12	mA

BASE : Octal 66 **DIMENSIONS** : L=92 mm D=30 mm

DL 71

Sub-miniature output pentode

FILAMENT
V_f 1.25 V I_f 25 mA Suitable for D.C. operation only

CAPACITANCES
Measured without an external screen

C_{a-g}	<0.5	μμF
C_{in}	2.6	μμF
c_{out}	3.6	μμF

CHARACTERISTICS

V_a	45	V
V_{g2}	45	V
V_{g1}	−1.25	V
I_a	0.6	mA
I_{g2}	0.15	mA
g_m	550	μA/V
r_a	0.35	MΩ
μ_{g1-g2}	15	

OPERATING CONDITIONS
As single valve Class " A " amplifier (screen fed direct from H.T. line)

V_b	45	V
$I_{a(0)}$	590	μA
$I_{g2(0)}$	150	μA
R_k	1.5	KΩ
V_{g1}	−1.25	V
R_a	0.1	MΩ
$V_{in(rms)}$	0.88	V
P_{out}	6.3	mW
D_{tot}	10	%

Note.—For the above conditions the signal source impedance consisted of a 0.47 MΩ resistor in series with a capacitor of 0.1 μF, the combination being shunted by a 10 MΩ resistor

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	1.7	mA

BASE : Wired-in (16) **DIMENSIONS** : L=38 mm plus 32 mm leads. D=10.1 mm

DL72

Sub-miniature output pentode

FILAMENT
V_f 1.25 V I_f 25 mA Suitable for D.C. operation only

CAPACITANCES
Measured without an external screen

c_{in}	1.6	μμF
c_{out}	3.6	μμF
c_{a-g}	<0.5	μμF

CHARACTERISTICS

V_a	45	V
V_{g2}	45	V
V_{g1}	−4.5	V
I_a	1.25	mA
I_{g2}	0.4	mA
g_m	500	μA/V
r_a	0.17	MΩ

OPERATING CONDITIONS
As single valve Class " A " amplifier (screen fed direct from H.T. line)

V_b	45	V
R_k	2.7	KΩ
V_{g1}	−4.16	V
I_a	1.16	mA
I_{g2}	0.35	mA
R_a	30	KΩ
$V_{in(rms)}$ (D_{tot}=10%)	2.65	V
P_{out} (D_{tot}=10%)	19.5	mW

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	1.7	mA

BASE : Wired-in (16) **DIMENSIONS** : L=38 mm plus 32 mm leads D=10.1 mm

DL92

Miniature output pentode

FILAMENT Suitable for D.C. operation only
(*a*) Series : V_f applied across the two filament sections in series, between pins 1 and 7. V_{g1} referred to pin 1
(*b*) Parallel : V_f applied across the two filament sections in parallel, between pin 5 and pins 1 and 7 connected together. V_{g1} referred to pin 5

	Series	*Parallel*	
V_f	2.8	1.4	V
I_f	0.05	0.1	A

DL 92 (contd.)

OPERATING CONDITIONS

As Class " A " amplifier

Filament Arrangement	Series		Parallel		
V_a	67.5	90	67.5	90	V
V_{g2}	67.5	67.5	67.5	67.5	V
V_{g1}	–7	–7	–7	–7	V
$I_{a(o)}$	6.0	6.1	7.2	7.4	mA
$I_{g2(o)}$	1.2	1.1	1.5	1.4	mA
g_m	1.4	1.43	1.55	1.58	mA/V
r_a	0.1	0.1	0.1	0.1	MΩ
R_a	5	8	5	8	KΩ
$V_{in(rms)}$	5	5	5	5	V
P_{out}	160	235	180	270	mW
D_{tot}	12	13	10	12	%

LIMITING VALUES

Filament Arrangement	Series	Parallel	
V_a max.	90	90	V
V_{g2} max.	67.5	67.5	V
I_k (max. signal)	5.5*	11.0	mA
$I_{k(o)}$ max.	4.5*	9.0	mA

*For each 1.4 V section

BASE : B7G (39) **DIMENSIONS** : L=55 mm D=19 mm

DL 93

Miniature output pentode

For operation in trans–mitting circuits see Section K, page 131

FILAMENT

(*a*) Series : V_f applied across the two filament sections in series, between pins 1 and 7. V_{g1} referred to pin 1

(*b*) Parallel : V_f applied across the two filament sections in parallel, between pin 5 and pins 1 and 7 con–nected together. V_{g1} referred to pin 5

	Series	Parallel	
V_f	2.8	1.4	V
I_f	0.1	0.2	A

Suitable for D.C. operation only

CAPACITANCES

Measured without external screen

c_{a-g1}	<0.34	μμF
c_{in}	4.8	μμF
c_{out}	4.2	μμF

DL 93 (contd.)

OPERATING CONDITIONS

As Class " A " amplifier

Filament Arrangement	Parallel*		
V_a	135	150	V
V_{g2}	90	90	V
V_{g1}	–7.5	–8.4	V
$I_{a(o)}$	14.8	13.3	mA
$I_{g2(o)}$	2.6	2.2	mA
I_a (max. sig.)	14.9	14.1	mA
I_{g2} (max. sig.)	3.5	3.5	mA
r_a	90	100	KΩ
g_m	1.9	1.9	mA/V
R_a	8	8	KΩ
$V_{in(rms)}$	5.3	5.9	V
P_{out}	600	700	mW
D_{tot}	5	6	%

*Operation with series connected filament will be similar to that with parallel connection. With series connection a shunting resistor must be connected between pins 1 and 5 to by–pass the cathode current

LIMITING VALUES

V_a max.	150	V
V_{g2} max.	90	V
p_a max.	2.0	W
p_{g2} max.	0.4	W
$I_{k(o)}$ max	18	mA

BASE : B7G (98) **DIMENSIONS** : L=54 mm D=19 mm

DL 94

Miniature output pentode

FILAMENT ARRANGEMENT

(*a*) Series : V_f applied across the two filament sections in series between pins 1 and 7. V_{g1} referred to pin 1

(*b*) Parallel : V_f applied across the two filament sections in parallel between pin 5 and pins 1 and 7 connected together. V_{g1} referred to pin 5

	Series	Parallel	
V_f	2.8	1.4	V
I_f	0.05	0.1	A

Suitable for D.C. operation only

CAPACITANCES

Without external screening

c_{a-g1}	0.2	μμF
c_{in}	5.5	μμF
c_{out}	3.8	μμF

DL 94 (contd.)

OPERATING CONDITIONS

As Class " A " amplifier

Filament Arrangement	Series	Parallel		
V_a	90	85	90	V
V_{g2}	90	85	90	V
V_{g1}	–4.5	–5.0	–4.5	V
$I_{a(0)}$	7.7	6.9	9.5	mA
$I_{g2(0)}$	1.7	1.5	2.1	mA
g_m	2.0	1.98	2.15	mA/V
r_a	0.12	0.12	0.1	MΩ
R_a	10	10	10	KΩ
$V_{in(rms)}$	3.2	3.5	3.2	V
P_{out}	240	250	270	mW
D_{tot}	7	10	7	%

LIMITING VALUES

Filament Arrangement	Series	Parallel	
V_a max.	90	90	V
V_{g2} max.	90	90	V
$I_{k(0)}$ max.	6	12	mA
I_k max. (max. sig.)	6	12	mA

The limiting values of I_k for series operation given above indicate the maximum for each 1.4 V section of the filament. As the actual I_k max. of the valve is 12 mA, it is necessary to connect a resistor between pins 1 and 5 in order to maintain the correct voltage across the filament

BASE : B7G (99) **DIMENSIONS** : L=55 mm D=19 mm

EBL 21

Double diode output pentode

For diode characteristics see Section C, page 51

HEATER

V_h 6.3 V I_h 0.8 A Suitable for A.C. mains operation

CAPACITANCE

c_{a-g1} <1.4 μμF

OPERATING CONDITIONS

As Class " A " amplifier

V_a	250	250	V
V_{g2}	250	275	V
V_{g1}	–6.0	–6.2	V
I_a	36	44	mA
I_{g2}	4.5	5.8	mA
R_k	150	120	Ω
g_m	9.0	9.5	mA/V
μ_{g1-g2}	23	23	
r_a	50	50	KΩ
R_a	7	5.7	KΩ
P_{out}	4.5	5.5	W
D_{tot}	10	10	%
$V_{in(rms)}$	4.2	4.5	V
$V_{in(rms)}$ (P_{out}=50 mW)	0.35	0.3	V

Mullard

EBL 21 (contd.)

OPERATING CONDITIONS

As Class " AB_1 " push–pull pair

V_a	300	V
V_{g2}	300	V
R_k	120	Ω
$I_{a(0)}$	2×30	mA
I_a (max. sig.)	2×36	mA
$I_{g2(0)}$	2×3.8	mA
I_{g2} (max. sig.)	2×6.5	mA
R_{a-a}	9	KΩ
$V_{in(rms)}$	2×7.0	V
P_{out}	13.2	W
D_{tot}	1.8	%
$V_{in(rms)}$ (P_{out}=50 mW)	2×0.3	V

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	11	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	3.5	W
I_k max.	60	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	50	V

BASE : B8G (87) **DIMENSIONS** : L=96 mm D=29 mm

EBL 31

Double diode output pentode

For diode characteristics see Section C, page 51

HEATER

V_h 6.3 V I_h 1.5 A Suitable for A.C. mains operation

OPERATING CONDITIONS

As Class " A " amplifier

V_a	250	V
V_{g2}	250	V
I_a	36	mA
R_k	150	Ω
V_{g1}	–6.0	V
I_{g2}	5.0	mA
g_m	9.5	mA/V
r_a	50	KΩ
R_a	7	KΩ
P_{out}	4.3	W
D_{tot}	10	%
$V_{in(rms)}$	3.6	V
$V_{in(rms)}$ (50 mW)	0.35	V

Mullard

EBL 31 (contd.)

LIMITING VALUES

$V_{a(b)}$	550	V
V_a max.	250	V
p_a max.	9	W
I_k max.	55	mA
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.5	W
R_{g1-k} max.	1	MΩ
V_{h-k} max.	50	V

BASE : Octal (75) **DIMENSIONS** : L=136 mm D=46 mm

EL 31

Output pentode rated for a continuous dissipation of 25 W

HEATER

V_h 6.3 V I_h 1.4 A Suitable for A.C. mains operation

CAPACITANCE

c_{a-g1}	1.2	μμF

CHARACTERISTICS

V_a	275	600	V
V_{g2}	275	400	V
V_{g1}	–9	–22	V
I_a	91	42	mA
I_{g2}	11	5	mN
g_m	14	7.0	mA/V
r_a	20	43	KΩ
μ_{g1-g2}	16.5	—	

OPERATING CONDITIONS

As push–pull pair (self bias)

V_a	350	375	400	V
V_{g2}	350	375	400	V
R_k	100	122	145	Ω
$I_{a(0)}$	2×71	2×67	2×63	mA
I_a (max. sig.)	2×83	2×75	2×69	mA
$I_{g2(0)}$	2×8.8	2×8.8	2×8.3	mA
I_{g2} (max. sig.)	2×23.5	2×24.5	2×24	mA
R_{a-a}	5	6	7	KΩ
$V_{in(rms)}$	2×15	2×15	2×15.5	V
*P_{out}	38	37.5	37	W
D_{tot}	4.2	5.0	5.0	%

*Measured at start of I_{g1} or 5% distortion

EL 31 (contd.)

OPERATING CONDITIONS *(contd.)*

As push–pull pair (fixed bias)

V_a	400	600	800	V
V_{g2}	400	400	400	V
V_{g1}	–23	–25.2	–26	V
$I_{a(0)}$	2×40	2×30	2×30	mA
I_a (max. sig.)	2×110	2×103	2×107	mA
$I_{g2(0)}$	2×5.2	2×3.4	2×3.1	mA
I_{g2} (max. sig.)	2×26.8	2×28.5	2×28.5	mA
R_{a-a}	4	7.5	10	KΩ
V_{in} (rms)	2×15.5	2×17.5	2×18	V
*P_{out}	55	84	120	W
D_{tot}	3.2	5.0	5.0	%

*Measured at start of I_{g1} or 5% distortion.

LIMITING VALUES

$V_{a(b)}$ max.	1,200	V
V_a max.	800	V
$V_{g2(b)}$ max.	800	V
V_{g2} max.	400	V
p_a max.	25	W
p_{g2} max.	8	W
I_k max.	200	mA
V_{h-k} max.	100	V
R_{g1-k} max. (self bias)	0.5	MΩ
R_{g1-k} max. (fixed bias)	0.1	MΩ

BASE : Octal (73) **DIMENSIONS** : L=141 mm D=54 mm

EL 32

Output pentode

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

For operation as triode see Section E2, page 69

OPERATING CONDITIONS

As Class " A " amplifier

V_a	250	V
V_{g2}	250	V
V_{g1}	–18	V
I_a	32	mA
I_{g2}	5	mA
g_m	2.8	mA/V
r_a	70	KΩ
R_a	8	KΩ
P_{out}	3.6	W
$V_{in(rms)}$	10	V
D_{tot}	10	%

EL 32 contd.

OPERATING CONDITIONS (*contd.*)

As push–pull pair (self bias)

V_a	200	250	V
V_{g2}	200	250	V
R_k	330	330	Ω
$I_{a(o)}$	2×21	2×27.5	mA
I_a (max. sig.)	2×24.5	2×32	mA
$I_{g2(o)}$	2×3.85	2×4.4	mA
R_{a-a}	9	8	KΩ
P_{out}	5.1	7	W
D_{tot}	1.6	1.5	%

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	8	W
I_k max.	45	mA
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.6	W
R_{g1-k} max. (fixed bias)	0.6	MΩ
R_{g1-k} max. (self bias)	1.0	MΩ
V_{h-k} max.	50	V

BASE : Octal (71) **DIMENSIONS** : L=110 mm D=37 mm

EL 33 Output pentode

For operation as triode see Section E2, page 70

HEATER

V_h 6.3 V I_h 0.9 A Suitable for A.C. mains operation

CAPACITANCE

c_{a-g1}	1.0	μμF

OPERATING CONDITIONS

As Class " A " amplifier

V_a	250	V
V_{g2}	250	V
I_a	36	mA
V_{g1}	–6	V
I_{g2}	4	mA
g_m	9	mA/V
r_a	50	KΩ
μ_{g1-g2}	23	
P_{out}	4.5	W
R_a	7	KΩ
$V_{in(rms)}$	4.2	V
$V_{in(rms)}$ (P_{out}=50 mW)	0.33	V
D_{tot}	10	%
R_k	150	Ω

EL 33 (contd.)

OPERATING CONDITIONS (*contd.*)

As push–pull pair (self bias)

V_a	250	V
V_{g2}	250	V
$I_{a(o)}$	2×24	mA
I_a (max. sig.)	2×28.5	mA
$I_{g2(o)}$	2×2.8	mA
I_{g2} (max. sig.)	2×4.6	mA
R_k	150	Ω
R_{a-a}	10	KΩ
P_{out}	8.2	W
$V_{in(rms)}$	6.7	V
D_{tot}	3.1	%

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	275	V
$p_{g2(o)}$ max.	1.2	W
p_{g2} (max. sig.) max.	2.5	W
I_k max.	55	mA
R_{g1-k} max.	1	MΩ
V_{h-k} max.	50	V

BASE : Octal (70) **DIMENSIONS** : L=126 mm D=46 mm

Output pentode EL 35

HEATER

V_h 6.3 V I_h 1.35 A Suitable for A.C. mains operation

CAPACITANCE

c_{a-g}	1.0	μμF

OPERATING CONDITIONS

As Class " A " amplifier

V_a	250	V
V_{g2}	250	V
R_k	180	Ω
V_{g1}	–15.5	V
I_a	72	mA
I_{g2}	8	mA
g_m	5	mA/V
r_a	15.5	KΩ
μ_{g1-g2}	8	
R_a	2.5	KΩ
P_{out}	6	W
$V_{in(rms)}$	13	V
D_{tot}	10	%

EL 35
(contd.)

OPERATING CONDITIONS

As Class "AB" push–pull pair (self bias)

V_a	270	360	V
V_{g2}	270	270	V
R_k	120	270	Ω
$I_{a(0)}$	2×67	2×44	mA
I_a (max. sig.)	2×70	2×53	mA
$I_{g2(0)}$	16	8.5	mA
I_{g2} (max. sig.)	25	17.5	mA
R_{a-a}	5	7	KΩ
P_{out}	17	21	W
$V_{in(rms)}$	31	46	V
D_{tot}	6	<3	%

As Class "AB" push–pull pair (fixed bias)

V_a	360	V
V_{g2}	270	V
V_{g1}	−26	V
$I_{a(0)}$	2×44	mA
I_a (max. sig.)	2×70	mA
$I_{g2(0)}$	8.5	mA
I_{g2} (max. sig.)	19.5	mA
R_{a-a}	6.25	KΩ
P_{out}	26	W
$V_{in(rms)}$	36	V
D_{tot}	<3.0	%

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	375	V
p_a max.	18	W
V_{g2} max.	250	V
p_{g2} max.	3.5	W
I_k	90	mA
R_{g1-k}	0.6	MΩ
V_{h-k}	50	V

BASE : Octal (70) **DIMENSIONS** : L=125 mm D=47 mm

EL 37 Output pentode

For operation as triode see Section E2, page 70

HEATER

V_h 6.3 V I_h 1.4 A Suitable for A.C. mains operation

CAPACITANCES

c_{out}	9.0	μμF
c_{in}	17.5	μμF
c_{a-g1}	1.0	μμF

EL 37
(contd.)

OPERATING CONDITIONS

As Class "A" amplifier

V_a	250	V
V_{g2}	250	V
V_{g1}	−13.5	V
I_a	100	mA
I_{g2}	13.5	mA
R_k	120	Ω
g_m	11.0	mA/V
r_a	13.5	KΩ
μ_{g1-g2}	10	
R_a	2.5	KΩ
$V_{in(rms)}$ (50 mW)	0.45	V
P_{out} (D_{tot}=10%)	10.5	W
$V_{in(rms)}$ (start of I_{g1})	10.8	V
D_{tot} (start of I_{g1})	13.5	%
P_{out} (start of I_{g1})	11.5	W

As push–pull pair (self bias)

V_a	250	325	V
V_{g2}	250	325	V
$I_{a(0)}$	2×59	2×77	mA
I_a (max. sig.)	2×68	2×90	mA
$I_{g2(0)}$	2×7.5	2×9.75	mA
I_{g2} (max. sig.)	2×18	2×30	mA
R_k	130	130	Ω
R_{a-a}	4	4	KΩ
P_{out}	20	35	W
$V_{in(rms)}$	2×14.5	2×21.5	V
D_{tot}	2.3	4.4	%

As push–pull pair (fixed bias)

V_a	350	400	V
V_{g2}	350	400	V
$I_{a(0)}$	2×40	2×50	mA
I_a (max. sig.)	2×118	2×138	mA
$I_{g2(0)}$	2×5	2×6	mA
I_{g2} (max. sig.)	2×29	2×36	mA
V_{g1}	−31	−36	V
R_{a-a}	3.25	3.25	KΩ
P_{out}	46	69	W
$V_{in(rms)}$	2×21.7	2×24.5	V
D_{tot}	2.8	2.5	%

LIMITING VALUES

$V_{a(b)}$ max.	800	V
V_a max.	400	V
$V_{g2(b)}$ max.	800	V
V_{g2} max.	400	V
V_{h-k} max.	75	V
R_{g1-k} max. (cathode bias)	0.5	MΩ
R_{g1-k} max. (fixed bias)	0.1	MΩ
p_a max.	25	W
p_{g2} max.	6	W
I_k max.	125	mA

BASE : Octal (70) **DIMENSIONS** : L=131 mm D=54 mm

EL 38

Output pentode, for use as line time base output valve in A.C. television receivers

HEATER

V_h 6.3 V I_h 1.4 A Suitable for A.C. mains operation

CAPACITANCES

c_{in}	17.5	μμF
c_{out}	6.5	μμF
c_{a-g1}	1.2	μμF

CHARACTERISTICS

V_a	250	600	V
V_{g2}	250	400	V
I_a	100	42	mA
I_{g2}	13	5	mA
V_{g1}	–7	–22	V
g_m	14.3	7.0	mA/V
μ_{g1-g2}	16.5	—	
r_a	21	43	KΩ

OPERATING CONDITIONS

As line time base output valve (see Fig. 2, page 147)

V_b	300	V
For EL 38		
I_a	64	mA
I_{g2}	18	mA
R_k	120	Ω
For EBC 33		
I_a	0.8	mA

N.B.—Above values measured under synchronised conditions

LIMITING VALUES

V_a max.	800	V
V_a pk. max.	4	KV
V_{g2} max.	400	V
p_a max.	25	W
p_{g2} max.	8	W
I_k max.	200	mA
R_{g1-k} ($p_a < 25$ W) max.	0.5	MΩ
R_{g1-k} ($p_a < 9$ W) max.	0.8	MΩ
V_{h-k} max.	100	V

BASE : Octal (73) **DIMENSIONS** : L=141 mm D=54 mm

EL 41

Output pentode, to be operated only with self-bias or semi-automatic bias

Preliminary data

HEATER

V_h 6.3 V I_h 0.7 A Suitable for A.C. mains operation

CAPACITANCES

c_{in}	10.2	μμF
c_{out}	7.8	μμF
c_{a-g1}	<1.0	μμF

OPERATING CONDITIONS

As single Class "A" amplifier

V_a	250	V
V_{g2}	250	V
R_k	180	Ω
V_{g1}	–7	V
I_a	36	mA
I_{g2}	5.2	mA
g_m	10	mA/V
r_a	40	KΩ
μ_{g1-g2}	22	
R_a	7	KΩ
$V_{in(rms)}$ (P_{out}=50 mW)	0.32	V
P_{out} (D_{tot}=10%)	4.2	W
$V_{in(rms)}$ (D_{tot}=10%)	3.7	V
P_{out} (η=50%)	4.5	W
$V_{in(rms)}$ (P_{out}=4.5 W)	4.0	V
D_{tot} (P_{out}=4.5 W)	11.5	%

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	9	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} (zero sig.) max.	1.4	W
p_{g2} (max. sig.) max.	3.3	W
I_k max.	55	mA
R_{g1-k} max.	1	MΩ
V_{h-k} max.	50	V

BASE : B8A (96) **DIMENSIONS** : L=80 mm D=22 mm

EL 42

Output pentode, particularly suitable for use in car radio receivers

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCE

c_{a-g}	0.2	μμF

EL 42 (contd.)

OPERATING CONDITIONS

As single Class " A " amplifier

V_a	200	225	V
V_{g2}	200	225	V
R_k	360	360	Ω
I_a	22.5	26	mA
I_{g2}	3.5	4.1	mA
g_m	3.2	3.2	mA/V
r_a	90	90	KΩ
μ_{g1-g2}	11	11	
R_a	9	9	KΩ
$V_{in(rms)}$ (P_{out}=50mW)	0.8	0.75	V
$V_{in(rms)}$	6.5	7.2	V
P_{out}	1.9	2.5	W
D_{tot}	10	10	%

As Class " AB " push–pull pair (self bias)

V_a	200	250	V
V_{g2}	200	250	V
R_k	310	310	Ω
$I_{a(o)}$	2×16	2×20	mA
I_a (max. sig.)	2×17	2×21.5	mA
$I_{g2(o)}$	2×2.6	2×3.2	mA
I_{g2} (max. sig.)	2×5.6	2×6.7	mA
R_{a-a}	15	15	KΩ
$V_{in(rms)}$ (P_{out}=50mW)	2×0.75	2×0.7	V
$V_{in(rms)}$	2×9.6	2×12.5	V
P_{out}	4.1	7.0	W
D_{tot}	5.5	5.5	%

As Class " B " push–pull pair (fixed bias)

V_a	200	250	V
V_{g2}	200	250	V
V_{g1}	–17	–22.5	V
$I_{a(o)}$	2×5	2×5	mA
I_a (max. sig.)	2×16	2×20	mA
$I_{g2(o)}$	2×0.8	2×0.8	mA
I_{g2} (max. sig.)	2×4.6	2×6.5	mA
R_{a-a}	16	16	KΩ
$V_{in(rms)}$ (P_{out}=50mW)	2×1.5	2×1.7	V
$V_{in(rms)}$	2×12	2×16	V
P_{out}	4.0	6.5	W
D_{tot}	3.5	5	%

LIMITING VALUES

$V_{a(b)}$	550	V
V_a max.	300	V
p_a max.	6	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
$p_{g2(o)}$ max.	1.0	mA
p_{g2} max. (max. sig.)	2.0	mA
I_k max.	35	mA
R_{g1-k} max.	2.0	MΩ
V_{h-k} max.	50	V

BASE : B8A (96) **DIMENSIONS** : L=60 mm D=22 mm

Miniature output pentode

EL 91

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{in}	4.2	μμF
c_{out}	3.2	μμF
c_{a-g}	0.5	μμF

OPERATING CONDITIONS

As single valve Class " A " amplifier

V_a	250	V
V_{g2}	250	V
I_a	16	mA
I_{g2}	2.4	mA
g_m	2.6	mA/V
μ_{g1-g2}	12	
r_a	130	KΩ
R_k	680	Ω
R_a	16	KΩ
$V_{in(rms)}$	5.3	V
P_{out}	1.4	W
D_{tot}	10	%

As push–pull pair (self bias)

V_a	250	V
V_{g2}	250	V
$I_{a(o)}$	2×11	mA
$I_{g2(o)}$	2×1.6	mA
R_k	600	Ω
R_{a-a}	24	KΩ
$V_{in(rms)}$ (P_{out}=50 mW)	2×0.8	V
I_a (max. sig.)	2×12.8	mA
I_{g2} (max. sig.)	2×4.1	mA
$V_{in(rms)}$	2×12	V
P_{out}	4.0	W
D_{tot}	3.2	%

As push–pull pair (fixed bias)

V_a	250	V
V_{g2}	250	V
V_{g1}	–19	V
$I_{a(o)}$	2×5	mA
$I_{g2(o)}$	2×0.65	mA
R_{a-a}	20	KΩ
$V_{in(rms)}$ (P_{out}=50 mW)	2×1.5	V
I_a (max. sig.)	2×16	mA
I_{g2} (max. sig.)	2×4.5	mA
$V_{in(rms)}$	2×13	V
P_{out} (start of I_{g1})	4.8	W
D_{tot} (start of I_{g1})	3.3	%

EL 91 (contd.)

LIMITING VALUES

V_a max.	250	V
V_{g2} max.	250	V
p_a max.	4.0	W
p_{g2} max.	0.6	W
I_k max.	25	mA
V_{h-k} max.	50	V
R_{g1-k} max. (cathode bias)	0.7	MΩ

BASE : B7G (78) **DIMENSIONS** : L=55 mm D=19 mm

KL 35

Output pentode

FILAMENT

V_f 2.0 V I_f 0.15 A Suitable for D.C. operation only

CHARACTERISTICS

V_a	135	V
V_{g2}	135	V
I_a	5.6	mA
g_m	2.2	mA/V
r_a	0.15	MΩ

OPERATING CONDITIONS

As single Class " A " amplifier

	Fixed bias	*Self bias*	
V_a	135	135	V
V_{g2}	135	135	V
V_{g1}	−4.5	−4.8	V
I_a	5.6	5.0	mA
R_a	19	20	KΩ
$V_{in(rms)}$	3.0	2.9	V
P_{out}	340	310	mW
D_{tot}	10	10	%

LIMITING VALUES

V_a max.	150	V
p_a max.	1.0	W
V_{g2} max.	150	V
I_k max.	10	mA
R_{g1-f} (fixed bias) max.	1.0	MΩ
R_{g1-f} (self bias) max.	1.5	MΩ
*V_{g1} (I_{g1}=+1 μA)	+0.3 to +0.8	V

*At V_a=V_{g2}=135 V

BASE: Octal (66) **DIMENSIONS**: L=106 mm D=41 mm

KLL 32

Double output pentode

FILAMENT

V_f 2.0 V I_f 0.3 A Suitable for D.C. operation only

KLL 32 (contd.)

CHARACTERISTICS

V_a	100	V
V_{g2}	100	V
V_{g1}	0	V
g_m	2.6	mA/V

OPERATING CONDITIONS

V_a	90	120	135	V
V_{g2}	90	120	135	V
$I_{a(0)}$	2.8	3.3	3.8	mA
I_a (max. sig.)	9.8	14.4	16.9	mA
V_{g1}	−7.4	−10.2	−11.3	V
I_{g2} (max. sig.)	2.8	4.6	5.7	mA
$V_{in\ (rms)}$	5.2	7.3	8.4	V
P_{out}	0.45	0.94	1.2	W
D_{tot}	1.8	2.5	2.8	%
R_{a-a}	16	16	16	KΩ

BASE: Octal (84) **DIMENSIONS**: L=101 mm D=41 mm

PL 33

Output pentode. Suitable for use in frame time base or audio output stage of D.C./A.C. television receivers

HEATER

V_h 19 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCE

c_{a-g1}	1.0	μμF

OPERATING CONDITIONS

As single Class " A " amplifier

V_a	175	200	225	V
V_{g2}	175	200	225	V
R_k	150	150	150	Ω
V_{g1}	−4	−4.65	−5.3	V
I_a	24	28	32	mA
I_{g2}	2.6	3.0	3.4	mA
g_m	8	8.6	9	mA/V
r_a	60	55	50	KΩ
μ_{g1-g2}	23	23	23	
R_a	7	7	7	KΩ
$V_{in\ (rms)}$ (D_{tot}=10%)	—	—	3.4	V
P_{out} (D_{tot}=10%)	—	—	3.3	W
$V_{in\ (rms)}$ (start of I_{g1})	2.6	3.1	3.6	V
P_{out} (start of I_{g1})	1.8	2.55	3.45	W
D_{tot} (start of I_{g1})	8.8	10	11	%

PL 33 (contd.)

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	275	V
$p_{g2(o)}$	1.2	W
p_{g2} (max. sig.) max.	2.5	W
I_k max.	55	mA
R_{g1-k} max. (self bias)	1.0	MΩ
V_{h-k} max.	300	V

BASE: Octal (70) **DIMENSIONS:** L=126 mm D=46 mm

PL 38

Output pentode. Suitable for use as line time base output valve in D.C./A.C. television receivers

Preliminary data

HEATER

V_h 30 V I_h 0.3 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{in}	17.5	μμF
c_{out}	6.5	μμF
c_{a-g1}	1.2	μμF

CHARACTERISTICS

V_a	200	V
V_{g2}	200	V
V_{g1}	−5.5	V
I_a	75	mA
I_{g2}	9.0	mA
g_m	13.5	mA/V
r_a	20	KΩ
μ_{g1-g2}	16.5	

LIMITING VALUES

V_a max.	800	V
V_a pk. max.	4	KV
V_{g2} max.	400	V
p_a max.	25	W
p_{g2} max.	8	W
I_k max.	200	mA
R_{g1-k} max. (p_a=25 W)	0.5	MΩ*
R_{g1-k} max. (p_a= 9 W)	0.8	MΩ*
V_{h-k} max.	300	V

*For self bias operation

BASE: Octal (73) **DIMENSIONS:** L=141 mm D=54 mm

UBL 21

Double diode output pentode

FILAMENT

V_h 55 V I_h=0.1 A Suitable for D.C./A.C. operation

For diode characteristics see Section C, page 53

CAPACITANCE

c_{a-g1}	<1.2	μμF

OPERATING CONDITIONS

As Class " A " amplifier

V_a	100	180	200	V
V_{g2}	100	180	200	V
R_k	140	140	200	Ω
V_{g1}	−5.3	−10	−13	V
I_a	32.5	61	55	mA
I_{g2}	5.5	10	9.5	mA
g_m	7.5	9.0	8.0	mA/V
r_a	25	22	25	KΩ
μ_{g1-g2}	9.0	9.0	9.0	
R_a	3	3	3.5	KΩ
$V_{in\,(rms)}$ (P_{out}=50 mW)	0.55	0.5	0.5	V
P_{out} (D_{tot}=10%)	1.35	4.8	4.8	W
$V_{in\,(rms)}$ (D_{tot}=10%)	3.8	6.2	6.2	V

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	11	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max. (max. sig.)	3.5	W
p_{g2} max. (zero sig.)	1.9	W
I_k max.	75	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	150	V

BASE : B8G (87) **DIMENSIONS** : L=96 mm D=29 mm

UL 41 Output pentode

HEATER

V_h 45 V I_h 0.1 A Suitable for D.C./A.C. operation

CAPACITANCES

c_{out}	9.3	μμF
c_{in}	12.0	μμF
c_{a-g1}	<0.5	μμF

OPERATING CONDITIONS

As single valve Class "A" amplifier

V_a	100	110	165	V
V_{g2}	100	110	165	V
R_k	140	140	140	Ω
I_a	32.5	36	54.5	mA
I_{g2}	5.5	6.0	9.0	mA
g_m	8.5	8.6	9.5	mA/V
r_a	18	18	20	KΩ
μ_{g1-g2}	10	10	10	
R_a	3	3	3	KΩ
P_{out}	1.35	1.7	4.2	W
$V_{in\ (rms)}$	4.0	4.4	6.2	V
D_{tot}	10	10	10	%
$V_{in\ (rms)}$ (P_{out}=50 mW)	0.55	0.55	0.5	V

LIMITING VALUES

$V_{g(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.5	W
p_{g2} (max. sig.)	3	W
I_k max.	75	mA
V_{g1} max. (I_{g1}=+0.3 μA)	-1.3	V
R_{g1-k} max.	1	MΩ
V_{h-k} max.	150	V

BASE : B8A (96) **DIMENSIONS** : L=77 mm D=22 mm

AZ 31 Directly-heated full-wave rectifier

FILAMENT

V_f 4.0 V I_f 1.1 A

OPERATING CONDITIONS

$V_{a\ (rms)}$ max.	2×500	2×400	2×300	V
I_a max.	60	75	100	mA
Maximum capacitance of reservoir capacitor	60	60	60	μF

At $V_{a\ rms}$ 300–0–300 V Reservoir capacitance 16 μF

I_{out} (mA)	Limiting resistance (each anode) 100	200	400	800 Ω
	V_{out} (D.C.)			
45	340	320	296	263 V
60	325	302	276	237 V
75	310	288	256	210 V
100	280	261	225	166 V
At $V_{a\ rms}$ 400–0–400 V				
30	484	472	457	430 V
45	464	451	433	397 V
60	450	434	412	364 V
75	435	420	393	332 V
At $V_{a\ rms}$ 500–0–500 V				
30	630	612	595	560 V
45	605	588	562	525 V
60	589	570	542	497 V

BASE: Octal (55) **DIMENSIONS:** L=111 mm D=46 mm

CY 31 Indirectly-heated half-wave rectifier

HEATER

V_h 20 V I_h 0.2 A Suitable for D.C./A.C. operation
Heating time 70 secs

OPERATING CONDITIONS

$V_{a\ (rms)}$ max.	250 V
I_a max.	120 V
V_{h-k} max.	350 V

Max. capacitance of reservoir capacitor (C) (μF)	Limiting resistance (R) in series with anode (Ω)
8.0	0
16.0	75
32.0	125

CY 31 (contd.)

