

1951



VALVE MANUAL

PART 1

RADIO RECEIVING VALVES
CATHODE RAY TUBES
ELECTRONIC DEVICES

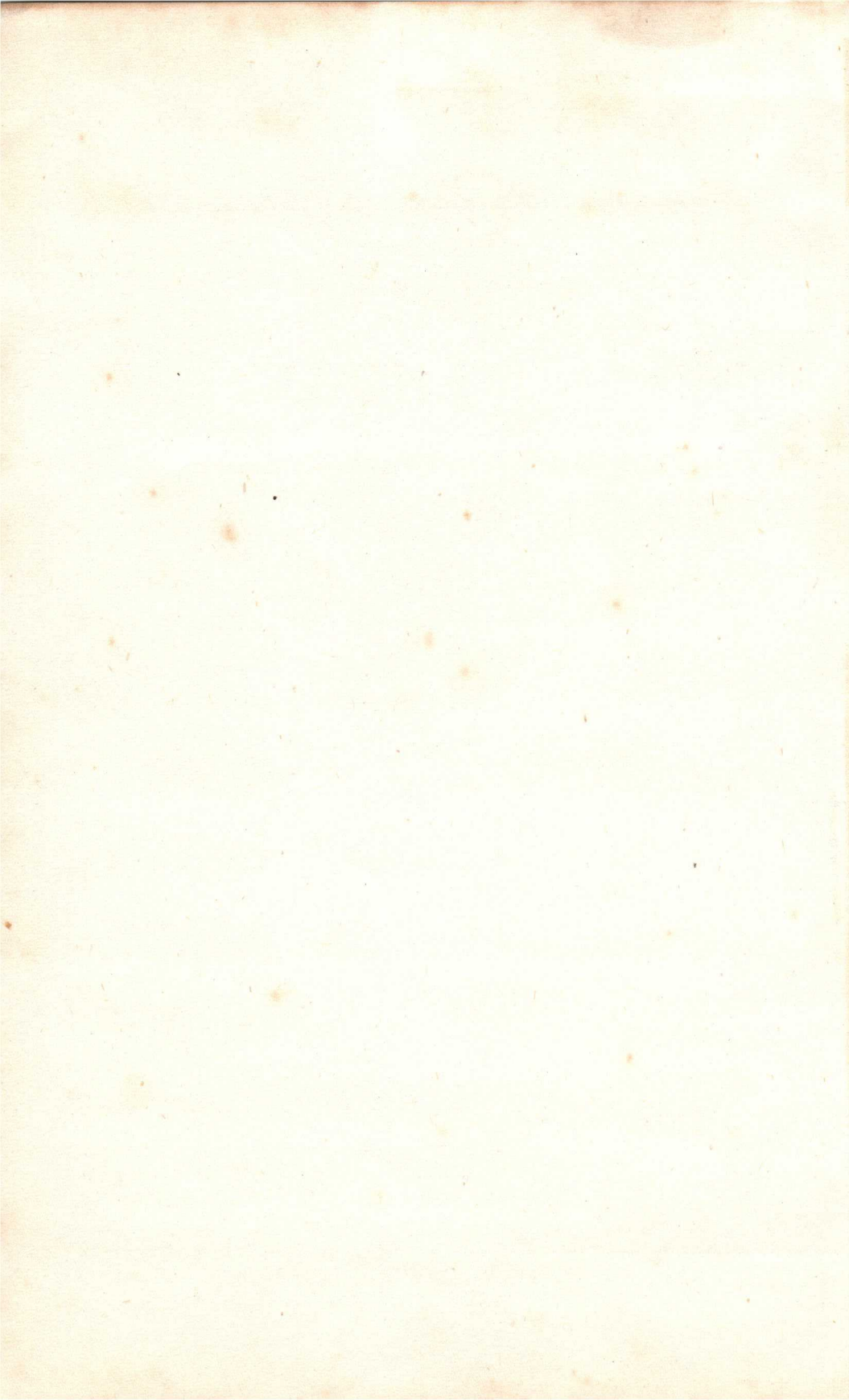
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PART 1
OSRAM VALVE MANUAL

ERRATA

- Page 34 N78 Operating Conditions
The external grid circuit resistance with auto bias
should read : "must not exceed $270\text{ k}\Omega$ (+20%)"
- Page 47 N37 and N108 Operating Conditions :
The external grid circuit resistance with auto bias
should read : "must not exceed $270\text{ k}\Omega$ (+20%)"
- Page 245 (Fig. 2) R17 should be $270\text{ k}\Omega$
- Page 246 (Fig. 3) R17 should be $270\text{ k}\Omega$



Osram

VALVE

MANUAL

PART 1

RECEIVING TYPES OF VALVES
CATHODE RAY TUBES
ELECTRONIC DEVICES

First Edition

APRIL, 1951

Published by

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FOREWORD

This manual is intended as a guide for radio engineers engaged in the maintenance or design of broadcast receivers and electronic apparatus. Full characteristics, operating data and curves are given for the types of amplifying and rectifying valves, and other electronic devices in use for such purposes.

Valves listed include battery, A.C. and D.C./A.C. types, and small rectifiers. Other electronic devices listed include cathode ray tubes, photoelectric cells, current and voltage regulator tubes, neon indicators, Geiger-Müller tubes, gasfilled arresters, and crystal valves including silicon and germanium diodes.

For data on transmitting and larger industrial valves, please refer to Osram Valve Manual, Part 2 (not issued at time of publication of Part 1).

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INTRODUCTION

Choice of characteristics

Each type of valve or other electronic tube mentioned in this manual is designed and manufactured to give the best service in the particular application for which it was intended.

Osram valves are not necessarily fully interchangeable with valves of other makes although in many cases the difference is not of practical importance.* For example, many types are interchangeable with established American (U.S.A.) valves, although each Osram valve bears its own type reference.

In general, however, Osram valves are designed to embody improvements, where practicable, on the design of established types so that the best possible results in any given application are obtainable.

Bases

Osram valves are in general fitted with bases or caps of standardised international pattern.

The following are the principal types of base employed.

British (B.V.A.) and European 4, 5 and 7 pin base (maintenance types only).

International Octal Base (U.S.A.).

Miniature all-glass 7 pin (B7G) base (U.S.A.).

Miniature all glass 9 pin (B9A) base (U.S.A.).

Certain types (for maintenance only) are supplied fitted with the 8 pin European and U.S.A. all-glass base sometimes known as B8G.

Preferred types for new equipment

Owing to the wide diversity of valve types, guidance is given in the introductory pages of each section of the manual as to *preferred types*, because in the immediate future, production and delivery will be concentrated on these. Care should be taken in choosing any valve type *not* shown as a *preferred type*, as such valves may be difficult to obtain and are intended only for maintenance purposes. In any cases of doubt regarding the choice of a suitable valve, reference should be made to The General Electric Co. Ltd., or its Branches, from whom guidance as to a suitable type can be readily obtained.

Designers are also referred to "Code of Practice on Electronic Valves" issued by the British Standards Institution, which supersedes "Radio Valve Practice," issued by The British Radio Valve Manufacturers Association.

Circuit information and technical service

The circuit diagrams given in the manual (pages 243 to 252) are for guidance of designers only. Although representing in every case a tried and practical circuit, they are typical only, and do not necessarily represent final manufacturing designs. Publication of circuits does not imply any licence under patents which might be involved.

The General Electric Co. Ltd., or its Branches are prepared at all times to give assistance to designers of equipment and to approve from the valve operating point of view, manufacturers' circuits intended for use with Osram valves.

* See tables, page 233.

NOMENCLATURE

With current receiving valves, a system of code letters and numerals now adopted for specifying the various types of Osram valve is set out below.

The code lettering which indicates the function of the valve precedes the numerals in all cases. Combinations of letters indicate combinations of valve functions in one bulb. The numerals refer to ranges and have no other significance.

CODE LETTERS

- A. Valve produced for specialised industrial application.
- B. Double triode.
- D. Diode or double diode.
- GU. Gasfilled rectifier.
- GT. Gasfilled triode (thyatron).
- H. High impedance triode.
- L. Low impedance triode.
- N. Output pentode.
- U. Rectifier.
- W. Variable-mu screened pentode.
- X. Frequency changer.
- Y. Tuning indicator.
- Z. Sharp cut-off screened pentode.

The above scheme does not apply to certain older types of valves, e.g. PX4, PX25, MPT4, etc., nor to transmitting valves.

In older types, KT indicates a tetrode with pentode characteristics (a "kinkless" tetrode). A suffix M indicates external metallising.

SYMBOLS

Common Symbols accepted for use with valves.

The following are examples of symbols in accordance with those agreed between *The British Radio Valve Manufacturers Association* and *The British Standards Institution*.

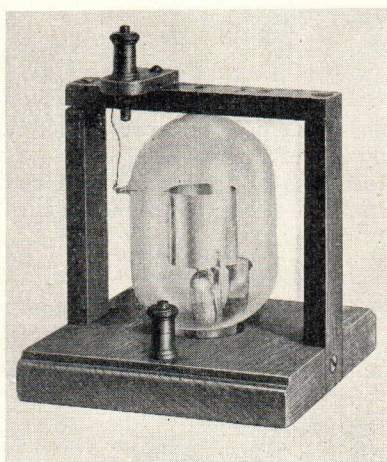
V_a	D.C. anode voltage
$V_{a(b)}$	D.C. H.T. supply voltage
V_g	D.C. grid voltage
$V_{g_1} V_{g_2} V_{g_3}$ etc.	D.C. voltages applied to grids numbered outwards from the cathode
V_{sig}	Signal voltage
V_{out}	Output voltage
I_a	D.C. anode current
I_g	D.C. grid current
$I_{g_1} I_{g_2}$ etc.	Currents to grids Nos. 1, 2, etc.
R_a	External anode load resistance
R_g	External grid leak
R_{g_2}	External resistance in series with g_2
R_k	External cathode resistance
r_a	Internal anode impedance
Z_a	External load impedance
C_{in}	Input capacitance (grid to all electrodes less anode)
C_{out}	Output capacitance (anode to all electrodes less grid)
C_{ga}	Capacitance of grid to anode
μ	Amplification factor (also micro, as a prefix)
P_{out}	Power output
P_a	Anode dissipation
g_m	Mutual conductance
g_c	Conversion conductance

IN BRIEF RETROSPECT

Milestones on the road of progress

THE thermionic valve, which has made broadcasting and television possible, was first manufactured during the 1914-1918 war. Some of the first valves were made by The General Electric Co. Ltd. and ever since those days of pioneering development, the Company has held a leading position.

When valves first began to appear as commercial products, the G.E.C. drew on its long experience in the manufacture of electric lamps, as these presented similar manufacturing problems. This reservoir of experience has proved of immense value in maintaining the quality of Osram valves, but above all, the G.E.C. has always realised the value of research in every branch of electrical manufacturing.



Fleming Diode

The forerunner of the modern thermionic valve

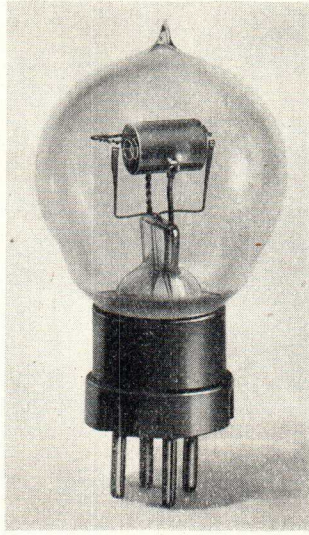
In 1918 only one type of radio receiving valve could be bought by the experimenter. This was the "R" valve, a general-purpose triode. To-day we should regard it as a pretty poor thing: but to those who used it then it was a wonder—and with it they obtained astonishing results, receiving telephonic and telegraphic transmissions over what were then almost incredible distances.

The "R" valve required 2.8 watts to heat its pure tungsten filament to the temperature needed to produce an adequate emission of electrons and, incidentally, a bright white glow. It was usually operated from a 6 V. accumulator L.T. battery, each valve in a receiving set having its own controlling rheostat.

In the "R" valve the mutual conductance was only 0.225 mA/V. Today not many receiving valves have a mutual conductance of less than 1 mA/V. In some it runs into double figures.

Despite all this the "R" valve worked well, and as new circuits were developed, did things which had never been done before. But the Research Departments were very conscious of its limitations, and efforts were soon made to effect

improvements. Many of these were made during the first world war, but the valves which incorporated them did not become available to the public until later.



"R" valve

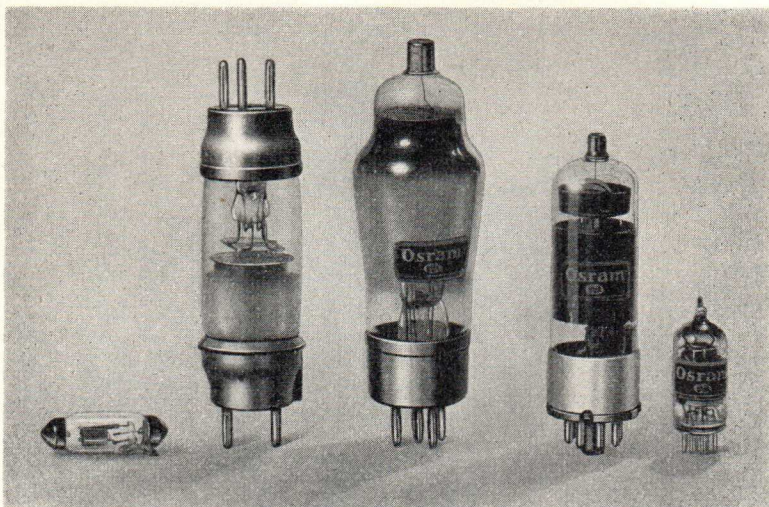
The early form of commercial receiving valve

For one thing, these early valves were not very satisfactory as high-frequency amplifiers. The main reason for this was the comparatively large capacitances that existed between electrodes.

A capacitance provides a path for oscillating current; the higher the frequency the easier the path for a given value of capacitance. In a high-frequency amplifying valve, inter-electrode capacitances, especially those between anode and grid, are of great importance. To be efficient, such an amplifier must have both grid and anode circuits sharply tuned. When this was done with an "R" valve the feed-back of energy from anode circuit to grid circuit made the arrangement unstable and liable to oscillate. The valve had to be "held down" by the deliberate introduction of damping, with the result that only a small fraction of the H.F. amplification theoretically possible could be obtained in practice.

Obviously it was essential to reduce inter-electrode capacitances to a minimum, and the first promising step was the production of "test-tube" valves of the V.24 and QX types. These had four small metal caps, one at each end of the tube and one at either side. By specially shaping the anode, grid and filament and by bringing their leads to widely separated caps the inter-electrode capacitances were very considerably reduced and much more efficient H.F. amplifiers became possible.

The greatest step forward however, was made when the G.E.C. introduced into this country the first practical form of screened grid valve, or tetrode. In this valve, anode-grid capacitance was cut down to an almost negligible figure. The valve had a very high amplification factor and for the first time full advantage could be taken of this by sharply tuning anode and grid circuits. By using screened tetrodes in cascade, a stable H.F. amplification approaching the million-fold became possible.



V24

S625

VMS4

W61

Z77

Progress in radio frequency amplifying valves from 1920 to the present day

Most of the high frequency amplifying valves of to-day are based on these early screened-grid valves.

Later a fifth electrode was added to the valve and the tetrode became a pentode.

The latter made its first appearance as an audio-frequency amplifier ; but it was not long before the R.F. pentode was developed and these two forms of the pentode made it possible to obtain enormous amplification from a comparatively small number of valves in cascade.

With the growing usefulness of shorter and shorter waves, corresponding to higher and higher frequencies, further reductions of stray capacitances have been needed. Osram valves have kept their position in the van of progress by the introduction of "planar electrode" and other types of low-capacitance, high-efficiency valves, the successful development of which has made communication on centimetric wavelengths possible. Also the development of radio links for television, of which the London-Birmingham Television Link, designed, made and installed by the G.E.C. is an excellent example.

As mentioned earlier, the first radio valves were all bright-emitters ; that is, their filaments had to be run at a temperature sufficient to make them white-hot in order to ensure sufficient emission of electrons. The bright-emitter valve however was uneconomical in two ways.

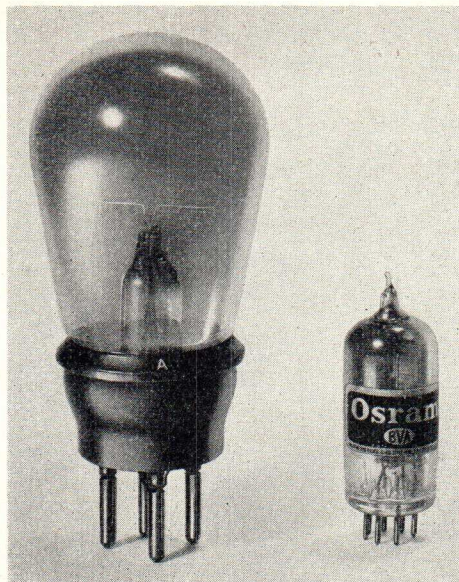
First, a current of 0.7 A to 1.5 A had to be supplied by a 6 V. accumulator battery. Even a 60-AH battery gave comparatively short service for each charge. Taking into account the cost per recharge and the depreciation of the battery, the provision of L.T. current, which served no direct radio purpose and was used merely to raise the filament to a satisfactory electron-emitting temperature, was a very expensive item.

Secondly, the fact that the filament was worked at a high temperature meant that its life (and therefore the life of the valve) was comparatively short.

The task which designers of Osram valves set themselves was to produce an efficient and durable filament which could be heated economically from an accumulator. The ideal was a valve which could be operated from a single secondary cell.

The problem was solved in a remarkably short time and almost immediately following the commencement of the B.B.C. services the G.E.C. gave to the world a sensational valve, combining new ideas in economy of running with remarkably long life. This was the Osram D.E.R.; the initials stood for Dull Emitter Receiving.

The great advantage of the D.E.R. valve was that it only required 0.35 A. of filament current at 1.8 V. Taking into account the 0.2 V. wasted across the rheostat, the filament consumption was thus only 0.7 watt, compared with the 4.2 watts of an "R" valve run from a 6 V. accumulator with series resistance.



DER

ZD17

Progress in battery receiving valves from 1922 to the present day

This was revolutionary; but it was only a beginning and the manufacturers of Osram valves continued to introduce improvements in emission efficiency and reliability of low temperature cathodes. To-day, a 4-valve battery-operated super-heterodyne receiver equipped with Osram valves can draw its filament current economically from one small dry cell. The total drain need not exceed 0.25 A. at 1.4 V., equivalent to 0.35 watt. Compare this with the 2.8 watts required by *one* of the original "R" valves.

It has already been stated why a special type of valve was needed for effective H.F. amplification but it was soon found that the forward march of radio demanded the evolution of several other kinds of valve, each designed to do one job really well.

The general-purpose valves used in the output stages of early radio receivers caused distortion to music and speech, to which was added distortion by the loudspeaker with a final result which would be found intolerable nowadays.

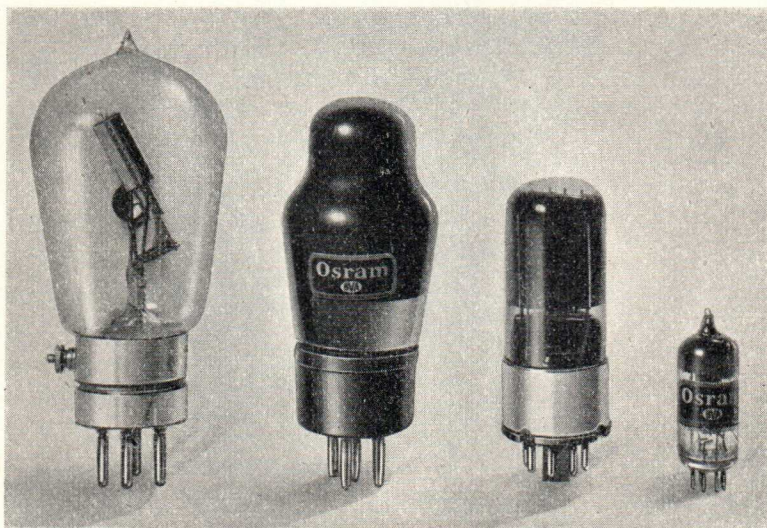
The loudspeaker is a current-operated instrument and power (watts, not just volts) is required to move the cone by means of which the sound waves are set up. It was therefore soon realised that if loudspeaker reproduction was ever to be anything like a faithful replica of the original sounds in the studio, a valve was needed which would convert large voltage changes in its grid circuit into considerable power changes in its anode circuit without linear loss.

In brief retrospect

One of the first power valves to be evolved for this purpose was an Osram bright emitter triode, which appeared in 1925. It worked fairly well—though it was expensive to operate, for its filament drew 1·5 amperes at from 5·5 to 6 volts and it was not really at its best unless the anode voltage was at least 500.

More efficient types followed one another with almost bewildering rapidity. One such valve was the well-known L.S.5—a truly outstanding power valve in its day, with a remarkable record of reliability and life.

So far, we have considered only battery-operated valves. The reason is that no other kind was known during the early years of radio history. One very important consideration was that if means could be found of contriving an indirectly-heated cathode, the whole of its surface could be maintained at the same potential. This cannot be done in directly-heated valves, for a potential gradient must exist from one end of the filament to the other.



KL1

MH4

L63

L77

Progress in indirectly-heated cathode valves from 1926 to the present day

Many attempts were made to produce indirectly-heated valves : but the first practical commercial type was introduced by the G.E.C. in 1925/26. This was the K.L.1, a radiation-heated triode. From that time onwards progress was continuous and rapid. Like their battery counterparts the Osram mains valves of to-day are second to none for their efficiency, reliability, freedom from noise, economical operation and long life.

Subsequent valve research introduced the glass-to-metal seal types, which, except for a brief appearance in receiving valves (the "Catkin" of 1933), are now confined to transmitting valves in which they have made possible a higher power rating than could have been achieved with all-glass envelopes.

As radio has expanded into the realm of higher frequencies with the development of television and radar, many specialised Osram valves have been designed. To these have been added a wide range of G.E.C. electronic devices, including various kinds of cathode ray tubes and photoelectric cells, gasfilled rectifiers and Geiger-Müller tubes ; all to serve the needs of science and industry, as well as the requirements of broadcasting, television and the many amateur transmitting enthusiasts throughout the world.

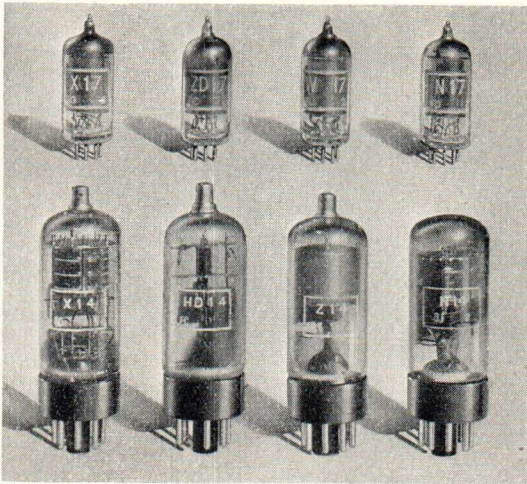
From the point of view of receiving valves, however, the most spectacular modern development has been the successful large-scale manufacture of "all-glass" valves. This development makes possible the miniature valves which are so widely used in domestic receivers. The story behind the making of a modern miniature valve is told in the next section. It is a proof that today, as at the beginning of valve history, the G.E.C. and Osram valves continue to lead in the service of electronics, in all its branches.

THE MAKING OF A MODERN MINIATURE VALVE

EARLY valves were all hand-made. This was possible when the numbers needed were small and when comparatively wide tolerances could be allowed in the positioning and spacing of their electrodes, which, to modern eyes, seem of such large size and of such simple nature.

The valve of to-day, with its often complex system of tiny parts, could not be made by hand. The degree of accuracy called for in the making and assembling of its components is as high as that needed for building the finest of watches.

To produce valves of the highest grade, it is first necessary to design and build machinery of extreme precision, capable of handling small, delicate parts and of turning out finished work with a *maximum* variation in its dimensions equal to less than half the thickness of a single sheet of the thinnest India paper.



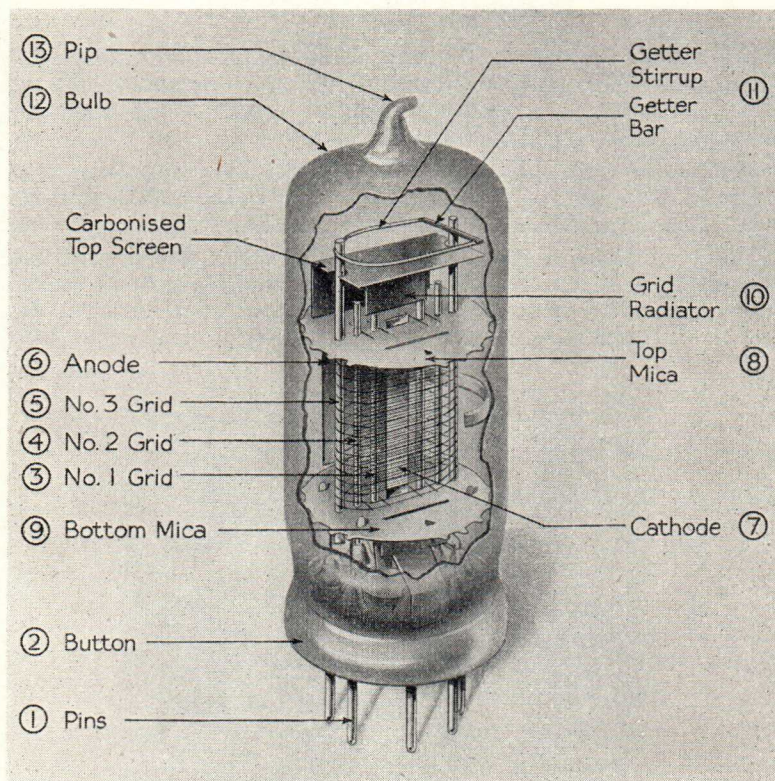
Osram miniature valves compared in size with
their octal-based predecessors

Two examples of miniature construction may be given. The filaments of the latest types of battery valves are so fine that they are barely visible to the unaided eye; such filaments are coated with an electron-emissive material in such a way that every portion of their tiny surface is evenly covered and they must be mounted under exactly the right tension to ensure that the finished valve is not microphonic. The other example is the control grid of valves, which must be wound under closely regulated tension with a diameter which must not vary by more than one thousandth of an inch from the standard measurement.

The making of a miniature valve

The assembly of a typical modern valve will be described, but it is first worth while explaining why the Osram works lay so much stress upon precision in every stage of the making of a valve.

To give its user good service, a valve must possess many qualities difficult to achieve. It must conform within close tolerances to the standard characteristics of its type ; it must remain consistent during a long working life, with neither a softening of its vacuum nor a serious falling off in emission ; it must not be microphonic nor prone to other kinds of "noisiness" ; it must be reasonably robust and not easily damaged either by insertion into and removal from its holder, or by the vibration and the minor shocks which may be expected to come its way in normal use.



Sketch showing position of components in valve type Z77

The main objects of all the research behind Osram valves and of the precision methods employed in their manufacture are to provide the user with the best and most reliable valve available to perform any duty that he may require of it.

It is because of this policy that *every* valve that leaves the Osram works (and not just a percentage of each batch made) is subjected to two separate and comprehensive series of severe tests. The user is thus assured that each valve can be relied upon to give the best possible performance during its working life.

The large, somewhat pear-shaped valve, with "silvered" bulb and a moulded cap, is rapidly becoming obsolete. Its place is being taken in radio receiving and television sets, as well as in many other kinds of electronic apparatus, by the miniature, glass-based valve, which, besides being much smaller, has many other important advantages.

For example, the miniature valve has no cemented-on cap to work loose, and its inter-electrode capacitances are in many cases considerably lower than in earlier types of valves.

THE GLASS "BUTTON"

The first stage in the making of a valve of the B7G or miniature base types is the placing of the pins in a jig, with that maximum tolerance of one thousandth of an inch which is the basis of Osram valve manufacturing technique. This process is done by a machine.

The pins^{1*} look simple enough, though they embody the results of a great deal of metallurgical research, undertaken to ensure that they give the user the best possible service. They must be of exactly the right tensile strength. What would happen if the valve was handled with too great a pressure on pins which were too soft needs no explanation. If, however, they were a little over-hard there would be a risk of cracking the glass base when the valve was pressed home in the socket.

Every pin must also be thoroughly cleaned because any dirt on the part inside the bulb might lead to faulty joints, with consequent poor performance, and "noise."

After the pins have been sealed in the base and cooling has taken place, a finished "button"²—a glass dish moulded exactly to size and containing seven or nine pins—is delivered from the machine.

ELECTRODE PREPARATION AND ASSEMBLY

Other parts of the valve assembly are also made by precision machines.

The grids,^{3,4,5} for instance, are small spirals of fine wire, with the turns secured to vertical supporting wires. It has already been mentioned that any finished grid must comply with very close tolerances, but the story may not end there.

In mains operated power valves, the control grid may run at a high temperature and in such cases would itself emit electrons, which would cause a most undesirable flow of grid current, were not its emissive qualities reduced by treating it, for example, by gold plating. Grid temperatures are even higher in television line-scan pentodes, in which that of the screen grid may reach 800°C. Even gold-plating would be of no use here; but other new and very effective processes have been developed as the result of research.

The anode⁶ of a valve has to be treated in a special way by a carbonising process to ensure its being able to dissipate sufficient heat to remain at a temperature consistent with efficient working.

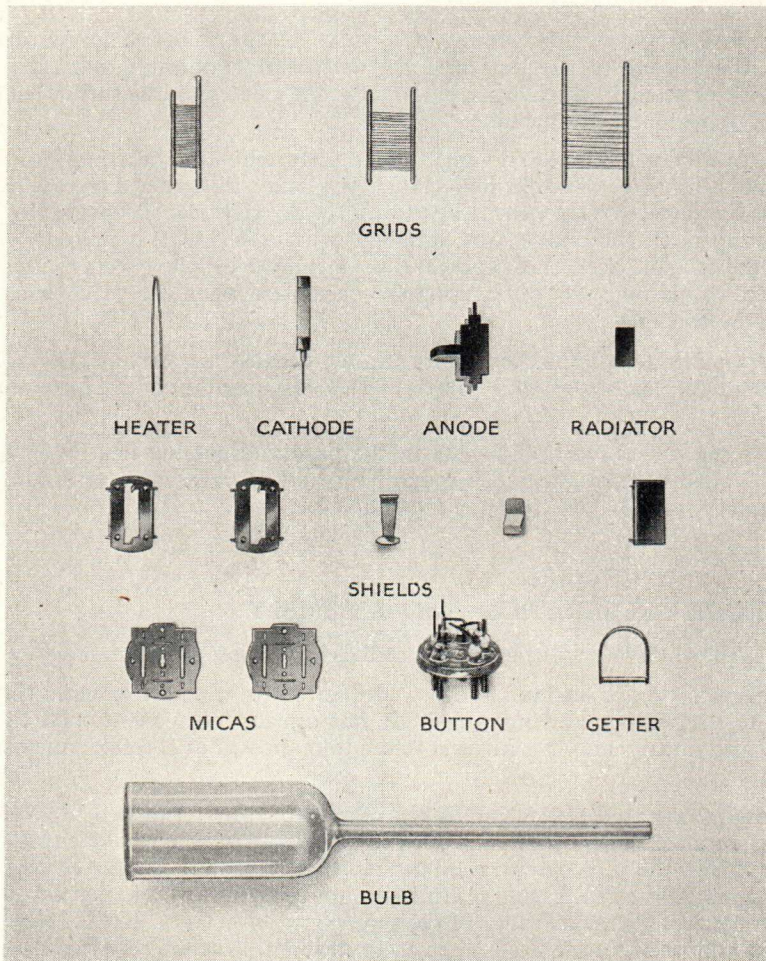
The cathodes in mains valves (and the filaments in those of the battery type) must be subjected to very carefully controlled application of emissive material. It is essential, if the valve is to perform well and consistently, that the surface of each cathode should be evenly coated and that no area should be left uncovered.

The cathodes⁷ of indirectly heated miniature valves are very small. Several different shapes are used, each suited to the design of a particular type of valve. Inside the cathode is the heater, a minute coil of wire, suitably shaped for each

*This and succeeding numbers correspond to those in the "exploded" drawing on page 12.

The making of a miniature valve

particular cathode. The heaters must also be sprayed, in this case with a thin coating of material which has very high insulating qualities at fairly high temperatures. Once more the interests of the user supplied the motives of the research to produce the best insulating substance and of the manufacturing methods which ensure that the coating is continuous and complete.



Set of components used for the assembly of an Osram Z.77 miniature valve

If the insulating material was less effective and its application to the heater less carefully controlled the valve would have considerable "hum." Owing to the high quality of their heater-cathode insulation, Osram miniature mains valves can justly claim to achieve a very high standard in this respect.

PRECISION TOOLING

The electrodes are held firmly and securely in position by the insertion of their supports into holes of precisely the right size, and positioned to within one thousandth of an inch in two mica discs, known as the top and bottom micas.^{8,9}

To avoid any possible microphonic tendencies it is essential that grid supports shall be rigid. For this reason the dimensions of the holes must be such as to produce what is termed an "interference" fit for the supports.

The discs themselves are of mica, treated to ensure the highest possible degree of inter-electrode insulation. Very small leakages would lead to valve "noises" which, however slight, would be *uneconomical*. Uneconomical? Yes, because the valve would be rejected and become a loss when subjected to its "passing out" tests. Nothing is allowed to impair the reputation of Osram valves for maintaining the highest standard of freedom from "noise" which is practicable in a commercial product.

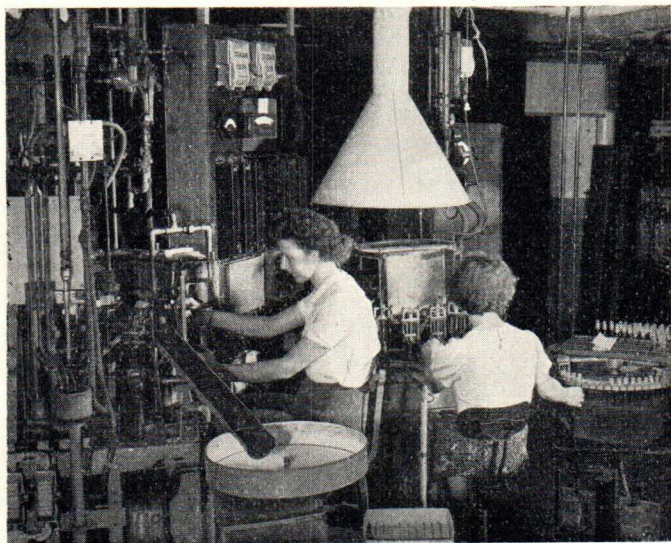
Throughout the various assembly processes minutely accurate jigs and gauges are used to ensure the exact positioning of every component part of the valve.

The electrode connecting wires are spot-welded to their respective pins. To ensure perfect joints of great strength and low resistance, each wire is cleaned by special methods and the spot-welding process is minutely controlled.

The electrode assembly is not yet quite complete. Above the control grid³ is placed a carbonised radiator,¹⁰ the purpose of which is to keep the working temperature of the grid reasonably low. To reduce anode-grid capacitance each mica is provided with a metal screen connected to the cathode.

HIGH VACUUM TECHNIQUE

There is something further to be done before the bulb can be placed over the electrode assembly and sealed to the button.



Complete sealing-in and pumping unit. The operator on the right is taking a seal from the pre-warming machine, prior to loading the sealing-in machine (centre). The operator on the left is taking the sealed-in valve and placing it on the 24-head pump. The collecting chute can be seen in foreground.

The making of a miniature valve

No matter what precautions are taken, considerable numbers of molecules of gas remain in the interstices of the metal parts. That there are innumerable such holes and crannies in even the most highly finished metal surface is difficult to realise until such a surface is seen under a high-powered microscope. If nothing was done to remove them, the gases would be liberated when the metal parts became hot and would impair the vacuum. To overcome this difficulty a substance known as a "getter"¹¹ forms one of the essential components of a valve. Barium, which is commonly used as a getter has the property of absorbing molecules of gas which may escape from the metal parts of the valve during its life, and a component of special form and location containing the getter is welded to the valve structure.

After completion of assembly and the meticulous inspection of every part the tightly fitting bulb¹² with its long thin exhaust tube is pushed on and the valve is sealed on to the button.

Pumping is the next process. After the bulb has been sealed on and pumped, the valve is brought into an intense high frequency magnetic field, intense enough to induce heavy currents in its metal parts and make them become red hot. The heat drives out the trapped gases and at the culminating point the barium getter volatilises. Just before the valve leaves the pump the upper part of the tube is sealed off, leaving the "pip"¹³ at the top of the bulb.

FINAL PROCESSES

The valve has now its final shape and general appearance ; but much remains to be done before it can pass from factory to stock-room as a valve certain to give the user the best possible service.

Its next process is *ageing*, one which consists (a) in developing the emission of the cathode or filament by operating them for carefully controlled times at temperatures (equally carefully controlled) in excess of those of ordinary working conditions ; and (b) in running the valve for a sufficient period under conditions which have been found by research and long experience to ensure stability.

After it has been aged, the valve is ready to undergo the stringent structural, static and dynamic tests awaiting it.

Static tests follow, the number varying according to the type of valve. Any valve which does not conform within prescribed tolerances with the published characteristics of its type is rejected and *every* individual Osram valve has to survive *every* test.

For the final "noise" test the valve is placed in an instrument which feeds its output, highly amplified, to a loudspeaker. Its bulb is now given a succession of sharp, quick raps with a rubber hammer and any response from the loudspeaker means rejection of the valve.

The valve now goes into stock ; but when it is withdrawn from stock to fulfil an order, its performance is not taken for granted. Far from it ; the valve goes to a separate department for visual examination and for a complete retest.

Osram valves have built up through the years a reputation for *consistent* high quality ; with the coming of the miniature, the steps taken to ensure maintenance of this reputation are even more vigorous. This becomes even more essential, as with the advent of television and complex electronic applications the numbers of valves in any one piece of apparatus may be very considerable, and the prevention of failure due to a valve fault proportionately more important.

MINIATURE RECEIVING VALVES

There are complete ranges of Osram miniature valves with B7G (button) or B9A (noval) bases for battery, AC and DC/AC operation. All are preferred types for new equipment.

1. Battery Range (1.4 volt).

The Osram battery range of miniature valves is eminently suitable for use in battery/mains receivers, in which case advantage can be taken of the parallel-series filament arrangement. When operated from a constant voltage source such as the mains supply, it is desirable to maintain the filament supply at 1.25 volts 46 mA in order to combine a long life with adequate performance.

2. A.C. Range (6.3 volt).

Though described as AC mains valves, those forming this range are very suitable for car radio sets or other mobile receivers, since they can be run from either 6 V. or 12 V. accumulators by suitable heater circuit connection. Valves having a heater rating of 0.3 amp. may also be series connected for DC/AC operation.

3. A.C./D.C. Range (0.1 amp.).

This range includes valves equivalent to those in the AC mains range. The heaters are rated at 100 mA at various voltages.

LIST OF TYPES

American equivalent types are shown bracketed.

1.4 volt Dry Battery Valves.

- N17 (3S4) Output pentode.
- N18 (3Q4) Output pentode.
- N19 (3V4) Output pentode.
- W17 (1T4) Variable-mu screened pentode.
- X17 (1R5) Heptode frequency changer.
- ZD17 (1S5) Diode-pentode.

6.3 volt Indirectly heated Valves for AC Mains Operation.

- D77 (6AL5) Double-diode.
- DH77 (6AT6) Double-diode-triode.
- L77 (6C4) Triode.
- N78 Output pentode.
- W77 Variable-mu screened pentode.
- X78 Triode hexode frequency changer.
- X79 Triode hexode frequency changer (B9A base).
- Z77 Screened H.F. pentode.
- U78 (6X4) Rectifier (see page 142).

0.1 amp. Indirectly Heated Valves for DC/AC operation (series heaters).

- DH107 Double-diode-triode.
- N108 Output pentode.
- W107 Variable-mu screened pentode.
- X109 Triode-hexode frequency changer (B9A base).
- U107 Rectifier (see page 143).

0.3 amp. Indirectly Heated Valve for DC/AC operation (series heaters).

- N37 Output pentode.

Also valves in 6.3 volt A.C. mains list above having a heater rating of 0.3 amps.

N17

Osram

VALVES

N17 OUTPUT PENTODE

DESCRIPTION

Type N17 is a miniature output pentode fitted with a centre-tapped filament for series or parallel operation. The valve is interchangeable with the American type 3S4.

RATINGS

	Series	Parallel	
Filament Voltage ...	2.8	1.4	volts
Filament Current ...	0.05	0.10	approx. amp
Anode Voltage ...	90	90	max. volts
Screen Voltage ...	67.5	67.5	max. volts
Cathode Current, no load†	4.5	4.5	max. mA
Cathode Current, full load†	5.5	5.5	max. mA
Mutual Conductance*	1.425	1.575	mA/V

* measured at $V_a = 90$; $V_{g_2} = 67.5$; $V_{g_1} = -7$.

† for each 1.4v. filament section.

Capacitances (taken on valve with external screening) :

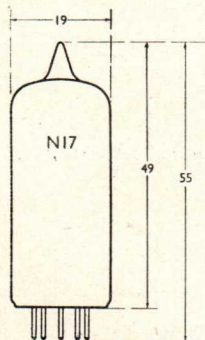
Control Grid to all other electrodes ...	5.2	approx. pF
Anode to all other electrodes ...	4.6	" "
Anode to Control Grid ...	0.35	" "

OPERATING CONDITIONS

Class A Amplifier

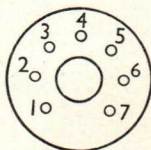
	Series		Parallel		
Anode Voltage ...	90	67.5	90	67.5	volts
Anode Current, no load ...	6.1	6.0	7.4	7.2	mA
Screen Voltage ...	67.5	67.5	67.5	67.5	volts
Screen Current, no load ...	1.1	1.2	1.4	1.5	mA
Control Grid Voltage ...	-7	-7	-7	-7	volts
Input Signal Voltage ...	7	7	7	7	peak volts
Anode Load Resistance ...	8,000	5,000	8,000	5,000	ohms
Distortion ...	13	12	12	10	%
Power Output ...	235	160	270	180	mW

DIMENSIONS



All dimensions are in mm. and are the maximum except where otherwise stated.

BASE



View looking on underside of base.

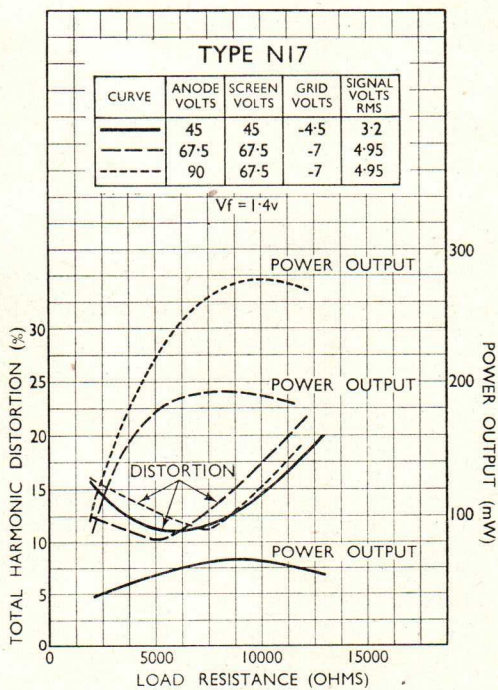
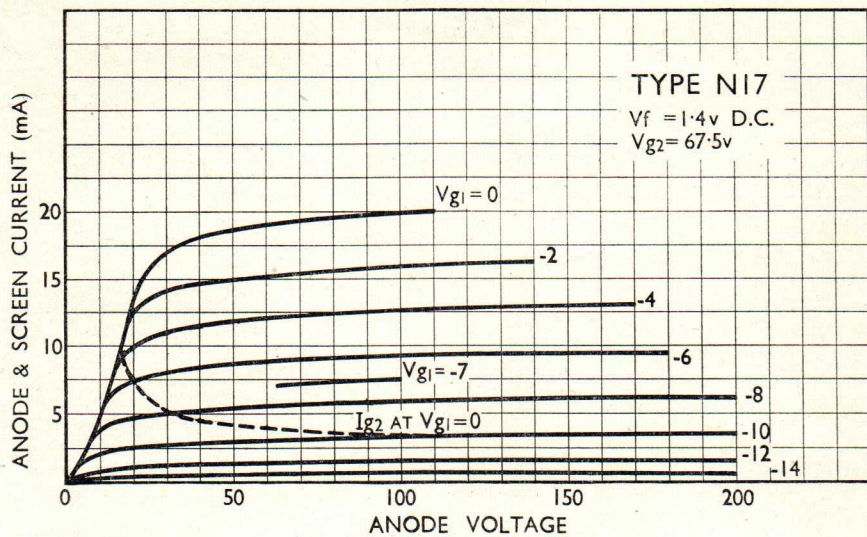
B7G

- Pin 1 : Filament (—series)
2 : Anode
3 : Control Grid, g_1
4 : Screen Grid, g_2
5 : Filament (—parallel)
6 : Anode
7 : Filament (+)

For parallel operation use pins 1 and 7 strapped, and 5.

For series operation use pins 1 and 7 only.

TYPE N17



CHARACTERISTIC CURVES OF AVERAGE VALVE.

N18 N19



N18 and N19 OUTPUT PENTODES

DESCRIPTION

Type N18 is a miniature directly heated output pentode fitted with a centre-tapped filament for series or parallel operation. It is interchangeable with the American type 3Q4.

The N19 is identical in characteristic to the N18 and differs only in the base pin connections. It is interchangeable with the American type 3V4.

RATINGS

	Series	Parallel	
Filament Voltage	2.8	1.4	volts
Filament Current	0.05	0.1	approx. amp.
Anode Voltage	90	90	max. volts
Screen Voltage	90	90	max. volts
Cathode Current*	6	6	max. mA

* For each 1.4 volts filament section.

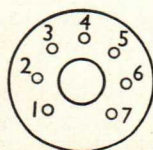
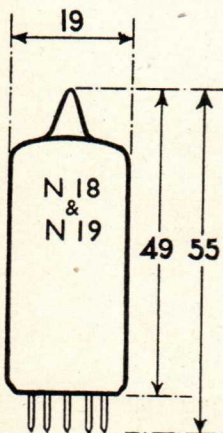
Capacitances (taken on cold valve with no external screening):

Control Grid to all other electrodes	5.6	approx. pF
Anode to all other electrodes	5.3	" "
Anode to Control Grid	0.35	" "

OPERATING CONDITIONS

	Series	Parallel	
Anode Voltage	90	90	volts
Anode Current, no load	7.7	9.5	mA
Screen Voltage	90	90	volts
Screen Current, no load	1.7	2.1	mA
Control Grid Voltage	-4.5	-4.5	volts
Input Signal Voltage	4.5	4.5	peak volts
Impedance	0.12	0.1	megohm
Mutual Conductance	2	2.1	mA/V
Anode Load Resistance	10000	10000	ohms
Distortion	7	7	%
Power Output	240	270	mW

DIMENSIONS



View looking on underside of base.

BASE

B7G

N18

- Pin 1: Filament (—series)
- 2: Anode
- 3: Control Grid, g_1
- 4: Screen Grid, g_2
- 5: Filament (—parallel)
- 6: Anode
- 7: Filament (+)

N19

- Pin 1: Filament (—series)
- 2: Anode
- 3: Screen Grid, g_2
- 4: I.C.
- 5: Filament (—parallel)
- 6: Control Grid, g_1
- 7: Filament (+)

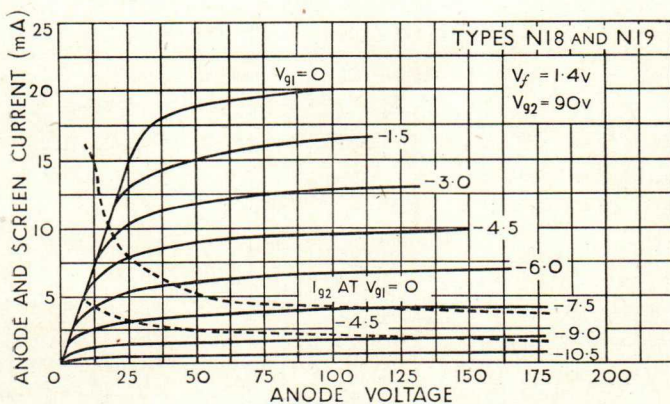
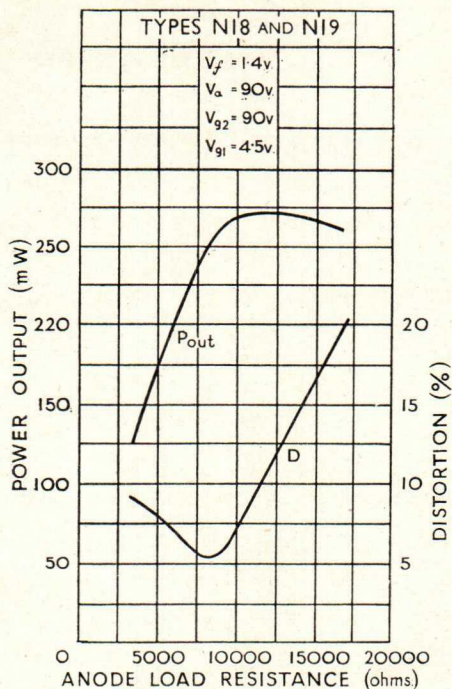
I.C. indicates that no external connection should be made to this pin.

For parallel operation use pins 1 and 7 strapped, and 5.

For series operation use pins 1 and 7 only.

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPES N18 and N19



CHARACTERISTIC CURVES OF AVERAGE VALVE.

W17

Osram

VALVES

W17 VARIABLE-MU SCREENED PENTODE

DESCRIPTION

Type W17 is a miniature variable-mu pentode, suitable for dry battery operation. The W17 is interchangeable with the American type 1T4.

RATINGS

Filament Voltage ...	...	...	...	...	...	...	1.4	volts
Filament Current ...	...	...	...	...	...	...	0.05	approx. amp
Anode Voltage ...	...	...	...	...	...	...	90	max. volts
Screen Voltage ...	...	...	...	...	...	...	67.5	max. volts
Cathode Current ...	...	...	...	...	...	...	5.5	max. mA
Anode Impedance*	...	...	...	...	...	...	0.5	megohm
Mutual Conductance*	...	...	...	...	...	...	0.9	mA/V

* measured at $V_a = 90$; $V_{g_2} = 67.5$; $V_{g_1} = 0$.

Capacitances (taken with external screening) :

Control Grid to all other electrodes ...	...	...	...	...	...	4.5	approx. pF
Anode to all other electrodes ...	...	...	...	...	...	7.5	" "
Anode to Control Grid ...	...	...	...	...	...	0.006	" "

OPERATING CONDITIONS

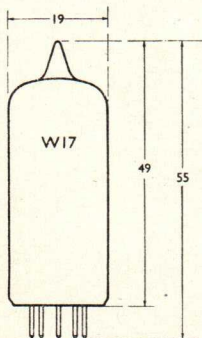
Class A Amplifier

Anode Voltage ...	...	...	90	90	67.5	45	volts
Anode Current ...	...	...	3.5	1.8	3.4	1.7	mA
Screen Voltage ...	...	...	67.5	45	67.5	45	volts
Screen Current ...	...	...	1.4	0.65	1.5	0.7	mA
Control Grid Voltage ...	...	...	0	0	0	0	volts
Control Grid Voltage for Mutual Conductance = $10 \mu\text{A}/\text{volt}$	...	...	-16	-10	-16	-10	volts

PRECAUTIONS IN USE

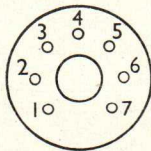
The screen may be supplied from a 90v. source through a series resistor, but the screen voltage must not exceed 67.5v. at zero control grid voltage.

DIMENSIONS



All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.

BASE



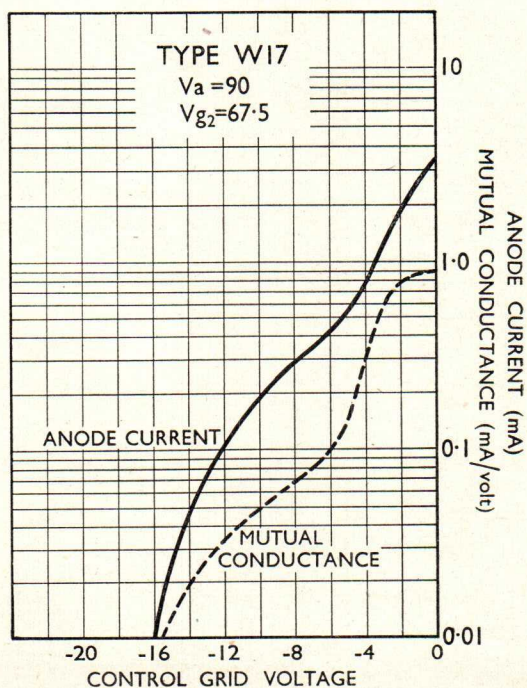
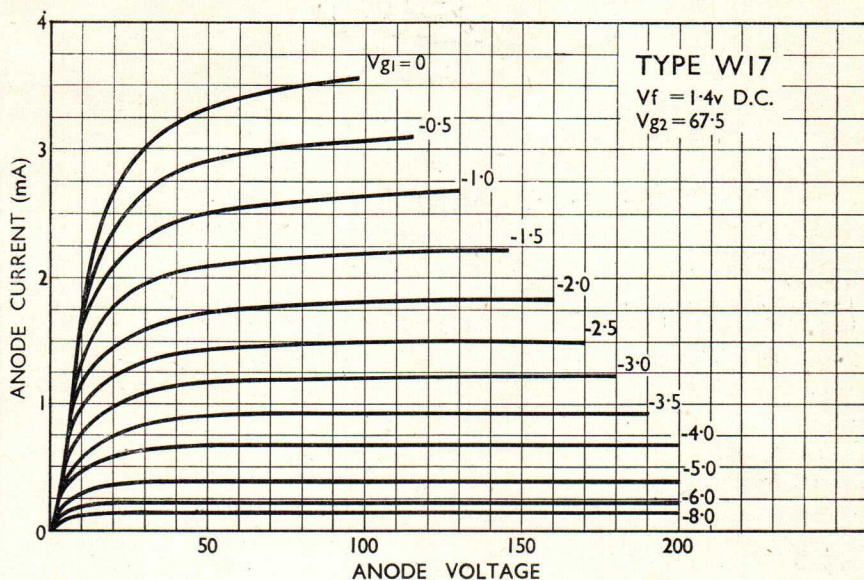
View looking on
underside of base.

B7G

- Pin 1: Filament (-)
2: Anode
3: Screen Grid, g_2
4: Not connected
5: Filament (-)
6: Control Grid, g_1
7: Filament (+)

An internal shield is fitted to this valve
and joined to pins 1 and 5.

TYPE W17



CHARACTERISTIC CURVES OF AVERAGE VALVE.

X17

Osram

VALVES

X17 HEPTODE FREQUENCY CHANGER

DESCRIPTION

Type X17 is a miniature heptode suitable for dry battery operation. When it is used as a frequency changer the screen grid is used as the oscillator anode.

Type X17 is interchangeable with the American type 1R5.

RATINGS

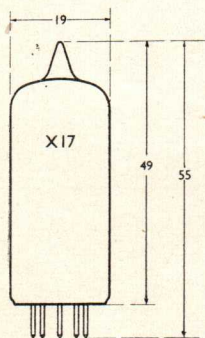
Filament Voltage ...	...	...	...	...	...	1.4	volts
Filament Current ...	...	...	...	...	...	0.05	approx. amp
Anode Voltage ...	...	...	...	...	...	90	max. volts
Screen Supply Voltage ...	...	...	...	...	...	90	max. volts
Screen Voltage ...	...	...	...	...	...	67.5	max. volts
Control Grid Voltage ...	...	...	...	...	...	0	max. volts
Total Cathode Current ...	...	...	...	...	...	5.5	max. mA
Conversion Impedance, at $V_{g_3}=0^*$...	...	...	...	...	...	0.75	megohm
Conversion Conductance, at $V_{g_3}=0^*$...	...	...	...	...	...	250	$\mu A/V$
Conversion Conductance, at $V_{g_3}=-9^*$...	...	...	...	...	...	5	$\mu A/V$

* measured at $V_a = 90$, $V_{g_2, 4} = 45$.

Capacitances (taken on valve with no external screening) :

Control Grid to all other electrodes ...	...	...	...	...	7.0	approx. pF.
Anode to all other electrodes ...	...	...	...	...	7.0	" "
Osc. Grid to all other electrodes ...	...	...	...	...	3.8	" "
Anode to Control Grid ...	...	...	...	...	0.4	" "
Osc. Grid to Control Grid ...	...	...	...	...	0.2	" "
Osc. Grid to Anode ...	...	...	...	...	0.1	" "

DIMENSIONS

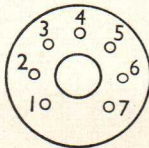


All dimensions are in mm.
and are the maximum except where otherwise stated.

BASE

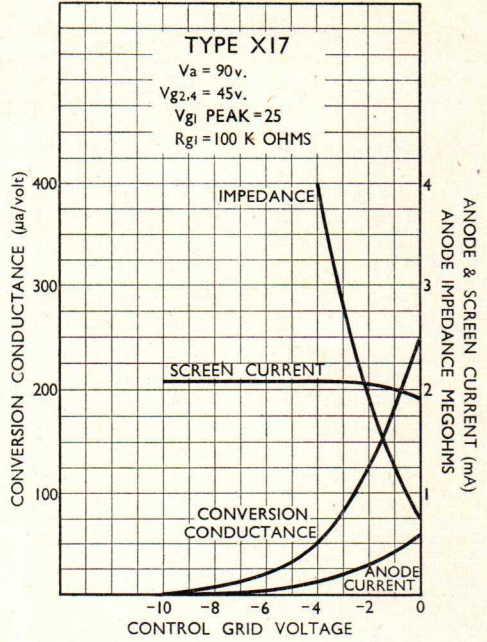
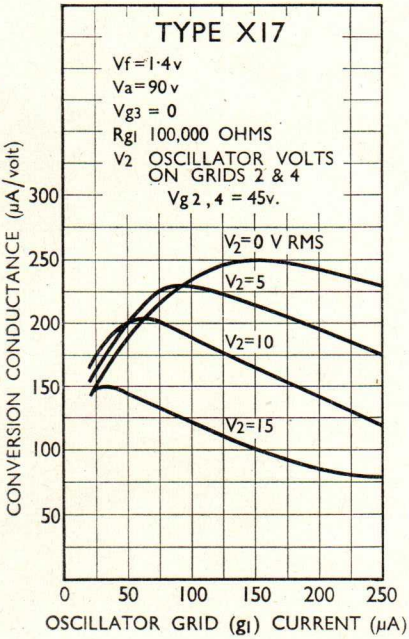
B7G

- Pin 1 : Filament (-), and Suppressor Grid, g_5
2 : Anode
3 : Oscillator Anode, g_2 , $\dagger$
4 : Oscillator Grid, g_1
5 : Filament (-), and Suppressor Grid, g_5
6 : Control Grid, g_3
7 : Filament (+)



View looking on
underside of base.

TYPE X17



CHARACTERISTIC CURVES OF AVERAGE VALVE.

ZD17

Osram

VALVES

ZD17 DIODE-PENTODE

DESCRIPTION

Type ZD17 is a miniature diode-pentode, suitable for dry battery operation. The valve is interchangeable with the American type 1S5.

RATINGS

Filament Voltage ...	...	...	...	...	...	1.4	volts
Filament Current ...	...	...	...	...	...	0.05	approx. amp
Anode Voltage ...	...	...	...	...	...	90	max. volts
Screen Voltage ...	...	...	...	...	...	90	max. volts
D.C. Cathode Current ...	...	...	...	...	...	3.0	max. mA
Impedance* ...	...	...	...	...	...	0.6	megohm
Mutual Conductance* ...	...	...	...	...	...	0.63	mA/V

* measured at $V_a = V_{g_2} = 67.5$; $V_{g_1} = 0$.

Capacitances (taken on cold valve with no external screening):

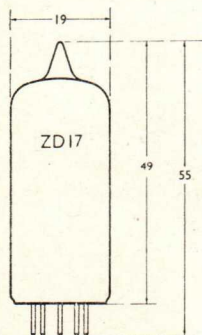
Control Grid to all other electrodes ...	...	...	...	...	2.2	approx. pF
Anode to all other electrodes ...	...	...	...	...	2.4	" "
Anode to Control Grid ...	...	...	...	...	0.2	" "
Diode to Anode ...	...	...	...	...	0.45	" "
Diode to Control Grid ...	...	...	...	...	0.5	" "
Diode to Filament ...	...	...	...	...	1.4	" "

OPERATING CONDITIONS

Class A Amplifier

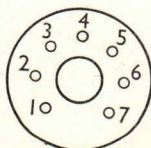
Anode and Screen Supply Voltage ...	...	90	67.5	45	volts
Series Screen Resistor ...	...	$R_a \times 5$	$R_a \times 5$	$R_a \times 5$	megohms
D.C. Control Grid Voltage ...	...	0	0	0	volts
Control Grid Resistor ...	...	10	10	10	megohms
Anode Load Resistor ...	...	0.5-1	0.5-1	0.5-1	megohm
Stage Gain ...	...	50	40	30	

DIMENSIONS



All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.

BASE



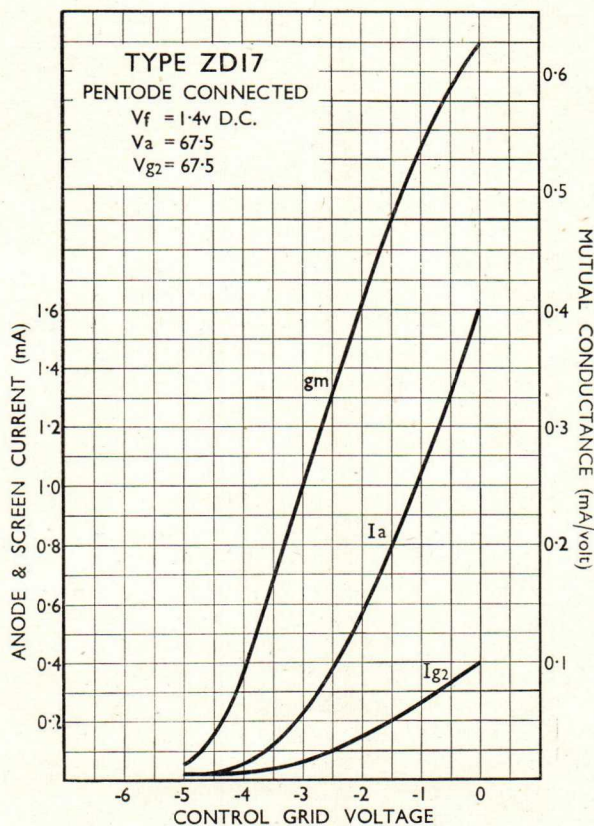
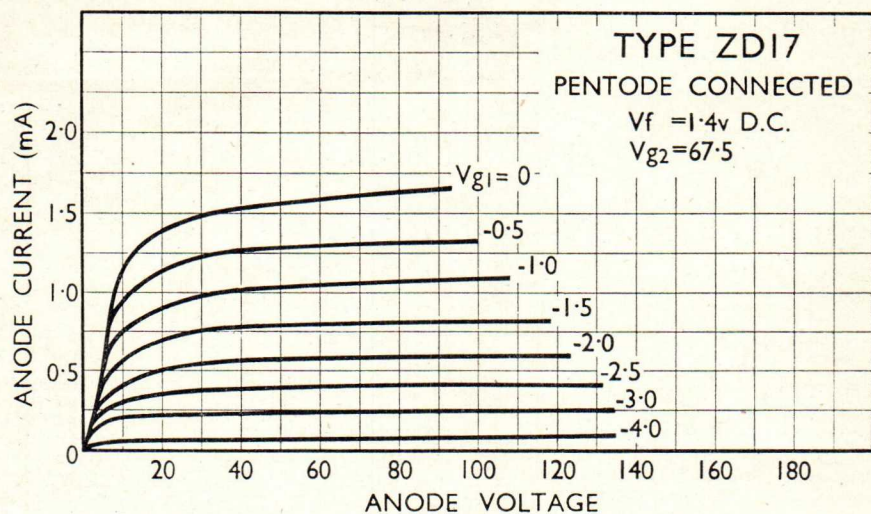
View looking on
underside of base.

B7G

- Pin 1: Filament (-)
2: Not connected
3: Diode Anode
4: Screen Grid, g_2
5: Pentode Anode
6: Control Grid, g_1
7: Filament (+)

The diode anode is mounted at the negative
end of the filament.

TYPE ZD17



CHARACTERISTIC CURVES OF AVERAGE VALVE.

D77



D77 DOUBLE-DIODE

DESCRIPTION

Type D77 is an indirectly heated double-diode in the miniature range, consisting of two low impedance H.F. diodes with a common heater and separate cathodes.

The valve is interchangeable with the American type 6AL5.

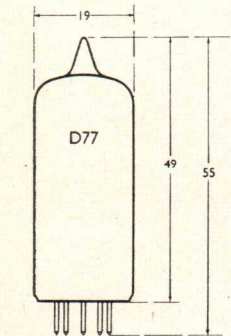
RATINGS

Heater Voltage	...	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	...	0.3	approx. amp
Anode Current	...	...	...	...	...	...	...	5.0	max. mA
Peak Anode Current	...	...	...	...	...	...	...	50	max. mA
Peak Inverse Voltage	...	...	...	...	...	...	...	350	max. volts

Capacitances (taken on valve with external screening can) :

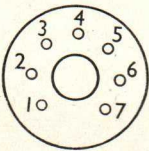
Anode' to Cathode' + Heater and Shield	...	...	...	...	...	...	...	3.5	approx. pF
Anode" to Cathode" + Heater and Shield	...	...	...	...	...	...	...	3.5	" "
Anode' to Anode"	...	...	...	...	...	...	...	0.025	" "

DIMENSIONS



All dimensions are in m/m and are maximum except where otherwise stated.