At $V_{a\ (rms)}$ 150 V

I_{out} (mA)	C= 8 µF, R= 0 Ω	C= 16 µF, R= 75 Ω	C= 32 µF, R= 125 Ω
	V_{out} (D.C.)		
40	163	157	153 V
60	143	144	140 V
80	125	132	130 V
100	110	123	120 V
120	92	115	111 V
At $V_{a\ (rms)}$ 200 V			
40	226	227	221 V
60	204	210	204 V
80	185	190	196 V
100	165	180	175 V
120	148	167	163 V
At $V_{a\ (rms)}$ 250 V			
40	300	292	282 V
60	271	276	266 V
80	248	262	252 V
100	229	247	240 V
120	210	232	227 V

BASE: Octal (53) **DIMENSIONS**: L=112 mm D=43 mm

EY 51

Miniature indirectly-heated half-wave high voltage rectifier

HEATER

V_h 6.3 V I_h 80 mA

Heater voltage tolerances

For I_{out} not exceeding 100 µA	−20% +10%
For I_{out} exceeding 100 µA	±10%

CAPACITANCE

c_{a-k}	0.8 µµF

OPERATING CONDITIONS

With sinusoidal input (up to 500 Kc/s)

V_a (pk. inverse) max.	15	KV
I_a max.	0.5	mA
Min. limiting resistance	0.1	MΩ
*Max. reservoir capacitance	0.1	µF

*For 50 c/s operation. At other frequencies capacitance to be inversely proportional to the frequency

OPERATING CONDITIONS

With pulse input

V_a (pk. input) max.	10	KV
I_a max.	100	µA
Min. limiting resistance	0.1	MΩ
Max. reservoir capacitance	0.1	µF

BASE : Wired in (146) **DIMENSIONS** : L=48 mm plus wire leads D=15 mm

EY 91

Miniature indirectly-heated half-wave rectifier

HEATER

V_h 6.3 V I_h 0.42 A Heating time 20 secs approx.

OPERATING CONDITIONS

$V_{a\ (rms)}$ V	Reservoir capacitance (C) (µF)	Limiting resistance (R) (Ω)
250	32	100
	16	50
	8	0
200	32	70
	16	30

At $V_{a\ (rms)}$ 150 V

I_{out} (mA)	C= 8 µF, R= 0 Ω	C= 16 µF, R= 0 Ω	C= 32 µF, R= 25 Ω
	V_{out} (D.C.)		
45	155	170	172 V
60	140	160	166 V
75	122	152	160 V

At $V_{a\ (rms)}$ 200 V

I_{out} (mA)	C= 8 µF, R= 25 Ω	C= 16 µF, R= 50 Ω	C= 32 µF, R= 75 Ω
	V_{out} (D.C.)		
45	217	228	218 V
60	200	215	207 V
75	182	202	195 V

At $V_{a\ (rms)}$ 250 V

I_{out} (mA)	C= 8 µF, R= 50 Ω	C= 16 µF, R= 100 Ω	C= 32 µF, R= 125 Ω
	V_{out} (D.C.)		
45	276	282	280 V
60	259	270	268 V
75	241	255	250 V

LIMITING VALUES

$V_{a\ (rms)}$ max.	250	V
I_a max.	75	mA
V_{h-k} max.	300	V
C max.	32	µF

BASE : B7G (54) **DIMENSIONS** : L=55 mm D=19 mm

EZ 35 Indirectly-heated full-wave rectifier

HEATER
V_h 6.3 V I_h 0.6 A

OPERATING CONDITIONS

$V_{a\,(rms)}$ max.	2×325 V
I_a max.	70 mA
V_{h-k} (max.)	350 V
Max. capacitance of reservoir capacitor	16 μF
Min. value of limiting resistance in series with each anode, when reservoir capacitance is 16 μF	350 Ω

Reservoir capacitance=4 μF

I_{out} (mA)	$V_{a\,(rms)}$ 2×150	2×200	2×250	2×300	2×350 V
	V_{out} (D.C.)				
30	172	235	307	375	437 V
40	165	228	300	368	430 V
50	158	220	292	360	421 V
60	150	210	284	350	415 V
70	143	202	278	342	409 V

BASE : Octal (56) **DIMENSIONS** : L=93 mm D=33 mm

EZ 40 Indirectly-heated full-wave rectifier

HEATER
V_h 6.3 V I_h 0.6 A

LIMITING VALUES

$V_{a\,(rms)}$	2×250	2×275	2×300	2×350	V
I_{out} max.	90	90	90	90	mA
Max. reservoir capacitance	50	50	50	50	μF
Min. limiting resistance (each anode) (R)	125	175	215	300	Ω
V_{h-k} max.	500	500	500	500	V

OPERATING CONDITIONS

I_{out} (mA)	$V_{a\,(rms)}$ 2×275 V (C = 50 μF R = 175 Ω)	2×350 V (C = 50 μF R = 300 Ω)
	V_{out} (D.C.)	
30	338	428 V
45	320	403 V
60	302	383 V
75	288	365 V
90	275	350 V

BASE : B8A (5) **DIMENSIONS** : L=80 mm D=22 mm

EZ 41 Indirectly-heated full-wave rectifier

Preliminary data

HEATER
V_h 6.3 V I_h 0.4 A

OPERATING CONDITIONS

$V_{a\,(rms)}$ max.	2×250 V
V_{out} (approx.)	260 V
I_{out}	60 mA
Reservoir capacitance (C)	8 μF
Limiting resistance (R)	150 Ω

LIMITING VALUES

$V_{a\,(rms)}$ max.	2×250 V
I_{out} max.	60 mA
C max.	32 μF
R min. (C= 8 μF)	150 Ω
(C=16 μF)	250 Ω
(C=32 μF)	300 Ω
V_{h-k} max.	350 V

BASE : B8A (5) **DIMENSIONS** : L=60 mm D=22 mm

FW 4-500 Directly-heated full-wave rectifier

FILAMENT
V_f 4.0 V I_f 3.0 A

OPERATING CONDITIONS

$V_{a\,(rms)}$ V	Capacitance of reservoir capacitor (μF)	Min. value of limiting resistances (Ω)
2×500	16	2×200
2×350	32	2×150

I_{out} (mA)	$V_{a\,(rms)}$ 2×300	2×400	2×500 V
	V_{out} (D.C.)		
50	375	516	650 V
100	330	470	600 V
150	290	425	560 V
200	260	390	522 V
250	240	380	500 V

LIMITING VALUES

$V_{a\,(rms)}$ max.	2×500 V
I_a max.	250 mA
P.I.V. max.	1,600 V

BASE : British 4-pin (1) **DIMENSIONS** : L=146 mm D=51 mm

GZ 32 Indirectly-heated full-wave rectifier

HEATER

V_h 5.0 V I_h 2.0 A Heating time 25 secs. approx.

LIMITING VALUES

Capacitor input

$V_{a\,(rms)}$ max.	2×300	2×350	V
I_{out} max.	300	250	mA

Reservoir capacitance (µF)	Limiting resistance (Ω)
60	2×150
32	2×100
16	2× 50

Choke input

$V_{a\,rms}$ max.	2×400	2×500	V
I_{out} max.	300	250	mA

OPERATING CONDITIONS

Capacitor input

$V_{a(rms)}$ V	C (µF)	R (Ω)	V_{out} (D.C.) at 100	150	200	250	300 mA	
250–0–250	16	50	280	260	242	230	218	V
	32	100	270	248	230	212	200	V
	60	150	260	236	212	192	178	V
300–0–300	16	50	342	322	305	290	280*	V
	32	100	330	308	290	272	260*	V
	60	150	321	295	272	254	240*	V
350–0–350	16	50	410	388	372	360*	—	V
	32	100	392	370	352	340*	—	V
	60	150	389	360	339	320*	—	V

Choke input

300–0–300	242	232	226	215	210*	V
400–0–400	328	320	312	302	290*	V
500–0–500	416	408	398	390*	—	V

*Limiting values

BASE: Octal (57) **DIMENSIONS**: L=120 mm D=46 mm

HVR 2 High-voltage half-wave rectifier

HEATER

V_h 4.0 V I_h 0.65 A Heating time 40 secs.

LIMITING VALUES

$V_{a(rms)}$ max.	6,000	V
I_a max.	3.0	mA
P.I.V. max.	20	KV

OPERATING CONDITIONS

Reservoir Capacitor=0.2 µF
Smoothing Capacitor=0.1 µF
Smoothing Resistor=0.4 M Ω

$V_{a(rms)}$ V	KV_{out} (D.C.) at 0.5	1.0	1.5	2.0	2.5	3.0 mA	
4,000 V	5.1	4.9	4.5	4.2	3.9	3.6	KV
6,000 V	8.0	7.8	7.5	7.2	7.0	6.7	KV

BASE: British 4-pin (2) **DIMENSIONS**: L=131 mm D=46 mm

PY 31 Indirectly-heated half-wave rectifier

HEATER

V_h 17 V I_h 0.3 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

$V_{a(rms)}$ V	Max. reservoir capacitance (C) (µF)	Min. limiting resistance (R) (Ω)
250	60	175
	32	125
	16	75
	8	0
170	60	100
	32	75
	16	30
127	60	0

With reservoir capacitance=32 µF

$V_{a(rms)}$ V	V_{out} (D.C.) at 50	75	100	125 mA	
110 (R=0)	120	110	100	90	V
220 (R=125 Ω)	235	216	195	179	V
V_{in} (D.C.)					
110 (R=0)	103	101	99	96	V
220 (R=125 Ω)	210	203	200	194	V

PY 31 (contd.)

LIMITING VALUES

V_a max.	250	V
I_a max.	125	mA
V_{h-k} max.	300	V
P.I.V. max.	1,000	V
C max.	60	µF

BASE : Octal (53) **DIMENSIONS** : L=112 mm D=44 mm

PZ 30

Indirectly-heated full-wave rectifier, primarily intended for use in D.C./A.C. television equipment

HEATER

V_h 52 V I_h 0.3 A Suitable for D.C./A.C. operation

INTERNAL RESISTANCE 100 Ω (per section)

OPERATING CONDITIONS

In half-wave circuit

$V_{a(rms)}$ V	Reservoir capacitance (µF)	Limiting resistance (each anode) (Ω)
240	50	50
240	32	30

With limiting resistors = 2 × 50 Ω and reservoir capacitor = 50 µF

V_a (V_{rms})	V_{out} (D.C.) at 50	100	150	200	240	300	400 mA
240	306	280	272	250	250	225	205 V

OPERATING CONDITIONS

In voltage doubler circuit

$V_{a(rms)}$	220	240	V
I_{out}	200	200	mA
V_{out}	425	480	V
Limiting resistance (each anode)	30	30	Ω
Reservoir capacitance	2 × 32	2 × 32	µF

With limiting resistors = 2 × 30 Ω and reservoir capacitor = 32 µF

$V_{a(rms)}$ V	V_{out} (D.C.) at 60	80	100	150	200 mA
220	520	505	490	452	425 V
240	571	557	540	502	480 V

LIMITING VALUES

$V_{a(rms)}$ max.	240	V
I_a max. (each anode)	200	mA
V_{h-k} max.	650	V
Max. reservoir capacitance	50	µF

BASE : Octal (17) **DIMENSIONS** : L=120 mm D=46 mm

UY 21

Indirectly-heated half-wave rectifier

HEATER

V_h 50 V I_h 0.1 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

$V_{a(rms)}$ (V)	Reservoir capacitance (µF)	Limiting resistance (R) (Ω)
250	60	175
	32	125
	16	75
	8	0
170	60	100
	32	75
	16	30
127	60	0

$V_{a(rms)}$ V	V_{out} (D.C.) at 50	75	100	125	140 mA	
110 (R=0)	116	108	100	95	88	V
127 (R=0)	140	130	122	115	110	V
220 (R=125 Ω)	232	211	195	180	169	V
V_a (D.C.)						
110 (R=0)	104	101	98	95	93	V
127 (R=0)	124	121	119	117	115	V
220 (R=125 Ω)	210	205	200	196	191	V

LIMITING VALUES

$V_{a(rms)}$ max.	250	V
I_a max.	140	mA
V_{h-k} max.	550	V
C max.	60	µF

BASE : B8G (85) **DIMENSIONS** : L=93 mm D=28 mm

UY 41 Indirectly-heated half-wave rectifier

HEATER

V_h 31 V I_h 0.1 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

V_a max. (V_{rms})	Minimum value of series protective resistance (with 50 μF capacitor) (R) (Ω)
220	160
127	0
117	0
110	0

$V_{a(rms)}$ V	V_{out} (D.C.) at 20	40	60	80	90 mA	
110 (R=0)	130	120	111	105	102	V
117 (R=0)	140	128	120	114	111	V
127 (R=0)	153	142	134	127	125	V
220 (R=160 Ω)	260	234	211	196	191	V
V_a (D.C.)						
110 (R=0)	105	101	98	96	95	V
220 (R=160 Ω)	210	203	196	192	190	V

LIMITING VALUES

$V_{a(rms)}$ max.	250	V
I_a max.	90	mA
V_{h-k} max. pk.	550	V
C max.	50	μF

BASE : B8A (14) **DIMENSIONS** : L=64 mm D=22 mm

EM 34

HEATER

V_h 6.3 V I_h 0.2 A Suitable for D.C./A.C. operation

OPERATING CONDITIONS

V_b	200	250	V
$R_{a'}$	1	1	MΩ
$R_{a''}$	1	1	MΩ
I_t	0.55	0.75	mA
V_g (1)	0	0	V
V_g (2)	0	0	V
V_g (5)	−4.2	−5.0	V
V_g (6)	−12.5	−16.0	V

(1) and (2) Max. angle of the shadows produced by the deflector plates x′, x″ and y′, y″ respectively

(5) and (6) Min. angle (5°) of the shadows produced by the deflector plates x′, x″ and y′, y″ respectively

LIMITING VALUES

$V_{a'(b)}$ max.	550	V
$V_{a'}$ max.	275	V
$V_{a''(b)}$ max.	550	V
$V_{a''}$ max.	275	V
$V_{t(b)}$ max.	550	V
V_t max.	275	V
V_{h-k} max.	100	V
R_{g-k} max.	3	MΩ

BASE : Octal (76) **DIMENSIONS** : L=90 mm D=28 mm

UM 34

HEATER

V_h 12.6 V I_h 0.1 A Suitable for D.C./A.C. operation

With the exception of heater ratings the Type UM 34 is identical with Type EM 34 to which please refer

EC 52

Single-ended short-wave triode for use as low power oscillator

HEATER
V_h 6.3 V I_h 0.43 A

CAPACITANCES

c_{in}	5.2	μμF
c_{out}	1.3	μμF
c_{a-g1}	3.1	μμF

CHARACTERISTICS

V_a	250	V
V_{g1}	−2.6	V
I_a	10	mA
g_m	6.5	mA/V
μ	60	
r_a	9.2	KΩ
R_{eq}	310	Ω

LIMITING VALUES

V_a max.	400	V
p_a max.	7.5	W
Limiting frequency of oscillation	400	Mc/s

Note.—At frequencies up to 300 Mc/s the inductance of the heater leads is sufficiently low to allow the heater pins to be earthed capacitatively

BASE : B9G (89) **DIMENSIONS** : L=78 mm D=38 mm

EC 53

Miniature triode for use as low power oscillator at frequencies up to 600/Mcs

For circuits see page **113**

HEATER
V_h 6.3 V I_h 0.25 A

CAPACITANCES

c_{in}	1.3	μμF
c_{out}	0.13	μμF
c_{a-g}	1.3	μμF

CHARACTERISTICS

V_a	200	V
V_g	−3.3	V
I_a	7.5	mA
g_m	2.9	mA/V
μ	33	
r_a	11.4	KΩ
g_m (V_g=0)	4.0	mA/V

EC 53 (contd.)

OPERATING CONDITIONS

As power oscillator up to 400 Mc/s

f (Mc/s)	V_a (V)	I_a (mA)	I_g (mA)	P_{out} W	η %	Refer to circuit
110	250	14.5	5	1.3	35	A
165	250	14.5	5	1.2	33	A
210	250	12.5	3.6	0.8	26	A
285	250	12.5	3.6	0.5	16	B
335	200	12.5	3.6	0.35	14	B
400	200	12.5	3.6	0.3	12	B

Note.—The input power is reduced at the higher frequencies in order to keep within the rated maximum anode dissipation

LIMITING VALUES

V_a max.	250	V
p_a max.	2.5	W
I_k max.	20	mA
R_{g-k} max.	0.5	M Ω
V_{h-k} max.	40	V
Max. operating frequency	600	Mc/s

BASE : B3G (136) **DIMENSIONS** : L=54 mm D=16 mm

EC 91

Miniature grounded-grid triode

HEATER

V_h 6.3 V I_h 0.3 A

CAPACITANCES

c_{a-g}	2.5	μμF
c_{a-k+h}	<0.2	μμF
c_{g-k+h}	8.5	μμF

OPERATING CONDITIONS

V_a	250	V
V_g	−1.5	V
R_k	150	Ω
I_a	10	mA
g_m	8.5	mA/V
μ	100	
r_a	12	K Ω
R_{eq}	400	Ω

LIMITING VALUES

V_a max.	250	V
p_a max.	2.5	W
I_k max.	15	mA
V_{h-k} max.	150	V
V_{g-k} max.	100	V
Max. operating frequency	250	Mc/s

BASE : B7G (59) **DIMENSIONS** : L=55 mm D=19 mm

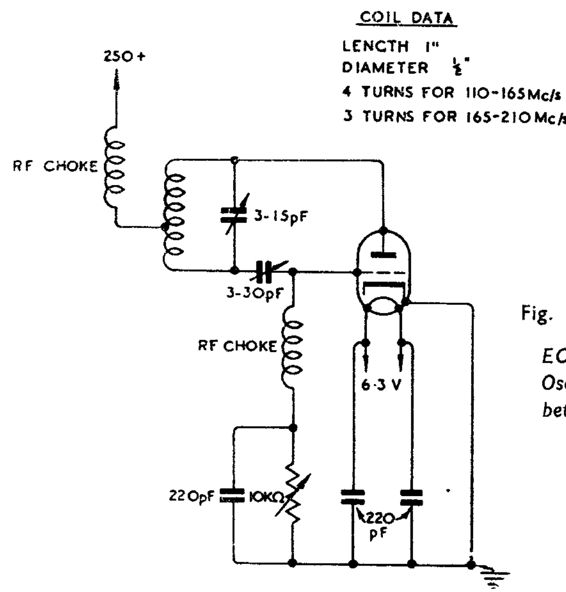


Fig. 1.

EC 53 as Low Power Oscillator at Frequencies between 110 and 210 Mc/s

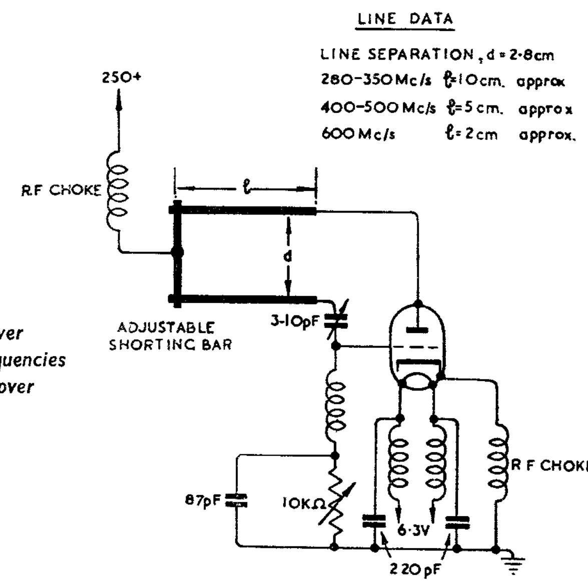


Fig. 2.

EC 53 as Low Power Oscillator at Frequencies of 280 Mc/s and over

ME 1001

Indirectly-heated disc seal triode (without internal feedback) intended mainly as a common grid, earthed anode, concentric line oscillator. It may also be used as a power amplifier.
When used in a co-axial line circuit with an anode input of 10 watts, the output power is approximately 0.5 watts at 10 cms, rising to 3 watts at 30 cms.
The lower limit of operating wavelength is 8–8.5 cms.

HEATER
V_h 6.3 V I_h 0.4 A approx.

MOUNTING POSITION
Any

CAPACITANCES

c_{a-g}	1.1	μμF
c_{a-k}	0.02	μμF
c_{g-k}	2.2	μμF

CHARACTERISTICS

V_a	250	V
V_g	−3.5	V
I_a	20	mA
g_m	6.0	mA/V
μ	30	approx.

LIMITING VALUES

V_a max.	350	V
p_a max.	10	W
I_a max.	50	mA
$i_{a\,(pk)}$ max.	150	mA
*Anode seal temp. max.	140°	C

*In order to limit the anode seal temperature and also to limit the rate of change of anode seal temperature, it is necessary that the mass of metal in close thermal contact with the anode disc be not less than 60 grams (2 ozs) of brass or its equivalent

BASE : (133) **DIMENSIONS** : L=63 mm D=23 mm

ECC 91

Double triode with common cathode for use as R.F. power amplifier or oscillator

For application as voltage amplifier see Section D1, page 63

HEATER
V_h 6.3 V I_h 0.45 A

MOUNTING POSITION
Vertical : base up or down

ECC 91 (contd.)

CAPACITANCES

Each section

c_{a-g}	1.6	μμF
c_{in}	2.2	μμF
c_{out}	0.4	μμF

CHARACTERISTICS

Each section

V_a	100	V
I_a	8.5	mA
V_{g1}	0.9	V
g_m	5.3	mA/V
μ	38	
r_a	7.1	KΩ

OPERATING CONDITIONS

As Class "C" telegraphy push-pull R.F. amplifier and oscillator at 80 Mc/s approx.

V_a	150	V
*V_g	−10	V
R_g	625	Ω
R_k	220	Ω
I_a	2×15	mA
I_g	2×8	mA
P drive	0.35	W
P_{out}	3.5	W

*Obtained from a fixed supply or from a grid or cathode resistor of value shown

Note.—An output of 1 watt may be obtained from an ECC 91 in a push-pull oscillator at 250 Mc/s with V_a=150 V, p_a=2×1.5 W and a common grid resistor of 2,000 Ω

LIMITING VALUES

V_a max.	300	V
p_a max.	2×1.5	W
V_g max.	−40	V
I_g max.	2×8	mA
V_{h-k} max.	100	V
R_{g-k} max. (self bias)	0.5	MΩ

BASE : B7G (80) **DIMENSIONS** : L=55 mm D=19 mm

TY2-125

Preliminary Data

V.H.F. triode with hard glass envelope and strong double helical thoriated tungsten filament, designed for use as an R.F. amplifier, oscillator, grounded-grid amplifier or modulator.

At maximum ratings the maximum operating frequency is 150 Mc/s but this is increased to 200 Mc/s at 67% of full ratings.

FILAMENT

V_f (D.C. or A.C.)	6.3	V
I_f (approx.)	5.4	A

TY2-125 (contd.)

MOUNTING POSITION

Vertical only, base up or down

CAPACITANCES

c_{a-g}	5.8 μμF approx.
c_{g-k}	6.0 μμF approx.
c_{a-k}	0.2 μμF approx.

CHARACTERISTICS. measured at V_a=2.5 KV, I_a=50 mA

g_m	3.0	mA/V
μ	26	

LIMITING VALUES

V_a max.	2,500	V
*p_a max.	135	W
I_k max.	240	mA

*Anode red hot, temperature 850° C

OPERATING CONDITIONS

As R.F. amplifier, Class "C", unmodulated

f	60	60	Mc/s
V_a	2,500	2,000	V
I_a	200	200	mA
V_g	−200	−150	V approx.
I_g	40	40	mA approx.
$v_{in\ (pk)}$	350	300	V approx.
P_{in}	14	12	W approx.
p_a	135	120	W
P_{out}	365	280	W
η	73	70	%

As Class "C" oscillator

f	100	150	Mc/s
V_a	2,000	1,500	V
I_a	200	200	mA
V_g	−150	−120	V
I_g	40	40	mA
P_{in}	400	300	W
p_a	135	130	W
P_{out}	265	170	W
η	66	57	%

BASE : (122) **DIMENSIONS** : L=142 mm D=65 mm

QVO4-7

Indirectly-heated beam tetrode with aligned grid construction to minimise screen current. It is rated to dissipate a maximum of 7.5 watts at the anode and is particularly suitable for use at frequencies up to 150 Mc/s as an R.F. amplifier or as a frequency multiplier.

HEATER

V_h 6.3 V I_h 0.6 A Suitable for D.C./A.C. operation
Heating time 22 secs.

QVO4-7 (contd.)

MOUNTING POSITION Any

CAPACITANCES

c_{in}	8.0	µµF
c_{out}	5.4	µµF
c_{a-g1}	<0.1	µµF

CHARACTERISTICS

At $V_a=300$ V $V_{g2}=250$ V $I_a=25$ mA

g_m	1.9	mA/V
μ_{g1-g2}	5.6	
r_a	67	KΩ

LIMITING VALUES

V_a max.	400	V
V_{g2} max.	250	V
p_a max.	7.5	W
p_{g2} max.	2.0	W
I_k max.	50	mA
I_{g1} max.	6.0	mA

OPERATING CONDITIONS

As single Class " C ", R.F. amplifier

Frequency	3	3	20	20	Mc/s
V_a	300	300	300	300	V
V_{g2}	150	250	150	250	V
V_{g1}	–35	–50	–30	–60	V
I_a	40	43	43.5	43.7	mA
I_{g2}	7.2	6.6	4.7	5.9	mA
I_{g1}	2.8	0.4	1.8	0.4	mA
$v_{in(pk)}$	58	60	48	67	V
P_{out}	7.1	8.1	7.3	7.9	W
p_a	4.9	4.8	5.8	5.2	W
η	59	62	56	60	%

Frequency	60	60	150	150	Mc/s
V_a	300	300	300	300	V
V_{g2}	150	250	150	250	V
V_{g1}	–30	–50	–30	–50	V
I_a	44	44	44	46	mA
I_{g2}	4.5	6.0	4.5	4.0	mA
I_{g1}	1.9	0.4	1.5	0.4	mA
$v_{in(pk)}$	48	57	52	57	V
P_{out}	7.0	7.7	6.3	6.3	W
η	53	58	47	45	%

As push–pull Class " C ", R.F. amplifier

Frequency	60	100	150	Mc/s
V_a	300	300	300	V
V_{g2}	250	250	250	V
V_{g1}	–60	–60	–50	V
I_a	2×43.0	2×44.4	2×46	mA
I_{g2}	2×6.7	2×5.3	2×4.0	mA
I_{g1}	2×0.5	2×0.4	2×0.4	mA
$v_{in(pk)}$	2×68	2×68	2×57	V
P_{out}	15.6	14.7	12.6	W
p_a	2×5.1	2×6.0	2×7.4	W
η	60	55	46	%

QVO4-7 (contd.)

OPERATING CONDITIONS *(contd.)*

As frequency doubler. *Single valve*

Output frequency	20	75	100	150	Mc/s
V_a	300	300	300	250	V
V_{g2}	250	250	200	200	V
V_{g1}	–80	–120	–120	–120	V
I_a	41.2	43.3	38.4	36.8	mA
I_{g2}	8.0	5.5	2.6	2.1	mA
I_{g1}	0.8	1.2	1.5	1.1	mA
$v_{in(pk)}$	81	124	120	144	V
P_{out}	5.6	5.6	4.4	2.3	W
p_a	6.8	7.4	7.1	6.9	W
η	45	44	38	25	%

As frequency trebler. *Single valve* *Push–pull*

Output frequency	20	75	100	150	Mc/s
V_a	300	300	275	225	V
V_{g2}	250	250	200	200	V
V_{g1}	–120	–140	–140	–140	V
I_a	35.2	34.1	36.0	2×36	mA
I_{g2}	4.2	2.8	2.5	2×2.5	mA
I_{g1}	0.6	0.6	1.5	2×1.3	mA
$v_{in(pk)}$	109	130	142	2×152	V
P_{out}	3.3	3.2	2.8	3.1	W
p_a	7.3	7.1	7.1	2×6.6	W
η	31	31	28	19	%

BASE : B9G (125) **DIMENSIONS** : L=78 mm D=38 mm

QVO5-25

Indirectly–heated beam tetrode rated for a maximum anode dissipation of 25 watts. It is suitable for use as an A.F. amplifier or modulator or as an R.F. amplifier or oscillator.

HEATER

V_h 6.3 V I_h 0.9 A Heating time 15 secs.

MOUNTING POSITION Any

CAPACITANCES

c_{in}	11	µµF
c_{out}	7	µµF
c_{a-g1}	<0.2	µµF

CHARACTERISTICS

At $V_a=600$ V $V_{g2}=300$ V $I_a=72$ mA

μ_{g1-g2}	8	
g_m	6.0	mA/V

QVO5-25 (contd.)

LIMITING VALUES

V_a max.	600	V
v_a pk. max.	2,000	V
V_{g2} max.	300	V
P_{g2} max.	3.5	W
V_{g1} max.	–200	V
I_k max.	150	mA
$i_{k\,(pk)}$ max.	400	mA
I_{g2} max.	10	mA
I_{g1} max.	5	mA
$i_{g1\,(pk)}$ max.	25	mA
p_a max.	25	W
V_{h-k} max.	100	V
R_{g1-k} max.	25	KΩ

Operating frequency (Mc/s)	Max. anode voltage (V)	Max. anode input power (W)
60	600	60
75	500	50

OPERATING CONDITIONS

For push–pull pair as Class "AB_2" A.F. power amplifier and modulator

V_a	400	500	600	V
V_{g2}	300	300	300	V
V_{g1}	–25	–25	–30	V
$I_{a(0)}$	2×50	2×50	2×30	mA
$I_{g2(0)}$	2×2.5	2×2.5	2×2.5	mA
$v_{in\,(pk)}$	2×39	2×39	2×39	V
I_a (max. sig.)	2×120	2×120	2×100	mA
I_{g2} (max. sig.)	2×5	2×5	2×5	mA
R_{a-a}	3.2	4.24	6.4	Ω
P_{drive} (max. sig.)*	0.2	0.2	0.1	W approx.
P_{out} (max. sig.)	55	75	80	W approx.

*The effective resistance of the grid circuit should be below 500 Ω and the effective impedance should not exceed 700 Ω at the highest response frequency required.

For single valve as R.F. amplifier, Class "B" telephony

V_a	400	500	600	V
V_{g2}	250	250	250	V
V_{g1}	–25	–25	–25	V
I_a	75	75	62.5	mA
I_{g2}	4	4	3	mA
$v_{in\,(pk)}$	30	30	20	V
P_{drive} (approx.)	0.25	0.25	0.2	W
P_{out} (approx.)	9.0	12.5	12.5	W

QV05-25 (contd.)

OPERATING CONDITIONS *(contd.)*

For single valve as R.F. amplifier, Class "C" telephony, anode modulated

V_a	325	400	475	V
*V_{g2}	225	225	225	V
R_{g2}	20	30	50	KΩ
**V_{g1}	–75	–80	–85	V
R_{g1}	25	22.8	21.3	KΩ
I_a	80	80	83	mA
I_{g2}	5	5.75	5	mA
I_{g1}	3	3.5	4	mA approx.
$v_{in\,(pk)}$	90	95	110	V
P_{drive}	0.25	0.3	0.4	W approx.
P_{out}	17.5	22.5	27.5	W approx.

*Preferably obtained from modulated anode supply through resistor R_{g2} of value shown.
**May be obtained either from fixed supply or by a grid resistor of value shown, or by a combination of fixed supply and grid resistor.

For single valve as R.F. amplifier and oscillator, Class "C" telegraphy

V_a	400	500	600	V
*V_{g2}	250	250	250	V
R_{g2}	20	42	50	KΩ
**V_{g1}	–45	–45	–45	V
R_{g1}	12.8	12.8	12.8	KΩ
R_k	410	410	410	Ω
I_a	100	100	100	mA
I_{g2}	7.5	6.0	7.0	mA
I_{g1}	3.5	3.5	3.5	mA approx.
$v_{in\,(pk)}$	65	65	65	V
P_{drive}	0.2	0.2	0.2	W approx.
P_{out}	25	30	40	W approx.

*Obtained from a fixed supply or from a potentiometer, or from the anode supply through resistor of value shown.
**May be obtained from a fixed supply or from a grid or cathode resistor of value shown, or by a combination of these methods.

BASE : (126) **DIMENSIONS** : L=147 mm D=53 mm

QY2-100

Beam power tetrode with a maximum anode dissipation of 100 watts, primarily intended for use as a Class "C" R.F. amplifier at frequencies up to 60 Mc/s

FILAMENT

Thoriated tungsten V_f 10.0 V I_f 5.0 A

MOUNTING POSITION

Vertical

CAPACITANCES

c_{in}	16.3	μμF
c_{out}	14.0	μμF
c_{a-g1}	<0.25	μμF

QY2-100 (contd.)

CHARACTERISTICS

At V_a=2,000 V V_{g2}=400 V I_a=50 mA

g_m	3.75	mA/V
r_a	45	KΩ
μ_{g1-g2}	8.5	

LIMITING VALUES

V_a max.	2,000	V
$v_{a(pk)}$ max.	7,000	V
V_{g2}	400	V
$V_{g2(b)}$ max.	800	V
V_{g1} max.	–300	V
I_k max.	225	mA
$i_{k(pk)}$ max.	800	mA
I_{g2} max.	55	mA
I_{g1} max.	25	mA
$i_{g1(pk)}$ max.	75	mA
p_a max.	100	W
p_{g2} max.	15	W

Operating Frequency (Mc/s)	Max. Anode Voltage (V)	Max. Anode Input Power (V)
30	2,000	375
60	1,000	175

OPERATING CONDITIONS

As single R.F. power amplifier, Class "B" telephony

V_a	1,500	2,000	V
V_{g2}	400	400	V
V_{g1}	–60	–75	V
I_a	100	75	mA
I_{g2}	4	3	mA
$v_{drive(pk)}$	70	80	V
P_{drive}	<2	<2	W
P_{out}	50	50	W

As single R.F. power amplifier (Class "C" unmodulated) or as oscillator

V_a	1,250	1,500	2,000	V
*V_{g2}	300	300	400	V
R_{g2}	27	40	36	KΩ
**V_{g1}	–75	–90	–120	V
R_{g1}	6	7.5	12	KΩ
R_k	330	400	520	Ω
I_a	180	180	180	mA
I_{g2}	35	30	45	mA
I_{g1}	12	12	10	mA
$v_{drive(pk)}$	160	175	205	V
P_{drive}	1.7	1.9	1.9	W
P_{out}	170	210	275	W

*May be obtained from a fixed supply or from the anode supply through a series resistor of value shown. In the latter case provision must be made to ensure the $V_{g2(b)}$ does not exceed 800 V.

**May be obtained either from a fixed supply or by a grid or cathode resistor of value shown, or by a combination of these methods.

OPERATING CONDITIONS (*contd.*)

QY2-100 (contd.)

As single R.F. power amplifier, Class "C", grid modulated

V_a	1,500	2,000	V
V_{g2}	400	400	V
V_{g1}	–140	–120	V
I_a	70	75	mA
I_{g2}	3	3	mA
$v_{drive(pk)}$ R.F.	145	120	V
$v_{drive(pk)}$ A.F.	60	60	V
P_{drive} R.F.	<2	<2	W
P_{mod}	<1	<1	W
P_{out}	40	50	W

As single R.F. power amplifier, Class "C", anode and screen modulated

V_a	1,250	1,600	V
*V_{g2}	300	300	V
R_{g2}	27	43	KΩ
**V_{g1}	–160	–160	V
R_{g1}	12.5	13.5	KΩ
I_a	150	150	mA
I_{g2}	35	30	mA
I_{g1}	13	12	mA approx.
$v_{drive(pk)}$ R.F.	250	250	V
P_{drive}	2.9	2.7	W approx.
P_{out}	140	180	W approx.

*May be obtained from a separate supply modulated simultaneously with the anode supply, or from a modulated anode supply through a series resistor of value shown.

**May be obtained from a fixed supply or by grid resistor of value shown.

BASE : (124) **DIMENSIONS** : L=192 mm D=66 mm

QY3-125

Directly-heated R.F. tetrode rated for a maximum anode dissipation of 125 W. It is capable of providing a power gain of 150.

Preliminary data

FILAMENT

V_f (D.C. or A.C.)	5.0	V
I_f (approx.)	6.8	A
Thoriated tungsten		

MOUNTING POSITION

Vertical, base up or down

CAPACITANCES

c_{in} (approx.)	11	μμF
c_{out} (approx.)	3.5	μμF
c_{a-g1} (approx.)	0.05	μμF

QY3-125 (contd.)

CHARACTERISTICS

At V_a=2,500 V V_{g2}=500 V I_a=40 mA

g_m	2.5 mA/V	approx.
μ_{g1-g2}	6	approx.

LIMITING VALUES

V_a max.	3,000	V
V_{g2} max.	600	V
*p_a max.	125	W
p_{g2} max.	25	W
I_k max.	270	mA
$i_{k\,(pk)}$ max.	1	A
Bulb temperature max.	180	°C

*Anode temperature (red hot)=800 °C

OPERATING CONDITIONS

As single R.F. power amplifier, (Class "C", unmodulated) (f=100 Mc/s)

V_a	2,000	2,500	3,000	V
V_{g2}	350	350	350	V
V_{g1}	−125	−150	−150	V
I_a	200	200	167	mA
I_{g2}	50	45	35	mA
I_{g1}	12	10	8	mA
$v_{in\,(pk)}$	290	300	280	V
p_{g1}	3.5	3	2.5	W
p_a	120	125	125	W
p_{g2}	17.5	16	12	W
P_{out}	280	375	375	W
η	70	75	75	%

BASE : (123) **DIMENSIONS** : L=131 mm D=64 mm

QQV 04-20

Twin beam tetrode with a maximum rated dissipation of 10 watts at each anode. It is primarily intended for use as a push-pull R.F. power amplifier or oscillator at frequencies up to 200 Mc/s. Arrangements should be made to earth the metal base of the valve by means of spring clips or by some alternative method. The cathode is indirectly heated with centre tapped heater for series or parallel connection.

HEATER

	Series	Parallel	
V_h	12.6	6.3	V
I_h	0.8	1.6	A

Heating time 20 secs.

MOUNTING POSITION

Vertical—base down Horizontal—plane of anodes vertical

QQV 04-20 (contd.)

CAPACITANCES

Each section

c_{in}	14	µµF
c_{out}	8.5	µµF
c_{a-g1}	<0.2	µµF

Between sections

c_{a-a}	0.8	µµF

CHARACTERISTICS

At V_a=400 V V_{g2}=200 V I_a=25 mA

g_m	4	mA/V
μ_{g1-g2}	6.5	

LIMITING VALUES

V_a max.	400	V
$v_{a\,(pk)}$ max.	1,400	V
V_{g2} max.	225	V
$V_{g2(b)}$ max.	600	V
V_{g1} max.	−175	V
I_k max.	2×100	mA
*$i_{k\,(pk)}$ max.	350	mA
I_{g2} max.	2×18	mA
I_{g1} max.	2×7	mA
*$i_{g1\,(pk)}$ max.	20	mA
p_a max.	2×10	W
p_{g2} max.	2×2.25	W
V_{h-k} max.	100	V
*R_{g1-k} max.	30	KΩ

*Per section

Operating frequency (Mc/s)	Max. anode voltage (V)	Max. anode input power (W)
125	400	60
175	280	42
200	240	36

OPERATING CONDITIONS

As push-pull Class "C" R.F. power amplifier and oscillator

V_a	400	V
*V_{g2}	145	V
R_{g2}	15	KΩ
**V_{g1}	−45	V
R_{g1}	10	KΩ
R_k	260	Ω
I_a	2×75	mA
I_{g2}	2×8.5	mA
I_{g1}	2×2.25	mA
$v_{in\,(pk)}$	2×58	V
P_{drive}	0.23	W
P_{out}	44	W

*May be obtained from a separate supply or from the anode supply through series resistor of value shown, in which case provision must be made to ensure that $V_{g2(b)}$ does not exceed 600 V.

**May be obtained from a separate supply or by a grid or cathode resistor of value shown, or by a combination of these methods.

QQV 04-20 (contd.)

OPERATING CONDITIONS (*contd.*)

As push–pull R.F. power amplifier, Class "B" telephony

V_a	400	V
V_{g2}	125	V
V_{g1}	–25	V
I_a	2×37.5	mA
I_{g2}	2×2.0	mA
$v_{in(pk)}$	2×25	V
P_{drive}	0.8	W
P_{out}	10.5	W

As push–pull grid–modulated Class "C" R.F. power amplifier

V_a	400	V
V_{g2}	125	V
V_{g1}	–40	V
I_a	2×37.5	mA
I_{g2}	2×1.5	mA
I_{g1}	2×0.2	mA
$v_{in(pk)}$ R.F.	2×40	V
†$v_{mod(pk)}$ A.F.	19	V
P_{drive}	0.32	W
P_{out}	10.5	W

As push–pull anode–modulated Class "C" R.F. power amplifier

V_a	325	V
*V_{g2}	165	V
R_{g2}	10	KΩ
V_{g1}	–45	V
**R_{g1}	11.25	KΩ
I_a	2×62	mA
I_{g2}	2×8	mA
I_{g1}	2×2	mA
$v_{in(pk)}$	2×56	V
P_{drive}	0.2	W
P_{out}	30	W

†For 100% modulation.

*May be obtained from a fixed supply or by a grid resistor of value shown.

**May be obtained from a separate supply or by a grid or cathode resistor of value shown, or by a combination of these methods.

As Class "AB_2" A.F. power amplifier or modulator

V_a	400	V
V_{g2}	125	V
V_{g1}	–15	V
I_{ao}	2×10	mA
I_a (max. sig.)	2×75	mA
I_{g2} (max. sig.)	2×16	mA
v_{in} pk.	2×30	V
R_{a-a}	6.2	KΩ
*P_{drive}	0.36	W
P_{out}	42	W

*The effective resistance in the grid circuit should be below 500 Ω and the effective impedance should not exceed 700 Ω at the highest response frequency required.

BASE : (129) **DIMENSIONS** : L=115 mm D=59 mm

QQV 04-60

Preliminary data

The QQV06-40 is a double tetrode having an oxide coated cathode. The valve is primarily intended for use as an RF amplifier or oscillator and has a rated anode dissipation of 20 W per anode. The limiting frequency of operation is approximately 300 Mc/s.

HEATER

V_h 2×6.3 V I_h 2×1.0 A approx.

MOUNTING POSITION

Vertical

CAPACITANCES

c_{g1-all}	(each section)	11	μμF
c_{a-all}	(each section)	3.5	μμF
c_{a-g1}	(each section)	< 0.1	μμF
*c_{out}		2.2	μμF
*c_{in}		6.6	μμF

*Two sections in push pull.

CHARACTERISTICS

Each section (measured at I_a=30 mA)

g_m	4.5	mA/V
μ_{g1-g2}	9	

LIMITING VALUES

V_a max.	600	V
p_a max.	2×20	W
V_{g2} max.	250	V
p_{g2} max.	2×3	W
I_{g1} max.	2×7	mA
I_k max.	2×120	mA
p_{g1}	2×1	W
V_{g1} max.	–175	V
$I_{k\,(pk)}$ max.	2×480	mA

Max. operating frequency

At full input	150	Mc/s
At reduced input (V_a max.=400 V)	300	Mc/s
Max. temperature of base pins	180	°C
Max. temperature of bulb	225	°C

OPERATING CONDITIONS

As push–pull R.F. amplifier or oscillator, Class "C" telegraphy

f	60	150	150	300	Mc/s
V_a	600	600	500	400	V
V_{g2}	250	250	250	200	V
V_{g1}	–100	–80	–60	–60	V
$v_{in\,(pk)}$	2×120	2×100	2×80	2×80	V
I_a	2×100	2×100	2×100	2×100	mA
I_{g2}	2×9	2×8	2×9	2×6	mA
I_{g1}	2×2	2×1	2×1	2×1.5	mA
p_a	2×17	2×20	2×17	2×20	W
P_{out}	85	80	65	40	W
η	71	67	65	50	%

BASE : (128) **DIMENSIONS** : L=122 mm D=50 mm

QQV 07-40

Push-pull R.F. power tetrode with a maximum anode dissipation of 20 watts per section and primarily intended for use as a Class "C" amplifier or oscillator at frequencies up to 250 Mc/s.
The cathode is indirectly heated with centre tapped heater for series or parallel connection.

HEATER

	Series	Parallel	
V_h	12.6	6.3	V
I_h	1.25	2.5	A

CAPACITANCES

Each section

c_{in}	14.5	μμF
c_{out}	7.0	μμF
*c_{a-g1}	<0.12	μμF
c_{g2-k} (including internal by-pass capacitor,	65	μμF approx.

*With external shield up to the flange seal

CHARACTERISTICS

Each section (at I_a=60 mA V_a=750 V V_{g2}=225 V)

g_m	8.5	mA/V
μ_{g1-g2}	9	

OPERATING CONDITIONS

As push-pull R.F. power amplifier or oscillator, Class "C" telegraphy

V_a	500	750	V
*V_{g2}	200	200	V
R_{g2}	9.3	18.3	KΩ
**V_{g1}	−45	−55	V
R_{g1-k}	3.75	4.6	KΩ
R_k	160	270	Ω
I_a	2×120	2×80	mA
I_{g2}	2×16	2×15	mA
I_{g1} (approx.)	2×6	2×6	mA
$v_{in\,(pk)}$	2×62	2×70	V
P_{drive} (approx.)	0.7	0.8	W
P_{out} (approx.)	83	87	W

As Class "C" anode-modulated push-pull R.F. amplifier

V_a	425	600	V
*V_{g2}	200	200	V
R_{g2}	6.4	13.3	KΩ
**V_{g1}	−60	−70	V
R_{g1-k}	5.5	5.8	KΩ
I_a	2×106	2×75	mA
I_{g2}	2×18	2×15	mA
I_{g1} (approx.)	2×5.5	2×6	mA
$v_{in\,(pk)}$	2×77	2×86	V
P_{drive} (approx.)	0.8	0.9	W
P_{out} (approx.)	63	70	W

QQV 07-40 (contd.)

OPERATING CONDITIONS (*contd.*)

As Class "C" grid-modulated push-pull R.F. power amplifier

V_a	500	750	V
V_{g2}	200	200	V
V_{g1}	−38	−55	V
I_a	2×60	2×40	mA
I_{g2}	2×5	2×2.5	mA
I_{g1}	2×1	0	mA approx.
$v_{in\,(pk)}$ (R.F.)	2×41	2×52	V
$v_{mod\,(pk)}$	17	15	V
P_{drive}	0.5	0.7	W approx.
P_{out}	23	24	W approx.

*Obtained from separate supply or from anode supply through series resistor (R_{g2}) of value shown, in which case provision must be made to ensure that $V_{g2(b)}$ does not exceed 600 V.

**Obtained from fixed supply or by means of grid or cathode resistor of value shown, or by a combination of these methods.

LIMITING VALUES

V_a max.	750	V
p_a max.	2×20	W
$v_{a\,(pk)}$ max.	2,500	V
$V_{g2(b)}$ max.	600	V
V_{g2} max.	225	V
p_{g2} max.	2×3.5	W
I_{g2} max.	2×17	mA
I_k max.	2×145	mA
*$i_{k\,(pk)}$ max.	550	mA
V_{g1} max.	−175	V
I_{g1} max.	2×7.5	mA
*$i_{g1\,(pk)}$ max.	30	mA
*R_{g1-k} max.	30	KΩ
V_{h-k} max.	100	V
**Max. bulb temp.	175	°C

*Per section.

**Forced air cooling may be required to limit the bulb temperature to the figure quoted. At normal dissipation an air flow of approx. 5 cu. ft./min. is required.

Operating frequency (Mc/s)	Max. anode voltage (V)	Max. anode input power (W)
100	750	120
150	700	120
200	600	120
250	500	100

BASE : (130) **DIMENSIONS** : L=109 mm D=61 mm

QQZ 04-15

Preliminary data

Quick-heating double tetrode with an oxide coated filament. It is primarily intended for mobile applications and has a rated anode dissipation of 8 watts, the limiting frequency being 186 Mc/s.

FILAMENT
Oxide coated

V_f	6.3	V
I_f	0.68	A
Heating time	2.0	Secs.

MOUNTING POSITION
Vertical

CAPACITANCES
Each section

c_{a-g}	0.1	μμF
c_{g-f}	8	μμF
c_{a-f}	3	μμF

CHARACTERISTICS
Each section (measured at I_a=20 mA)

g_m	2	mA/V
μ_{g1-g2}	9	

OPERATING CONDITIONS
As Class "C" R.F. amplifier at 186 Mc/s
Intermittent operation

V_a	400	250	V
V_{g2}	200	175	V
V_{g1}	−80	−70	V
I_a	2×40	2×40	mA
I_{g2}	2×5	2×5	mA
I_{g1}	2×1.75	2×1.75	mA
P_{out}	19.5	12	W
η	61	60	%

LIMITING VALUES
Continuous operation

V_a max.	400	V
p_a max.	2×6	W
V_{g2} max.	250	V
p_{g2} max.	2×2	W
I_k max.	2×40	mA
$i_{k\,(pk)}$ max.	2×160	mA
V_{g1} max.	−250	V
I_{g1} max.	2×5	mA
R_{g1-f} max. (each section)	0.5	MΩ
Max. operating frequency at full ratings	186	Mc/s
Max. temperature of base pins	80	°C
Max. temperature of bulb	200	°C

Intermittent operation

p_a max.	2×8	W
p_{g2} max.	2×2.5	W
I_k max.	2×50	mA
$i_{k\,(pk)}$ max.	2×200	mA
Max. temperature of base pins	100	°C
Max. temperature of bulb	250	°C

BASE : (127) **DIMENSIONS** : L=100 mm D=32 mm

DL 93

Directly-heated for use in miniature communication equipment as an R.F. power amplifier

For application as output pentode see Section G, page 80

FILAMENT ARRANGEMENT
Suitable for D.C. operation only

(*a*) Series — V_f applied across the two filament sections in series between pins 1 and 7. V_{g1} referred to pin 1.

(*b*) Parallel — V_f applied across the two filament sections in parallel between pin 5 and pins 1 and 7 connected together. V_{g1} referred to pin 5.

Series 1.4 V 0.2 A Parallel 2.8 V 0.1 A

CAPACITANCES
Measured without external screen

c_{a-g1}	<0.34	μμF
c_{in}	4.8	μμF
c_{out}	4.2	μμF

OPERATING CONDITIONS
As R.F. power amplifier at 50 Mc/s
Filament arrangement : Parallel*

V_a	150	V
V_{g2}	135	V
R_{g1}	0.2	MΩ
I_a (max. sig.)	18.3	mA
I_{g2} (max. sig.)	6.5	mA
I_{g1} (max. sig.)	0.13	mA
P_{out}	1.2	W approx.

*Operation with series connected filament will be similar to that with parallel connection. With series connection a shunting resistor must be connected between pins 1 and 5 to by-pass the cathode current.

LIMITING VALUES
R.F. operation

V_a max.	150	V
V_{g2} max.	135	V
V_{g1} max.	−30	V
I_a max.	20	mA
I_{g1} max.	0.25	mA
I_k max.	25	mA
p_a max.	2	W

BASE : B7G (98) **DIMENSIONS** : L=55 mm D=19 mm

RG1-240A

Mercury vapour rectifier

FILAMENT
V_f 4.0 V I_f 2.7 A approx.

RG1-240A (contd.)

LIMITING VALUES

Max. peak inverse voltage (150 c/s max.)	6,500	V
Max. peak anode current	1,250	mA
Max. mean anode current	250	mA
Voltage drop across valve	16	V approx.
Ambient temperature	10 to 40	°C
Condensed mercury temperature	25 to 65	°C

FULL LOAD OPERATING CONDITIONS

Circuit	No. of Valves	Full load D.C. output (V)	(mA)	Applied A.C. volts (V_{rms})	Initial filter Elements L henries (min.)	C μF (max.)
Single phase full wave	2	2,000	500	2,220 (per valve)	7.0	5.0
Single phase bridge	4	4,000	500	4,440 (total)	14.0	2.5
Three phase half wave	3	2,750	750	2,350 (per phase)	2.5	2.0
Three phase full wave	6	6,000	750	2,570 (per phase)	5.0	1.0

BASE : British 4-pin (134)

DIMENSIONS : L=139 mm D=48 mm

RG3-250 Mercury vapour rectifier

FILAMENT

V_f 2.5 V I_f 5.0 A approx.

LIMITING VALUES

Max. peak inverse voltage (150 c/s max.)	10,000	V
Max. peak anode current	1.0	A
Max. mean anode current	0.25	A
Voltage drop across valve	16	V approx.
Ambient temperature	10 to 40	°C
Condensed mercury temperature	25 to 65	°C

RG3-250 (contd.)

FULL LOAD OPERATING CONDITIONS

Circuit	No. of valves	Full Load D.C. output (V)	(mA)	Applied A.C. volts (V_{rms})	Initial Filter elements L henries (min.)	C μF (max.)
Single phase full wave	2	3,150	500	3,500 (per valve)	10	2
Single phase bridge	4	6,300	500	7,000 (total)	20	1
Three phase half wave	3	4,100	750	3,500 (per phase)	6.0	1
Three phase full wave	6	9.500	750	4,000 (per phase)	10	0.5

BASE : Standard Edison Screw (135)

DIMENSIONS : L=138 mm D=48 mm

Neon-filled stabilising tube **4687**

OPERATING CONDITIONS

V ignition max.	130	V
V burning	90–110	V
I quiescent	20	mA
I max.	40	mA
I min.	10	mA
A.C. resistance max.	250	Ω

BASE : P-base (49) **DIMENSIONS** : L=87 mm D=29 mm

Neon-filled stabilising tube, identical with the 4687 except that it has a British 4-pin base **4687A**

BASE : British 4-pin (23)

DIMENSIONS : L=102 mm D=29 mm

Neon-filled stabilising tube **7475**

OPERATING CONDITIONS

V ignition max.	140	V
V burning	90–110	V
I quiescent	4	mA
I max.	8	mA
I min.	1	mA
A.C. resistance max.	300	Ω

BASE : British 4-pin (23)

DIMENSIONS : L=85 mm D=31 mm

NEON STABILISING TUBES

85A1

Neon-filled two-electrode tube having a high order of stability over both long and short periods and very small variations from valve to valve

Preliminary data

PREFERRED OPERATING CONDITION

I (quiescent) 4.5±0.2 mA

CHARACTERISTICS

At preferred operating condition

A.C. resistance	290	Ω
V (burning) variation from valve to valve	83–86	V
Temperature co-efficient of V (burning)	−1.8	mV/°F
Max. percentage variation of V (burning) for current change of 4.3–4.7 mA	0.17	%
Max. percentage variation of V (burning) during life	0.5	%
Max. percentage variation of V (burning) after the first 300 hours of life	0.2	%
Max. short term (100 hours max.) variation of V (burning) after the first 300 hours of life	0.1	%

Equilibrium conditions are normally reached after 3 minutes operation.

Over life, the A.C. resistance will remain sensibly constant but the temperature co-efficient of burning voltage can be expected to decrease slightly.

The noise generated by the valve over a frequency band of 30–10,000 c/s, is of the order of 70 μV which is equivalent to the noise generated by a resistance of approximately 30 MΩ. The noise is evenly distributed over the frequency range.

The tube should not be subjected to shock or continuous vibration.

LIMITING CONDITIONS

V (ignition) max.	125	V
V (burning)	83–87	V
I max.	8	mA
I min.	1	mA
A.C. resistance max.	450	Ω

BASE: B8G (113) **DIMENSIONS**: L=80 mm D=32 mm

OSCILLOSCOPE AND PICTURE TUBES

ECR 30

Oscilloscope tube with 3 in. diameter screen

HEATER

V_h 4.0 V I_h 1.0 A

CAPACITANCES

Grid to all other electrodes	<20	μμF
Each X plate or each Y plate to all other electrodes	<15	μμF
One X plate to one Y plate	<3	μμF

FLUORESCENT COLOUR

Green—non-persistent

DEFLECTION

Electrostatic. The tube is primarily intended for symmetrical deflection

OPERATING CONDITIONS

$V_{a1}=V_{a3}$	800	V
V_{a2}	100 to 170	V
V_g	−1.0 to −18	V

LIMITING VALUES

$V_{a1}=V_{a3}$ max.	1,000	V
V_{h-k} max.	50	V

DEFLECTION SENSITIVITY

X and Y plates $\frac{170}{V_{a3}}$ mm/V

Viewed from the screen end and with the tube positioned so that spigot key of the base is uppermost, a positive voltage on X' will deflect the spot to the left and a positive voltage on Y' will deflect the spot upwards.

BASE : 12-pin Octal (98)

DIMENSIONS : L=206 mm D=70 mm

ECR 35
ECR 35P

High-sensitivity oscilloscope tube with 3½ in. diameter screen

HEATER

V_h 4.0 V I_h 1.0 A

CAPACITANCES

Grid to all other electrodes	<25	μμF
Each X plate or each Y plate to all other electrodes	<25	μμF
One X plate to one Y plate	<5	μμF

FLUORESCENT COLOUR

ECR 35	Green—non-persistent
ECR 35P	Blue—with yellow-green afterglow

ECR 35 ECR 35P (contd.)

DEFLECTION

Electrostatic. The tube is suitable for either symmetrical or asymmetrical deflection.
With asymmetrical deflection the trapezoidal distortion is such that the angle between adjacent sides of a 45 mm × 70 mm raster is between 85° and 95°.

OPERATING CONDITIONS

$V_{a_1}=V_{a_3}$	1,200	V
V_{a_2}	150–250	V
V_g	−1.0 to −50	V

LIMITING VALUES

$V_{a_1}=V_{a_3}$ max.	2,500	V
V_{h-k} max.	50	V

DEFLECTION SENSITIVITY

X plates $\frac{360}{V_{a_3}}$ mm/V

Y plates $\frac{780}{V_{a_3}}$ mm/V

Viewed from the screen end and with the tube positioned so that the spigot key of the base is uppermost, a positive voltage on X' will deflect the spot to the left and a positive voltage on Y' will deflect the spot upwards.

BASE : 12-pin side contact (138)

DIMENSIONS : L=341 mm D=90 mm

ECR 60

High-sensitivity oscilloscope tube with 6 in. diameter screen

HEATER

V_h 4.0 V I_h 1.0 A

CAPACITANCES

Grid to all other electrodes	<25	μμF
Each X plate or each Y plate to all other electrodes	<25	μμF
One X plate to one Y plate	<5	μμF

FLUORESCENT COLOUR

Green—non-persistent

DEFLECTION

Electrostatic. The tube is suitable for either symmetrical or asymmetrical deflection.
With asymmetrical deflection the trapezoidal distortion is such that the angle between adjacent sides of an 80 mm × 80 mm raster is between 85° and 95°.

Mullard

ECR 60 (contd.)

OPERATING CONDITIONS

$V_{a_1}=V_{a_3}$	2,000	V
V_{a_2}	250 to 450	V
V_g	−1.0 to −100	V

LIMITING VALUES

$V_{a_1}=V_{a_3}$ max.	2,500	V
V_{h-k}	50	V

DEFLECTION SENSITIVITY

X plates $\frac{600}{V_{a_3}}$ mm/V

Y plates $\frac{1,150}{V_{a_3}}$ mm/V

Viewed from the screen end and with the tube positioned so that the spigot key of the base is uppermost, a positive voltage on X' will deflect the spot to the left and a positive voltage on Y' will deflect the spot upwards.

BASE : 12-pin side contact (138)

DIMENSIONS : L=432 mm D=160 mm

MW22-7

Television picture tube with 9-in. diameter screen

HEATER

V_h 6.3 V I_h 0.6 A

With the exception of the heater rating, Type MW22-7 is identical with Type MW22-14C to which please refer.

MW 22-14 MW22-14c

Television picture tube with 9 in. diameter screen. This tube is suitable for D.C./A.C. operation

HEATER

V_h 6.3 V I_h 0.3 A

Important Note.—The heater voltage must not exceed 7.5 V when the supply is switched on. If the heater is connected in series with the heaters of other valves a current limiting device must be included in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

C_{g-all}	10	μμF
C_{k-all}	5	μμF
C_{a_2}–M	1,000	μμF

EXTERNAL CONDUCTIVE COATING

Type MW 22-14 has an external conductive coating designated M which must be earthed. The capacitance C_{a_2}–M may be used to provide smoothing for the EHT supply.
Type MW 22-14C has no external conductive coating and is a direct replacement for Type MW 22-7.

FLUORESCENT COLOUR

Blue-white

Mullard

MW 22-14 / MW22-14c (contd.)

FOCUSSING AND DEFLECTION Magnetic

With the centre of the deflector coils 215 mm from the centre of the screen, the deflection sensitivity is 0.1 × L mm/gauss.
Where L = length of the electron path through the field of the deflector coil in mm.

TYPICAL OPERATING CONDITIONS

V_{a2}	7.0	KV
V_{a1}	200	V
*V_{g1} for cut–off	–40	V
Focussing ampere-turns	600	approx.

*In no circumstances must the grid be allowed to become positive with respect to the cathode.

LIMITING VALUES

V_{a2} max.	7.0	KV
V_{a1} max.	300	V
I_{a2} max.	100	µA
V_{h-k} max.	150	V

BASE: B8G (140) **DIMENSIONS**: L=376 mm D=230 mm

Television picture tube with 12 in. diameter screen

MW31-14c

HEATER

V_h 6.3 V I_h 0.3 A This tube is suitable for D.C./A.C. operation

Important Note.—The heater voltage must not exceed 7.5 V when the supply is switched on. If the heater is connected in series with the heaters of other valves a current limiting device must be included in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	10.0	µµF
C_{k-all}	5.0	µµF

FLUORESCENT COLOUR

Blue-white

FOCUSSING AND DEFLECTION Magnetic

TYPICAL OPERATING CONDITIONS

V_{a2}	7.0	7.0	KV
V_{a1}	160	200	V
*V_{g1} for cut–off	–35	–40	V
Focussing ampere-turns	600	600	approx.

With the centre of the deflector coils 300 mm from the centre of the screen the deflection sensitivity is 0.11 × L mm/gauss.
Where L = length in mm of the electron path through the field of the deflector coil.
*In no circumstances may the grid be allowed to become positive with respect to cathode.

LIMITING VALUES

V_{a2} max.	7.0	KV
V_{a1} max.	300	V
I_{a2} max.	100	µA
V_{h-k} max.	150	V

BASE: B8G (140) **DIMENSIONS**: L=465 mm D=307 mm

EN 31

Thyratron for use in H.F. time bases and control equipment

HEATER

V_h 6.3 V I_h 1.3 A

CAPACITANCES

c_{in}	6.1	µµF
c_{out}	4.2	µµF
c_{a-g}	2.3	µµF
c_{g-h}	<1.5	µµF

OPERATING CONDITIONS

As triode

V_{a-g} pk. max.	1,500	V
V_a pk. max.	1,000	V
I_a max.	10	mA
i_a pk. max.	750	mA
R_g min.	750	Ω/V
R_g max.	0.75	MΩ
*V_{h-k} max.	100	V
Valve voltage drop	33	V
Control ratio	35	
Max. operating frequency	150	K/cs

*Cathode always positive with respect to heater.

As half wave rectifier (grid connected to cathode)

V_a max.	350	V
I_{out} max.	40	mA
Min. limiting resistance	100	Ω
Max. reservoir capacitance	6	µF
V_{h-k} max.	100	V

BASE: Octal (83) **DIMENSIONS**: L=114 mm D=42 mm

1267

Cold-cathode gas-filled triode

CHARACTERISTICS

Max. operating anode voltage (starter anode connected to cathode)	225	V
Min. starter anode–cathode breakdown voltage	70	V
Max. starter anode–cathode breakdown voltage	90	V
Max. starter anode current for anode breakdown (V_a=140 V)	100	µA
Starter anode to cathode voltage drop	60	V
Anode to cathode voltage drop	70	V
Max. peak cathode current	100	mA
Max. D.C. cathode current	25	mA

BASE: Octal (131) **DIMENSIONS**: L=100 mm D=31 mm

2D21

Preliminary data

Gas-filled tetrode primarily intended for use in relay or grid controlled rectifier circuits

HEATER

	Min.	Av.	Max.	
V_h	5.7	6.3	6.9	V
I_h	0.54	0.6	0.66	A

Suitable for use on either D.C. or A.C.
Heating time 10 secs.

CAPACITANCES

Measured without external shield

c_{a-g1}	0.03	μμF
c_{in}	2.5	μμF
c_{out}	1.6	μμF

CHARACTERISTICS

Anode voltage drop	8	V
Grid 1 control ratio ($R_{g1}=0\ \Omega$ $V_{g2}=0$ V)	250 approx.	
Grid 2 control ratio ($R_{g1}=0\ \Omega$ $V_{g1}=0$ V)	1,000 approx.	

TYPICAL OPERATING CONDITIONS

For relay applications

Anode voltage (r.m.s.)	400	V
Grid 2 voltage	0	V
Grid 1 voltage (D.C.)	−6	V
Grid 1 signal voltage (pk.)	6	V
Grid 1 circuit resistance	1.0	MΩ
Anode circuit resistance*	2,000	Ω

*Sufficient resistance must be used to avoid exceeding the limiting current values.

LIMITING VALUES

Peak anode voltage : Forward max.	650	V
Inverse max.	1,300	V
Grid 2 voltage :		
Peak before anode conduction max.	−100	V
*Average during anode conduction max.	−10	V
Grid 1 voltage :		
Peak before anode conduction max.	−100	V
*Average during anode conduction max.	−10	V
Cathode current : Peak max.	0.5	A
*Average max.	0.1	A
Surge for 0.1 second max.	10	A
Grid 2 current : *Average max.	0.01	A
Grid 1 current : *Average max.	0.01	A
Peak heater-cathode voltage :		
Heater negative max.	100	V
Heater positive max.	25	V
Ambient temperature range	−75 to +90	°C

*Averaged over any 30 second interval.

BASE : B7G (132) **DIMENSIONS** : L=54 mm D=19 mm

See circuit diagram on page 221

CHARACTERISTICS	TYPES			
	LSD2	LSD3* LSD3A*	LSD4*	LSD7*
Max. energy of discharge (joules)	56	100	400	200
Operating voltage (V)	7,000–10,000	2,000–2,700	2,000–2,700	2,000–2,700
Trigger voltage (V) min.	5,000	3,000	3,000	3,000
Approx. flash duration (micro-seconds)	1	150	300	200
Peak light output (lumens)	100×10^6	40×10^6	66×10^6	60×10^6
Integrated light output (lumen-seconds)	1,500	4,000	26,000	10,000
Efficiency (lumens/watt)	27	40	65	50
Effective tube resistance (Ω)	0.5	4.5	3.0	3.5
Size : Length (mm) / Diameter (mm)	140 / 33	100 / 35	169 / 71	100 / 35
BASE	ESB (142)	LSD3 4-pin UX (144) LSD3A 3-pin 5 Amp (143)	3-pin (143)	4-pin UX (144)

* Data taken at operating voltage=2.6 KV.