BASE

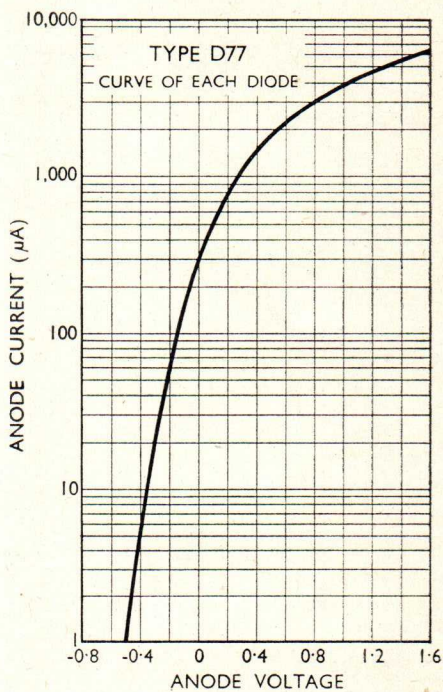
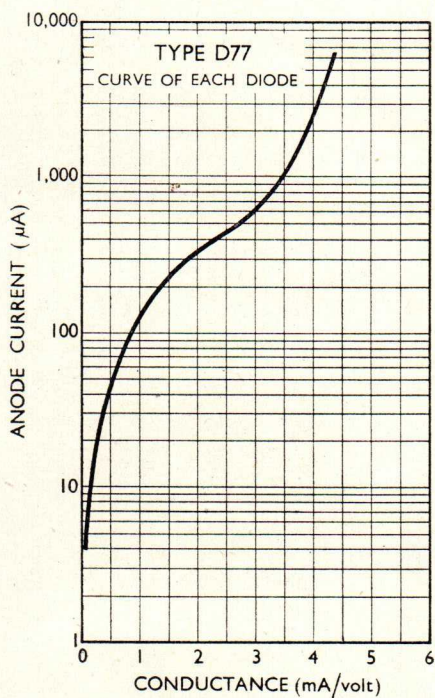


View looking on underside of base.

B7G

- Pin 1 : Cathode"
- 2 : Anode'
- 3 : Heater
- 4 : Heater
- 5 : Cathode'
- 6 : Shield
- 7 : Anode"

TYPE D77



CHARACTERISTIC CURVES OF AVERAGE VALVE

DH77

Osram

VALVES

DH77 DOUBLE-DIODE-TRIODE

DESCRIPTION

Type DH77 is a double-diode triode mounted on the miniature B7G all-glass base. It is designed for parallel heater operation.

RATINGS

Heater Voltage	...	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	...	0.3	approx. amp
Anode Voltage	...	...	...	...	...	...	...	250	max. volts
Amplification Factor	...	...	...	...	...	...	...	70	
Impedance	...	...	...	...	...	...	...	58,000	ohms
Mutual Conductance	...	...	...	...	...	...	...	1.2	mA/V

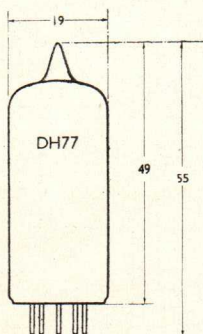
Capacitances (taken on unscreened valve) :

Control Grid to Anode	...	...	...	...	...	...	...	1.9	approx. pF
Anode to Cathode	...	...	...	...	...	...	...	1.1	" "
Control Grid to Cathode	...	...	...	...	...	...	...	2.0	" "
Diode" to Cathode	...	...	...	...	...	...	...	1.5	" "
Diode' to Cathode	...	...	...	...	...	...	...	1.1	" "
Diode" to Diode'	...	...	...	...	...	...	...	0.4	" "
Diode" to Control Grid	...	...	...	...	...	...	...	0.05	" "
Diode' to Control Grid	...	...	...	...	...	...	...	0.04	" "
Diode" to Anode	...	...	...	...	...	...	...	0.17	" "
Diode' to Anode	...	...	...	...	...	...	...	0.24	" "

OPERATING CONDITIONS

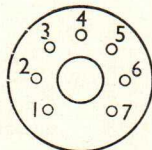
Anode Voltage	...	...	...	...	...	...	...	250	volts
Anode Current	...	...	...	...	...	...	...	1	mA
Control Grid Voltage	...	...	...	...	...	...	...	-3	volts
Cathode Bias Resistor	...	...	...	...	...	...	...	2,000	ohms
Anode Load	...	...	...	...	...	...	...	0.25	megohm

DIMENSIONS



BASE

B7G



View looking on underside of base.

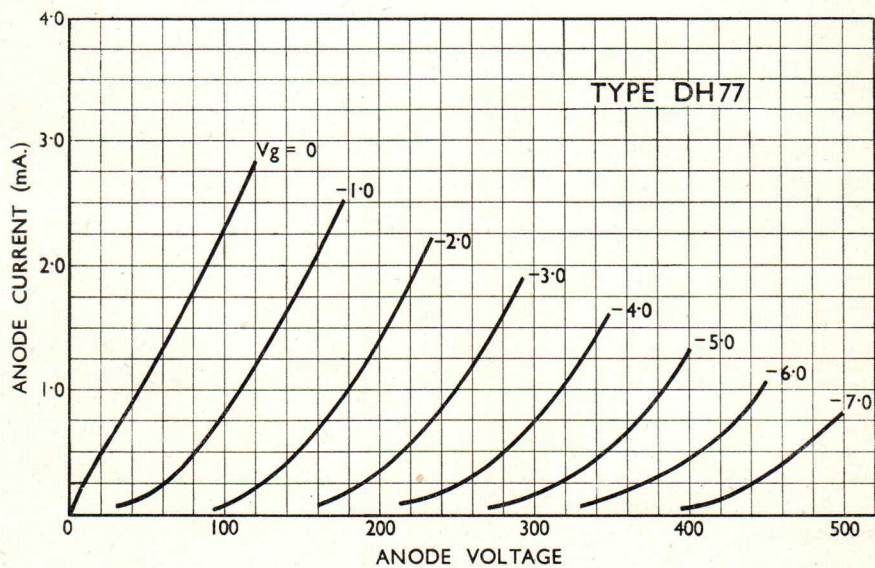
- Pin 1 : Control Grid
2 : Cathode
3 : Heater
4 : Heater
5 : Signal Diode, d"
6 : A.V.C. Diode, d'
7 : Anode

All dimensions are in mm. and are maximum except where otherwise stated.

SCREENING. No internal or external screening is fitted to the valve.

MOUNTING. Any position.

TYPE DH77



CHARACTERISTIC CURVES OF AVERAGE VALVE.

L77



L77 TRIODE

DESCRIPTION

The L77 is an indirectly heated triode suitable for operation up to 250 Mc/s. It is mounted on the miniature B7G base.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.15	amp
Anode Voltage	...	...	...	...	...	300	max. volts
Anode Dissipation	...	...	...	...	...	3.5	max. watts
Amplification Factor	...	...	...	...	...	17*	
Mutual Conductance	...	...	...	...	...	2.2*	mA/V
Impedance	...	...	...	...	...	7,700*	ohms

* Measured at $V_a=250$, $V_g=-8.5$, $I_a=10.5$ mA.

Capacitances (taken on unscreened valve) :

Grid to Cathode	...	...	...	...	...	1.7	approx. pF
Anode to Cathode	...	...	...	...	...	2.6	" "
Grid to Anode	...	...	...	...	...	2.0	" "

SCREENING

No internal or external screening is fitted to the valve. A separate screening canister should be used when application demands.

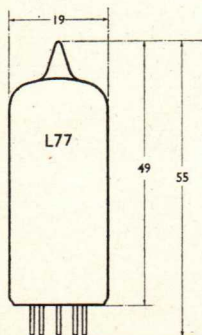
MOUNTING

Any position.

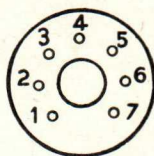
RETENTION

It is recommended that a retaining device is employed.

DIMENSIONS



BASE



View looking on underside of base.

B7G

- Pin 1 : Anode
 2 : I.C.
 3 : Heater
 4 : Heater
 5 : Anode
 6 : Grid
 7 : Cathode

I.C. indicates that this pin must not be used for any external connection.

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPICAL OPERATING CONDITIONS

Class A A.F. Amplifier

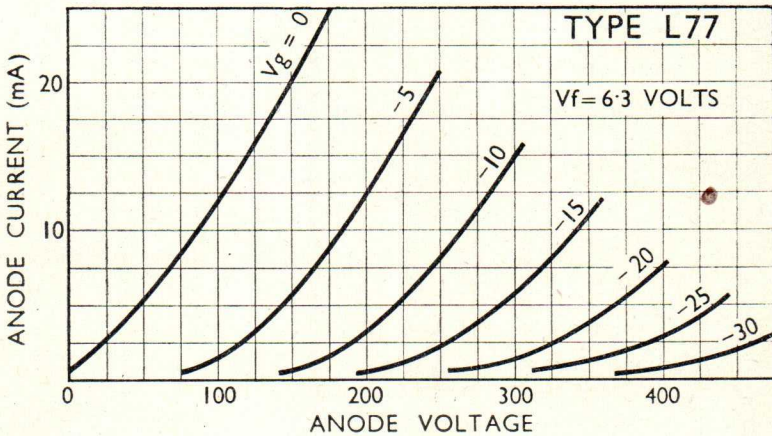
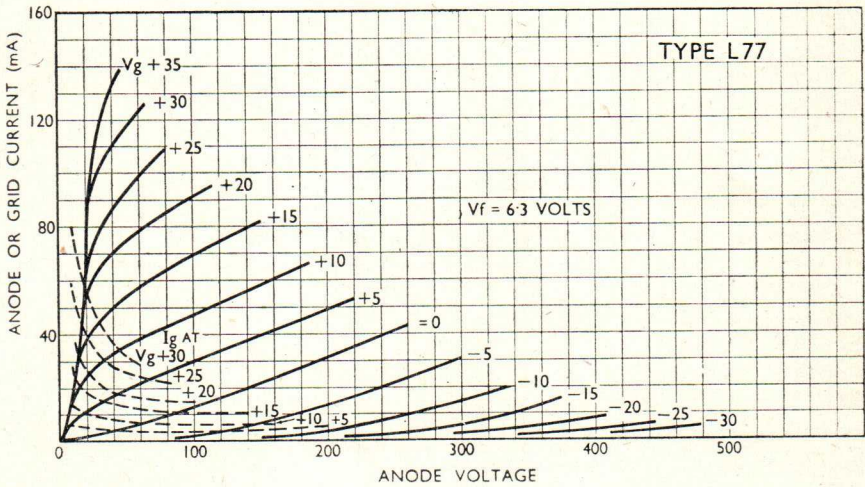
Anode Voltage	...	...	...	...	100	250	volts
Grid Voltage	...	...	...	...	0	-8.5	volts
Anode Current	...	...	...	...	12	10.5	mA
Amplification Factor	...	...	...	...	19.5	17	
Impedance	...	...	...	...	6,250	7,700	ohms
Mutual Conductance	...	...	...	...	3.1	2.2	mA/V

Under maximum rated conditions, the resistance in the grid circuit should not exceed 0.25 megohm with fixed bias or 1 megohm with cathode bias.

TYPE L77

R.F. POWER AMPLIFIER AND OSCILLATOR. Class C Telegraphy.

D.C. Anode Voltage	...	...	...	...	...	...	...	300	volts
D.C. Grid Voltage	...	...	...	...	...	...	...	-27	volts
D.C. Anode Current	...	...	...	...	...	...	...	25	mA
D.C. Grid Current	...	...	...	...	...	...	...	7	approx. mA
Input Power	...	...	...	...	...	...	...	0.35	approx. watt
Power Output	...	...	...	...	...	...	...	5.5	approx. watts



CHARACTERISTIC CURVES OF AVERAGE VALVE.

N78

Osram

VALVES

N78 OUTPUT PENTODE

DESCRIPTION

Type N78 is a high slope indirectly heated pentode mounted on the B7G miniature base, and is primarily intended for use as an audio power amplifier.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.64	approx. amp
					Pentode connected	Triode connected	
Anode Voltage	...	...	...	...	250	250	max. volts
Screen Voltage	...	...	...	...	250		max. volts
Anode Dissipation	...	...	...	...	9	12	max. watts
Screen Dissipation	...	...	...	...	3		max. watts
Peak Heater/Cathode Voltage	...	...	...	...	150	150	max. volts
Amplification Factor*	...	...	...	...	420	24	
Impedance*	...	...	...	...	40,000	2,100	ohms
Mutual Conductance*	...	...	...	...	10.5	11.4	mA/V

* measured at $V_a = V_{g_2} = 250$; $V_{g_1} = -5$

Capacitances :

Anode to All other Electrodes	...	...	...	...	10.5	approx. pF
Control Grid to All other Electrodes	...	...	...	...	11.5	" "
Anode to Control Grid	...	...	...	...	0.3	" "

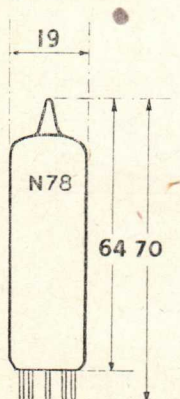
OPERATING CONDITIONS

Single Valve, Class A, Pentode connection.

Anode Voltage	...	...	...	...	...	250	volts
Screen Voltage	...	...	...	...	...	250	volts
Control Grid Voltage	...	...	...	...	...	-5	approx. volts
Anode Current (no signal)	...	...	...	...	...	35	mA
Screen Current (no signal)	...	...	...	...	...	5.5	mA
Anode Load	...	...	...	...	...	7,000	ohms
Input Signal Voltage	...	...	...	...	...	5.0	peak volts
Power Output	...	...	...	...	...	4	watts
Distortion	...	...	...	...	...	9.2	%
Cathode Bias Resistor	...	...	...	...	...	120	ohms

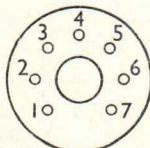
The external grid circuit resistance should be kept as low as possible and should not exceed 250,000 ohms with auto bias or 100,000 ohms with fixed bias.

DIMENSIONS



BASE

B7G



View looking on underside of base.

- Pin 1 : Control Grid
2 : Cathode and Suppressor
3 : Heater
4 : Heater
5 : Anode
6 : IC
7 : Screen Grid

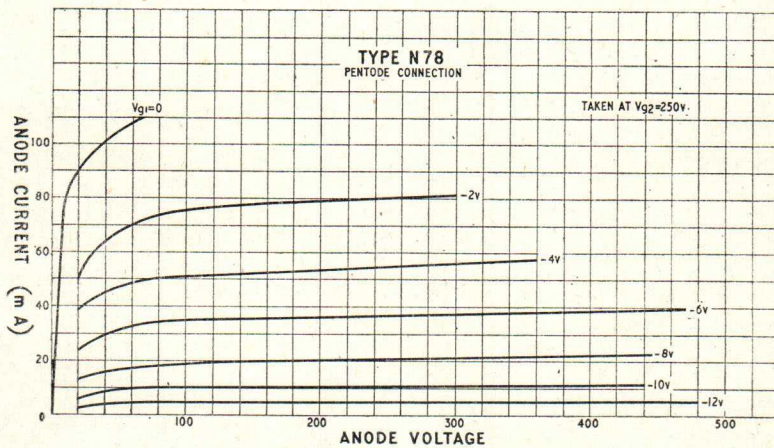
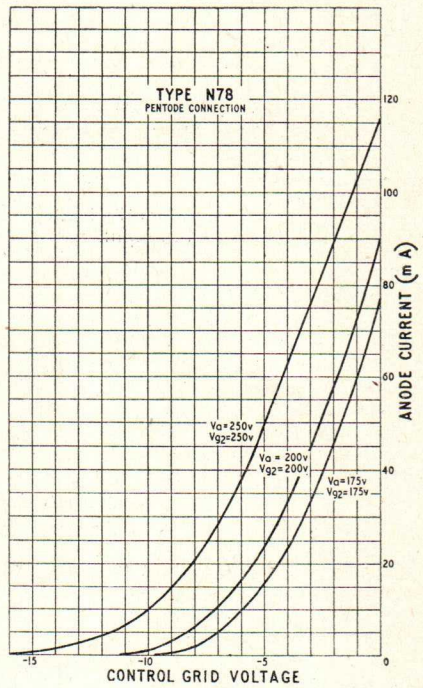
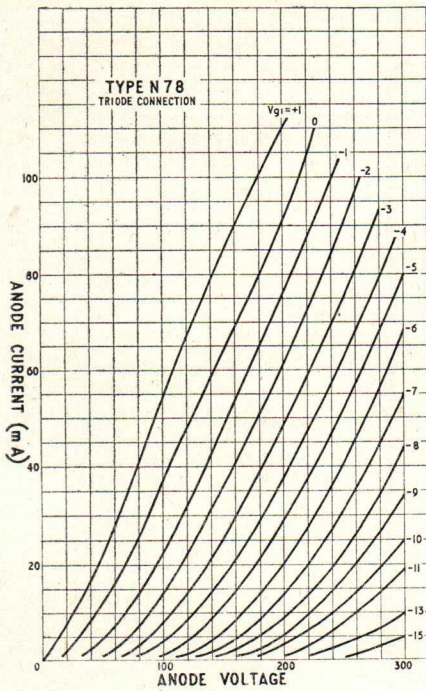
IC indicates that this pin must not be used for any external connection.

All dimensions are in mm. and are the maximum except where otherwise stated.

VENTILATION

It is recommended that free air circulation be employed whenever possible. Where a retaining device in the form of a metal canister is employed the surfaces should be blackened.

TYPE N78



CHARACTERISTIC CURVES OF AVERAGE VALVE.

W77

Osram

VALVES

W77 VARIABLE-MU SCREENED PENTODE

DESCRIPTION

Type W77 is an indirectly heated variable-mu pentode in the miniature range, and is suitable for R.F. and I.F. amplifiers.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.2	approx. amps
Anode Voltage	...	...	...	...	...	250	max. volts
Anode Dissipation	...	...	...	...	...	2.5	max. watts
Screen Voltage	...	...	...	...	...	250	max. volts
Screen Dissipation	...	...	...	...	...	0.5	max. watts
Impedance*	...	...	...	...	...	0.5	approx. megohm
Mutual Conductance*	...	...	...	...	...	2.5	mA/V

* measured at $V_a = V_{g_2} = 200$; $V_{g_1} = -2.5$

Capacitances (taken on valve with external screening can) :

Control Grid to all other electrodes	...	...	...	...	4.2	approx. pF
Anode to all other electrodes	...	...	...	...	7.0	" "
Anode to Control Grid	...	...	...	...	0.006	" "

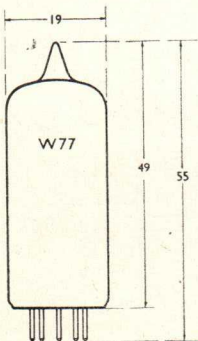
OPERATING CONDITIONS

R.F. Amplifier, Class A

Anode Voltage	...	...	...	...	200	200	volts
Screen Voltage	...	...	...	...	200	200	volts
Suppressor Voltage	...	...	...	...	0	0	volts
Anode Current	...	...	...	...	8.0	7.7	mA
Screen Current	...	...	...	...	2.0	1.9	mA
Cathode Bias Resistor	...	...	...	...	250	270	ohms
Control Grid Voltage	...	...	...	...	-2.5	-2.7	volts

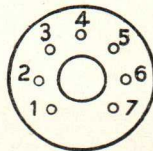
The effective external grid to cathode resistance should not exceed 4 megohms.

DIMENSIONS



All dimensions are in mm and are the maximum except where otherwise stated.

BASE



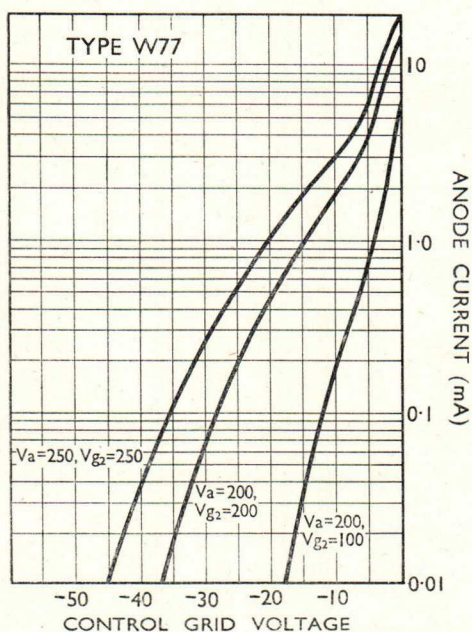
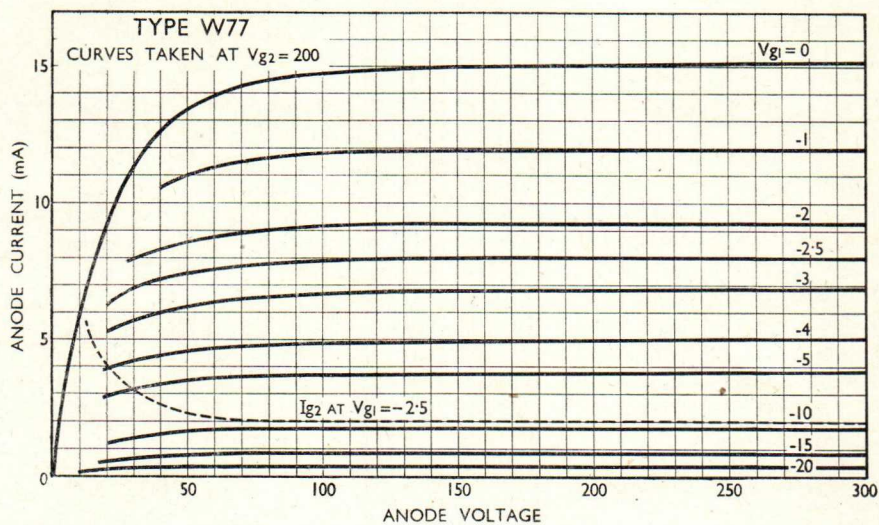
View looking on underside of base.

B7G

- Pin 1 : Control Grid, g_1
2 : Cathode
3 : Heater
4 : Heater
5 : Anode
6 : Suppressor Grid, g_3 and Shield
7 : Screen Grid, g_2

An internal shield is fitted to this valve and joined to pin 6.

TYPE W77



CHARACTERISTIC CURVES OF AVERAGE VALVE.

X78 and X79 TRIODE-HEXODE FREQUENCY CHANGERS

DESCRIPTION

Type X78 and X79 are triode-hexode frequency changers mounted on the B7G and B9A base respectively. Both types have identical electrical characteristics and are suitable for use up to 100 Mc/s.

RATINGS

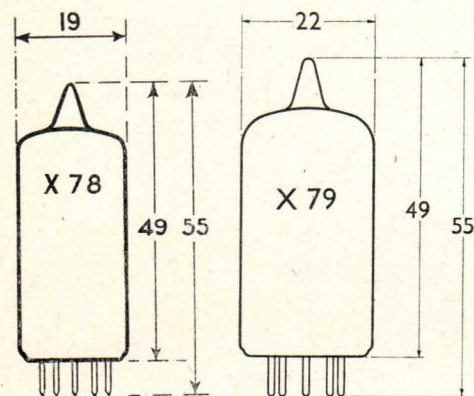
Heater Voltage	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	0.3	approx. amp
Hexode Anode Voltage	...	...	...	...	...	...	250	max. volts
Screen Grid Voltage	...	...	...	...	...	...	100	max. volts
Triode Anode Voltage	...	...	...	...	...	...	100	max. volts
Cathode Current	...	...	...	...	...	...	20	max. mA
Optimum Triode Grid Voltage	...	...	...	...	...	...	10	peak volts
Triode Amplification Factor	...	...	...	...	...	...	22*	
Triode Mutual Conductance	...	...	...	...	...	...	2.8*	mA/V

* measured at $V_{at}=100$, $V_{gt}=0$.

Capacitances (taken on unshielded valve):

Control Grid to Hexode Anode	...	...	...	...	...	0.11	approx. pF
Control Grid to Triode Anode	...	...	...	...	...	0.08	" "
Control Grid to Triode Grid	...	...	...	...	...	0.22	" "
Triode Grid to Triode Anode	...	...	...	...	...	1.48	" "
Control Grid to all other electrodes	...	...	...	...	...	4.1	" "
Triode Anode to all other electrodes (Triode grid earthed)	...	...	...	...	...	1.5	" "
Triode Grid to all other electrodes (Triode anode earthed)	...	...	...	...	...	5.47	" "
Hexode Anode to all other electrodes	...	...	...	...	...	4.34	" "

DIMENSIONS



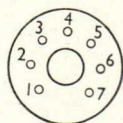
All dimensions are in mm. and are the maximum except where otherwise stated.

BASES

X78

B7G

- Pin 1: Screen Grid
2: Control Grid
3: Heater and Cathode
4: Heater
5: Hexode Anode
6: Triode Anode
7: Triode Grid

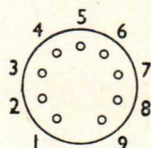


View looking on underside of base.

X79

B9A

- Pin 1: Screen Grid
2: Control Grid
3: Cathode
4: Heater
5: Heater
6: Hexode Anode
7: Triode Grid
8: Triode Anode
9: I.C.



View looking on underside of base.

I.C. No external connections should be made to this pin.

TYPES X78 & X79

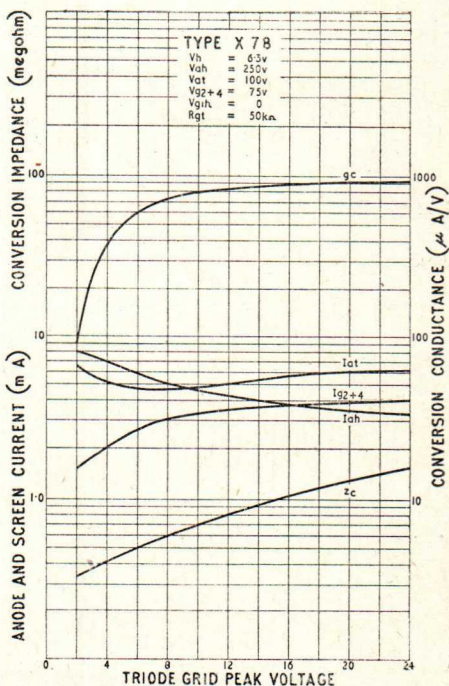
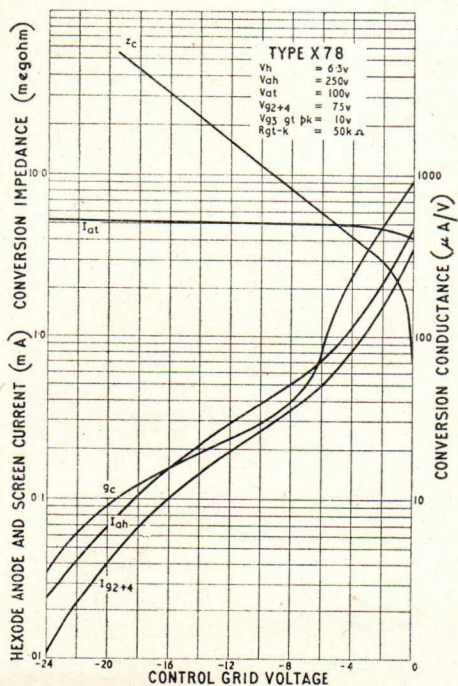
OPERATING CONDITIONS

Hexode Anode Voltage	...	...	...	...	...	250	volts
Screen Grid Voltage	...	...	...	...	...	75	volts
Triode Anode Voltage	...	...	...	...	...	100	volts
Triode Grid Voltage	...	...	...	...	...	10	peak volts
Control Grid Voltage	...	...	...	...	...	0	volts
Hexode Anode Current	...	...	...	...	...	4.5	mA
Screen Grid Current	...	...	...	...	...	3.4	mA
Triode Anode Current	...	...	...	...	...	4.5	mA
Conversion Conductance	...	...	...	...	...	780	$\mu\text{A/V}$
Conversion Impedance	...	...	...	...	...	0.7	megohm
Triode Grid Resistor	...	...	...	...	...	0.05	megohm
Equivalent Noise Resistance†	...	...	...	...	...	150,000	ohms
Input Impedance at 45 Mc/s.	...	...	...	...	...	3,500	ohms
Control Grid to Cathode Capacitance at 45 Mc/s.	...	...	...	...	...	6	pF

† Referred to Control Grid.

KEY TO SYMBOLS

zc	Conversion Impedance
gc	Conversion Conductance
lah	Hexode Anode Current
lg ₂₊₄	Screen Grid Current
lat	Triode Anode Current



CHARACTERISTIC CURVES OF AVERAGE VALVES.

Z77

Osram
VALVES

Z77 SCREENED PENTODE

DESCRIPTION

Type Z77 is an indirectly heated high slope pentode mounted on the miniature B7G base, and is primarily intended for use in wide-band high frequency amplifiers.

RATINGS

	Pentode connected	Triode connected	
Heater Voltage	6.3	6.3	volts
Heater Current	0.3	0.3	amp
Heater/Cathode Voltage	150	150	peak volts
Anode Voltage	250	250	max. volts
Anode Dissipation	2.5	3.3	max. watts
Screen Voltage	250		max. volts
Screen Dissipation	0.8		max. watt
Impedance	0.3*	0.01†	megohm
Amplification Factor		75†	
Mutual Conductance	7.5*	7.5†	mA/V

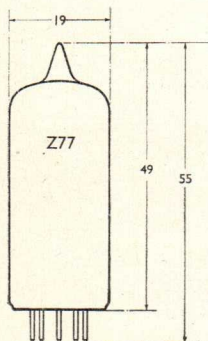
*measured at $V_a = V_{g_2} = 250$; $I_a = 10$ mA

†measured at $V_a + V_{g_2} = 250$; $V_{g_1} = -2$

Capacitances (taken on cold valve with external screening) :

Grid to all other electrodes	7.4	approx. pF
Anode to all other electrodes	3.1	" "
Anode to Grid	0.009	" "

DIMENSIONS

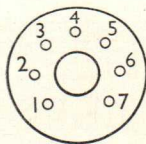


*All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.*

BASE

B7G

- Pin 1: Control grid, g_1
 2: Cathode
 3: Heater
 4: Heater
 5: Anode
 6: Suppressor grid, g_2
 7: Screen grid, g_3



View looking on
underside of base.

TYPE Z77

OPERATING CONDITIONS

Class A Amplifier

	Pentode connected		Triode connected	
	250	200	250†	
Anode Voltage	250	200	250†	volts
Anode Current (no signal)	10	8.3	12.5†	mA
Anode Dissipation (no signal)	2.5	—	—	watts
Suppressor Grid Voltage	0	0	—	volts
Screen Grid Voltage	250	200	—	volts
Screen Grid Current (no signal)	2.5	2.1	—	mA
Screen Dissipation (no signal)	0.63	0.42	—	watts
Cathode Bias Resistance	160	—	160	ohms
Control Grid Voltage	-2	-1.5	-2	volts

† combined anode and screen ratings.

CLASS A AMPLIFIER. PENTODE CONNECTION

Anode and Suppressor Voltage	28	volts
Screen Voltage	8	volts
Anode Current	0.75	mA
Screen Current	0.15	mA
Anode Load Resistance	22,000	ohms
Cathode Bias Resistor	2,200	ohms
Gain	30	db

MIXER. PENTODE CONNECTION

Series injection to control grid

Anode Voltage	250	volts
Screen Voltage	250	volts
Suppressor Voltage	0	volts
Anode Current	4.5	mA
Screen Current	1.5	mA
Cathode Bias Resistor	680	ohms
Oscillator Voltage	4.5	peak volts
Conversion Conductance	2.7	mA/V

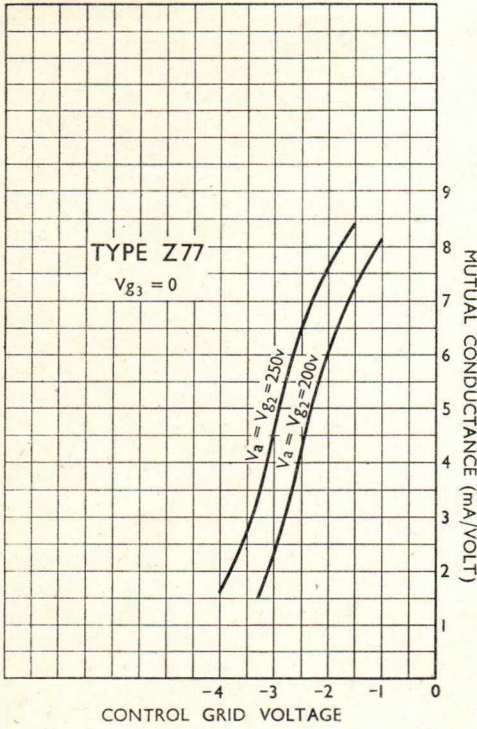
GENERAL

Control Grid to Cathode Capacitance	10	pF
Anode to Cathode Capacitance	3	pF
Heater to Cathode Capacitance	4	pF
Input Resistance at 45 Mc/s.	9,000	ohms
Equivalent Noise at Control Grid	1,000	ohms

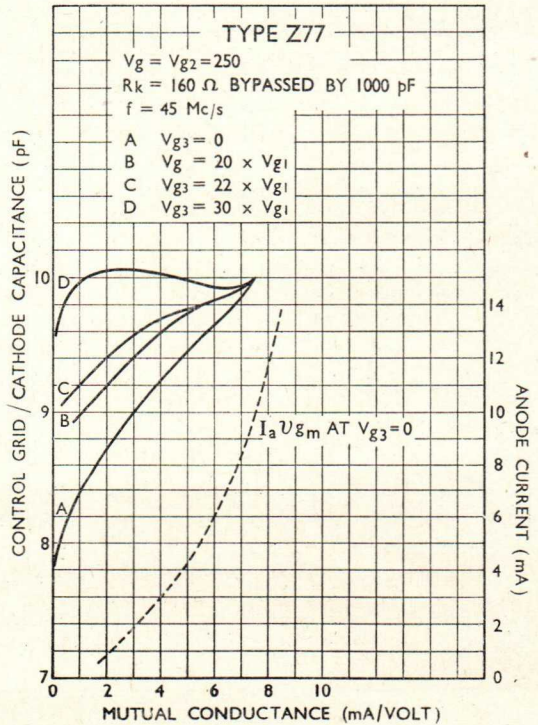
All above measured at $V_a = V_{g_2} = 250$; $V_{g_3} = 0$; $I_a = 10$ mA.

Under conditions of maximum anode and screen dissipation, the effective external control grid-to-cathode resistance should not exceed 0.5 megohm with auto-bias, or 0.1 megohm with fixed bias.

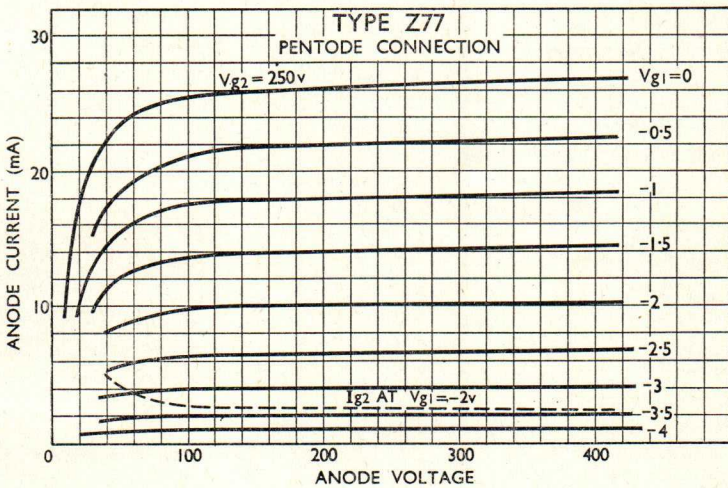
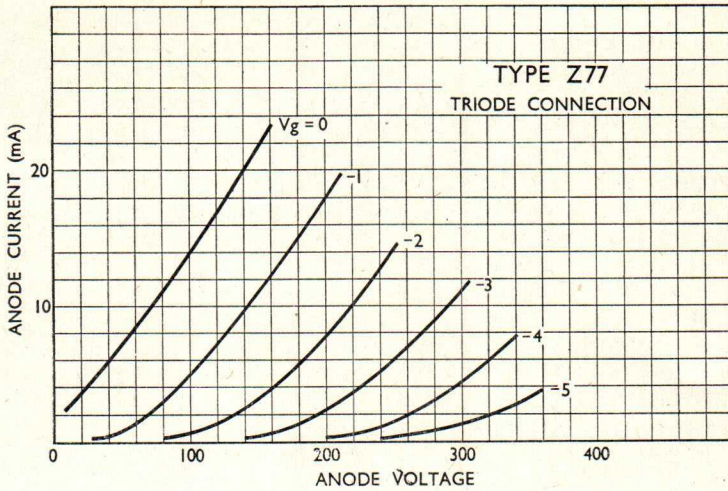
TYPE Z77



CHARACTERISTIC CURVES OF
AVERAGE VALVE.



TYPE Z77



CHARACTERISTIC CURVES OF AVERAGE VALVE.

DH107



DH107 DOUBLE-DIODE-TRIODE

DESCRIPTION

Type DH107 is a double-diode triode mounted on the miniature B7G all-glass base. It is designed for series heater operation.

RATINGS

Heater Current	...	...	...	...	...	...	...	0.1	amp
Heater Voltage	...	...	...	...	...	...	...	19	approx. volts
Anode Voltage	...	...	...	...	...	...	...	250	max. volts
Amplification Factor	...	...	...	...	...	...	...	70	
Impedance	...	...	...	...	...	...	...	58,000	ohms
Mutual Conductance	...	...	...	...	...	...	...	1.2	mA/V

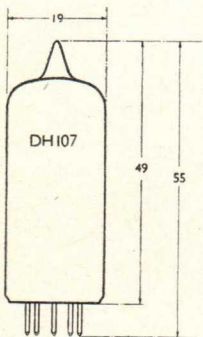
Capacitances (taken on unscreened valve) :

Control Grid to Anode	...	...	...	...	...	...	...	1.9	approx. pF
Anode to Cathode	...	...	...	...	...	...	...	1.1	" "
Control Grid to Cathode	...	...	...	...	...	...	...	2.0	" "
Diode" to Cathode	...	...	...	...	...	...	...	1.5	" "
Diode' to Cathode	...	...	...	...	...	...	...	1.1	" "
Diode" to Diode'	...	...	...	...	...	...	...	0.4	" "
Diode" to Control Grid	...	...	...	...	...	...	...	0.05	" "
Control Grid	...	...	...	...	...	...	...	0.04	" "
Diode" to Anode	...	...	...	...	...	...	...	0.17	" "
Diode' to Anode	...	...	...	...	...	...	...	0.24	" "

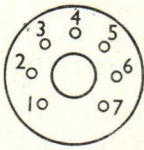
OPERATING CONDITIONS

Anode Voltage	...	...	...	...	...	...	...	250	volts
Anode Current	...	...	...	...	...	...	...	1	mA
Control Grid Voltage	...	...	...	...	...	...	...	-3	volts
Cathode Bias Resistor	...	...	...	...	...	...	...	2,000	ohms
Anode Load	...	...	...	...	...	...	...	0.25	megohm

DIMENSIONS



BASE



View looking on underside of base.

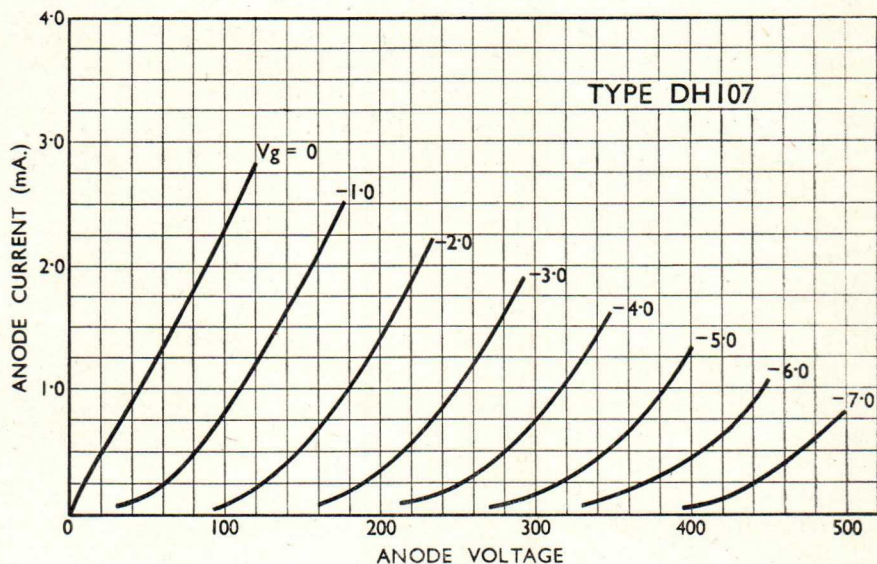
B7G

- Pin 1 : Control Grid
- 2 : Cathode
- 3 : Heater
- 4 : Heater
- 5 : Signal Diode, d"
- 6 : A.V.C. Diode, d'
- 7 : Anode

All dimensions are in mm. and are the maximum except where otherwise stated.

- SCREENING. No internal or external screening is fitted to the valve.
- MOUNTING. Any position.

TYPE DH107



CHARACTERISTIC CURVES OF AVERAGE VALVE.

N37 N108



N37 and N108 OUTPUT PENTODES

DESCRIPTION

Types N37 and N108 are high slope indirectly heated pentodes mounted on the B7G miniature base. Both types are identical except for the heater rating, and are intended for use as audio power amplifiers in universal equipments. The N37, owing to its heater rating, has special application in D.C./A.C. television receivers.

RATINGS

	N37	N108	
Heater Current	0.3	0.1	amp
Heater Voltage	13	40	approx. volts
Peak Heater/Cathode Voltage		150	max. volts
	Pentode connected	Triode connected	
Anode Voltage	165	165	max. volts
Screen Voltage	165		max. volts
Anode Dissipation	9	11.3	max. watts
Screen Dissipation	2.3		max. watts
Amplification Factor*	285	105	
Impedance*	28,500	950	ohms
Mutual Conductance*	10	11.25	mA/V

* measured at $V_a = V_{g_2} = 165$; $V_{g_1} = -8$.

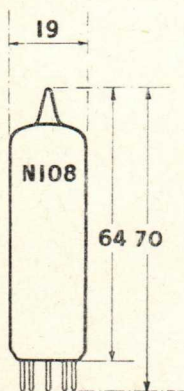
Capacitances :

Anode to all other electrodes	10.5	approx. pF
Control Grid to all other electrodes	10.5	" "
Anode to Control Grid	0.3	" "

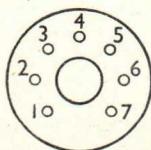
VENTILATION

It is recommended that free air circulation be employed wherever possible. Where a retaining device in the form of a metal cannister is employed the surfaces should be blackened.

DIMENSIONS



All dimensions are in mm.
and are the maximum except
where otherwise stated.



View looking on
underside of base.

The dimensions of
N37 are identical.

BASE

B7G

- Pin 1: Control Grid
2: Cathode and Suppressor
3: Heater
4: Heater
5: Anode
6: 1C
7: Screen Grid

1C indicates that this pin must not be
used for any external connection.

TYPES N37 and N108

OPERATING CONDITIONS

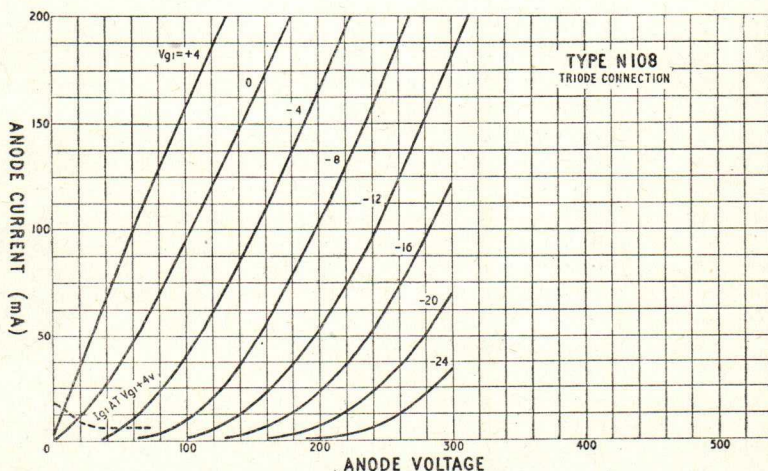
Single Valve, Class A, Pentode Connection.

Anode Voltage	...	...	...	...	...	...	165	volts
Screen Voltage	...	...	...	...	...	...	165	volts
Control Grid Voltage	...	...	...	...	...	...	-8	approx. volts
Anode Current (no signal)	...	...	...	...	...	...	54.5	mA
Screen Current (no signal)	...	...	...	...	...	...	7	mA
Anode Dissipation	...	...	...	...	...	...	9	watts
Screen Dissipation	...	...	...	...	...	...	1.2	watts
Anode Load	...	...	...	...	...	...	3 000	ohms
Input Signal Voltage	...	...	...	...	...	...	7.7	peak volts
Power Output	...	...	...	...	...	...	4	watts
Distortion (total)	...	...	...	...	...	...	10	%
Cathode Bias Resistor	...	...	...	...	...	...	120	ohms

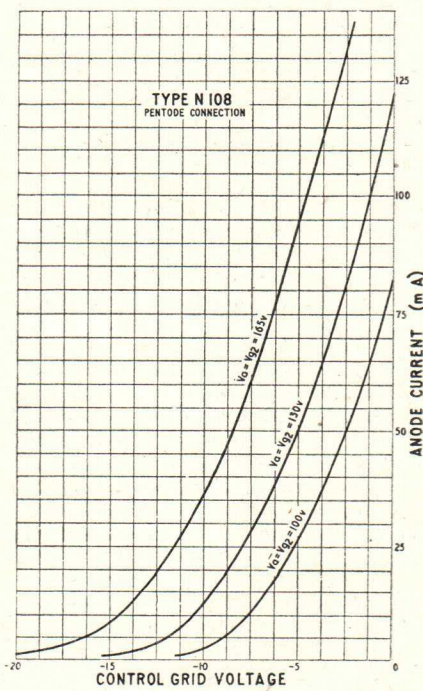
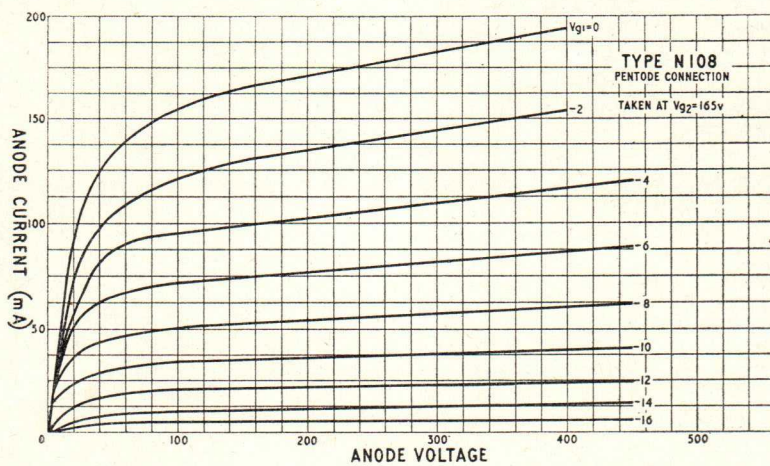
Low Voltage Condition.

Anode Voltage	...	...	...	...	...	...	100	volts
Screen Voltage	...	...	...	...	...	...	100	volts
Control Grid Voltage	...	...	...	...	...	...	-4.4	approx. volts
Anode Current (no signal)	...	...	...	...	...	...	31	mA
Screen Current (no signal)	...	...	...	...	...	...	3.3	mA
Anode Dissipation	...	...	...	...	...	...	3.1	watts
Screen Dissipation	...	...	...	...	...	...	0.33	watts
Anode Load	...	...	...	...	...	...	3,000	ohms
Input Signal Voltage	...	...	...	...	...	...	4	peak volts
Power Output	...	...	...	...	...	...	1.2	watts
Distortion (total)	...	...	...	...	...	...	10	%
Cathode Bias Resistor	...	...	...	...	...	...	120	ohms

The external grid circuit resistance should be kept as low as possible, and should not exceed 250,000 ohms with auto bias or 100,000 ohms with fixed bias.



TYPES N37 and N108



CHARACTERISTIC CURVES OF AVERAGE VALVE.



W107 VARIABLE-MU SCREENED PENTODE

DESCRIPTION

Type W107 is a variable-mu H.F. pentode mounted on the miniature B7G all-glass base. It is designed for series heater operation.

RATINGS

						Pentode Connection	Triode Connection	
Heater Current	...	...	...	...	...	0.1	0.1	amp
Heater Voltage	...	...	...	...	...	12.6	12.6	volts
Cathode Current	...	...	...	...	...	12	12	mA
Anode Voltage	...	...	...	...	...	250	250†	max. volts
Screen Grid Voltage	...	...	...	...	...	250	—	max. volts
Anode Dissipation	...	...	...	...	...	2.5	3†	max. watts
Screen Grid Dissipation	...	...	...	...	...	0.5	—	max. watt
Impedance*	...	...	...	...	...	0.5	0.01	megohm
Mutual Conductance*	...	...	...	...	...	2.5	3	mA/V
Amplification Factor*	...	...	...	...	...	...	30	

* Measured at $V_a = V_{g_2} = 200$; $V_{g_1} = -2.5$.

† Combined Anode and Screen ratings.

Capacitances (taken on screened valve) :

Anode to all other electrodes	...	...	...	...	...	7	approx. pF
Grid to all other electrodes	...	...	...	...	...	4.2	" "
Anode to Grid	...	...	...	...	...	0.006	" "

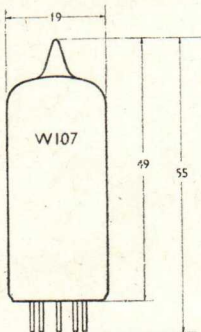
OPERATING CONDITIONS

Class A Amplifier—Pentode Connection

Anode Voltage	...	...	...	...	...	200	200	volts
Screen Grid Voltage	...	...	...	...	...	200	200	volts
Suppressor Grid Voltage	...	...	...	...	...	0	0	volts
Control Grid Voltage	...	...	...	...	...	-2.5	-2.7	volts
Anode Current	...	...	...	...	...	8	7.7	mA
Screen Grid Current	...	...	...	...	...	2	1.9	mA
Cathode Bias Resistor	...	...	...	...	...	250	270	ohms

The effective external grid-to-cathode resistance should not exceed 4 megohms.

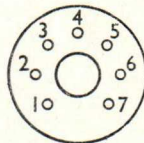
DIMENSIONS



BASE

B7G

- Pin 1: Control Grid, g_1
 2: Cathode
 3: Heater
 4: Heater
 5: Anode
 6: Suppressor Grid, g_3
 7: Screen Grid, g_2



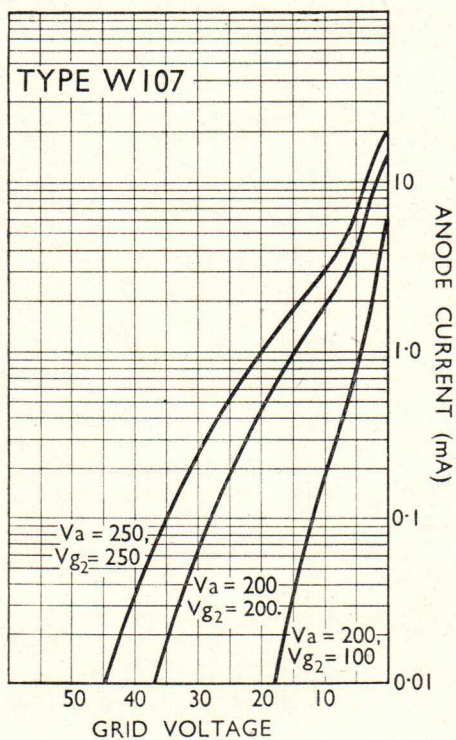
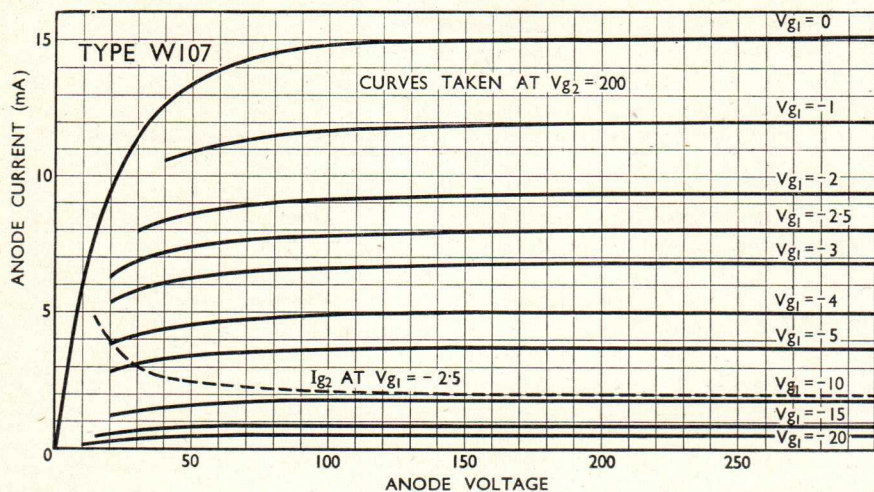
View looking on underside of base.

All dimensions are in mm. and are the maximum except where otherwise stated.

SCREENING. No internal or external screening is fitted to the valve.

MOUNTING. Any position.

TYPE W107



CHARACTERISTIC CURVES OF AVERAGE VALVE.



X109 · TRIODE-HEXODE FREQUENCY CHANGER

DESCRIPTION

Type X109 is a triode-hexode mounted on the B9A miniature base and is intended for series heater operation in DC/AC equipments. It is suitable for use at frequencies up to 100 Mc/s.

RATINGS

Heater Current	...	...	...	...	...	0.1	amp
Heater Voltage	...	...	...	...	...	19	volts
Hexode Anode Voltage	...	...	...	...	...	250	max. volts
Screen Grid Voltage	...	...	...	...	...	100	max. volts
Triode Anode Voltage	...	...	...	...	...	100	max. volts
Cathode Current	...	...	...	...	...	20	mA
Optimum Triode Grid Voltage	...	...	...	...	...	10	peak volts
Triode Amplification Factor	...	...	...	...	...	22*	
Triode Mutual Conductance	...	...	...	...	...	2.8*	mA/V

* Measured at $V_{at} = 100$, $V_{gt} = 0$, $I_{at} = 10$ mA.

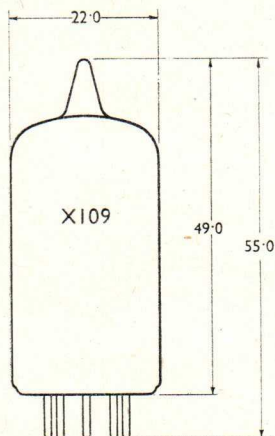
Capacitances (measured on unshielded valve) :

Control Grid to Hexode Anode	...	...	...	...	...	0.11	approx. pF
Control Grid to Triode Anode	...	...	...	...	...	0.08	" "
Control Grid to Triode Grid	...	...	...	...	...	0.22	" "
Triode Grid to Triode Anode	...	...	...	...	...	1.48	" "
Control Grid to all other electrodes	...	...	...	...	...	4.1	" "
Triode Anode to all other electrodes (triode grid earthed)	...	...	...	...	...	1.5	" "
Triode Grid to all other electrodes (triode anode earthed)	...	...	...	...	...	5.47	" "
Hexode Anode to all other electrodes	...	...	...	...	...	4.34	" "

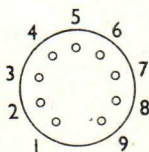
OPERATING CONDITIONS

Hexode Anode Voltage	...	...	...	...	...	175	volts
Screen Grid Voltage	...	...	...	...	...	75	volts
Triode Anode Voltage	...	...	...	...	...	100	volts
Triode Grid Voltage	...	...	...	...	...	10	peak volts
Control Grid Voltage	...	...	...	...	...	0	volts
Hexode Anode Current	...	...	...	...	...	4.3	mA
Screen Grid Current	...	...	...	...	...	3.6	mA

DIMENSIONS



BASE



View looking on underside of base.

B9A

- Pin 1 : Screen Grid
- 2 : Control Grid
- 3 : Cathode
- 4 : Heater
- 5 : Heater
- 6 : Hexode Anode
- 7 : Triode Grid
- 8 : Triode Anode
- 9 : I.C.

I.C. indicates that no external connection should be made to this pin.

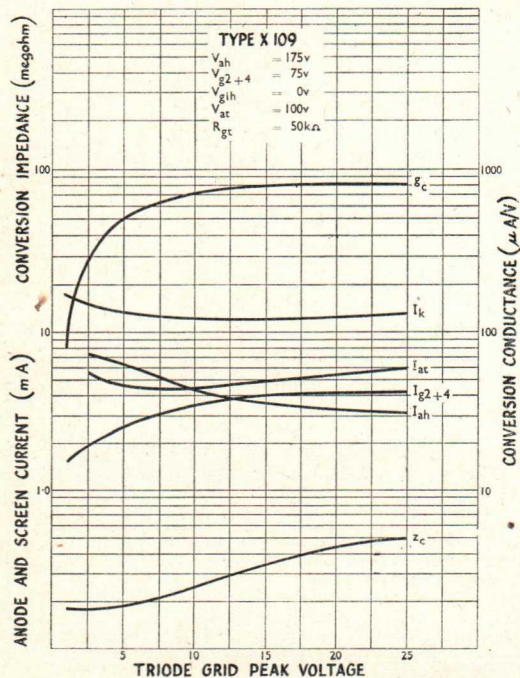
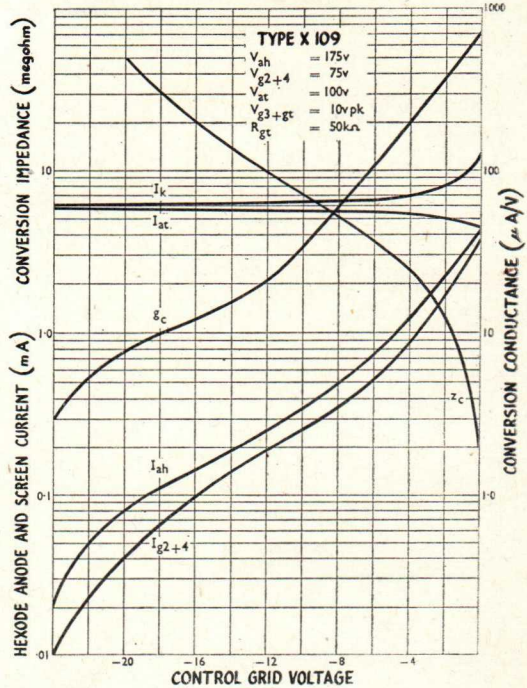
All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE X109

OPERATING CONDITIONS—continued

Triode Anode Current	...	4.5	mA
Conversion Conductance	...	710	$\mu\text{A/V}$
Conversion Impedance	...	0.25	megohm
Triode Grid Resistor	...	0.05	megohm
Equivalent Noise Resistance†	...	150,000	ohms
Input Impedance at 45 Mc/s	...	3,600	ohms
Control Grid to Cathode Capacitance at 45 Mc/s	...	6.0	pF

† Referred to Control Grid.



KEY TO SYMBOLS.

Z_c	Conversion Impedance.
g_c	Conversion Conductance.
I_{ah}	Hexode Anode Current.
I_{g2+4}	Screen Grid Current.
I_{at}	Triode Anode Current.
V_{g3+gt}	Triode Grid Voltage

CHARACTERISTIC CURVES OF AVERAGE VALVE

OCTAL-BASED RECEIVING VALVES

The following valves with the international octal base are listed. With the exception of the B36 and KT36 television types and KT66 beam power tetrode, all these valves are recommended as *Maintenance types* only and are *not* preferred types for new equipment.

LIST OF TYPES

American equivalent types are shown bracketed.

B36	(12SN7G) Double triode.
B65	(6SN7G) Double triode.
D63	(6H6G) Double-diode.
DH63	(6Q7G) Double-diode-triode.
DL63	(6R7G) Double-diode-triode.
H63	(6F5G) Triode.
L63	(6J5G) Triode.
KT32	(25L6G) Output tetrode.
KT33C	Output tetrode.
KT36	Power tetrode.
KT61	Output tetrode.
KT63	(6F6G) Output tetrode.
KT66*	Power tetrode.
KTW63	(6U7G or 6K7G) Variable-mu H.F. pentode.
W61	Variable-mu screened pentode.
X61M	Triode-hexode frequency changer.
X63	(6A8G) Heptode frequency changer.
X65	Triode-hexode frequency changer.
Y61	Tuning indicator.
Y63	Tuning indicator.
Z63	(6J7G) Screened pentode.
Z66	Screened pentode.

(For rectifiers see pages 121—144).

* See also Section, *Power Amplifying Valves*.



B36 DOUBLE TRIODE

DESCRIPTION

Type B36 is an indirectly heated double triode with separate cathodes. The valve is electrically interchangeable with the American type 12SN7GT.

RATINGS

Heater Current	...	...	...	...	...	...	...	0.3	amp
Heater Voltage	...	...	...	...	...	...	...	12.6	volts
each unit									
Anode Voltage	...	...	...	...	...	...	...	300	max. volts
Anode Dissipation	...	...	...	...	...	...	...	2.5	max. watts
Cathode Current	...	...	...	...	...	...	...	20	max. mA
D.C. Heater/Cathode Voltage	...	...	...	...	...	...	...	150	max. volts
Amplification factor*	...	...	...	...	...	...	...	20	
Impedance*	...	...	...	...	...	...	...	7,700	ohms
Mutual Conductance*	...	...	...	...	...	...	...	2.6	mA/V

* measured at Va = 250 ; Vg1 = -8.

Capacitances :

						Triode'	Triode''	
Control Grid to Anode	...	...	...	...	...	4.5	4.5	approx. pF
Control Grid to Cathode	...	...	...	...	...	3.5	3.7	" "
Anode to Cathode	...	...	...	...	...	1.5	1.2	" "
Anode' to Anode''	...	...	...	...	...		1.0	" "

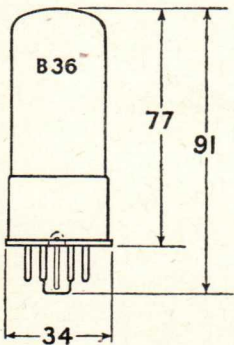
OPERATING CONDITIONS (each unit)

Class A Amplifier

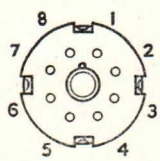
Anode Supply Voltage	...	...	...	...	...	250	250	volts
Cathode Voltage	...	...	...	...	...	2.52	1.46	volts
Anode Current	...	...	...	...	...	5.75	6.65	mA
Cathode Resistor	...	...	...	...	...	440	220	ohms
Anode Resistor	...	...	...	...	...	22,000	22,000	ohms
Stage Gain	...	...	...	...	...	15.5	16	
Peak Output Voltage	...	...	...	...	...	32	18.5	volts
Distortion	...	...	...	...	...	2	1	%

Under maximum rated conditions the D.C. resistance in the grid circuit must not exceed 1 megohm per unit.

DIMENSIONS



BASE



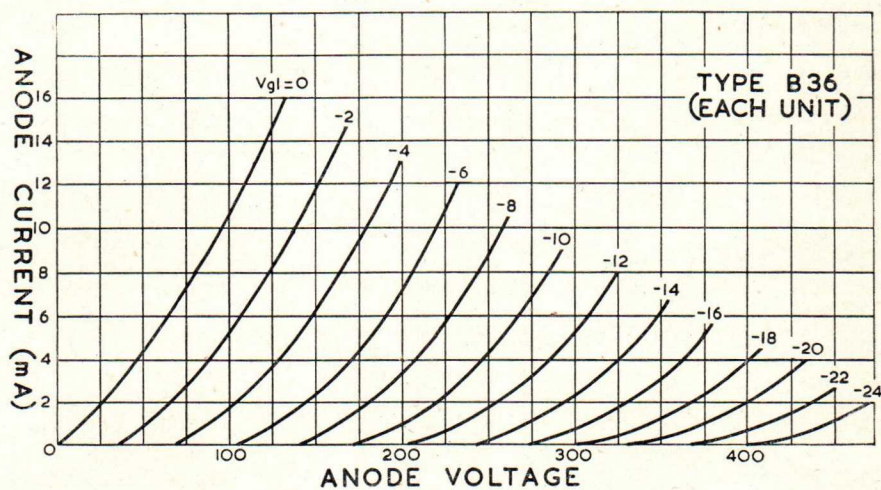
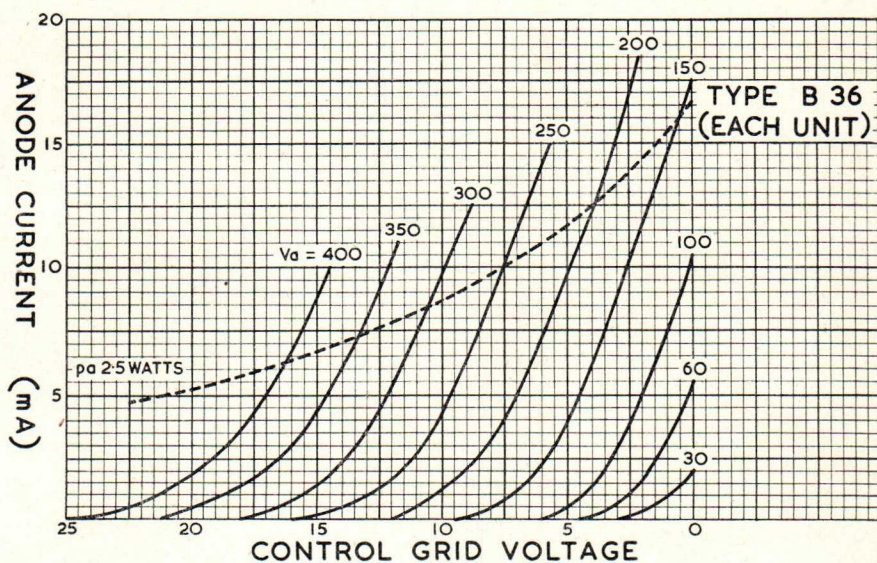
View looking on underside of base.