GENERAL NOTES

The recommended mode of operation is to arrange that the anode and trigger are at chassis potential, whilst the cathode is live. If the cathode and trigger are at chassis potential and the anode is live, the tube may break down at voltages below 3 KV in the case of Types LSD 3, LSD 3A, LSD 4 and LSD 7.

Very great care must be taken not to exceed the maximum voltage at which a given capacitor delivers the stated maximum number of joules. The energy in joules stored in a capacitor is proportional to the square of the voltage ($\frac{1}{2}CV^2$ where C is in farads) and it is therefore easy to overload and damage the tube by exceeding the maximum voltage.

It is insufficient to rely upon the stated voltage of the transformer employed. In all cases the voltage which is applied to the tube should be measured by means of a high grade voltmeter.

GENERAL NOTES

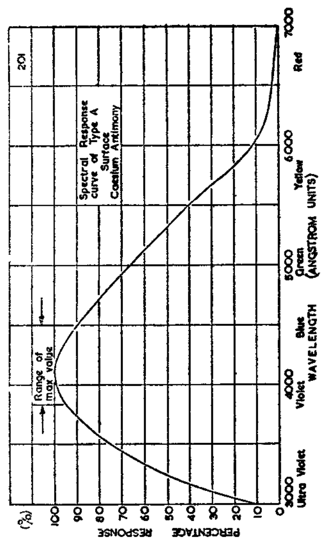
Exposure to Intense Illumination. If a photo cell is exposed to intense illumination such as direct sunlight, the sensitivity may decrease temporarily even if no voltage is applied to the cell. It is therefore recommended that photo cells should be stored in the dark.

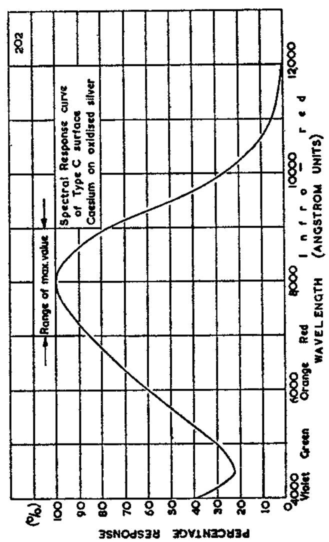
Light Intensities. The light intensity " L " in lumens per square cm. produced at a distance " d " (cm.) by a tungsten filament lamp of wattage " W " and luminous efficiency " E " lumens per watt is given by the expression $L = \frac{EW}{4\pi d^2}$ A typical value of E for a 60-watt 230-volt single-coil tungsten filament lamp is 9.2 L/W. This expression may be used as a guide in determining the approximate light intensity at the cathode of a photo cell.

Stability. Within limits, the stability of a photo cell is increased as current and voltage are reduced. In those applications where the prime consideration is a high degree of stability, the use of vacuum cells is to be preferred.

Operating Conditions. The values specified in the following table under the heading " Recommended maximum operating conditions ", are those which, if not exceeded in continuous operation, ensure normal working life of the cell coupled with a high degree of constancy. Cells may, however, be operated up to their limiting conditions for short periods without reduction of life but if continuous operation under this condition is desired, a decrease in working life must be accepted.

Ambient Temperature. The maximum ambient temperature quoted on the data sheets should not be exceeded. If the bulb temperature of a photo cell is allowed to exceed this value, evaporation of the emissive cathode surface may result with consequent reduction of the life and sensitivity of the cell.





P PHOTO CELLS

*TYPES	20 AV	20 CG	20 CV	90 AV	90 CG	90 CV	
SENSITIVITY	Daylight and bluish light	Incandescent light and near infra-red		Daylight and bluish light	Incandescent light and near infra-red		
CATHODE							
Surface	CA	COS	COS	CA	COS	COS	
Projected area	11	6.7	6.7	4	3.0	3.0	sq. cm
	1.7	1.05	1.05	0.62	0.47	0.47	sq. in.
MOUNTING POSITION	Any	Any	Any	Any	Any	Any	
CAPACITANCE							
c_{a-k}	0.2	1.5	1.5	0.6	0.8	0.8	μμF
CHARACTERISTICS AND RECOMMENDED MAXIMUM OPERATING CONDITIONS							
Dark Current	at 150	90	250	100	90	100	V
	0.05	0.1	0.05	0.05	0.1	0.05	μA
Anode supply voltage	150	90	100	100	90	50	V
Cathode current	10	5	10	5	2	5	μA
Sensitivity	45†	150‡	25†	45†	125‡	20†	μA/l
Gas Amp. factor max.	—	10	—	—	10	—	
LIMITING VALUES							
Anode supply voltage max.	150	90	250	100	90	100	V
Cathode current max.	10	5	20	5	2	10	μA
Ambient temperature max.	70	100	100	70	100	100	°C
BASE	B8G (114)	B8G (115)	B8G (115)	B7G (120)	B7G (137)	B7G (137)	
DIMENSIONS L	80	80	80	54	54	54	mm
D	32	32	32	19	19	19	mm
Height to centre of cathode (cell seated)	23	32	32	12	20	20	mm

* The letter " V " in the type number indicates a vacuum cell and " G " indicates a gas-filled type.

† Sensitivity measured with a lamp of colour temperature 2,700°K.

‡ Sensitivity measured with a lamp of colour temperature 2,700°K and with a series resistor of 1 M Ω.

CA=Caesium-antimony. COS=Caesium-on-oxidised-silver.

Mullard

MISCELLANEOUS APPLICATIONS Q

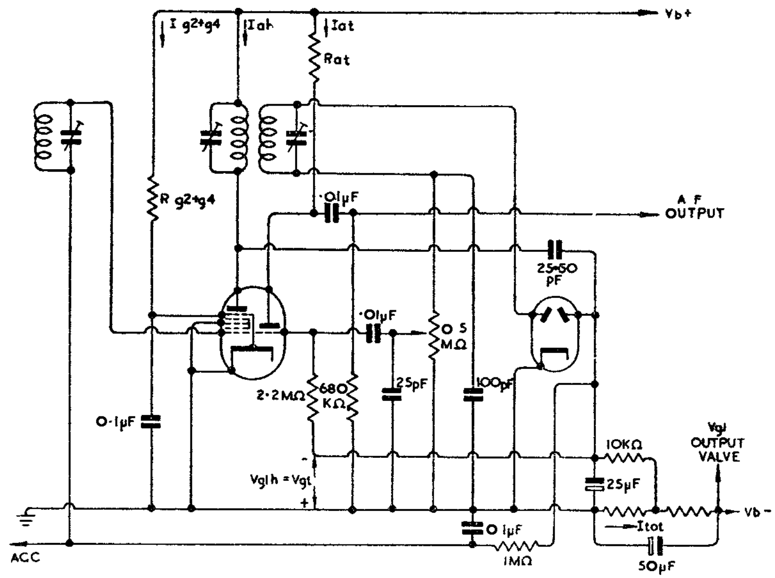


Fig. 1.
Circuit for triode-hexode as combined I.F. and A.F. amplifier.

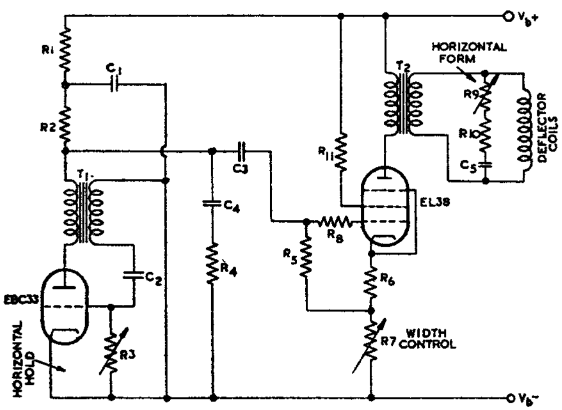


Fig. 2
Line time base circuit.

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Q MISCELLANEOUS APPLICATIONS

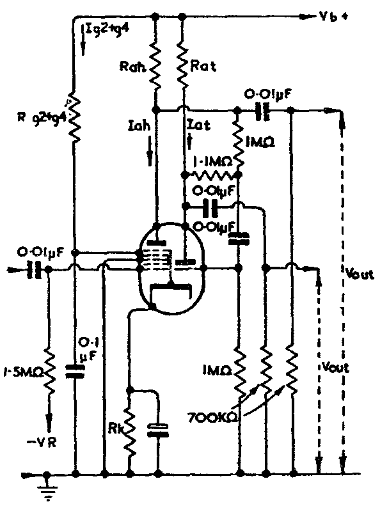


Fig. 3.
Circuit for phase inverter using ECH 21 with negative feed-back.

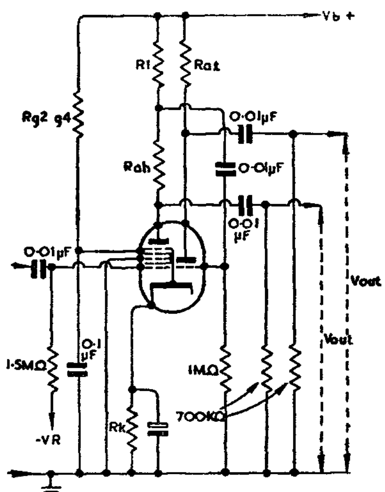


Fig. 4.
Circuit for phase inverter using ECH 21 without feed-back.

2 VOLT MISCELLANEOUS TYPES

Type	Description	Base*	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics Working Conditions: ra (ohms)	μ	gm. or gc (mA/V)	P out (W)	Optimum Load KΩ
TH2	Triode Hexode F.C.	7-pin (30)	0·23	135	60	1·5	0·95	600,000	—	0·43	—	—
FC2	Octode Frequency Changer...	7-pin (32)	0·1	135	135‡‡	0	0·95	—	—	0·2	—	—
FC2A	Octode Frequency Changer...	7-pin (32)	0·13	135	135†	0·5	0·7	2,500,000	—	0·27	—	—
PM12M	Vari-mu Tetrode (M. or C.)	4-pin (4)	0·18	150	90	0-7	2·5	—	—	1·4	—	—
VP2	Vari-mu R.F. Pentode ...	7-pin (24)	0·18	135	135	0-7	3·0	400,000	—	1·5	—	—
VP2B	Vari-mu R.F. Hexode ...	7-pin (28)	0·14	135	60‡	1·5-7·5	2·0	1,300,000	—	1·4	—	—
SP2	R.F. Pentode	7-pin (24)	0·18	135	135	0	3·0	700,000	1,200	1·8	—	—
PM2HL	Medium Impedance Triode (M. or C.)	4-pin (3)	0·1	135	—	1·5	2·2	21,500	30	1·4	—	—
TDD2A	Double Diode Triode ...	5-pin (10)	0·12	135	—	1·5	1·95	25,000	30	1·2	—	—
PM2A	Output Triode	4-pin (3)	0·2	135	—	6·0	5·0	6,000	12	2·0	0·15	7
PM202	Super-Power Triode ...	4-pin (3)	0·2	150	—	14	14·0	2,000	7	3·5	—	3·7
PM2B	Class B Double Triode ...	7-pin (22)	0·2	120	—	0	3·0	—	—	—	1·25	14
PM22A	Output Pentode	5-pin (11)	0·15	135	135	4·5	5·6	150,000	—	2·2	0·35	19
QP22B	Double Output Pentode ...	7-pin (35)	0·3	120	120	10·2	3·3	—	—	2·6***	0·94	16
HVR2A	High Voltage Rectifier ...	4-pin (2)	1·5	6,000**	—	—	3**	—	—	—	—	—

* Numbers in brackets in "Base" Column refer to the Base Diagrams. ** Max. Ratings. *** Measured at $V_a = V_{g2} = 100V$; $V_{g1} = 0$.
† $V_{g3+g5} = 45V$. ‡ $V_{g3} = 60V$. ‡‡ $V_{g3+g5} = 70V$.

4 VOLT MISCELLANEOUS TYPES

Type	Description	Base*	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (KΩ)
FC4	Octode Frequency Changer	7-pin (34)	0·65	250	90‡	1·5	1·6	—	—	0·6	—	—
TH4B	Triode Heptode	7-pin (31)	1·45	250	100	2·5	3·25	1,500,000	—	0·75	—	—
SP4	R.F. Pentode (M. or C.)	5-pin (13) / 7-pin (27)	1·0	200	100	2·0	3·0	2,200,000	5,000	2·3	—	—
SP4B	R.F. Pentode	7-pin (26)	0·65	250	250	2·4	4·0	2,000,000	6,800	3·4	—	—
TSE4	Secondary Emission Valve for Television	7-pin (23)	1·1	250	150	2·5	8.0	100,000	—	14·5	—	—
TSP4	High Slope R.F. Pentode for Television	7-pin (26)	1·3	200	200	2·5	8.0	1,400,000	6,730	4·73	—	—
VP4	Vari-mu R.F. Pentode	5-pin (13) / 7-pin (27)	1·0	200	100	2–50	4·5	1,000,000	2,300	2·3	—	—
VP4A	Vari-mu R.F. Pentode	5-pin (13) / 7-pin (27)	1·2	200	100	2–25	4·25	1,400,000	3,500	2·5	—	—
VP4B	Vari-mu R.F. Pentode	7-pin (26)	0·65	250	250	3·0	11·5	—	—	2·0	—	—
2D4A	Double Diode	5-pin (8)	0·65	200	—	—	0·8	—	—	—	—	—
T4D	Television Diode	Special (141)	0·2	50	—	—	5·0	—	—	—	—	—
TDD4	Double Diode Triode	7-pin (20)	0·65	250	—	7·0	4·0	13,500	27	2·0	—	—
TT4	Low Impedance Triode...	5-pin (9)	1·0	250	—	16·0	20·0	3,300	10·5	3·2	0·5	10
354V	Med. Impedance Triode (M. or C.) ...	5-pin (9)	0·65	250	—	4·5	6·5	11,500	40	3·5	—	—
Pen4DD	Double Diode Output Pentode ...	7-pin (29)	2·25	250	250	6·0	36·0	50,000	—	9·5	4·3	7
PenA4	Output Pentode...	7-pin (25)	1·96	250	250	5·8	36·0	50,000	—	9·5	3·8	8
PenB4	Output Pentode...	7-pin (25)	2·1	250	275	14·0	72·0	22,000	—	8·5	8·8	3·5
Pen4VA	Output Pentode...	5-pin (12) / 7-pin (25)	1·35	250	250	20·0	36·0	40,000	—	2·8	3·8	6

* Numbers in brackets in "Base" Column refer to the Base Diagrams.

‡ Vg3 + g5 = 70V.

4 VOLT MISCELLANEOUS TYPES

Type	Description	Base*	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (KΩ)
Pen428	Output Pentode... ...	7-pin (25)	2·1	375	275	Rk= 165Ω	2×48	—	—	—	28·0***	6·5
AZ1	Full Wave Rectifier (D.H.)	P. Base (43)	1·1	2×300	—	—	100	—	—	—	—	—
AZ50	Full Wave Rectifier (D.H.)	P. Base (43)	3·0	2×500	—	—	250	—	—	—	—	—
DW2	Full Wave Rectifier (D.H.)	4-pin (1)	1·0	2×250	—	—	60	—	—	—	—	—
DW4/350	Full Wave Rectifier (D.H.)	4-pin (1)	2·0	2×350	—	—	120	—	—	—	—	—
DW4/500	Full Wave Rectifier (D.H.)	4-pin (1)	2·0	2×500	—	—	120	—	—	—	—	—
FW4/800	Full Wave Rectifier (D.H.)	4-pin (1)	3·0	2×850	—	—	125	—	—	—	—	—
IW4/350	Full Wave Rectifier (I.H.)	4-pin (7)	2·0	2×350	—	—	120	—	—	—	—	—
IW4/500	Full Wave Rectifier (I.H.)	4-pin (7)	2.5	2×500	—	—	120	—	—	—	—	—

* Numbers in brackets in "Base" Column refer to the Base Diagrams-
All ratings quoted for rectifiers are max.

*** Data for 2×Pen428 in class A.B. push-pull.

4 VOLT DIRECTLY HEATED OUTPUT VALVES

Type	Description	Base*	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (ohms)
ACO42	Output Triode	4-pin (3)	{2·0V / 2·0A}	300	—	38·0	50·0	1,200	6·0	5·0	3·5	2,300
ACO44	Output Triode	4-pin (3)	1·0	300	—	38·0	50·0	1,200	6·0	5·0	3·5	2,300
PM24A	Output Pentode... ...	5-pin (11)	0·275	300	200	21	20·0	—	—	1·7	2·5	16,000
PM24M	Output Pentode... ...	5-pin (11)	1·1	250	250	17·0	30·0	43,000	130	3·0		7,000

* Numbers in "Base" Column refer to the Base Diagrams.

6.3 VOLT MISCELLANEOUS TYPES

Type	Description	Base*	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load
ECH3	Triode Hexode F.C.	P. Base (52)	0·2	250	100	2·0	3.0	1,300,000	—	0·65	—	—
EK2	Octode Frequency Changer	P. Base (33)	0·2	250	200††	2·0	1.0	2,000,000	—	0·55	—	—
EF36	R.F. Pentode	Octal (72)	0·2	250	100	2·0	3.0	2,500,000	4,500	1·8	—	—
EF9	Sliding Screen R.F. Pentode	P. Base (47)	0·2	250	100	2·5	6.0	1,250,000	—	2·2	—	—
EE50	Secondary Emission Television Valve	B9G	0·3	250	250	3·0	10.0	250,000	—	14·0	—	—
EBC3	Double Diode Triode	P. Base (45)	0.2	250	—	5·5	5.0	15,000	30	2·0	—	—
EM1	Tuning Indicator...	P. Base (21)	0·2	250	—	0–5	—	—	—	—	—	2MΩ
EM4	Tuning Indicator...	P. Base (51)	0·2	{250 / 250}	— / —	{0–16 / 0–5}	—	—	—	—	—	‡1MΩ
EBL1	Double Diode Output Pentode ...	P. Base (50)	1·5	250	250	6·0	36.0	50,000	—	9·5	4·3	7KΩ
EL2	Output Pentode	P. Base (48)	0·2	250	250	18·0	32.0	70,000	—	2·8	3·6	8KΩ
EL3	Output Pentode	P. Base (46)	0·9	250	250	6·0	36.0	50,000	—	9·0	4·5	7KΩ

††Vg3 + g5 = 50V

‡ Load resistance each anode

* Numbers in brackets in "Base" Column refer to the Base Diagrams

0.2 AMP. DC/AC MISCELLANEOUS TYPES

Type	Description	Base*	Working Conditions: Vf or Vh (V)	If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (KΩ)
FC13	Octode Frequency Changer ...	P. Base (33)	13·0	0·2	200	90‡	1·5	1·6	—	—	0·6	—	—
FC13C	Octode Frequency Changer .	7-pin (34)	13·0	0·2	200	90‡	1·5	1·6	—	—	0·6	—	—
TH21C	Triode Hexode F.C.	7-pin (31)	21·0	0·2	250	70	1·5	4·0	1,500,000	—	1·0	—	—
TH30C	Triode Heptode F.C.	7-pin (31)	29·0	0·2	250	100	2·5	3·25	1,500,000	—	0·75	—	—
VP13A	Vari-mu R.F. Pentode	P. Base (47)	13·0	0·2	200	100	2–18	4·0	—	2,200	2·2	—	—
VP13C	Vari-mu R.F. Pentode	7-pin (26)	13·0	0·2	200	200	2–34	9·0	—	—	2·2	—	—
SP13	R.F. Pentode	P. Base (47)	13·0	0·2	200	100	2·0	3·3	1,300,000	3,000	2·2	—	—
SP13C	R.F. Pentode	7-pin (26)	13·0	0·2	200	200	2·2	2·5	2,500,000	7,000	2·8	—	—
HL13	Med. Impedance Triode (M) ...	P. Base (44)	13·0	0·2	200	—	3·7	5·0	12,000	40	3·3	—	—
HL13C	Med. Impedance Triode (M) .	7-pin (19)	13·0	0·2	200	—	3·7	5·0	12,000	40	3·3	—	—
TDD13C	Double Diode Triode	7-pin (20)	13·0	0·2	200	—	5·0	4·0	13,500	27	2·0	—	—
CBL1	Double Diode Output Pentode	P. Base (50) / Octal (75)	44 0	0·2	200	200	8·5	45·0	35,000	—	8·0	4·0	4·5
Pen40DD	Double Diode Output Pentode	7-pin (29)	44·0	0·2	200	200	8·5	45·0	35,000	—	8·0	4·0	4·5
CL4 / Pen36C	Output Pentode...	P. Base (48) / 7-pin (25)	33·0	0·2	200	200	8·5	45·0	35,000	—	8·0	4·0	4·5
CY1	Half Wave Rectifier (I.H.) ...	P. Base (42) / Octal (53)	20	0·2	250	—	—	120	—	—	—	—	—
UR1C	Half Wave Rectifier (I.H.) ...	5-pin (6)	20	0·2	250	—	—	75	—	—	—	—	—
UR3C	Multiple Rectifier (I.H.) ...	7-pin (18)	30	0·2	250	—	—	120	—	—	—	—	—

* Numbers in brackets in "Base" column refer to the base diagrams

‡ Vg3 + g5 = 70V

2 VOLT MISCELLANEOUS TYPES

Type	Description	Base	Working Conditions: If or Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions: ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (ohms)
PM12A	R.F. Screened Tetrode ...	4-pin	0·18	125	75	0	1·9	330,000	500	1·5	—	—
2D2	Indirectly Heated Double Diode	5-pin	0·09	125*	—	—	0·5*	—	—	—	—	—
TDD2	Double Diode Triode	5-pin	0·1	150	—	5.5	2·5	12,000†	16·5†	1·4†	—	—
PM2	Output Triode	4-pin	0·2	150	—	12·0	6·6	4,400†	7·5†	1·7†	—	9,000
PM252	Output Triode	4-pin	0·4	150	—	9·0–12·0	19·0	1,900†	7·0†	3·7†	—	4,500
PM2BA	Class B Output Triode ...	7-pin	0·2	120	—	4·5	3·0	—	—	2·15	1.45	14,000
PM22	Output Pentode	4-pin or 5-pin	0·3	150	150	10·0	15·0	—	—	1·3†	—	8,000
PM22D	High Sensitivity Output Pentode	5-pin	0·3	135	135	2·4	5·0	—	—	3·0	0.3	24,000
QP22A	Double Output Pentode ...	9-pin	0·45	135	125	11·5	2·5–3·0	—	—	4·0	1.4	16,000

* Maximum rating

† Measured at Va = 100V Vg1 = 0V

4 VOLT MISCELLANEOUS TYPES

Type	Description	Base	Working Conditions Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load
TH4	Triode Hexode Frequency Changer	7-pin	1·0	250	70	1·5	4·0	1,500,000	—	1·0	—	—
TH4A	Triode Hexode Frequency Changer	7-pin	1·45	250	100	2·0	3·5	1,500,000	—	0·75	—	—
SD4	Diode Tetrode	7-pin	1·0	200	100	—	—	—	—	3·0	—	—
MM4V	Variable-Mu Screened Tetrode	5-pin	1·0	200	110	1·5	6·0	—	—	2·5	—	—
S4VA	Screened Tetrode	5-pin	1·0	200	110	1·5	2·75	500,000	1,000	2·0	—	—
S4VB	Screened Tetrode	5-pin	1·0	200	110	1·5	4·6	300,000	750	2·5	—	—
SP4C	R.F. Pentode...	P. Base	0·65	250	250	2·0	4·5	—	—	4·0	—	—
VM4V	Variable-Mu Screened Tetrode	5-pin	1·0	200	100	1·5	8·5	—	—	1·2	—	—
2D4B	Double Diode (separate cathodes)	7-pin	0·35	200*	—	—	0·8*	—	—	—	—	—
164V	Medium Impedance Triode	5-pin	0·65	200	—	9·0	12·0	4,700	16	3·4	—	—
244V	Medium Impedance Triode	5-pin	0·65	200	—	5·5	5·5	9,000†	25†	2·8†	—	—
484V	Medium Impedance Triode	5-pin	1·0	200	—	3·0	2·8	21,800†	48†	2·2†	—	—
994V	High Impedance Triode ...	5-pin	0·65	200	—	1·5	1·35	35,000†	125†	3·6†	—	—
104V	Small Output Triode ...	5-pin	1·0	200	—	12·0	17·0	3,000†	12†	4·0†	—	6KΩ
AL60	Output Pentode	7-pin	2·1	250	250	7· 0	72·0	20,000	—	14·5	8·0	3·5KΩ
Pen4V	Output Pentode	5-pin	1·0	250	200	10·0	35·0	—	—	3·0†	—	8KΩ
Pen4VB	Output Pentode	7-pin	1·95	250	250	5·8	36·0	50,000	—	9·5	3·8	8KΩ
TV4	Tuning Indicator	P. Base	0·3	250	—	—	0–5	—	—	—	—	2MΩ
TV4A	Tuning Indicator	P. Base	0·3	250	—	—	0–21	—	—	—	—	1MΩ
IW3	Full-Wave Rectifier (I.H.) ...	4-pin	2·4	2×350*	—	—	120*	—	—	—	—	—
IW4	Full-Wave Rectifier (I.H.) ...	4-pin	2·4	2×500*	—	—	120*	—	—	—	—	—
DW3	Full-Wave Rectifier (D.H.)	4-pin	2·0	2×350*	—	—	120*	—	—	—	—	—
DW4	Full-Wave Rectifier (D.H.)	4-pin	2·0	2×500*	—	—	120*	—	—	—	—	—
AZ3	Full-Wave Rectifier (I.H.) ...	P. Base	2·0	2×350*	—	—	120*	—	—	—	—	—

* Maximum rating. † At Va = 100V; Vg1 = 0V.

DC/AC MISCELLANEOUS TYPES

Type	Description	Base	Working Conditions Vh (V)	Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (KΩ)
2D13A	Double Diode	V. Base	13.0	0.2	200*	—	—	0.8*	—	—	—	—	—
2D13C	Double Diode	5-pin											
TDD13	Double Diode Triode	P. Base	13.0	0.2	200	—	5.0	4.0	13,500	27	2.0	—	—
CL6	Output Pentode... ...	P. Base	35.0	0.2	200	100	9.5	45	19,000	—	8.0	4.0	4·5
Pen26	Output Pentode... ...	P. Base	24.0	0.2	200	100	19	40	—	—	3.1	3.0	5
CY2	Multiple Rectifier (I.H.)	P. Base	30.0	0.2	2×250*	—	—	120*	—	—	—	—	—
UY31	Half-Wave Rectifier (I.H.)	Octal	50.0	0.1	250*	—	—	125*	—	—	—	—	—

4-VOLT DIRECTLY HEATED OUTPUT VALVES

Type	Description	Base	Working Conditions If (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	Characteristics at Working Conditions ra (ohms)	μ	gm or gc (mA/V)	P out (W)	Optimum Load (KΩ)
D024	Triode...	4-pin	1.85	400	—	40.0	63.0	1,070	8	7.5	7.1	3·1
D026	Triode...	4-pin	2.0	400	—	92.0	63.0	950	3.6	3.8	7.5	3
PM24B	Pentode	5-pin	1.0	400	300	40.0	30.0	—	—	2.1†	—	8

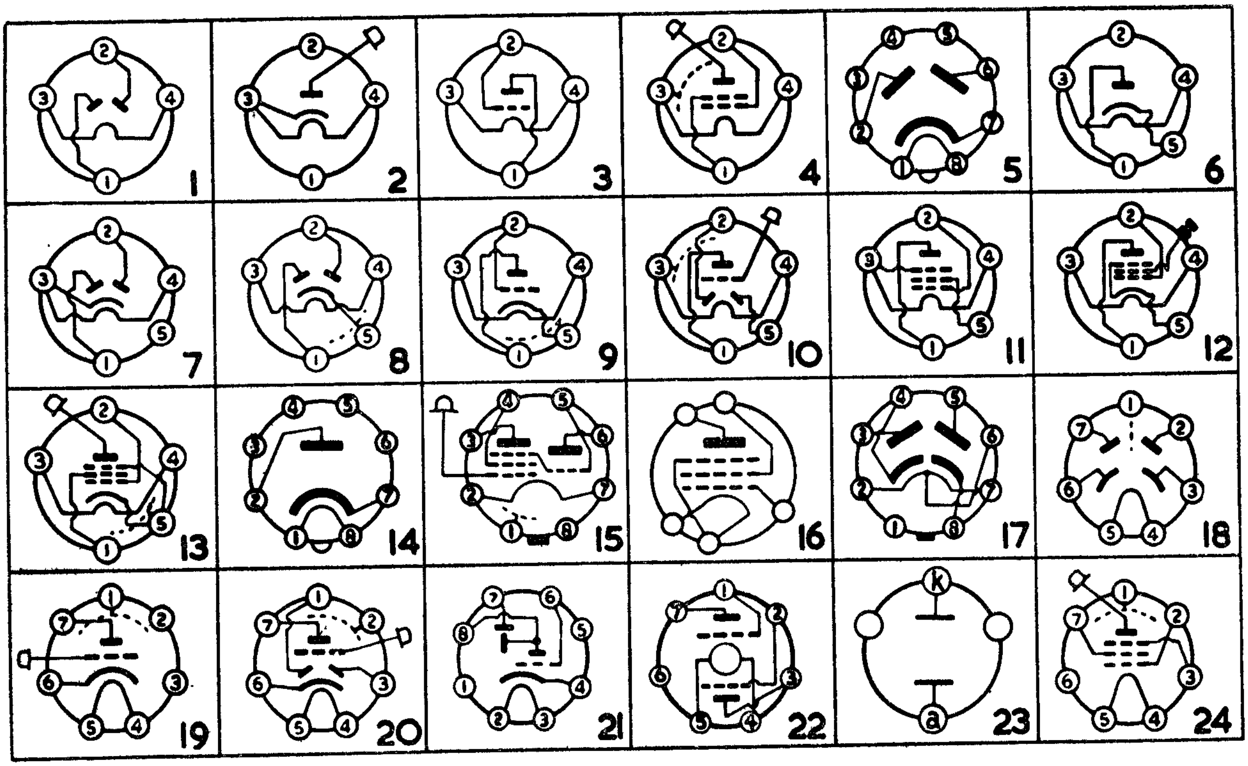
*Maximum rating. † At Va = 100v; Vg1 = 0v.

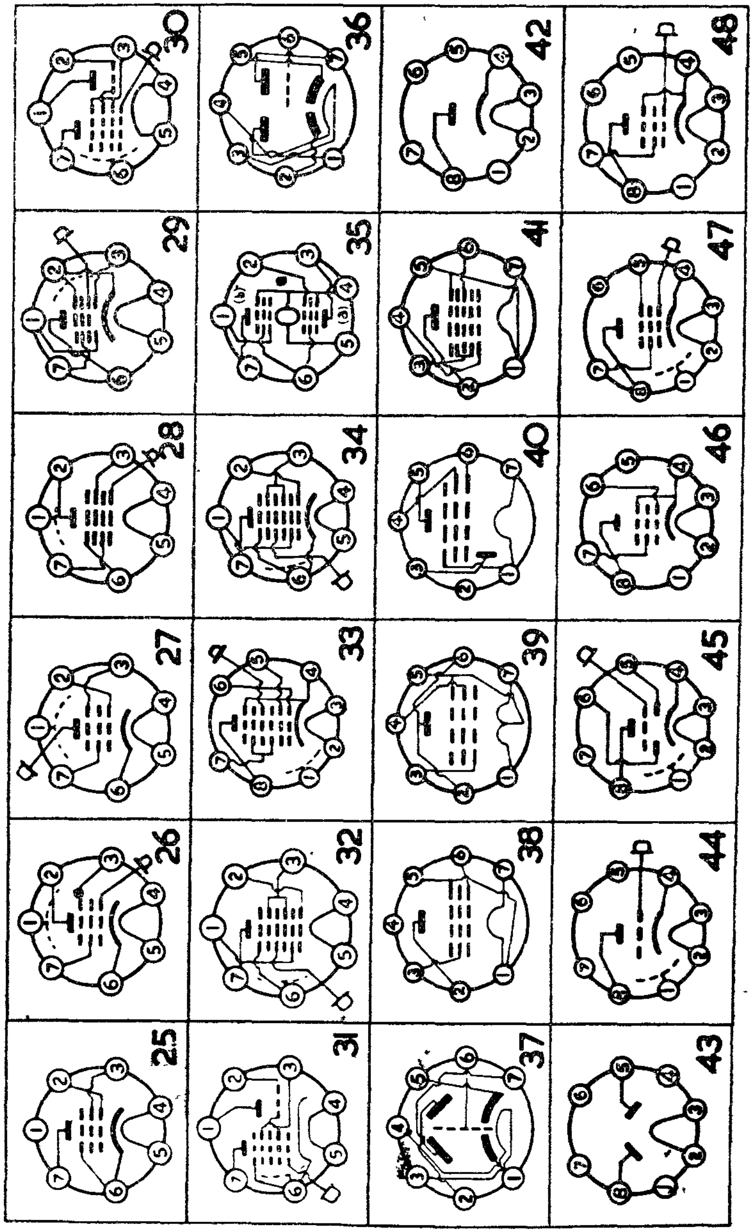
6.3 VOLT MISCELLANEOUS TYPES

Type	Description	Base	Working Conditions					Characteristics at Working Conditions			P out (W)
			Ih (A)	Va (V)	Vg2 (V)	—Vg1 (V)	Ia (mA)	ra (ohms)	μ	gm or gc (mA/V)	
EF6	R.F. Pentode	P. Base	0·2	250	100	2	3	2,500,000	—	1·8	—
EF8	Low Noise R.F. Hexode	P. Base	0·2	250	250	2·5†	8	450,000	—	1·8	—
EH2	R.F. Hexode	P. Base	0·2	250	100	-3	1·85	2,000,000	—	0·4	—
EK3	Octode Frequency Changer	P. Base	0·6	250	100	2·5	2·5	2,000,000	—	0·65	—
EB4	Double Diode	P. Base	0·2	200*	—	—	0·8*	—	—	—	—
EAB1	Triple Diode	P. Base	0·2	200*	—	—	0·8*	—	—	—	—
EFM1	A.F. Amplifier and Electron Beam Indicator	P. Base	0·2	250	—	2–20	0·8	—	—	—	—
EZ2	Full Wave Rectifier (I.H.)	P. Base	0·4	2×350	—	—	60*	—	—	—	—

* Maximum rating.

† g2 and g4 connected to cathode.

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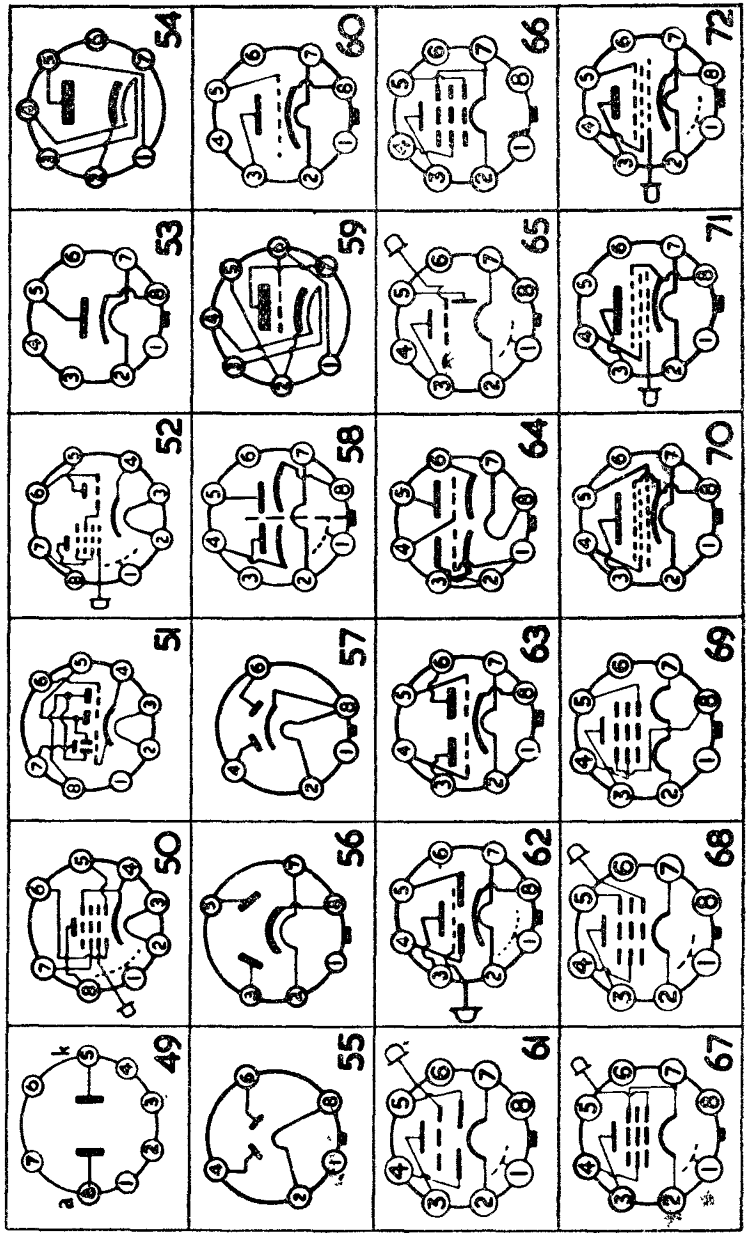
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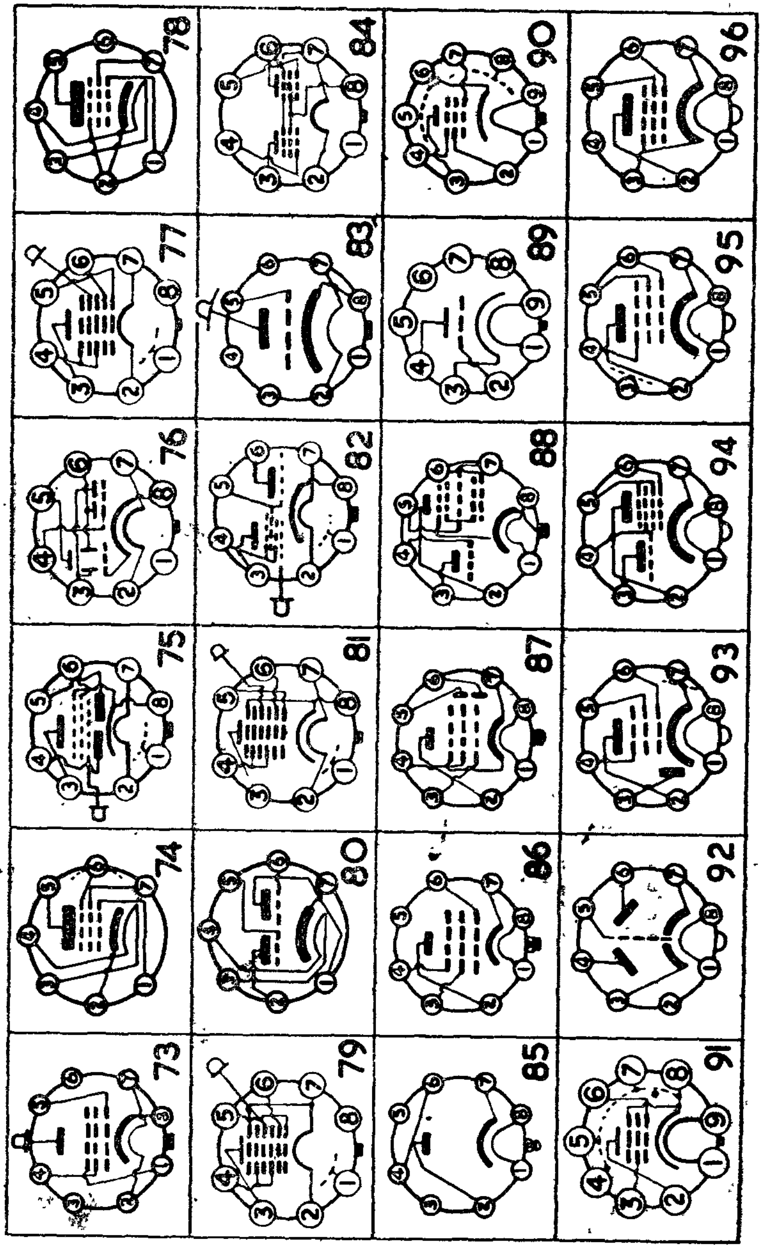
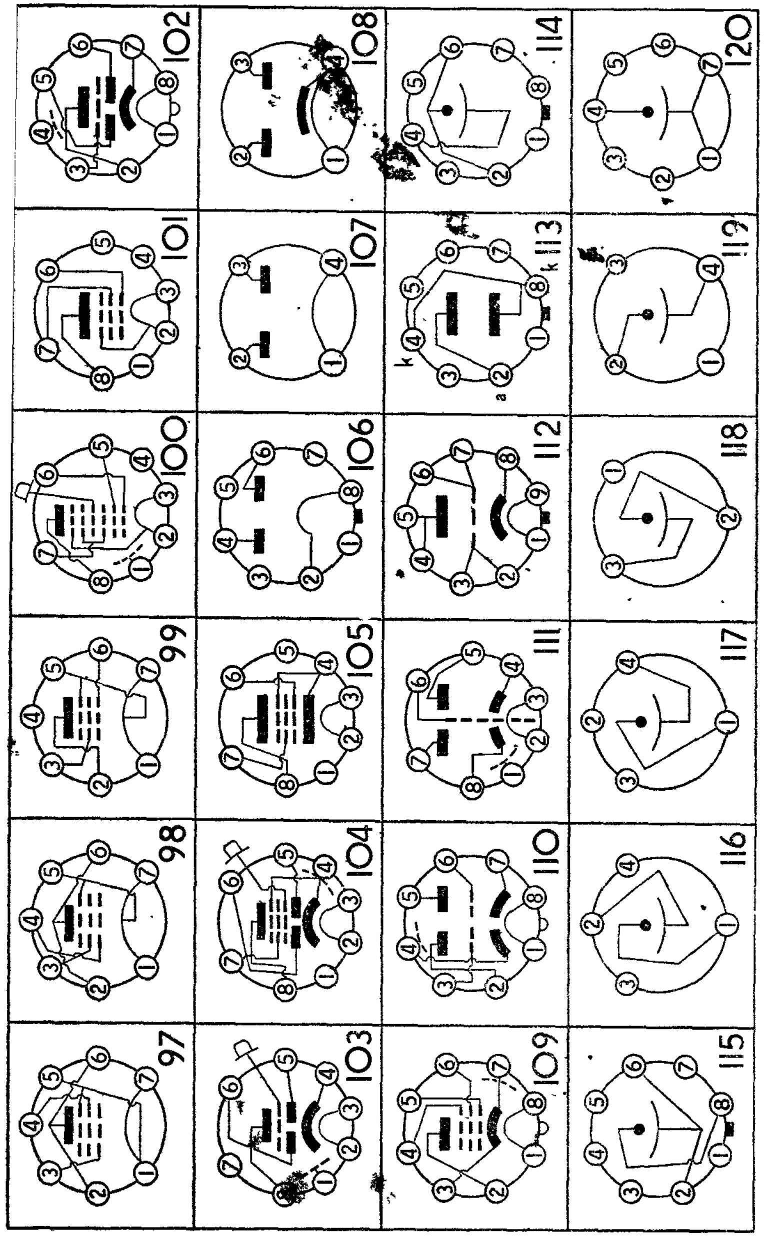
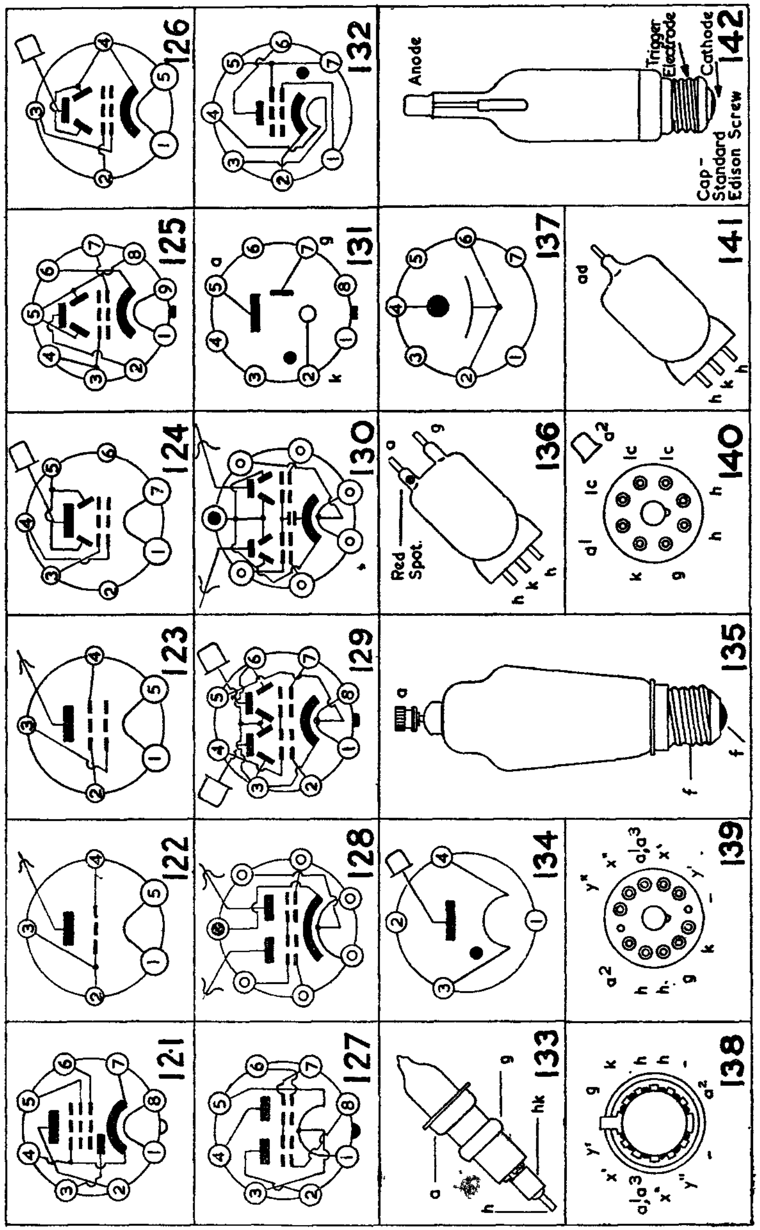
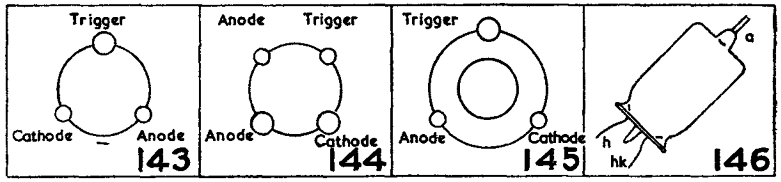




VALVE BASES

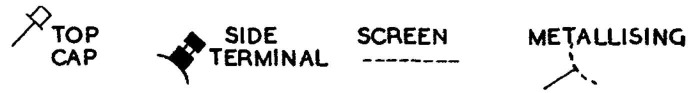


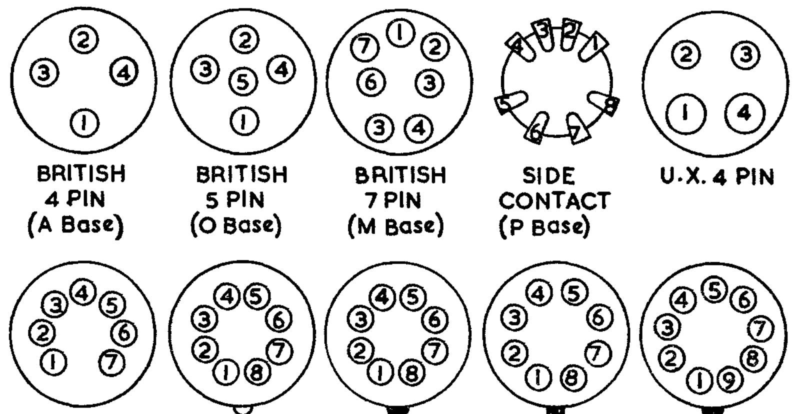
VALVE BASES



PIN ARRANGEMENT OF STANDARD VALVE BASES

(Viewed from Pin-end of Valve or Underside of Valve-holder)





BRITISH 4 PIN (A Base)

BRITISH 5 PIN (O Base)

BRITISH 7 PIN (M Base)

SIDE CONTACT (P Base)

U.X. 4 PIN

7 PIN MINATURE (B7G)

8 PIN MINATURE (B8A)

LOCTAL (B8G)

OCTAL (K Base)

9 PIN ALL GLASS (B9G)

BATTERY TYPES A

Mullard	Brimar	Cossor	Ever-Ready	Ferranti	Marconi/Osram	Mazda	Tungsram	Hivac	Triotron	Philips	Mullard
DAC32	IH5GT/G	IH5G†	DAC32	IH5G†	HD14	—	—	—	—	—	DAC32
DF33	IN5GT/G	IN5VG	DF33	IN5G	Z14	—	—	—	—	—	DF33
DK32	IA7GT/G	IA7VG	DK32	IA7G†	X14	—	—	—	—	—	DK32
DL33	3Q5GT/G	—	DL33	—	N16	—	—	—	—	—	DL33
DL35	IC5GT/G	IC5G	DL35	IC5G	N14	—	—	—	—	—	DL35
DAF91	IS5	IS5	DAF91	—	ZD17	IFD9	IS5	—	—	—	DAF91
DF91	IT4	IT4	DF91	—	W17	IF3	IT4	—	—	—	DF91
DK91	IR5	IR5	DK91	—	X17	IC1	IR5	—	—	—	DK91
DL92	3S4	3S4	DL92	—	N17	IP10	—	—	—	—	DL92
FC2	—	210PG	K80A	VHT2	X22	—	VO2	—	—	—	FC2
FC2A	—	210PGA, 210SPG	K80B	VHT2A	—	—	—	—	—	—	FC2A
PM2A	—	220P	K30G	—	LP2	P220	LP220	P220	YD2	—	PM2A
PM2B	—	240B, 220B	K33A	—	—	PD220	CB215	B230	E220B	B240	PM2B
PM2HL	—	210HF, 210HL	K30	—	HL2, H210, HL2K, HL210	HL2	HL2	H210	SD2	B228	PM2HL
PM12M	—	220VS, 220V5G, 215SG	K40N	VS2	V524, VS24K	S215VM	SE211c	VS215, V5210	S213	—	PM12M
PM22A	PenB1	220HPT, 220/OT	K70B	PT2	KT2, PT2	Pen220	PP2	—	—	—	PM22A
PM202	—	230XP	—	—	P2, P240	P220	SP220	PP220, PX230	UD2, E235	—	PM202
QP22B	—	240QP	—	QPT2	QP21	QP230	—	—	—	—	QP22B
SP2	—	—	—	—	Z21, Z22	SP210, SP215	HP210Nc	HP215	S218	—	SP2
TDD2A	—	210DDT	K23B	—	HD22, HD23, HD24	HL21DD	DDT2	DDT220	—	—	TDD2A
VP2	—	—	K50M	—	—	VP210, VP215	HP211c	VP215	S217	—	VP2
VP2B	—	—	K50N	—	—	—	—	—	—	—	VP2B

† May be necessary to use valve screen when making substitution.

A 4.0 VOLT TYPES

Mullard	Brimar	Cossor	Ever-Ready	Ferranti	Marconi/Osram	Mazda	Tungsram	Hivac	Triotron	Philips	Mullard
FC4	—	41MPG	A80A	VHT4	MX40, X42	—	VO4	—	O406	—	FC4
PENA4	7A3	420/OT, 42MP/PEN	A70D	—	KT41, N41	AC2/PEN	APP4B	AC/Z	P495	—	PENA4
PENB4 } PEN428 }	—	—	A70E	—	—	AC4/PEN	APP4E	AC/Q	—	—	{ PENB4 { PEN428
PEN4VA	7A2	MP/PEN	A70B	—	MPT4,MKT4,KT42	AC/PEN	APP4A	AC/Y	—	—	PEN4VA
PEN4DD	—	—	A27D	—	—	—	DDPP4M	—	DP495	—	PEN4DD
SP4	8A1	MS/PEN, MSG/HA	A50A	SPT4A	MSP4	AC/S2PEN	HP4101C	AC/HP	S435N	E446	SP4
SP4B	—	—	A50B	—	—	—	SP4B	—	—	—	SP4B
TDD4	—	—	A23A	—	MHD4, DH42	AC/HLDD	DDT4	AC/DDT	DT436	—	TDD4
TH4B	—	—	A30C	—	—	AC/TH1	TH4B	—	—	—	TH4B
TT4	—	41FP	—	—	ML4	AC/P	—	—	—	—	TT4
VP4	9A1	—	A50M	VPT4	VMP4	AC/VP1	MP4106c	—	—	—	VP4
VP4A	—	MVS/PEN	A50N	VPT4B	VMP4G	—	VP4A, HP4115c	AC/VP	S434N	AF2	VP4A
VP4B	—	MVS/PENB	A50P	—	—	AC/VP2	VP4B	AC/VPB	S420	—	VP4B
2D4A	—	DD4, DDL4	A20B	—	D41	V914	DD4	AC/DD	D400	—	2D4A
354V	HLA2	41MHF, 41MHL	A30D	D4	MH4, MHL4	AC/HL	HL4	AC/HL	A430N	—	354V
ACO42	—	2P	S30D	—	—	PA20	—	—	—	—	ACO42
ACO44	—	4XP	S30c	—	PX4	PP3/250	—	—	—	—	ACO44
DO30	—	—	—	—	DA30	—	—	—	—	—	DO30
PM24M	PenA1	PT41	—	—	PT4	—	—	—	—	—	PM24M

6.3 VOLT TYPES A

Mullard	Brimar	Cossor	Ever-Ready	Ferranti	Marconi/Osram	Mazda	Tungsram	Hivac	Triotron	Philips	Mullard
EA50	—	—	—	—	—	6D1	—	—	—	—	EA50
EB34	—	—	EB34	—	D63*	—	EB34	—	—	—	EB34
EB91	—	—	—	DD6	D77	6D2	—	—	—	—	EB91
EBC3	—	—	EBC3	—	—	—	EBC3	—	—	EBC3	EBC3
EBC33	—	OM4	EBC33	—	—	—	EBC33	—	—	—	EBC33
EBL1	—	—	EBL1	—	—	—	EBL1	—	—	EBL1	EBL1
EBL21	—	—	—	—	DN143	—	—	—	—	—	EBL21
EC91	—	—	—	—	—	6L34	—	—	—	—	EC91
ECH3	—	—	ECH3	—	—	—	ECH3	—	—	ECH3	ECH3
ECH21	—	—	—	—	X143	—	—	—	—	—	ECH21
ECH35	—	OM10*	ECH35	—	X61M	—	ECH35	—	—	—	ECH35
EF9	—	—	EF9	—	—	—	EF9	—	—	EF9	EF9
EF22	—	—	—	—	W143	—	—	—	—	—	EF22
EF37	—	{ OM5 { OM5A }	—	—	—	—	—	—	—	—	EF37
EF39	—	{ OM6 { OM7 }	EF39	—	—	—	EF39	—	—	—	EF39
EF91	8D3	SP6	—	—	Z77	6F12	—	—	—	—	EF91
EF92	9D6	—	—	—	W77	—	—	—	—	—	EF92
EL3	—	—	EL3	—	—	—	EL3	—	—	EL3	EL3
EL32	—	OM9	EL32	—	—	—	—	—	—	—	EL32
EL33	—	—	EL33	—	KT61	—	EL33	—	—	—	EL33
EL37	—	—	—	—	KT66	—	—	—	—	—	EL37
EL91	—	—	—	—	N77	—	—	—	—	—	EL91
EZ35	—	—	—	—	U70	—	—	—	—	—	EZ35

* Valve having different heater current, not direct replacement in DC/AC receivers.

A DC/AC TYPES

Mullard	Brimar	Cossor	Ever-Ready	Ferranti	Marconi/Osram	Mazda	Tungsram	Hivac	Triotron	Philips	Mullard
CCH35	—	OM10	CCH35	—	—	—	—	—	—	—	CCH35
CL33	—	332PEN	CL33	—	—	—	CL33	—	—	—	CL33
FC13	—	—	—	—	—	—	VO13s	—	01307 (P base)	CK1	FC13
FC13C	—	13PGA	C80B	—	—	—	VO13	—	01307 (7-pin)	—	FC13C
HL13	—	—	—	—	—	—	HL13s	—	—	CC2	HL13
HL13C	4D1	—	C30B	DA	—	HL1320	HL13	—	—	—	HL13C
PEN36C	7D6	—	C70D	PTZ	—	PEN3520	PP35	—	—	—	PEN36C
PEN40DD	—	—	C27D	—	—	—	DDPP39N	—	DP4480	—	PEN40DD
SP13	—	—	—	—	—	—	SP13s	—	SP1328	CF1, CF7	SP13
SP13C	—	—	C50B	—	—	—	SP13B	—	S1324	—	SP13C
TDD13C	—	220DDT	C23B	HAD	—	HLDD1320	DDT13	—	DT1336 (7-pin)	—	TDD13C
TH21C	—	202STH	C36A	—	—	—	TX21	—	—	—	TH21C
TH30C	—	302THA	C36C	—	—	TH2321	TH30	—	—	—	TH30C
UAF42	—	—	—	—	WD142	—	—	—	—	—	UAF42
UCH42	—	—	—	—	X142	—	—	—	—	—	UCH42
UL41	—	—	—	—	N142	—	—	—	—	—	UL41
VP13A	—	—	—	—	—	—	HP13s	—	—	CF2	VP13A
VP13C	—	—	C50N	—	—	VP1322	VP13B	—	—	—	VP13C

RECTIFIERS A

Mullard	Brimar	Cossor	Ever-Ready	Ferranti	Marconi/Osram	Mazda	Tungsram	Hivac	Triotron	Philips	Mullard
AZ31	—	—	AZ31	—	U143	—	AZ31	—	—	—	AZ31
CY31	—	OM1	CY31	—	—	—	—	—	—	—	CY31
DW2	—	506BU	S11A	—	U10	—	PV495	—	G431, G470	1821	DW2
DW4/350	—	442BU	S11D	R4	U12	UU120/350	PV4, RV120/350	—	GN24	—	DW4/350
DW4/500	—	460BU	—	—	U12/14	—	PV4200, RV120/500	—	G4120	1561	DW4/500
FW4/500	—	4/100BU	—	—	U18	—	RV200/600	—	—	1561	FW4/500
FW4/800	—	—	—	—	U18/20	—	—	—	—	—	FW4/800
IW4/350	R2	431U	A11D	—	MU12	UU3, UU4	—	—	—	—	IW4/350
IW4/500	R3	441U	A11C	—	MU12/14	UU5	APV4	UU120/350	G412ON	1861	IW4/500
UR1C	—	40SUA	C10B	RZ	—	U4020	V20	—	G2080 (5-pin)	—	UR1C
UR3C	—	—	—	—	—	—	PV30	—	—	—	UR3C
UY41	—	—	—	—	U142	—	—	—	—	—	UY41

AMERICAN — MULLARD

American Type	Base	Mullard Type	Base	Conversion
1A6	UX	FC2	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. g2 g1 g3–g5 f f M a g4
1C6	UX	FC2	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. g2 g1 g3–g5 f f M a g4
1C7G	K	KK32	K	Vg3+g5=45 V. Earth Pin 1. Receiver may require re-aligning.
1D7G	K	KK32	K	Vg3+g5=45 V. Earth Pin 1. Receiver may require re-aligning.
1Q5GT	K	DL35	K	Bias may require adjustment.
5Y3G	K	GZ32	K	GZ32 has indirectly heated cathode.
5Y4G	K	GZ32	K	Re-wire base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h — a′ — a″ — h, k
6AC7/1852	K	EF50	B9G	Change base. Pin. No. 1 2 3 4 5 6 7 8 9 Conn. h g2 a g3 s k g1 s h Alter Rk according to application.
6C6	UX	EF37	K	Change Base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6D6	UX	EF39	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6E5	UX	EM34	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a′ g t a″ h k Supply second anode from HT+ through 1 M.ohm load resistor. In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6F8G	K	ECC32	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. g′ a′ k′ g″ a″ k″ h h Rk may require adjustment.
6J7G	K	EF37	K	Earth Pin 1. Rk may require adjustment. In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6J8G	K	ECH35	K	Earth Pin 1. Receiver may require re-aligning.

AMERICAN — MULLARD (*continued*)

American Type	Base	Mullard Type	Base	Conversion
6K8GT	K	ECH35	K	In some cases the receiver may require re-aligning.
6L6G	K	EL37	K	Rk may require adjustment.
6N7G	K	ECC32	K	Re-wire base. Pin No. 1 2 3 4 5 6 7 8 Conn. g′ a′ k′ g″ a″ k″ h h ECC32 unsuitable for use as Class B output valve.
6P8G	K	ECH35	K	Earth Pin 1. Reduce triode anode resistor to 45,000 ohms.
6Q7G	K	EBC33	K	Earth Pin 1. In AC/DC receivers shunt heater with 62 ohm 1 W resistor. There may be a slight reduction in sensitivity.
6R7G	K	EBC33	K	Earth Pin 1. Alter Rk. In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6SC7	K	ECC35	K	Re-wire base. Pin No. 1 2 3 4 5 6 7 8 Conn. g′ a′ k′ g″ a″ k″ h h ECC35 Ih=0·4 A.
6U5/6G5	UX	EM34	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a′ g t a″ h k Supply second anode from HT+ through 1 M.ohm load resistor. In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6U7G	K	EF39	K	Earth Pin 1. In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
6V6G	K	EL33	K	Alter Rk according to application.
6Y5	UX	EZ35	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a′ — a″ — h k
7C5	B8G	EL22	B8G	Single valve condition, change Rk to 140 ohms.
39/44	UX	EF39	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
42	UX	EL33	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a g2 g1 — h k Alter Rk to 150 ohms.

AMERICAN — MULLARD *(continued)*				
American Type	**Base**	**Mullard Type**	**Base**	**Conversion**
75	UX	EBC33	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a ad′ ad″ — h k g In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
77	UX	EF37	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
78	UX	EF39	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
80	UX	GZ32	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h — a′ — a″ — h, k
84/6Z4	UX	EZ35	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a′ — a″ — h k

COSSOR — MULLARD				
Cossor Type	**Base**	**Mullard Type**	**Base**	**Conversion**
1A7G	K	DK32	K	Earth Pin 1.
IN5G	K	DF33	K	Earth Pin 1.
210LF	A	PM2HL	A	Alter Vg1 to –1·5 V.
215P	A	PM2A	A	Alter Vg1 to –6 V.
MS/PENB	M	SP4B	M	Increase Vg2 to 250 V.
41MTL	O	354V	O	Bias may require adjustment.
DDT	M	TDD4	M	Increase Rk to 1,500 ohms.
PT41	O	PM24M	O	Increase Vg1 to –17 V.
13VPA	M	VP13C	M	Increase Vg2 to 200 V.
13SPA	M	SP13C	M	Increase Vg2 to 200 V.
13DHA	M	TDD13C	M	Sensitivity may be slightly reduced.
4THA	M	TH4B	M	Receiver may require re-aligning.
210SPT	M	SP2	M	Increase Vg2 to 120 V.
210VPT	M	VP2	M	Increase Vg2 to 120 V.

BRIMAR — MULLARD				
Brimar Type	**Base**	**Mullard Type**	**Base**	**Conversion**
7D6	M	CL33	K	Change base, Pin No. 1 2 3 4 5 6 7 8 Conn. — h a g2 g1 — h k. g3
8D2	M	EF37	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
9D2	M	VP13C	M	Raise Vg2 to 200 V. Earth Pin 1.
11A2	M	TDD4	M	Raise Rk to 1,500 ohms. Earth Pin 2.
11D3	M	TDD13C	M	Earth Pin 2. Rk may require adjustment.
15A2	M	FC4	M	Decrease Vg2 to 90 V. Receiver may require re-aligning.
15D1	M	FC13C	M	Decrease Vg2 to 90 V. Receiver may require re-aligning.
36	UX	EF37	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
42/42E	UX	EL33	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a g2 g1 — h k Alter Rk to 150 ohms.
77/77E	UX	EF37	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
78/78E	UX	EF39	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1 In AC/DC receivers shunt heater with 62 ohm 1 W resistor.
2101	UX	KL35	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — f+ a g2 g1 — f–, g3 —
2102	UX	KBC32	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f+ a ad′ ad″ — f– — g1

For Additional Types see American Substitutions List (pp. 172-174)

HIVAC — MULLARD

Hivac Type	Base	Mullard Type	Base	Conversion
VP215	M	VP2	M	Raise Vg2 to Va.
DDT215	O	TDD2A	O	Vg1 may require adjustment.
P215	A	PM2A	A	Reduce Vg1 to –6 V.
QP240	M	QP22B	M	Reduce Vg1 to –10 V.
Y220	O	PM22A	O	Bias may require adjustment.
AC/SH	O	SP4	O	Rk may require adjustment.
AC/VH	O	VP4	O	Rk may require adjustment.
AC/ZDD	M	Pen4DD	M	Interchange connections to Pins 2 and 6.
VP13	M	VP13C	M	Interchange connections of Pin 2 and Top Cap. Increase Vg2 to 200 V. Shunt heater with 130 ohm 2 W resistor.
DDT13	M	TDD13C	M	Rk may require adjustment. Shunt heater with 130 ohm 2 W resistor.
HL13	M	HL13C	M	Shunt heater with 130 ohm 2 W resistor.

MARCONI/OSRAM — MULLARD

Marconi/ Osram Type	Base	Mullard Type	Base	Conversion
DL63	K	EBC33	K	In AC/DC receiver shunt heater with 62 ohm 1 W resistor. Earth Pin 1.
DN41	M	Pen4DD	M	Re-wire base. Pin: 1 2 3 4 5 6 7 TC PEN4DD: ad′ g3 g2 h h ad″ a g1 DN41: ad′ g3 ad″ h h a g2 g1
KTW63	K	EF39	K	In AC/DC receiver shunt heater with 62 ohm 1 W resistor. Earth Pin 1.
X65	K	ECH35	K	Earth Pin 1. Receiver may require re-aligning.
Y61, Y62, Y63	K	EM34	K	Supply a″ (Pin 6) from H.T.+ through 1 M.ohm resistor. Interchange connections to Pins 4 and 5. In AC/DC receiver shunt heater with 62 ohm 1 W resistor.
KTZ63	K	EF37	K	In AC/DC receiver shunt heater with 62 ohm 1 W resistor. Join Pins 5 and 8. Rk may require adjustment.
W21	M	VP2	M	Join together Pins 3 and 4.
KT24	O	PM22A	O	Bias may require adjustment.

NOTE: The data provided assume that the valve to be substituted was being operated under the manufacturer's recommended conditions.