8-PIN OCTAL

- Pin 1 : Control grid*
- 2 : Anode*
- 3 : Cathode*
- 4 : Control grid'
- 5 : Anode'
- 6 : Cathode'
- 7 : Heater
- 8 : Heater

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE B36



CHARACTERISTIC CURVES OF AVERAGE VALVE.

B65



B65 DOUBLE TRIODE

DESCRIPTION

Type B65 is an indirectly heated double triode with separate cathodes. The valve is electrically interchangeable with the American type 6SN7GT.

RATINGS

Heater Voltage	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	0.6	approx. amp
Each unit								
Anode Voltage	...	...	...	...	...	...	300	max. volts
Anode Dissipation	...	...	...	...	...	...	2.5	max. watts
Control Grid Voltage	...	...	...	...	...	...	0	volts
D.C. Heater/Cathode Voltage	...	...	...	...	...	...	150	max. volts
Cathode Current	...	...	...	...	...	...	20	max. mA
Amplification Factor*	...	...	...	...	...	...	20	
Impedance*	...	...	...	...	...	...	7,700	ohms
Mutual Conductance*	...	...	...	...	...	...	2.6	mA/V

*Measured at $V_a=250$; $V_{g1}=-8$.

Capacitances :

					Triode'	Triode'	
Control Grid to Anode	...	...	...	...	4.5	4.5	approx. pF
Control Grid to Cathode	...	...	...	...	3.5	3.7	"
Anode to Cathode	...	...	...	...	1.5	1.2	"
Anode' to Anode''	...	...	...	...		1.0	"

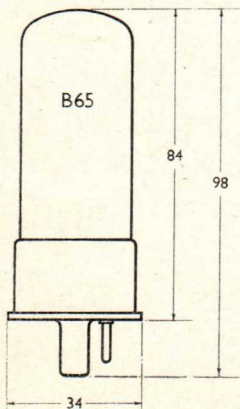
OPERATING CONDITIONS (each unit)

Class A Amplifier

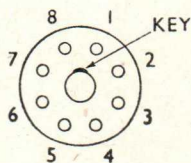
Anode Supply Voltage	...	...	...	...	250	250	volts
Anode Current	...	...	...	...	5.75	6.65	mA
Control Grid Voltage	...	...	...	...	-2.52	-1.46	volts
Cathode Resistor	...	...	...	...	440	220	ohms
Anode Resistor	...	...	...	...	22,000	22,000	ohms
Stage Gain	...	...	...	...	15.5	16	

Under maximum rated conditions the D.C. resistance in the grid circuit should not exceed 1 megohm per unit.

DIMENSIONS



BASE



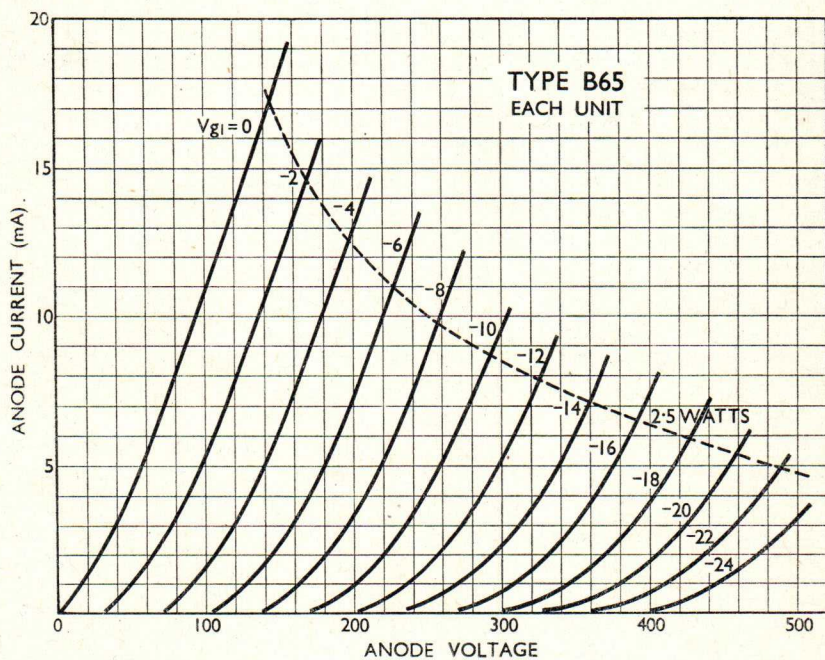
View looking on underside of base.

8-PIN OCTAL

- Pin 1 : Control Grid*
- 2 : Anode''
- 3 : Cathode''
- 4 : Control Grid'
- 5 : Anode'
- 6 : Cathode'
- 7 : Heater
- 8 : Heater

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE B65



CHARACTERISTIC CURVES OF AVERAGE VALVE.

D63



D63 DOUBLE DIODE

DESCRIPTION

Type D63 is an indirectly heated double diode consisting of two diodes with a common heater and separate cathodes.

The valve is interchangeable with the American type 6H6G.

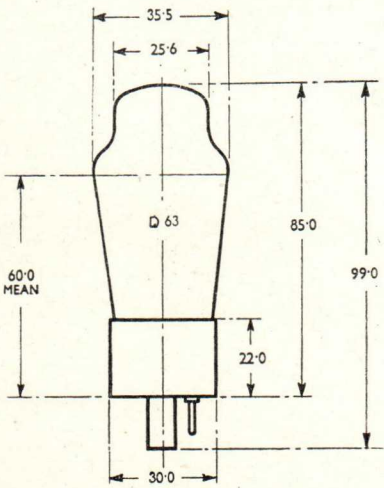
RATINGS

Heater Voltage	...	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	...	0.3	approx. amp
Cathode Current (D.C.)	...	...	...	...	...	...	...	2	max. mA
Anode Voltage R.M.S.	...	...	...	...	...	...	...	100	max. volts

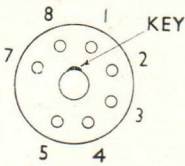
Capacitances (taken on metallised bulb) :

Anode ¹ to Anode ²	...	...	...	...	...	...	...	0.18	approx. pF
Anode ¹ to Cathode ¹	...	...	...	...	...	...	...	6.0	" "
Anode ² to Cathode ²	...	...	...	...	...	...	...	7.0	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- 1 : Metallising
- 2 : Heater
- 3 : Anode 2
- 4 : Cathode 2
- 5 : Anode 1
- 6 : Heater
- 7 : Cathode 1

Supplied in metallised or clear bulb.

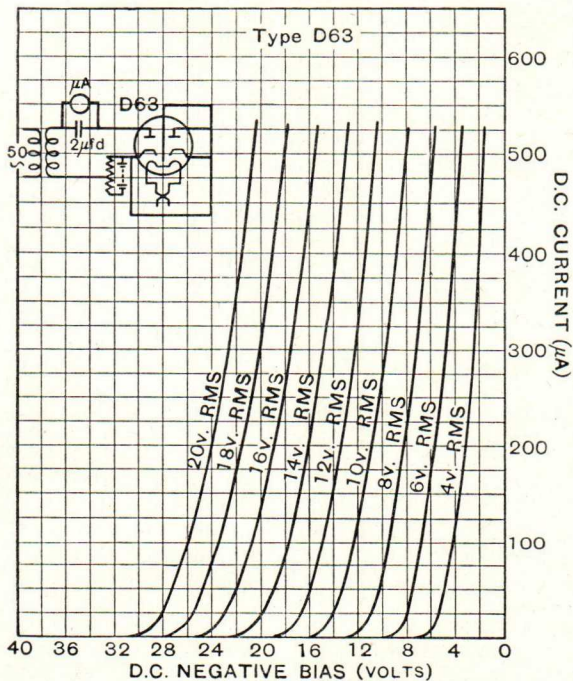
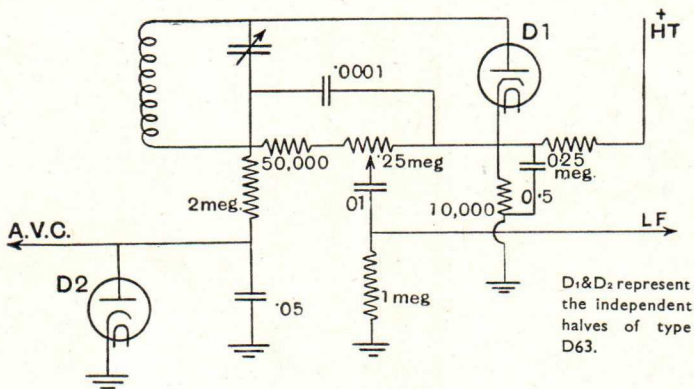
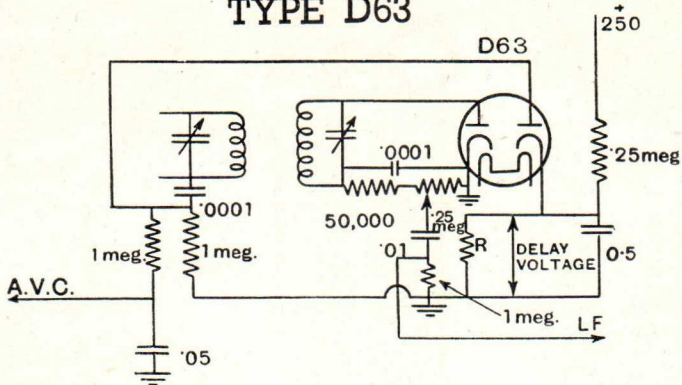
All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS

Load resistance 0.25 megohm :

Anode Voltage R.M.S.	...	...	...	...	4	8	12	16	20
Average Current μ A	...	...	...	...	20	40	60	80	100

TYPE D63



CHARACTERISTIC CURVES OF AVERAGE VALVE.

DH63



DH63 DOUBLE-DIODE-TRIODE

DESCRIPTION

Type DH63 is an indirectly heated double-diode triode, with a high impedance triode section. The valve is interchangeable with the American type 6Q7G.

RATINGS

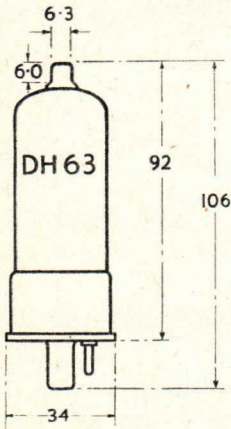
Heater Voltage	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	0.3	approx. amp
Anode Voltage	...	...	...	...	...	...	250	max. volts
Amplification Factor*	...	...	...	...	...	...	70	
Impedance*	...	...	...	...	...	...	58,000	ohms
Mutual Conductance	...	...	...	...	...	...	1.2	mA/V

*Measured at $V_a = 250$; $V_{g1} = -3$

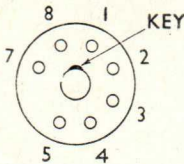
Capacitances (taken on metallised valve) :

Grid to Anode	...	...	...	...	...	...	1.6	approx. pF
Grid to Cathode	...	...	...	...	...	...	2.5	" "
Anode to Cathode	...	...	...	...	...	...	7.0	" "
Diodes to all other electrodes	...	...	...	...	...	...	7.0	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- Pin 1 : Metallising Base
- 2 : Heater
- 3 : Anode
- 4 : Signal Diode
- 5 : A.V.C. Diode
- 6 : Omitted
- 7 : Heater
- 8 : Cathode

Top Cap : Control Grid

Type DH63 is supplied plain or metallised.

All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS

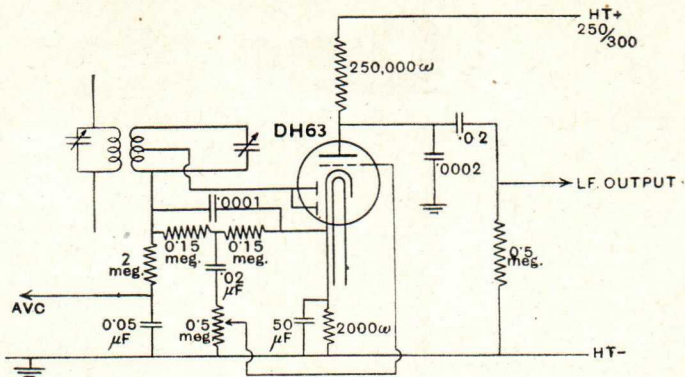
A typical circuit is shown overleaf.

Anode Supply Voltage	...	...	200/250	volts
Grid Voltage	...	...	-1/-1.5	volts
Cathode Bias Resistance	...	...	2,000	ohms
Optimum Load Resistance	...	...	220,000	ohms

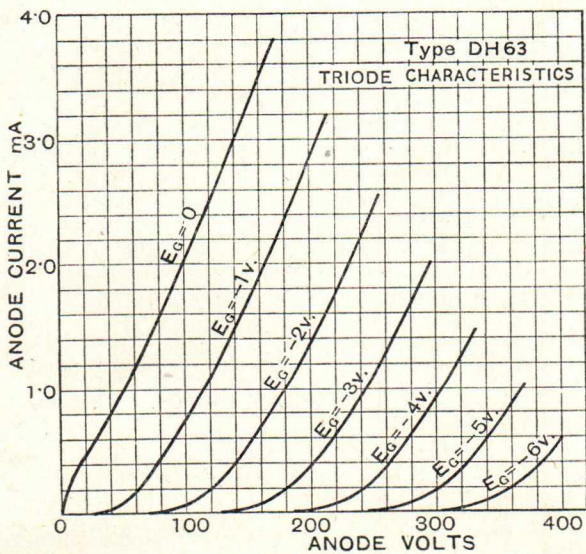
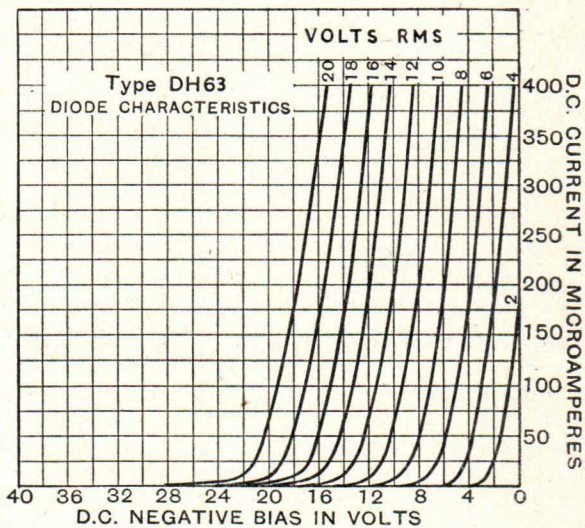
Triode Performance

Anode Load	...	47,000	100,000	220,000	ohms
Stage Gain	...	30	35	40	
Output Voltage R.M.S. (1% distortion)	...	8	10	11	volts
Bias Resistance	...	1,000	1,800	2,200	ohms

TYPE DH63



CHARACTERISTIC CURVES OF AVERAGE VALVE.



DL63



DL63 DOUBLE-DIODE-TRIODE

DESCRIPTION

Type DL63 combines a double diode and triode electrode system on a common cathode, the two diodes being enclosed within a metal shield joined to the cathode, providing an electrostatic screen.

RATINGS

Heater Voltage	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	0.3	amp

Triode :

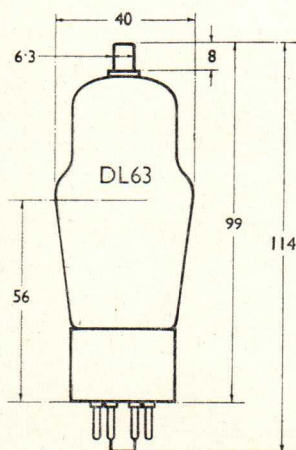
Anode Voltage ...	...	...	...	...	...	...	250	max. volts
Amplification Factor*	...	...	...	...	...	...	36	
Impedance*	...	...	...	...	...	...	22,500	ohms
Mutual Conductance*...	...	...	...	...	...	...	1.60	mA/V

* measured at $V_a = 250$, $V_g = -3$

Capacitances :

Grid to Anode	...	...	...	...	...	...	2.3	approx. pF
Grid to Cathode	...	...	...	...	...	...	1.5	" "
Anode to Cathode	...	...	...	...	...	...	3.5	" "
Diodes to All other Electrodes	...	...	...	...	...	...	6.5	" "

DIMENSIONS

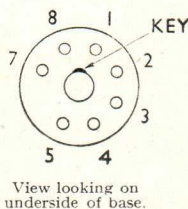


BASE

7-PIN OCTAL

- Pin 1 : Not Connected
2 : Heater
3 : Anode
4 : Diode
5 : Diode
6 : Omitted
7 : Heater
8 : Cathode

Top Cap : Control Grid



View looking on underside of base.

Type DL63 is not supplied in metallised bulb. Screening should be used when necessary.

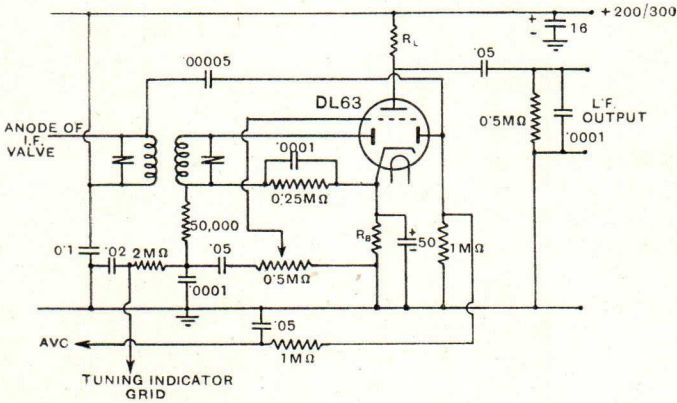
All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE DL63

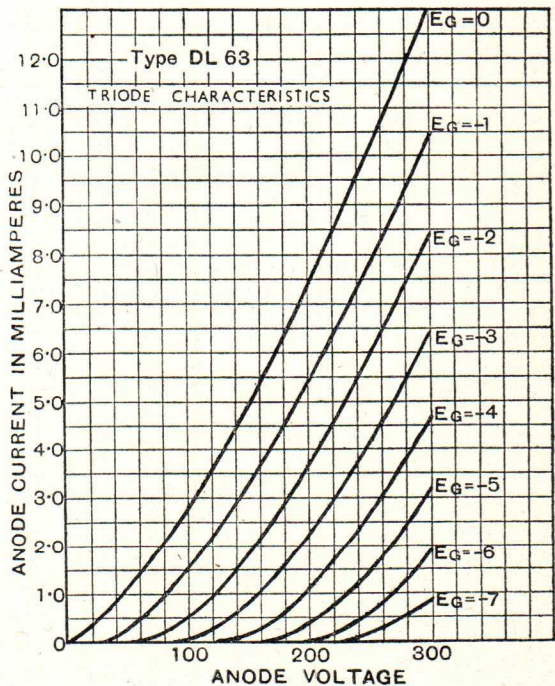
OPERATING CONDITIONS

Triode Performance

Anode Load (R _L)	...	...	...	50,000	100,000	150,000	ohms
Stage Gain	...	...	...	24	38	30	
Output Voltage R.M.S.	...	...	...	25	30	29	volts
Bias Resistor (R _B)	...	...	...	1,000	1,500	2,000	ohms



Typical circuit diagram. For values of R_L and R_B , see table above.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

H63 L63



H63 TRIODE

DESCRIPTION

Type H63 is a "high mu" indirectly heated triode for use in the early stages of an audio frequency amplifier, or as a detector. It is interchangeable with American type 6F5G.

L63 TRIODE

DESCRIPTION

Type L63 is a medium impedance indirectly heated triode for use in the early stages of an audio frequency amplifier, as an oscillator or as a detector. It is interchangeable with American type 6J5G.

RATINGS

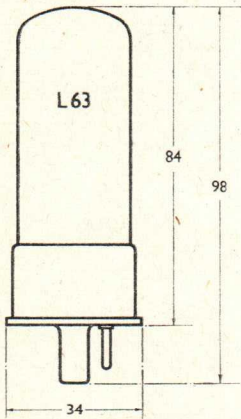
	H63	L63	
Heater Voltage	6.3	6.3	volts
Heater Current	0.3	0.3	amp
Anode Voltage	250	250	max. volts
Amplification Factor*	100	20	
Impedance*	66,000	7,700	ohms
Mutual Conductance*	1.5	2.6	mA/V

* Measured at Va = 100, Vg = 0

Capacitances (taken on unshielded valve) :

Grid to Cathode	2.3	3.8	approx. pF
Anode to Cathode	3.7	3.2	" "
Anode to Grid	2.5	4.1	" "

DIMENSIONS



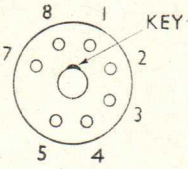
All dimensions are in mm. and are the maximum except where otherwise stated.

BASE

H63

5-PIN OCTAL

- Pin 1 : Not connected
 - 2 : Heater
 - 3 : Omitted
 - 4 : Anode
 - 5 : Omitted
 - 6 : Omitted
 - 7 : Heater
 - 8 : Cathode
- Top Cap : Grid



View looking on underside of base of L63

L63

6-PIN OCTAL

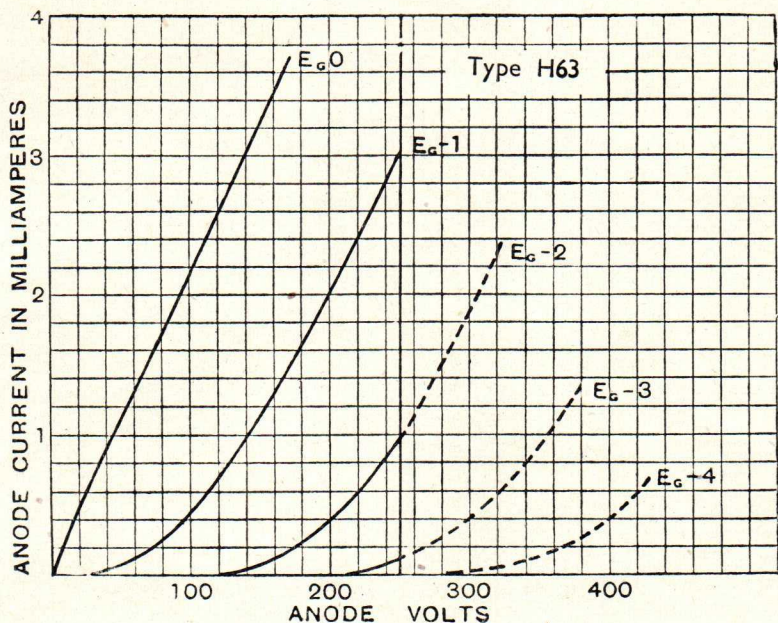
- Pin 1 : Not connected
- 2 : Heater
- 3 : Anode
- 4 : Omitted
- 5 : Grid
- 6 : Omitted
- 7 : Heater
- 8 : Cathode

Type H63 similar dimensions but fitted with top cap for grid connection, cap dimension 11 x 9 mm.

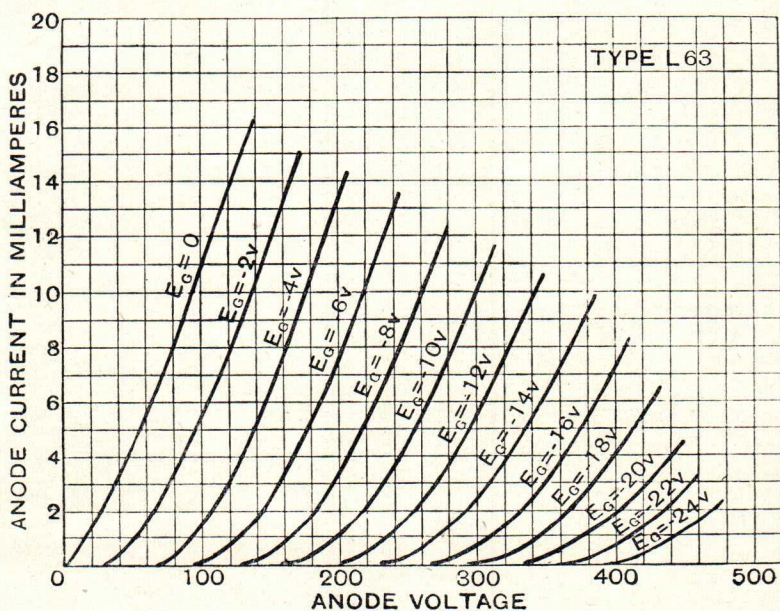
OPERATING CONDITIONS

OPERATING CONDITIONS				H63		L63		
Anode Voltage	...	...	250	200	250	200	150	volts
Grid Voltage	...	...	-2	-1.6	-8	-6	-4	approx. volts
Anode Current average	...	...	1.0	0.9	9.0	7.5	6.5	mA
Cathode Bias Resistor...	...	...	2,000		800			ohms
Optimum Load Resistor	...	...	200,000		50,000			ohms

TYPE H63



TYPE L63



CHARACTERISTIC CURVES OF AVERAGE VALVE.

KT32



KT32 OUTPUT TETRODE

DESCRIPTION

Type KT32 is an indirectly heated power tetrode for use in the output stage of D.C. and A.C./D.C. mains receivers and amplifiers designed for a working H.T. voltage of 110—135 volts.

The type is designed with alignment of the control and screen grids resulting in reduced screen current.

Type KT32 is interchangeable with American type 25L6G.

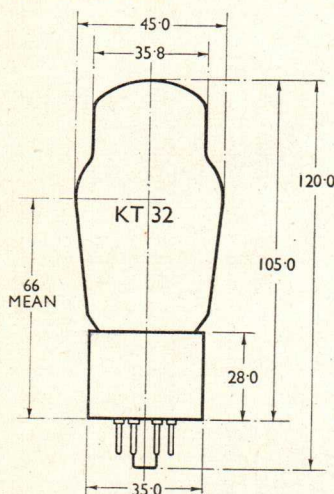
RATINGS

Heater Current ...	...	...	...	...	...	0.3	amp
Heater Voltage ...	...	...	...	...	...	26.0	volts
Anode Voltage ...	...	...	...	...	...	135	max. volts
Screen Voltage ...	...	...	...	...	...	135	max. volts
Anode Dissipation ...	...	...	...	...	...	10	max. watts
Mutual Conductance, at $V_a = V_{g_2} = 110$; $I_a = 50$ mA	...	...	...	...	...	9.0	mA/V

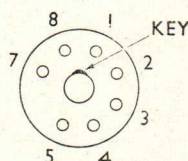
Capacitances :

Grid to all other electrodes ...	...	...	...	...	...	20.0	approx. pF
Anode to all other electrodes ...	...	...	...	...	...	12.0	" "
Anode to control grid ...	...	...	...	...	...	1.2	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- Pin 1: Not connected
 2: Heater
 3: Anode
 4: Screen Grid
 5: Control Grid
 6: Omitted
 7: Heater
 8: Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS

	Single Valve Class A			Two Valves in Class AB1 push-pull	
	135	110	80	135	volts
Anode Voltage ...	135	110	80	135	volts
Screen Voltage ...	75	60	44	100*	mA
Anode Current ...	5	4	4	8*	mA
Screen Current ...	-7.6	-6.0	-4.5	-10	volts
Grid Voltage ...	95	95	95	200†	ohms
Cathode Bias Resistor ...	1,300	1,600	1,600	2,500‡	ohms
Anode Load Resistance ...	7.1	5.6	4.2	19.7	peak volts
Input Signal Voltage ...	11	6.5	9.5	5	%
Distortion ...	3.5	2.3	1.2	7.5	watts
Power Output ...					

* Per pair.

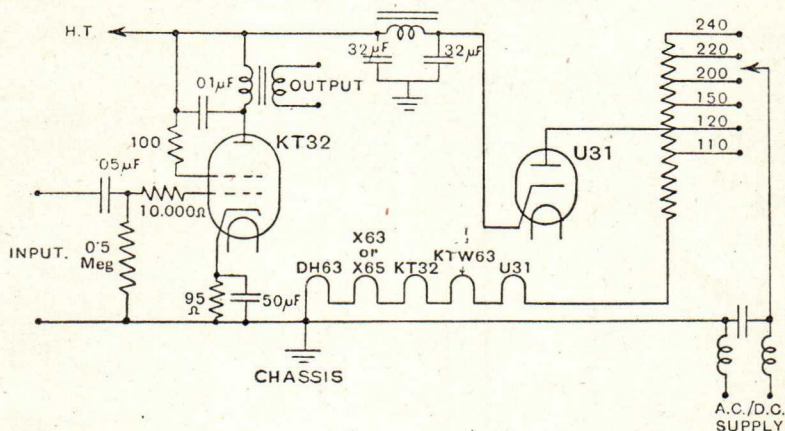
† Per valve.

‡ Anode to anode.

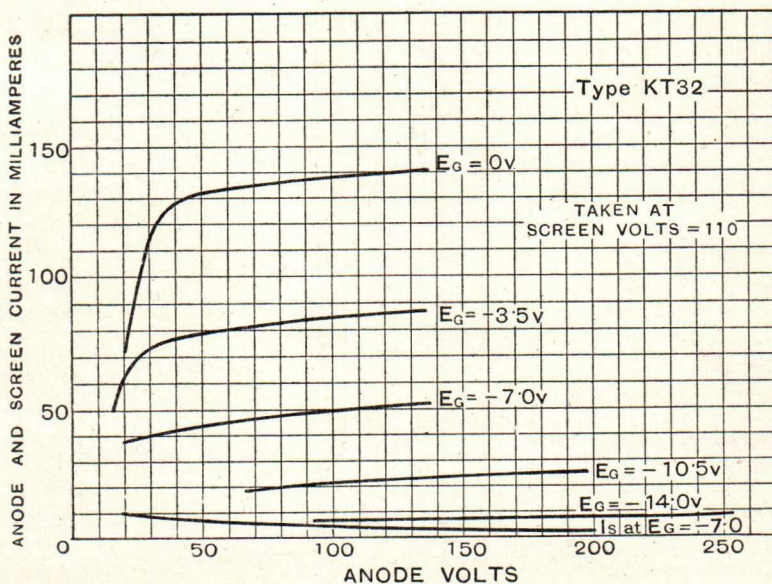
TYPE KT32

OPERATING CONDITIONS (cont.)

To prevent instability a screen stopping resistance of 100 ohms should be used ; a grid stopping resistance of 10,000 ohms or more may be used in addition.



Typical circuit for KT32 output tetrode, showing heater wiring system for DC/AC receiver, suitable for any supply from 100 to 250 volts. If the supply voltage range is 200—250, the U31 anode tap should be taken to 150 volt tapping on resistance shown.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

KT33C OUTPUT TETRODE

DESCRIPTION

Type KT33C is an indirectly heated power tetrode for use in A.C./D.C. receivers or amplifiers where the supply mains voltage is 200 to 250 volts.

By utilising the heater centre tap, the valve becomes suitable for operation from a 12-13 volt low tension supply, such as a car battery.

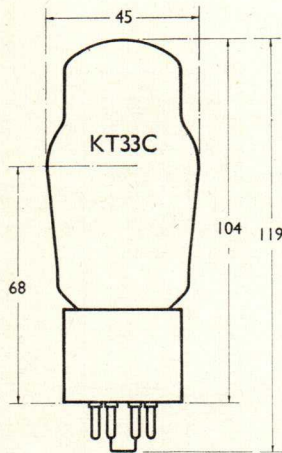
RATINGS

Heater Current ...	...	...	...	...	0.6	0.3	amp
Heater Voltage ...	...	...	...	...	13.0	25.0	volts
Anode Voltage ...	...	...	...	...	...	200	max. volts
Screen Voltage ...	...	...	...	...	...	200	max. volts
Anode Dissipation ...	...	...	...	...	...	13	max. watts
Mutual Conductance measured at $V_a = V_{g_2} = 175$; $V_{g_1} = -7.0$	...	...	...	...	...	10	mA/V

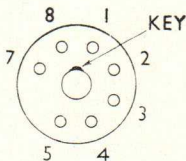
Capacitances :

Anode to all other electrodes ...	...	...	...	...	12.0	approx. pF
Control Grid to all other electrodes ...	...	...	...	...	19.0	" "
Anode to Control Grid ...	...	...	...	...	1.2	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- Pin 1 : Heater Centre Tap
2 : Heater
3 : Anode
4 : Screen Grid
5 : Control Grid
6 : Omitted
7 : Heater
8 : Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS

	Single Valve Class A		Pair in Push-pull Class IAB		
	200	150	200	150	
Anode Voltage ...	200	150	200	150	volts
Screen Voltage ...	200	150	200	150	volts
Grid Voltage approx. ...	-13.3	-9.9	-19.1	-13.2	volts
Anode Current average ...	60	44	113*	80*	mA
Screen Current average ...	10	8	18*	12*	mA
Bias Resistor (per valve) ...	190	190	240	240	ohms
Load Resistance ...	3,000	3,000	4,000†	4000†	ohms
Input Signal Voltage ...	12.3	8.9	44	24	peak volts
Distortion ...	8	8	7.5	3.9	%
Power Output ...	5.0	3.0	15.5	7.5	watts

* Total no load.

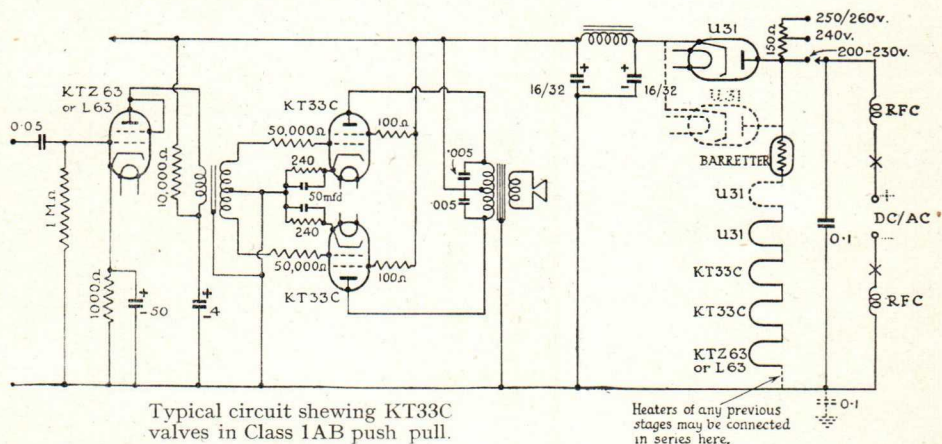
† Anode-to-anode.

TYPE KT33C

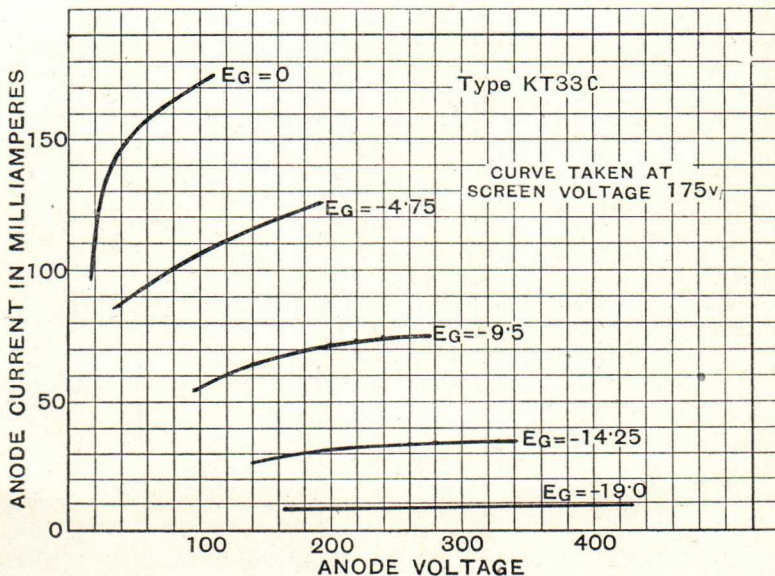
OPERATING CONDITIONS (cont.)

Any tendency to instability is prevented by the use of a grid stopping resistor (10,000—100,000 ohms) and/or a screen stopping resistor, mounted close to the valve holder, of 50—100 ohms.

It may be necessary to include a tapped resistor (approx. 150 ohms.) in the mains lead in order to keep the anode dissipation within the maximum safe value, in cases of high voltage (240—260 volts) supply mains.

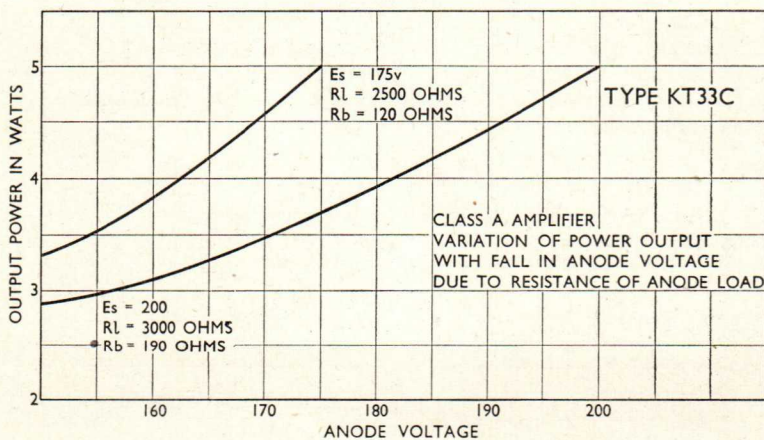
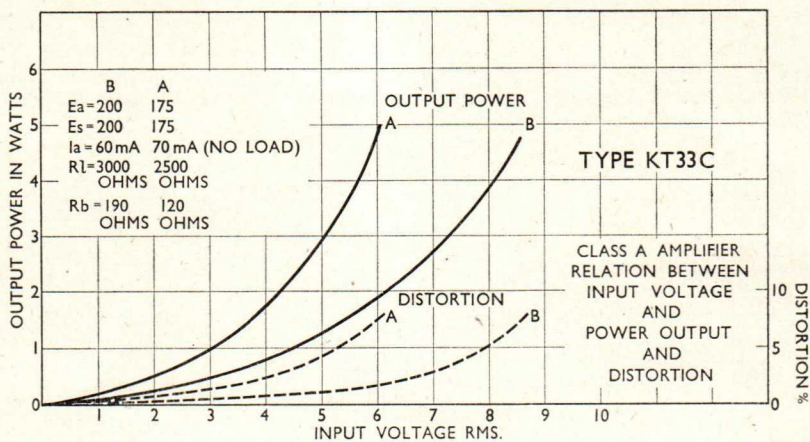


Two U31 rectifiers are necessary when operating a push pull output stage under maximum conditions with 200—240 volt supply.



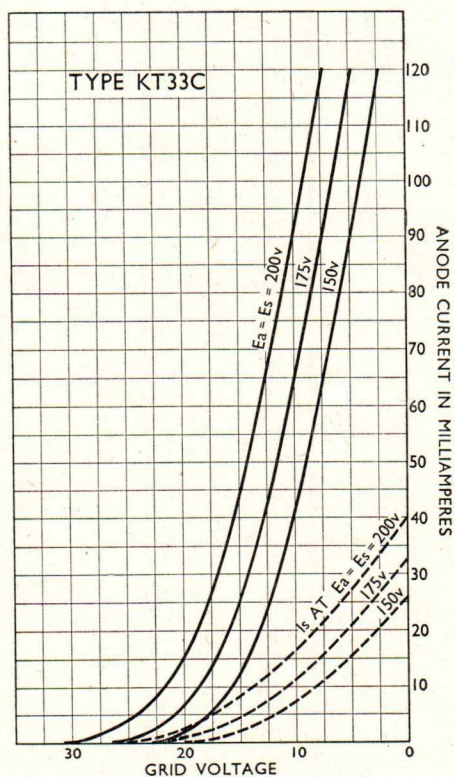
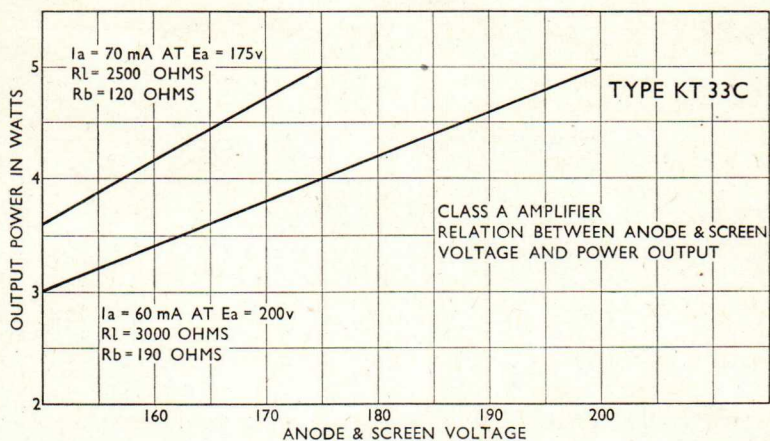
CHARACTERISTIC CURVES OF AVERAGE VALVE.

TYPE KT33C



CHARACTERISTIC CURVES OF AVERAGE VALVE.

TYPE KT33C



CHARACTERISTIC CURVES OF AVERAGE VALVE.

KT36



KT36 POWER TETRODE

DESCRIPTION

Type KT36 is an indirectly heated power tetrode primarily designed for use as the line time base amplifier in D.C./A.C. television receivers.

RATINGS

Heater Current	...	...	...	...	...	...	0.3	amp
Heater Voltage	...	...	...	...	...	...	26	approx. volts
Heater/Cathode Voltage R.M.S.	...	...	...	...	...	...	200	max. volts

							Tetrode Connection	Triode Connection	
Anode Voltage D.C.	...	...	...	...	...	250		200	max. volts
Anode Voltage peak	...	...	...	...	...	4			max. kV
Screen Grid Voltage	...	...	...	...	...	200			max. volts
Anode Dissipation	...	...	...	...	...	10		13	max. watts
Screen Grid Dissipation	...	...	...	...	...	3			max. watts
Mutual Conductance	...	...	...	...	...	11*		10.5†	mA/V
Impedance	...	...	...	...	...	...	...	800†	ohms
Amplification Factor	...	...	...	...	...	...	...	7.5†	

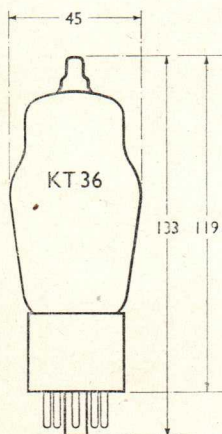
* Measured at $V_a = V_{g_2} = 150$; $V_{g_1} = -10$.

† Measured at $V_a + g_2 = 150$; $V_{g_1} = -10$.

Capacitances :

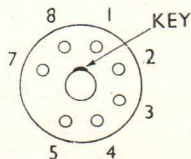
Control Grid to all other electrodes	...	...	...	...	...	20	approx. pF
Anode to all other electrodes	...	...	...	...	...	12	" "
Anode to Control Grid	...	...	...	...	...	1.2	" "

DIMENSIONS



All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.

BASE

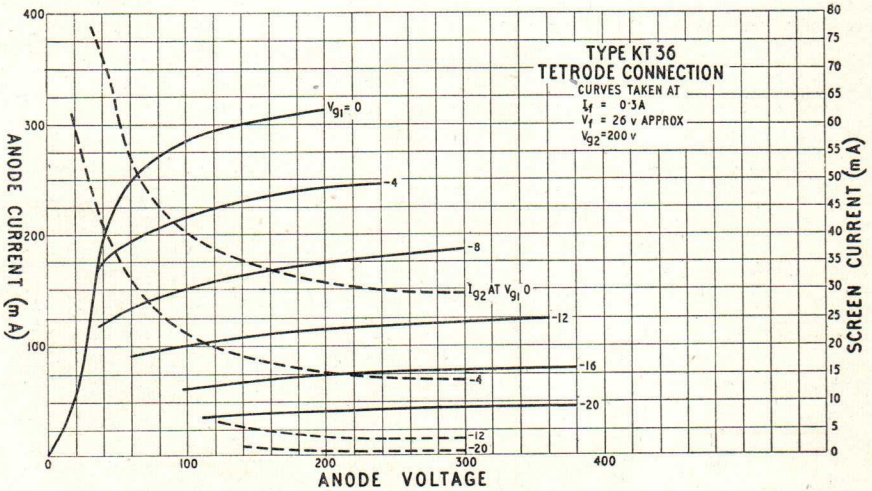
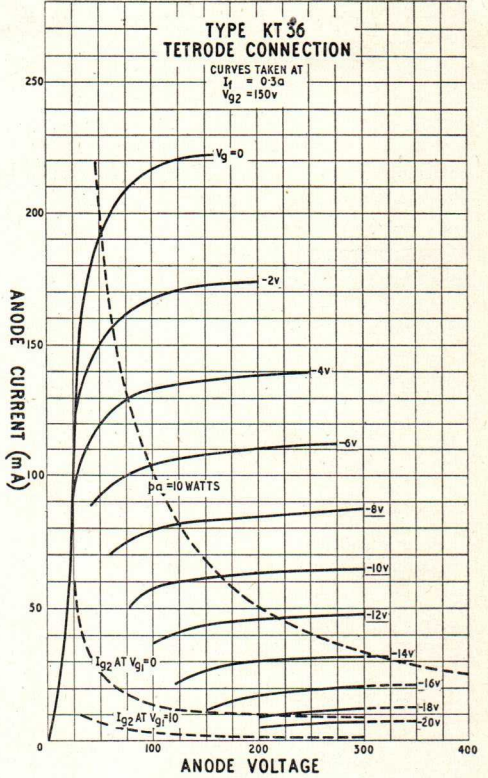
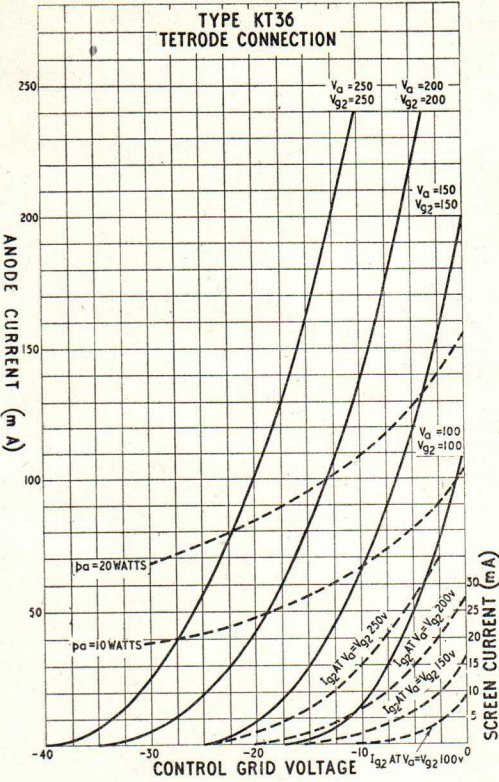


View looking on
underside of base.

7-PIN OCTAL

- Pin 1 : NC
2 : Heater
3 : NC
4 : Screen Grid
5 : Control Grid
7 : Heater
8 : Cathode
Top Cap : Anode

TYPE KT36



CHARACTERISTIC CURVES OF AVERAGE VALVE.

KT61

Osram

VALVES

KT61 OUTPUT TETRODE

DESCRIPTION

Type KT61 is a high slope indirectly-heated tetrode for use in the output stage of radio receivers and LF amplifiers operating from AC mains.

The valve has a high power sensitivity. It is suitable for operation from a diode detector, if desired, but should not be employed in amplifiers which already have substantial low frequency amplification.

Type KT61 may also be employed connected as a triode, in which case a push-pull circuit and increased anode voltage is recommended.

RATINGS

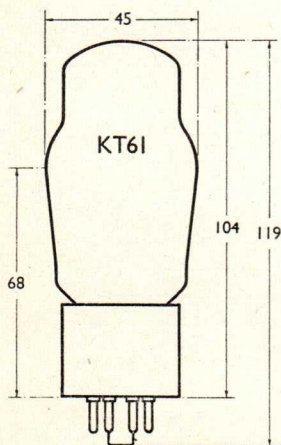
Heater Voltage ...	...	...	...	...	...	...	...	6.3	volts
Heater Current ...	...	...	...	...	...	...	...	0.95	approx. amp
Anode Voltage ...	...	...	...	...	...	275	350	max. volts	
Screen Voltage ...	...	...	...	...	...	275		max. volts	
Anode Dissipation ...	...	...	...	...	...	10		max. watts	
Amplification Factor* ...	...	...	...	...	...		27		
Impedance* ...	...	...	...	...	...		2,750	ohms	
Mutual Conductance* ...	...	...	...	...	...	10.5	9.8	mA/V	

*measured at $V_a = 250$; $V_{g_2} = 250$; $I_a = 40\text{mA}$.

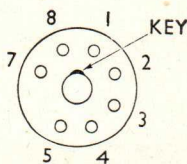
Capacitances :

Control Grid to all other electrodes ...	...	...	...	...	...	17.5	approx. pF
Anode to all other electrodes ...	...	...	...	...	...	0.8	" "
Anode to Control Grid ...	...	...	...	...	...	1.2	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- Pin 1: Not connected
2: Heater
3: Anode
4: Screen Grid
5: Control Grid
6: Omitted
7: Heater
8: Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE KT61

OPERATING CONDITIONS

Single Valve, Class A

	Tetrode connected	Triode connected
Anode Voltage	250	250 volts
Screen Voltage	250	volts
Anode Current (no load)	40	30 mA
Screen Current (no load)	7.5	mA
Grid Bias Voltage	-4.4	-6 volts
Bias Resistor	90	200 ohms
Anode Load	6,000	5,000 ohms
Maximum Input Signal Voltage, peak	4.3	5.5 volts
Power Output	4.3	0.7 watts
Distortion	8	Up to 5 %

Single Valve Class A Amplifier

Due to the high sensitivity of type KT61, degeneration (feedback) can be incorporated. A typical circuit is given.

The effect of a small variable capacitor in parallel with the feedback resistor enables a range of tone control to be obtained if desired, increased capacitance giving a cut of the higher frequencies.

Two Valves in Class AB1 Push-Pull Amplifier. Tetrode Connection

Anode Voltage	275	volts
Screen Voltage	275	volts
Anode Current average (per pair)	72	mA
Screen Current average (per pair)	12	mA
Grid Bias Voltage	-6.7	approx. volts
Input Voltage (grid to grid)	16	peak volts
Load Resistance (anode-to-anode)	10,000	ohms
Common Bias Resistor	80	ohms
Power Output	11.5	approx. watts
Total Distortion	6.5	%

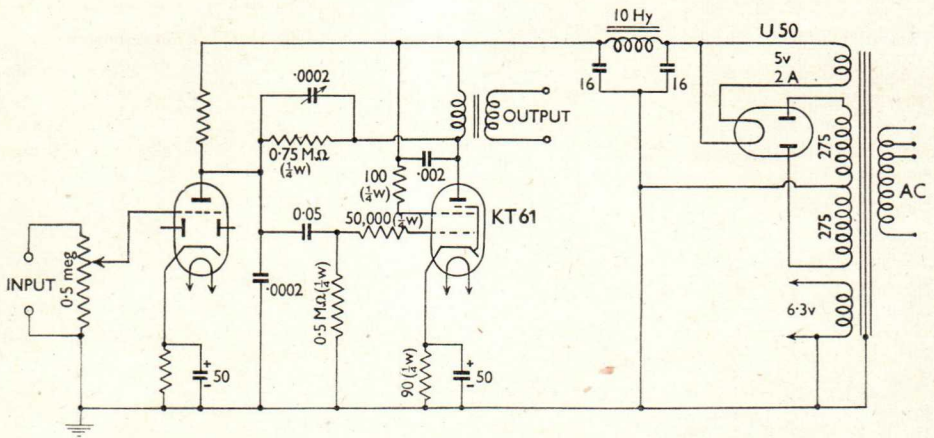
Two Valves in Class AB1 Push-Pull. Triode Connected

Anode and Screen Voltage	350	volts
Anode and Screen Current (per pair, no load)	63	mA
Anode and Screen Current (per pair, full load)	73	mA
Load Resistance (anode to anode)	6,000	ohms
Common Bias Resistor... ..	150	ohms
Input Voltage (grid to grid)	23	peak volts
Power Output	6	watts
Distortion	2	%

The common bias resistor should be shunted with a 50 μ F capacitor.

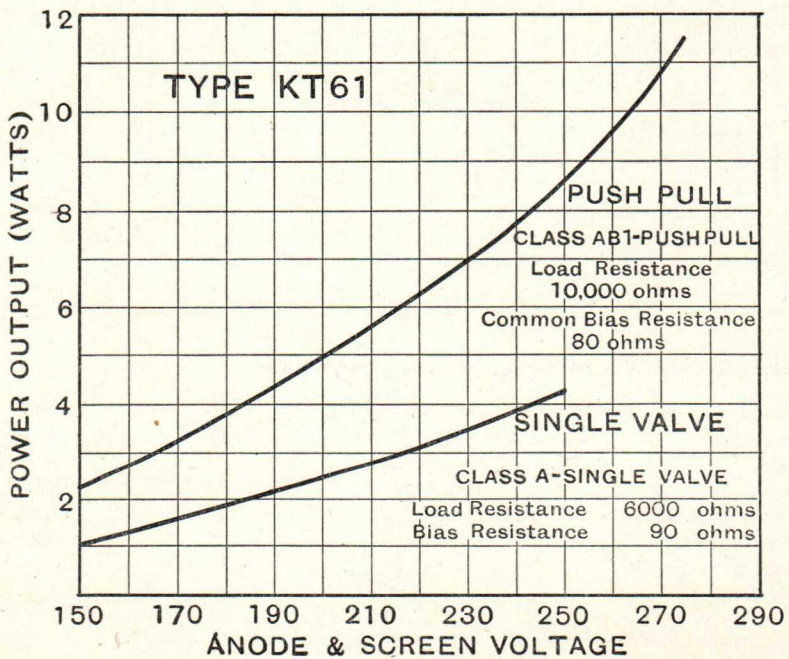
The screen grids should be joined to the anodes via 100 ohm resistors, and grid stopper resistors of 10,000 ohms should be used in order to suppress parasitic oscillation.

TYPE KT61



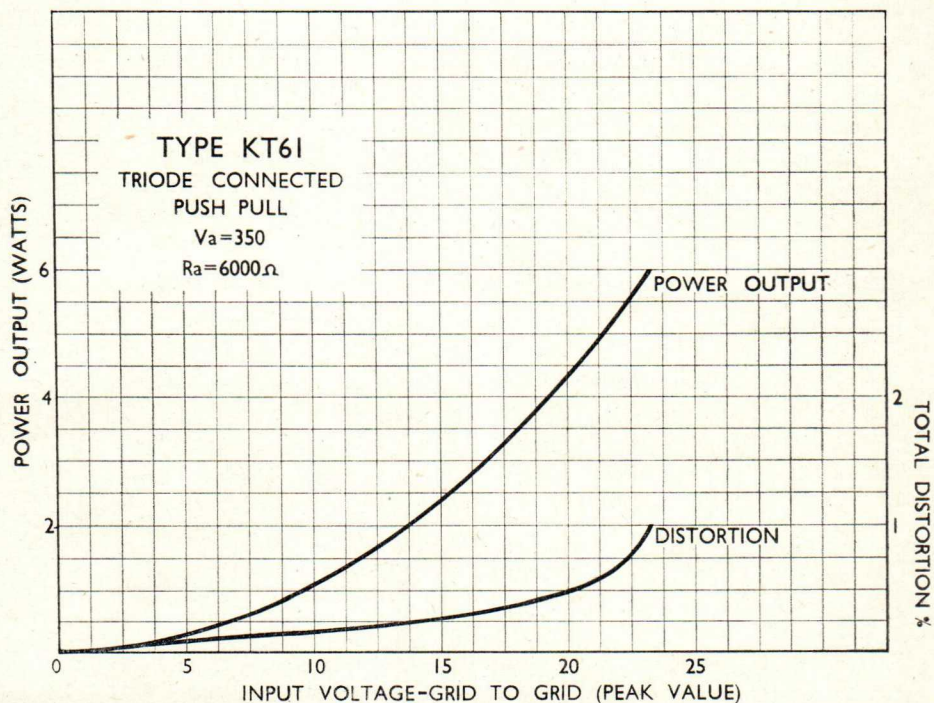
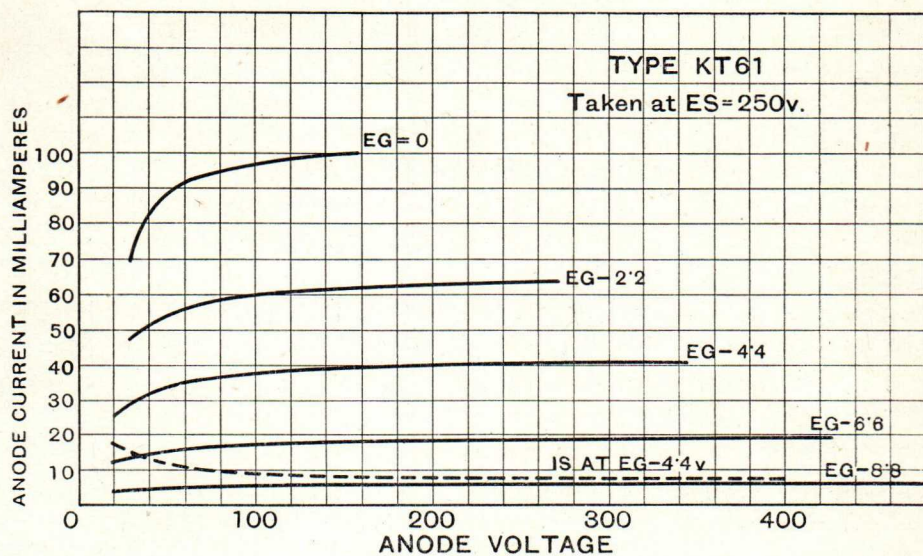
SINGLE VALVE CLASS A AMPLIFIER CIRCUIT

Illustrating method of applying negative feedback and driving the KT61 with DH63, with 220K ohms anode load resistance.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

TYPE KT61



CHARACTERISTIC CURVES OF AVERAGE VALVE.

KT63

Osram VALVES

KT63 OUTPUT TETRODE

DESCRIPTION

Type KT63 is an indirectly heated tetrode for use in the output stage of A.C. receivers or car radios. It is interchangeable with American type 6F6G.

RATINGS

Heater Voltage ...	...	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	...	0.7	approx. amp

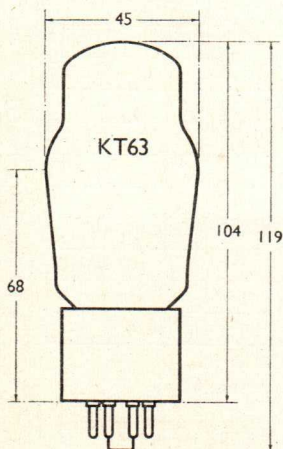
					Tetrode connected	Triode connected		
Anode Voltage ...	...	...	...	...	250	250	max. volts	
Screen Voltage ...	...	...	...	...	250		max. volts	
Anode Dissipation ...	...	...	...	...	8.5	7.5	max. watts	
Amplification Factor*	...	...	...	...		7.7		
Impedance*	...	...	...	...		3,200	ohms	
Mutual Conductance*	...	...	...	...	2.5	2.4	mA/V	

*measured at $V_a = 250$; $V_{g_2} = 250$; $I_a = 34\text{mA}$

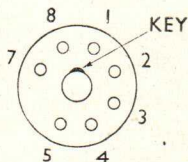
Capacitances :

Grid to all other electrodes ...	...	...	...	...	9.9	approx. pF
Anode to all other electrodes ...	...	...	...	...	8.5	" "
Anode to Grid ...	...	...	...	...	0.85	" "

DIMENSIONS



BASE



View looking on
underside of base.

7 PIN OCTAL

- Pin 1: Not connected
2: Heater
3: Anode
4: Screen Grid
5: Control Grid
6: Omitted
7: Heater
8: Cathode

*All dimensions are in mm. and are the maximum except
where otherwise stated.*

TYPE KT63

OPERATING CONDITIONS

Single Valve, Class A					Tetrode connected	Triode connected	
Anode Voltage	...	...	...	...	250	250	volts
Screen Voltage	...	...	...	...	250		volts
Anode Current	...	...	...	...	34	30	mA
Screen Current	...	...	...	...	5.5		mA
Grid Bias Voltage	...	...	...	...	-16.5	-20	volts
Bias Resistor	...	...	...	...	420	650	ohms
Anode Load	...	...	...	...	7,000	4,500	ohms
Power Output	...	...	...	...	3.0	0.7	watts

A typical circuit is given showing type KT63 in a resistance-coupled amplifier.

Two Valve Class ABI Push Pull Amplifier, Tetrode Connection

Operating data :—

Anode Voltage	...	...	...	...	250	volts
Screen Voltage	...	...	...	...	250	volts
Anode Current average (2 valves)	...	...	...	...	64	mA
Screen Current average (2 valves)	...	...	...	...	14	mA
Grid Voltage	...	...	...	...	-20	volts
Input Voltage (grid-to-grid)	...	...	...	...	39	peak volts
Load Resistance (anode-to-anode)	...	...	...	...	12,000	ohms
Common Bias Resistor	...	...	...	...	250	ohms
Power Output	...	...	...	...	6	approx. watts
Total Distortion	...	...	...	...	4	%

A typical circuit is given for a push-pull amplifier in which 10% degeneration (negative feedback) is applied. This reduces the sensitivity, but at the same time reduces distortion and levels the frequency response. The feedback circuit may be omitted if desired.

Precautions in use

The wiring and arrangement of the circuit should be such as to keep the capacitance between input and output circuits at as low a value as possible.

A grid stopper resistor of approximately 10,000 ohms, or screen stopper of 100 ohms should be inserted in the circuit close to the connections of the valve holder.

The total resistance in the grid circuit should in no case exceed 50,000 ohms with fixed bias, or 500,000 ohms with automatic bias.

Automatic bias by means of a cathode resistor should be employed whenever possible.

Care should be taken to remove the screen voltage if the anode is disconnected from the H.T supply.

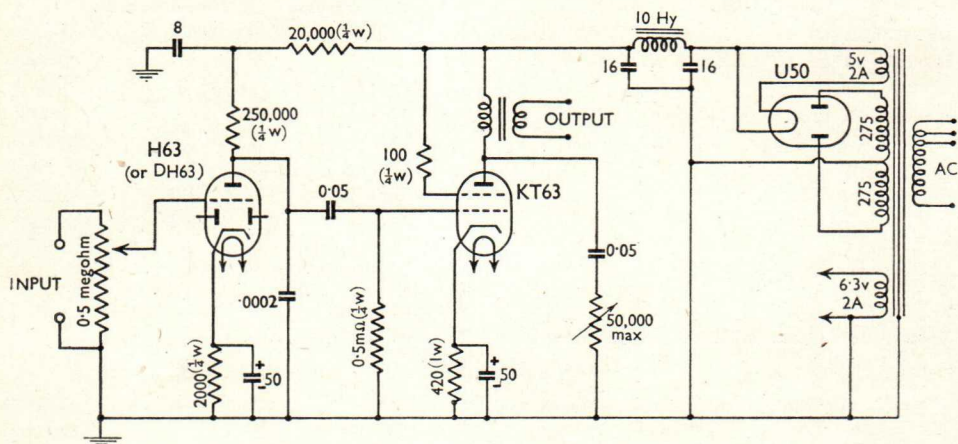
Adequate ventilation must be provided.

The output transformer in all cases should have low leakage inductance and be of ratio :—

$$\frac{\text{Total Primary Turns}}{\text{Total Secondary Turns}} = \sqrt{\frac{\text{Anode Load.}}{\text{Speaker Impedance.}}}$$

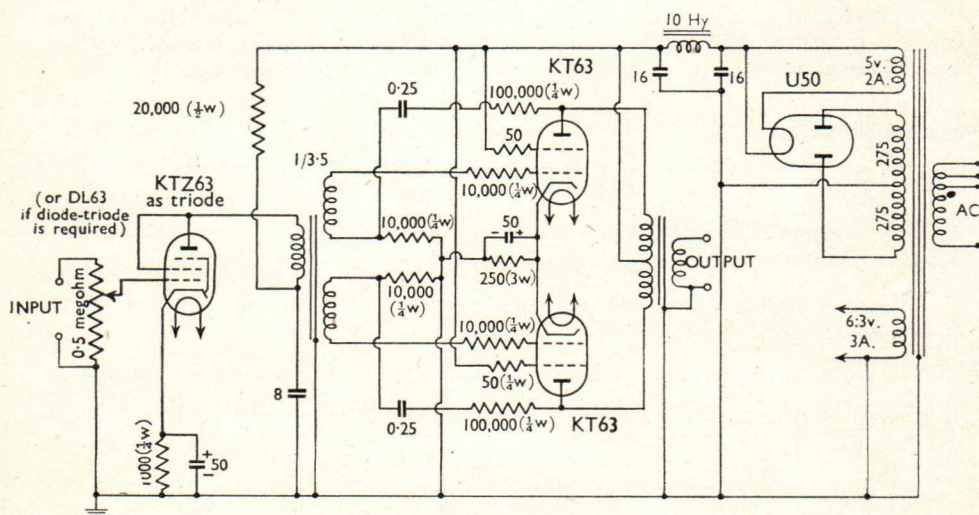
The circuit information given does not imply any licence under any patents which may be involved.