MAZDA — MULLARD

Mazda Type	Base	Mullard Type	Base	Conversion
AC2/PENDD	M	PEN4DD	M	Re-wire base. Pin: 1 2 3 4 5 6 7 TC Pen4DD: ad′ k,g3 ad″ h h a g2 g1 AC2/PENDD: ad′ a ad″ h h k g2 g1
DD620	O	EB34	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. M h ad″ k″ ad′ — h k′
HL133DD	MO	TDD13C	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. ad′ M ad″ h h k a g1
HL22	MO	PM2HL	A	Change base. Pin No. 1 2 3 4 Conn. a g f f
HL41	MO	354V	O	Change base. Pin No. 1 2 3 4 5 Conn. a g h hk, M
HL23DD	MO	KBC32	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f a ad′ ad″ — f — g1
HL41DD	MO	TDD4	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. ad′ M ad″ h h k a g1
PENDD4020	M	PEN40DD	M	Re-wire base. Pin: 1 2 3 4 5 6 7 TC PEN40DD: ad′ Mk ad″ h h a g2 g1 PENDD4020: ad′ a ad″ h h k,g3 g2 g1
PEN24	MO	KL35	K	Change base. Raise Vg1 to –4·5 V. Pin No. 1 2 3 4 5 6 7 8 Conn. — a g2 g1 — f,g3 —
PEN25	MO	KL35	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — f a g2 g1 — f,g3 —
QP240	9-pin	KLL32	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. — f a″ g1″ g1′ a′ f g2′, g2″
SP22	MO	SP2	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. M g1 g3 f f — g2 a
TH2320	M	CCH35	K	Change base. Check Ih=0·2 A. Receiver may require re-aligning. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h ah g2,g4 gt, g3 at h k g1
TP25	MO	KCF30	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f+ ap g2 gt at f– — g1

B NEAR EQUIVALENTS

MAZDA — MULLARD *(continued)*

Mazda Type	Base	Mullard Type	Base	Conversion
TH41	MO	TH4B	M	Change base. Receiver may require re-aligning. Pin No. 1 2 3 4 5 6 7 TC Conn. at gt, g3 g2,g4 h h k,g5 ah g1
TH233	MO	TH30C	M	Change base. Receiver may require re-aligning. Pin No. 1 2 3 4 5 6 7 TC Conn. at gt,g3 g2,g4 h h k,g5 ah g1
UU6	MO	IW4/350	A	Change base. Pin No. 1 2 3 4 Conn. a′ a″ h,k h
U403	MO	CY31	K	Change base. Check Ih=0·2 A. Pin No. 1 2 3 4 5 6 7 8 Conn. — h — — a — h k
VP1321	M	VP13C	M	Re-wire base. 1 2 3 4 5 6 7 TC VP13C M a g3 h h k g2 g1 VP1321 M g1 g3 h h k g2 a
VP22	MO	KF35	K	Change base. Increase Vg2 to 120 V. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f a g2 g3 — f — g1
VP41	MO	VP4B	M	Change base. Alter RK to 160 ohm. Pin No. 1 2 3 4 5 6 7 TC Conn. M a g3 h h k g2 g1
VP133	MO	VP13C	M	Change base. Pin No. 1 2 3 4 5 6 7 TC Conn. M a g3 h h k g2 g1

MO indicates Mazda Octal Base.

FERRANTI — MULLARD

Ferranti Type	Base	Mullard Type	Base	Conversion
PT4D	M	PEN4DD	M	Re-wire base 1 2 3 4 5 6 7 TC Pen4DD ad′ a ad″ h h k g2 g1 PT4D ad′ k ad″ h h a g2 g1
VHTA	M	FC13C	M	Oscillator anode voltage must not exceed 90 V.

SUBSTITUTIONS FOR OBSOLETE TYPE VALVES

The information in this section will be of some assistance in maintaining receivers for which direct replacement valves are no longer available. There can, of course, be no assurance that such sets will operate as efficiently with the substitute types.

MULLARD VALVE TYPE EFM1—No supplies available

With circuit modifications this valve may be replaced by the Mullard Type EF9 in Mullard and Philips sets as detailed:

(1) Lead to contact 5 disconnected and insulated.

(2) Lead to contact 6 disconnected and extended, and fitted with top cap adaptor to reach the top cap of the EF9.

(3) Join together contacts 4 and 5.

(4) Reduce the anode load resistor from approximately 130,000 ohms to 50,000 ohms. It may be necessary to continue the screening on the lead formerly to contact 6 as far as the top cap, though in many cases this will not be necessary. Should the top cap of the EF9 touch the tuning scale it may be necessary to bend the platform for the EFM1 slightly so as to give a small clearance. Under these conditions the set should operate as before but without the tuning indicator.

SUBSTITUTION OF TDD2A FOR THE 2D2

Change connections as below:

Connections for 2D2 Pin Number		Connections for TDD2A Pin Number
1	Disconnect and take wire to	5
2	As at present	2
3	As at present	3
4	As at present	4
5	Disconnect and insulate end of lead	—

Also connect the earth end of the speech diode load to LT+, care being taken not to short out the grid bias supply.

Under these conditions the receiver should operate as before, but with a reduction of volume due to the removal of the A.V.C. delay voltage.

SUBSTITUTION OF TDD4 FOR THE SD4

Change connections as below:

Connections for SD4 Pin Number		Connections for TDD4 Pin Number
1	Not used with SD4	1
2	Disconnect and take this lead to	Top Cap
3	Disconnect and insulate end of lead	
4, 5, 6	These connections remain as they are at present	4, 5, 6
7	Disconnect and take lead to	3
Top Cap	Disconnect and take lead to	7

Join together pins 1 and 6.

In some cases the lead to the top cap may have to be screened.

SUBSTITUTION OF EB34 FOR THE EAB1

In Philips Receivers Types 753A and 895X, also Mullard MAS17, MAS109 and MAS112.

Circuit alterations:

1. Change valve holder to octal type.
2. Change connections as opposite.

Contacts on— EAB1 holder	EB34 holder
No. 1 to	1
2 to	2
3 to	7
4 to	4
5 to	3
7 Insulate end of lead.	
8 to	5
Join together pins 4 and 8.	

Under these conditions the set should operate as before, but without the A.V.C. delay characteristic.

SUBSTITUTIONS FOR OBSOLETE TYPE VALVES

Original Type	Base	Substitute Type	Base	Remarks
AC054	A	AC044	A	Redesign circuit (There is no valve which will directly replace these valves, and full working conditions of the AC044 should be studied before substitution is made.)
AC064	A	AC044	A	Redesign circuit
AC084	A	AC044	A	Redesign circuit
AC084N	A	AC044	A	Redesign circuit
AC104	A	AC044	A	Redesign circuit
AL60	M	PenB4	M	Re-wire base, change cathode resistance to 175 ohms. Pin No. 1 2 3 4 5 6 7 Conn. — g1 g2 h h k a
AZ2	P	FW4/500	A	Pin No. 1 2 3 4 Conn. a″ a′ f f
AZ3	P	IW4/350	A	No circuit change. Pin No. 1 2 3 4 Conn. a″ a′ f f
AZ32	K	FW4/500	A	Pin No. 1 2 3 4 Conn. a″ a′ f f
AZ33	K	IW4/350	A	No circuit change. Pin No. 1 2 3 4 Conn. a″ a′ h h, k
CL6	P	CL4	P	Change bias resistance to 170 ohms. Raise Vg2 to 200 V.
CY2	P	UR3C	M	No circuit change. Pin No. 1 2 3 4 5 6 7 Conn. — a′ k′ h h k″ a″
CY32	K	UR3C	M	No circuit change. Pin No. 1 2 3 4 5 6 7 Conn. — a′ k′ h h k″ a″
DAC1	P	DAC32	K	Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f a — a d — f — g1
DF1	P	DF33	K	No circuit change. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f+ a g2 — — f, g3 — g1
DK1	P	DK32	K	Pin No. 1 2 3 4 5 6 7 8 TC Conn. M f a g3 g5 g1 g2 f — g4
DL2	P	DL35	K	Pin No. 1 2 3 4 5 6 7 8 Conn. — f a g2 g1 — f —
DO25	A	DO30	A	Add series filament resistance of 1 ohm, 10 watts; no further change.
DT3 DT30	A	DW4/500	A	Add series filament resistance of approx. 1·7 ohm, 10 watts; no further change.
DW3	A	DW4/350	A	No change.
DW4	A	DW4/500 FW4/500	A	No change.

SUBSTITUTIONS FOR OBSOLETE TYPE VALVES

Original Type	Base	Substitute Type	Base	Remarks
EAB1	P	EB34	K	Redesign circuit. (See instructions at beginning of list.)
EB4	P	EB34	K	No circuit change. Pin No. 1 2 3 4 5 6 7 8 Conn. M, s h ad′ k′ ad″ — h k″
ECH2	P	ECH3	P	No change. ECH3 I_h=0·2A.
ECH33	K	CCH35	K	For AC/DC receivers—CCH35. For AC receivers—ECH35.
EF2	P	EF39	K	EF39 has longer grid base.
EF5	P	EF9	P	No change.
EF6	P	EF36	K	Change base. Pin No. 1 2 3 4 5 6 7 8 TC Conn. M h a g2 g3 — h k g1
EF8	P	EF39	K	Change base-holder and re-wire pins as follows: EF8— Pin No. 1 2 3 4 5 6 7 8 TC EF39—Pin No. 1 2 7 8 5 1 4 3 TC
EFM1	P	EF9	P	Redesign circuit without tuning indicator. (See instructions at beginning of list.)
EH2	P	ECH3	P	Use hexode section only in extreme cases.
EK3	P	EK2	P	Raise screen volts to 200 V. EK2, I_h=0·2A.
EL5	P	EL35	K	EL35 Vg2=250 V. max. Change bias resistance to 180 ohms. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a g2 g1 — h k,g3
EL6	P	EL35	K	EL35 Vg2=250 V. max. Change bias resistance to 180 ohms. Pin No. 1 2 3 4 5 6 7 8 Conn. — h a g2 g1 — h g3, K
EL36	K	EL35	K	EL35 Vg2=250 V. max. Change bias resistance to 180 ohms.
EZ1	P	EZ35	K	Pin No. 1 2 3 4 5 6 7 8 Conn. — h a″ — a′ — h k I_h=0.6A
IW3	A	IW4/350	A	No change.
IW4	A	IW4/500	A	No change.
MM4V	O	VP4	O	No change. Volume control will be less gradual in operation.
MW22/7	B8G	MW22/14C	B8G	No change.
MW31/7	B8G	MW31/14C	B8G	No change.
Pen4V	O	Pen4VA	O	Change grid bias to –22 volts. No change with automatic bias.
Pen4VB	M	PenA4	M	No change.
Pen26	P	CL4	P	Change bias resistance to 170 ohms. CL4, Vg=200 volts.
PM1A	A	PM2HL	A	No change.

SUBSTITUTIONS FOR OBSOLETE TYPE VALVES

Original Type	Base	Substitute Type	Base	Remarks
PM1HF	A	PM2HL	A	No change.
PM1HL	A	PM2HL	A	No change.
PM1LF	A	PM2HL	A	Change grid bias to –1·5 volts.
PM2	A	PM2A	A	Change grid bias to –6·0 volts.
PM2BA	M	PM2B	M	Remove bias supply from the valve.
PM2DL	A	PM2HL	A	No change.
PM2DX	A	PM2HL	A	No change.
PM12	A	PM12M	A	Raise Vg2 to 90 volts.
PM12A	A	PM12M	A	Raise Vg2 to 90 volts.
PM22	A/O	PM22A	A/O	Change grid bias to –4·5 volts at Va=Vg2=135 volts, and anode load to approx. 19,000 ohms.
PM22D	O	PM22A	O	Increase bias to –4·5 V.
PM24	A/O	PM24A	O	No circuit change. Pin No. 1 2 3 4 5 Conn. a g1 f f g2
PM24B	O	PM24M	O	Redesign circuit. PM24M Va=Vg2=250 volts max.
PM24C	O	PM24M	O	Redesign circuit. PM24M Va=Vg2=250 volts max.
PM252	A	PM2A	A	Anode load=7,000 ohms. Change bias to –6·0 volts.
SD4	M	TDD4	M	Redesign circuit. (See instructions at beginning of list.)
SP4C	P	SP4B	M	No circuit change. Pin No. 1 2 3 4 5 6 7 TC Conn. M a g3 h h k g2 g1
S4V	A/O	SP4	O	No circuit change. Pin No. 1 2 3 4 5 TC Conn. g2 g1 h h k a
S4VA	O	SP4	O	No change.
S4VB	O	SP4	O	No change.
TDD2	O	TDD2A	O	Change grid bias to –1·5 volts. Not suitable as Class B driver.
TDD13	P	TDD13C	M	No circuit change. Pin No. 1 2 3 4 5 6 7 TC Conn. ad′ M ad″ h h k a g1
TH4	M	TH4B	M	Change bias resistance to 140 ohms. Grid leak to be increased to 47,000 ohms between oscillator grid and cathode.
TH4A	M	TH4B	M	No change.

SUBSTITIONS FOR OBSOLETE TYPE VALVES

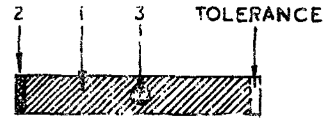
Original Type	Base	Substitute Type	Base	Remarks
TH22C	M	TH30C	M	No change.
TH62	K	CCH35 ECH35	K	For AC/DC receivers—CCH35. For AC receivers—ECH35. No change.
TV6	P	EM1	P	No change.
UAF41	B8A	UAF42	B8A	Connect pins 4 and 7 together.
UR1	P	CY1	P	No change.
UR2	P	UR3C	M	No circuit change. Pin No. 1 2 3 4 5 6 7 Conn. — a′ k′ h h k″ a″
UR3	P	UR3C	M	No circuit change. Pin No. 1 2 3 4 5 6 7 Conn. — a′ k′ h h k″ a″
UY31	K	UY21	B8G	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. h a — a — a k h
VM4V	O	VP4	O	No change. Volume control will not be so gradual in operation.
O54V	O	ACO44	A	Redesign circuit.
2D2	O	TDD2A	O	Redesign circuit. (See instructions at beginning of list.)
2D4	O	2D4A	O	No circuit change. Pin No. 1 2 3 4 5 Conn. ad″ ad′ h h k 2D4A has no top cap.
244V	O	354V	O	No change.
484V	O	354V	O	Change grid bias to –4·5 volts or bias resistance to 700 ohms.
IA7G	K	DK32	K	Earth pin 1.
IC5G	K	DL35	K	No change.
IH5G	K	DAC32	K	Earth pin 1.
IN5G	K	DF33	K	Earth pin l.
2D13	V	EB34	K	As for 2D13C.
2D13A	V	EB34	K	As for 2D13C.
2D13C	O	EB34	K	Change base. Pin No. 1 2 3 4 5 6 7 8 Conn. Ms h ad″ k″ ad′ — h k′ When re-wiring connect separate cathodes of EB34 together. EB34, Vh=6·3 V.
3Q5G	K	DL33	K	No change.
164V	O	TT4	O	In R-C stage increase Rk to 10,000 Ω and Ra to 82,000 Ω.

RESISTOR AND CAPACITOR COLOUR CODES A

RESISTOR COLOUR CODE

The British system of colour coding for fixed resistors is indicated by one or the other of two methods illustrated in Figs. A and B below.

(A)

(B)

In method A the colours are read from the end of tne resistor adjacent to the colour bands. In method B the sequence is : body colour, tip colour, and spot or band colour. The third colour always indicates the number of " noughts " following the first two numerals.

The colour code is as follows :

Black	0	Brown	1	Red	2	Orange	3	Yellow	4
Green	5	Blue	6	Violet	7	Grey	8	White	9

If a fourth band is added on resistors marked by method A, or an additional tip in method B, it indicates the tolerance according to the following code :

Gold $\pm$ 5% tolerance Silver $\pm$10% tolerance

If this fourth metallic indication is absent, the tolerance is assumed to be $\pm$20%.

EXAMPLES

(1)	RED–GREEN–ORANGE–SILVER	25,000 Ω$\pm$10%
(2)	YELLOW–VIOLET–BLACK–GOLD	47 Ω$\pm$ 5%
(3)	BLUE–GREY–BROWN	680 Ω$\pm$20%

CAPACITOR COLOUR CODE

Up to six colours are sometimes used to indicate the capacity in micro–micro-farads, the direct current voltage rating and the tolerance. The sequence of colours is shown by an arrow or some such device and the code is as follows :

First colour	First figure.
Second colour	Second figure.
Third colour	Third figure.
Fourth colour	Number of " noughts " following the first three figures.
Fifth colour	Direct current voltage test rating.
Sixth colour	Percentage tolerance, plus or minus.

	First Four Colours (Numerals and Noughts)	Fifth Colour (D.C. voltage test rating)	Sixth Colour (Tolerance %)
Black	0	0	0
Brown	1	100	1
Red	2	200	2
Orange	3	300	3
Yellow	4	400	4
Green	5	500	5
Blue	6	600	6
Violet	7	700	7
Grey	8	800	8
White	9	900	9
Gold	0.1 (fourth colour only)	1,000	5
Silver	0.01 (fourth colour only)	2,000	10
No colour	—	500	20

EXAMPLES

(1) ORANGE–GREEN–BLACK–BROWN–GREEN or NO COLOUR–SILVER=3,500 $\mu\mu$F, 500–volt D.C. test rating, 10% tolerance.

(2) YELLOW–VIOLET–BLACK–BLACK–GOLD–RED=470 $\mu\mu$F, 1,000–volt D.C. test rating, 2% tolerance.

STANDARD RESISTOR VALUES

The standardisation of fixed resistor values has been introduced to obviate, as far as possible, the use of a large number of intermediate values. Tolerance ranges of 5%, 10%, 20% and 33⅓% are included, identification being by means of gold, silver, no colour and white (where distinguishable) rings or dots respectively. In modern radio receiver practice, however, it is usual to adhere to either the 10% or the 20% tolerance range, the former being used only where essential.

20% TOLERANCE RANGE

In the following table the standard resistor values in ohms are shown in heavy type in the left-hand column whilst the resistor range these are intended to cover is given in the right-hand column.

10	10– 12	**1,000**	800– 1,200	**100,000**	80,000–120,000
15	12– 18	**1,500**	1,200– 1,800	**150,000**	120,000–180,000
22	18– 26	**2,200**	1,760– 2,640	**220,000**	176,000–264,000
33	27– 39	**3,300**	2,640– 3,960	**330,000**	264,000–396,000
47	38– 56	**4,700**	3,760– 5,640	**470,000**	376,000–564,000
68	55– 81	**6,800**	5,440– 8,160	**680,000**	544,000–816,000
100	80–120	**10,000**	8,000–12,000	**1.0 Meg**	0.8 Meg– 1.2 Meg
150	120–180	**15,000**	12,000–18,000	**1.5 Meg**	1.2 Meg– 1.8 Meg
220	178–264	**22,000**	17,600–26,400	**2.2 Meg**	1.76 Meg– 2.64 Meg
330	264–396	**33,000**	26,400–39,600	**3.3 Meg**	2.64 Meg– 3.96 Meg
470	376–564	**47,000**	37,600–56,400	**4.7 Meg**	3.76 Meg– 5.64 Meg
680	544–820	**68,000**	54,400–81,600	**6.8 Meg**	5.44 Meg– 8.16 Meg
				10.0 Meg	8.0 Meg–10.0 Meg

10% TOLERANCE RANGE

The following table lists the standard resistor values in ohms, comprising the 10% Tolerance Range. Each resistor covers values within ±10% of its nominal value.

10	100	1,000	10,000	100,000	1.0 Meg
12	120	1,200	12,000	120,000	1.2 Meg
15	150	1,500	15,000	150,000	1.5 Meg
18	180	1,800	18,000	180,000	1.8 Meg
22	220	2,200	22,000	220,000	2.2 Meg
27	270	2,700	27,000	270,000	2.7 Meg
33	330	3,300	33,000	330,000	3.3 Meg
39	390	3,900	39,000	390,000	3.9 Meg
47	470	4,700	47,000	470,000	4.7 Meg
56	560	5,600	56,000	560,000	5.6 Meg
68	680	6,800	68,000	680,000	6.8 Meg
82	820	8,200	82,000	820,000	8.2 Meg

The tables on this page are reprinted from "Radio Designer's Handbook", F. Langton Smith, published in England by Iliffe & Sons, Ltd.

INDUCTIVE AND CAPACITATIVE REACTANCES

REACTANCE IN OHMS AT AUDIO FREQUENCIES

Inductance (henries)	30 c/s	50 c/s	100 c/s	400 c/s	1000 c/s	5000 c/s
250	47,100	78,500	157,000	628,000	1,570,000	7,850,000
100	18,800	31,400	62,800	251,000	628,000	3,140,000
50	9,420	15,700	31,400	126,000	314,000	1,570,000
25	4,710	7,850	15,700	62,800	157,000	785,000
10	1,880	3,140	6,280	25,100	62,800	314,000
5	942	1,570	3,140	12,600	31,400	157,000
1	188	314	628	2,510	6,280	31,400
.1	18.8	31.4	62.8	251	628	3,140
.01	1.88	3.14	6.28	25.1	62.8	314
1000 uH	0.188	0.314	0.628	2.51	6.28	31.4
200 uH	0.0376	0.0628	0.126	0.502	1.26	6.28
100 uH	0.0188	0.0314	0.0628	0.251	0.628	3.14

REACTANCE IN OHMS AT RADIO FREQUENCIES

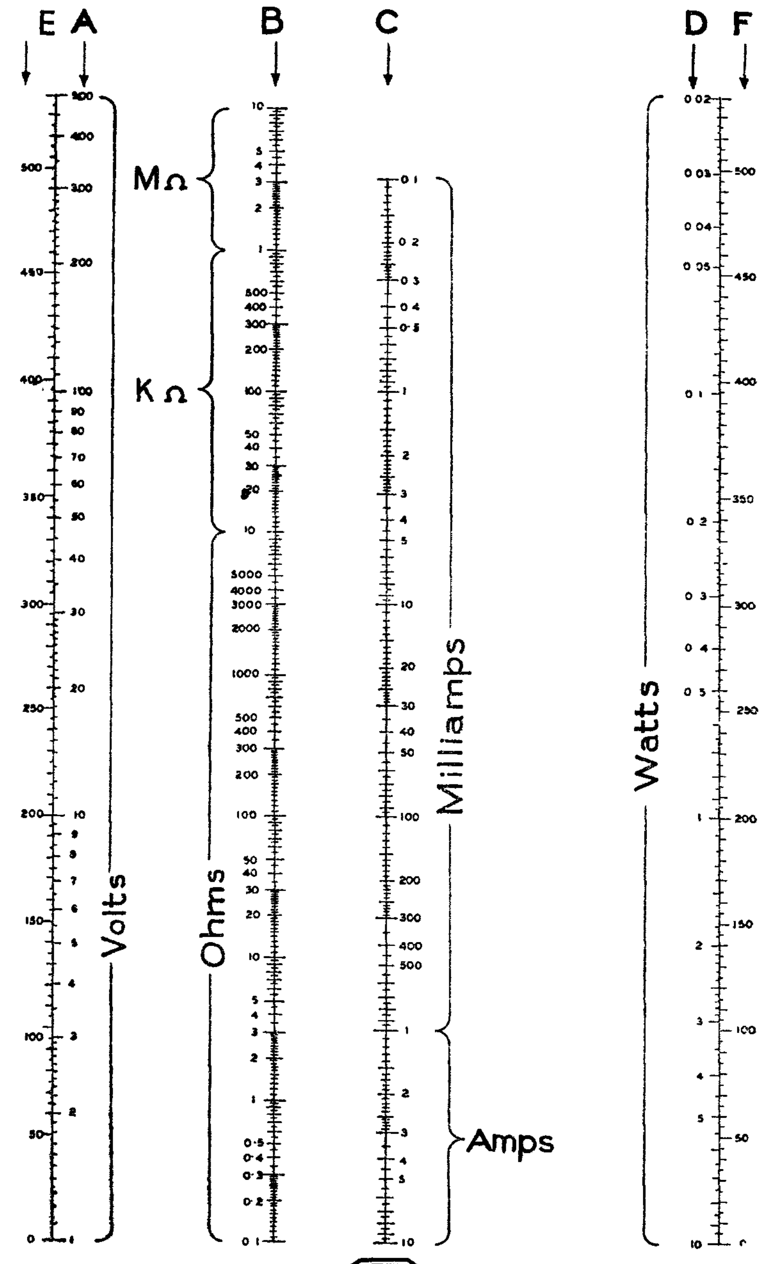
Inductance (henries)	175 Kc/s	252 Kc/s	465 Kc/s	550 Kc/s	1000 Kc/s	1500 Kc/s
1	1,100,000	1,580,000	2,920,000	3,460,000	6,280,000	9,430,000
.1	110,000	158,000	292,000	346,000	628,000	943,000
.01	11,000	15,800	29,200	34,600	62,800	94,300
1000 uH	1,100	1,580	2,920	3,460	6,280	9.430
200 uH	220	317	484	691	1,260	1,890
100 uH	110	158	292	346	628	943

REACTANCE IN OHMS AT AUDIO FREQUENCIES

Capacitance Microfarads	30 c/s	50 c/s	100 c/s	400 c/s	1000 c/s	5000 c/s
.00005	—	—	—	—	—	637,000
.0001	—	—	—	—	1,590,000	318,000
.00025	—	—	—	1,590,000	637,000	127,000
.0005	—	—	3,180,000	796,000	318,000	63,700
.001	—	3,180,000	1,590,000	398,000	159,000	31,800
.005	1,060,000	637,000	318,000	79,600	31,800	6,370
.01	531,000	318,000	159,000	39,800	15,900	3,180
.02	263,000	159,000	79,600	19,900	7,960	1,590
.05	106,000	63,700	31,800	7,960	3,180	637
.1	53,100	31,800	15,900	3,980	1,590	318
.25	21,200	12,700	6,370	1,590	637	127
.5	10,600	6,370	3,180	796	318	63.7
1	5,310	3,180	1,590	389	159	31.8
2	2,650	1,590	796	199	79.6	15.9
4	1,310	796	398	99.5	39.8	7.96
8	663	398	199	49.7	19.9	3.98
16	332	199	99.5	24.9	9.95	1.99
25	212	127	63.7	15.9	6.37	1.27
35	152	91	45.5	11.4	4.55	0.91

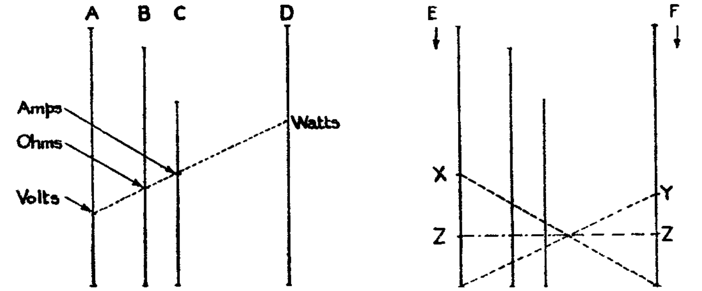
REACTANCE IN OHMS AT RADIO FREQUENCIES

Capacitance Microfarads	175 Kc/s	252 Kc/s	465 Kc/s	550 Kc/s	1000 Kc/s	1500 Kc/s
.00005	18,200	12,600	6,850	5,800	3,180	2,120
.0001	9,100	6,320	3,420	2,900	1,590	1,060
.00025	3,640	2,530	1,370	1,160	637	424
.0005	1,820	1,260	685	579	318	212
.001	910	632	342	290	159	106
.005	182	126	68.5	57.9	31.8	21.2
.01	91	63.2	34.2	28.9	15.9	10.6
.02	45.5	31.6	17.1	14.5	7.96	2.31
.05	18.2	12.6	6.85	4.79	3.18	2.12
.1	9.1	6.32	3.42	2.89	1.59	1.06
.25	3.64	2.53	1.37	1.16	0.637	0.424
.5	1.82	1.26	0.685	0.579	0.318	0.212
1	0.91	0.632	0.342	0.289	0.159	0.106
2	0.455	0.316	0.171	0.145	0.0796	0.0531
4	0.227	0.158	0.0856	0.0723	0.0398	0.0265



OHM'S LAW

If any two of the quantities (volts, amperes, ohms or watts) are known, the remaining two can be found by placing a straight edge across the scales A, B, C, D, so that it coincides with the values of the two known quantities.



RESISTORS IN PARALLEL

To find the resultant resistance of two or more resistors in parallel use scales E and F.
Select a point on scale E corresponding to the ohmic value of one resistor (X) and join X to the bottom of scale F. Select a point on scale F corresponding to the ohmic value of the second resistor (Y) and join Y to the bottom of scale E. The intersection of these two lines projected on either scale E or scale F (Z) gives the resultant resistance to the same units.

EXAMPLE 1

To find the resultant resistance of 17,000 ohms and 9,000 ohms in parallel, X may be selected as 170 and Y as 90. Point Z will be found to be 59, and the resultant resistance is thus 5,900 ohms.

If the resultant resistance of more than two resistors in parallel is required, the resultant resistance of the first two should be found as described above, and the answer combined with the third resistor in the same way and so on.

EXAMPLE 2

To find the resultant resistance of 17,000, 9,000 and 3,000 ohms in parallel. The resultant resistance of 17,000 ohms and 9,000 ohms is 5,900 ohms (see Example 1). This figure now becomes the new point X (59) on Scale E and 3,000 ohms is represented by a new point Y (30) on Scale F.
Proceeding as in Example 1, the final resultant will be found to be 19.9 on Scale E or F, i.e. 1,990 ohms.

The above operations can, of course, be performed in reverse to determine what combination of standard resistors can be used in parallel to obtain any desired resultant resistance.

CAPACITORS IN SERIES

Exactly the same procedure can be employed for determining the resultant capacitance of two or more capacitors in series.

DECIBEL CONVERSION CHART

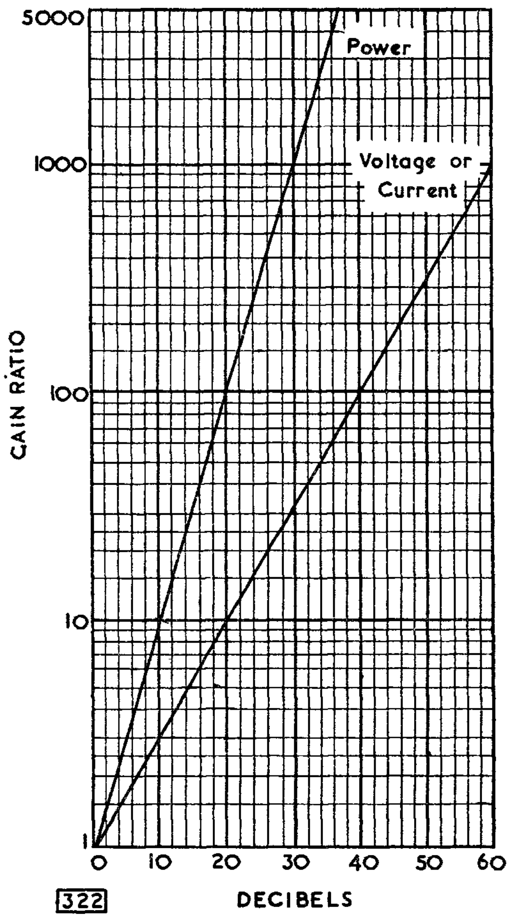
The relation between Voltage, Current or Power Ratios and Decibels is:—

Voltage $20 \log \frac{V_1}{V_2} =$ decibels

Current $20 \log \frac{I_1}{I_2} =$ decibels.

Power $10 \log \frac{P_1}{P_2} =$ decibels.

The chart reproduced below enables gain ratios to be converted to decibels direct. The conversion of voltage or current ratios, however, is correct only when the two powers compared are dissipated in equal impedances.



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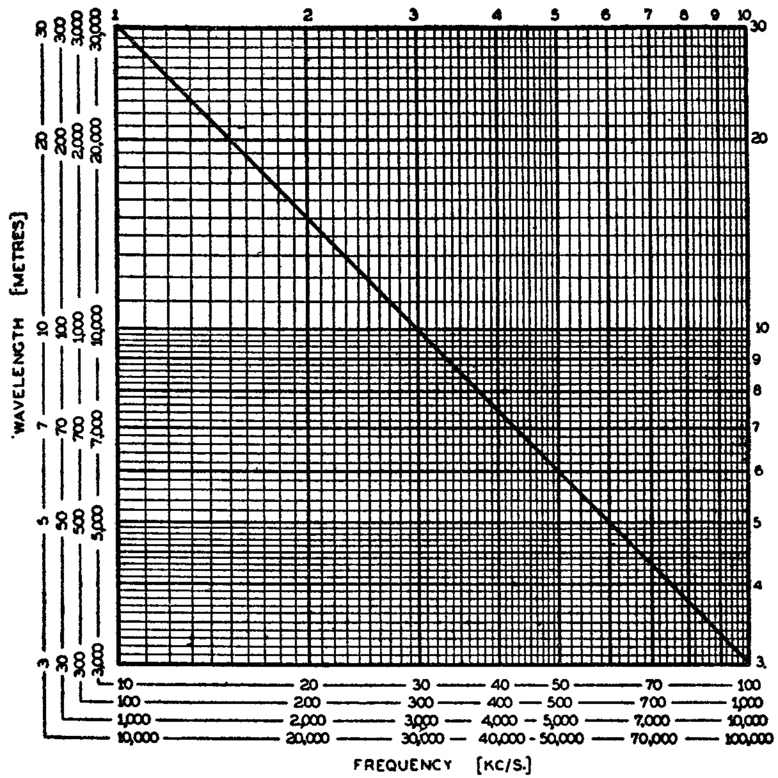
WAVELENGTH/ FREQUENCY CHART

Wavelength-Frequency Conversion Chart



Wavelength-Frequency Conversion Table

Convenient Points Selected for Rapid Reference.

Broadcast Band				Short Waves			
Frequency Kc/s.	Wave-length Metres	Frequency Kc/s.	Wave-length Metres	Frequency Mc/s.	Wave-length Metres	Frequency Mc/s.	Wave-length Metres
550	545	1050	286	1.5	200	11	27.3
600	500	1100	273	2	150	12	25.0
650	461	1150	261	3	100	13	23.1
700	429	1200	250	4	75.0	14	21.4
750	400	1250	240	5	60.0	15	20.0
800	375	1300	231	6	50.0	16	18.8
850	353	1350	222	7	42.9	17	17.6
900	333	1400	214	8	37.5	18	16.7
950	316	1450	207	9	33.3	19	15.8
1000	300	1500	200	10	30.0	20	15.0

ABAC - OUTPUT TRANSFORMER RATIOS

Reproduced from "Radio Data Charts" (Beatty and Sowerby) by permission of the publishers, Iliffe and Sons, Ltd.

A problem that is continually arising is the turns ratio between primary and secondary of an ouput transformer properly to match a given load to a given output stage. This is a fairly simple calculation when there is only one secondary winding, but becomes tedious when several ratios have to be calculated.