TYPE KT63



SINGLE VALVE IN CLASS A AMPLIFIER CIRCUIT.

Input to H63 (or DH63) grid for max. output ... 0.14v R.M.S.



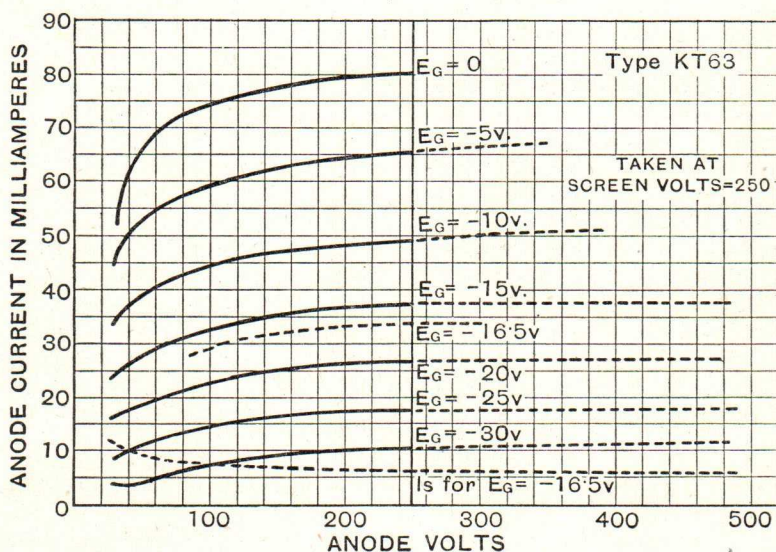
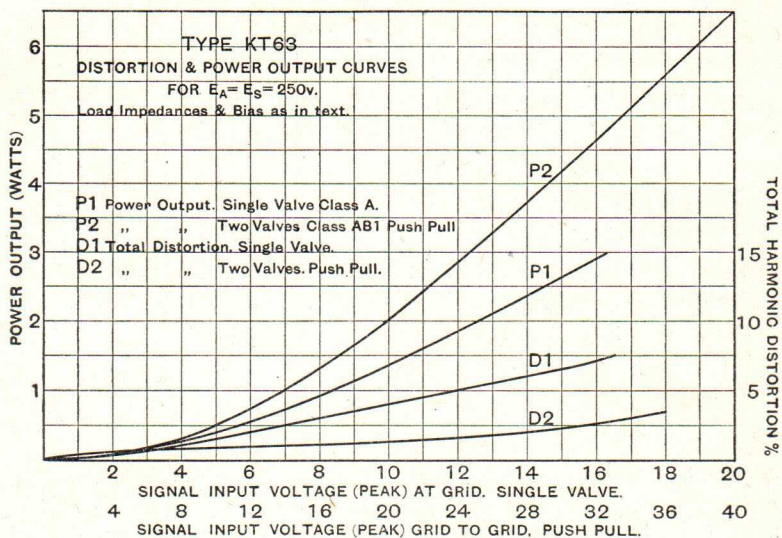
TWO VALVES IN CLASS AB1 PUSH-PULL AMPLIFIER CIRCUIT.

(with degeneration).

Input to KTZ63 for max. output ... 0.5v R.M.S.

(If DL63 is used, input ... 0.2v R.M.S.)

TYPE KT63



KT66

Osram

VALVES

KT66 POWER TETRODE

DESCRIPTION

Type KT66 is a high slope, indirectly heated beam tetrode designed principally for use in the output stage of audio amplifiers. It may also be used as an oscillator or R.F. power amplifier at frequencies up to 30 Mc/s.

It is suitable for either single or push-pull audio operation, and may be employed as a triode with screen connected through a 100 ohm resistor to the anode.

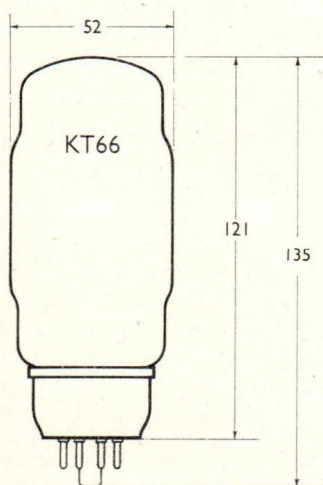
RATINGS

					Tetrode connected	Triode connected	
Heater Voltage	...	...	...	...	6.3	6.3	volts
Heater Current	...	...	...	...	1.27	1.27	amps
Anode Voltage	...	...	...	...	500	400	max. volts
Screen Voltage	...	...	...	...	400	—	max. volts
Anode Dissipation	...	...	...	...	25	25	max. watts
Screen Dissipation	...	...	...	...	3.5	—	max. watts
Anode Impedance*	...	...	...	...	22500	1450	ohms
Mutual Conductance*	...	...	...	...	6.3	5.5	mA/V
*measured at { V_a					250	400	
{ V_{g2}					250	—	
{ V_{g1}					-15	-38	

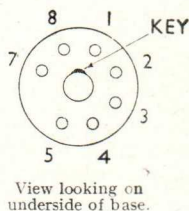
Capacitances :

Grid to all other electrodes...	...	...	...	16.0	approx pF
Anode to all other electrodes	...	...	...	11.5	" "
Anode to Grid	...	...	...	1.1	" "
Grid to Cathode	...	...	...	...	8.7
Anode to Cathode	...	...	...	...	15.8
Anode to Grid	...	...	...	...	7.2

DIMENSIONS



BASE



7-PIN OCTAL

- Pin 1 : Not connected
2 : Heater
3 : Anode
4 : Screen Grid g_2
5 : Control Grid g_1
6 : Omitted
7 : Heater
8 : Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS—

Please refer to page 108.



KTW63 VARIABLE-MU SCREENED TETRODE

DESCRIPTION

Type KTW63 is an indirectly heated variable-mu screened tetrode suitable for use as an R.F. amplifier. The variable-mu characteristics enable control of gain to be effected by variation of grid bias voltage, and the operating grid base is adequate to allow for full A.G.C. to be applied without modulation distortion on normal signal inputs.

Type KTW63 is interchangeable with American types 6K7G and 6U7G.

RATINGS

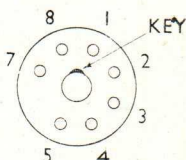
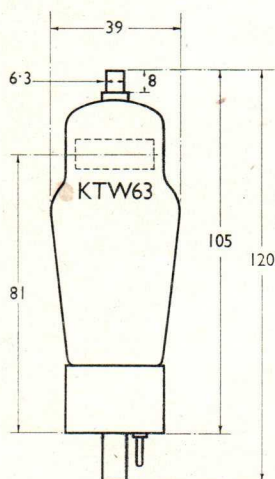
Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.3	approx. amp
Anode Voltage	...	...	...	...	...	250	max. volts
Screen Voltage	...	...	...	...	...	125	max. volts
Mutual Conductance*	...	...	...	...	...	1.5	mA/V

*measured at $V_a = 250$, $V_{g_2} = 100$, $V_{g_1} = -3$.

Capacitances :

Grid to all other electrodes	...	...	...	...	...	4.5	approx. pF
Anode to all other electrodes	...	...	...	...	...	7.5	" "
Anode to Grid	...	...	...	...	...	0.005	" "

DIMENSIONS



View looking on underside of base.

BASE

7 PIN "OCTAL"

- Pin 1: Not connected
- 2: Heater
- 3: Anode
- 4: Screen Grid
- 5: Not connected
- 6: Omitted
- 7: Heater
- 8: Cathode

Top Cap: Control Grid

Supplied with plain bulb only.

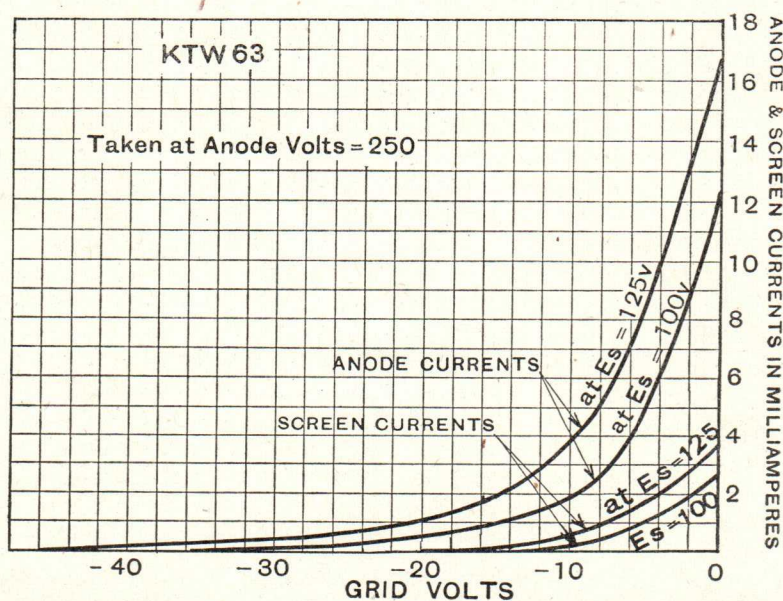
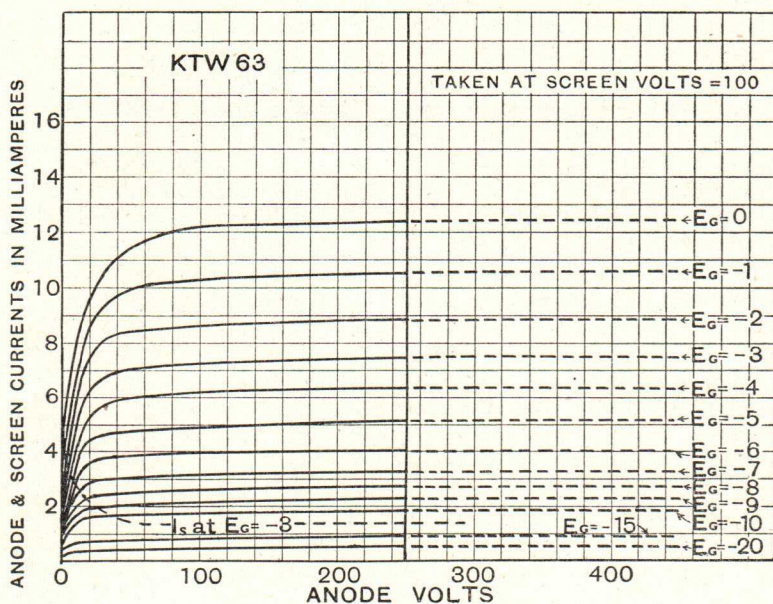
All dimensions are in mm. and are the maximum except where otherwise stated.

OPERATING CONDITIONS

Anode Voltage	...	...	...	250	volts
Screen Voltage	...	...	...	100	volts
Anode Current	...	...	...	7.6	mA
Screen Current	...	...	...	1.5	mA
Grid Bias Voltage	...	...	...	-3	volts
Bias Resistor	...	...	...	300	ohms

A potentiometer network may be employed in order to maintain the screen voltage sensibly constant. The total effective resistance between the grid and cathode must not exceed 4 megohms. The valve is not metallised, but in cases where screening is essential a can with the following dimensions may be used ; the suggested length of the can is 75 mm., extending from the bottom of the Bakelite base to the centre of the earthed screen inside the dome of the bulb. The diameter should be about 42.5 mm. These dimensions should be closely followed in order to take full advantage of the low value of anode to grid capacitance.

TYPE KTW63



CHARACTERISTIC CURVES OF AVERAGE VALVE.



W61 VARIABLE-MU SCREENED PENTODE

DESCRIPTION

Type W61 is an indirectly heated variable-mu screened pentode suitable for use in radio frequency amplifiers. The W61 is a direct replacement of the earlier valve KTW61.

The valve has a high mutual conductance/total cathode current ratio resulting in a high signal-to-noise ratio, and also is capable of a high stage gain.

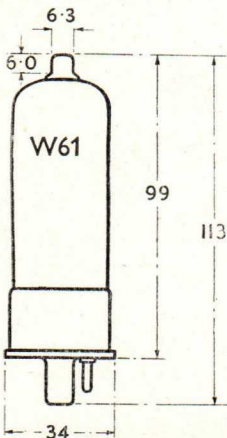
RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.3	approx. amp
Heater/Cathode Voltage	...	...	...	...	...	150	max. volts
Anode Voltage	...	...	...	...	...	250	max. volts
Screen Voltage	...	...	...	...	...	100	max. volts
Mutual Conductance at $V_{g1} -3$	...	...	...	...	...	2.9	mA/V
at $V_{g2} -25$	...	...	...	...	...	0.02	mA/V
Anode Impedance	...	...	...	...	...	0.6	megohm

Capacitances (taken on metallised valve) :

Control Grid to all other electrodes	...	...	...	...	...	7	approx. pF
Anode to all other electrodes	...	...	...	...	...	9.5	" "
Control Grid to all other electrodes	...	...	...	...	...	0.002	" "

DIMENSIONS

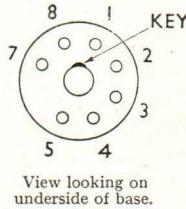


All dimensions are in mm. and are the maximum except where otherwise stated.

BASE

7-PIN OCTAL

- Pin 1: Base Shell (Metallising)
 2: Heater
 3: Anode
 4: Screen Grid
 5: Suppressor Grid
 6: Omitted
 7: Heater
 8: Cathode
 Top Cap: Control Grid



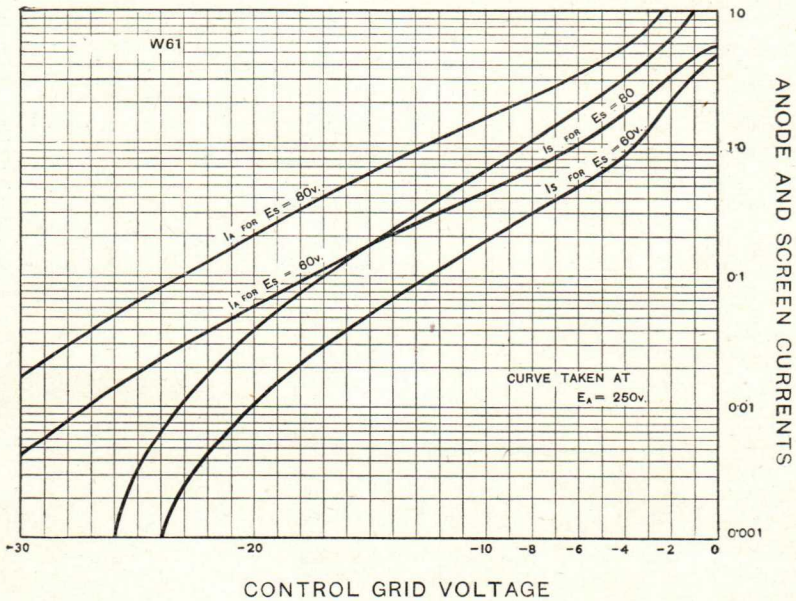
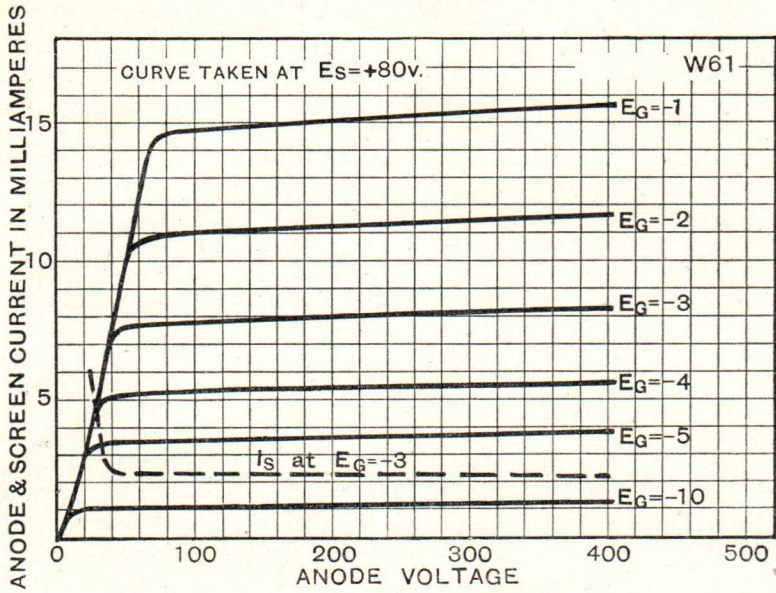
Type W61 is supplied plain or metallised.

OPERATING CONDITIONS

Anode Voltage...	...	250	250	250	volts
Screen Voltage	...	100	80	80	volts
Control Grid Voltage	...	-3	-3	-25	volts
Anode Current (Average)	...	10	8.5	0.5	mA
Screen Current (Average)	...	...	2.8	...	mA
Fixed Bias Resistor	...	250	300	...	ohms

For constant screen voltage conditions a potentiometer network should be employed. The valve may be operated with series screen feed to obtain a higher output voltage, if desired. In this case a series screen dropping resistance of 77,000 ohms may be used. The total effective resistance between the grid and cathode must not exceed 4 megohms.

TYPE W61



CHARACTERISTIC CURVES OF AVERAGE VALVE.



X61M TRIODE-HEXODE FREQUENCY CHANGER

DESCRIPTION

Type X61M is an indirectly heated triode-hexode. It has a high conversion conductance and a comparatively low cathode current giving a good signal to noise ratio, and is suitable for use up to 60 Mc/s.

The X61M is a near equivalent of the American type 6K8G.

RATINGS

Heater Voltage	...	...	6.3	volts
Heater Current	...	...	0.3	approx. amp
Anode Voltage	...	...	250	max. volts
Screen Grid Voltage	...	...	100	max. volts
Signal Grid Voltage	...	...	-3	min. volts
Oscillator Anode Voltage	...	...	100	max. volts
Total Cathode Current	...	...	10	mA
Conversion Conductance*, at $V_{g1} = -3$	...	...	620	$\mu A/V$
Conversion Conductance*, at $V_{g1} = -25$	...	...	5	$\mu A/V$
Conversion Impedance*	...	...	0.7	megohm
Input Impedance, at 30 Mc/s.*	...	...	13,000	ohms

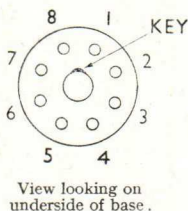
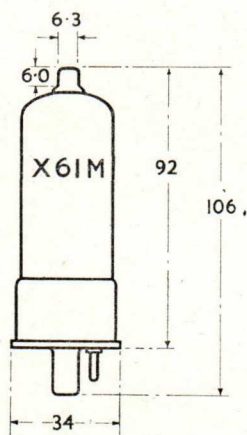
* measured at $V_a = 250$; $V_{g2, 4} = 100$; $V_{oa} = 100$; $V_{g1} = -3$

Capacitances :

Oscillator Anode to all other electrodes	...	...	6.0	approx. pF
Signal Grid to all other electrodes	...	...	4.9	" "
Hexode Anode to all other electrodes	...	...	11.5	" "
Oscillator Grid to all other electrodes	...	...	10.5	" "

DIMENSIONS

BASE



View looking on underside of base.

8-PIN OCTAL

- 1: Metallising
 - 2: Heater
 - 3: Anode
 - 4: Screen Grids $g_{2, 4}$
 - 5: Oscillator and Mixer Grid g_3
 - 6: Oscillator Anode
 - 7: Heater
 - 8: Cathode
- Top Cap: Signal Grid g_1

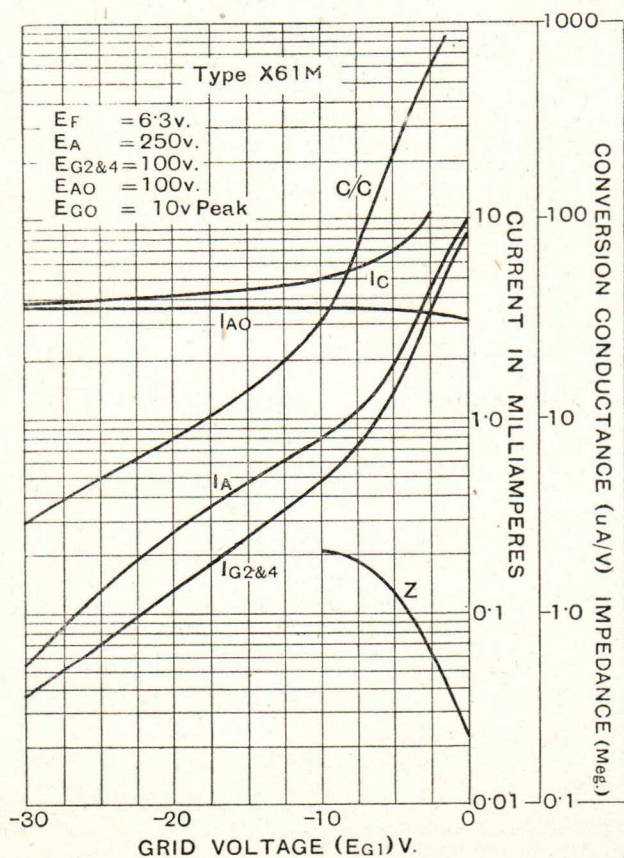
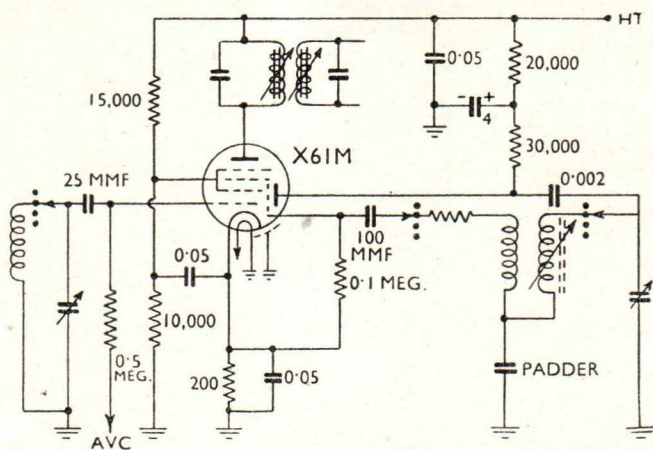
OPERATING CONDITIONS

It is desirable to supply the screen grids from a low resistance potentiometer as shown in the diagram overleaf. This potentiometer may provide screen voltage for other valves in the receiver. In DC/AC receivers the heater of type X61M should be placed as near the earthy end of the heater chain as possible. In AC receivers one side of the heater should be earthed close to the valve holder, and a capacitor of $0.001 \mu F$ connected from the other side to earth. The tuned anode oscillator circuit as shown opposite should always be used.

All dimensions are in mm. and are the maximum except where otherwise stated.

Signal Grid D.C. Voltage	...	...	-3	volts
Oscillator Anode D.C. Voltage (series supply)	...	...	100	volts
Oscillator Anode Resistor (from 250v. supply)	...	...	30,000	ohms
Optimum R.F. Oscillator Grid Voltage, peak	...	...	15	volts
Oscillator Grid Resistor	...	...	50,000	ohms
Total Cathode Current	...	...	10	mA
Anode Voltage	...	...	250	volts
Screen Grid Voltage (Potentiometer supply)	...	...	100	volts

TYPE X61M



CHARACTERISTIC CURVES OF AVERAGE VALVE.

Osram

VALVES

X63 HEPTODE FREQUENCY CHANGER

DESCRIPTION

Type X63 is an indirectly heated variable-mu heptode. It can be operated successfully up to 20 Mc/s, in which case it is essential that the input and oscillator circuits be thoroughly screened.

RATINGS

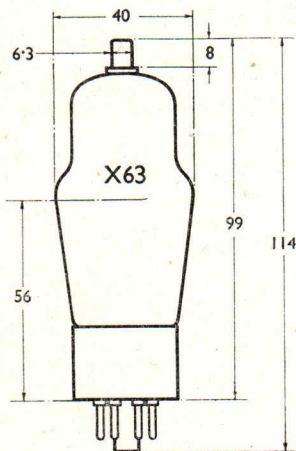
Heater Voltage	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	0.3	amp
Anode Voltage	...	...	...	...	250	max. volts
Screen Grid Voltage	...	...	...	...	100	max. volts
Signal Grid Voltage	...	...	...	...	-3	min. volts
Oscillator Anode Voltage	...	...	...	...	100	max. volts
Total Cathode Current	...	...	...	...	9.5	mA
Conversion Conductance*	at $V_{g4} = -3$	...	...	...	490	$\mu\text{A/V}$
	at $V_{g4} = -45$	...	...	...	6.0	$\mu\text{A/V}$
Conversion Impedance*	...	...	...	...	0.3	megohm

*measured at $V_a = 250$, $V_{g3,5} = 100$, $V_{g2} = 100$, $V_{g4} = -3$.

Capacitances :

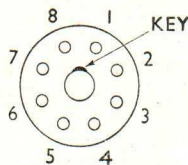
Oscillator anode to all other electrodes	...	...	...	...	5.9	approx. pF
Signal Grid to all other electrodes	...	...	...	...	4.9	" "
Heptode Anode to all other electrodes	...	...	...	...	11.5	" "
Oscillator grid to all other electrodes	...	...	...	...	10.5	" "

DIMENSIONS



All dimensions are in mm. and are the maximum except where otherwise stated.

BASE



View looking on underside of base.

8-PIN OCTAL.

- Pin 1: Not connected
 2: Heater
 3: Anode
 4: Screen Grid $g_{3,5}$
 5: Osc. Grid g_1
 6: Osc. Anode g_2
 7: Heater
 8: Cathode
 Top Cap: Control Grid g_4

Type X63 is not supplied with metallised bulb. Screening should be used when necessary.

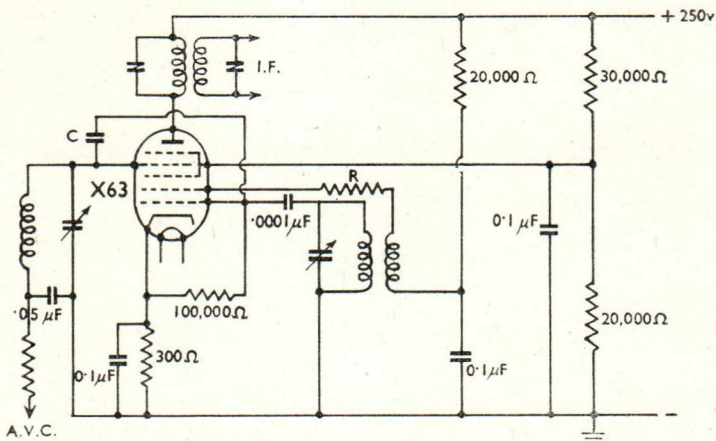
OPERATING CONDITIONS

Anode Voltage	...	...	...	250	volts
Screen Grid Voltage (Potentiometer supply)	...	...	...	100	volts
Signal Grid D.C. Voltage	...	...	...	-3	volts
Oscillator Anode D.C. Voltage (Series supply)	...	...	...	100	volts
Oscillator Anode Resistor (from 250v. supply)	...	...	...	20,000	ohms
Optimum R.F. Oscillator Grid Voltage	...	...	...	25	peak volts
Oscillator Grid Resistor	...	...	...	100,000	ohms
Total Cathode Current	...	...	...	9.5	mA

Automatic grid bias should always be used. The total oscillator grid to cathode resistance must not exceed 4 megohms. For optimum performance the oscillator anode voltage should be at least double the screen voltage

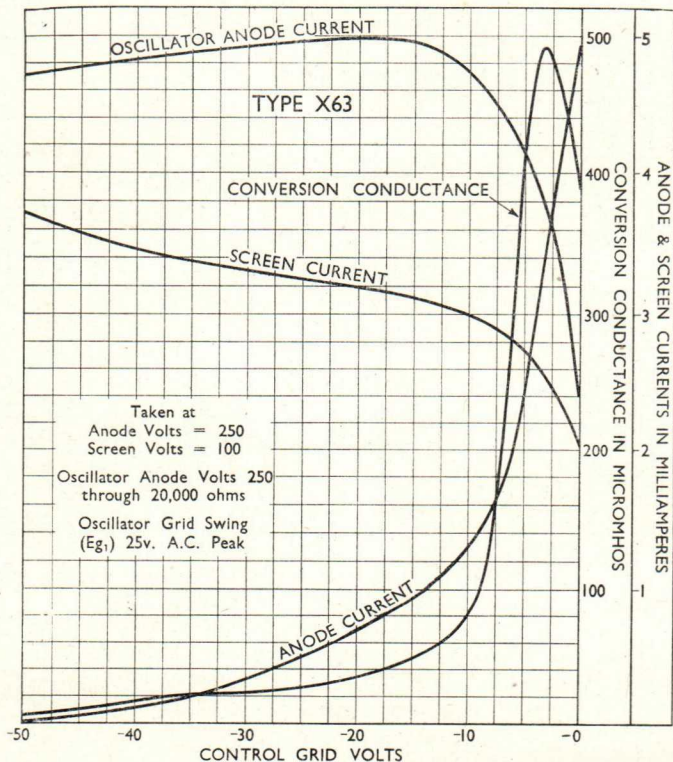
A typical circuit is shown on page 90.

TYPE X63



C = Neutralising capacitor 1 to $2\mu\text{F}$ approx.

R = Resistance dependent on design of oscillator coils.



CHARACTERISTIC CURVES OF AVERAGE VALVE.



VALVES

X65 TRIODE-HEXODE FREQUENCY CHANGER

DESCRIPTION

Type X65 is a triode-hexode valve designed primarily for use as a frequency changer in superheterodyne circuits. Its major advantage is its high input impedance. Due to the electrode design the positive grid current effect on short waves is negligible, and thus the actual stage gain is of a high order on the short waveband, resulting in a good signal-to-noise ratio, and can be made reasonably constant over a wide frequency band.

RATINGS

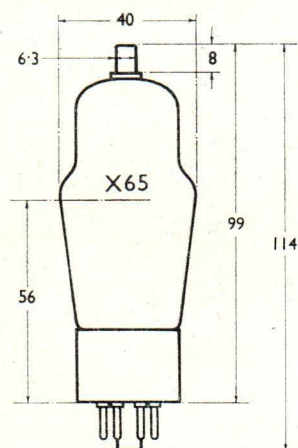
Heater Voltage ...	6.3	volts
Heater Current ...	0.3	amp
Anode Voltage ...	250	max. volts
Screen Grid Voltage ...	100	max. volts
Signal Grid Voltage ...	-3	min. volts
Oscillator Anode Voltage ...	100	max. volts
Total Cathode Current ...	11	mA
Conversion Conductance* at $V_{g1} = -3$...	225	$\mu A/V$
$V_{g1} = -45$...	0.2	$\mu A/V$
Input Impedance* at 28 Mc/s ...	22,400	ohms
56 Mc/s ...	6,800	ohms
Conversion Impedance* ...	2.5	megohms

* measured at $V_a = 250$; $V_{g2, 4} = 100$; $V_{oa} = 100$.

Capacitances :

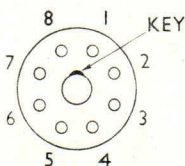
Oscillator Anode to all other electrodes ...	5.6	approx. pF
Signal Grid to all other electrodes ...	3.7	" "
Hexode Anode to all other electrodes ...	7.8	" "
Oscillator Grid to all other electrodes ...	9.6	" "

DIMENSIONS



All dimensions are in mm.
and are the maximum except where otherwise stated.

BASE



View looking on underside of base.

8 PIN OCTAL

- Pin 1: Not connected
2: Heater
3: Anode
4: Screen Grids $g_2, 4$
5: Oscillator and Mixer Grid g_3
6: Oscillator Anode
7: Heater
8: Cathode
Top Cap: Signal Grid g_1

Type X65 is not supplied with metallised bulb.
Screening should be used when necessary.

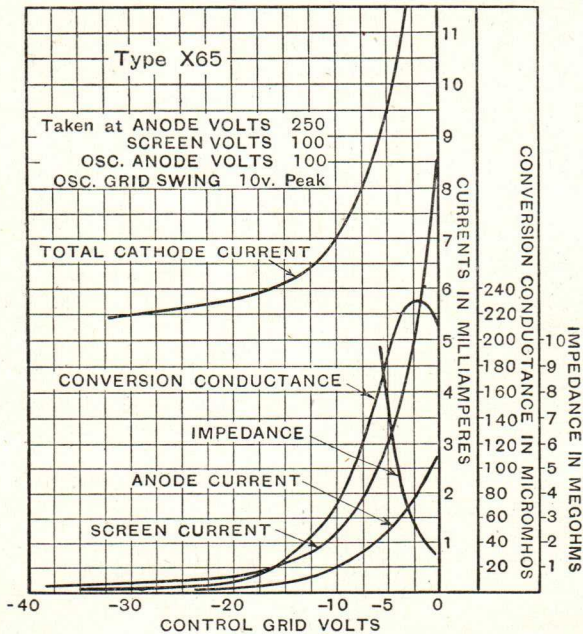
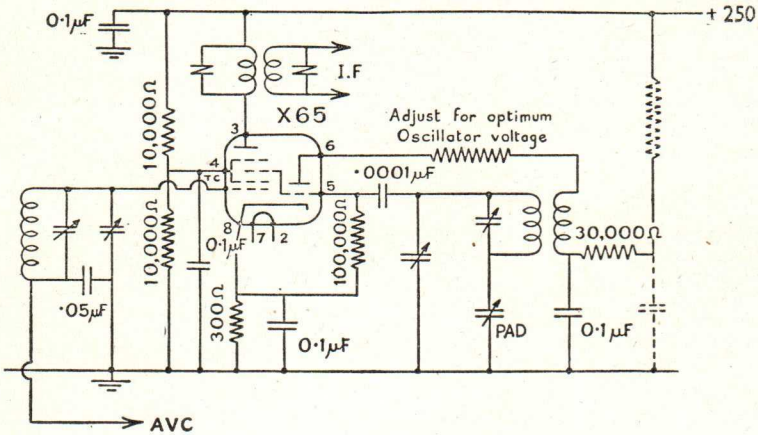
OPERATING CONDITIONS

Anode Voltage...	250	volts
Screen Grid Voltage (Potentiometer supply)	100	volts
Signal Grid D.C. Voltage ...	-3	volts
Oscillator Anode D.C. Voltage (Series supply) ...	100	volts
Oscillator Anode Resistor (from 250v. supply) ...	30,000	ohms
Optimum R.F. Oscillator Grid Voltage	10 peak	volts
Oscillator Grid Resistor ...	100,000	ohms
Total Cathode Current ...	11	mA

TYPE X65

OPERATING CONDITIONS—continued

It is desirable to supply the screen grids from a potentiometer consuming several times the screen current, as shown in the typical diagram below. This potentiometer may provide screen voltage for other valves in the receiver. In A.C./D.C. receivers the heater of type X65 should be placed as near the "earthy" end of the heater chain as possible. In A.C. receivers one side of the heater should be earthed close to the valve holder, and a capacitor of 0.001 mfd. connected from the other side to earth.



CHARACTERISTIC CURVES OF AVERAGE VALVE.



Y61 and Y63 TUNING INDICATORS

DESCRIPTION

Types Y61 and Y63 are intended for visual indication of the correct tuning point in a receiver, or for any circuit where a small change in voltage is required to be indicated visually.

They consist of a fluorescent target and an indirectly heated cathode to provide a source of electrons which on striking the target cause a glow to appear. The glow area is controlled by a third electrode internally connected to a triode amplifier so that adequate sensitivity is provided. This triode has "variable- μ " characteristics which enable good angular movement to be obtained on a weak signal without overloading on a strong signal.

Type Y63 is similar to the Y61 but has different bulb dimensions.

RATINGS

Heater Voltage ...	...	...	...	...	...	6.3	volts
Heater Current ...	...	...	...	...	...	0.3	approx. amp
Anode Supply Voltage ...	...	...	...	...	...	250	max. volts
Target Voltage* ...	...	...	...	...	...	250	max. volts
Target Current at $V_g=0$...	...	...	...	...	...	4.5	approx. mA
Triode Current at $V_g=0$...	...	...	...	...	...	0.25	approx. mA
Triode Grid Voltage for 0° shadow angle ...	...	...	...	...	...	-22	approx. volts

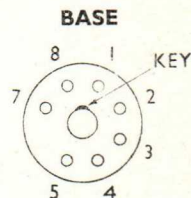
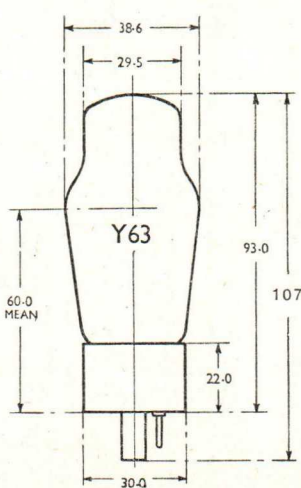
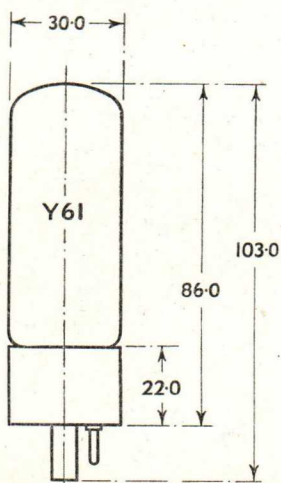
* The target voltage should in no circumstances fall below 180v.

OPERATING CONDITIONS

A typical circuit is shown overleaf in which variation in A.V.C. voltage causes a relative change in potential on the anode and control electrodes which in turn varies the shadow angle on the target.

Variation in the value of the resistor R1 will vary the shadow angle: the lower the resistance the smaller the zero bias shadow angle and the earlier the overload point occurs.

DIMENSIONS



View looking on underside of base.

7-PIN OCTAL

Pin 1: Not connected

2: Heater

3: Anode

4: Target

5: Grid

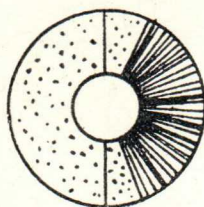
6: Omitted

7: Heater

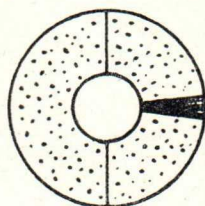
8: Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

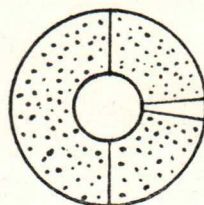
TYPES Y61 and Y63



(a) Zero Grid Bias.

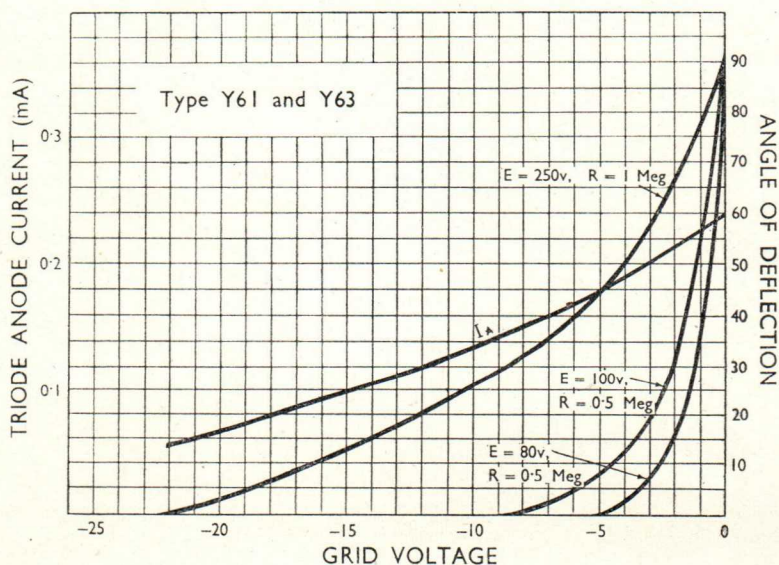
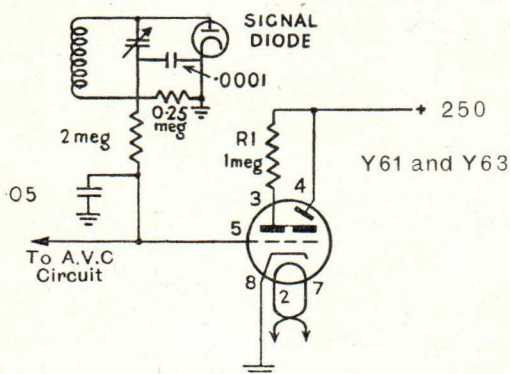


(b) Negative Grid Bias.
(Signal in tune)



(c) Valve Overloaded.

Patch of extreme brightness.



CHARACTERISTIC CURVES OF AVERAGE INDICATOR.



Z63 SCREENED PENTODE

DESCRIPTION

Type Z63 is an indirectly heated high frequency pentode. It is interchangeable with the American valve 6J7G.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.3	approx. amp
Anode Voltage	...	...	...	...	...	250	max. volts
Screen Voltage	...	...	...	...	...	125	max. volts
Mutual Conductance*	...	...	...	...	...	1.23	mA/V

* Measured at $V_a = 250$; $V_{g_2} = 100$; $V_{g_1} = -3$.

Capacitances :

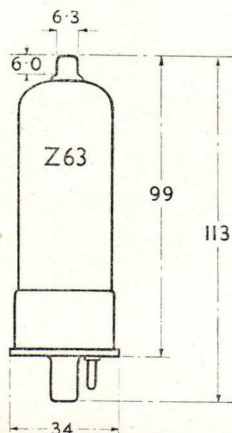
Control Grid to all other electrodes	...	...	...	...	4.7	approx pF
Anode to all other electrodes	...	...	...	...	9.9	" "
Anode to Control Grid	...	...	...	...	0.0038	" "

OPERATING CONDITIONS

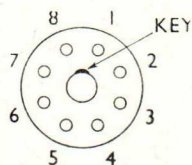
	Pentode connected	Triode connected	
Anode Voltage	250	250	volts
Screen Voltage	100	—	volts
Anode Current	1	3	mA
Screen Current	0.25	—	mA
Control Grid Voltage	-2	-3	volts
Anode Impedance	1.5 meg	10,500	ohms
Cathode Bias Resistor	2,200	1,000	ohms
Optimum Load	250,000	50,000	ohms
Screen Resistor	1	—	megohm

MOUNTING POSITION ... Any

DIMENSIONS



BASE



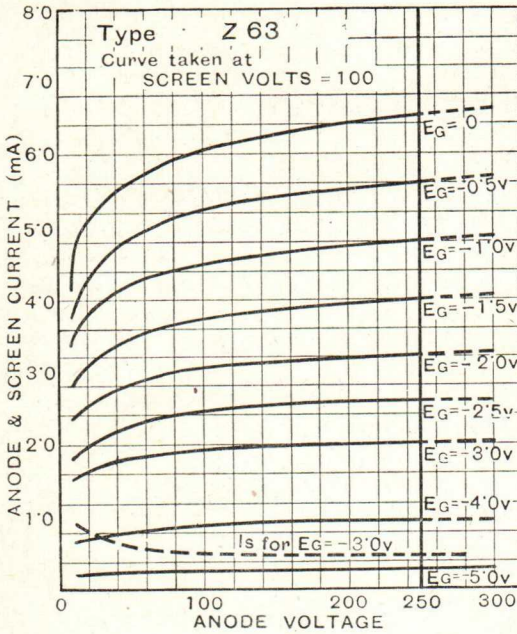
View looking on
underside of base.

7-PIN OCTAL

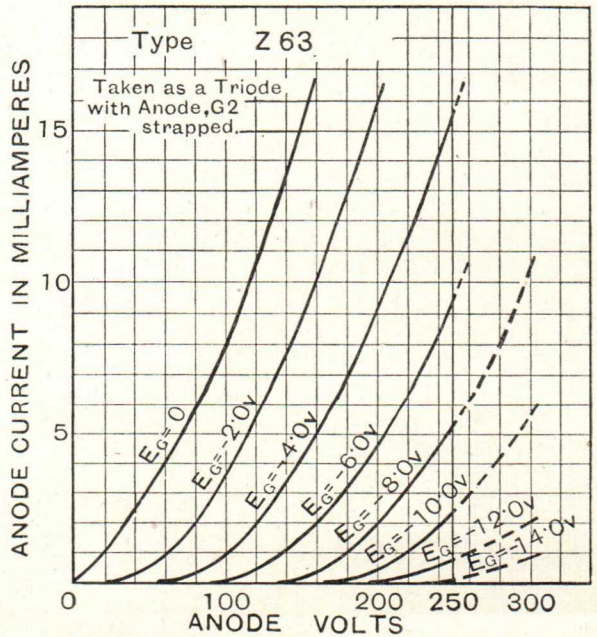
- Pin 1 : Base Shell
 2 : Heater
 3 : Anode
 4 : Screen Grid, g_2
 5 : Suppressor Grid, g_3
 6 : Omitted
 7 : Heater
 8 : Cathode
 Top Cap : Control Grid

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE Z63



CHARACTERISTIC CURVES OF
AVERAGE VALVE.





Z66 SCREENED PENTODE

DESCRIPTION

Type Z66 is an indirectly heated high slope high frequency pentode.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.63	approx. amp
				Pentode connected		Triode connected	
Anode Voltage	...	...	...	250		250	max. volts
Anode Dissipation	...	...	...	3		4	max. watts
Screen Voltage	...	...	...	250			max. volts
Screen Dissipation	...	...	...	1			max. watt
Mutual Conductance	...	...	...	8.5†		9.0*	mA/V
				7.5‡			mA/V
Operating Frequency	...	...	...	100			max. mc/s

† measured at $V_a=200$; $V_{g_2}=200$; $I_a=10.9$ mA.

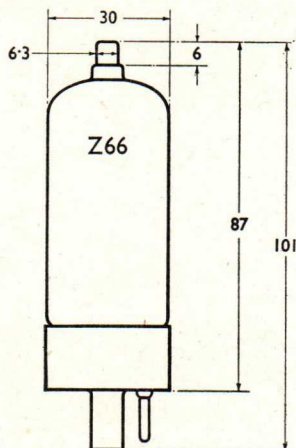
‡ measured at $V_a=250$; $V_{g_2}=200$; $I_a=8.0$ mA.

* measured at $V_a=200$; $I_a=10$ mA.

Capacitances (taken with close-fitting shield) :

Control Grid to all other electrodes	...	...	...	...	11.0	approx. pF
Anode to all other electrodes	...	...	...	...	5.5	" "
Anode to Control Grid	...	...	...	...	0.006	" "

DIMENSIONS



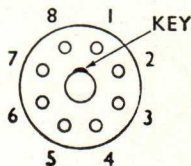
All dimensions are in mm.
and are the maximum except where otherwise stated.

BASE

8-PIN OCTAL

- Pin 1 : Not connected
 2 : Heater
 3 : Anode
 4 : Screen Grid, g_2
 5 : Suppressor Grid, g_3 and Internal Shield
 6 : Not connected
 7 : Heater
 8 : Cathode

Top Cap : Control Grid, g_1



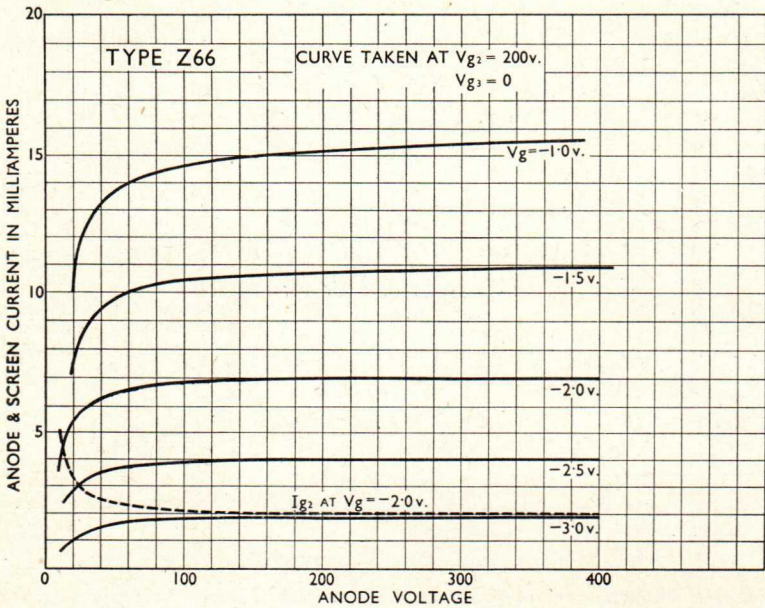
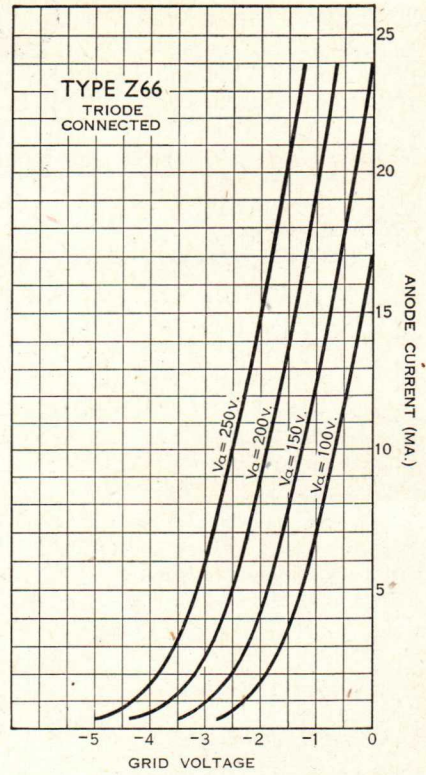
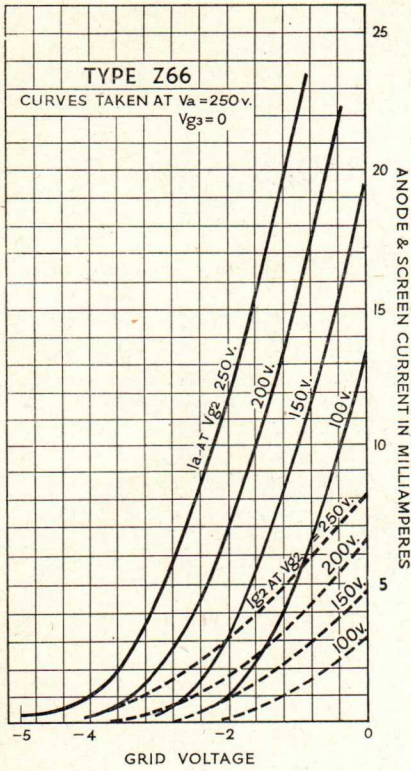
View looking on
underside of base.

OPERATING CONDITIONS

Class A Amplifier		Pentode Connected	Triode Connected	
Anode Voltage	...	200	200	volts
Anode Current	...	8.0	14.2	mA
Supp. Grid Voltage	...	0		volts
Screen Grid Voltage	...	200		volts
Screen Current	...	2.0		mA
Control Grid Voltage	...	-1.85	-1.42	volts
Cathode Bias Resistor	...	180	100	ohms
Impedance	...	1.5	0.0075	megohm
Amplification Factor	...		75	

The effective external control-grid-to-cathode resistance should be kept as low as possible and should not exceed 1 megohm under the above operating conditions. Higher resistance values may be used at an increased value of grid bias.

TYPE Z66



CHARACTERISTIC CURVES OF AVERAGE VALVE.

POWER AMPLIFYING VALVES

The following valves are power amplifying triodes with directly heated filaments. These power triodes are backed by years of manufacturing experience and proved reliability. They are suitable for use in push pull-circuits and are designed to give the maximum undistorted output within their power ratings.

LIST OF TYPES

PX4	15 watt dissipation triode.
PX25	30 watt dissipation triode.
DA41	40 watt dissipation zero bias class B triode.
DA100	100 watt dissipation triode.
DA250	250 watt dissipation triode.

Included also in types suitable for this application is type KT66 25 watt dissipation indirectly heated power tetrode.

(For suitable rectifiers see pages 121—144).

PX4 POWER TRIODE

DESCRIPTION

Type PX4 is a directly heated power triode for the output stage of receivers and amplifiers where a considerable undistorted power output is required with an anode voltage up to 300.

The filament is of the robust oxide coated type and may be heated from A.C. through a suitable step-down transformer.

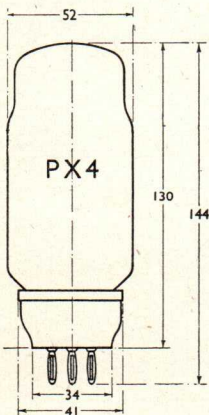
RATINGS

Filament Voltage	...	...	...	...	...	...	4.0	volts
Filament Current	...	...	...	...	...	...	1.0	approx. amp
Anode Voltage	...	...	...	...	...	...	300	max. volts
Anode Current	...	...	...	...	...	...	50	max. mA
Anode Dissipation	...	...	...	...	...	...	15	max. watts
Mutual Conductance	} ... measured at $V_a = 100, V_g = 0$						{ 6	mA/V
Amplification Factor								
Impedance								
	...	...					830	ohms

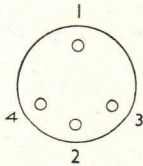
Capacitances :

Anode to Control Grid	...	...	...	...	...	...	13.7	approx. pF
Control Grid to Filament	...	...	...	...	...	...	7.7	" "
Anode to Filament	...	...	...	...	...	...	3.9	" "

DIMENSIONS



BASE



View looking on underside of base.

4-PIN

- 1 : Anode
- 2 : Control Grid
- 3 : Filament
- 4 : Filament

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE PX4

OPERATING CONDITIONS

Single Valve Class A.

Anode Voltage	...	...	...	...	300	250	200	volts
Anode Current	...	...	...	...	50	60	30	mA
Bias Resistor	...	...	...	...	1000	600	1000	ohms
Anode Load Resistance	...	...	...	...	3500	2500	3500	ohms
Power Output	...	...	...	...	4.5	3.2	1.6	watts
Distortion	...	...	...	...	4	4	5	%
Signal Input	...	...	...	...	49	36	30	peak volts

Two Valves in Push-Pull.

Anode Voltage	...	...	...	...	300	250		volts
Anode Current (per pair)	...	...	...	...	100	116		mA
Bias Resistor (per valve)	...	...	...	...	1000	650		ohms
Bias Voltage	...	...	...	...	-50	-38		approx. volts
Anode Load Resistor	...	...	...	...	4000	3000		ohms
Power Output	...	...	...	...	13.5	9		watts
Distortion	...	...	...	...	2.5	2		%
Input Signal	...	...	...	...	110	80		peak volts

A typical circuit is given showing the provision of independent automatic bias which necessitates separate filament windings for the PX4 valves.

The output transformer in all cases should have low leakage inductance, and be of ratio as below :—

$$\frac{\text{Total Primary Turns}}{\text{Total Secondary Turns}} = \sqrt{\frac{\text{Anode Load}}{\text{Speaker Impedance}}}$$

The circuit information given does not imply any licence under any patents which may be involved.

Precautions in Use.

The wiring and arrangement of the circuit should be such as to keep the capacitance between input and output circuits at as low a value as possible.

A grid stopper resistor to prevent parasitic oscillation is required, this should be wired close to the valve holder.

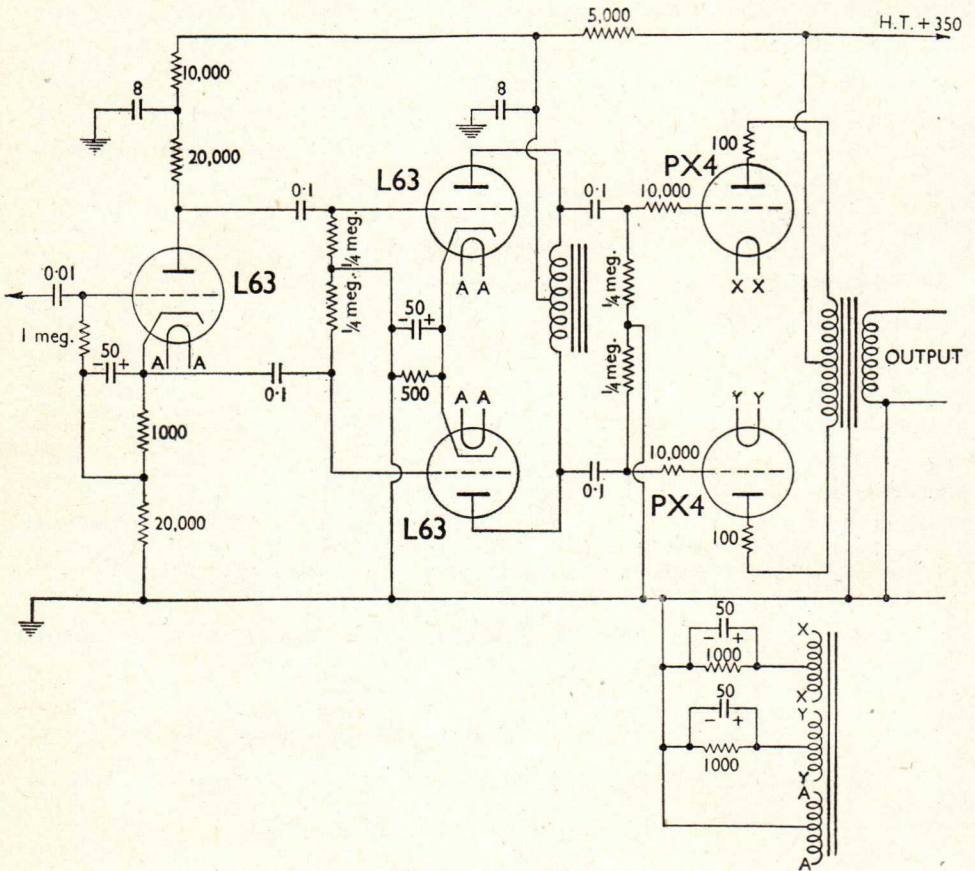
The total resistance in the grid circuit should in no case exceed 250,000 ohms.

Automatic bias should always be employed and it is recommended that separate bias should be used for each valve in the case of a push-pull circuit. In cases where the valves are operated well below the maximum voltage or wattage limit, however, a common bias resistor may be used.

Care should be taken to switch off the power supply when inserting or removing the valve from its socket, or when any adjustments are made, such as alteration to the grid bias.

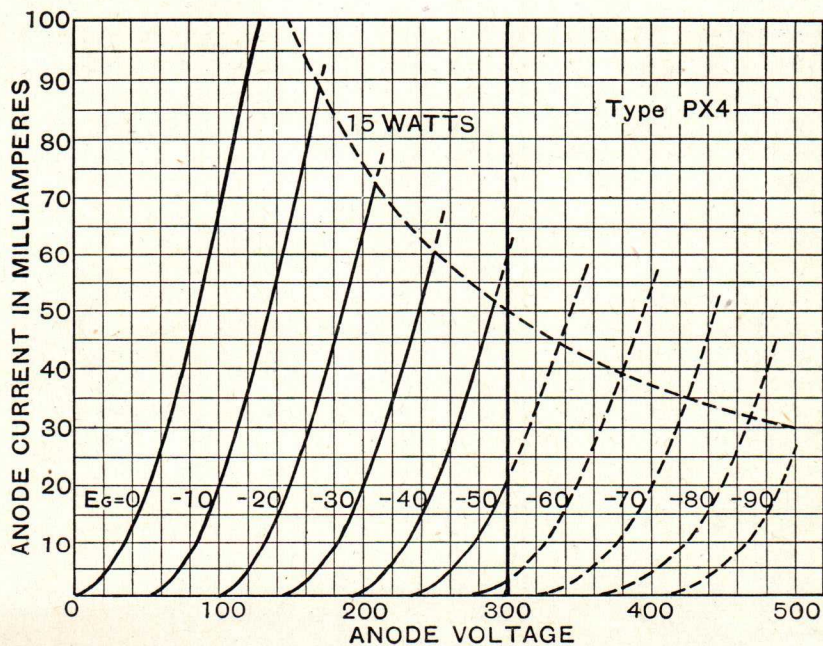
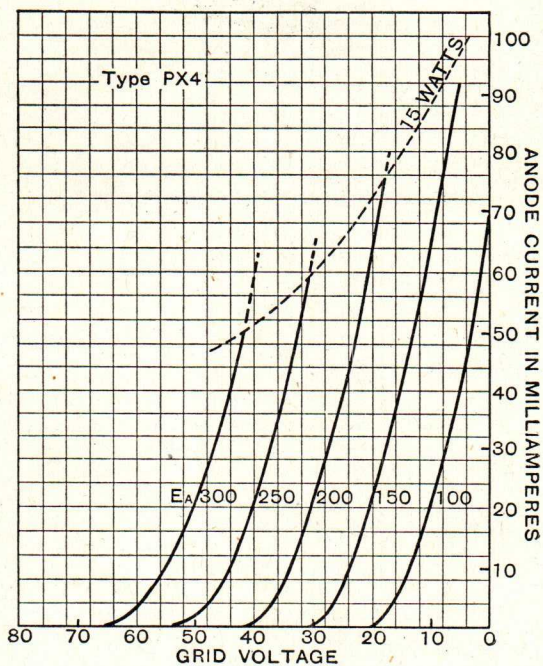
Adequate ventilation must be provided.

TYPE PX4



TWO VALVES IN CLASS AB1 PUSH-PULL AMPLIFIER CIRCUIT.

TYPE PX4



CHARACTERISTIC CURVES OF AVERAGE VALVE.

PX25



PX25 POWER TRIODE

DESCRIPTION

Type PX25 is a directly heated power triode suitable for use in audio power amplifiers either singly or in push-pull.

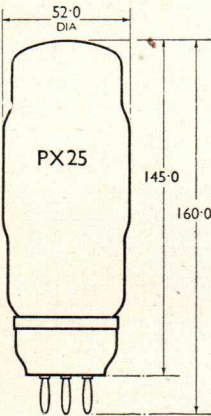
RATINGS

Filament Voltage ...	...	...	...	...	...	...	...	4.0	volts
Filament Current ...	...	...	...	...	...	...	...	2.0	approx. amps
Anode Voltage ...	...	...	...	...	...	...	...	500	max. volts
Anode Current ...	...	...	...	...	...	...	...	62.5	max. mA
Anode Dissipation ...	...	...	...	...	...	...	...	30	max. watts
Amplification Factor	}	measured at $V_a = 100$; $V_g = 0$						9.5	ohms mA/V
Impedance								1,265	
Mutual Conductance								7.5	

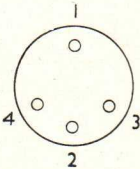
Capacitances :

Control Grid to Filament	...	...	...	...	...	11.4	approx. pF
Anode to Filament	...	...	...	...	...	8.3	" "
Control Grid to Anode	...	...	...	...	...	14.8	" "

DIMENSIONS



BASE



View looking on underside of base.

4-PIN

- 1 : Anode
- 2 : Control Grid
- 3 : Filament
- 4 : Filament

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE PX25

OPERATING CONDITIONS

Single Valve, Class A.

Anode Voltage	...	...	...	...	...	400	500	volts
Anode Current	...	...	...	...	...	62.5	50	mA
Bias Resistor	...	...	...	...	...	550	1,000	ohms
Load Resistance	...	...	...	...	...	3,200	5,500	ohms
Power Output	...	...	...	...	...	6	8.5	watts
Distortion	...	...	...	...	...	6	7	%
Signal Input	...	...	...	...	...	33	50	peak volts

Two Valves, Class A push-pull.

Two PX25 valves may be used in push-pull when a greater output is required, up to 20 watts with low distortion being given.

The operating conditions are as follows, values are for two valves unless otherwise stated :

Anode Voltage	...	...	...	...	...	400	500	volts
Anode Current	...	...	...	...	...	125	100	mA
Bias Resistor (per valve)	...	...	...	...	...	600	1,000	ohms
Anode Dissipation (per valve)	...	...	...	...	...	25	25	watts
Load Resistance	...	...	...	...	...	5,000	10,000	ohms
Power Output	...	...	...	...	...	15.5	20	watts
Distortion	...	...	...	...	...	2.5	2	%
Signal Input	...	...	...	...	...	76	102	peak volts

The control grid circuit should be isolated from the components in the anode circuit and the use of grid stopper resistors will prevent any tendency to oscillation if the connecting leads are kept short.

Independent automatic bias should be used whenever possible.

Fixed Bias Operation—Class AB1 push-pull.

The PX25 may be operated in push-pull Class AB1 with fixed bias : this permits the use of a low anode to anode load and considerably more output is obtainable at the expense of the separate bias supply unit. However, since no grid current is drawn this bias unit need not be of low impedance and hence it will consume only a small amount of power.

						<i>No signal.</i>	<i>Max. output.</i>	
Anode Voltage	...	...	...	...	...	525	500	volts
Anode Current (per pair)	...	...	...	...	...	50	165	mA
Anode Dissipation (per valve)	...	...	...	...	...	13	28	approx. watts
Bias Voltage	...	...	...	...	...	-54	-54	approx. volts
Load Resistance (anode to anode)	...	...	...	...	...	—	3,400	ohms
Power Output	...	...	...	...	...	—	26	watts
Distortion	...	...	...	...	...	—	4	%

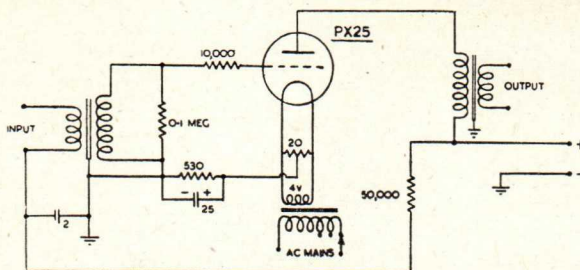
Maximum permissible resistance in grid to filament circuit :

With Automatic Bias	...	...	...	...	...	250,000 ohms
With Fixed Bias	...	...	...	...	...	100,000 ohms

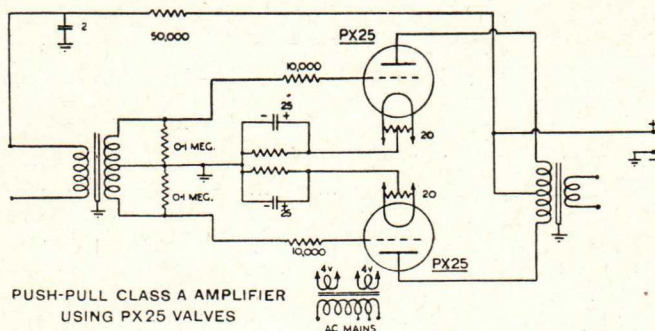
To prevent the " trigger " effect caused by an excessive positive voltage being applied to the PX25 grids, a diode, D41, is shunted across the intervalve transformer and bias unit, providing a low impedance to earth for positive voltages. It is essential not to omit this valve.