The fundamental formula on which the chart is based is :

$$\text{Turns Ratio} = \sqrt{\frac{R_p \times W_p}{R_s \times W_s}}$$

Where R_p = Primary load ; i.e. load on output stage in ohms.
R_s = Secondary load ; i.e. speech coil impedance.
W_p = Primary power ; i.e. power delivered by output stage.
W_s = Secondary power ; i.e. power supplied to load (speaker).

Of course, if there is only one secondary winding all the power is delivered to it and W_p/W_s becomes 1. If there are several secondaries, obviously the total power delivered to them must be equal to the total power available from the output stage.

Now turn to the chart. In reality there are two abacs here superimposed upon one another, and they are used as shown by the two keys. It is essential to follow the key appropriate to the problem carefully. Key I is used when it is required to find the ratio for one secondary, or for several provided they are used one at a time. Key II is used when it is desired to use several secondaries simultaneously and to deliver different powers to different loads. The proportion of the total power delivered to any load may be chosen by the reader and the corresponding turns ratio calculated. This is often convenient when it is desired to run several speakers simultaneously from one transformer, the speakers having differing power handling capabilities.

Scales in frames are used when the secondary load is high, and the resulting turns ratio found when using these scales must be divided by ten. This, if not already clear, will become so from consideration of the examples given below.

EXAMPLE 1

An amplifier has an output of 4 watts in 6,500 ohms. It is required to match this output stage to 500 ohms, and an 8 ohm speaker alternatively. What are the required turns ratios?

Following Key I, join 6,500 on the first scale to 500 on the fourth. The ruler cuts the turns ratio scale at 36.1, but since the framed scale was used the turns ratio is 3.61. Similarly, join 6,500 to 8 ohms on the fourth scale. The ruler cuts the turns ratio scale at 28.5. Thus the two ratios are 3.61 and 28.5 and they must not be used simultaneously, but *alternatively*.

EXAMPLE 2

Now suppose with the same amplifier it is desired to deliver 1 watt into the 500 ohms load, and the remaining 3 watts into the 8 ohms speaker. What are the turns ratios?

Following Key II, join 6,500 to 500 on the third scale and note the point of intersection on the reference line. Join this point to 4 watts on the primary power scale and a second point of intersection is found on the primary load scale. Join this point to 1 watt on the fourth scale (secondary power) and the ruler cuts the turns ratio scale at 72.1. Since the framed scale was used the ratio is 7.21. A similar operation for the 8 ohms speaker gives a turns ratio of 32.9. Hence the two ratios are 7.21 and 32.9, and for the output stage to be properly matched the loads must be connected *simultaneously* (from the point of view of the output stage they are in parallel).

Obviously these procedures may be extended indefinitely and provision may be made for speakers of all sorts of impedances by means of a tapped secondary using Key I. As many speakers as desired may be used (each with its own secondary) to provide the correct matching load by continual repetition of the operation shown by Key II.

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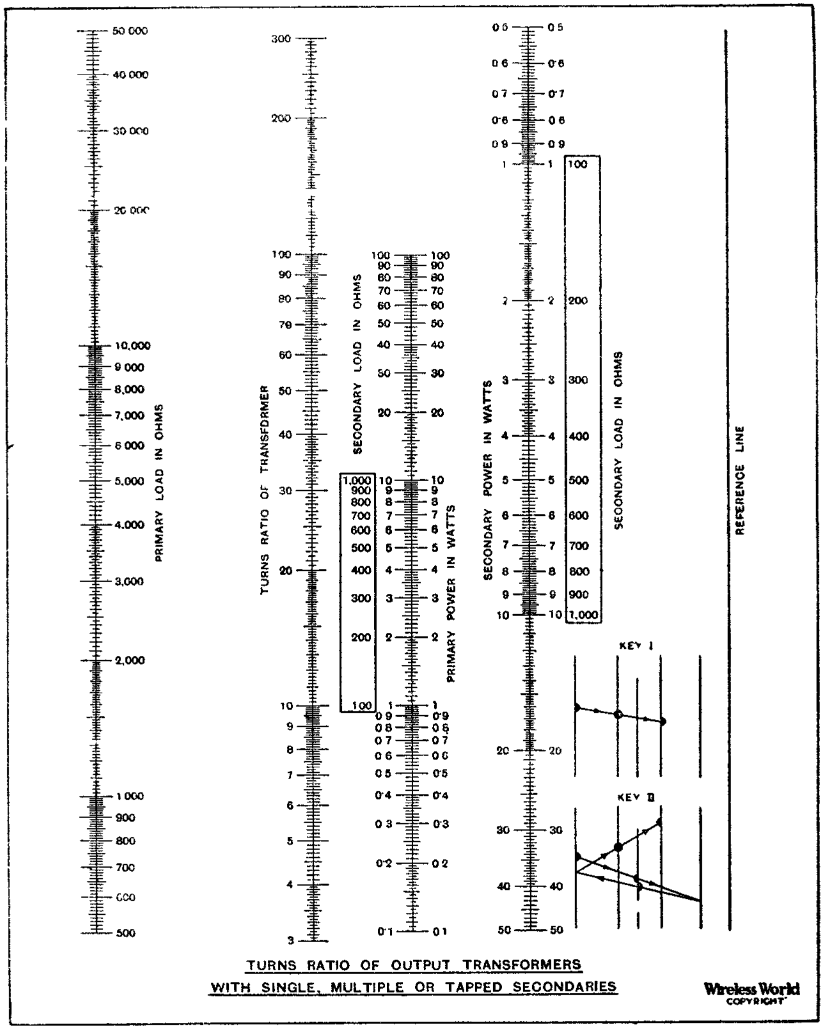
ABAC - OUTPUT TRANSFORMER RATIOS



It should be noted that if a number of loads are connected simultaneously and then one is removed, the matching will be upset. If it is required to silence one speaker, a resistance equal to the speech coil impedance should be switched in its place—and the correct matching will be preserved.

MULTIPLES AND SUB-MULTIPLES

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Multiply Reading in	By	To obtain Reading in
Amperes	×1,000,000,000,000	micromicroamperes
Amperes	×1,000,000	microamperes
Amperes	×1,000	milliamperes
Cycles	×.000,001	megacycles
Cycles	×.001	kilocycles
Farads	×1,000,000,000,000	micromicrofarads
Farads	×1,000,000	microfarads
Farads	×1,000	millifarads
Henrys	×1,000,000	microhenrys
Henrys	×1,000	millihenrys
Kilocycles	×1,000	cycles
Kilowatts	×1,000	watts
Megacycles	×1,000,000	cycles
Mhos	×1,000,000	micromhos
Mhos	×1,000	millimhos
Microamperes	×.000,001	amperes
Microfarads	×.000,001	farads
Microhenrys	×.000,001	henrys
Micromhos	×.000,001	mhos
Microvolts	×.000,001	volts
Micromicrofarads	×.000,000,000,001	farads
Milliamperes	×.001	amperes
Millihenrys	×.001	henrys
Millimhos	×.001	mhos
Millivolts	×.001	volts
Milliwatts	×.001	watts
Volts	×1,000,000	microvolts
Volts	×1,000	millivolts
Watts	×1,000	milliwatts

USEFUL FORMULAE

OHM'S LAW

$$I = \frac{E}{R}$$

where I = current in amperes,
E = voltage in volts, and
R = resistance in ohms

A convenient method of memorising Ohm's Law is by setting it out thus:

$$\frac{\text{Volts}}{\text{Amps} \times \text{Ohms}}$$

when, in order to find the unknown value, the latter should be covered and the remaining calculation performed.

RESISTORS IN PARALLEL

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \frac{1}{R_n}}$$

CAPACITORS IN SERIES

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \frac{1}{C_n}}$$

REACTANCE OF COIL

$$X_L = 2\pi fL$$

where $\pi = 3.14$
f = frequency in cycles per second
L = inductance in henrys

REACTANCE OF A CAPACITOR

$$X_C = \frac{10^6}{2\pi fC}$$

where C is the capacitance in microfarads

RESONANT FREQUENCY OF TUNED CIRCUIT

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where f = frequency in cycles per second
$\pi = 3.14$
L = inductance in henrys
C = capacitance in farads

In making radio frequency calculations it is more convenient to reduce L and C to smaller units so that f may be expressed in megacycles. The three equations then become:

$$f^2 = \frac{25{,}330}{LC} \text{ or } L = \frac{25{,}330}{f^2C} \text{ or } C = \frac{25{,}330}{f^2L}$$

where f = frequency in megacycles
L = inductance in microhenrys, and
C = capacity in micro-micro-farads

1 USEFUL FORMULAE

TIME CONSTANT OF RESISTANCE AND CAPACITANCE IN SERIES

$$T = R \times C$$

where T is the time constant in seconds, R in ohms and C in farads

STAGE GAIN—VALVE AMPLIFIER

$$M = \frac{\mu R_a}{r_a + R_a}$$

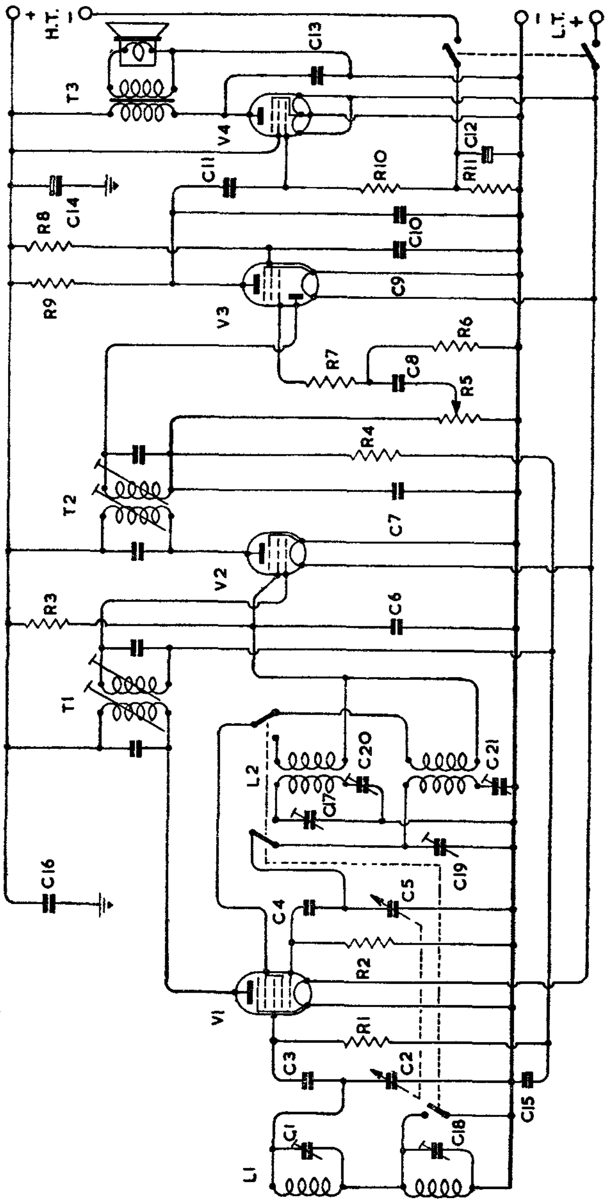
where μ = amplification factor of valve
r_a = impedance of valve
R_a = anode load resistor in ohms

OUTPUT TRANSFORMER RATIO

$$N = \sqrt{\frac{R_a}{Z}}$$

where N = turns ratio
R_a = optimum load resistance of valve
Z = impedance of loudspeaker

CIRCUITS



4-VALVE MINIATURE BATTERY-OPERATED RECEIVER

4-VALVE MINIATURE BATTERY-OPERATED RECEIVER

Provision is made for long and medium wave reception by the use of switched coils. In order to obtain a balanced remote cut-off characteristic for the frequency changer and the I.F. amplifier, the screen grids of both valves are fed from a common voltage-dropping resistor. This mode of operation reduces modulation distortion.

L1 may conveniently consist of a frame aerial.

RESISTORS

R1	1.0	MΩ	¼W
R2	100	KΩ	¼W
R3	27	KΩ	½W
R4	2.2	MΩ	¼W
R5	1.0	MΩ	potentiometer
R6	6.8	MΩ	¼W
R7	22	KΩ	¼W
R8	2.2	MΩ	½W
R9	470	KΩ	½W
R10	1.0	MΩ	¼W
R11	1,000	Ω	½W

VALVES

V1	DK91
V2	DF91
V3	DAF91
V4	DL92

CAPACITORS

*C1, C18	Aerial trimmers			
*C2	Aerial tuning		0.0005	μF
C3	0.0001	μF	—	
C4	0.0001	μF	—	
*C5	Oscillator tuning		0.0005	μF
C6	0.1	μF	200	V
C7	0.0001	μF	—	
C8	0.005	μF	—	
C9	0.1	μF	200	V
C10	0.0001	μF	—	
C11	0.01	μF	—	
†C12	25	μF	12	V
C13	0.005	μF	150	V
†C14	2.0	μF	150	V
C15	0.1	μF	—	
C16	0.1	μF	—	
*C17, C19	Oscillator Trimmers			
*C20, C21	Oscillator padders			

*Variable
†Electrolytic

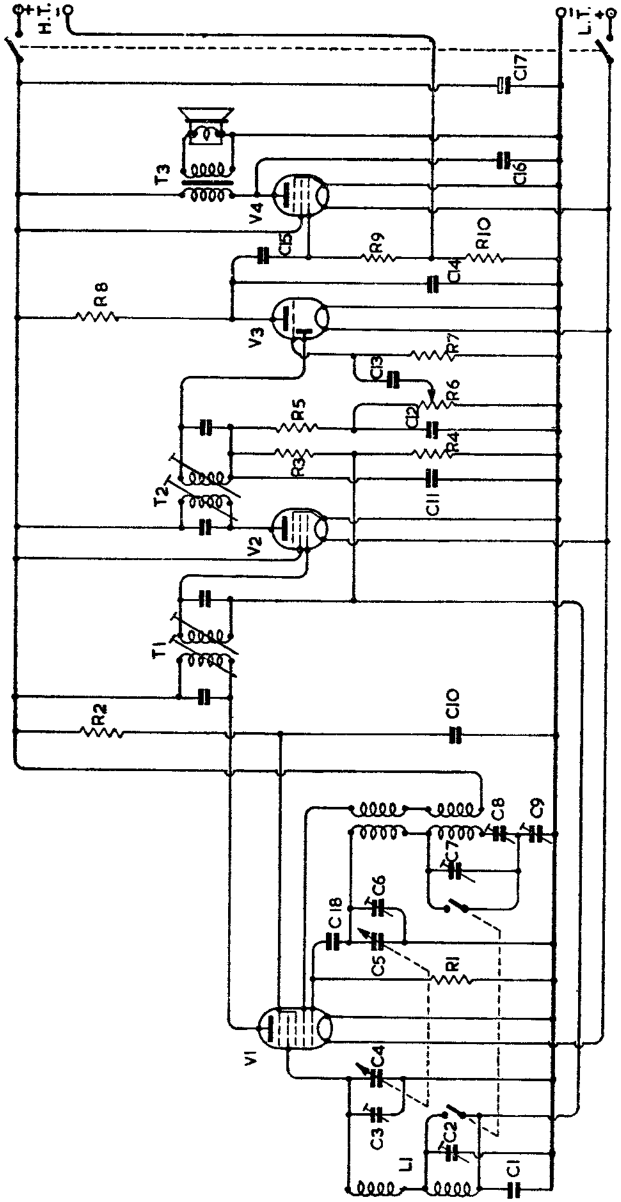
TRANSFORMERS

T1, T2 465 Kc/s Intermediate frequency transformers.
T3 Output transformer. Ratio—44 : 1 for speech coil impedance of 2–3 ohms.

OPERATING VOLTAGES

HT voltage 69 V LT voltage 1.5 V

4-VALVE BATTERY-OPERATED PORTABLE RECEIVER



1.4-VOLT BATTERY-OPERATED PORTABLE RECEIVER

Provision is made for long and medium wave reception by the use of switched coils. L consists of a frame aerial, tapped for medium wave reception. Fixed tone correction is effected by C16 which serves to by-pass the higher audio harmonics.

RESISTORS

R1	220	KΩ	¼W
R2	68	KΩ	¼W
R3	10	MΩ	¼W
R4	4.7	MΩ	¼W
R5	100	KΩ	¼W
R6	0.5	MΩ potentiometer	
R7	10	MΩ	¼W
R8	1.0	MΩ	¼W
R9	1.0	MΩ	¼W
R10	820	Ω	¼W

VALVES

V1	DK32
V2	DF33
V3	DAC32
V4	DL35

CAPACITORS

C1		0.05 μF	
*C2	Aerial circuit trimmer		
*C3	Aerial circuit trimmer		
*C4	Frame aerial tuning	0.00045 μF	
*C5	Oscillator tuning	0.00045 μF	
*C6	Oscillator trimmer		
*C7	Oscillator trimmer		
*C8	Oscillator padder		
*C9	Oscillator padder		
C10	0.01 μF		150 V
C11	0.00005 μF		
C12	0.00005 μF		
C13	0.001 μF		
C14	0.0001 μF		
C15	0.01 μF		150 V
C16	0.001 μF		150 V
†C17	8.0 μF		150 V
C18	0.0001 μF		

*Variable
†Electrolytic

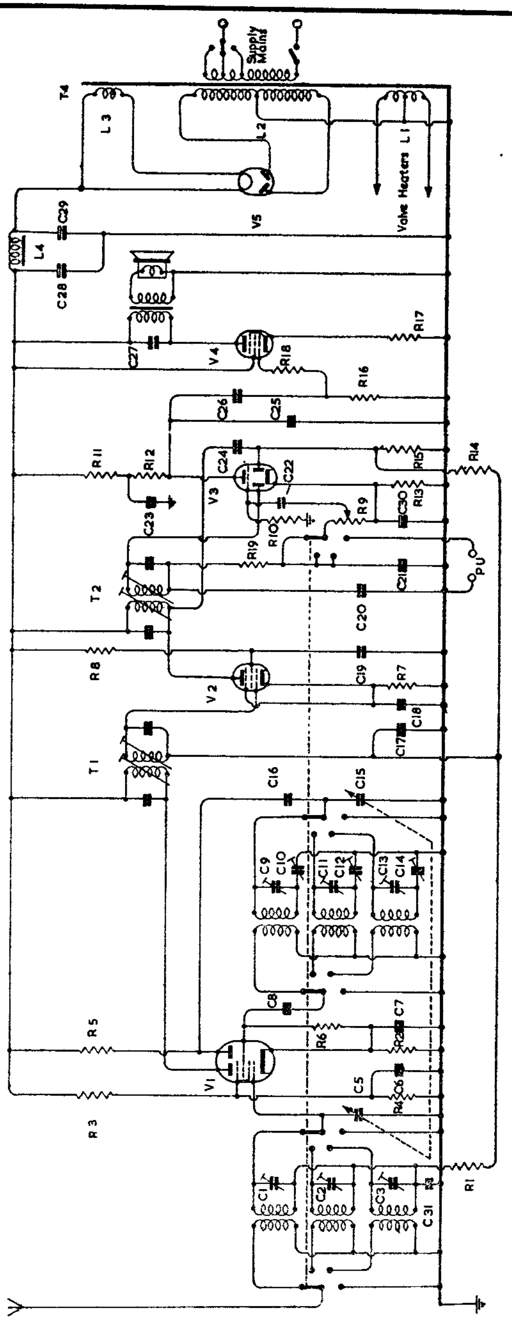
TRANSFORMERS

T1, T2 465 Kc/s Intermediate frequency transformers.

T3 Output transformer. Ratio 55 : 1 for speech coil impedance of 2–3 ohms (anode load=8,000 ohms).

OPERATING VOLTAGES

HT voltage 90 V LT voltage 1.5 V



4+1-VALVE A.C. MAINS-OPERATED SUPERHETERODYNE RECEIVER

4+1-VALVE A.C. MAINS-OPERATED SUPERHETERODYNE RECEIVER

Provision is made for long, medium and short wave reception and gramophone reproduction by means of a five-bank, four-way rotary switch, the un-by-passed cathode resistor R17 provides a degree of negative feedback.

RESISTORS

R1	1.2	MΩ	¼W
R2	150	Ω	¼W
R3	33	KΩ	½W
R4	47	KΩ	½W
R5	10	KΩ	¼W
R6	47	KΩ	¼W
R7	150	Ω	¼W
R8	47	KΩ	¼W
R9	0.5	MΩ	potentiometer
R10	470	KΩ	¼W
R11	22	KΩ	¼W
R12	150	KΩ	¼W
R13	3,300	Ω	¼W
R14	1.2	MΩ	¼W
R15	1.2	MΩ	¼W
R16	470	KΩ	¼W
R17	180	Ω	½W
R18	50	KΩ	¼W
R19	50	KΩ	¼W

VALVES

V1	ECH35
V2	EF39
V3	EBC33
V4	EL33
V5	AZ31

CAPACITORS

*C1	Aerial SW trimmer		
*C2	Aerial MW trimmer		
*C3	Aerial LW trimmer		
*C5, C15,	0.0005+0.0005	μF (two gang)	
C6	0.01	μF	350 V
C7	0.01	μF	—
C8	0.0001	μF	—
*C9	Oscillator SW trimmer		
*C10	Oscillator SW padder		
*C11	Oscillator MW trimmer		
*C12	Oscillator MW padder		
*C13	Oscillator LW trimmer		
*C14	Oscillator LW padder		
*C15, C5,	0.0005+0.0005	μF (two gang)	
C16	0.0001	μF	350 V
C17	0.01	μF	350 V
C18	0.01	μF	350 V
C19	0.1	μF	350 V
C20	0.00015	μF	350 V
C21	0.00015	μF	350 V
C22	0.05	μF	350 V
C23	2.0	μF	350 V
C24	5	μμF	—
C25	0.0001	μF	350 V
C26	0.05	μF	—
C27	0.002	μF	500 V
†C28	16	μF	350 V
†C29	16	μF	350 V
†C30	25	μF	12 V
C31	0.01	μF	—

*Variable
†Electrolytic

TRANSFORMERS

T1, T2 Intermediate frequency transformers (465 Kc/s).
T3 Output transformer. Load resistance of EL33=7,000 Ω.
T4 Mains transformer.

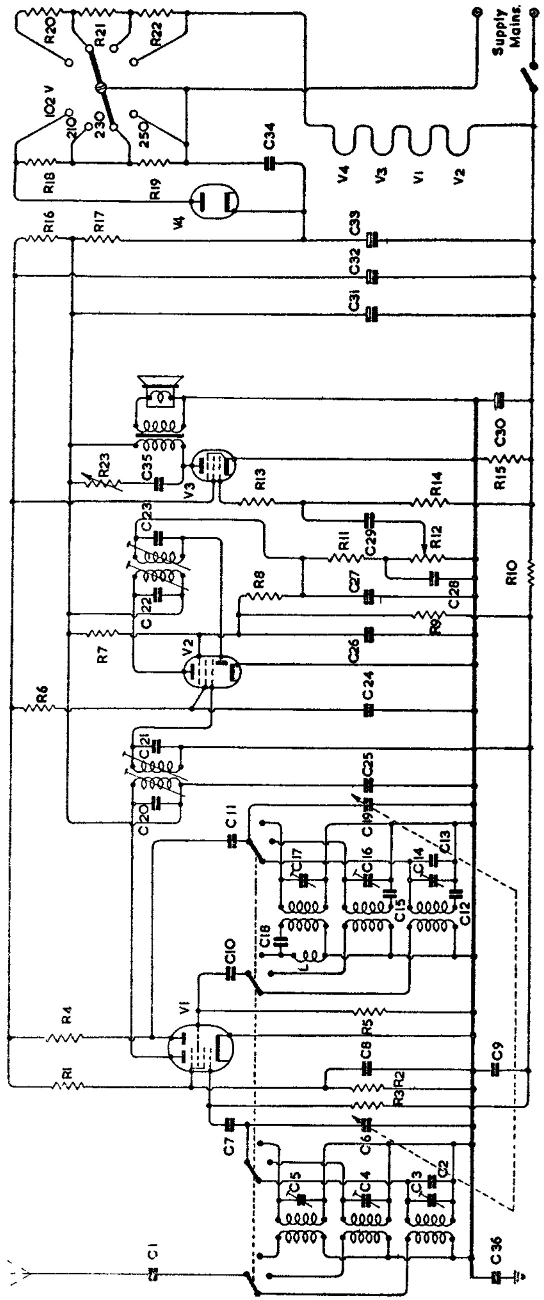
L1	6.3 V centre tapped	2 A
L2	250—0—250 V	60 mA
L3	4 V 1 A	

INDUCTOR

L4 Smoothing choke. Inductance 12 henries 60 mA

Mullard

3+1-VALVE D.C./A.C. MAINS-OPERATED SUPERHETERODYNE RECEIVER



3+1-VALVE D.C./A.C. MAINS-OPERATED SUPERHETERODYNE RECEIVER

This receiver is a 3-valve+rectifier superheterodyne : suitable for operation on long, medium and short wavebands, it is designed for operation on any mains voltage between 102 and 250 V.

An interesting feature of the receiver is the use of grid 3 of V2 as the source of A.V.C. delay voltage; this has the advantage that the I.F. transformer is not loaded by the delay diode, an arrangement which normally results in a degree of modulation distortion. The specified values of R7 and R8 provide a delay voltage of 15 V. It should be noted, however, that in this system only a D.C. potential may be applied to grid 3 and the current to that electrode must be limited to a maximum 10 µA. This imposss a lower limit of 15 M Ω for R7 and confines the use of grid 3 to supplying the A.V.C. delay voltage.

For optimum performance on short waves, it is essential that the number of turns on the oscillator feedback winding is approximately one half to one third the number of turns on the tuning winding. Coupling should be tight between these coils. In order to obtain an even response over the whole of the short wave range, L and C18 are used to boost feedback at the L.F. end of the band. In order to achieve this L and C18 must resonate at a frequency lower than the lowest oscillator frequency, for example 4.75 Mc/s for a tuning range of 16–50 metres. The overall sensitivity of the receiver is better than 60 µV.

RESISTORS

R1	18	K Ω	½W
R2	27	K Ω	½W
R3	1.0	M Ω	¼W
R4	22	K Ω	½W
R5	47	K Ω	¼W
R6	47	K Ω	¼W
R7	22	M Ω	½W
R8	2.2	M Ω	¼W
R9	2.2	M Ω	¼W
R10	10	M Ω	¼W
R11	47	K Ω	¼W
R12	0.5	M Ω	potentiometer
R13	100	K Ω	¼W
R14	0.82	M Ω	¼W
R15	140	Ω	1W
R16	1,500	Ω	½W
R17	470	Ω	2W
R18	180	Ω	5W
R19	100	Ω	3W
R20	200	Ω	2W
R21	200	Ω	2W
R22	1,074	Ω	12W wirewound
R23	0.1	M Ω	potentiometer

CAPACITORS

C1	1,000	pF	750 V.
C2	LW aerial circuit added cap.		
*C3	LW aerial circuit trimmer		
*C4	MW aerial circuit trimmer		
*C5	SW aerial circuit trimmer		
*C6	C19, 0.0005+0.0005 µF (two gang)		
C7	220	pF	Mica
C8	0.1	µF	350 V
C9	0.02	µF	350 V
C10	47	pF	Mica
C11	220	pF	Mica
C12	LW osc. circuit padder		
C13	LW osc. circuit added capac.		
*C14	LW osc. circuit trimmer		
C15	MW osc. circuit padder		
*C16	MW osc. circuit trimmer		
*C17	SW osc. circuit trimmer		
C18	SW osc. circuit booster		
*C19	C6, 0.0005+0.0005 µF (two gang)		
C20	100	pF	Mica
C21	100	pF	Mica
C22	100	pF	Mica

* Variable

3+1-VALVE D.C./A.C. MAINS-OPERATED SUPERHETERODYNE RECEIVER—*Continued*

VALVES

V1	UCH42
V2	UAF42
V3	UL41
V4	UY41

CAPACITORS—*Continued*

C23	180	pF	Mica
C24	0.1	μF	350 V
C25	0.1	μF	350 V
C26	0.02	μF	350 V
C27	47	pF	Mica
C28	47	pF	Mica
C29	0.002	μF	350 V
†C30	50	μF	25 V
†C31 } †C32 }	25+25	μF	275 V
†C33	40	μF	350 V
C34	0.02	μF	750 V
C35	0.05	μF	350 V
C36	0.02	μF	750 V

†Electrolytic

TRANSFORMERS

T1, T2 Intermediate frequency transformer (465 Kc/s).

T3 Output transformer.
Load resistance of UL41 3,000 ohms.

INDUCTOR

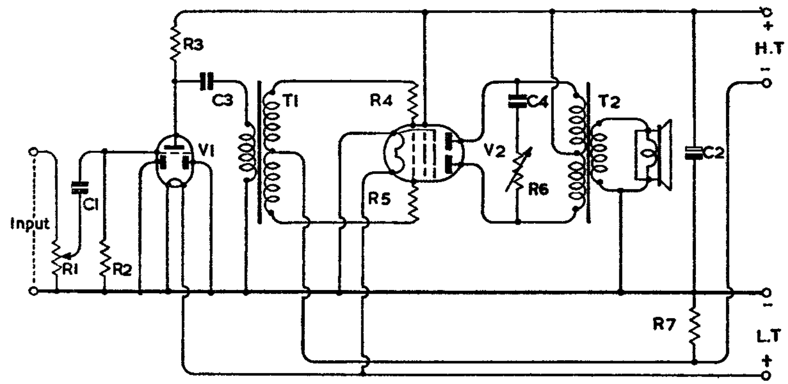
L Short wave booster winding.

The values of components which are not stated are dependent upon type of coil pack employed.

2-VALVE BATTERY-OPERATED GRAMOPHONE AMPLIFIER

This amplifier is suitable for the reproduction of speech and music. A variable tone control is provided in order that the quality of reproduction may be adjusted to meet individual requirements. The value of the capacitor C3 will affect the bass response and its value is dependent upon the type of transformer T1. A typical value for C3 is 0.25 μF.

When using a 120-V H.T. battery, an output power of 780 mW may be obtained with an input drive voltage of 200 mV. The total H.T. current drain under these conditions will be about 9.5 mA.



RESISTORS

R1	0.5	MΩ potentiometer	
R2	10	MΩ	¼W
R3	47	KΩ	½W
R4	1	KΩ	¼W
R5	1	KΩ	¼W
R6	100	KΩ potentiometer	
R7	820	Ω	½W

CAPACITORS

C1	0.02	μF	—
*C2	8	μF	350 V
C3	0.25	μF	—
C4	0.005	μF	

*Electrolytic

VALVES

V1 KBC32
V2 KLL32

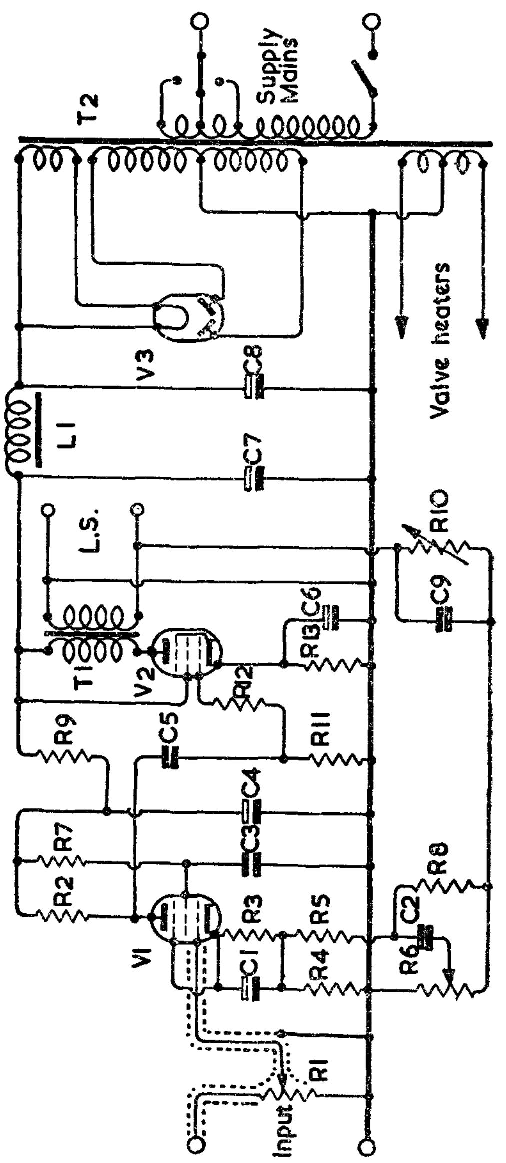
TRANSFORMERS

T1 Push–pull input transformer ratio 1 : 2 + 2.

T2 Output transformer R_{a-a}=16,000 Ω (ratio dependent upon impedance of speaker).

H.T. voltage 90 to 135 V L.T. voltage 2.0 V

4-WATT A.C. MAINS-OPERATED A.F. AMPLIFIER WITH SELECTIVE FEEDBACK.



4-WATT A.C. MAINS-OPERATED A.F. AMPLIFIER WITH SELECTIVE FEEDBACK

The design of this amplifier is such that good quality reproduction of gramophone recordings is possible, at a maximum output of 3.5 watts.

Bass and treble tone controls are incorporated in the feedback circuit. Care must be taken when connecting up the feedback loop to ensure that the voltage fed back is in phase with the input voltage. If the phase relationship is incorrect the amplifier will oscillate. The degree of feedback is determined by the ratio of the output transformer and the value of R4. Suitable values are shown below for various output transformer ratios.

Transformer Ratio	Speech Coil Impedance	Value of R4
22 : 1	15	120
32 : 1	7	180
48 : 1	3	270

The recommended value of R1 is suitable for all normal armature pickups. Its value may, however, be changed to suit any particular type of pickup employed.

RESISTORS

R1	220 KΩ potentiometer	
R2	100 KΩ	½W
R3	1,000 Ω	½W
R4	For value see text	
R5	1,000 Ω	½W
R6	25 KΩ potentiometer	
R7	470 KΩ	½W
R8	3,900 Ω	¼W
R9	10 KΩ	½W
R10	100 KΩ potentiometer	
R11	1 MΩ	¼W
R12	1,000 Ω	¼W
R13	150 Ω	½W

CAPACITORS

*C1	100	μF	12 V
C2	0.05	μF	—
C3	0.1	μF	350 V
*C4	8	μF	350 V
C5	0.02	μF	350 V
*C6	100	μF	12 V
*C7	32	μF	320 V
*C8	32	μF	320 V
C9	0.2	μF	—

*Electrolytic

VALVES

V1 EF37
V2 EL33
V3 AZ31

INDUCTORS

L1 Inductance—10 henries — Current rating 60 mA

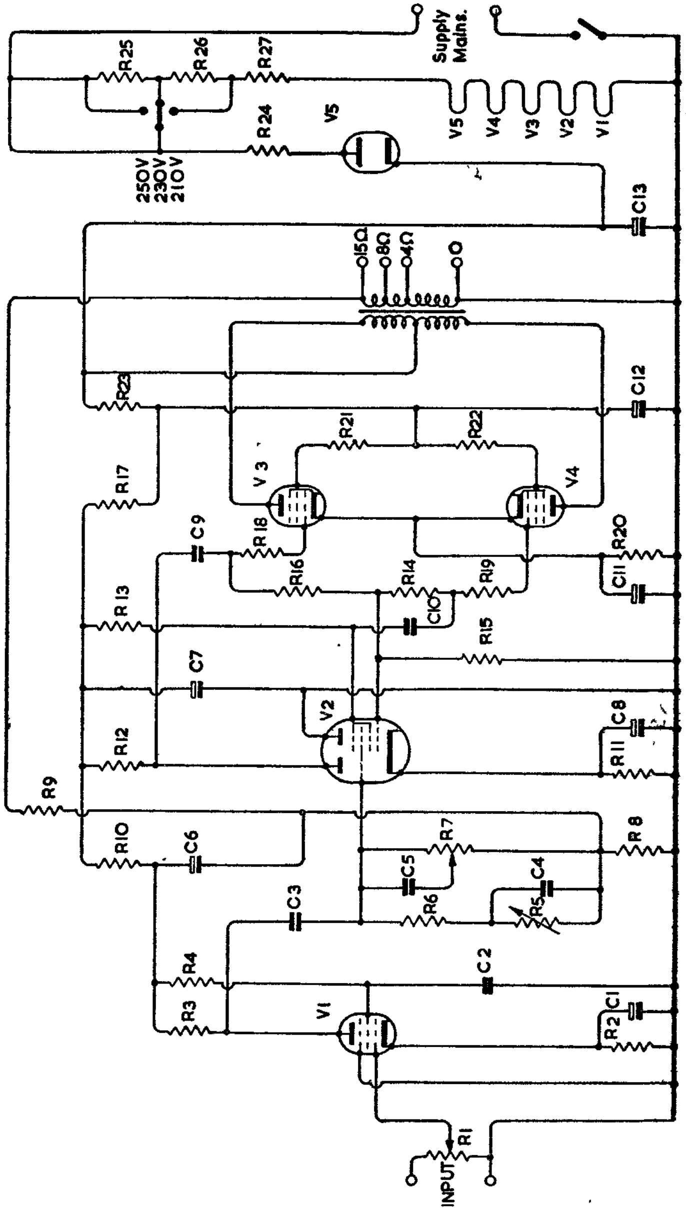
TRANSFORMERS

T1 Output transformer (see text) — Primary winding current rating 50mA

T2 Mains transformer

Rating		
250–0–250	V_{rms}	60 mA
6.3 V		2 A centre-tapped
4.0 V		1 A

10-WATT D.C./A.C. MAINS-OPERATED A.F. AMPLIFIER



10-WATT D.C./A.C. MAINS-OPERATED A.F. AMPLIFIER

This amplifier is suitable for the reproduction of speech and music and is capable of providing an audio output of approximately 10 watts peak for an input to the grid of V1 of 50 mV. Bass and treble tone controls incorporated between V1 and V2 provide a wide range of tone correction. Care must be taken in the construction of this stage to ensure that if a metal-cased component is used for C6, the case is not connected to the chassis.

In order to eliminate the switching of mains voltage dropping resistors it is possible over a supply voltage range 200–250 V to replace R25, R26 and R27 by the Philips barretter type C1.

RESISTORS

R1	0.5	MΩ	potentiometer	—
R2	4,700	Ω	¼W	10%
R3	0.47	MΩ	½W high stability	10%
R4	2.2	MΩ	¼W	10%
R5	2.0	MΩ	potentiometer	
R6	0.1	MΩ	¼W	10%
R7	2.0	MΩ	potentiometer	
R8	100	Ω	¼W	10%
R9	1,200	Ω	¼W	10%
R10	47	KΩ	¼W	10%
R11	1,200	Ω	¼W	10%
R12	0.1	MΩ	⅛W	10%
R13	0.1	MΩ	⅛W	10%
R14	0.47	MΩ	¼W high stability	2%
R15	0.27	MΩ	¼W	10%
R16	0.33	MΩ	¼W high stability	2%
R17	10	KΩ	¼W	10%
R18	1,000	Ω	¼W	20%
R19	1,000	Ω	¼W	20%
R20	220	Ω	2W wirewound	5%
R21	47	Ω	¼W	20%
R22	47	Ω	¼W	20%
R23	1,000	Ω	1W	10%
R24	150	Ω	5W wirewound	10%
R25	100	Ω	5W wirewound	10%
R26	100	Ω	5W wirewound	10%
R27	550	Ω	15W wirewound	5%

CAPACITORS

†C1	100 μF	6 V	—
C2	0.1 μF	350 V	20%
C3	0.02 μF	500 V	20%
C4	0.005 μF	350 V	10%
C5	0.002 μF	350 V	10%
†C6	4 μF	350 V	—
†C7	4 μF	350 V	—
†C8	100 μF	6 V	—
C9	0.02 μF	500 V	20%
C10	0.02 μF	500 V	20%
†C11	50 μF	25 V	—
†C12	40 μF	350 V	—
†C13	40 μF	350 V	—

†Electrolytic

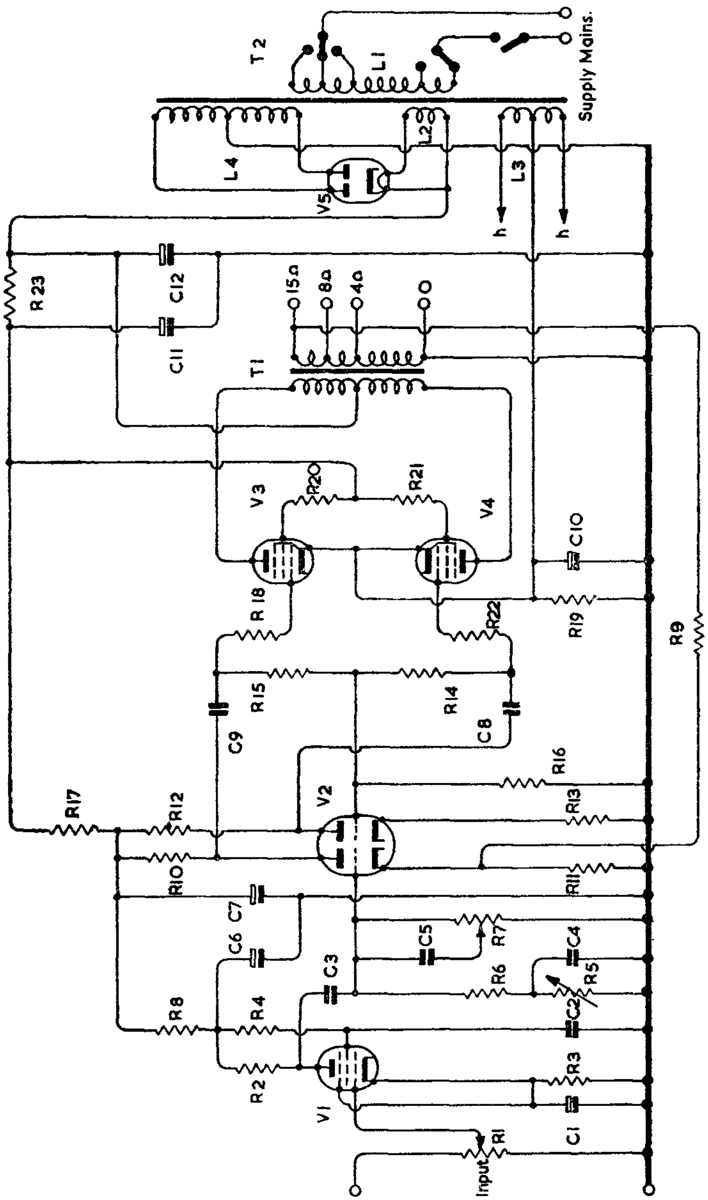
VALVES

V1	EF37
V2	CCH35
V3	CL33
V4	CL33
V5	CY31

TRANSFORMER

T1 Push-pull output transformer. Effective primary impedance 5,500 Ω (anode to anode). Secondary 0–4–8–15 Ω.

30-WATT A.C. MAINS-OPERATED PUSH-PULL A.F. AMPLIFIER



30-WATT A.C. MAINS-OPERATED PUSH-PULL A.F. AMPLIFIER

This amplifier is intended for the reproduction of speech and music and is capable of providing an output power of 30 watts. The signal input voltage for maximum output power is about 50 mV (rms). This enables the amplifier to be fed directly from most types of gramophone pick-up.
The input lead to V1 must be as short as possible and should consist of a length of low capacity screened cable.
In order to limit the peak current in V5 the effective resistance (R_t) in each anode circuit should be 100 ohms minimum. This resistance consists of the resistance of half the H.T. secondary winding plus that reflected into one half of the secondary from the primary. The value of R_t is given by :

$$R_t = R_s + N^2 R_p$$

where R_s = resistance of half secondary winding
R_p = resistance of primary winding
N = turns ratio of half secondary to primary windings

Negative feedback is obtained from the output transformer secondary and is fed back via R9 to the cathode of the input section for V2.
The ripple current in the reservoir capacitor C12 is 220 mA. This component must be of a type suitable to withstand this current.

RESISTORS

R1	500	KΩ		P	
R2	470	KΩ	1W	H.S.	
R3	4,700	Ω	¼W		
R4	2.2	MΩ	¼W		
R5	2.0	MΩ		P.	
R6	100	KΩ	¼W		
R7	2.0	MΩ		P.	
R8	47	KΩ	¼W		
R9	22	KΩ	¼W		
R10	100	KΩ	½W		
R11	2,200	Ω	¼W		
R12	100	KΩ	½W		
R13	2,200	Ω	¼W		
R14	270	KΩ	½W	H.S.	2%
R15	220	KΩ	½W	H.S.	2%
R16	220	KΩ	¼W		
R17	10	KΩ	¼W		
R18	1,000	Ω	¼W		20%
R19	250	Ω	6W	w	5%
R20	47	Ω	¼W		20%
R21	47	Ω	¼W		20%
R22	1,000	Ω	¼W		20%
R23	1,000	Ω	2W		

All values 10% unless otherwise stated.
P—Potentiometer (Log.). H.S.—High stability. w—wirewound.

CAPACITORS

†C1	100 µF	6 V	—
C2	0.05 µF	500 V	20%
C3	0.02 µF	500 V	20%
C4	0.005 µF	500 V	10%
C5	0.002 µF	500 V	10%
†C6	4 µF	450 V	—
†C7	4 µF	450 V	—
C8	0.05 µF	500 V	20%
C9	0.05 µF	500 V	20%
†C10	50 µF	50 V	—
†C11	16 µF	450 V	—
†C12	32 µF	450 V	—

†Electrolytic

VALVES

V1	EF37
V2	ECC33
V3	EL37
V4	EL37
V5	GZ32

TRANSFORMERS

Output transformer T1 : Effective anode—anode load for two EL37 is 5,000 Ω.
Mains transformer T2 :

L1	Primary		L2	5 V	2 A
L3	6.3 V c.t.	4A	L4	350–0–350	170 mA

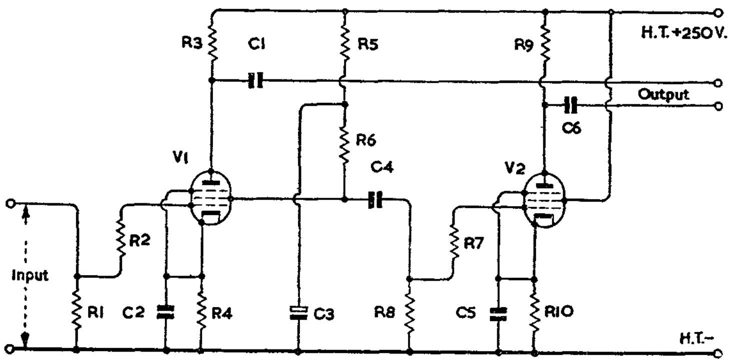
CIRCUITS

AMPLIFIER, TIME BASE AND POWER SUPPLY FOR OSCILLOSCOPE

By means of the time base generator, amplifier and power supply unit described below, a simple but efficient oscilloscope may be constructed for the visual examination of a large variety of waveforms.
The use of the two amplifiers enables ample deflection to be obtained in both axes under all normal conditions.

THE AMPLIFIERS

The horizontal and vertical amplifiers are similar in construction and are of the paraphase type. This enables an output voltage balanced on either side of earth to be fed to the deflection plates of the cathode ray tube, thus avoiding deflection defocusing. The grid and anode leads to the valves should be as short as possible in order to avoid stray capacitative coupling. When used in conjunction with the 3-inch cathode ray tube, Type ECR30, the amplifier will enable a deflection sensitivity of 1.25 cm/V (D.C.) to be obtained. The response of the amplifier is substantially linear up to 2 Mc/s.



RESISTORS

R1	1	MΩ
R2	150	Ω
R3	10	KΩ
R4	180	Ω
R5	10	KΩ
R6	1.2	KΩ
R7	150	Ω
R8	1	MΩ
R9	10	KΩ
R10	180	Ω

All resistors are rated at $\frac{1}{4}$W.

CAPACITORS

C1	0.1	μF	350 V
C2	1,500	pF	—
*C3	32	μF	350 V
C4	0.22	μF	350 V
C5	1,500	pF	—
C6	0.1	μF	350 V

*Electrolytic

VALVES

V1, V2 EF42

CIRCUITS

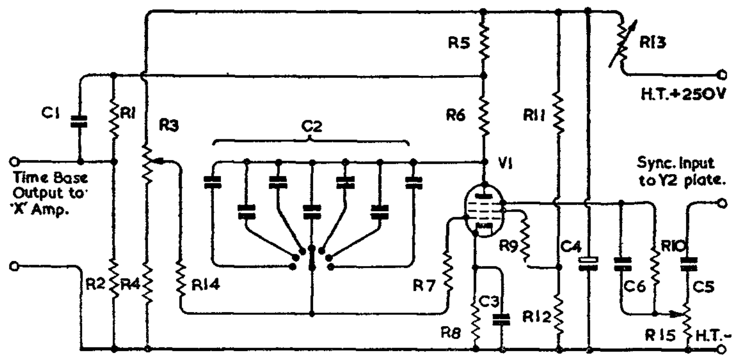
AMPLIFIER, TIME BASE AND POWER SUPPLY FOR OSCILLOSCOPE—*Continued.*

TIME BASE GENERATOR

The time base generator is of the single-valve type and is capable of providing a linear sweep voltage over the frequency range 7.5 c/s—30 Kc/s, with the choice of capacitors given on the circuit diagram. The capacitors are selected in turn by means of a single-pole seven-way rotary switch.
Provision is made for synchronising the time base frequency with that of the waveform under examination by applying a fraction of the latter to the suppressor grid of the valve.

FREQUENCY RANGE

C2	Frequency Range
220 pF	7.5 Kc/s— 30 Kc/s
680 pF	2.5 Kc/s— 10 Kc/s
2,200 pF	750 c/s — 3 Kc/s
6,800 pF	250 c/s — 1 Kc/s
0.022 μF	75 c/s —300 c/s
0.068 μF	25 c/s —100 c/s
0.22 μF	7.5 c/s — 30 c/s



RESISTORS

R1	220	KΩ	1W
R2	100	KΩ	$\frac{1}{2}$W
**R3	250	KΩ	
R4	56	KΩ	$\frac{1}{2}$W
R5	39	KΩ	1W
R6	4.7	KΩ	$\frac{1}{4}$W
R7	150	Ω	$\frac{1}{4}$W
R8	470	Ω	$\frac{1}{4}$W
R9	39	KΩ	1W
R10	1.5	MΩ	$\frac{1}{2}$W
R11	22	KΩ	1W
R12	82	KΩ	1W
*R13	50	KΩ (amplitude control)	
R14	560	KΩ	$\frac{1}{2}$W
**R15	0.5	MΩ	

*Wirewound
**Potentiometer

CAPACITORS

C1	5	pF	—
C2	See notes above		
C3	560	pF	—
†C4	32	μF	320 V
C5	0.2	μF	—
C6	5	pF	—

†Electrolytic

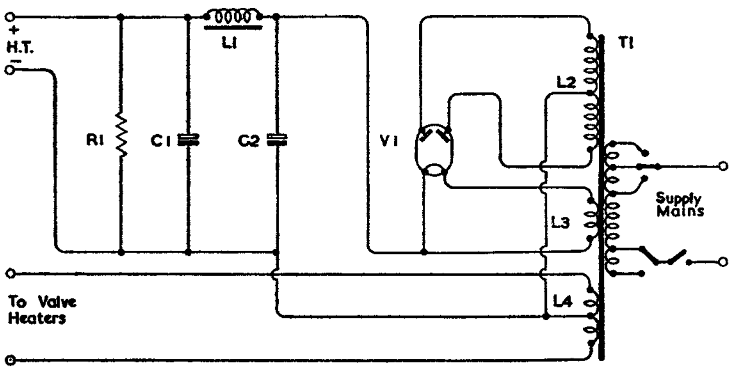
VALVE

V1 EF42

AMPLIFIER, TIME BASE AND POWER SUPPLY FOR OSCILLOSCOPE—*Continued*

POWER SUPPLY

This is a power pack of conventional type using a full-wave rectifier capable of delivering an output of 60 mA at approximately 250 V.



RESISTOR

R1	50 KΩ	2W

VALVE

V1 AZ31

INDUCTOR

L1	10 henries	60 mA

MAINS TRANSFORMER

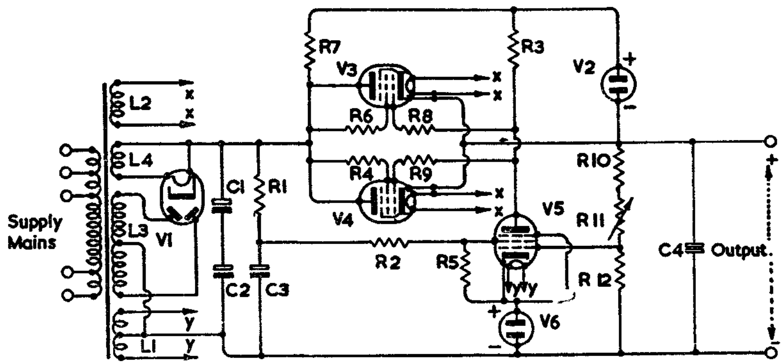
L2	250–0–250	60 mA
L3	4 V	1 A
L4	6.3 V	2 A c.t.

CAPACITORS

†C1	32 μF	320 V
†C2	16 μF	450 V

†Electrolytic

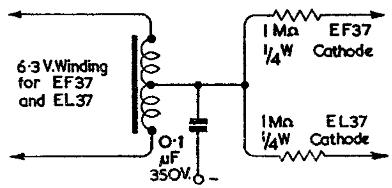
VOLTAGE-REGULATED POWER SUPPLY UNIT



The circuit diagram shows a high stability voltage–regulated power supply unit capable of providing a high degree of stabilisation over the range of 150–300 V at 125 mA.

The output current is limited at low voltage output by the maximum anode dissipation of V3 and V4. When the output voltage approaches 300 V the limit is set by the start of I_{g1} in V3 and V4.

Stability from minimum to maximum load current, at an output voltage of 250 V, is better than 0.5 V, and under these conditions the hum output is less than 25 mV. If only one heater winding is available for the control and stabilising valves, it should be utilised as shown below.



RESISTORS

R1	33	KΩ	2W
R2	22	KΩ	2W
R3	220	KΩ	½W
R4	47	Ω	¼W
R5	15	KΩ	1W
R6	47	Ω	¼W
R7	68	KΩ	2W
R8	1	KΩ	¼W
R9	1	KΩ	¼W
R10	7.5	KΩ	2W wirewound
R11	20	KΩ	wirewound potentiometer
R12	10	KΩ	2W wirewound

TRANSFORMER

L1	6.3 V centre tapped
L2	6.3 V 3 A
L3	375–0–375 150 mA
L4	5 V 2 A

CAPACITORS

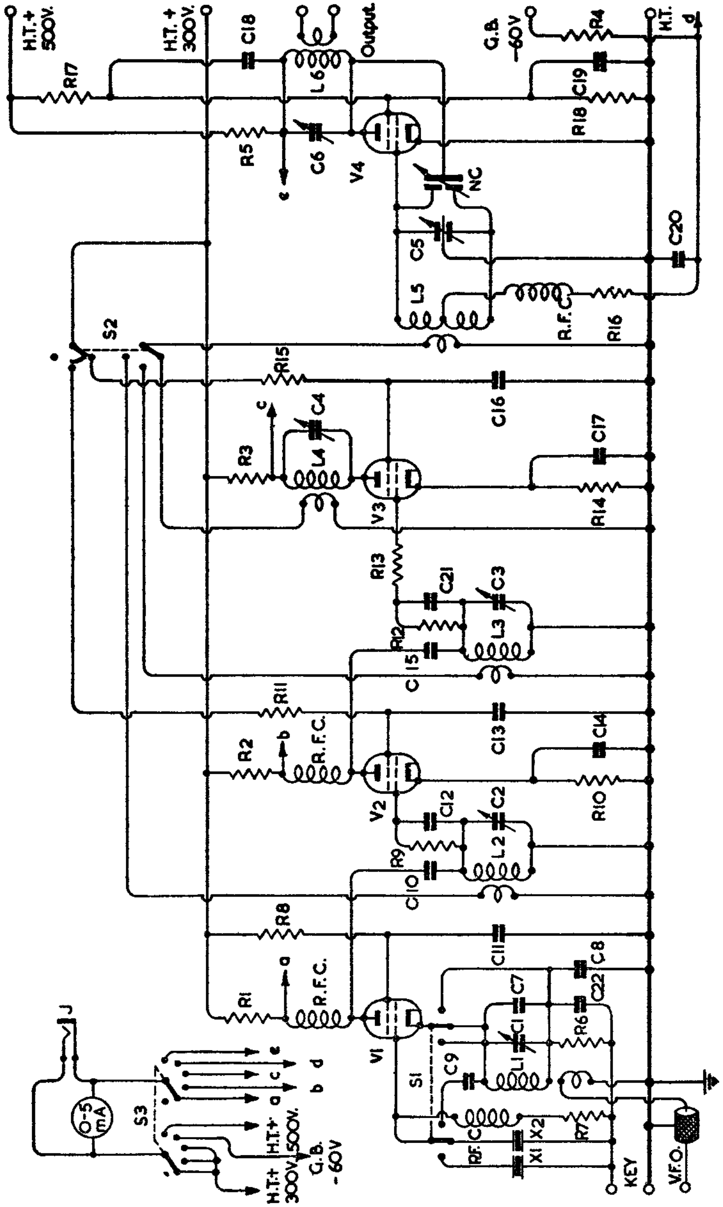
*C1	60 μF	350 V
*C2	60 μF	350 V
*C3	4 μF	450 V
*C4	32 μF	450 V

*Electrolytic

VALVES

V1	GZ32
V2	7475
V3	EL37
V4	EL37
V5	EF37
V6	85A1

25-WATT BAND-SWITCHED EXCITER



25-WATT BAND-SWITCHED EXCITER

The circuit diagram is of a four-stage band-switched exciter unit suitable for use on either the 7, 14 or 28 Mc/s bands. The first stage may be operated either as a crystal oscillator or as a frequency doubler, the latter mode of operation being that employed when a V.F.O. is used to drive the exciter. The output power and crystal currents are practically independent of the tuning of the cathode circuit when S1 is in the C.O. position, hence the trimmer C1 may be adjusted in order that the cathode circuit resonates in the middle of the V.F.O. range, i.e. in the 3.5 Mc/s band.

The second and third stages follow conventional doubler practice, the link windings on each anode coil being connected to the band switch S2 by screened cable. The switch S2 is so arranged that it removes the H.T. voltage from the screens of valves which are not in use.

The unit may be employed as a transmitter, in which case, using 500 volts on the anode of V4, an output power of 40 watts may be obtained. Anode and screen modulation may readily be employed by connecting the modulation transformer in the common H.T. supply lead.

The resistors R1, R2, R3, R4 and R5 serve as shunts for the 0–5 milliameter. The meter switch S3 is for the purpose of connecting the meter across any one of the shunts. A jack is also provided in the meter circuit to enable external measurements to be made.

RESISTORS

R1	Meter shunts		
R2	Meter shunts		
R3	Meter shunts		
R4	Meter shunts		
R5	Meter shunts		
R6	220	Ω	½W
R7	50	KΩ	½W
R8	47	KΩ	1W
R9	50	KΩ	½W
R10	1,500	Ω	1W
R11	10	KΩ	1W
R12	50	KΩ	½W
R13	100	Ω	½W
R14	1,500	Ω	1W
R15	10	KΩ	1W
R16	4.7	KΩ	1W
R17	40	KΩ	10W
R18	100	KΩ	1W

NC Neutralising Capacitor

VALVES

V1 QVO4-7
V2 QVO4-7
V3 QVO4-7
V4 QVO5-25

METER

M1 0–5 mA ammeter

CAPACITORS

†C1	40	pF	
†C2	100	pF	
†C3	100	pF	
†C4	60	pF	
†C5	60+60	pF	(split stator)
†C6	60	pF	
C7	100	pF	
C8	0.01	μF	
C9	500	pF	
C10	100	pF	
C11	0.01	μF	
C12	330	pF	
C13	0.01	μF	
C14	0.01	μF	
C15	330	pF	
C16	0.01	μF	
C17	0.004	μF	
C18	0.001	μF	
C19	0.002	μF	
C20	0.01	μF	
C21	330	pF	
C22	0.01	μF	

†Variable

INDUCTORS

For specification of Coils, see p.220

25-WATT BAND-SWITCHED EXCITER—*continued*

COILS

The coils are wound on standard 1⅛–inch formers, basic winding data being given in the table below.

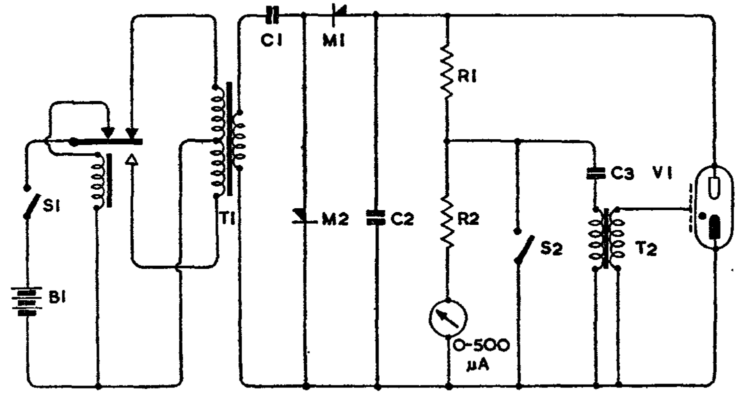
	7 Mc/s		14 Mc/s		28 Mc/s	
	Turns	Turns/inch	Turns	Turns/inch	Turns	Turns/inch
L2 (Tuning)	15	14				
(Link)	3½	14				
L3 (Tuning)			7	14		
(Link)			3	14		
L4 (Tuning)					5	7
•(Link)					2	7
L5 (Tuning)	24	20	14	14	8	7
(Link)	8	20	4	14	3	7
L6 (Tuning)	16	20	8	14	5	7
(Link)	6	20	4	14	2½	7

The coil L1 in the input circuit consists of 30 turns closely wound on a ¾–inch diameter former, together with a coupling winding of 8 turns. The total winding occupies a length of ⅞ inch.

PORTABLE BATTERY-OPERATED PHOTOGRAPHIC FLASH EQUIPMENT

The circuit below is of a portable unit intended for the production of high intensity short-duration luminous flashes of a type suitable for studio or press photography.

The reader is referred to pages 143–144 for general operating data on the flash tubes which may be incorporated in this type of apparatus.



RESISTORS
RI 10 MΩ
R2 0.68 MΩ
BI 6.0 V battery or accumulator

TUBE
VI LSD3/LSD3A

RECTIFIERS
MI, M2: Metal rectifiers; Open circuit input voltage 900 V_{rms}; Mean output current 8 mA

CAPACITORS

CI	0.05	µF	1,500 V
*C2	33	µF	2,500 V
C3	1.0	µF	500 V

*This value of capacitor will enable a flash duration of approximately 150 µ Sec. to be obtained.

SWITCHES
SI Charging switch
S2 Firing switch

TRANSFORMERS
TI Primary 6–0–6 V Secondary 900 V_{rms}
T2 Trigger transformer, minimum output; 3,000 V

1. SYMBOLS FOR ELECTRODES.

Anode	a	Fluorescent Screen or Target	t
Cathode	k	External Metallisation	M
Grid	g	Internal Metallisation	m
Heater	h	Deflector Electrodes	x or y
Filament	f	Internal Shield	s
Beam Plates	bp		

NOTE 1. In valves having more than one grid, the grids are distinguished by numbers—g1, g2, etc., g1 being the grid nearest the cathode.

NOTE 2. In multiple valves, electrodes of the different sections may be distinguished by adding one of the following letters :

Diode	d	Hexode	h
Triode	t	Heptode	h
Tetrode	q	Octode	h
Pentode	p	Rectifier	r

Thus, the grid of the triode section of a triode-hexode is denoted by g_t.

NOTE 3. Two or more similar electrodes which cannot be distinguished by any of the above means may be denoted by adding one or more apostrophes to indicate to which electrode system the electrode forms a part.
Thus, the anode of the first diode in a double diode valve is denoted a'.

2. SYMBOLS FOR ELECTRIC MAGNITUDES.

Voltages		Current	
Direct Voltage	V	Direct Current	I
Alternating Voltage (rms)	V_{rms}	Alternating Current (rms)	I_{rms}
Alternating Voltage (mean)	V_{av}	Alternating Current (mean)	I_{av}
Alternating Voltage (peak)	v_{pk}	Alternating Current (peak)	i_{pk}
Peak Inverse Voltage	P.I.V.		

Miscellaneous

Frequency	f
Amplification Factor	μ
Mutual Conductance	g_m
Conversion Conductance	g_c
Distortion	D
Anode efficiency	η

	Inside Valve.	Outside Valve.
Resistance	r	R
Reactance	x	X
Impedance	z	Z
Admittance	y	Y
Mutual Inductance	m	M
Capacitance	c	C
Capacitance at Working Temperature	c_w	
Power	p	P

3. AUXILIARY SYMBOLS.

Battery or other source of supply	b
Inverse (Voltage or Current)	inv
Ignition (Voltage)	ign
Extinction (Voltage)	ext
No signal	o
Input	in
Output	out
Total	tot
Centre Tap	ct

4. COMPLEX SYMBOLS.

Symbols in Sections 1 and 3 above may be used as subscripts to symbols in Section 2, to denote such magnitudes as Anode Current, Grid Volts, etc., e.g. :—

Anode Voltage	V_a	Anode Current (D.C.)	I_a
Control Grid Voltage	V_{g1}	Anode Current (A.C. rms)	$I_{a(rms)}$
Anode Supply Voltage	$V_{a(b)}$	No signal Anode Current	$I_{a(o)}$
Filament Voltage	V_f	Control Grid Current	I_{g1}
Heater Voltage	V_h	Total Distortion	D_{tot}
Anode Dissipation	p_a	3rd Harmonic Distortion	D_3
Output Power	P_{out}	Equivalent Noise Resistance	R_{eq}
Drive Power	P_{drive}		

	Internal.	External.
Anode Resistance	r_a	R_a
Insulation Resistance (heater to cathode)	r_{h-k}	
Resistance between Control Grid and Cathode	r_{g1-k}	R_{g1-k}
Capacitance (cold)—		
Anode to all other electrodes		c_{a-all}
Anode to control grid		c_{a-g1}
Control grid to cathode at working temperature		$c_{g1-k(w)}$
Control grid to all other electrodes except anode (Input Capacitance)		c_{in}
Anode to all other electrodes except control grid (Output Capacitance)		c_{out}

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Alternating Voltage (peak)	v_{pk}	Alternating Current (peak)	i_{pk}
Peak Inverse Voltage	P.I.V.		

Miscellaneous

Frequency	f
Amplification Factor	μ
Mutual Conductance	g_m
Conversion Conductance	g_c
Distortion	D
Anode efficiency	η

	Inside Valve.	Outside Valve.
Resistance	r	R
Reactance	x	X
Impedance	z	Z
Admittance	y	Y
Mutual Inductance	m	M
Capacitance	c	C
Capacitance at Working Temperature	c_w	
Power	p	P

3. AUXILIARY SYMBOLS.

Battery or other source of supply	b
Inverse (Voltage or Current)	inv
Ignition (Voltage)	ign
Extinction (Voltage)	ext
No signal	o
Input	in
Output	out
Total	tot
Centre Tap	ct

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Anode Dissipation	p_a	3rd Harmonic Distortion	D_3
Output Power	P_{out}	Equivalent Noise Resistance	R_{eq}
Drive Power	P_{drive}		

	Internal.	External.
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Anode to all other electrodes	c_{a-all}	
Anode to control grid	c_{a-g1}	
Control grid to cathode at working temperature	$c_{g1-k(w)}$	
Control grid to all other electrodes except anode (Input Capacitance)	c_{in}	
Anode to all other electrodes except control grid (Output Capacitance)	c_{out}	