A selection of typical circuits is shown overleaf.

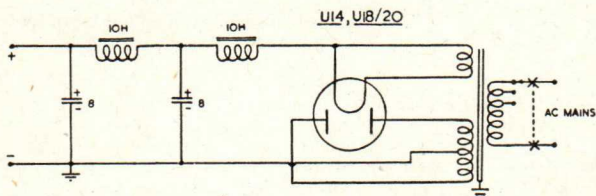
TYPE PX25



SINGLE VALVE CLASS A AMPLIFIER

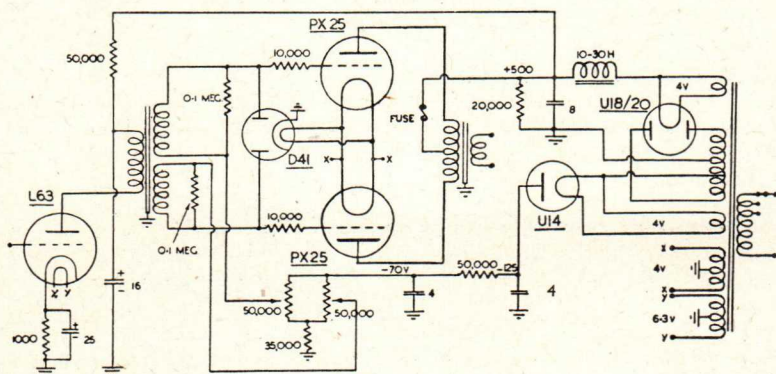


PUSH-PULL CLASS A AMPLIFIER
USING PX25 VALVES



SUITABLE ANODE SUPPLY FOR PX25 AMPLIFIER

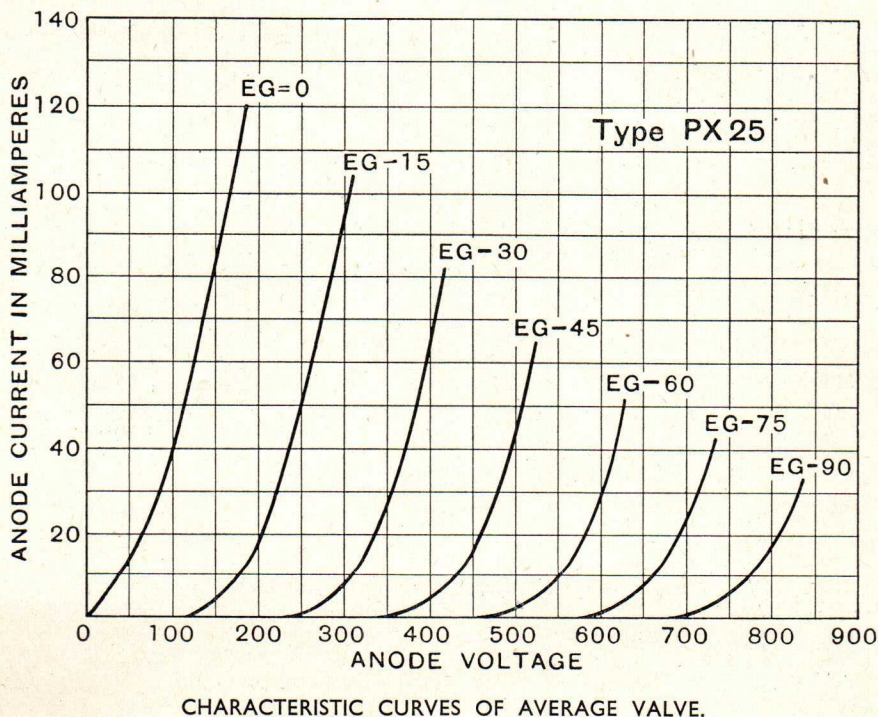
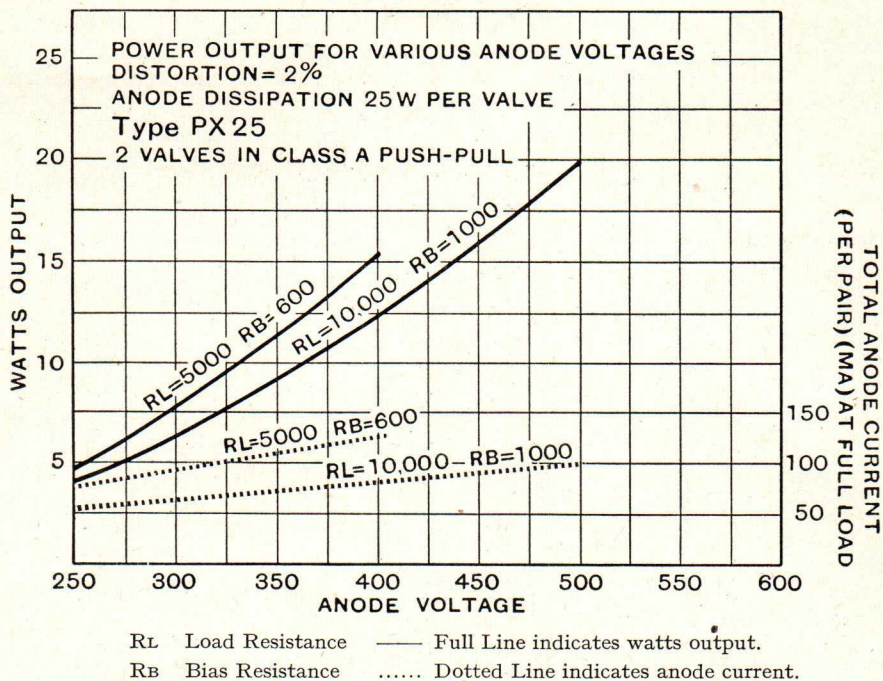
The choice of rectifier will depend on the number of valves used and on the anode voltage: a U14 will supply one PX25 together with the earlier valves in the amplifier but for two PX25 valves, a U18/20 should be used.



PUSH-PULL CLASS AB₁ AMPLIFIER WITH SEPARATE FIXED GRID BIAS

The circuit information given does not imply any licence under any patents which may be involved.

TYPE PX25



KT66



KT66 POWER TETRODE

DESCRIPTION

Type KT66 is a high slope, indirectly heated beam tetrode designed principally for use in the output stage of audio amplifiers. It may also be used as an oscillator or R.F. power amplifier for frequencies up to 30 Mc/s.

It is suitable for either single or push-pull audio operation, and may be employed as a triode with screen connected through a 100 ohm resistor to the anode.

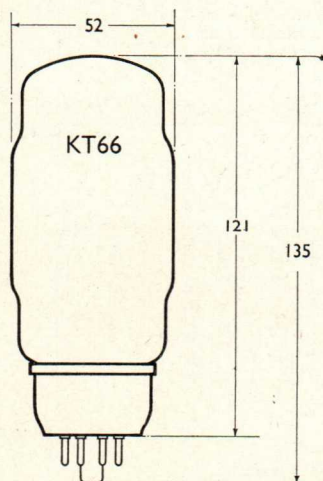
RATINGS

					Tetrode connected	Triode connected	
Heater Voltage	...	...	...	...	6.3	6.3	volts
Heater Current	...	...	...	...	1.27	1.27	amps
Anode Voltage	...	...	...	...	500	400	max. volts
Screen Voltage	...	...	...	...	400	—	max. volts
Anode Dissipation	...	...	...	...	25	25	max. watts
Screen Dissipation	...	...	...	...	3.5	—	max. watts
Anode Impedance*	...	...	...	...	22500	1450	ohms
Mutual Conductance*	...	...	...	...	6.3	5.5	mA/V
*measured at	V _a	...	...	...	250	400	
	V _{g2}	...	...	...	250	—	
	V _{g1}	...	...	...	—15	—38	

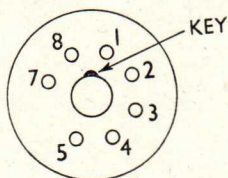
Capacitances :

Control Grid to all other electrodes	...	...	...	16.0	—	approx. pF
Anode to all other electrodes	...	...	...	11.5	—	" "
Anode to Control Grid	...	...	...	1.1	—	" "
Control Grid to Cathode	...	...	...	—	8.7	" "
Anode to Cathode	...	...	...	—	15.8	" "
Anode to Control Grid	...	...	...	—	7.2	" "

DIMENSIONS



BASE



View looking on underside of base.

7-PIN OCTAL

- Pin 1: Not connected
- 2: Heater
- 3: Anode
- 4: Screen Grid, g₂
- 5: Control Grid, g₁
- 6: Omitted
- 7: Heater
- 8: Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE KT66

OPERATING CONDITIONS

Single Valve A.F. Amplifier

				Tetrode connected	Triode connected	
Anode and Screen Voltage	...	...	...	250	400 250	volts
Bias Voltage	...	...	...	-15	-38 -19	volts
Anode Current	...	...	...	85	63 60	mA
Screen Current	...	...	...	6.3	— —	mA
Signal Input	...	...	...	15	38 19	peak volts
Bias Resistor	...	...	...	160	600 315	ohms
Anode Load Resistance	...	...	...	2200	4500 2750	ohms
Distortion	...	...	...	9	7 6	%
Power Output	...	...	...	7.25	5.8 2.2	watts

Two Valves Push-Pull A.F. Amplifier. Tetrode connected, Auto Bias.

(Data per pair of valves unless otherwise stated.)

				450v. supply	250v. supply	
Anode Voltage.	Full load	...	...	390	250	volts
Screen Voltage.	Full load	...	...	275	250	volts
Bias Voltage	...	...	...	-22.5	-17.5	volts
Anode Current	{ No load	...	...	104	162	mA
	{ Full load	...	...	125	165	mA
Screen Current	{ No load	...	...	5	12	mA
	{ Full load	...	...	18	20	mA
Anode Dissipation, per valve	{ No load	...	...	9.5	12	watts
Screen Dissipation, per valve		...	...	2.5	2.5	watts
Bias Resistor, per valve	...	...	...	500	200	ohms
Signal Input, grid to grid	...	...	...	70	36	volts
Load Resistance, anode to anode	...	...	...	8000	4000	ohms
Distortion	...	...	...	6	4	%
Power Output	...	...	...	30	17	watts

Two Valves Push-Pull A.F. Amplifier. Triode connected. Auto Bias.

(Data per pair of valves unless otherwise stated.)

				450v. supply	250v. supply	
Anode and Screen Voltage	...	...	...	400	250	volts
Bias Voltage	...	...	...	-38	-20	volts
Anode Current	...	...	...	125	110	mA
Signal Input, grid to grid	...	...	...	80	40	volts
Bias Resistor, per valve	...	...	...	600	360	ohms
Load Resistance, anode to anode	...	...	...	4000	2500	ohms
Distortion	...	...	...	3.5	2	%
Power Output	...	...	...	14.5	4.5	watts

Two Valves Push-Pull A.F. Amplifier. Tetrode connected. Fixed Bias.

For low distortion and permitting continuous full load operation.

(Data per pair of valves unless otherwise stated.)

				No signal	Full signal	
Anode Voltage	...	...	...	510	475	volts
Screen Voltage†	...	...	...	395	360	volts
Bias Voltage	...	...	...	-40	-40	volts
Anode Current	...	...	...	80	175	mA
Screen Current	...	...	...	3	19	mA
Anode Dissipation, per valve	...	...	...	21	17	watts
Screen Dissipation, per valve	...	...	...	0.6	3.5	watts
Signal Input, grid to grid	...	...	...	—	80	volts
Load Resistance, anode to anode	...	...	...	5000	5000	ohms
Distortion	...	...	...	—	5	%
Power Output	...	...	...	—	50	watts

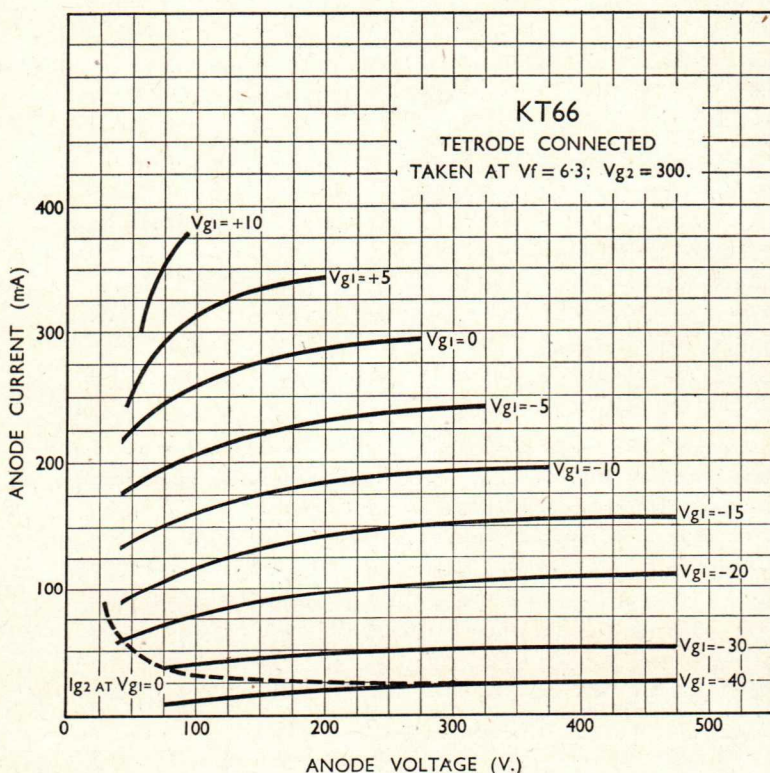
† Stabilised screen supply voltage

TYPE KT66

Precautions in Use

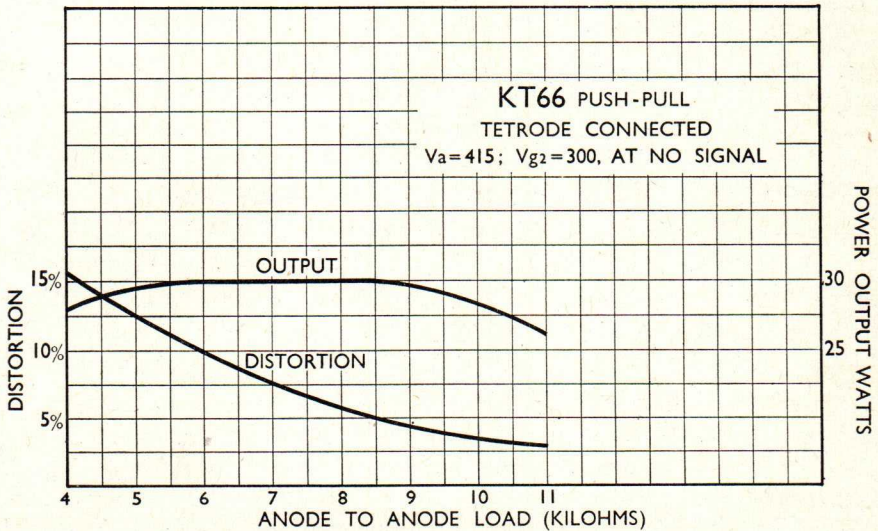
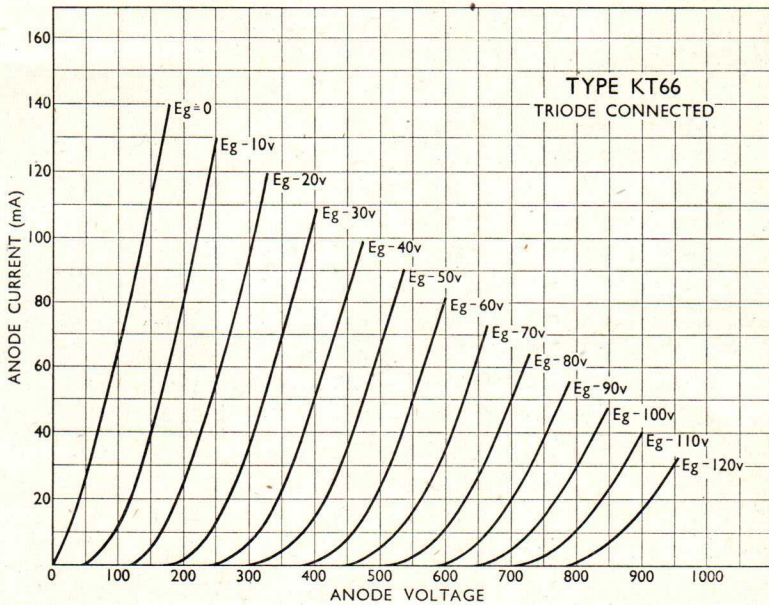
1. For the prevention of parasitic oscillation, always connect a resistor of 100/300 ohms close to the screen grid terminal of the valve holder. When used as a triode this resistor is connected between screen and anode. A control grid (stopper) resistor of 10,000 ohms to 50,000 ohms. is also recommended.
2. The maximum permissible D.C. resistance from control grid to cathode is limited to 0.5 megohms for auto bias and 0.1 megohm for fixed bias application.
3. The heater-cathode voltage should not exceed 150 volts. When used as a cathode-coupled driver valve, the heater and cathode should be joined and a separate heater supply used for each valve.
4. In push-pull applications showing a large change in anode current between the quiescent and full output conditions, a choke input smoothing circuit having a good regulation should be used. A badly regulated supply will lead to a fall in power output and/or excessive quiescent anode dissipation.
5. The use of a common auto-bias resistor is not recommended except in applications where the maximum anode dissipation is not attained under any condition of operation.
6. Ventilation: Adequate ventilation around the bulb should be provided.

The circuit information given does not imply any licence under any patents which may be involved.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

TYPE KT66



CHARACTERISTIC CURVES OF AVERAGE VALVE.

DA41 POWER TRIODE

DESCRIPTION

Type DA41 is a power triode with carbon anode and fitted with a thoriated tungsten dull emitter filament and designed mainly for use in pairs in a positive grid drive Class B push-pull audio frequency amplifier. Under suitable conditions an output of up to 175 watts may be obtained from a pair of DA41 valves operating at an anode voltage of 1,000.

The valve is designed to operate under the zero grid bias condition, so effecting a considerable saving by avoiding the necessity for a separate grid bias supply.

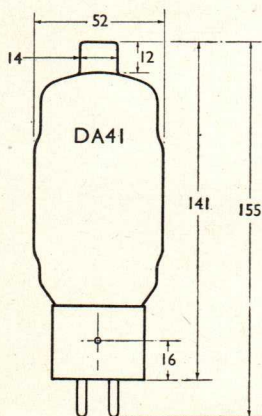
RATINGS

Filament Voltage	...	...	...	...	...	...	7.5	volts
Filament Current	...	...	...	...	...	...	2.5	approx. amps
Anode Voltage	...	...	...	...	...	...	1000	max. volts
Anode Dissipation	...	...	...	...	...	...	40	max. watts
Amplification Factor	}	measured at $V_a = 1000$; $W_a = 40$	}	17,500	3.6	ohms mA/V	62	
Impedance							3.6	
Mutual Conductance								

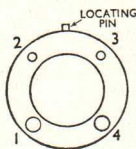
Capacitances:

Anode to Control Grid	...	...	...	...	...	5.9	approx. pF
Control Grid to Filament	...	...	...	...	...	10.0	" "
Anode to Filament	...	...	...	...	...	1.8	" "

DIMENSIONS



BASE



View looking on underside of base.

AMERICAN MEDIUM 4-PIN BAYONET

- 1: Filament.
- 2: Not connected.
- 3: Control Grid.
- 4: Filament.

Top Cap: Anode.

*All dimensions are in mm and are max.
except where otherwise stated.*

TYPE DA41

OPERATING CONDITIONS

Per pair of valves ; push-pull. Class B.

Anode Voltage	1000	volts
Grid Voltage	0	volts
Anode Current (zero signal)	44	approx. mA
Anode Current (max. signal)	280	approx. mA
Load Resistance (anode to anode)	7000	ohms
Signal Input (grid to grid)	220	peak volts
Grid Current (max. signal)	30	approx. mA
Power Output	175	watts
Distortion	5	%

It will be found that the anode dissipation at approximately one half maximum output will exceed 40 watts per valve : this is permissible as it is intermittent. It is not possible to dissipate this wattage for long periods but normal speech and music, because of their intermittent nature, do not cause any overload.

Typical Circuit.

The circuit shown is suggested as a simple arrangement giving good quality. The driver stage consists of a pair of triode-connected KT61 valves in push-pull, cathode-coupled to the output stage by a " bridged transformer."

The resistors R1 and R2 in the cathode circuit of the KT61 valves are added in series with each half-primary to make up a total of 300 ohms to provide automatic bias for the KT61 valve.

In this arrangement of driver circuit, the pre-driver stage must supply a comparatively large signal voltage to the driver—slightly more in fact than the input to the DA41—and for this purpose two triode-connected Z63 or L63 valves in push-pull are used with a coupling transformer having a ratio of 1 : 3. This transformer should be designed to give an undistorted secondary voltage of about 85 + 85 volts R.M.S.

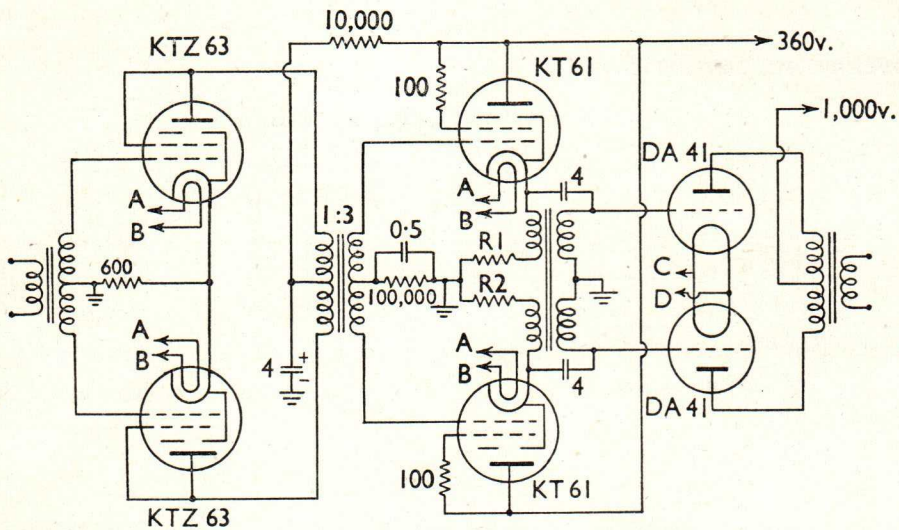
The Z63 valves have a common bias resistor of 600 ohms, no by-pass capacitor being required. The input transformer need only give an undistorted secondary voltage of 6+6 volts R.M.S. and may have any suitable ratio.

A suitable mains unit is also shown. Bi-phase half-wave rectification with two GU50 valves provides H.T. power for the DA41 stage and a smaller unit with a vacuum rectifier supplies the driver and pre-driver positions. It is essential that some form of delayed switching system is used in the GU50 circuit.*

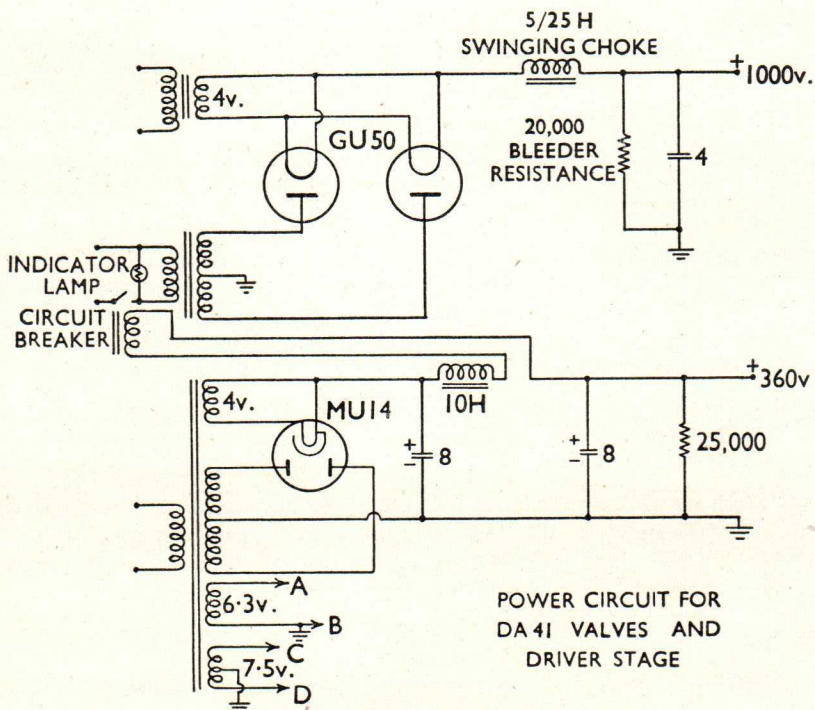
* For operating data see page 122 for GU50 valve.

The circuit information given does not imply any licence under any patents which may be involved.

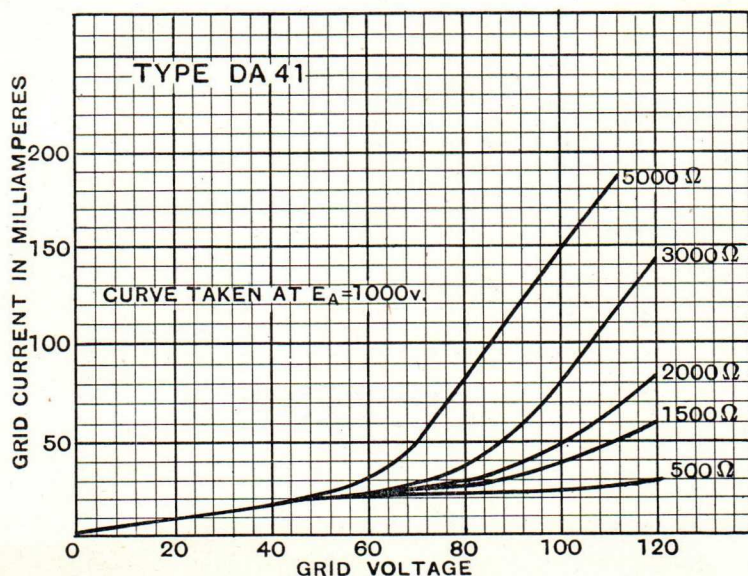
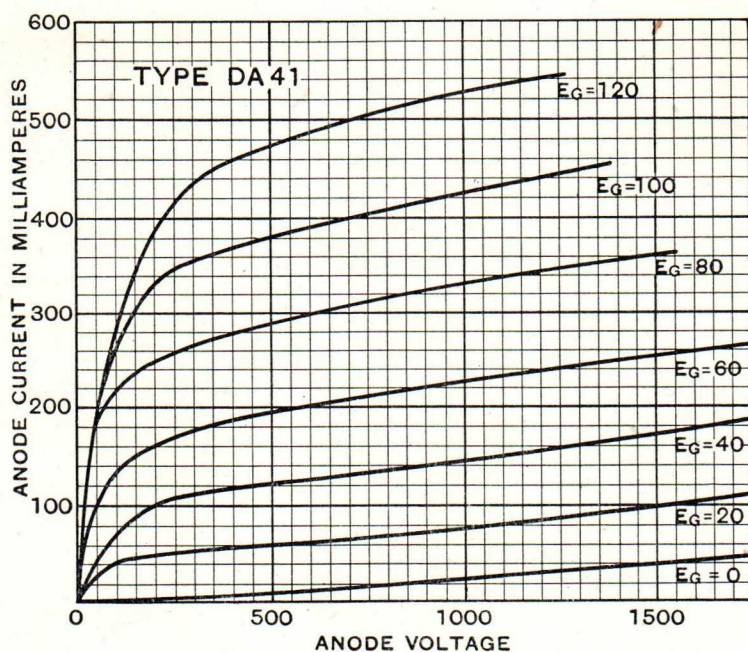
TYPE DA41



USE OF CATHODE COUPLING AND BRIDGED TRANSFORMER FOR DRIVING A PAIR OF DA41 VALVES



TYPE DA41



CHARACTERISTIC CURVES OF AVERAGE VALVE.

DA100



DA100 POWER TRIODE

DESCRIPTION

Type DA100 is a directly-heated triode having an oxide coated filament and is suitable for use in Class AB1 or AB2 amplifiers, or as a modulator.

RATINGS

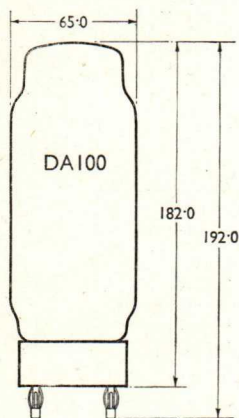
Filament Voltage ...	...	...	...	...	...	...	6.0	volts
Filament Current ...	...	...	...	...	...	...	2.7	approx. amps
Anode Voltage ...	...	...	...	...	...	...	1250	max. volts
Anode Dissipation ...	...	...	...	...	...	...	100	max. watts
Amplification Factor ...	...	...	...	...	...	...	5.5*	
Impedance ...	...	...	...	...	...	...	1410*	ohms
Mutual Conductance ...	...	...	...	...	...	...	3.9*	mA/V

* Measured at $V_a=1000$, $I_a=100$ mA.

Capacitances :

Grid to Filament ...	...	...	...	...	...	...	15.8	approx. pF
Anode to Filament ...	...	...	...	...	...	...	10.8	" "
Grid to Anode ...	...	...	...	...	...	...	15.7	" "

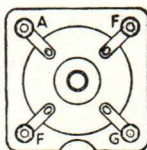
DIMENSIONS



MOUNTING POSITION

The valve should be mounted vertically with the base down.

BASE



View looking on underside of base.

SPECIAL 4-PIN

A : Anode
F : Filament
G : Grid

All dimensions are in mm. and are the maximum unless otherwise stated.

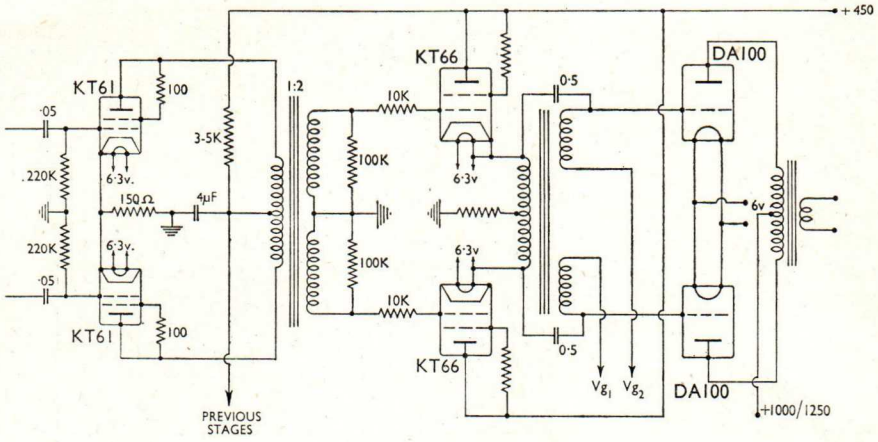
OPERATING CONDITIONS

Per pair unless otherwise stated

	CLASS AB1		CLASS AB2		
Anode Voltage (max. signal) ...	1000	1250	1000	1250	volts
Anode Current (no signal) ...	100	100	100	100	mA
Anode Current (max. signal) ...	330	300	300	365	mA
Anode Dissipation (no signal, per valve) ...	55	70	55	55	watts
Anode Dissipation (max. signal, per valve) ...	53	100	50	80	watts
Control Grid Voltage ...	-200	-225	-200	-225	volts
Signal Input (grid-to-grid) ...	400	450	500	560	peak volts
Control Grid Current ...	—	—	15	20	mA
Anode Load Resistance ...	4000	8000	8000	8000	ohms
Power Output ...	125	175	200	300	watts
Distortion ...	4	5	6	6	%

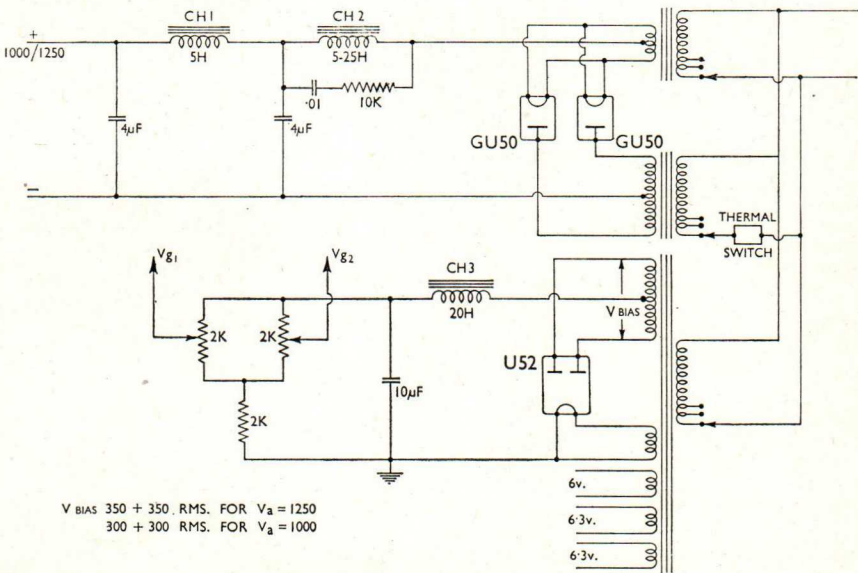
The power supply should have an impedance not exceeding 400 ohms. Under AB2 conditions the anode dissipation rises to a maximum at approximately one half full output.

TYPE DA100



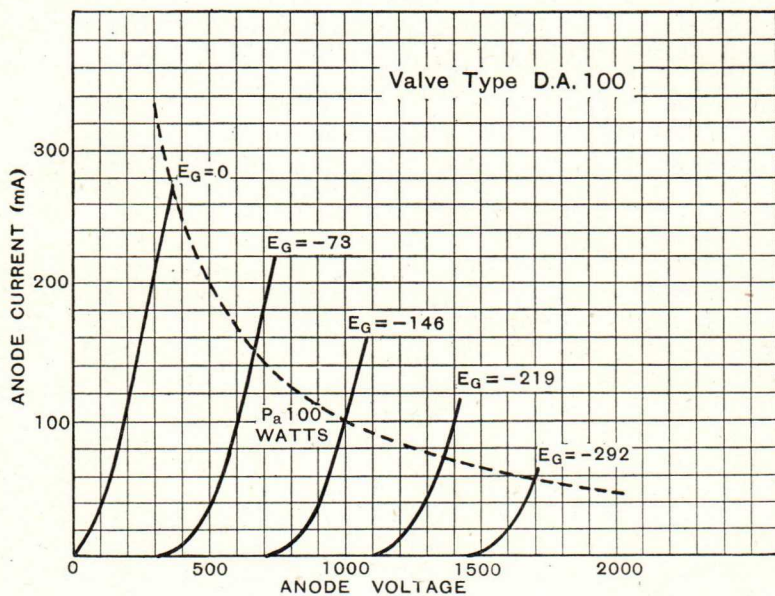
CIRCUIT OF DA100 IN CLASS AB2

The earthing resistor for the centre tap of the second interval transformer is to be of such value that together with the d.c. resistance of the transformer it will equal 600 Ω per valve. The value of the KT66 screen resistors is 100 Ω each.



Power supply for use with above.

TYPE DA100



CHARACTERISTIC CURVES OF AVERAGE VALVE.

Osram

VALVES

DA250 POWER TRIODE

DESCRIPTION

Type DA250 is a directly heated triode, suitable for use in the output stage of an amplifier.

The valve is designed primarily to operate both in negative and positive drive Class "AB" push-pull circuits. Greatly increased power is obtainable in the positive drive condition with suitable circuit arrangements and precautions.

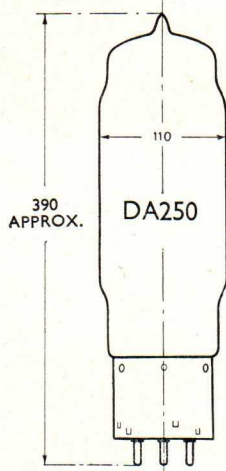
RATINGS

Filament Voltage ...	...	...	...	...	...	...	10	volts
Filament Current ...	...	...	...	...	...	...	2.0	approx. amps
Anode Voltage ...	...	...	...	...	...	...	2,500	max. volts
Anode Dissipation ...	...	...	...	...	...	...	250	max. watts
Amplification Factor	} measured at $V_a=2,500$; $I_a=100$ }						16	
Impedance							2,300	ohms
Mutual Conductance							7.0	mA/V

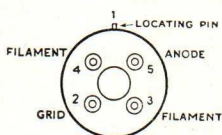
Capacitances :

Grid to Filament ...	...	...	...	...	...	...	21	approx. pF
Anode to Filament	...	...	...	...	...	...	6.0	" "
Anode to Grid	...	...	...	...	...	...	41	" "

DIMENSIONS



BASE



View looking on
underside of base.

Special large 4-pin B.C.

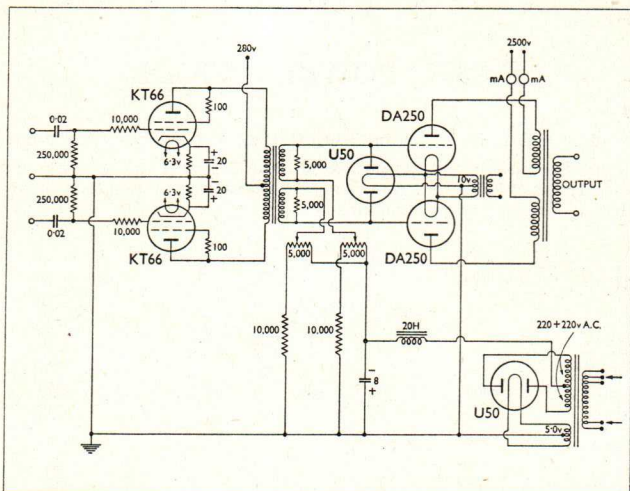
*All dimensions are in mm. and are approximate except
where otherwise stated.*

OPERATING CONDITIONS

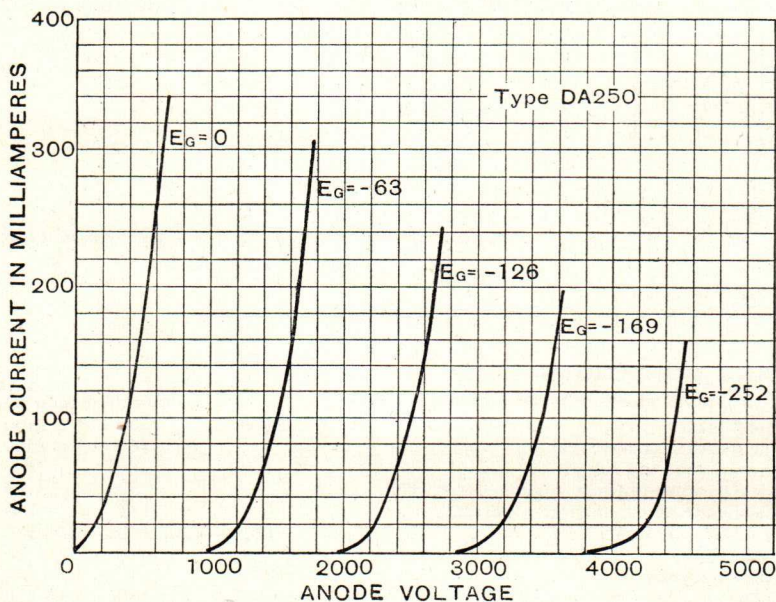
Per pair of valves unless otherwise stated

	Class A	Class AB1 push pull	Class AB2 push pull	
D.C. Anode Voltage ...	2500	2500	2500	volts
D.C. Anode Current (max. signal) ...	—	360	500	mA
D.C. Anode Current (no signal) ...	100	100	100	mA
D.C. Anode Dissipation (max. signal, per valve) ...	—	250	190	watts
D.C. Anode Dissipation (no signal, per valve) ...	—	135	135	watts
D.C. Control Grid Voltage ...	-126	-130/-160	-130/-160	volts
Grid Current ...	—	—	20	mA
Cathode Bias Resistor ...	1260	—	—	ohms
Signal Input, peak ...	—	130/160	180/220	volts
Anode Load Resistance ...	17,500	12,000	12,000	ohms
Power Output ...	90	400	800	watts
Distortion ...	—	up to 5	up to 6	%

TYPE DA250



Typical circuit for Class AB1 push pull with DA250 valves. The U50 is included in order to prevent the "Trigger Effect" due to the reversal of grid current during periods of excess input voltage.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

POWER RECTIFIERS

LIST OF TYPES

American equivalent types are shown bracketed.

The following Rectifiers are listed, being types with various bases and power ratings, suitable for use in conjunction with the Receiving and Amplifying valves in previous sections :

- GU50 Half wave mercury vapour rectifier for power amplifying circuits.
- U18/20 Bi-phase half wave rectifier for power amplifier circuits.
- U19 Half wave high power rectifier.
- U31 Indirectly heated half wave rectifier for DC/AC sets (0.3 amp.).
- U33 EHT rectifier for C.R. tube applications.
- U37 Miniature EHT rectifier for C.R. tube applications.
- U52 Bi-phase half wave rectifier for power amplifying (5U4G) circuits.
- U78 B7G miniature bi-phase half wave rectifier for AC (6X4) sets.
- U107 B7G miniature half wave rectifier for DC/AC sets (0.1 amp.).

The following are recommended as *maintenance types only* :

- MU14 Indirectly heated bi-phase half wave rectifier.
- U14 Directly heated bi-phase half wave rectifier.
- U50 Directly heated bi-phase half wave rectifier. (5Y3G)

GU50

Osram

VALVES

GU50 MERCURY VAPOUR RECTIFIER

DESCRIPTION

Type GU50 is a directly heated half-wave mercury vapour rectifier.

RATINGS

Filament Voltage ...	...	...	...	...	...	...	$4 \pm 10\%$	volts
Filament Current ...	...	...	...	...	...	...	3	amps
Input Voltage, R.M.S. ...	...	...	...	...	...	...	1,750	max. volts
Peak Inverse Voltage ...	...	...	...	...	...	...	5,200	max. volts
D.C. Output Current ...	...	...	...	...	...	...	0.25	max. amp
Peak Anode Current ...	...	...	...	...	...	...	1	max. amp
Forward Voltage Drop ...	...	...	...	...	...	...	12	approx. volts

MOUNTING POSITION

The valve must be mounted vertically, with the anode at the top.

TYPE OF SWITCHING

Delayed.

PREHEATING TIME

When newly installed after transit or following a period of disuse, the filament must be run at normal temperature for at least 15 minutes prior to the application of the anode voltage.

After installation, a delay of 30 seconds is essential when switching on from cold.

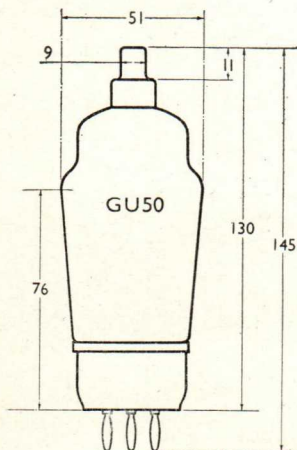
Failure to observe these precautions will destroy the filament and render the valve useless.

PRECAUTIONS IN USE

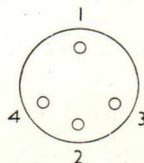
A choke input filter circuit must always be used.

The ambient temperature of the valve must not exceed 35°C. measured by a thermometer suspended six inches from the valve with the bulb level with the top of the valve base.

DIMENSIONS



BASE



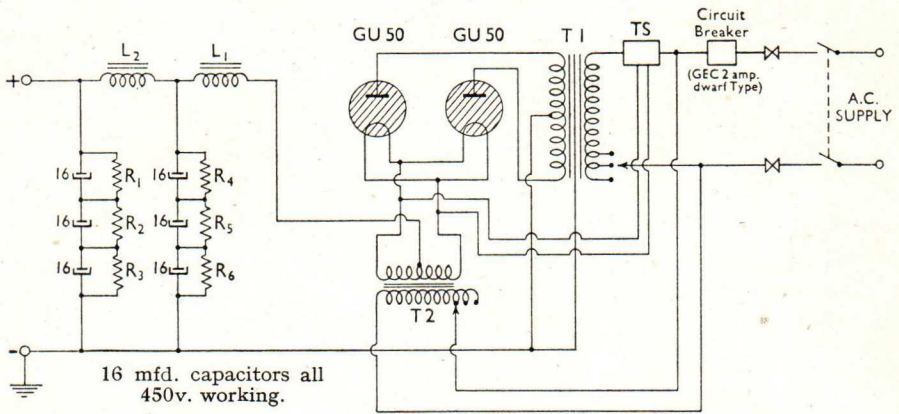
View looking on underside of base.

4-PIN BRITISH

- Pin 1: Not connected
 - 2: Not connected
 - 3: Filament
 - 4: Filament
- Top cap: Anode

All dimensions are in mm and are the maximum except where otherwise stated.

TYPE GU50



TYPICAL CIRCUIT DIAGRAM

$R_1, R_2, R_3, R_4, R_5, R_6$ are 50,000 ohm resistors, only required if series connected electrolytic capacitors are used, as shown.

A paper capacitor of 4 μF may be used instead of each group of three electrolytic capacitors.

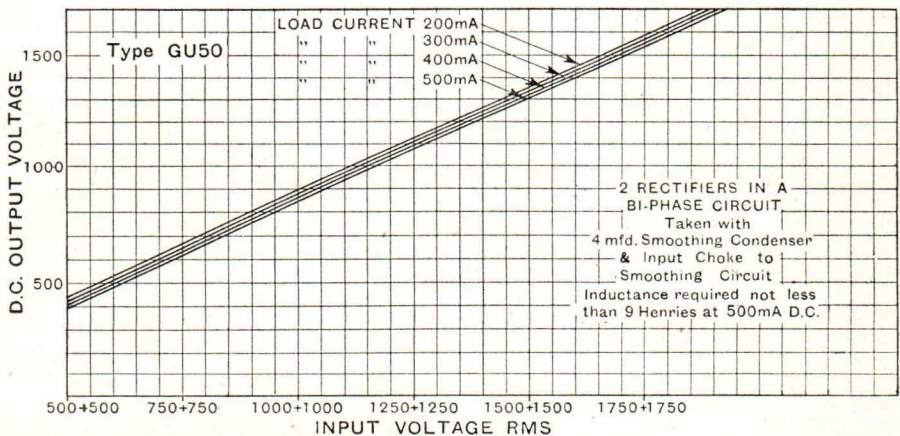
L_1, L_2 should be not less than 9 henries at 500 mA, D.C. resistance not greater than 100 ohms.

T1. For reasonably good regulation, the primary winding should be designed for 0.55 k.V.A. and the secondary for 0.8 k.V.A., 1300 + 1300 volts for D.C. output 465 mA at 1000 v.

T2. Filament transformer, secondary winding 4 volts total at 6 amps.

TS. Time switch for delayed switching of anode voltage.

If less smoothing is required, L_2 and one capacitor bank may be omitted.



CHARACTERISTIC CURVES OF AVERAGE VALVE.

MU14



MU14 RECTIFIER

DESCRIPTION

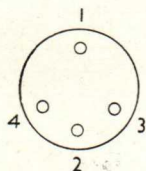
Type MU14 is a bi-phase half wave rectifier valve having an indirectly heated cathode. It replaces types MU12 and MU12/14.

RATINGS

Heater Voltage ...	...	...	...	...	...	...	4.0	volts
Heater Current	...	...	...	...	...	...	2.5	amps
Capacitor Input, Bi-phase half-wave circuit								
Input Voltage R.M.S. ...	...	...	...	...	...	...	500	max. volts
Peak Inverse Voltage ...	...	...	...	...	...	...	1,400	max. volts
D.C. Output Current ...	...	...	...	...	...	...	120	max. mA
Peak Anode Current (running)	...	...	...	...	...	...	380	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	100	min. ohms
Reservoir Capacitor	...	...	...	...	...	...	32	max. μ F
Inductor Input Bi-phase half-wave circuit								
Input Voltage R.M.S. ...	...	...	...	...	...	...	500	max. volts
Peak Inverse Voltage ...	...	...	...	...	...	...	1,400	max. volts
D.C. Output Current ...	...	...	...	...	...	...	135	max. mA
Peak Anode Current (running)	...	...	...	...	...	...	380	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	100	min. ohms
Input Inductor ...	...	...	...	...	...	...	5	henries at 135 mA
Type of Switching	...	...	...	...	...	...	...	Direct
Preheating Time	...	...	...	...	...	...	...	Nil

DIMENSIONS

Overall Length	...	...	...	...	...	...	120	max. mm
Seated Length	...	...	...	...	...	...	105	max. mm
Diameter	...	...	...	...	...	...	45	max. mm



View looking on underside of base.

BASE

4 PIN BRITISH

- 1: Anode
- 2: Anode
- 3: Heater & Cathode
- 4: Heater

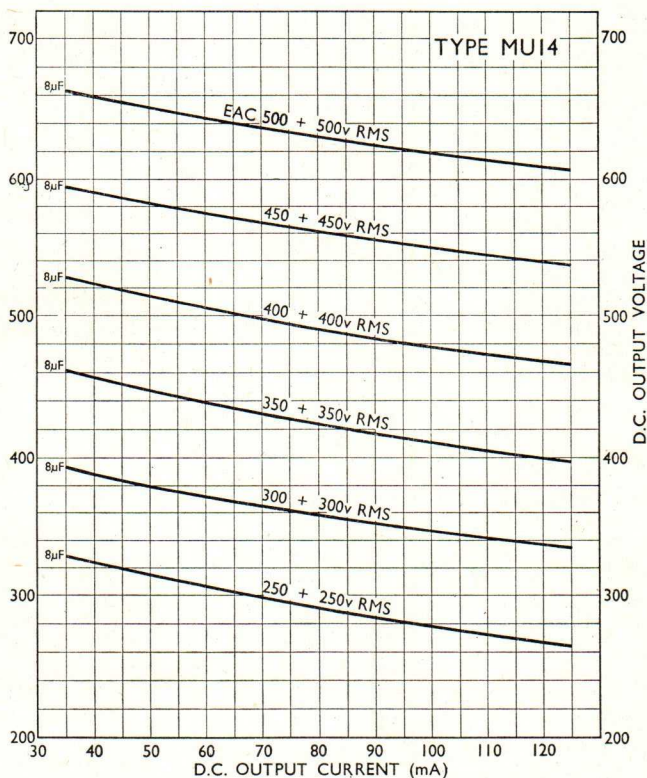
TYPE MUI4

OPERATING CONDITIONS

Variations in output voltage must never be made by varying the heater voltage, but may be made :

- (1) By tapings in the transformer secondary.
- (2) By the use of a high resistance in series with the output.
- (3) By the use of a potentiometer, in which case the total current taken by the potentiometer and load must not exceed the rating given overleaf.

The D.C. output current should in no case exceed the maximum of 120 mA under smoothed conditions using a capacitor input filter.



CHARACTERISTIC CURVES OF AVERAGE VALVE, WITH
8 μF CAPACITOR INPUT.

U14

Osram

VALVES

U14 RECTIFIER

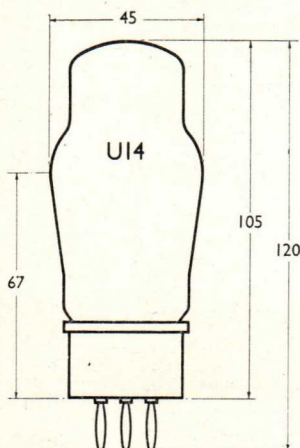
DESCRIPTION

Type U14 is a bi-phase half-wave vacuum rectifying valve with directly heated filament. It replaces types U12 and U12/14.

RATINGS

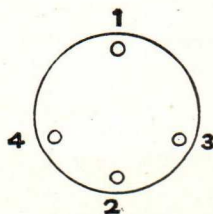
Filament Voltage	...	...	...	...	...	...	4.0	volts
Filament Current	...	...	...	...	...	...	2.5	amps
Capacitor Input, Bi-phase half-wave circuit								
Input Voltage R.M.S.	...	...	...	...	...	...	500	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	1400	max. volts
D.C. Output Current	...	...	...	...	...	...	120	max. mA
Peak Anode Current (running)	...	...	...	...	...	...	380	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	100	min. ohms
Reservoir Capacitor	...	...	...	...	...	...	32	max. mfd
Inductor Input, Bi-phase half-wave circuit								
Input Voltage R.M.S.	...	...	...	...	...	...	550	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	1400	max. volts
D.C. Output Current	...	...	...	...	...	...	135	max. mA
Peak Anode Current (running)	...	...	...	...	...	...	380	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	100	min. ohms
Input Inductor	...	...	...	...	...	...	5	henries at 135 mA
Type of Switching	...	...	...	...	...	...	Direct	
Preheating Time	...	...	...	...	...	...	Nil	

DIMENSIONS



All dimensions are in mm. and are the maximum except where otherwise stated.

BASE

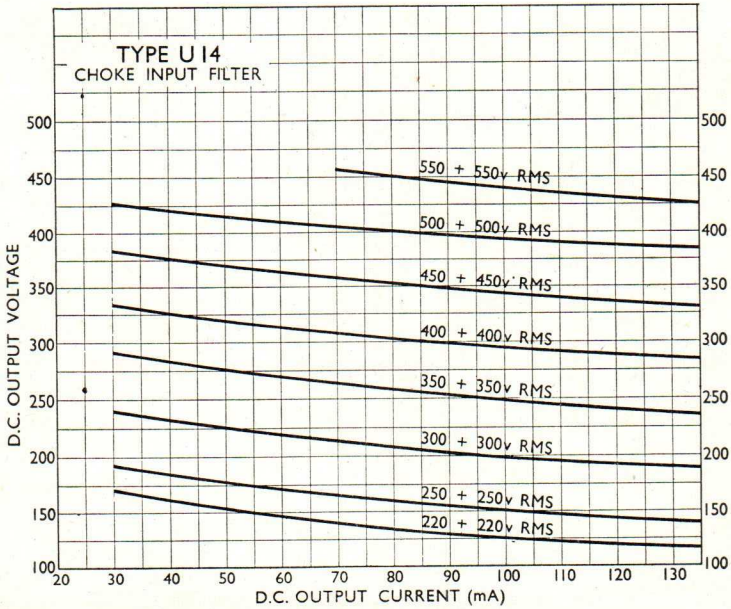
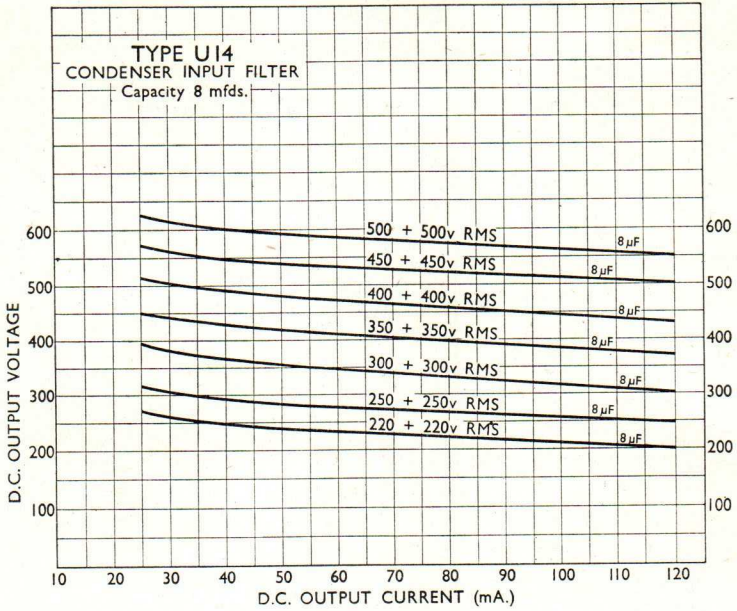


View looking on underside of base.

4-PIN BRITISH

- 1: Anode
- 2: Anode
- 3: Filament
- 4: Filament

TYPE U14



CHARACTERISTIC CURVES OF AVERAGE VALVE.

U18/20



U18/20 RECTIFIER

DESCRIPTION

Type U18/20 is a directly heated bi-phase half-wave rectifier. It replaces types U18 and U20.

RATINGS

Filament Voltage	...	...	...	...	...	...	...	4.0	volts
Filament Current	...	...	...	...	...	...	...	3.0	amps

Capacitor Input, Bi-phase half-wave circuit

Input Voltage R.M.S.	...	...	...	...	500	850	max. volts
Peak Inverse Voltage	...	...	...	...	1,400	2,400	max. volts
D.C. Output Current	...	...	...	...	250	125	max. mA
Peak Anode Current (running)	...	...	...	...	750	400	max. mA
Anode Limiting Resistance	...	...	...	...	180	180	min. ohms
Reservoir Capacitor	...	...	...	...	16	8	max. mfd

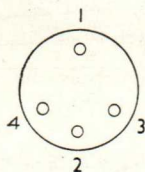
Inductor Input, Bi-phase half-wave circuit

Input Voltage R.M.S.	...	...	...	...	550	850	max. volts
Peak Inverse Voltage	...	...	...	...	1,400	2,400	max. volts
D.C. Output Current	...	...	...	...	275	150	max. mA
Peak Anode Current (running)	...	...	...	...	750	400	max. mA
Anode Limiting Resistance	...	...	...	...	180	180	min. ohms
Input Inductor	...	...	...	...	10	10	henries at 150 mA

Type of Switching	...	...	...	...	...	...	...	...	Direct
Preheating Time	...	...	...	...	...	...	...	...	Nil

DIMENSIONS

Maximum overall length	...	135 mm.
Maximum seated length	...	120 mm.
Maximum overall diameter	...	56.5 mm.



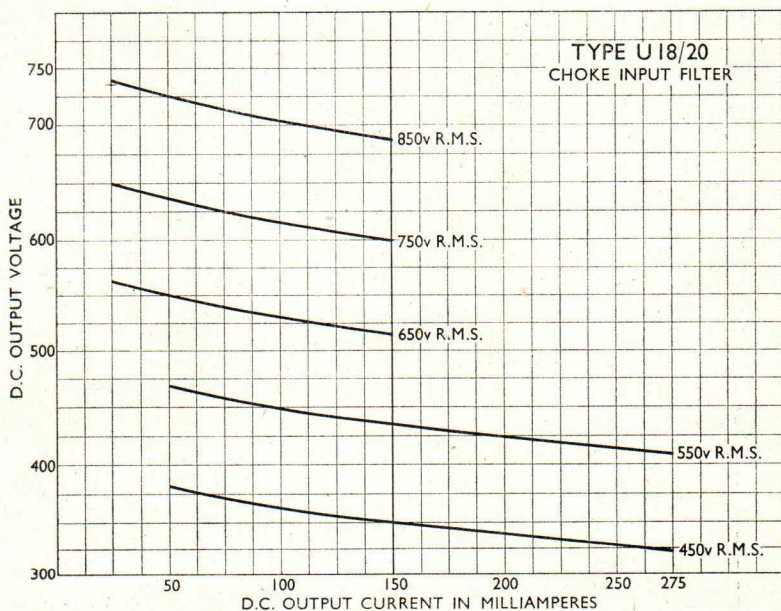
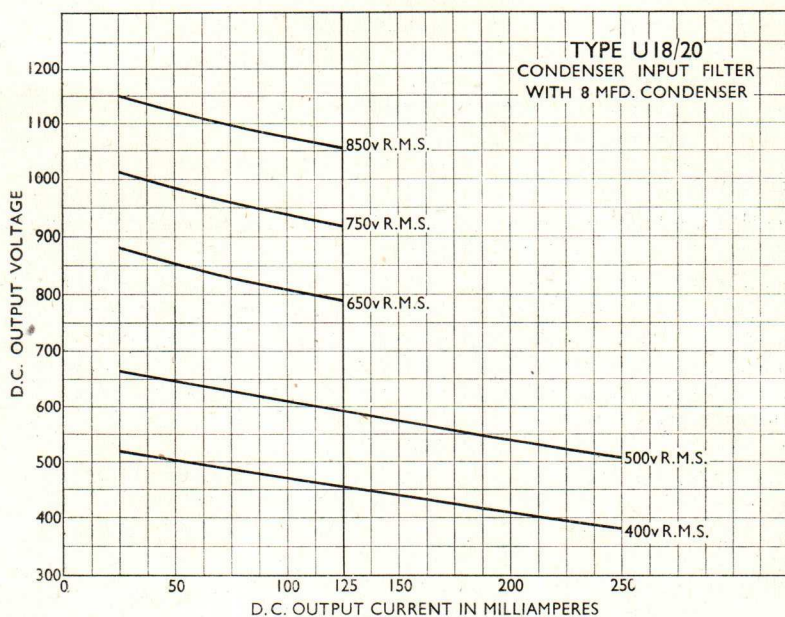
View looking on underside of base.

BASE

4-PIN BRITISH

- Pin 1: Anode
2: Anode
3: Filament
4: Filament

TYPE U18/20



CHARACTERISTIC CURVES OF AVERAGE VALVE.

U19 RECTIFIER

DESCRIPTION

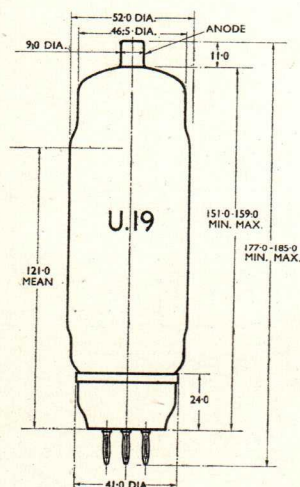
Type U19 is a hard vacuum directly heated half-wave rectifier having an oxide coated filament.

It is capable of giving an output up to 500mA for a pair of valves used in a bi-phase half-wave circuit and is suitable for applied anode voltages up to 2,500v. When used under maximum rectified current conditions an inductor input to the filter circuit is recommended. Where the peak inverse voltage exceeds 5,000v. the filament should be switched on at least twenty seconds before the anode voltage is applied, otherwise direct switching of the filament and anode voltage is permissible for this valve.

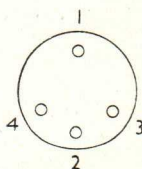
RATINGS

Filament voltage	...	...	...	...	...	...	...	4.0	volts
Filament current	...	...	...	...	...	...	...	3.3	approx. amps
Single phase half-wave circuit									
Anode voltage R.M.S.	...	...	...	...	...	...	...	2,500	max. volts
Peak inverse voltage	...	...	...	...	...	...	...	7,100	max. volts
Peak current	...	...	...	...	...	...	...	2.0	max. amps
D.C. output current	...	...	...	...	...	...	...	250	max. mA
Anode limiting resistance...	...	...	...	...	...	...	...	100	min. ohms
Reservoir Capacitor (for Capacitor Input Filter)	...	...	...	...	...	...	...	4	μ F
Input Inductor (for Inductor Input Filter)	...	...	...	...	...	...	...	10	min. henries

DIMENSIONS



BASE



View looking on underside of base.

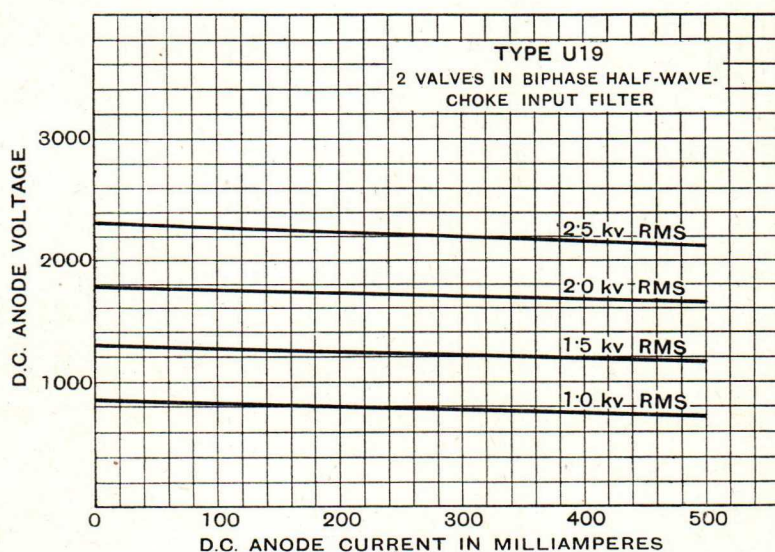
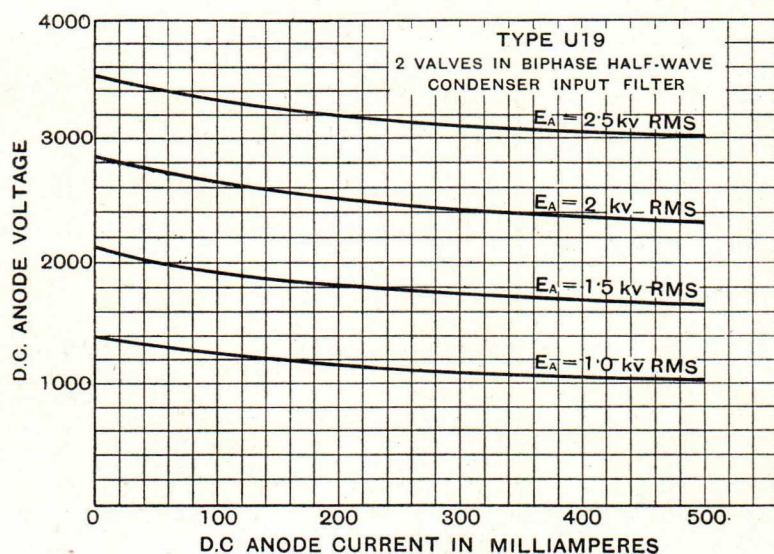
4-PIN

- 1: Not connected
- 2: Not connected
- 3: Filament
- 4: Filament

Top Cap: Anode

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U19



CHARACTERISTIC CURVES OF AVERAGE VALVE.

U31



U31 RECTIFIER

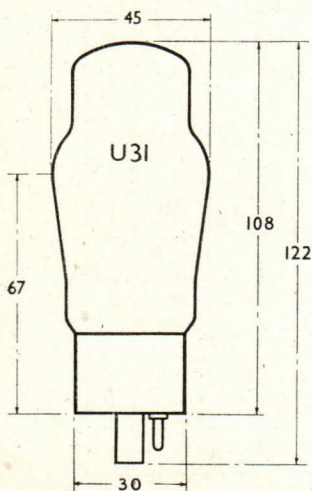
DESCRIPTION

Type U31 is a half-wave rectifier with indirectly heated cathode system. It is designed primarily for use in DC/AC receivers.

RATINGS

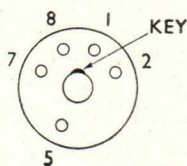
Heater Current	...	...	...	...	...	...	...	...	0.3	amp
Heater Voltage	...	...	...	...	...	...	...	...	26	approx. volts
Capacitor Input										
Single phase, half-wave										
Input Voltage	...	...	...	...	...	...	...	...	250	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	...	...	700	max. volts
D.C. Output Current	...	...	...	...	...	...	...	...	120	max. mA
Peak Anode Current	...	...	...	...	...	...	...	...	750	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	...	...	100	min. ohms
Reservoir Capacitor	...	...	...	...	...	...	...	...	32	μ F
Type of Switching	...	...	...	...	...	...	...	...	Direct	
Preheating Time	...	...	...	...	...	...	...	...	Nil	

DIMENSIONS



All dimensions are in mm.
and are the maximum except
where otherwise stated.

BASE



View looking on
underside of base.

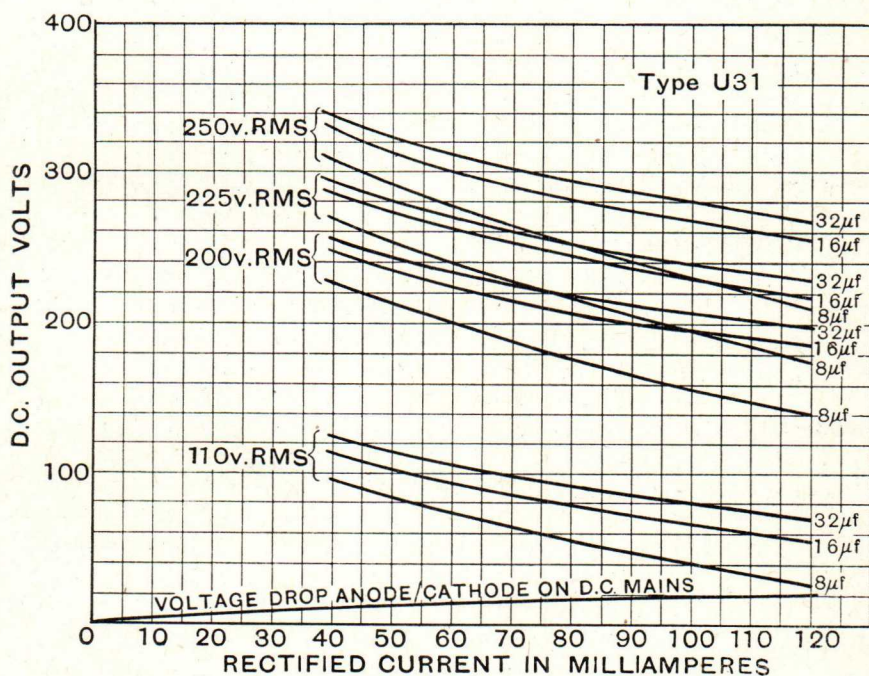
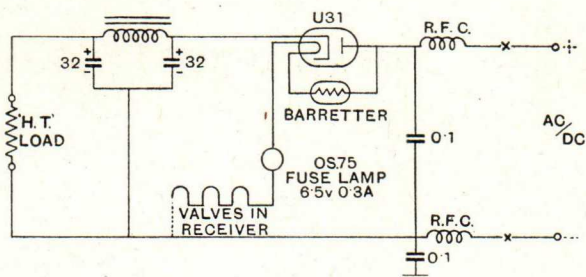
5-PIN OCTAL

- 1 : Not connected
- 2 : Filament
- 5 : Anode
- 7 : Filament
- 8 : Cathode

OPERATING CONDITIONS

The heater of the U31 should be wired at the positive end of the series chain (assuming DC supply) between the dropping resistor or barretter and a pilot or fuse lamp as shown in diagram on the opposite page.

TYPE U31



CHARACTERISTIC CURVES OF AVERAGE VALVE

U33



U33 RECTIFIER

DESCRIPTION

Type U33 is a directly heated single phase half wave rectifier. It is suitable for use in the E.H.T. supply for cathode ray tubes.

RATINGS

Filament Voltage	...	...	...	...	...	...	2	volts
Filament Current	...	...	...	...	...	...	1	approx. amp
Peak Inverse Voltage	...	...	...	...	...	...	18	max. kV
D.C. Output Current	...	...	...	...	...	...	3	max. mA
Peak Anode Current...	...	...	...	...	...	...	20	max. mA
Surge Anode Current	...	...	...	...	...	...	60	max. mA
Type of Switching	...	...	...	...	...	...	Direct	
Mounting Position	...	...	...	...	...	...	Any	

Capacitance :

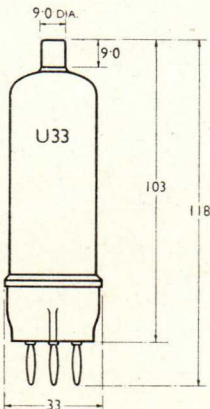
Anode to Filament	...	...	...	...	...	...	2.5	max. pF
-------------------	-----	-----	-----	-----	-----	-----	-----	---------

OPERATING CONDITIONS

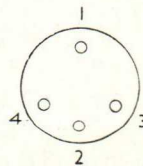
Capacitor Input, Single Phase Half-Wave Circuit

Input Voltage, R.M.S.	...	...	...	...	...	...	6.3	kV
Peak Inverse Voltage	...	...	...	...	...	...	18	kV
D.C. Output Current	...	...	...	...	...	...	3	mA
D.C. Output Voltage	...	...	...	...	...	...	8	kV
Anode Current, R.M.S.	...	...	...	...	...	...	6.3	mA
Reservoir Capacitor	...	...	...	...	...	...	0.25	mfd
Source Resistance	...	...	...	...	...	...	0.1	megohm
Ripple	...	...	...	...	...	...	15	%

DIMENSIONS



BASE



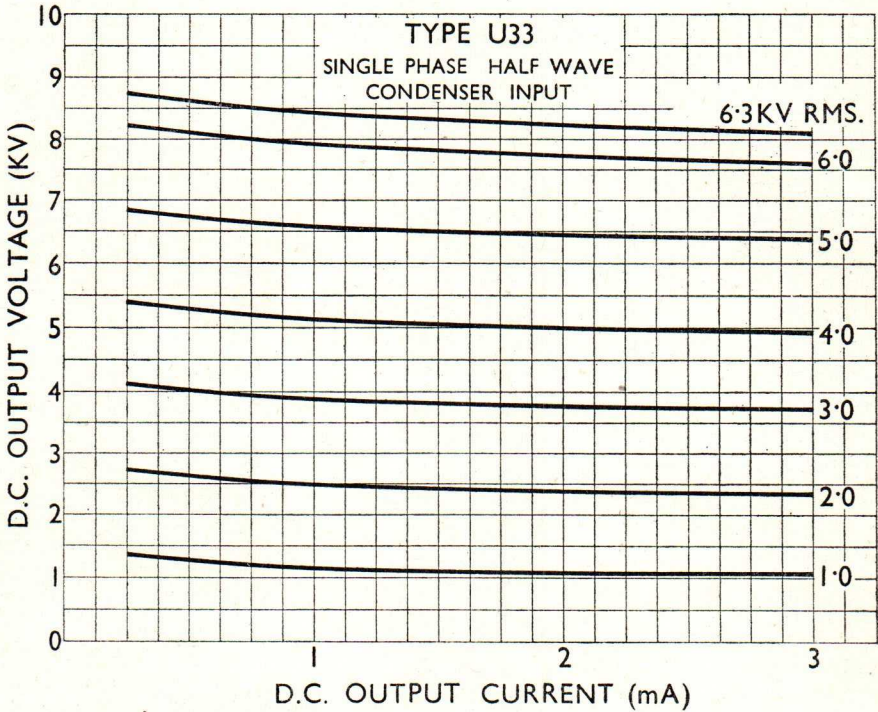
View looking on underside of base.

4-PIN BRITISH

- Pin 1 : Not connected
2 : Not connected
3 : Filament
4 : Filament
Top Cap : Anode

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U33



CHARACTERISTIC CURVES OF AVERAGE VALVE



U37 RECTIFIER

DESCRIPTION

Type U37 is a directly heated half wave rectifier primarily designed for providing E.H.T. for cathode ray tubes from an R.F. source or by rectification of the fly back voltage.

RATINGS

Filament Voltage ...	...	...	...	...	...	1.4	volts
Filament Current ...	...	...	...	...	...	0.14	amp
Peak Inverse Voltage	...	...	...	...	...	15*	max. kV
D.C. Output Current	...	...	...	...	...	2	max. mA
Peak Anode Current	...	...	...	...	...	12	max. mA
Surge Anode Current	...	...	...	...	...	40	max. mA

*For circuits where the anode voltage rises at approximately the same rate as the filament voltage (e.g. in fly back and R.F. oscillator circuits). Where used on power input circuits with the full A.C. anode voltage applied on switching, the maximum P.I.V. is 10 KV.

Capacitance :

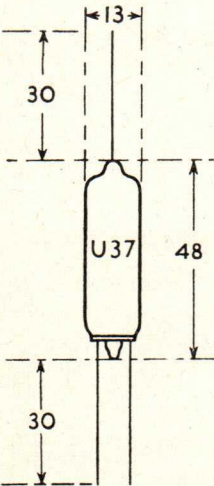
Anode to filament	...	...	...	...	...	0.65	approx. pF
-------------------	-----	-----	-----	-----	-----	------	------------

OPERATING CONDITIONS

Fly Back E.H.T. System

Filament Current R.M.S....	...	...	...	...	...	0.14	amp
Peak Inverse Voltage	...	...	...	...	...	7.5	kV
D.C. Output Voltage	...	...	...	...	...	7	kV
D.C. Output Current	...	...	...	...	...	100	μA
Reservoir Capacitor	...	...	...	...	...	0.001	mfd

DIMENSIONS



R.F. Oscillator System

Filament Current R.M.S.	...	...	0.14	amp
Peak Inverse Voltage	...	...	15	kV
Input Voltage R.M.S.	...	...	5.3	kV
D.C. Output Voltage	...	...	7.5	kV
D.C. Output Current	...	...	100	μA

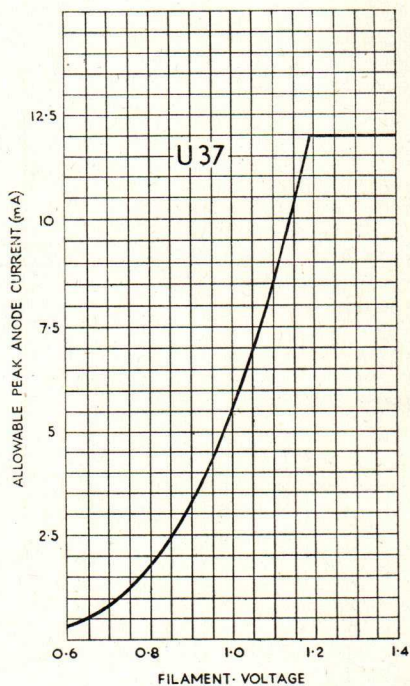
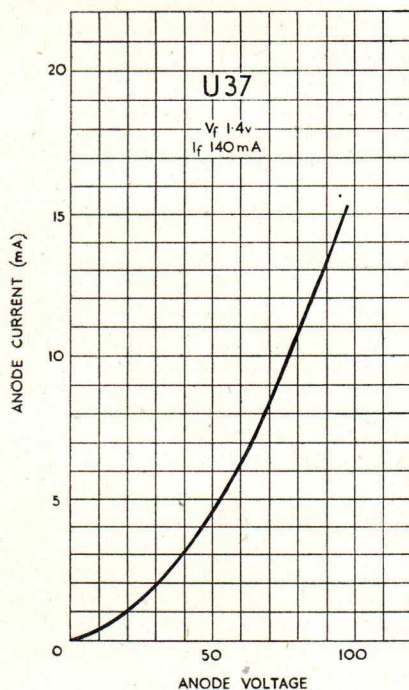
The filament should be operated at the same temperature as it would attain if operated at 1.4 volts D.C.

BASE

SOLDERED-IN TYPE VALVE

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U37



CHARACTERISTIC CURVES OF AVERAGE VALVE.

U50



U50 RECTIFIER

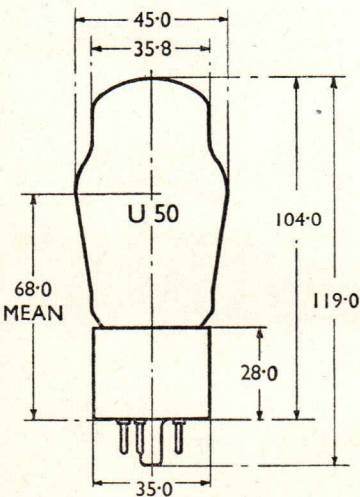
DESCRIPTION

Type U50 is a directly heated bi-phase half-wave rectifier.

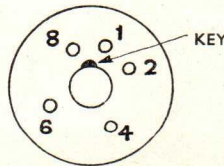
RATINGS

Filament Voltage	...	...	...	...	...	5	volts
Filament Current	...	...	...	...	...	2	amps
Capacitor Input, Bi-phase Half Wave Circuit							
Peak Inverse Voltage	...	...	...	...	...	1000	max. volts
Input Voltage R.M.S.	...	...	...	...	...	350	max. volts
D.C. Output Current	...	...	...	...	...	120	max. mA
Anode Limiting Resistance	...	...	...	...	...	100	min. ohms
Reservoir Capacitor	...	...	...	...	...	32	max. μ F
Inductor Input, Bi-Phase Half Wave Circuit							
Input Voltage R.M.S.	...	...	...	...	...	550	max. volts
D.C. Output Current	...	...	...	...	...	135	max. mA
Anode Limiting Resistance	...	...	...	...	...	100	min. ohms
Input Inductor	...	...	...	...	...	5	H at 135 mA
Type of Switching	...	...	...	...	...	Direct	
Preheating Time	...	...	...	...	...	Nil	

DIMENSIONS



BASE



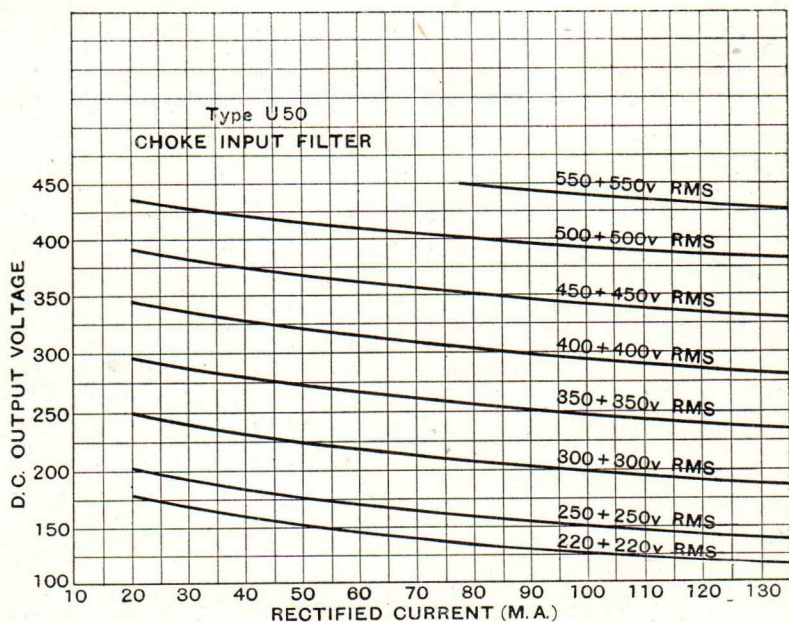
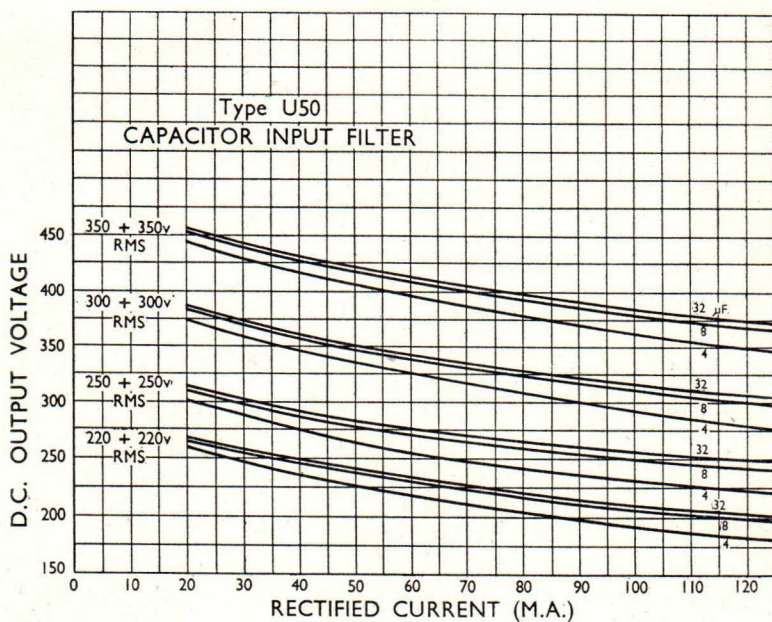
View looking on underside of base.

5-PIN OCTAL

- 1: —
- 2: Filament
- 4: Anode
- 6: Anode
- 8: Filament

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U50



CHARACTERISTIC CURVES OF AVERAGE VALVE.

U52



U52 RECTIFIER

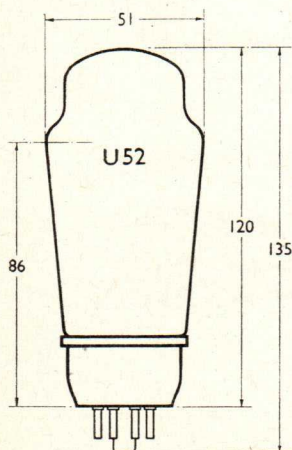
DESCRIPTION

Type U52 is a bi-phase half-wave rectifier with a directly heated filament.

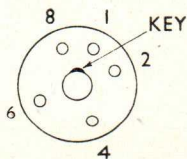
RATINGS

Filament Voltage	...	...	...	...	...	...	...	5.0	volts
Filament Current	...	...	...	...	...	...	...	3.0	approx. amps
Capacitor Input Bi-phase half-wave circuit									
Input Voltage	...	...	...	...	...	...	...	500	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	...	1,400	max. volts
D.C. Output Current	...	...	...	...	...	...	...	250	max. mA
Peak Anode Current (Running)	...	...	...	...	...	...	...	750	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	...	180	min. ohms
Reservoir Capacitor	...	...	...	...	...	...	...	16	max. μ F
Choke Input Bi-phase half-wave circuit									
Input Voltage R.M.S.	...	...	...	...	...	...	...	550	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	...	1,400	max. volts
D.C. Output Current	...	...	...	...	...	...	...	275	max. mA
Peak Anode Current (Running)	...	...	...	...	...	...	...	750	max. mA
Anode Limiting Resistance	...	...	...	...	...	...	...	180	min. ohms
Input Inductor	...	...	...	...	...	...	...	10	henries at 275 mA
Type of Switching	...	...	...	...	...	...	...	Direct	
Preheating Time	...	...	...	...	...	...	...	Nil	

DIMENSIONS



BASE



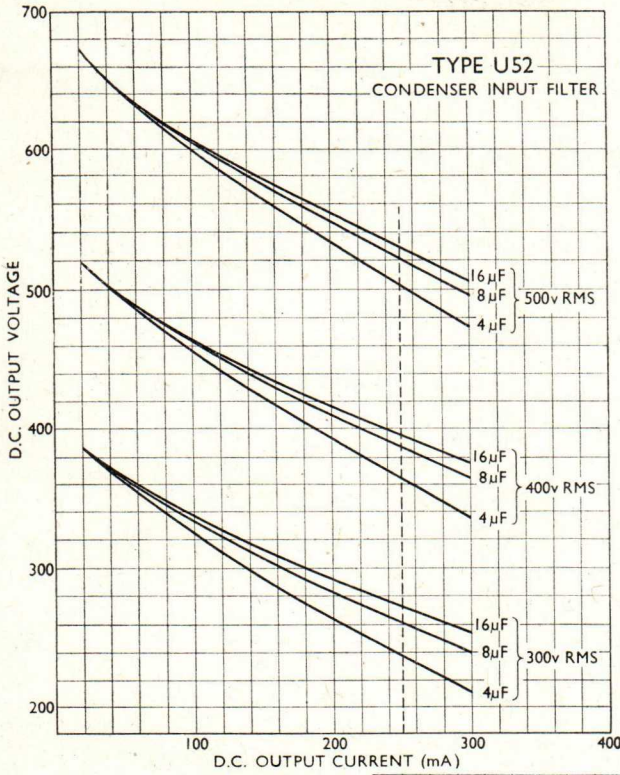
View looking on underside of base.

5-PIN OCTAL

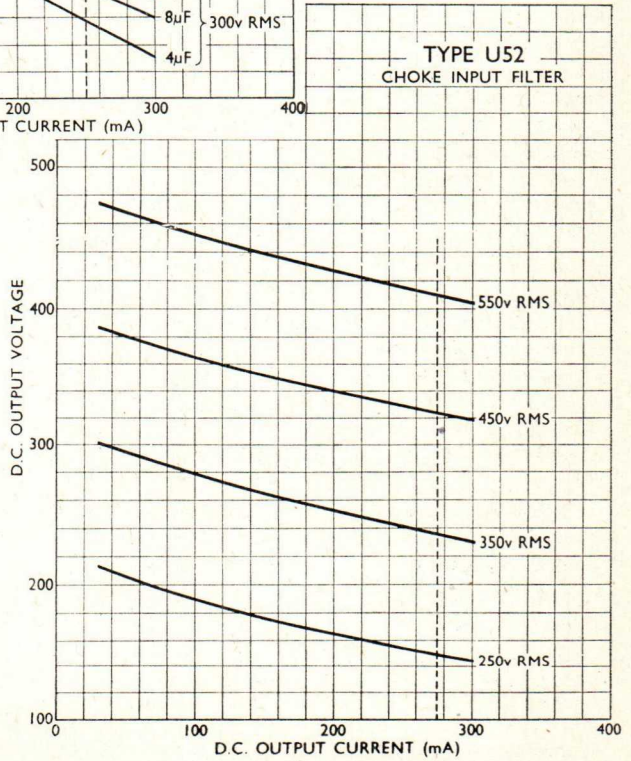
- 1 : Not connected
- 2 : Filament
- 4 : Anode
- 6 : Anode
- 8 : Filament

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U52



CHARACTERISTIC CURVES
OF AVERAGE VALVE.



U78



U78 RECTIFIER

DESCRIPTION

Type U78 is an indirectly heated bi-phase half wave rectifier mounted on the miniature B7G all-glass base. The valve is interchangeable with the American type 6X4.

RATINGS

Heater Voltage	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	0.6	amp
Heater/Cathode Voltage	...	...	...	...	...	450	max. volts
Peak Inverse Voltage	...	...	...	...	...	1,250	max. volts
Anode Voltage R.M.S.	...	...	...	...	...	325	max. volts
D.C. Output Current	...	...	...	...	...	70	max. mA
Peak Anode Current	...	...	...	...	...	210	max. mA
Surge Anode Current	...	...	...	...	...	750	max. mA

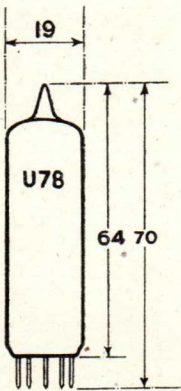
OPERATING CONDITIONS

Capacitor input bi-phase half-wave circuit.

Heater Voltage	...	...	...	...	...	6.3	volts
Peak Inverse Voltage	...	...	...	...	...	930	volts
Input Voltage R.M.S.	...	...	...	...	...	325	volts
D.C. Output Voltage	...	...	...	...	...	355	volts
D.C. Output Current	...	...	...	...	...	70	mA
Peak Anode Current...	...	...	...	...	...	210	mA
Surge Anode Current	...	...	...	...	...	700	mA
Phase Current R.M.S.	...	...	...	...	...	73	mA
Reservoir Capacitor	...	...	...	...	...	4	mfd
Source Resistance	...	...	...	...	...	450	ohms

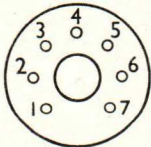
Type of Switching	...	...	...	...	...	Direct
Mounting	...	...	...	...	...	Any position
Retaining	...	...	...	...	...	The use of a retaining device is recommended

DIMENSIONS



All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.

BASE



View looking on
underside of base.

B7G

- Pin 1 : Anode, a'
- 2 : NC
- 3 : Heater
- 4 : Heater
- 5 : NC
- 6 : Anode, a'
- 7 : Cathode

See page 144 for Characteristic Curves.



U107 RECTIFIER

DESCRIPTION

Type U107 is an indirectly heated half-wave rectifier mounted on the miniature B7G all-glass base. It is designed for series heater connection.

RATINGS

Heater Current	...	...	...	...	...	...	0.1	amp
Heater Voltage	...	...	...	...	...	...	40	volts
D.C. Heater/Cathode Voltage	...	...	...	...	...	...	350	max. volts
Peak Heater/Cathode Voltage	...	...	...	...	...	...	700	max. volts
Peak Inverse Voltage	...	...	...	...	...	...	700	max. volts
Input Voltage, R.M.S.	...	...	...	...	...	...	250	max. volts
D.C. Output Current	...	...	...	...	...	...	90	max. mA
Peak Anode Current	...	...	...	...	...	...	540	max. mA
Surge Anode Current	...	...	...	...	...	...	1.8	max. amps

OPERATING CONDITIONS

Single phase half wave circuit capacitor input.

Peak Inverse Voltage	...	...	...	...	...	...	700	volts
Input Voltage, R.M.S.	...	...	...	...	...	...	250	volts
D.C. Output Voltage	...	...	...	...	...	...	240	volts
D.C. Output Current	...	...	...	...	...	...	90	mA
Peak Anode Current	...	...	...	...	...	...	540	mA
Surge Anode Current	...	...	...	...	...	...	1.8	amps
Phase Current, R.M.S.	...	...	...	...	...	...	190	mA
Source Resistance	...	...	...	...	...	...	200	ohms
Reservoir Capacitance	...	...	...	...	...	...	16	mfd
Ripple	...	...	...	...	...	...	15	%

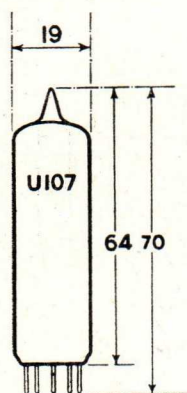
MOUNTING

Any position

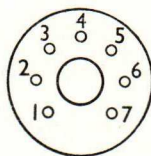
TYPE OF SWITCHING

Direct

DIMENSIONS



BASE



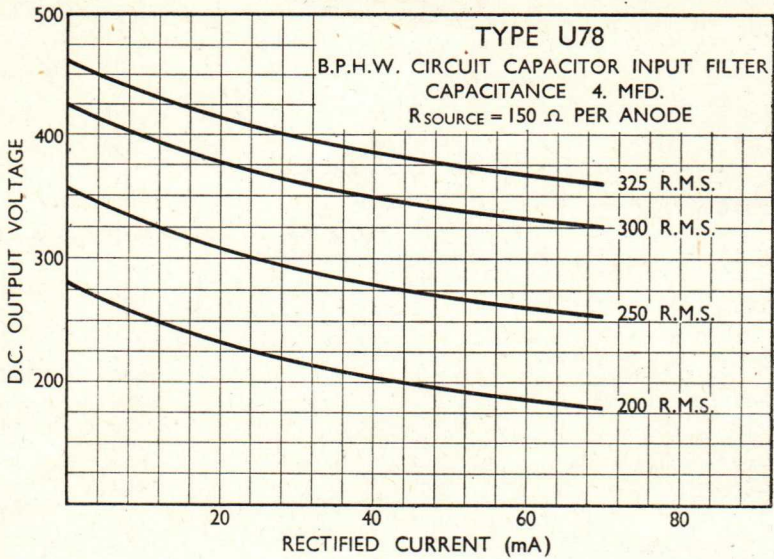
View looking on underside of base.

B7G

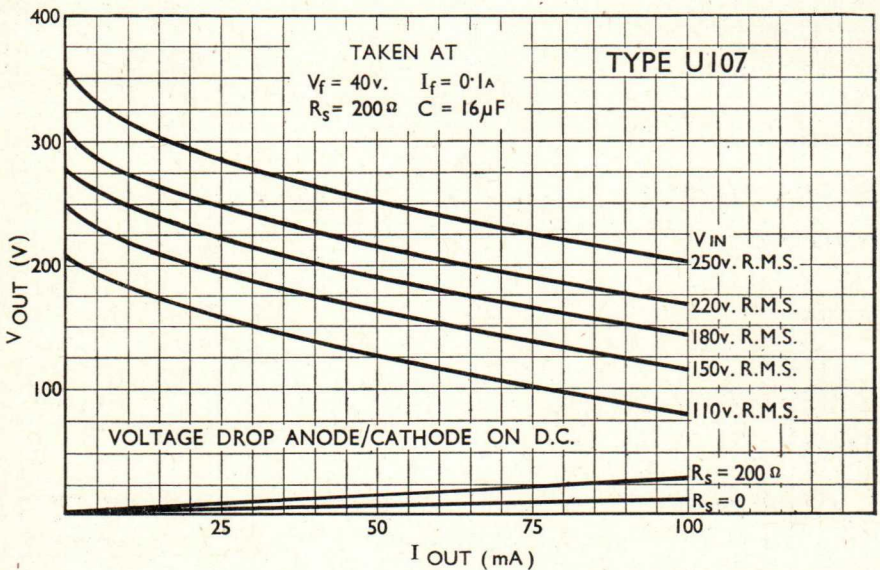
- Pin 1: Heater
- 2: Anode
- 3: Cathode
- 4: Not connected
- 5: Not connected
- 6: Anode
- 7: Heater

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE U78



TYPE U107



V_f = Heater voltage

I_f = Heater Current

R_s = Source resistance

C = Reservoir Capacitance

CHARACTERISTIC CURVES OF AVERAGE VALVE.

CATHODE RAY TUBES

The cathode ray tubes listed in this Section are divided into two groups; those directly designed for television use, and those designed for oscillographic and industrial applications.

Television tubes

G.E.C. cathode ray tubes intended for high quality television reception are magnetically focussed and deflected. The screen fluorescence is white.

The fluorescent screens are backed with a very thin metallic coating which considerably increases the life of the tube and at the same time gives better picture contrast under normal conditions of use.

The types listed are as follows :

- 6504A 9" flat screen tube for AC operation.
- 6505A 9" flat screen tube for series DC/AC operation.
- 6703A 12" tube for AC operation.
- 6704A 12" tube for series DC/AC operation.

Oscillographic tubes

The list includes a range of Electrostatic focussing and deflection tubes of varying screen diameters which are available with screens of different colour and persistence, according to requirements.

- E4103 1½" screen electrostatic focussing and deflection.
- E4205 2¾" screen electrostatic focussing and deflection.
- E4412 3½" screen electrostatic focussing and deflection.
- E4504 6" screen electrostatic focussing and deflection.

- | | |
|-----------|---|
| 1608 ABCA | } Post-deflection accelerator tubes for high speed oscillography. |
| 908 BCC | |
| 401 CAHA | |
| 408 CAHA | |

6504A



CATHODE RAY TUBES

6504A TELEVISION TUBE

DESCRIPTION

The G.E.C. type 6504A 9" diameter cathode ray tube is intended for high quality television reception, and is magnetically focussed and deflected. The screen fluorescence is white and the tube is indirectly heated.

The outside of the bulb is partially covered with a conductive coating which can be used in conjunction with the internal coating to form a capacitance sufficiently large to use as the reservoir capacitor in an R.F. or fly-back E.H.T. system.

The fluorescent screen is backed with a very thin metallic coating which considerably increases the life of the tube and at the same time gives better picture contrast under normal conditions of use.

RATINGS

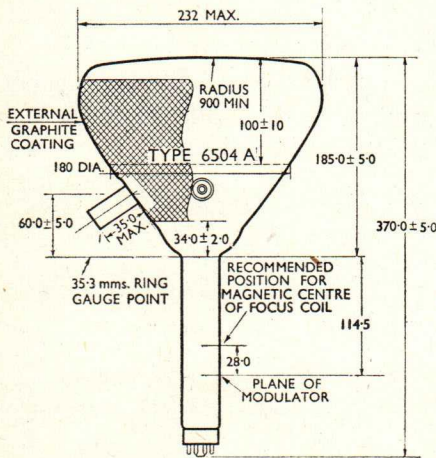
Heater Voltage ...	...	...	...	...	...	6.3	volts
Heater Current ...	...	...	...	...	...	0.5	approx. amp
Heater/Cathode Voltage ...	...	...	...	...	...	150	max. volts
Anode Voltage ...	...	...	...	...	...	7000	max. volts
Anode Voltage ...	...	...	...	...	...	5000	min. volts
Nominal Modulator Voltage for Cut-off ...	...	...	...	...	...	— Anode Voltage/150	approx. volts
Modulator Voltage ...	...	...	...	...	...	— 100	max. volts
Cathode Current ...	...	...	...	...	...	150	max. μ A
Modulator/Cathode Resistance ...	...	...	...	...	...	1.0	max. megohm
Neck Diameter ...	...	...	...	...	...	35.0	max. mm
Neck Diameter ...	...	...	...	...	...	33.5	min. mm
Picture Diagonal ...	...	...	...	...	...	208	max. mm

CAPACITANCE

Modulator to all other electrodes ...	...	...	...	...	...	15	max. pF
---------------------------------------	-----	-----	-----	-----	-----	----	---------

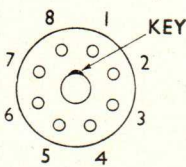
MOUNTING POSITION ... Any

DIMENSIONS



BASE

INTERNATIONAL 8-PIN OCTAL



- Pin 1 : I.C.
- 2 : Heater
- 3 : I.C.
- 4 : I.C.
- 5 : Modulator
- 6 : I.C.
- 7 : Heater
- 8 : Cathode

View from underside of base.

Side Contact : Anode (flush type)

I.C. indicates that no external connection should be made to this pin.

The neck diameter is gauged by a tubular gauge of length 50 mm. and internal diameter 35.3 mm.

All dimensions are in mm.

TYPICAL OPERATING CONDITIONS

Anode Voltage ...	...	...	...	...	...	7000	volts
Modulator Cut-off Voltage ...	...	...	...	...	...	— 47	approx. volts
Mean Signal input to Modulator ...	...	...	...	...	...	20	peak volts
Picture Size ...	...	...	...	...	...	207 × 155	mm
Picture Brightness ...	...	...	...	...	...	10	e.f.c.

TYPE 6504A

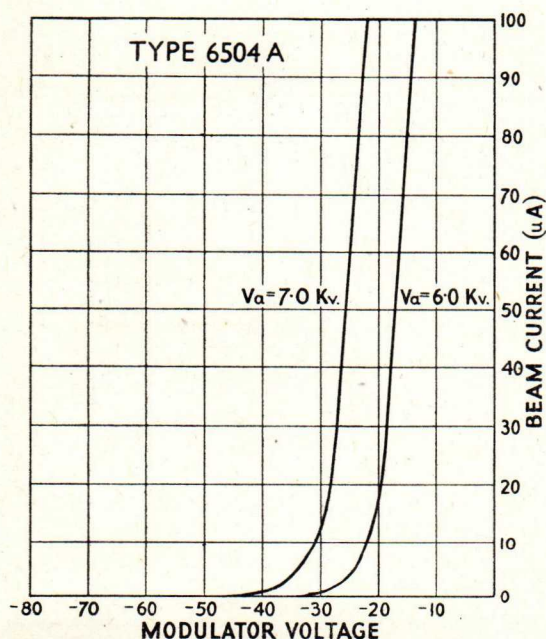
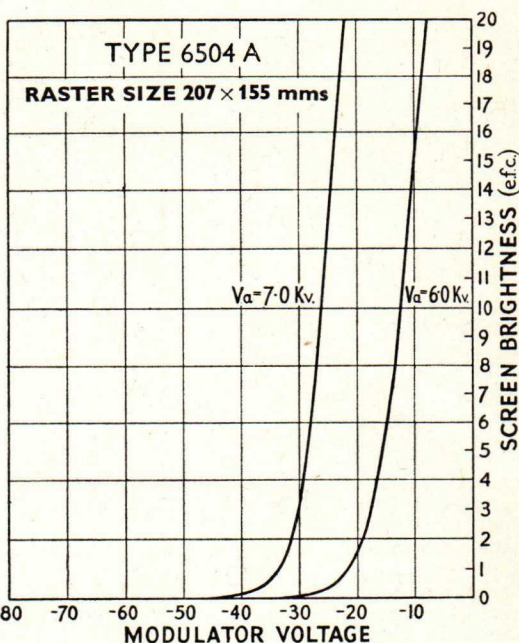
PRECAUTIONS IN USE

The attention of the user is drawn to the CODE OF PRACTICE FOR USE OF CATHODE RAY TUBES IN EQUIPMENT, B.S. 1147, 1943, obtainable from the British Standards Institution, 28 Victoria Street, London, S.W.1. Failure to observe the recommendations contained therein may result in poor performance or damage to both tube and equipment.

If it is not desired to apply modulation to the cathode one side of the heater should be connected direct to cathode.

The tube is designed for use with deflecting coils which position the centre of deflection at 25 mm. approximately from the 35.3 mm. ring gauge point. It will be appreciated that the possibility of cut off of the picture area is intimately linked with the design of the deflecting coils.

It is desirable to maintain the external graphite coating at chassis potential, otherwise it may acquire a charge capable of imparting an electric shock to the user and/or causing picture interference.



6505A



CATHODE RAY TUBES

6505A TELEVISION TUBE

DESCRIPTION

The G.E.C. type 6505A 9" diameter cathode ray tube is intended for high quality television reception and is magnetically focussed and deflected. The screen fluorescence is white and the tube is indirectly heated.

The outside of the bulb is partially covered with a conductive coating which can be used in conjunction with the internal coating to form a capacitance sufficiently large to use as the reservoir capacitor in an R.F. or fly-back E.H.T. system.

The fluorescent screen is backed with a very thin metallic coating which considerably increases the life of the tube and at the same time gives better picture contrast under normal conditions of use.

RATINGS

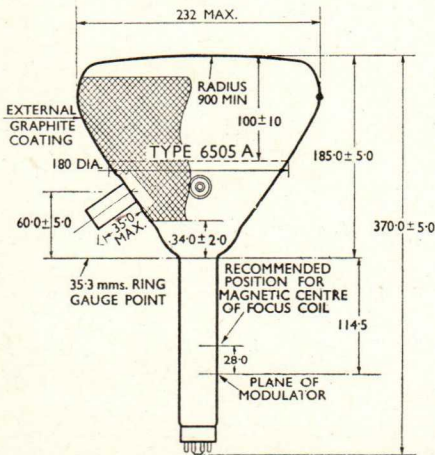
Heater Current	0.3	amp
Heater Voltage	10.5	approx. volts
Heater/Cathode Voltage	150	max. volts
Anode Voltage	7000	max. volts
Anode Voltage	5000	min. volts
Nominal Modulator Voltage for Cut-off	— Anode voltage/150	approx. volts
Modulator Voltage	—100	max. volts
Cathode Current	150	max. μ A
Modulator/Cathode Resistance	1.0	max. megohm
Neck Diameter	35.0	max. mm
Neck Diameter	33.5	min. mm
Picture Diagonal	208	max. mm

CAPACITANCE

Modulator to all other electrodes	15	max. pF
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MOUNTING POSITION Any

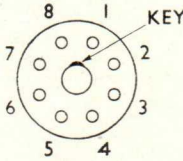
DIMENSIONS



BASE

INTERNATIONAL 8-PIN OCTAL

- Pin 1 : I.C.
2 : Heater
3 : I.C.
4 : I.C.
5 : Modulator
6 : I.C.
7 : Heater
8 : Cathode



View from underside of base.

Side Contact : Anode (flush type)

I.C. indicates that no external connection should be made to this pin.

All dimensions are in mm.

The neck diameter is gauged by a tubular gauge of length 50 mm. and internal diameter 35.3 mm.

TYPICAL OPERATING CONDITIONS

Anode Voltage	7000	volts
Modulator Cut-off Voltage	—47	approx. volts
Mean signal input to Modulator	20	peak volts
Picture Size	207 × 155	mm
Picture Brightness	10	e.f.c.

TYPE 6505A

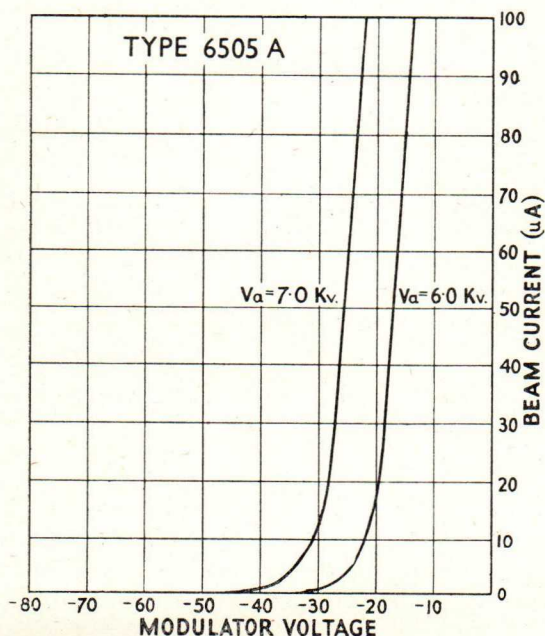
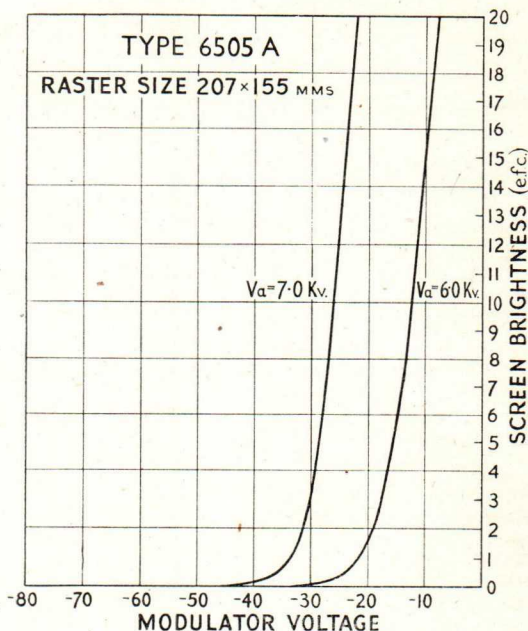
PRECAUTIONS IN USE

The attention of the user is drawn to the CODE OF PRACTICE FOR USE OF CATHODE RAY TUBES IN EQUIPMENT, B.S. 1147, 1943, obtainable from the British Standards Institution, 28 Victoria Street, London, S.W.1. Failure to observe the recommendations contained therein may result in poor performance or damage to both tube and equipment.

If it is not desired to apply modulation to the cathode one side of the heater should be connected direct to cathode.

The tube is designed for use with deflecting coils which position the centre of deflection at 25 mm. approximately from the 35.3 mm. ring gauge point. It will be appreciated that the possibility of cut off of the picture area is intimately linked with the design of the deflecting coils.

It is desirable to maintain the external graphite coating at chassis potential, otherwise it may acquire a charge capable of imparting an electric shock to the user and/or causing picture interference.



The heater of the tube is suitable for operation in series with a range of 0.3 amp. valves, but it is essential to ensure that the peak surge voltage across the tube heater does not exceed 12.5 volts. A suitable surge limiting device should be introduced into the circuit to restrict the voltage to this maximum value.

The heater should also be so positioned in the heater chain that the voltage between heater and cathode is kept as low as possible.

6703A

G.E.C.

CATHODE RAY TUBES

6703A TELEVISION TUBE

DESCRIPTION

The G.E.C. type 6703A 12" diameter cathode ray tube is intended for high quality television reception, and is magnetically focussed and deflected. The screen fluorescence is white and the tube is indirectly heated.

The outside of the bulb is partially covered with a conductive coating which can be used in conjunction with the internal coating to form a capacitance sufficiently large to use as the reservoir capacitor in an R.F. or fly-back E.H.T. system.

The fluorescent screen is backed with a very thin metallic coating which considerably increases the life of the tube and at the same time gives better picture contrast under normal conditions of use.

RATINGS

Heater Voltage	...	...	...	...	...	...	6.3	volts
Heater Current	...	...	...	...	...	...	0.5	approx. amp
Heater/Cathode Voltage	...	...	...	...	...	...	150	max. volts
Anode Voltage	...	...	...	...	...	...	8000	max. volts
Anode Voltage	...	...	...	...	...	...	6000	min. volts
Nominal Modulator Voltage for Cut-off	...	...	...	...	...	- Anode Voltage/150	approx. volts	
Modulator Voltage	...	...	...	...	...	...	-100	max. volts
Cathode Current	...	...	...	...	...	...	100	max. μ A
Modulator/Cathode Resistance	...	...	...	...	...	...	1.0	max. megohm
Neck Diameter	...	...	...	...	...	...	35.0	max. mm
Neck Diameter	...	...	...	...	...	...	33.5	min. mm
Picture Diagonal	...	...	...	...	...	...	227	max. mm

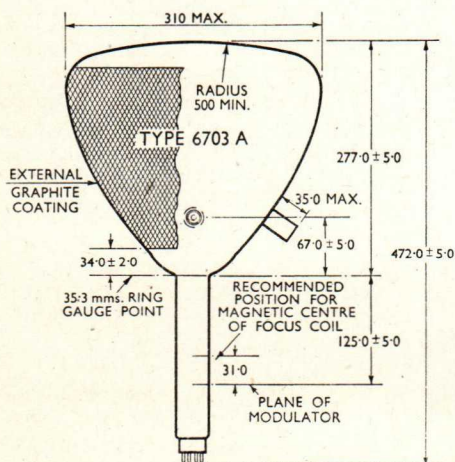
Capacitance :

Modulator to all other electrodes	...	...	...	...	...	...	15	max. pF
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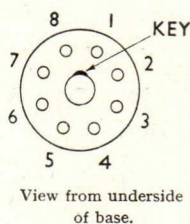
MOUNTING POSITION

Any

DIMENSIONS



BASE



INTERNATIONAL OCTAL

- Pin 1: I.C.
 2: Heater
 3: I.C.
 4: I.C.
 5: Modulator
 6: I.C.
 7: Heater
 8: Cathode
 Side Contact: Anode (flush type)

I.C. indicates that no external connection should be made to this pin.

All dimensions are in mm.

TYPE 6703A

TYPICAL OPERATING CONDITIONS

Anode Voltage	...	...	...	...	...	...	7000	volts
Modulator Cut-off Voltage	...	...	...	...	...	...	-47	approx. volts
Mean Signal Input to Modulator	...	...	...	...	...	...	23	peak volts
Picture Size	...	...	...	...	...	...	263 x 196	mm
Picture Brightness	...	...	...	...	...	...	10	e.f.c.

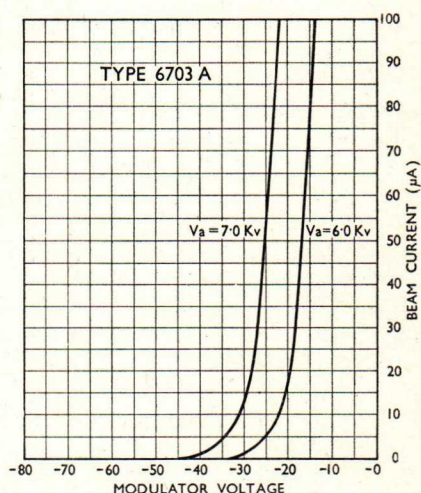
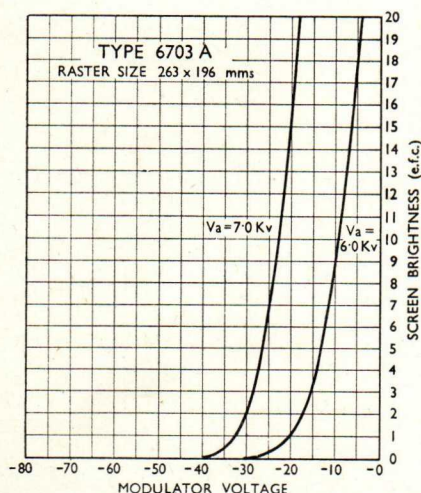
PRECAUTIONS IN USE

The attention of the user is drawn to the CODE OF PRACTICE FOR USE OF CATHODE RAY TUBES IN EQUIPMENT, B.S. 1147, 1943, obtainable from the British Standards Institution, 28, Victoria Street, London, S.W. 1. Failure to observe the recommendations contained therein may result in poor performance of, or damage to, both tube and equipment.

If it is not desired to apply modulation to the cathode one side of the heater should be connected direct to cathode.

The tube is designed for use with deflecting coils which position the centre of deflection at 25 mm. approximately from the 35.3 gauge point. It will be appreciated that the possibility of cut off of the picture area is intimately linked with the design of the deflecting coils, and focussing system.

It is desirable to maintain the external graphite coating at chassis potential, as otherwise this may acquire a charge capable of imparting an electric shock to the user and/or causing picture interference.



AVERAGE CHARACTERISTIC CURVES OF TYPE 6703A CATHODE RAY TUBE.

6704A

G.E.C.

CATHODE RAY TUBES

6704A TELEVISION TUBE

DESCRIPTION

The G.E.C. type 6704A 12" diameter cathode ray tube is intended for high quality television reception, and is magnetically focussed and deflected. The screen fluorescence is white and the tube is indirectly heated.

The outside of the bulb is partially covered with a conductive coating which can be used in conjunction with the internal coating to form a capacitance sufficiently large to use as the reservoir capacitor in an R.F. or fly-back E.H.T. system.

The fluorescent screen is backed with a very thin metallic coating which considerably increases the life of the tube and at the same time gives better picture contrast under normal conditions of use.

RATINGS

Heater Current	...	...	...	...	...	...	...	0.3	amp
Heater Voltage	...	...	...	...	...	...	...	10.5	approx. volts
Heater/Cathode Voltage	...	...	...	...	...	...	...	150	max. volts
Anode Voltage	...	...	...	...	...	...	...	8000	max. volts
Anode Voltage	...	...	...	...	...	...	...	6000	min. volts
Nominal Modulator Voltage for Cut-off	...	...	...	...	...	...	...	- Anode Voltage/150	approx. volts
Modulator Voltage	...	...	...	...	...	...	...	-100	max. volts
Cathode Current	...	...	...	...	...	...	...	100	max. μ A
Modulator/Cathode Resistance	...	...	...	...	...	...	...	1.0	max. megohm
Neck Diameter	...	...	...	...	...	...	...	35.0	max. mm
Neck Diameter	...	...	...	...	...	...	...	33.5	min. mm
Picture Diagonal	...	...	...	...	...	...	...	277	max. mm

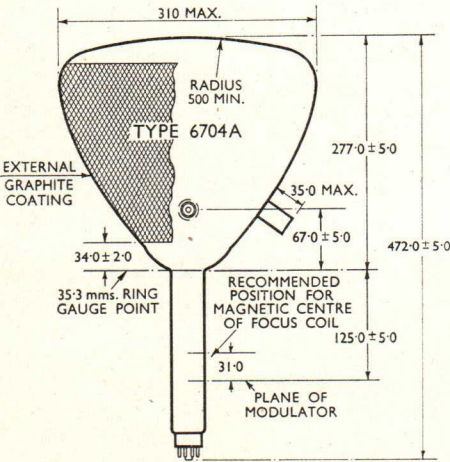
Capacitance :

Modulator to all other electrodes	...	...	...	...	...	...	...	15	max. pF
-----------------------------------	-----	-----	-----	-----	-----	-----	-----	----	---------

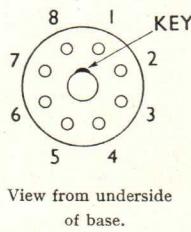
MOUNTING POSITION

Any

DIMENSIONS



BASE



INTERNATIONAL OCTAL

- pin 1 : I.C.
 - 2 : Heater
 - 3 : I.C.
 - 4 : I.C.
 - 5 : Modulator
 - 6 : I.C.
 - 7 : Heater
 - 8 : Cathode
- Side Contact : Anode (flush type)

I.C. indicates that no external connection should be made to this pin.

All dimensions are in mm.

TYPE 6704A

TYPICAL OPERATING CONDITIONS

Anode Voltage	...	...	...	...	...	...	...	7000	volts
Modulator Cut-off Voltage	...	...	...	...	...	...	...	-47	approx. volts
Mean Signal Input to Modulator	...	...	...	...	...	...	...	23	peak volts
Picture Size	...	...	...	...	...	...	...	263 × 196	mm
Picture Brightness	...	...	...	...	...	...	...	10	e.f.c.

PRECAUTIONS IN USE

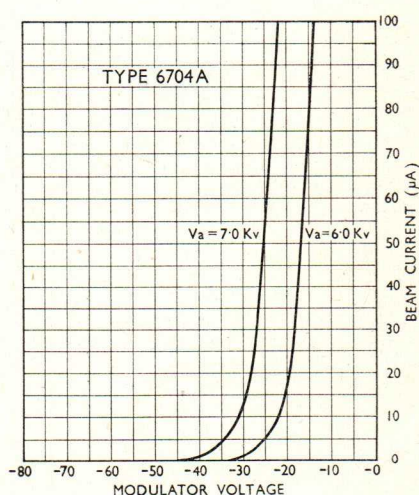
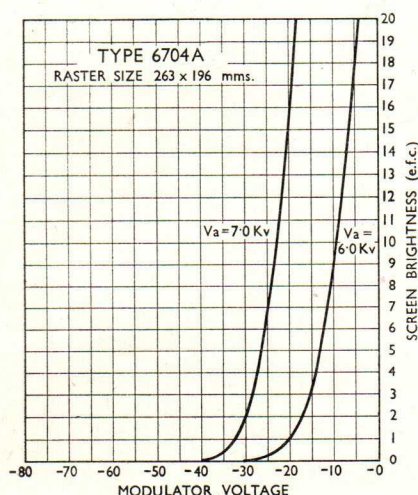
The attention of the user is drawn to the CODE OF PRACTICE FOR USE OF CATHODE RAY TUBES IN EQUIPMENT, B.S. 1147, 1943, obtainable from the British Standards Institution, 28 Victoria Street, London, S.W. 1. Failure to observe the recommendations contained therein may result in poor performance of, or damage to, both tube and equipment.

The tube is designed for use with deflecting coils which position the centre of deflection at 25 mm. approximately from the 35.3 ring gauge point. It will be appreciated that the possibility of cut off of the picture area is intimately linked with the design of the deflecting coils, and focussing system.

It is desirable to maintain the external graphite coating at chassis potential, as otherwise this may acquire a charge capable of imparting an electric shock to the user and/or causing picture interference.

The heater of the tube is suitable for operation in series with a range of 0.3 amp. valves, but it is essential to ensure that the peak surge voltage across the tube heater does not exceed 12.5 volts. A suitable limiting device should be introduced into the circuit to restrict the voltage to this maximum value.

The heater should also be so positioned in the heater chain that the voltage between heater and cathode is kept as low as possible.



AVERAGE CHARACTERISTIC CURVES OF TYPE 6704A CATHODE RAY TUBE.

OSCILLOGRAPHIC TUBES

The G.E.C. electrostatic tubes types E4103, E4205, E4412 and E4504 are available with either of four different types of screen according to whether short, normal or long persistence is required.

As the special screens are often only required in very small quantities the E4103 is supplied with either the B or E screen, and the E4205 with the B screen only as standard, although either of these tubes can be supplied with other screen types against a special minimum quantity order.

The E4412 and E4504 can be supplied with either of the four screen types as standard.

The second letter of the tube nomenclature indicates the type of screen employed.

SCREEN TYPES

TYPE B

This is the ordinary green willemite screen with which the standard tubes are normally supplied. It is suitable for visual observation of the trace although it has a very slight persistence which can be troublesome when recording photographically on moving film.

TYPE E

This screen is highly actinic with very short persistence and is therefore suitable for photographic recording of high speed transients particularly when used with blue sensitive photographic emulsion.

TYPE C

This screen should be used where it is desired to record high speed transients in which a relatively small amount of energy is available to excite the screen. The persistence enables the transient to be observed for several seconds after it has occurred. This type of screen is useful for reducing the flicker with recurrent traces of low frequency say 5—10 c/s.

TYPE M

This screen should be used where a relatively large amount of energy is available and a bright afterglow of considerable duration is required. It is useful in observing low speed phenomena which may have a duration of several seconds, e.g. electro-cardiography.

It is not possible to define the characteristics of the C and M screens in more precise terms unless the exact conditions of use are specified.

G.E.C.

CATHODE RAY TUBES

E-4103-B-4 OSCILLOGRAPHIC TUBE, 1½" SCREEN

DESCRIPTION

The G.E.C. cathode ray tube, type E-4103-B-4, is a miniature high vacuum cathode ray tube with indirectly heated cathode and is designed for electrostatic focus and deflection.

It is intended for use in portable oscillographic apparatus, as used for radio servicing purposes, and may also be employed in applications where a visual means of studying transient or recurrent phenomena is required.

Features of the E-4103-B-4 are—small overall length and comparatively low operating voltage.

In this tube all four deflector plates are brought out to separate pins so that symmetrical (push-pull) deflection can be used if desired; the tube can also be used with unsymmetrical (non-push-pull) deflection with some deterioration of performance.

The screen has green fluorescence of negligible persistence.

RATINGS

Heater voltage	.....	.....	.....	.....	.....	4.0 ± 5%	volts
Heater current	.....	.....	.....	.....	.....	1.1	approx. amp
First anode voltage (VA1)	}	internally connected	.....	.....	.....	600	min. volts
Third anode voltage (VA3)			.....	.....	.....	1000	max. volts
Second anode focussing voltage (VA2)	.....	.....	.....	.....	.....	VA3 × 0.15	mean volts
Brightness control (modulator or grid) voltage (VM).	.....	.....	.....	.....	.....	—VA1 × 0.025	max. volts

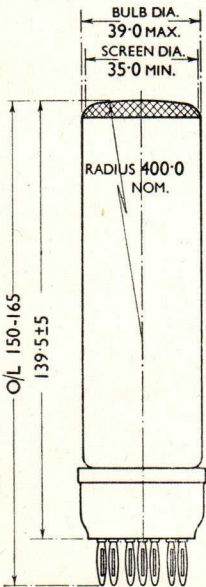
Deflection Sensitivity :

1. Deflectors nearest base Y1 and Y2	.....	.....	.....	.....	.....	100 VA3	mm/v
2. Deflectors nearest screen X1 and X2	.....	.....	.....	.....	.....	90 VA3	mm/v

Capacitances :

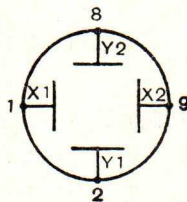
Modulator (grid) to all other electrodes	.....	.....	.....	.....	.....	20	max. pF
Either X or Y deflector to all other electrodes	.....	.....	.....	.....	.....	15	max. pF
Either X to either Y deflector, other electrodes earthed	.....	.....	.....	.....	.....	5	max. pF

DIMENSIONS



All dimensions are in mm. and are the maximum except where otherwise stated.

DEFLECTOR PLATES

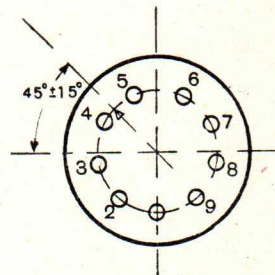


Disposition of plates viewed from screen end of tube.

With the tube viewed from the screen end and the arrow between pins 4 and 5 pointing downwards, a positive voltage applied to X1 and Y1 simultaneously will deflect the spot downwards.

Tolerances should be allowed for by mounting the tube holder in such a way that it may be rotated to accommodate individual tubes.

BASE



External view. Base end of tube.

PIN CONNECTIONS

Pin 1:	X1, Deflector Plate
2:	Y1, Deflector Plate
3:	A2
4:	Heater and Cathode
5:	Heater
6:	Modulator
7:	A1 and A3
8:	Y2, Deflector Plate
9:	X2, Deflector Plate

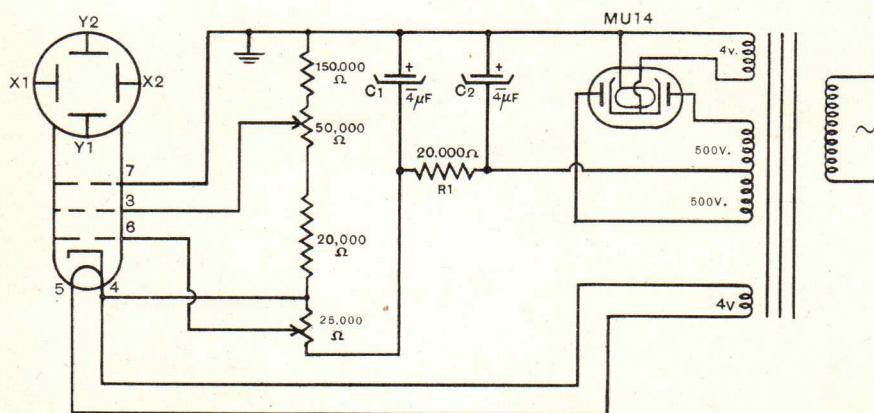
TYPE E-4103-B-4

OPERATING CONDITIONS

The attention of the user is drawn to the CODE OF PRACTICE FOR THE USE OF CATHODE RAY TUBES IN EQUIPMENT BS. 1147, 1943. Failure to observe the recommendations contained therein may result in poor performance of, or damage to, both tube and equipment.

A.C. supplies for operating these tubes should be obtained from transformers provided with an earthed screen between primary and secondary windings in order to protect the main supplies from any high voltage surges produced under fault conditions in the equipment.

Supplies for the tube may be conveniently obtained from A.C. mains by the use of the rectifier circuit shown below.



TYPICAL CIRCUIT SHOWING POWER SUPPLY TO E-4103-B-4 TUBE.



CATHODE RAY TUBE

E-4205-B-7 OSCILLOGRAPHIC TUBE, 2 3/4" SCREEN

DESCRIPTION

The G.E.C. cathode ray tube, type E-4205-B-7 is a small high vacuum cathode ray tube with indirectly heated cathode and is designed for electrostatic focus and deflection. As the cathode is brought out separately from the heater, modulation voltage can be applied between modulator and cathode without distortion of the wave form which might be caused by the capacitance to earth of the heater and transformer.

This tube is intended for use in portable oscillographic apparatus such as that used for radio servicing and may also be employed where a visual means of studying transient or recurrent phenomena is required.

Feature of the type E-4205-B-7 are the small overall length and comparatively low operating voltage with a screen of adequate dimensions.

The screen has a green fluorescence of negligible persistence.

RATINGS

Heater voltage	...	...	...	...	...	$4.0 \pm 5\%$	volts
Heater current	...	...	...	...	...	1.0	approx. amps
First anode voltage (VA1)	internally connected	...	...	...	...	600	min. volts
Third anode voltage (VA3)		...	...	...	...	1500	max. volts
Second anode voltage (VA2)		...	...	...	...	$VA3 \times 0.15$	mean volts
Brightness control (modulator or grid) voltage (VM)		...	...	...	...	$-(VA1 \times 0.03)$	max. volts

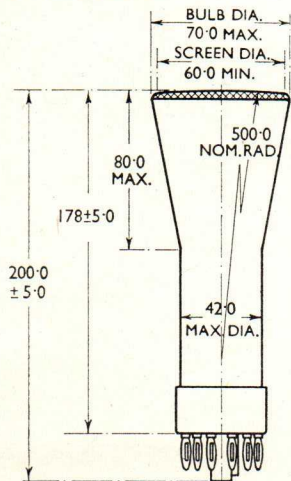
Deflection Sensitivity :

1. Deflectors nearest base X1 and X2	...	...	...	...	...	$\frac{170}{VA3}$	mm/v
2. Deflectors nearest screen Y1 and Y2	...	...	...	...	...	$\frac{170}{VA3}$	mm/v

Capacitances :

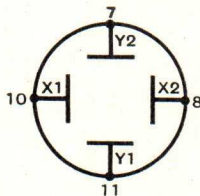
Modulator (grid) to all other electrodes	...	...	...	...	...	20	max. pF
Either X or Y Deflector to all other electrodes	...	...	...	...	...	15	max. pF
Either X to either Y deflector all other electrodes earthed	...	...	...	...	...	5	max. pF

DIMENSIONS



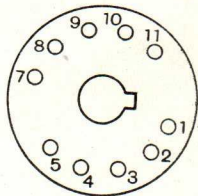
All dimensions are in mm. and are the maximum except where otherwise stated.

DEFLECTOR PLATES



With the tube viewed from the screen end and with the spigot uppermost, a positive potential applied to pin 10 will deflect the spot to the left and a positive potential applied to pin 11 will deflect the spot downwards.

BASE



View of underside of base

PIN CONNECTIONS

- Pin 1 : Cathode
2 : Modulator
3 : Heater
4 : Heater
5 : A2
6 : Pin omitted
7 : Y2 deflector
8 : X2 deflector
9 : A3 and A1
10 : X1 deflector
11 : Y1 deflector
12 : Pin omitted

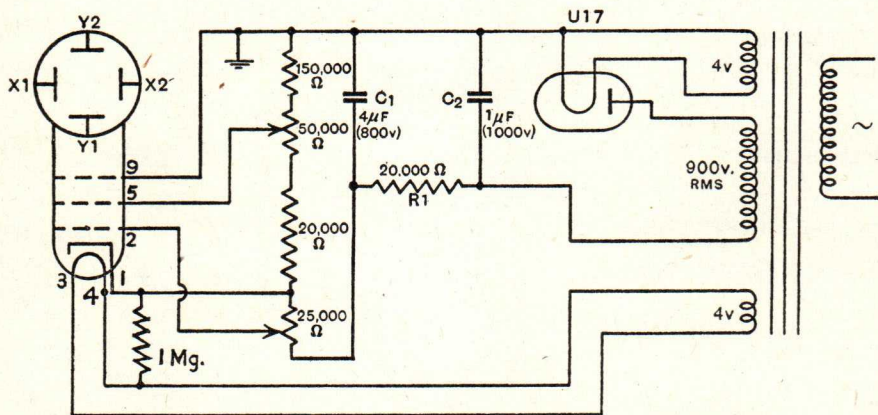
TYPE E-4205-B-7

OPERATING CONDITIONS

The attention of the user is drawn to the CODE OF PRACTICE FOR THE USE OF CATHODE RAY TUBES IN EQUIPMENT B.S.1147, 1943. Failure to observe the recommendations contained therein may result in poor performance of, or damage to, both tube and equipment.

A.C. supplies for operating these tubes should be obtained from transformers provided with an earthed screen between primary and secondary windings in order to protect the main supplies from any high voltage surges produced under fault conditions in the equipment.

Supplies for the tube may be conveniently obtained from A.C. mains by the use of the rectifier circuit shown below.



TYPICAL CIRCUIT SHOWING HIGH VOLTAGE POWER SUPPLY TO E-4205-B-7.



CATHODE RAY TUBES

E-4412-B-9 OSCILLOGRAPHIC TUBE, 3½" SCREEN

DESCRIPTION

The G.E.C. cathode ray tube type E-4412-B-9 has an indirectly heated cathode with separate connection so that modulating voltages can be applied between cathode and modulator without the distortion which might otherwise be caused by the capacitance to earth of the heater transformer.

It is intended for use in portable or fixed oscillographic apparatus for studying a variety of phenomena at high or low frequencies. The screen has a green fluorescence of negligible persistence.

A particular feature of this tube is the short overall length for the high deflection sensitivity obtained.

RATINGS

Heater voltage	...	...	...	...	...	$4.0 \pm 5\%$	volts
Heater current	...	...	...	...	...	1.1	approx. amps
First anode voltage (VA1)	...	...	...	...	...	2500	max. volts
Second anode voltage (VA2)	...	...	...	...	...	$VA3 \times 0.175$	mean volts
Third anode voltage (VA3)	...	...	...	...	...	$\begin{cases} 4000 \\ 1000 \end{cases}$	$\begin{matrix} \text{max. volts} \\ \text{min. volts} \end{matrix}$
Brightness control (modulator or grid) voltage (VM)	...	...	...	...	...	$-(VA1 \times 0.04)$	max. volts

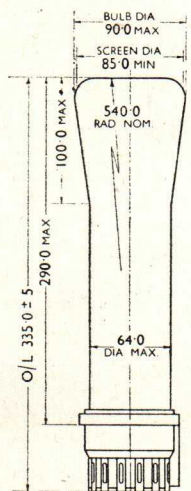
Deflection Sensitivity:

1. Deflectors nearest base X1 and X2	...	...	...	...	...	$\frac{750}{VA3}$	mm/v
2. Deflectors nearest screen Y1 and Y2	...	...	...	...	...	$\frac{350}{VA3}$	mm/v

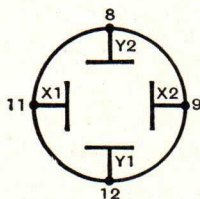
Capacitances :

Modulator (grid) to all other electrodes	...	...	...	...	...	25	max. pF
Either X or Y deflector to all other electrodes	...	...	...	...	...	25	max. pF
Either X to either Y deflector, other electrodes earthed	...	...	...	...	...	6	max. pF

DIMENSIONS

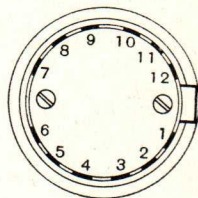


DEFLECTOR PLATES



With the tube viewed from the screen end with the base spigot uppermost, a positive potential applied to contact 11 will deflect the spot to the left and a positive potential applied to contact 12 will deflect the spot downwards.

BASE



View of underside of base

PIN CONNECTIONS

- Pin 1: Modulator
- 2: Cathode
- 3: Heater
- 4: Heater
- 5: A1
- 6: A2
- 7: Graphite
- 8: Y2 deflector
- 9: X2 deflector
- 10: A3
- 11: X1 deflector
- 12: Y1 deflector

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE E-4412-B-9

OPERATING CONDITIONS

The attention of the user of these tubes is directed to the CODE OF PRACTICE FOR THE USE OF CATHODE RAY TUBES IN EQUIPMENT. BS.1147, 1943.

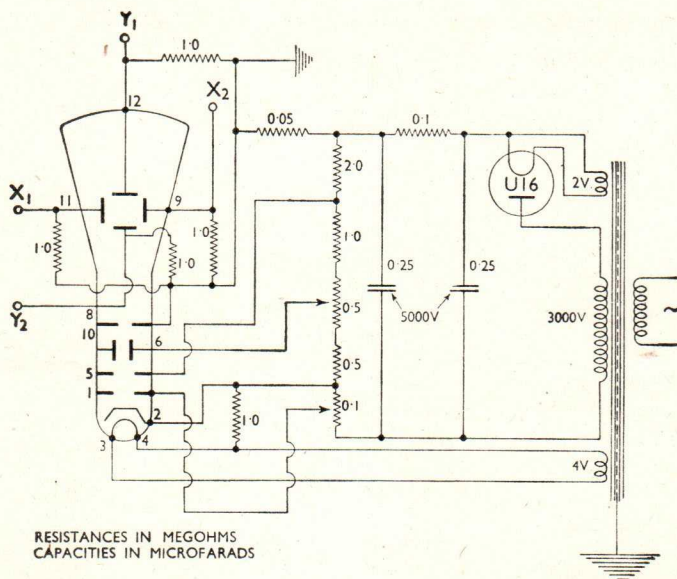
Failure to observe the recommendations contained therein result in poor performance of, or damage to, both tube and equipment.

A.C. supplies for operating these tubes should be obtained from transformers provided with an earthed screen between primary and secondary windings in order to protect the main supplies from any high voltage surges produced under fault conditions in the equipment.

A circuit from which the various electrode potentials can be obtained is shown below.

The internal conducting coating of the tube is connected to contact 7. This should be normally tied directly to contact 10 (A3) but if it should be desired to read the current in the spot (beam current) a meter reading 0-100 microamperes may be connected between contact 7 and contact 10.

If it is not desired to apply any modulation between cathode and modulator, one side of the heater should be connected directly to the cathode, otherwise through a resistance of approximately 1 megohm.



TYPICAL CIRCUIT SHOWING HIGH VOLTAGE POWER SUPPLY TO TUBE.

This circuit applies approx. 4000 v. between A.3 and cathode. If the tube is to be operated on some other voltage, proportional modifications should be made to the output voltage of the h.t. windings and to the insulation between the windings of the transformer and to the rating of the capacitors employed.

G.E.C.

CATHODE RAY TUBES

E-4504-B-16 OSCILLOGRAPHIC TUBE, 6" SCREEN

DESCRIPTION

The G.E.C. cathode ray tube type E.4504-B-16, has an indirectly heated cathode with separate connection so that modulating voltages can be applied between cathode and modulator without the distortion which might otherwise be caused by the capacitance to earth of the heater transformer.

It is intended for use in portable or fixed oscillographic apparatus for studying a variety of phenomena at high or low frequencies. The screen has a green fluorescence of negligible persistence.

A particular feature of this tube is the short overall length for the high deflection sensitivity obtained.

RATINGS

Heater voltage ...	...	...	...	...	...	$4 \pm 5\%$	volts
Heater current ...	...	...	...	...	...	1.1	approx. amps
First anode voltage (VA1) ...	...	...	...	...	...	2500	max. volts
Second anode voltage (VA2) ...	...	...	...	...	...	$VA3 \times 0.175$	mean volts
Third anode voltage (VA3) ...	...	...	...	...	...	$\begin{cases} 5000 \\ 1000 \end{cases}$	$\begin{matrix} \text{max. volts} \\ \text{min. volts} \end{matrix}$
Brightness control (modulator or grid) voltage (VM) ...	...	...	...	...	...	$-(VA1 \times 0.04)$	max. volts

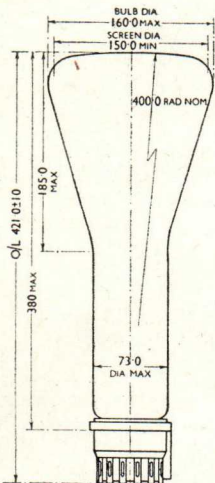
Deflection Sensitivity :

1. Deflectors nearest base Y1 and Y2 ...	...	...	...	...	...	$\frac{1100}{VA3}$	mm/v
2. Deflectors nearest screen X1 and X2 ...	...	...	...	...	...	$\frac{600}{VA3}$	mm/v

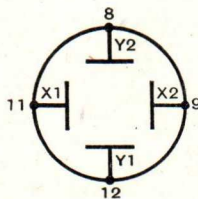
Capacitances :

Modulator (grid) to all other electrodes ...	...	...	...	...	...	25	max. pF
Either X or Y deflector to all other electrodes ...	...	...	...	...	...	25	max. pF
Either X to either Y deflector, other electrodes earthed ...	...	...	...	...	...	6	max. pF

DIMENSIONS

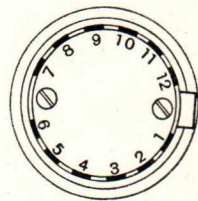


DEFLECTOR PLATES



With the tube viewed from the screen end with the base spigot uppermost, a positive potential applied to contact 11 will deflect the spot to the left and a positive potential applied to contact 12 will deflect the spot downwards.

BASE



View of underside of base

PIN CONNECTIONS

Pin 1 :	Modulator
2 :	Cathode
3 :	Heater
4 :	Heater
5 :	A1
6 :	A2
7 :	Graphite
8 :	Y2 deflector
9 :	X2 deflector
10 :	A3
11 :	X1 deflector
12 :	Y1 deflector

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE E-4504-B-16

OPERATING CONDITIONS

The attention of the user of these tubes is directed to the CODE OF PRACTICE FOR USE OF CATHODE RAY TUBES IN EQUIPMENT. BS.1147, 1943.

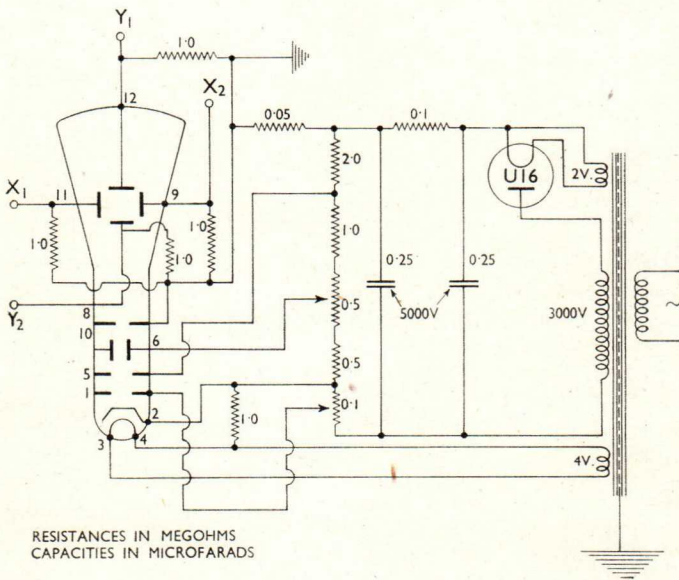
Failure to observe the recommendations contained therein may result in poor performance of, or damage to, both tube and equipment.

A.C. supplies for operating these tubes should be obtained from transformers provided with an earthed screen between primary and secondary windings in order to protect the main supplies from any high voltage surges produced under fault conditions in the equipment.

A circuit from which the various electrode potentials can be obtained is shown below.

The internal conducting coating of the tube is connected to contact 7. This should be normally tied directly to contact 10 (A3) but if it should be desired to read the current in the spot (beam current) a meter reading 0-100 microamperes may be connected between contact 7 and contact 10.

If it is not desired to apply any modulation between cathode and modulator, one side of the heater should be connected directly to the cathode, otherwise through a resistance of approximately 1 megohm.



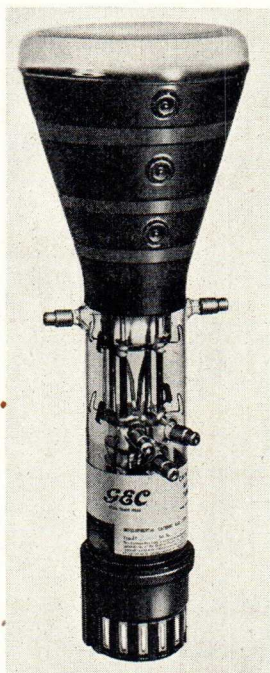
TYPICAL CIRCUIT SHOWING HIGH POWER VOLTAGE SUPPLY TO TUBE.

This circuit applies approx. 4000 v. between A.3 and cathode. If the tube is to be operated on some other voltage, proportional modifications should be made to the output voltage of the h.t. windings and to the insulation between the windings of the transformer and to the rating of the capacitors employed.

G.E.C.

CATHODE RAY TUBES

SPECIAL OSCILLOGRAPHIC TUBES



A range of specialised cathode ray tubes is available for certain applications where the requirements are so stringent that normal cathode ray tubes are unsuitable, and only tubes made under laboratory controlled conditions would be satisfactory. Brief details of some of these are given below and more detailed information is available on request.

Owing to the highly specialised nature of these tubes, involving continued changes in design, there is no guarantee of continuity of supply of these types, except in particular instances where the assurance of the G.E.C. has been obtained.

TYPE 401CAHA

A 1½" high vacuum indirectly heated cathode ray tube which is electrostatically focussed and deflected. The tube is fitted with a post deflector accelerator which enables the high brightness, resulting from a high accelerating potential, to be obtained without suffering the loss in deflection sensitivity unavoidable with the conventional type of tube. The screen fluorescence is green.

TYPE 408CAHA

This tube is identical to the 401CAHA except that the screen fluorescence is blue, making the tube particularly suitable for photographic recording of the trace.

TYPE 908BCC

A 3½" blue photographic screen indirectly heated cathode ray tube which is electrostatically focussed and deflected. The final anode and the deflector plates are brought through the neck of the bulb through side arms resulting in a very low capacitance deflection system. This feature, combined with the ability to use the tube at voltages up to 10 kV, enables traces with a writing speed of up to 3,000 km/sec. to be recorded.

TYPE 1608ABCA

This tube is similar to the 908BCC except that it has a bulb diameter of 6".

MISCELLANEOUS VALVES FOR SCIENTIFIC AND INDUSTRIAL PURPOSES

Ionisation Gauge.

A1998. This tube is employed as a vacuum indicator and is supplied in one type only.

Thyratron.

GT1C. Argon filled triode, 0.3 amp. average, 1.0 amp. peak anode current.

Electrometer Triodes.

The electrometer is a high vacuum thermionic tube intended for the indication or measurement of extremely small currents involving a very high input grid resistance. The grid current and leakage of these valves is therefore extremely low and special precautions have to be taken in the handling to avoid impairing their special qualities of high input resistance. The following types are listed :

ET1 Electrometer triode.

ET3 Sub-miniature electrometer triode.



A1998

A1998 IONISATION GAUGE

The A1998 ionisation gauge is a thermionic device intended to indicate degrees of vacuum.

It is supplied with a 3 mm. diameter pinch stem by which it may be connected directly to the vacuum system, and instructions are given below for use under these conditions. It is permissible, however, for the gauge to be re-stemmed at the wide end of the envelope with a 16 mm. diameter tube and higher sensitivity realised as described under the appropriate section below.

OPERATING CONDITIONS

USING NORMAL 3 mm. STEM

The gauge must be thoroughly outgassed each time the electrodes have been exposed to the atmosphere.

1. Bake at 350°—380°C. for 5 minutes.
2. Still under bake, connect anode and grid to +200 volts supply.
3. Adjust emission current by varying the filament voltage (6-7 volts A.C.) and bring up slowly to 50 mA.
4. Maintain anode temperature at 900°—1000°C. (bright orange-red) for 15 minutes.

Conditions of use (external collection).

Grid Potential	...	...	...	...	...	...	...	...	+100	volts
Anode (collector)	...	...	...	...	...	...	...	...	- 20	volts
Emission Current	...	...	...	...	...	...	...	...	2	mA

Obtain correct emission current by adjustment of filament voltage (4.0 approx. volts).

Positive ion current varies linearly with the pressure up to about one micron (0.001 mm. Hg).

The sensitivity is 20 μ A per micron.

Conditions of use (internal collection).

Anode Potential	...	...	...	...	...	...	...	...	+100	volts
Grid (collector)	...	...	...	...	...	...	...	...	- 10	volts
Emission Current	...	...	...	...	...	...	...	...	4	mA

The sensitivity is 10 μ A per micron linear up to about 2 microns.

USING 16 mm. OR LARGER STEM

No special outgassing treatment is required, but the gauge should be run under operating conditions for 15 minutes before any readings are taken. If operated under the conditions described in the previous section the same sensitivities are obtained, in addition, however, the following higher sensitivity is now attainable.

Conditions of use (external collection).

Grid Potential	...	...	...	...	...	...	...	...	+166	volts
Anode (collector)	...	...	...	...	...	...	...	...	- 9	volts
Emission Current	...	...	...	...	...	...	...	...	25	mA

Obtain correct emission current by adjustment of filament voltage (5.0 approx. volts).

Positive ion current is linear with pressure up to about 0.8 micron (0.0008 mm. Hg).

Sensitivity is 150 μ A per micron.

GENERAL

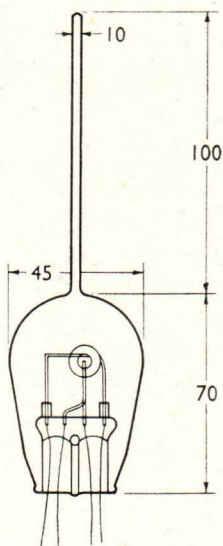
The calibrations are for dry air only. It is essential to use a liquid air trap as water vapour will lead to spurious readings.

Stability of supply voltages is most important. The filament should be operated from an accumulator of ample capacity.

The lowest pressure which can be recorded is limited only by the sensitivity of the meter used for recording the positive ion current.

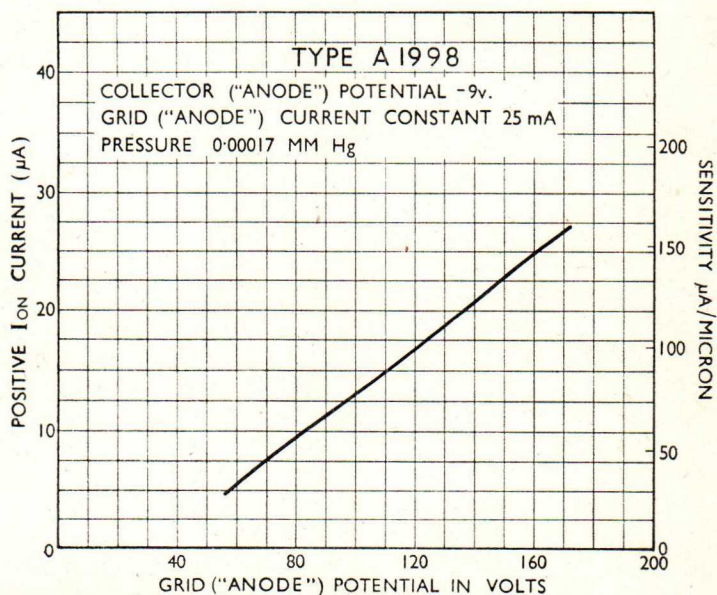
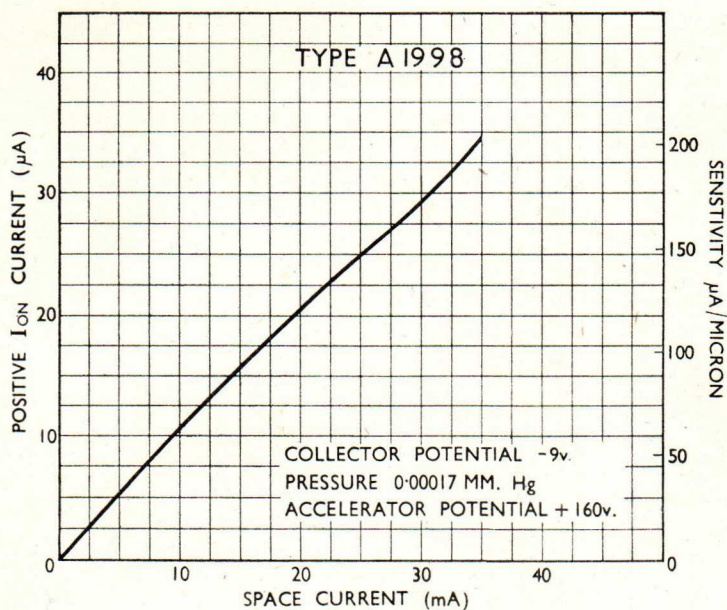
It is not recommended that the gauge be operated up to the limit of the linear characteristic. Pressures should be kept below 0.0005 mm. Hg whenever possible.

DIMENSIONS



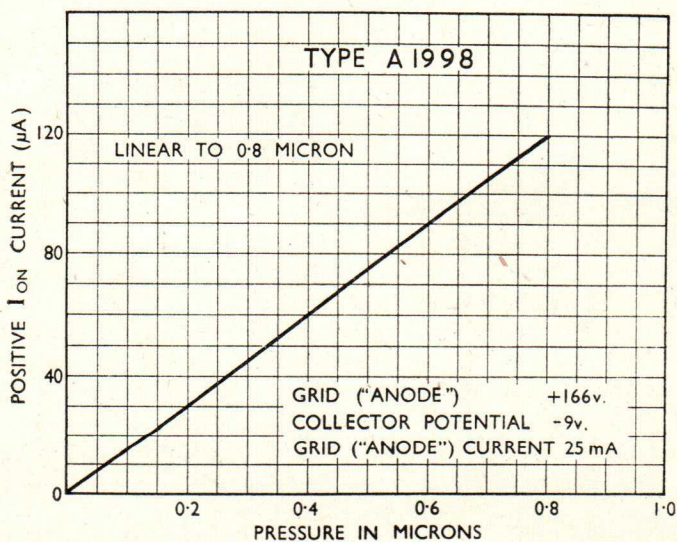
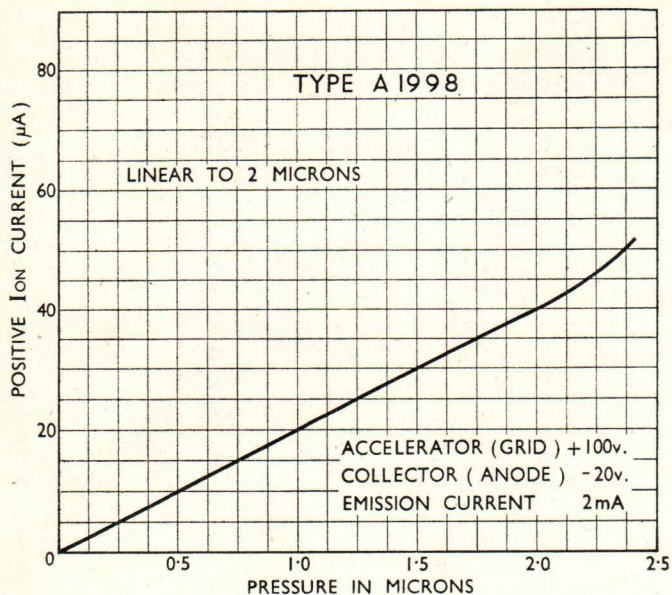
All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE A1998



CHARACTERISTIC CURVES OF AVERAGE VALVE.

TYPE A1998



CHARACTERISTIC CURVES OF AVERAGE VALVE.



GT1C THYRATRON (ARGON-FILLED)

DESCRIPTION

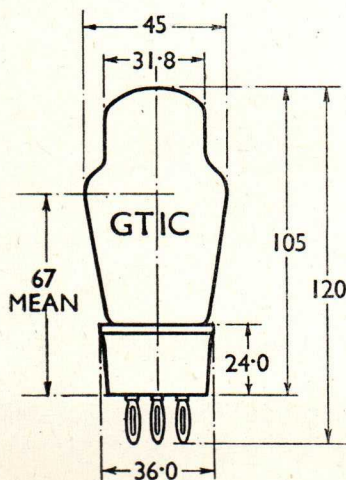
Type GT1C Thyatron is a trigger device. It comprises an indirectly heated cathode, an anode and a control grid, and is enclosed in a bulb which is argon-filled. The GT1C can be employed to control current up to 1 amp. (peak value) in either A.C. or D.C. circuits.

Owing to the special design a long life with freedom from clean-up is ensured with anode currents up to 1.0 amp. peak value.

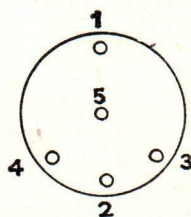
RATINGS

Heater Voltage	...	...	...	...	...	4.0 to 4.3	volts
Heater Current	...	...	...	...	...	1.35	approx. amp
Maximum Safe Anode Voltage	...	...	...	...	...	500	peak volts
Maximum Safe Anode Current	...	...	...	...	...	1.0	peak amp
						0.5	R.M.S. amp
						0.3	average amp
							(measured on a moving coil meter)
Cathode—anode Voltage drop	...	...	...	...	...	16	max. volts
Grid Control Ratio	...	...	...	...	...	28	
Cathode heating time	...	...	...	...	...	30	min. secs

DIMENSIONS



BASE



View looking on underside of base.

5-PIN

- Pin 1: Anode
- 2: Grid
- 3: Heater
- 4: Heater
- 5: Cathode

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE GT1C

OPERATING CONDITIONS

General

Current is carried through the Thyatron by the passage of electrons from the cathode to the anode under the influence of a positive potential applied to the latter. If, however, a sufficiently negative grid bias is applied before the anode is made positive, the flow of current between anode and cathode will be withheld. If the anode voltage is now increased above, or the negative grid bias reduced below a critical value (see characteristic curve), anode current will start to flow and the argon becomes ionised.

Under this condition the internal voltage drop between anode and cathode is about 10/16 volts irrespective of the value of anode current. It is therefore, essential that the impedance of the external circuit shall be sufficient to limit the anode current to the rating given above.

Once the argon is ionised, the grid has normally no longer any power to control the value of the anode current. In D.C. circuits the anode current can only be stopped by breaking the circuit or by removing the applied anode voltage for a time long enough to allow the ions to disperse. In A.C. circuits, since the anode current falls to zero at some part of every cycle, the grid is able to control the instant in the succeeding cycle at which current will start again.

In Time Base Circuit

Type GT1C may be used to provide a "saw-tooth" wave for a linear time base if the required frequency is confined to the lower audio frequencies. Up to about 500 c/s the departure from the desired wave form is negligible.

Type GT1C being designed primarily as a relay for handling relatively large current has a comparatively long de-ionization time, approximately 30/40 microseconds. For this reason it may be said that the maximum operating frequency of a time base using a GT1C does not exceed 8 kc/s. The recommended circuit for type GT1C in a time base is shown on opposite page.

The voltage developed by the relay under linear conditions is of insufficient amplitude to produce an adequate trace on a high vacuum cathode ray tube and a sweep amplifier is therefore provided. In the circuit shown, the stage gain of this amplifier is controlled by degeneration, using a variable unshunted cathode resistor.

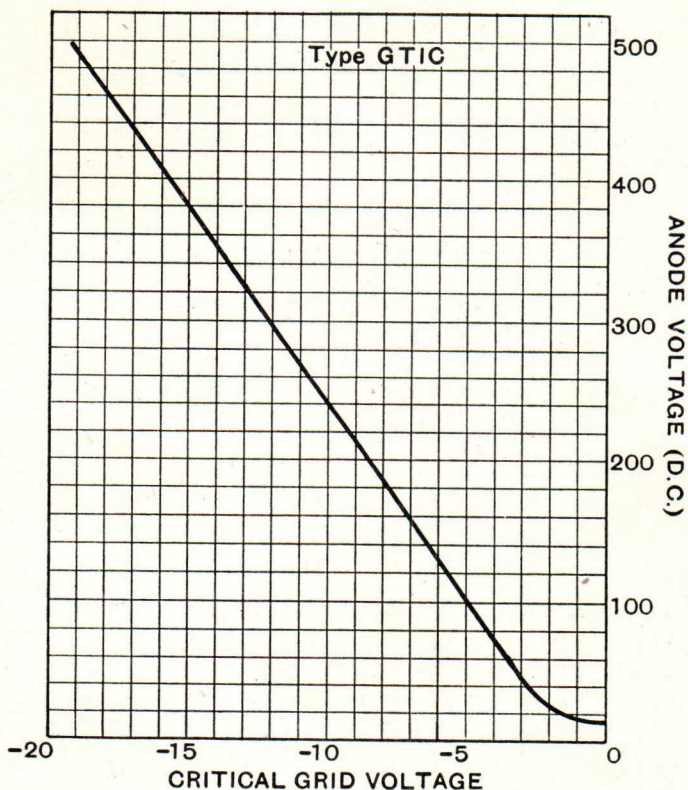
PRECAUTIONS IN USE

It is essential that the cathode be allowed at least 30 seconds to reach full operating temperature before any anode current is permitted to flow. Disregard of this precaution will cause cumulative destruction of the cathode.

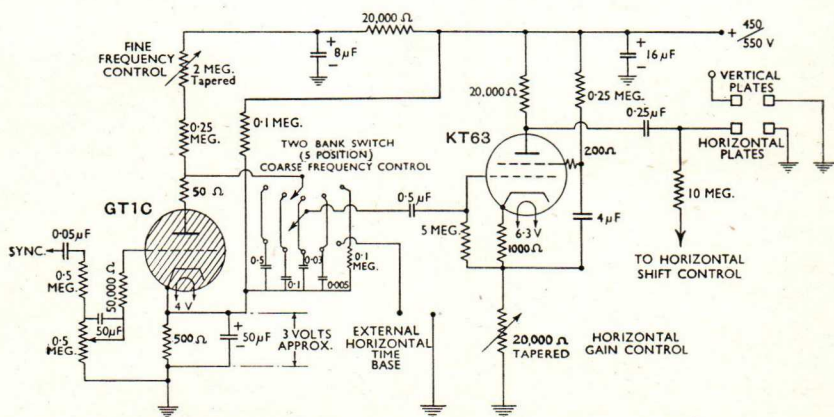
It is also essential that the anode current shall never, even momentarily, exceed the rated peak value of 1 amp. This point requires particular attention in circuits where there are capacitors which may charge or discharge through the Thyatron. In circuits where an accident overload may be liable to occur, it is wise to protect the Thyatron with an instantaneous overload circuit breaker set to operate at about 1 amp.—a fuse is not sufficiently rapid to afford protection.

The peak voltage developed at the grid of the GT1C during the discharge period should not exceed 10 volts negative to cathode, and this can usually be achieved by the use of a grid resistor of value between 10,000 ohms and 1 megohm.

TYPE GT1C



CHARACTERISTIC CURVE OF AVERAGE VALVE.



Typical circuit for GT1C in a time base, with "sweep" amplifier.

ET1

Osram
VALVES

ET1 ELECTROMETER TRIODE

DESCRIPTION

Type ET1 is a thermionic measuring device similar in principle to the triode valve but designed to have a very high value of input resistance, so that it may be employed for any purpose for which an electrometer is required. Typical applications include measurements of ionisation currents and hydrogen-ion concentration, and the study of piezo-electric effects. For such work this electrometer triode has the advantages, over other forms of electrometer, of simplicity, robustness and low capacitance.

The "control grid" electrode is connected to the terminal mounted at the end of a special high resistance glass stem. Internal and external guard rings and an electrostatic shield round the electrode system are connected to a pin in the valve base, and may be connected to the negative end of the filament or given any desired negative potential.

RATINGS

Filament Voltage	...	...	...	...	...	...	...	1-0	volt
Filament Current	...	...	...	...	...	...	...	0-1	amp
Mutual Conductance,	at $V_a = +4$, $V_{g_1} = -2$	...	...	...	...	...	...	0-05	mA/V
	at $V_a = +6$, $V_{g_1} = -2$	...	...	...	...	...	...	0-10	mA/V

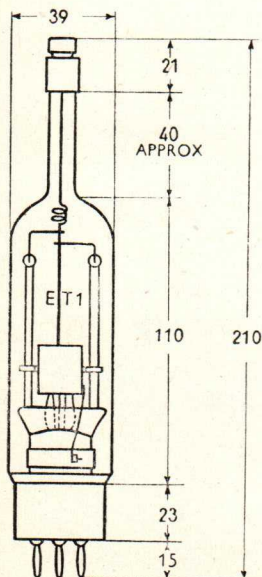
Capacitances :

Control Grid to all other electrodes	2·0 approx. pF
---	----------------

OPERATING CONDITIONS

To obtain the minimum possible electrical leakage the operating grid potential should be greater than two volts negative with respect to the negative end of the filament, the glass surface should be kept perfectly clean and dry, and the valve operated in the dark. Particularly in circuits where the highest sensitivity is required, electrical screening of the valve and input circuit should be employed, together with some form of anti-microphonic mounting; and the use of high-capacity accumulators for filament and anode supplies is also recommended, in order to reduce fluctuations and drift as much as possible.

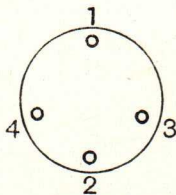
DIMENSIONS



BASE

4-PIN

- Pin 1 : Anode
2 : Guard Rings and Screen
3 : Filament
4 : Filament
Top Cap : Control Grid

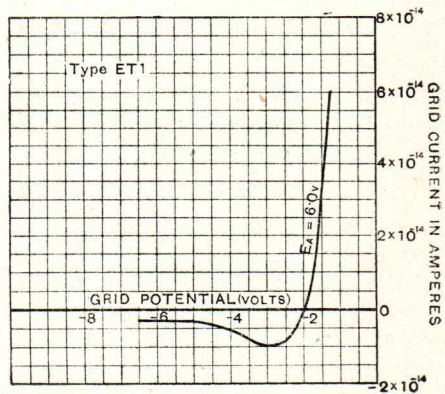
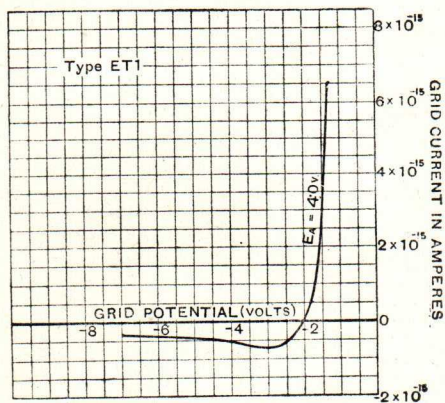
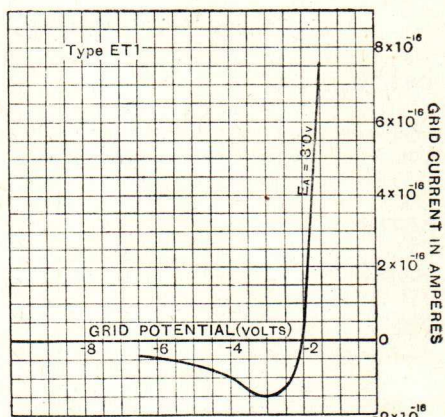
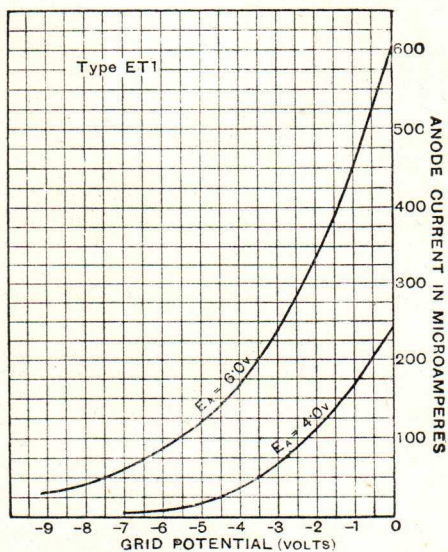


View looking on
underside of base.

Top Cap: Threaded 5BA.
Threaded portion 4mm. long.

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE ET1



CHARACTERISTIC CURVES OF AVERAGE VALVE

ET3



VALVES

ET3 SUB-MINIATURE ELECTROMETER TRIODE

DESCRIPTION

The ET3 sub-miniature electrometer triode is a thermionic valve having a very high input resistance and low capacitance while being considerably smaller than the type ET1. The valve has a low filament current which, with the voltage rating of the filament, enables it to be run from a small dry cell.

RATINGS

Filament Voltage	...	...	...	...	...	...	1.25	volts
Filament Current	...	...	...	...	...	...	0.025	amp
Anode Voltage	...	...	...	...	...	...	9	max. volts
Mutual Conductance*	...	...	...	...	...	...	70	$\mu\text{A}/\text{volt}$
Amplification Factor*	...	...	...	...	...	...	1	
Grid Resistance†	...	...	...	...	...	...	$>10^{14}$	ohms

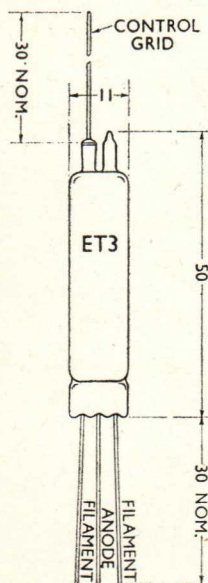
* Measured at $V_a=6$, $V_g=-2$.

† Measured at $V_a=6$, $V_g=-3.5$.

Capacitances :

Control Grid to all other electrodes	...	...	...	...	...	...	1.7	pF
Control Grid to Anode	...	...	...	...	...	...	0.2	pF

DIMENSIONS



BASE

Soldered-in type valve.

One of the filament leads is painted black and is connected internally to a screening electrode: this should be earthed and connected to the negative end of the filament supply.

OPERATING CONDITIONS

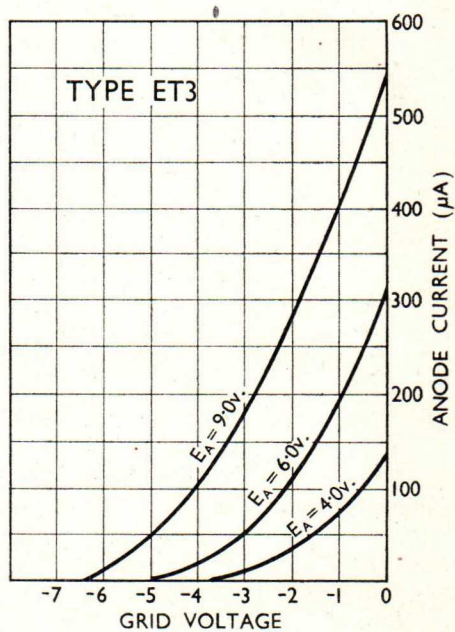
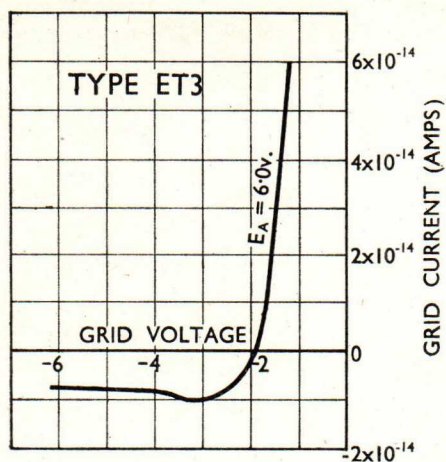
To obtain the smallest possible grid current the anode potential should not be greater than six volts positive and the grid voltage not less than two volts negative with respect to the negative end of the filament. The valve should be operated in darkness and it is advisable to enclose it in a dry container. This should be of metal to serve as an earthed electrostatic screen.

GENERAL

In order to maintain the high value of grid-filament insulation in a humid atmosphere, the glass envelope is coated with a water repellent substance which should not be allowed to become contaminated, particularly by handling with bare fingers. Should contamination occur the valve may be washed by immersion in clean carbon tetrachloride or methylated spirit and dried in a current of warm air. The coating is tough and will withstand careful rubbing with a soft cloth.

The valve is supplied in a paper envelope. When required for use, a quarter of an inch of paper should be carefully torn from each end of the envelope, exposing the tinned leads. With the valve still in the envelope, these leads should be soldered to the appropriate points in the circuit, using only a resin-cored solder. No other form of flux must be employed. When the leads have been soldered in position, the remaining portion of the envelope should be carefully cut away, taking care not to touch the glass bulb.

TYPE ET3



CHARACTERISTIC CURVES OF AVERAGE VALVE.

ELECTRONIC AND ALLIED DEVICES

(EXCLUDING VALVES)

There are a number of electronic and allied devices used in Scientific and Industrial applications, and the following are listed.

Barretters (Current Stabilisers).

A barretter consists of an iron wire filament suspended in an atmosphere of hydrogen, and is designed to maintain a substantially constant current for varying values of applied voltage.

The types listed are as follows :

161	for control of current	0.16 amp.
202	" "	0.2 amp.
301	" "	0.3 amp.
302	" "	0.3 amp.
303	" "	0.3 amp.
304	" "	0.3 amp.

Voltage Stabilisers.

The types listed include single- and multi-gap neon tubes for stabilisation of voltage at various values of voltage and current.

QS 70/20	miniature for 70 volts 20 mA.
QS 70/60	octal base type for 70 volts 60 mA.
QS 95/10	miniature for 95 volts 10 mA.
QS 150/15	miniature for 150 volts 15 mA.
QS 105/45	8-pin all-glass base type for 105 volts 45 mA.
QS 150/45	8-pin all-glass base type for 150 volts 45 mA.
S 130	4-pin base type for 120 volts 75 mA.
ST 11	4-pin base type for 100 volts 8 mA.
QS 83/3	miniature high stability type.
STV 280/40	4-gap 5-pin base type.
STV 280/80	4-gap 5-pin base type.

Neon Indicator Tubes.

Type F. Miniature neon indicating tube for A.C. operation.

Type G. Miniature neon indicating tube for A.C. operation.

Button Tuneon, Tuning indicator for D.C./A.C. operation.

Photoelectric Cells.

Various types of photoelectric cells are available for the detection and measurement of light, and these have numerous scientific and industrial applications. The following types are listed :

CMG 8	} Caesium-silver oxide gasfilled photo cells.
CMG22	
CMG25	
CMV28	Double system caesium-silver oxide vacuum photo cell.
CMG28	Double system caesium-silver oxide gasfilled photo cell.
CWS24	Secondary emission photo cell.
CMV6	Caesium-silver oxide vacuum photo cell.
UNG7	Sodium gasfilled photo cell.
UDG7	Cadmium gasfilled photo cell.
KG7	Potassium gasfilled photo cell.
KMV6	Potassium/silver oxide vacuum photo cell.
No. 1.	} Rectifier type photo cells.
No. 2.	
Type MD	photo cell relay amplifier.
Photo electric	daylight control unit.
Photometer	Unit.

Geiger-Müller tubes.

A range of Geiger tubes is listed for the detection of alpha, beta and gamma rays.

Three types of Geiger tubes are listed, differing mainly in the thickness of the end window and therefore applicable to detect different types of radiation.

GM2 for measurement of γ rays and fast β rays.

GM4 for measurement of medium speed β rays.

EHM2 for detection of slow β particles.

Lightning Arresters.

For line protection against sudden surges of high voltage. Two types are listed :

CCA For protection of power circuits.

CCB For protection of communication circuits.

161 202
301/2/3/4



BARRETTERS

161, 202, 301, 302, 303 and 304 BARRETTERS

DESCRIPTION

Barretters are designed to maintain the current passing through them at a level which is substantially constant within certain limits, although fluctuating values of voltage are applied across the barretter in series with the load.

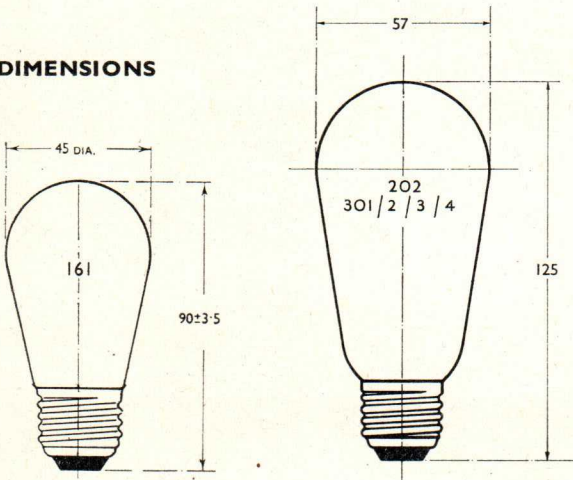
They may thus be employed with advantage to obviate the necessity for an external tapped resistor in receivers operating from A.C. or D.C. mains in which the valve heaters are wired in series, and the full heater current is drawn from the mains without (in the case of A.C. mains) the intervention of a filament transformer.

They are available in four types for use with 0.3 amp. valves, and a further two types for use with 0.2 amp. and 0.16 amp. valves respectively.

RATINGS

									Mean Current	Voltage Range
Type 161	...	...	...	...	...	...	...	...	0.16 amp.	100—180
Type 202	...	...	...	...	...	...	...	...	0.2 amp.	120—200
Type 301	...	...	...	...	...	...	...	...	0.3 amp.	138—221
Type 302	...	...	...	...	...	...	...	...	0.3 amp.	112—195
Type 303	...	...	...	...	...	...	...	...	0.3 amp.	86—129
Type 304	...	...	...	...	...	...	...	...	0.3 amp.	95—165

DIMENSIONS



CAP

Standard Edison Screw.

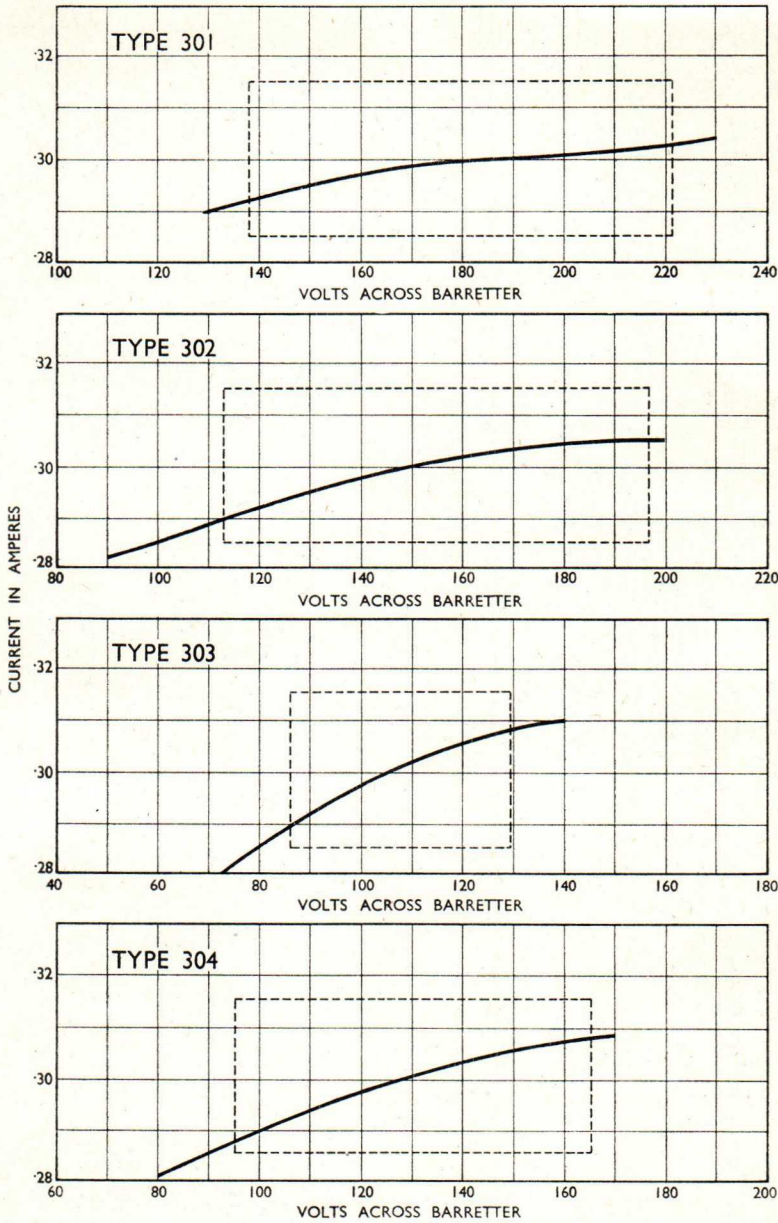
All dimensions are in mm. and are the maximum unless otherwise stated.

OPERATING CONDITIONS

In operation, ample air circulation should be allowed round the barretter. Care should be taken in handling as the bulb becomes hot when the barretter is in circuit and remains so for some time after the current is switched off.

Approximately five minutes should be allowed for the barretter to settle to its steady current state.

301, 302, 303 and 304 BARRETTERS



CHARACTERISTIC CURVES OF AVERAGE BARRETTERS.

VOLTAGE STABILISER TUBES

SINGLE GAP TYPES

Type	Striking Voltage	Operating Voltage	Current max. mA	Current min. mA	Regulation over range v.	Base (See below)	Pin Connections			Dimensions Overall mm.
							Anode	Cathode	Ignition Electrode	
QS70/20 STV70/60	95 105	70 70	20 60	2 5	6 6	B7G Octal	4, 7 5	1, 3 2	— —	47 × 18.2 107 × 39.5
QS95/10	110	95*	10	2	5	B7G	(3, 7 shorted)	1, 3	4	47 × 18.2
QS150/15	177	150†	15	2	5	B7G	5, 7	1, 3	4	47 × 18.2
QS105/45	130‡	105	45	5	5	B8G	5, 7	1, 3	3	75 × 33
QS150/45	170§	150	45	5	5	B8G	1, 2	4, 8	3	75 × 33
SI30	160	120	75	6	5	B8G	1, 2	4, 8	3	123 × 52
ST11	140	100	8	1	5	4-pin	1	2	—	85 × 31
QS83/3	130	83	5	1	see note A	B7G	1, 5	2, 4, 7	—	54 × 19

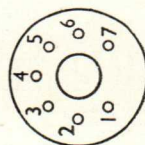
* Ignition electrode voltage 150.

† Ignition electrode voltage 210.

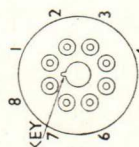
‡ With ignition electrode connected to 150 v. supply through 40,000 Ω

§ With ignition electrode connected to 200 v. supply through 80,000 Ω

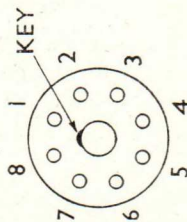
A. High stability type, max. variation of voltage at constant current (3mA) 0.1%. Impedance 150 ohms, corresponding to a regulation of 0.3 v. over the current range 2-4 mA.



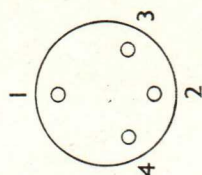
B7G



B8G



Octal

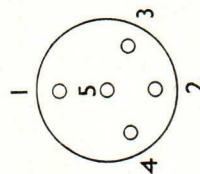


4-pin

VOLTAGE STABILISER TUBES

MULTI-GAP TYPES "STABLOVOLTS"

Type	Minimum applied voltage to tube and resistance approx.				Operating Voltage				Permissible tube currents at various electrodes (mA)				Tube Current min. mA	Base (See below)	Dimensions mm.
	A4—C	A3—C	A2—C	A1—C	A4—C	A3—C	A2—C	A1—C	A4	A3	A2	A1			
STV280/40	420	320	210	110	280	210	140	70	35	40	60	60	5	5-pin	142 × 41
STV280/80	420	320	210	110	280	210	140	70	70	70	90	100	10	5-pin	142 × 62



Pin 1 : Anode 4
 2 : Cathode
 3 : Anode 2
 4 : Anode 3
 5 : Anode 1

Gaps not required should be short circuited.

It is recommended that where possible, the supply voltage should be not less than $1\frac{1}{2}$ times the voltage developed across the gaps employed, and must be applied to the Stabilovolt through a series resistance.

It is essential that resistances be connected from one supply line to the individual electrodes. These should be approximately 1 megohm in value.

It is necessary to warm the tubes for a period of not less than 15 minutes at an average current (say 30 mA.)

BUTTON TUNEON F & G

S.E.C.

NEON INDICATORS

BUTTON TUNEON, F and G NEON INDICATORS

DESCRIPTION

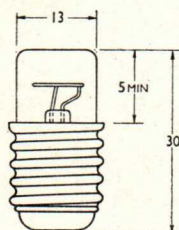
The Button Tuneon, F and G neon discharge tubes are designed for applications where a low consumption visual indicator is required.

When operating from mains supplies, it is essential to use an external series dropping resistor of 0.25—0.5 megohms, in order to limit the current passed by the indicator.

RATINGS	Button Tuneon and Type F		Type G	
Operating Voltage	200—260	200—260		volts
Striking Voltage	180	180		volts
Approx. Operating Current	0.5	0.15		mA
Maximum Operating Current	0.6	0.20		max. mA
Series Resistance	0.25—0.5	0.25—0.5		megohm

Types F & G should be used for AC operation only, and the Button Tuneon for DC/AC operation.

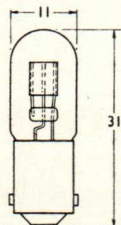
DIMENSIONS



BASE

Button Tuneon and Type F

Small Edison Screw Cap.



Type G

Miniature bayonet centre contact cap.

(Type G may also be supplied with miniature Edison screw cap to special order).

*All dimensions are in mm.
and are the maximum ex-
cept where otherwise stated.*

PRECAUTIONS IN USE

Under normal operating conditions these indicators must always be operated in conjunction with the specified series resistor.

CMG8, CMG22 and CMG25 PHOTO CELLS

DESCRIPTION

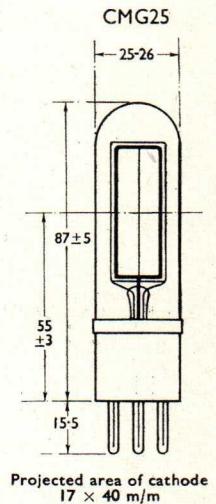
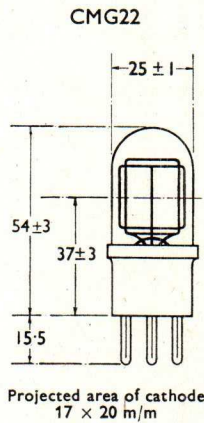
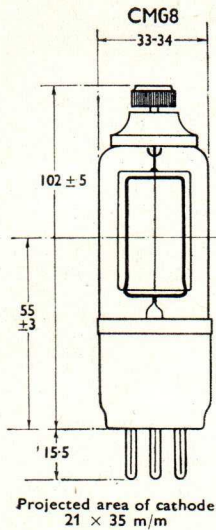
The caesium-silver oxide or CM type of gasfilled photo cell is designed for acoustic reproduction, relay work and innumerable industrial applications. It is made in three standard patterns differing only in size and arrangement of electrodes.

At a low voltage, of the order of 20, the photo-electric current is due to the primary cathode emission and is practically proportional to the illumination. At high voltages the ratio of current-to-light increases with the voltage due to gas ionisation, the increase over the primary current being termed the gas magnification. A gas magnification of 10 is about the safe limit. A higher value may produce a glow discharge in the cell which persists after the light has been removed and which will, if continued, damage the cell. A high resistance should always be in circuit to protect the cell against a glow discharge which may result from a sudden increase in voltage or illumination.

The sensitivity in microamps per lumen as specified previously is measured under an illumination of approximately 40 millilumens from a gasfilled lamp and with the voltage marked on the bulb applied between the electrodes. Under these conditions, the applied potential is called the working voltage. It is marked on each cell and represents the maximum voltage which should normally be applied to the cell to secure adequate emission without seriously impairing the frequency response for acoustic reproduction or incurring danger from a glow discharge.

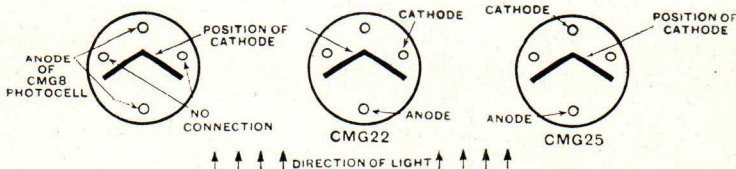
[continued on page 184]

DIMENSIONS



*All dimensions are in mm. and
are the maximum except where
otherwise stated.*

BASES



View looking on underside of bases.

TYPES CMG8, CMG22 and CMG25

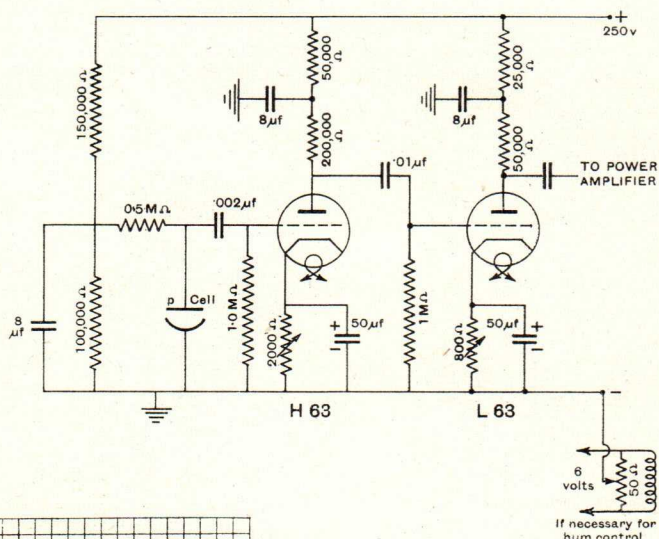
Although the photo-electric current depends on the total light reaching the cathode and not on its distribution, the light should preferably be spread over the cathode surface to avoid local inequalities of sensitivity.

The peak spectral sensitivity is at the red end of the spectrum and the response extends into the near infra red. By using a filter over the light source to cut out visible rays, relay circuits can be operated with invisible radiation.

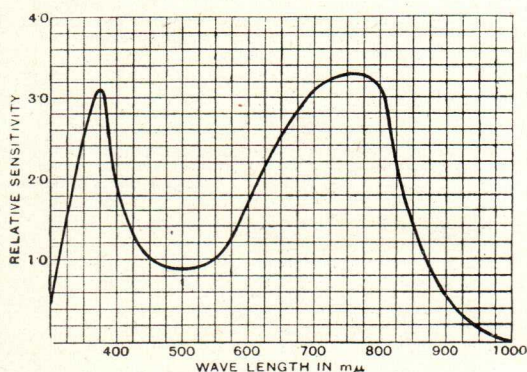
Grade "A" cells, which differ from the standard types only in sensitivity, are usually adequate for simple relay circuits.

For making measurements of light, specially designed vacuum cells should be used.

Sensitivity exceeds	...	...	...	...	...	...	...	...	75 μ A/lumen
Grade "A" cells	...	...	...	...	...	...	...	...	50-75 μ A/lumen
Working voltage	...	...	...	...	...	...	...	...	80-110



Circuit for photo cell used on a sound head amplifier.



Spectral sensitivity curve.

**PHOTO CELLS****CMV28 and CMG28 PHOTO CELLS****DESCRIPTION**

These photo cells, which are similar in spectral response to those of the existing CM range, have duplicated electrode systems, the two cathodes and two anodes being connected to separate pins of a standard British four pin valve vase.

They can be supplied as vacuum (CMV28) or gasfilled (CMG28) cells.

These cells are designed for all industrial applications where two cathodes in close proximity are required and where the use of two separate cells introduces difficulty of accommodation due to the size of the separate bulbs and makes the optical system asymmetrical. Such cases occur in push-pull sound recording, galvanometer amplifier circuits, balanced bridge circuits, servo mechanism controls, etc.

Attention is called to the existence of the Osram B65 double triode valve which is very suitable for use with these photocells where separate amplification channels are required.

In the vacuum cell (CMV28) each cathode has a minimum sensitivity of $7.5 \mu\text{A/L}$ to light from a gasfilled tungsten filament lamp operating at a colour temperature of 2850°K and approximate saturation of current occurs at about 50 volts.

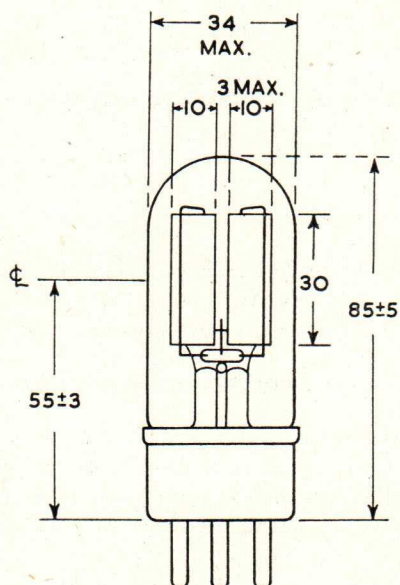
In the gasfilled cell (CMG28) increased sensitivity for the purpose of detection of light changes can be secured by increasing the applied voltage so that advantage can be taken of the amplification of the primary emission due to gas ionisation.

In the gasfilled cell (CMG28) which has substantially the same electrical characteristics as the existing gasfilled cells of the CM range, the applied voltage should not exceed 90, under which conditions the minimum sensitivity is $75 \mu\text{A/L}$.

The vacuum cell is recommended where stability in measuring circuits is called for while the gasfilled cell is most useful as a detector of light changes or for establishing conditions of balance in a circuit.

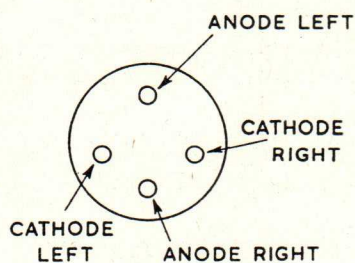
TYPES CMV28 and CMG28

DIMENSIONS



BASE

VIEW OF UNDERSIDE OF BASE



Osram

PHOTOCELLS

CWS24 PHOTOCELL, SECONDARY EMISSION TYPE

DESCRIPTION

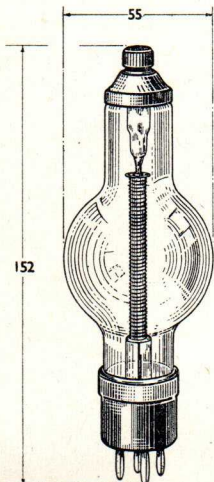
The demand for photocells of high sensitivity with stable characteristics has led to the development of the Osram CWS24 Secondary Emission type cell.

Secondary emission cells have sensitivities comparable with or even greater than the gasfilled type of cell hitherto available, and they have none of the disadvantages that are associated with the use of gas magnification. In fact they combine the good points of both the vacuum and gasfilled cells with the disadvantages of neither.

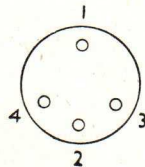
In addition to high sensitivity the absence of gasfilling ensures low noise level and a good frequency characteristic to interrupted light. Consequently secondary emission cells can be used in applications demanding a frequency response up to several megacycles per second. They can also be used for acoustic reproduction from film as well as for innumerable industrial applications.

The glass envelope housing the electrode assembly is evacuated and the primary emission from the cathode impinges on another and secondary cathode which is termed a target from which secondary electrons are ejected by the impacts of the primary electrons. Each primary electron sets free several secondaries so that a magnification of the primary current is secured. The secondary emission finally reaches a collector which is adjacent to the target and which performs the same function as the anode in the ordinary photocell.

DIMENSIONS



BASE



View looking on underside
of base.

4-PIN

- Pin 1: Target
- 2: Cathode
- 3: Not connected
- 4: Not connected

Top screw cap: Collector

*Dimensions are in mm. and are the maximum except
where otherwise stated.*

CWS24 PHOTOCELL

OPERATING CONDITIONS (see Fig. 1)

The collector is maintained at a positive potential with respect to the primary cathode. The secondary cathode or target is also at a positive potential with respect to the primary cathode but at a negative potential with respect to the collector.

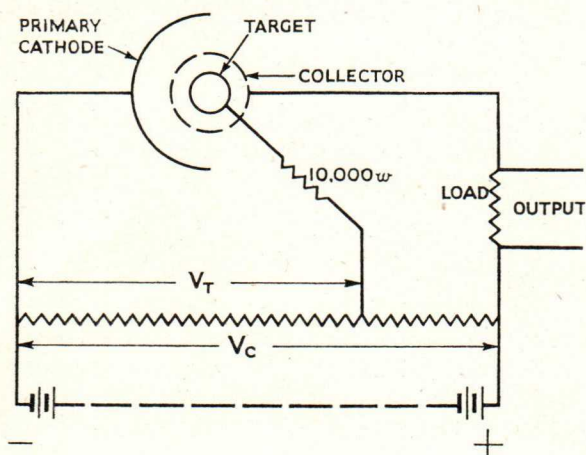


Fig. 1

It is recommended that the potential difference between the primary cathode and target be 75 per cent. of that between primary cathode and collector. The total voltage between primary cathode and collector (anode) may be anything up to 800 volts, but under most conditions a total voltage of half this value will be found to give sufficient output.

A safety resistance of 10,000 ohms should be inserted between the source of potential and the target, the load resistance whose value will be determined by the purpose for which the cell is used, should be connected between the source of potential and the collector.

CONSTRUCTION OF THE CELL

The primary cathode is formed on the silver surface which is deposited on one half of the internal surface of the spherical bulb.

The target is formed on a silver tube which is supported in the middle of the bulb and the collector or anode is also supported at the centre of the bulb and consists of a molybdenum spiral coaxial with and surrounding the target.

Both primary cathode and target are of the caesium-oxygen-silver type ($\text{Ag}-\text{Cs}_2\text{O}$, $\text{Ag}-\text{Cs}$). The collector and target have separate seals through the bulb in order to reduce the capacitance of the collector to a minimum.

ELECTRODE CONNECTIONS

The primary cathode is connected to the grid pin of the valve base, the target to the anode pin and the collector to a screw cap at the top of the bulb (see base connections).

Fig. 2 shows the variation in sensitivity with overall voltage when the potential of the target is 75 per cent. of the collector voltage.

CWS24 PHOTOCELL

PERFORMANCE

The sensitivities are given in $\mu\text{A}/\text{lumen}$, the source of illumination being a gasfilled tungsten lamp running at $2,848^\circ\text{K}$, and the degree of constancy of the cell is that which is usually associated with the vacuum type. Tests carried out with frequencies up to 1 Mc/s have shown that the response is consistent with that which would be expected from a vacuum type cell.

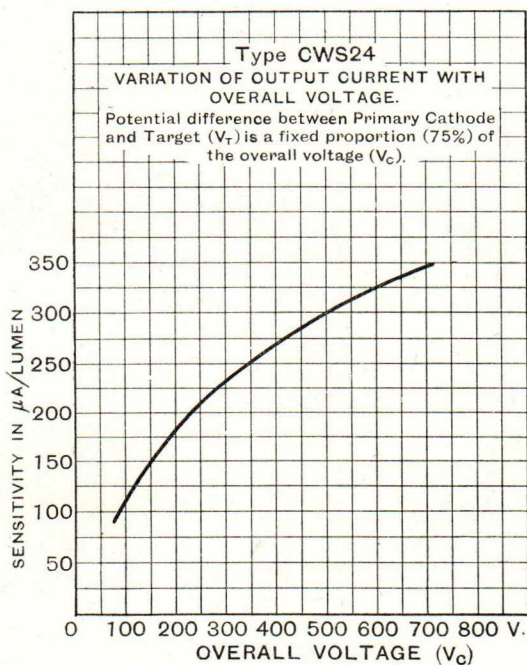


Fig. 2

Average sensitivity curve of an Osram CWS24 Secondary emission cell.

The background noise is extremely low compared with that present in a gas-filled cell under fairly high gas magnification. Here again it is what would normally be associated with a good vacuum cell.

Minimum sensitivity when tested at an overall voltage of 300.

CMV6 PHOTOCELL

DESCRIPTION

This vacuum photocell has a caesium-silver oxide cathode and is designed principally for measurement in the visible and near infra red spectra.

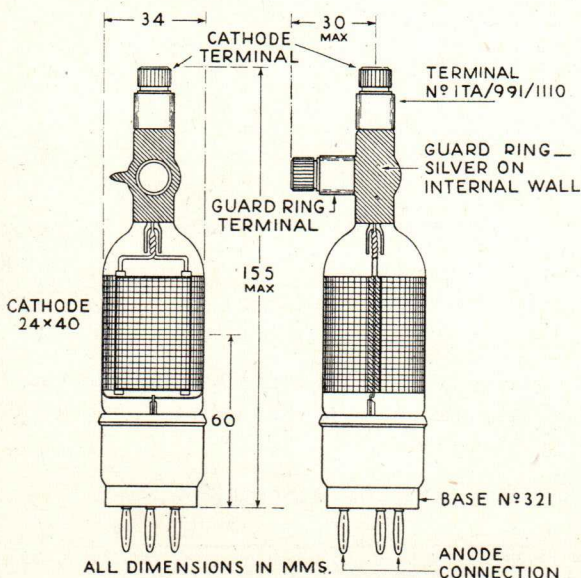
The cathode is in the form of a rectangular plate, centrally placed within the bulb and connection is made to it by a screw cap at the top of the bulb. The anode, which is in the form of a wire mesh surrounding the cathode and in contact with the internal surface of the bulb, is brought out to what are normally the anode and grid pins of a standard valve base, with which the cell is fitted.

A side terminal makes connection to an internal guard ring which consists of a metallic ring deposited on the internal surface of the elongated neck of the bulb, and serves to shunt internal leakage current between the electrodes. An external guard ring can be formed by wrapping a few turns of bare copper wire round the neck of the bulb and connecting the end to the same side terminal.

Where only detection of light is involved it is preferable to use the corresponding gasfilled cell type CMG 8.

The emission of the CMV 6 cell is not less than $7.5 \mu\text{A/lumen}$, and the average value is about $15 \mu\text{A/lumen}$ when the source of illumination is a tungsten gasfilled lamp at a colour temp. of 2848°K .

DIMENSIONS

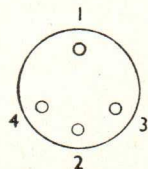


BASE

4-PIN

- Pin 1: Anode
- 2: Anode
- 3: Not connected
- 4: Not connected

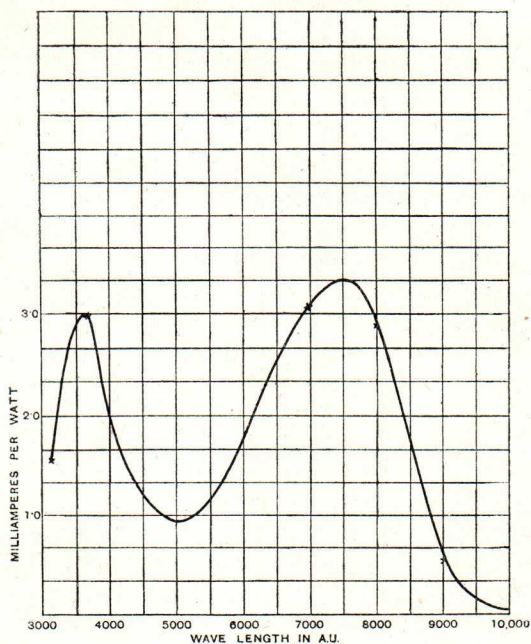
Top screw cap: Cathode
Side screw cap: Internal guard ring



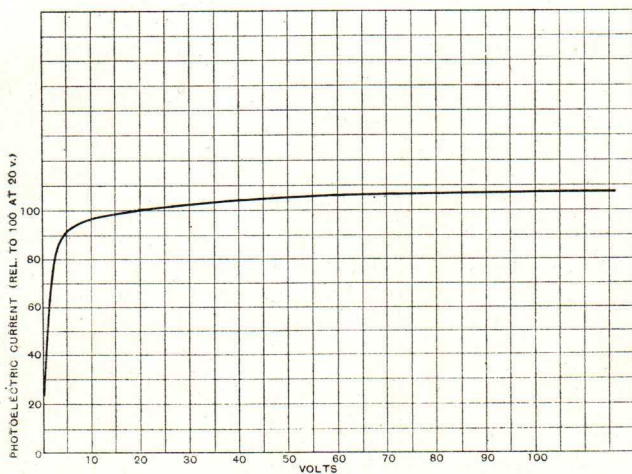
View looking on underside of base.

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE CMV6



AVERAGE SPECTRAL SENSITIVITY CURVE.
(Equal distribution of energy in the source of radiation.)



AVERAGE VOLTAGE-CURRENT CHARACTERISTIC
OF CMV6 TYPE PHOTOCELL.

UNG7



PHOTO CELLS

UNG7 PHOTO CELL

Sodium Gasfilled

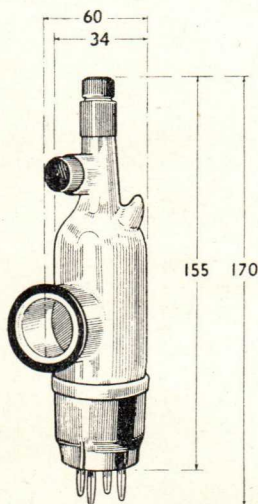
For detection and measurement of ultra violet rays in the spectral range 3,000—4,400 A.U.

DESCRIPTION

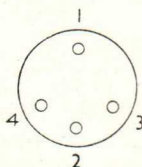
This photo cell has a sodium cathode of the mass layer type and is suitable for use in the range 3,000—4,400 A.U. The bulb is fitted with a standard valve base to the anode and grid pins of which the light sensitive surface is connected. The anode of the photocell is taken to a screw cap at the top of the bulb. A side terminal makes connection to a guard ring deposited on the internal surface of the neck of the bulb, and serves to shunt internal surface leakage between the electrodes. An external guard ring can be made by wrapping a few turns of bare copper wire round the neck of the bulb and connecting the end of the side terminal.

Radiation reaches the cathode through a quartz window which is attached to the glass bulb by a special gastight joint. A small circular glass disc will be found loose inside the bulb. This is inserted during manufacture to keep the alkali from depositing on the quartz window. It should be shaken down into the well of the bulb when the cell is in use.

DIMENSIONS



BASE



View looking on underside of base.

4-PIN

- Pin 1: Cathode
- 2: Cathode
- 3: Not connected
- 4: Not connected

Top screw cap: Anode
Side screw cap: Internal guard ring

All dimensions are in mm. and are the maximum except where otherwise stated.

PHOTO CELL TYPE UNG7

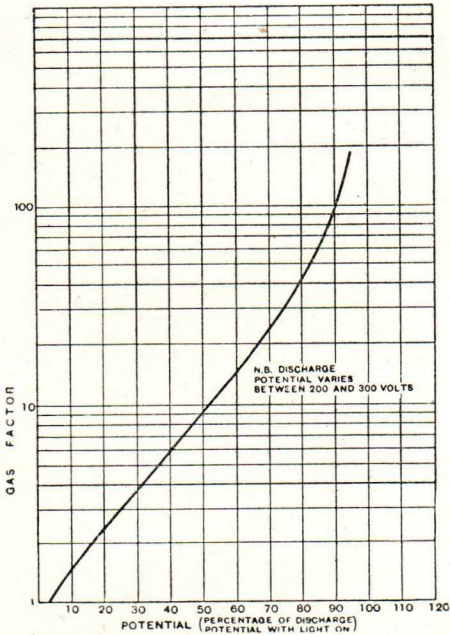


Fig. 1

AVERAGE SPECTRAL SENSITIVITY CURVE

As in the case of all gasfilled cells, a resistance of at least 100,000 ohms should be included in the circuit in which this cell is used.

If voltages in the upper portion of the curve of Fig. 1 are used to secure higher sensitivity, care must be taken to see that a glow discharge is not allowed to pass in the cell.

If allowed to continue for more than a few seconds the glow discharge will ruin the cathode.

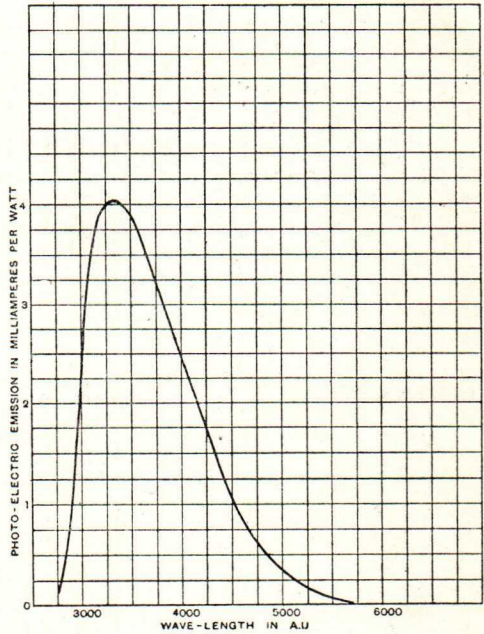


Fig. 2

CHARACTERISTIC CURVE OF UNG7 TYPE PHOTO CELL

UDG7

Osram

PHOTO CELLS

UDG7 PHOTO CELL

Cadmium Gasfilled

For detection and measurement of ultra violet radiation in the spectral range 2,500—3,000 A.U. which includes the Erythema region.

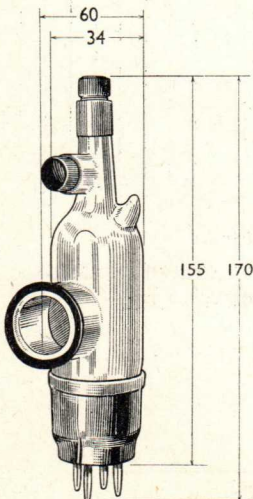
DESCRIPTION

This photocell has a cadmium cathode of the thick film type and is suitable for use in the range 2,500—3,000 A.U. (approx.). The bulb is fitted with a standard valve base to the anode and grid pins of which the light sensitive surface is connected. The anode of the photocell is taken to the screw cap at the top of the bulb. A side terminal makes connection to a guard ring deposited on the internal surface of the neck of the bulb and serves to shunt internal surface leakage between the electrodes. An external guard ring can be made by wrapping a few turns of bare copper wire round the neck of the bulb and connecting to the side terminal.

Radiation reaches the cathode through a quartz window which is attached to the glass bulb by a special gastight joint. A small circular glass disc will be found loose inside the bulb. This is inserted during manufacture to keep the cadmium from depositing on the quartz window. It should be shaken down into the well of the bulb when the cell is in use.

As in the case of all gasfilled cells, a resistance of at least 100,000 ohms should be included in the circuit in which this cell is used.

DIMENSIONS



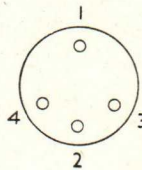
BASE

4-PIN

- Pin 1: Cathode
- 2: Cathode
- 3: Not connected
- 4: Not connected

Top screw cap: Anode

Side screw cap: Internal guard ring



View looking on underside of base.

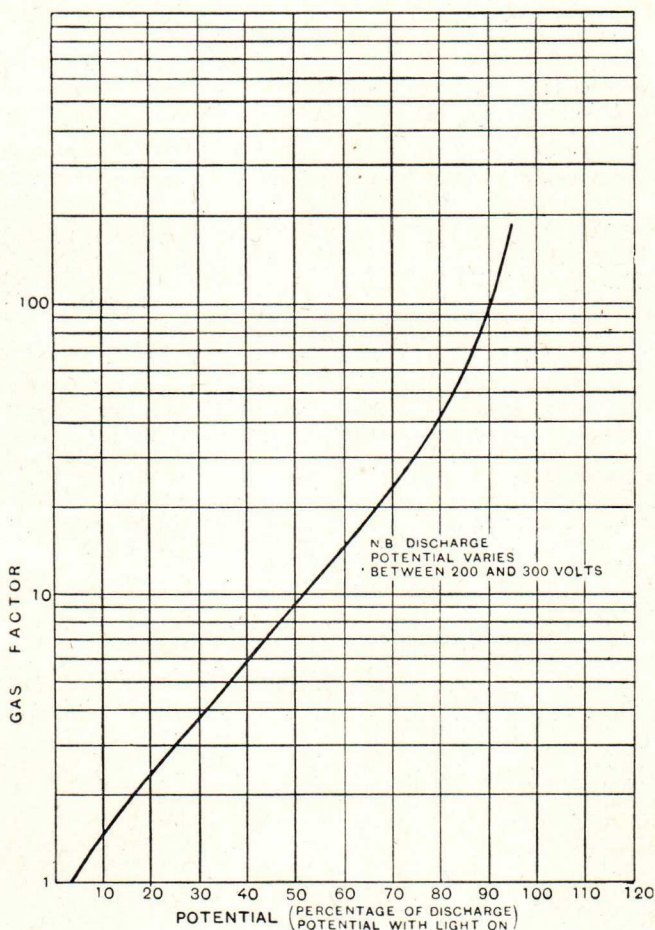
All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE UDG7

If voltages in the upper portion of the curve of Fig. 3 are used to secure higher sensitivity, care must be taken to see that a glow discharge is not allowed to pass in the cell.

If allowed to continue for more than a few seconds the glow discharge will ruin the cathode.

If a linear relation between incident radiation and current is desired, the applied potential should not exceed 20 volts. Under these conditions the cell has practically the characteristics of a vacuum type with correspondingly lower sensitivity.



AVERAGE VOLTAGE-CURRENT CHARACTERISTIC
OF UDG7 TYPE PHOTOCCELL

KG7

Osram

PHOTOCELLS

KG7 PHOTOCELL

Potassium Gasfilled

For detection and measurement of radiation from the blue end of the visible spectrum, particularly in the range 4,000-5,000 A.U.

DESCRIPTION

This photocell has a hydrogen-sensitised potassium cathode of the thick film type and is suitable for use in the blue end of the visible spectrum, particularly in the range 4,000-5,000 A.U.

The anode of the cell is in the form of a rectangular loop of nickel wire and is placed in the bulb symmetrically with respect to the cathode, which is deposited on the internal surface of the glass bulb. The cathode covers the whole of the internal cylindrical surface of the bulb except for a clear window which is the same shape as the anode, and through which the radiation is admitted to the cathode.

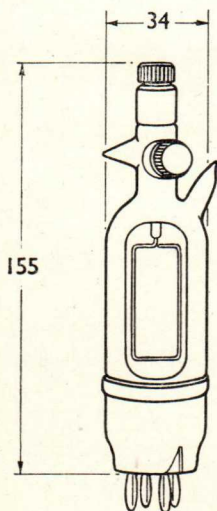
When used for the purpose of measurement the voltage applied to the cell through a suitable protective resistance should lie between 15 and 20 volts. Under such conditions the characteristics are practically those of a vacuum cell.

The cell should not be exposed to heat as a moderate rise of temperature may distil off the cathode deposit and ruin the cell.

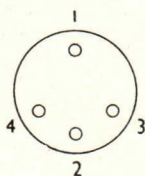
The primary emission of the KG7 cell normally lies in the range 0.1 to 0.8 $\mu\text{A}/\text{lumen}$ when the source of illumination is a tungsten gasfilled lamp at a colour temperature of 2848°K. For maximum sensitivity the cell may be safely used at a voltage such that the sensitivity is from 40 to 50 times the primary emission at 17 volts. The voltage at which this occurs is usually about 250 volts.

As in the case of all gasfilled cells, a resistance of at least 100,000 ohms. should be included in the circuit in which this cell is used. If high voltage is employed to secure increased sensitivity, care must be taken to avoid passing a glow discharge in the cell which, if allowed to pass for more than a few seconds, will ruin the cathode.

DIMENSIONS



BASE



View from underside of base.

4 PIN

- Pin 1: Cathode
- 2: Cathode
- 3: N.C.
- 4: N.C.

Top Screw Cap: Anode

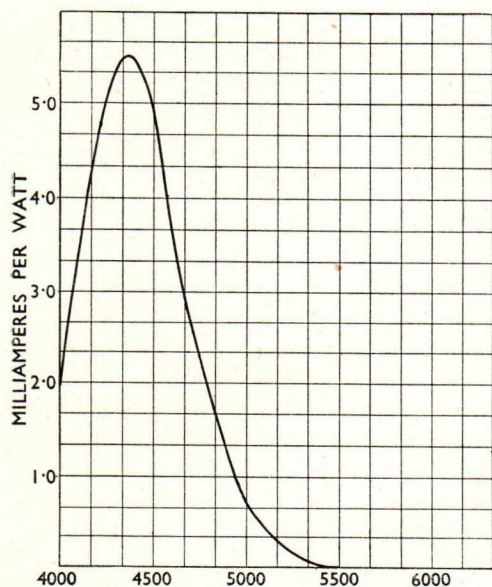
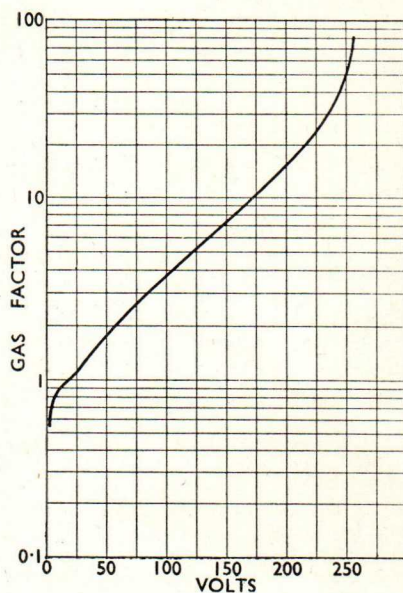
Side Screw Cap: Internal Guard Ring

Light centre to base (excluding pins) 57 ± 3 mm.

All dimensions are in mm. and are the maximum except where otherwise stated.

TYPE KG7

AVERAGE VOLTAGE-CURRENT
CHARACTERISTIC OF KG. 7
TYPE PHOTOCELL.



AVERAGE SPECTRAL SENSITIVITY
CURVE.

(Equal distribution of energy in the
source of radiation.)

KMV6

Osram
PHOTOCELLS

KMV6 PHOTOCELL

DESCRIPTION

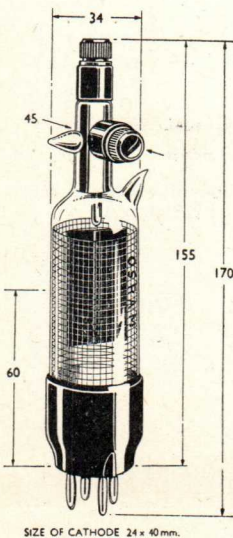
Type KMV6 Photocell (potassium on silver oxide) is suitable for applications which involve the measurement of illumination and applications demanding some sensitivity over the whole visible spectrum, and for cases where objection is raised to the more peaked spectral response of such types as the CMV6 and KG7.

The cathode is in the form of a rectangular plate, centrally placed in the bulb and brought out to a screw cap at the top.

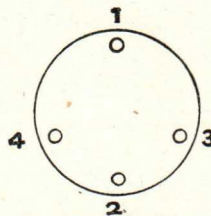
The anode, which is in the form of a wire mesh covering the internal surface of the bulb, is brought out to the anode and grid pins of a standard valve base.

A side terminal makes connection to an internal guard ring which is deposited on the neck of the bulb and serves to shunt internal leakage current between the electrodes. An external guard ring can be formed by wrapping a few turns of bare copper wire round the neck of the bulb and connection to the side terminal. The sensitivity of the cell is about $2 \mu\text{A}/\text{lumen}$ to a source at 2360°K .

DIMENSIONS



BASE



View looking on
underside of base.

4 PIN

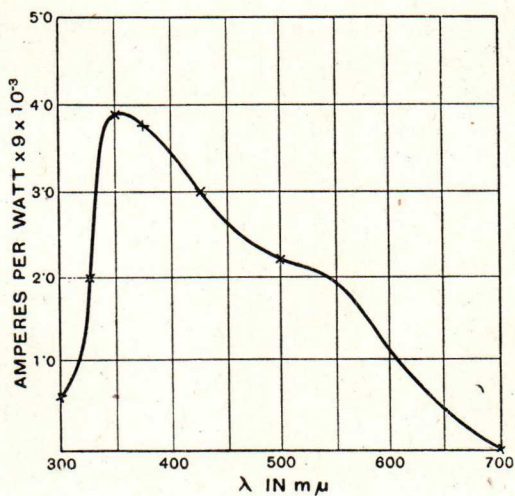
- Pin 1: Anode
- 2: Anode
- 3: Not connected
- 4: Not connected

Top screw cap: Cathode

Side screw cap: Internal guard ring

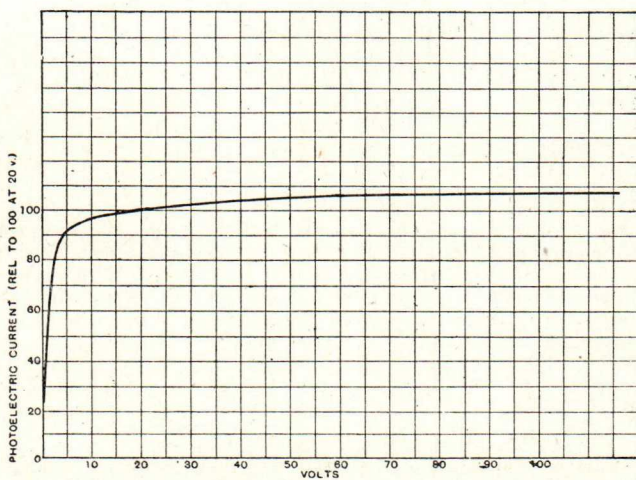
*All dimensions are in mm. and are the maximum except
where otherwise stated.*

TYPE KMV6



AVERAGE SPECTRAL SENSITIVITY CURVE.

(Equal distribution of energy at source.)



KMV6 AVERAGE VOLTAGE-CURRENT CURVE.



RECTIFIER TYPE PHOTOCELLS

Photocells of the rectifier type have characteristics markedly distinct from emission type cells. They require no electrical supply and are used directly connected to a suitable measuring instrument. They are thus extremely useful where it is desired to measure illumination on a galvanometer or dial reading microammeter.

In view of the fact that a higher current can be secured than from an emission cell, rectifier cells are extensively used in industry in exposure meters, foot candle meters, etc.

Rectifier cells can be used to operate a relay directly but as the power available is obviously very small and is all derived from the incident light, a relay with a delicate suspension is necessary and it is much more satisfactory in such cases to use an emission cell with a simple single valve amplifier (see page 203).

Rectifier cells are current rather than voltage generators and their relatively low internal resistance makes them less suitable than the emission type of cell for use with valve amplifiers or any applications involving light fluctuating at audible frequencies, e.g. : sound reproduction.

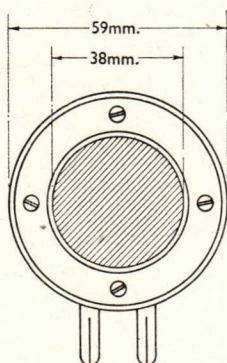


Fig. 1

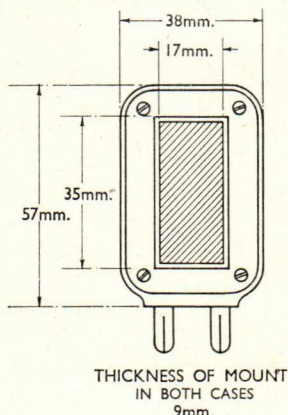


Fig. 2

G.E.C. rectifier cells are supplied in two forms : No. 1, circular (fig. 1) and No. 2, rectangular (fig. 2). In both cases, the sensitised surface is fitted in a mount provided with prong terminals which fit a standard 3-amp socket.

The user is warned against removing the cell from its mount or making connections to it other than those provided in the sealed enclosure.

No responsibility for unsatisfactory performance can be accepted when cells are removed from their mounts. Under no circumstances may any battery or other electric supply be connected in circuit with the photocell.

CURRENT OUTPUT

The current in the external circuit will depend on :-

- (1) the efficiency of the photocell.
- (2) the area of the cell illuminated.
- (3) the intensity of the light and its spectral distribution.
- (4) the external resistance.

Other things being equal, the current is greater the greater the area of the cell illuminated. When the external resistance is low, i.e. of the order of 100 ohms or less the current is closely proportional to the intensity of the incident light. Departure from linear response occurs however as the external resistance is increased, as shown by the curves of fig. 4, which give the average output for the No. 1 type circular cell at illuminations from 0 to 50 ft. candles with load resistances from 100 to 1,500 ohms. Corresponding curves relating to the No. 2 rectangular type of cell are shown in Fig. 5.

The average sensitivity with 100 ohms external resistance, to light from a tungsten filament source at 2850°K is :

No. 1. Circular	...	490 μ A/lumen.
No. 2. Rectangular	...	450 μ A/lumen.

The average current output under the same conditions under an illumination of 50 ft. candles is 300 microamps for the No. 1. type and 145 microamps for the No. 2.

SENSITIVITY MAINTENANCE

These cells are extremely stable when exposed continuously to light and tests have shown that after 300 hours exposure to an illumination of 50 ft. candles, with an external resistance of 100 ohms, the output does not fall by more than 2 or 3 per cent.

TEMPERATURE COEFFICIENT

The sensitivity to light is practically independent of temperature over the normal range of ambient temperature, the temperature coefficient being less than 0.05 per cent per degree centigrade and therefore negligible in most applications.

SPECTRAL SENSITIVITY

The spectral response of these cells is indicated in fig. 3, together with that of the C.I.E.* average eye for comparison purposes. It will be seen that the peak of the cell response is not very far from that of the average eye. The illumination from tungsten filament lamps at all operating colour temperatures can therefore be measured to commercial accuracy without making corrections for the effect of the colour temperature of the light.

If, however, having calibrated against tungsten filament standard lamps, it is required to measure illumination from other types of light source, it may be necessary to apply a correction to the indicated figure. Multiplying factors are indicated in the following table for the more common illuminants :—

Type of lamp	Distinctive Colour	Scale reading multiplying factor
High pressure mercury vapour	Greenish blue	1.10
Neon	Reddish orange	0.75
Sodium	Yellow	1.30
Tubular fluorescent	Daylight	1.00
Tubular fluorescent	Warm white	1.00

* Commission Internationale d'Eclairage.

No one multiplying factor for use when measuring daylight would be strictly accurate, because of the very large variations in the colour temperature and spectral composition of daylight, but for most commercial measurements it is probably sufficient to regard the factor as unity.

For the most accurate work it is desirable to use a colour filter over the photocell, so chosen that the combined spectral response of the two is closely that of the average eye as defined by the C.I.E.

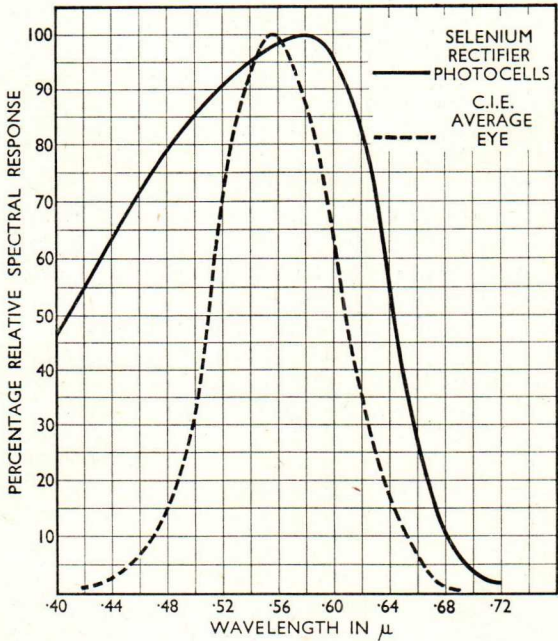


Fig. 3

Although as previously stated, the temperature coefficient is small, the possibility of disturbance due to heat radiation from the source of illumination or to other changes in temperature to which the cell may be exposed, must not be overlooked. In cases where radiation is troublesome, a suitable filter of heat absorbing glass must be interposed in the light path.

Since the light output from a tungsten filament lamp varies with the third or fourth

power of the voltage, the indication of current when the cell is exposed to a lamp operated from supply mains with normal fluctuations may be entirely determined by the light changes in the source itself. Therefore, in making quantitative measurements, the necessity for a stabilised light source, operated from batteries preferably, will be obvious.

For direct measurement of illumination or for any commercial or industrial application which involves estimation of light changes due to transmission or absorption, the simple circuits possible with rectifier cells are a great convenience, and will give accurate indications provided the suitable conditions of use, as previously indicated, are fulfilled.

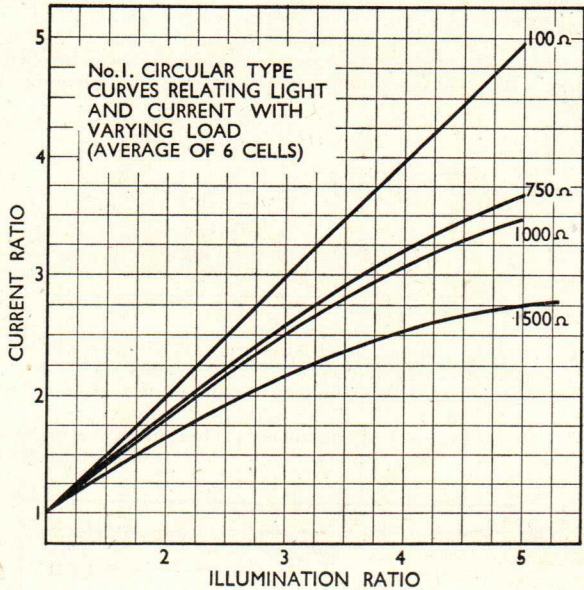


Fig. 4

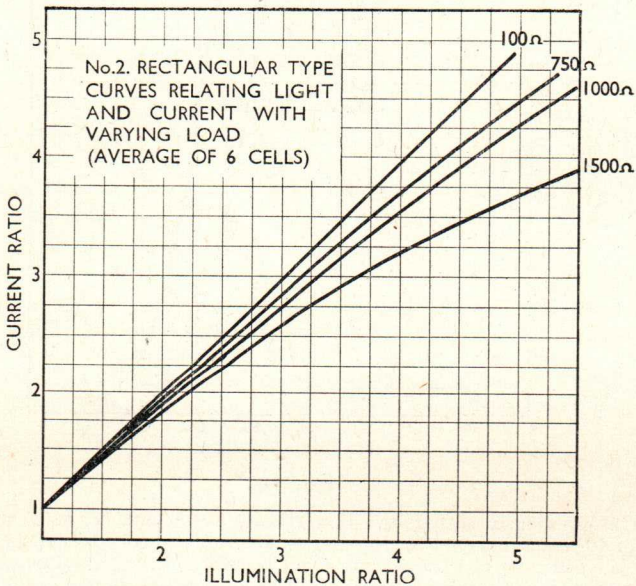
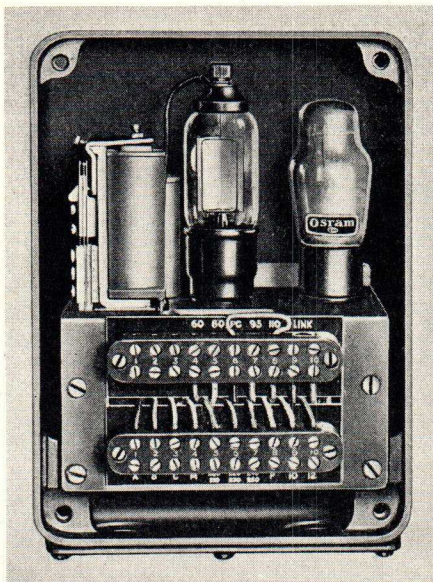


Fig. 5



PHOTOCELL RELAY AMPLIFIER TYPE MD



The type MD photocell relay amplifier incorporates a number of improvements over similar equipments hitherto available. It is designed to enable simple and efficient switching operations to be carried out in numerous industrial applications merely by the interruption or incidence of a beam of light.

The unit, which is designed for operation from an A.C. supply of 200-250 volts, comprises an Osram type CMG8A photocell, an L63 valve amplifier and a relay in a simple circuit and constitutes a light operated switch. It can thus be employed for such applications as counting, burglar alarms, switching on signs or lamps and can be incorporated into more elaborate switching controls where required. The contact springs of the relay are designed to carry a small load only, about 50 watts, which will be sufficient to actuate a small indicator ; or the exciting coil of a larger relay or contactor where large loads are required to be handled.

ACCESSORY EQUIPMENT

Lens attachment (Type LA)

The range of operation of the amplifier can be extended by the use of a lens attachment which can be fitted to the amplifier and which enables more light to be concentrated on the photocell. This attachment comprises a 4-inch diameter convex lens in a metal mount provided with three fixing holes to enable it to be bolted to the cover of the MD amplifier.

Daylight Attachment

When the MD amplifier is to be used in full daylight extraneous light will, unless excluded, interfere with its operation. For use under such conditions a daylight attachment is available which consists of a pair of telescopic tubes the end of one of which has a small hole in contact with the face of the photocell. This attachment must be used in conjunction with the type LA lens attachment and enables the amplifier to be used in full sunlight, providing the sun's rays are not within 15° of the direction of the projected beam.

Lamphouse (Type LH)

For most purposes where the distance between the light source is between 4 ft. and 16 ft. the LH type lamphouse is suitable. This includes a 12-volt 24-watt Osram line filament headlamp mounted horizontally with a concave mirror to produce a projected beam. The lamp operates from a 10-12-volt winding on the amplifier transformer. The position of the lamp relative to the mirror is adjustable by loosening the clamping screws of the holder, accessible by removing the back cover. The lamp should be focussed when installed in position so as to produce the maximum brightness on the cathode of the photocell.

Lamphouse (Type LDLH)

When the distance to be spanned between the light source and the amplifier exceeds 48 ft. without the use of an infra-red filter it will be necessary to use the type LDLH lamphouse. This unit consists of two sections, one of which forms the housing for the optical projection system and includes the lamp, and the other which contains the mains transformer through which the 12-volt 36-watt S.B.C. Osram headlamp is fed from the A.C. supply mains.

Miniature lamphouse (Type MLH)

For short distances up to 4 ft. the miniature lamphouse type MLH can be used. The small size of this housing makes it very useful in industrial applications in such cases. It is provided with two fixing screws and carries a 12-volt 6-watt Osram S.B.C. automobile lamp which may be operated from the winding provided on the amplifier transformer. The front of the telescopic housing is fitted with a lens and can be focussed to produce maximum brightness.

Infra Red Operation

Either the LH or LDLH lamphouses can be provided with infra red screens so that the projected beam cannot be seen unless viewed directly in the line of projection. Double screens still further reduce visibility, but as the use of these screens cuts off much of the radiation to which the photocells respond, the distance which can be spanned is considerably reduced. The screen is inserted between the two glasses on the front of the lamphouse.

Operating Distances

The following table indicates the range of operation of the photoelectric equipment under the conditions specified. The distances specified should not be exceeded if reliable operation is to be ensured.

Attachment to MD amplifier	Lamphouse	White Light	Single Infra Red screen
None	MLH	4 ft.	3 ft.
None	LH	16 "	10 "
LA Attachment	LH	48 "	32 "
None	LDLH	56 "	35 "
LA Attachment	LDLH	230 "	130 "
Daylight Attachment	LH	38 "	24 "
Daylight Attachment	LDLH	175 "	112 "

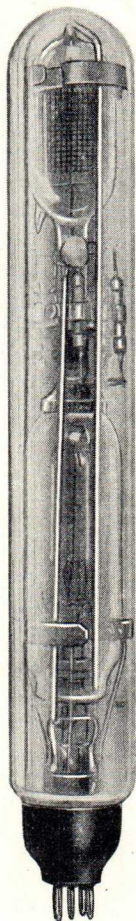
Where double infra red screens are used the distances shown in the last column are approximately halved.

For installations which necessitate the use of flameproof apparatus, certified equipment can be supplied. Particulars can be furnished on application.

Detailed information on all the above equipment is available on request.



PHOTOCELL PHOTOMETER UNIT



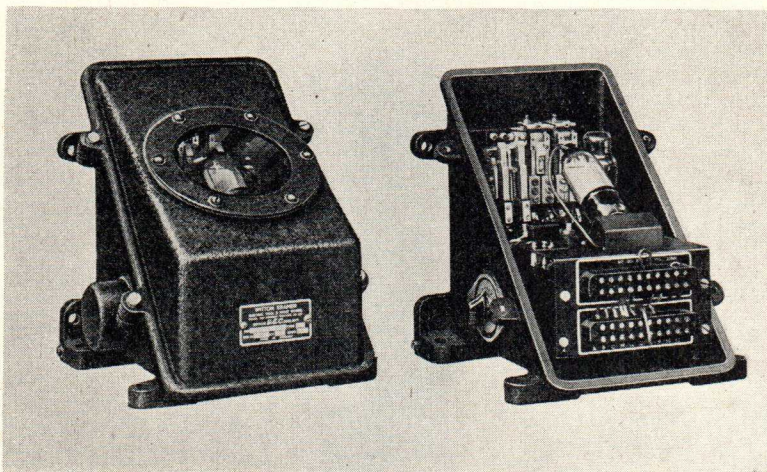
The Osram Photocell Photometer unit is intended for precision measurement of light and incorporates the Osram Electrometer Triode type ET1 and the Osram Photocell type KMV6 with a high value coupling resistor, the whole assembly being contained in an evacuated glass bulb measuring 36cm × 5cm and fitted with a standard British 5 pin valve base.

The construction of this unit is such that variations in the grid circuit resistance of the valve are eliminated since the vacuum enclosure avoids all surface contamination which might otherwise result from exposure to the air and extremely high values of grid resistance can therefore be maintained. It also ensures a very short grid connection between the photocell and the triode resulting in a direct coupled amplifier of high stability.

Detailed information regarding this unit is available on request.

G.E.C.

PHOTOELECTRIC DAYLIGHT CONTROL UNIT



The repeated appeals which from time to time are made to restrict the consumption of electric power if cuts in the supply are to be avoided is a constant reminder of the need for switching off all unnecessary loads. If for no other reason, therefore, there is some obligation on all users of electricity to see that waste of power is avoided.

There is not usually much fear that people will fail to switch on the lighting when it becomes too dark to see in comfort, though even here it is frequently found that quite unconsciously workers in factories will carry on their job at far less than their optimum efficiency because the lighting is too bad, and production is in consequence reduced; but often it is found that workers neglect to switch off the light long after the need for it has passed. Every job requires a minimum light intensity in order that it may be carried on efficiently, whether that illumination is provided by daylight or by artificial light.

All modern factories are designed to utilise daylight as much as possible and to supplement this by artificial light switched on at the right time. The right time is not the time by the clock but the time at which daylight falls below the limit at which the job can be carried on efficiently, which may be at any time of day.

In order, therefore, that the lighting level may be maintained, any automatic switching control must be actuated by a device sensitive to light and not by a clock controlled mechanism. This can be achieved by the use of an Osram photocell incorporated in a specially designed daylight control unit, which includes a valve circuit and switchgear for the switching of factory or street lighting, advertising signs, aircraft obstruction beacons, etc. This unit is illustrated above.

The G.E.C. Daylight Control Unit is housed in a cast metal weatherproof case having fixing lugs both below and at the rear so that it can be mounted either on the top or side of a wall or structure. The circuit components are all mounted on a sheet steel chassis. The unit operates from A.C. supply only, 200-250 volts 50-c/s and tapplings are provided for different voltages in this range. The final relay has contacts to give single pole change-over switching with a maximum loading of 900 VA up to 400-volts. For controlling heavier currents, an additional external contactor must be added. The amplifier relay has a duplicate set of contacts not wired in circuit. In the event of the normal contacts being damaged through an external fault, the wiring can be transferred to the spare contacts and loss of service of the unit is avoided.

Separate controls are provided for varying the sensitivity of the unit and altering the overlap of the switching points. The circuit is arranged so that in the event of valve failure, the lighting under control is automatically switched on so that the circuit fails to safety.

Further information regarding installation and operation of this equipment is available on application to the Osram Valve and Electronics Dept., The General Electric Co. Ltd., Magnet House, Kingsway, W.C. 2.

GM2 GM4 EHM2

G.E.C.

GEIGER-MÜLLER TUBES

Radioactive substances are unstable elements which occur naturally or are artificially produced and which are in course of breaking down into simpler substances. During the transition period, which according to the substances concerned, may vary from a fraction of a second to thousands of years, α , β and γ rays and X rays may be emitted as a result of the internal atomic disintegrations. Such radiations are employed in certain medical and industrial applications but none is immediately detectable by the senses, so special devices have to be used to indicate their existence and estimate quantitatively their relative intensity.

The Geiger-Müller tube is a special type of gas discharge chamber for this purpose. A potential of the order of 1200-1400 volts is maintained between the central electrode and the case and is in series with an external high resistance. When radiation enters the tube, rapid cumulative ionisation is produced and a pulse of current passes between the electrodes. The nature of the gasfilling is such that the discharge is self extinguishing so that each ionising particle entering the discharge space produces a single current pulse. β radiation has very little penetration through matter so that a thin window is therefore necessary and in the case of G.E.C. tube this window is at the end of the tube. These current pulses can be detected by headphones or amplified to operate a counting rate meter and the rate of counting is a measure of the intensity of the radiation.

The G.E.C. market three types of standard GM tubes. These differ mainly in the thickness of the end window and are therefore used to detect different types of radiation.

With the usual gas filling of argon plus 10% ethyl alcohol vapour at a pressure of approximately a tenth of an atmosphere, the tube is approaching the point where a continuous discharge takes place. Over a range of about 250 volts known as the "plateau," each ionising particle (such as a fast electron from a radio-active source) entering the discharge space causes a single discharge around the anode, which alters its potential by the order of 1-50 volts according to the size of the tube. γ rays or cosmic rays will not ionise the gas directly but some of them release electrons from the wall of the tube which are counted and a measure of the intensity of the γ rays can be obtained.

Tubes of various designs can thus measure the intensity of α , β , or γ radiations from radioactive materials or X-rays and cosmic rays.

TYPE G.M.2

This type is for measurement of γ rays and fast β rays such as those from P.32 (Radiophosphorus).

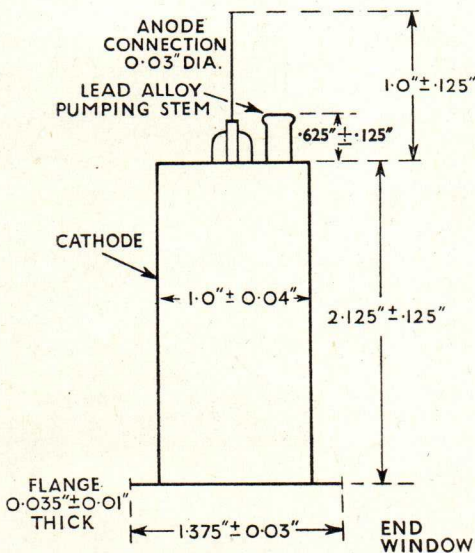
General Characteristics

Cathode Wall. Nickel plated copper 0.03" thick. Suitable for γ rays.

End Window. Duralumin 0.0025" thick (20 mg./cm²) diameter $\frac{1}{8}$ ". Just transparent to β rays above 0.2 M.E.V. approx.

Fixing arrangements.

The tube may be clamped by the rim around the bottom of the cathode, and the electrical connection made to the clamp or by a clip on to the pumping stem. The anode connection to the top wire should also be a clamping connector. Soldering should not be attempted. Care should be taken to avoid damage to the fragile end window, which is fitted with a cover for protection during transport.



TYPES GM2. AND GM4.

Electrical Characteristics

The gas filling is an alcohol/argon mixture suitable for a fast rate of counting.

Starting voltage.

Where signals are just audible on headphones on an amplifier of approximately 30 db gain without delay bias, the starting voltage is 1250 ± 100 volts.

Recommended running voltage (marked on tube).

Starting voltage + 100v. Running above this point will reduce the life very considerably. The life is also reduced by operation at rates of count exceeding about 20,000 per minute. The normal life is of the order of 10^8 counts.

Signal output at this point $\left(\frac{230}{60 + C} \right)$ volts, where C is the total pF. capacitance across the tube (shielded lead and counting circuit input capacitance). With a convenient length of lead this signal will probably not be quite adequate to operate most types of counting circuit and a stage of amplification is recommended.

Length of "plateau" 250 volts (minimum 200 volts)

Slope of "plateau" 0.06% per volt (maximum 0.10%)

Natural background in 1" thick lead container 12 per minute (maximum 20)

Series resistance 1 megohm minimum.

Either cathode or anode may be run at earth potential, the signal being taken from the electrode with the series resistance in circuit.

Effect of temperature.

The starting voltage alters with temperature and should be checked under conditions of use. The tube should not be operated under 10°C . as the plateau shortens considerably below this temperature. If the temperature varies, the rate of count from a standard source may alter slightly and allowance for this should be made in accurate measurements.

TYPE G.M.4

This type is similar to G.M.2 except for the window.



End window.

Duralumin $0.001''$. Weight 7 mg. per cm^2 . Diameter $\frac{1}{8}''$. Just transparent to β rays of energy 0.1 M.E.V. approx. The tube can therefore be used for the measurements of medium speed β particles.

TYPE EHM2

This tube has a mica window weight 1.6—2.4 mg./ cm^2 , and a special high pressure gas filling. It is recommended for detection of slow β particles such as those from C.14 and S.35. The window weight to the nearest 0.1 mgm./ cm^2 is marked on the tube. The operating voltage marked on the tube is 1450 approx. Other operational details are as for G.M.2.

Nickel planchettes to hold specimens 3 mm. under the window of tubes GM2 and GM4 and give equal sensitivity are available (see British Journal Radiography Vol. 20, No. 233, p. 190, 1947).



GASFILLED ARRESTERS

Line protection against sudden surges of high voltage, such as produced by lightning discharge, may be effected by means of a spark gap but the use of a properly designed gasfilled arrester has advantages over the spark gap for the following reasons :

1. It has in general a lower striking voltage.
2. There is comparative constancy of striking voltage due to discharge occurring in an inert atmosphere.
3. It has a lower impedance.
4. There is more certain extinction after the surge has passed.

With the spark gap type of arrester, if the gap is made sufficiently short to give a striking voltage as low as frequently desirable, considerable difficulty is often experienced due to the gap bridging over, either with accumulated dirt, or following the passage of a surge. The gap is, therefore, in practice usually set to a higher value than that demanded solely from considerations of minimum desirable breakdown voltage.

The gasfilled arrester will, therefore, afford a more certain protection than the spark gap type.

For many purposes the arrester may be provided with robust metal electrodes which have not been given any special activating treatment. When the largest surges have to be dealt with it is usual, however, to employ activated electrodes. The use of these reduces greatly the voltage drop in the arrester for a given discharge current. Consequently the risk of the arrester being destroyed is very much lessened on account of the reduced energy to be dissipated.

The voltage which is permanently applied across the arrester under normal conditions (the so-called "back-up voltage") is an important factor in choosing the particular type to be employed, since it is naturally essential that, once the surge has passed, the arrester will immediately cease to operate and will not continue to pass current under the voltage permanently applied to it. In general, the higher the "back-up voltage" superimposed, the higher must be the striking voltage of the arrester employed.

Types of G.E.C. Gasfilled Arrester are manufactured suitable for :

- (a) Protection of power circuits.
 - (b) Protection of communication circuits.
- (a) **Type CCA.**—Suitable for the protection of power circuits.
Cold cathode type.
Large double-ended arrester.
Striking voltage ; 140 to 150 D.C.
Capping : G.E.S.
Overall length 212 approx. mms. Diameter 80 max. mms.
- (b) **Type CCB.**—Suitable for protection of communication circuits.
Cold cathode type.
Small three-electrode arrester in tubular bulb.
Striking voltage ; 200-300 D.C.
Approximate surge capacity : 8 amp.—seconds.
Capping : E.S. at one end, Festoon at other.
Overall length 100 approx. mms. Diameter 26 max. mms.

Exhaustive life tests on the above Arresters have been carried out, and have confirmed that the striking voltage is in each case very stable.

The General Electric Co. will be pleased to give advice in connection with the problems involving the use of gasfilled arresters.



CRYSTAL VALVES

The term crystal valve is used for Silicon and Germanium devices not only to differentiate them from the older forms of crystal detector but also to avoid confusion with the quartz crystals commonly used in radio for frequency control.

This crystal rectifier, which was one of the earliest forms of detector to be used in radio, suffered from disadvantages which caused its virtual eclipse on the arrival of thermionic valves.

Later, the need for a mixer in centimetric radar circuits resulted in a return to prominence of the crystal in a new form more compact and stable than its predecessors.

For this particular application silicon was used and this material is still best for the purpose although the capsule form has given place to improvements such as co-axial construction.

SILICON DIODES

SIM 1. These crystals have been specially designed for use in pre-tuned mixer

SIM 2. circuits and are of co-axial construction. A high degree of consistence in admittance and noise figure has been achieved and the material used allows application of considerable R.F. power without burn-out.

SIM 1 and SIM 2 are identical except for polarity and are intended for use together in balanced mixers.

SIM 8. This is a mixer for the 8 mm. band and is designed to form an integral part of a wave-guide.

GERMANIUM DIODES

By using Germanium in place of Silicon a robust rectifier of great stability can be made which will withstand much higher back voltage and so embrace a much wider range of applications.

Four standard types of Germanium crystal rectifiers are listed,

GEX 33	} Ratings and applications are given in the following pages.
GEX 44	
GEX 45	
GEX 55	

Other types are available for specialised applications, details of which can be supplied on request.



GERMANIUM CRYSTAL RECTIFIERS

TYPES GEX 33, 44, 45 and 55

DESCRIPTION

Types GEX 33, 44, 45 and 55 germanium crystal rectifiers each consist of a small piece of germanium in contact with a springy metallic wire conductor which is sealed into a glass tube. Advantages of this type of rectifier include very small size, robustness, low capacitance and ability to be soldered directly into the circuit. In addition, since a heater is not required no hum is introduced.

Compared with other non-thermionic rectifiers, germanium is outstanding in giving a low forward resistance combined with a high reverse resistance and in ability to handle relatively high voltages.

A typical characteristic curve is shown overleaf from which it will be noticed that when the reverse voltage exceeds a certain figure the reverse resistance suddenly decreases and then becomes negative. The voltage at which this occurs is known as the "turnover" voltage.

RATINGS (at 20°C)

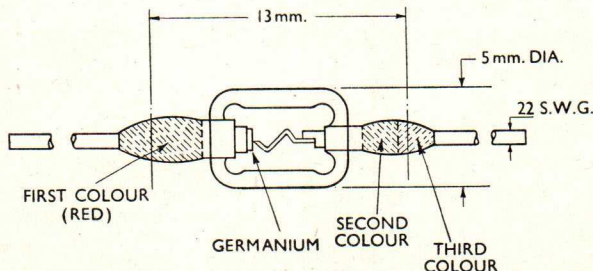
	GEX 33	GEX 44	GEX 45	GEX 55
Forward Current at + 1 volt ...	8	8	8	8 average mA
Reverse Current at -10 volts ...	<1000	<100	<33	<10 μ A
Turnover Voltage ...	30-60	>60	>60	>60 volts
Forward Current ...	50	50	50	50 max. mA
Repetitive Peak (sinusoidal) ...	100	100	100	100 max. mA
Repetitive Peak (brief, recurrent)*	200	200	200	200 max. mA
Occasional one second overload	0.5	0.5	0.5	0.5 max. amp

* On-off ratio 1/1000

Capacitance (all types) :

0.3	min. pF
0.7	average pF
1.0	max. pF

DIMENSIONS



TYPES GEX 33, 44, 45 and 55

TEMPERATURE RANGE

The rectifiers will function satisfactorily in the range -100°C. to $+120^{\circ}\text{C.}$

HUMIDITY

The rectifiers are hermetically sealed and it is impossible for moisture to penetrate to the working surfaces. They may be immersed in boiling water or exposed to low temperature steam without detriment to their characteristics.

VIBRATION

All rectifiers are subjected to severe vibration test after manufacture.

CONNECTION

Soldered joints may be made direct to the wire connecting leads. No special precautions are necessary when carrying out this operation since they will withstand the 10 second test required by R.I.C. component specifications.

EXPECTATION OF LIFE

Shelf life is expected to be greater than 10 years. Operating life is greater than 10,000 hours.

APPLICATION

Type GEX 33.

Colour code : Red/Orange/Orange.

Suitable for use as a rectifier feeding low impedance circuits, such as detector in wide band amplifiers or television interference limiter.

Type GEX 44.

Colour code : Red/Yellow/Yellow

Suitable for use as rectifier feeding medium impedance circuits such as detector in narrow band amplifiers, television sound limiter or frame integrator.

Type GEX 45.

Colour code : Red/Yellow/Green.

Suitable for similar applications as GEX 44 but capable of working into a higher impedance.

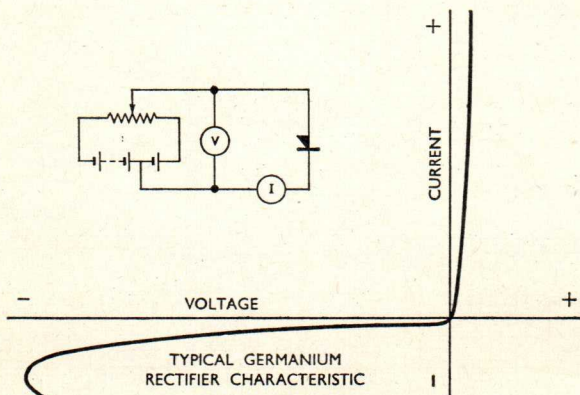
Type GEX 55.

Colour code : Red/Green/Green.

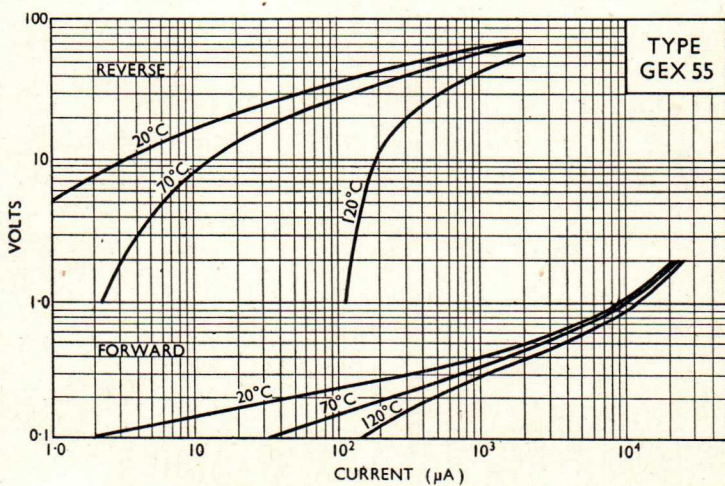
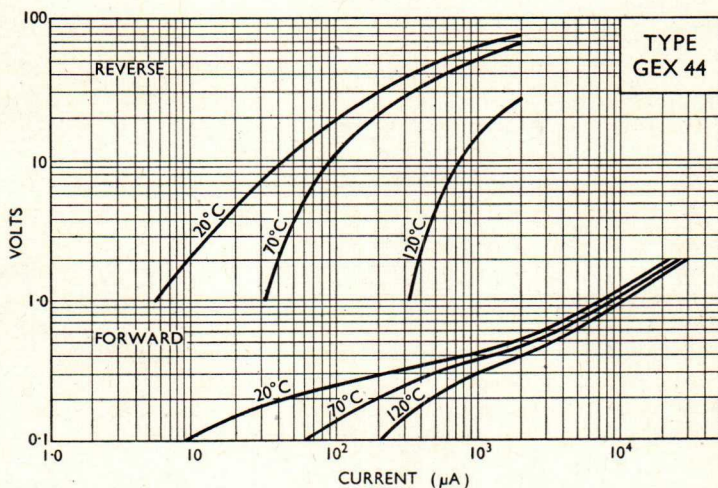
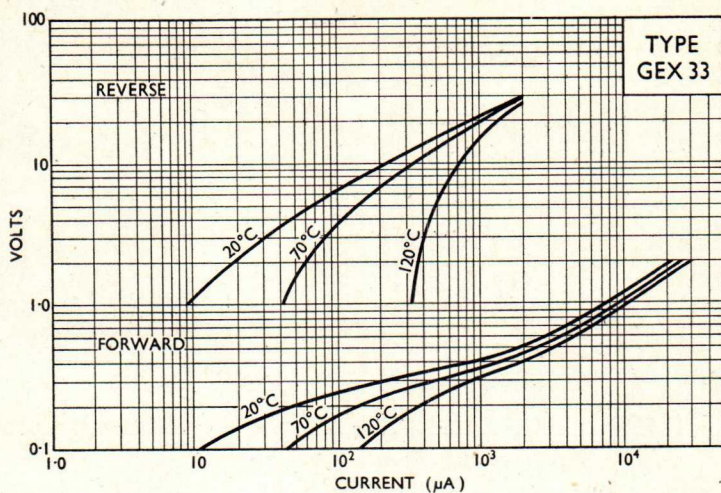
Suitable for use as rectifier feeding high impedance circuits, such as discriminator in F.M. circuits with high output impedance, or rectifier in valve-voltmeter probe.

COLOUR CODE

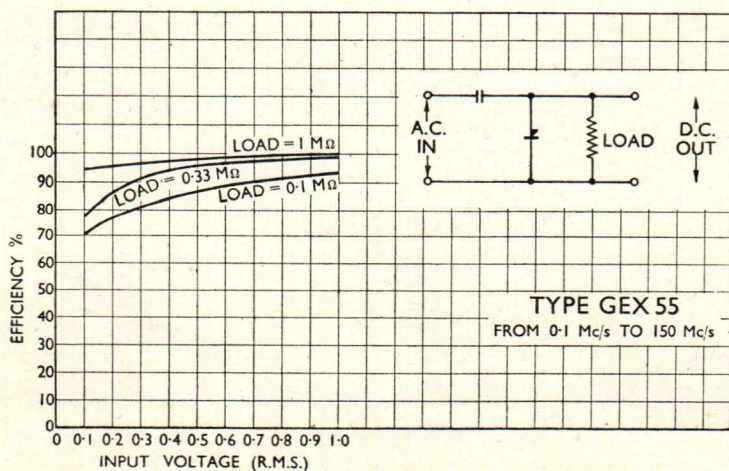
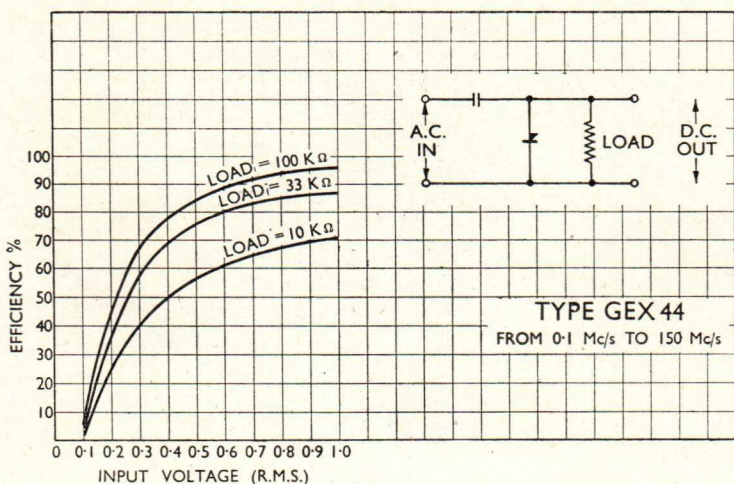
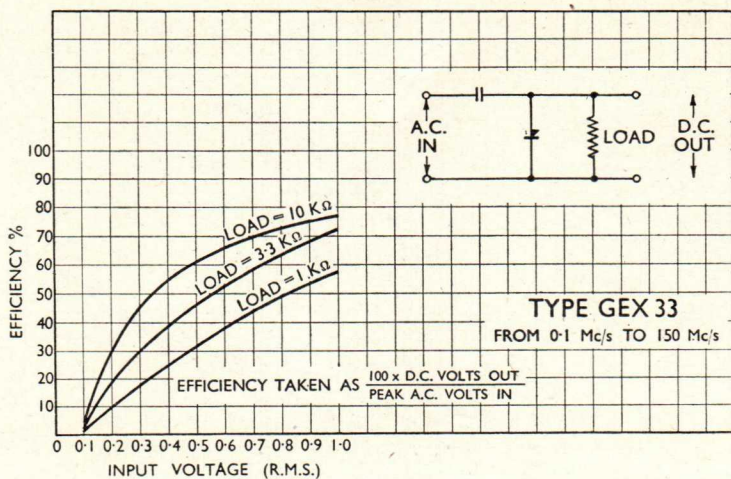
In the colour coding system, red is an indication of the negative end of the rectifier. Thus, when compared with a thermionic diode the red end of the rectifier corresponds to the cathode.



TYPICAL CHARACTERISTICS OF TYPES GEX 33, 44 and 55



TYPICAL RECTIFICATION CHARACTERISTICS OF TYPES GEX 33, 44 and 55



SUMMARISED DATA OF OBSOLESCEENT TYPES

R.F. PENTODES AND TETRODES (see note page 227)

Type	Filament or Heater		Anode Volts Max.	Screen Volts Max.	Mutual Conduct- ance mA/V	As Amplifier under conditions of Max. Anode and Screen Volts				Base. See page
	Volts	Amps.				Grid Bias Volts	Bias Resistor Ohms	Average Anode Current mA.	Average Screen Current mA.	
Z14	1.4	0.05	90	90	0.75	0	—	1.2	0.24	230
S23	2.0	0.1	150	70	1.1	-1.5	—	2.8	0.8	228
S24	2.0	0.15	150	70	1.4	-1.5	—	3.2	1.0	228
VP21	2.0	0.1	150	60	1.1	-1.5	—	1.4	0.4	229
VS24	2.0	0.15	150	75	1.5	-1.5	—	2.3	0.2	228
W21	2.0	0.1	150	150	1.4	0	—	3.6	1.2	228/9
Z21	2.0	0.1	150	150	1.7	0	—	2.5	0.8	228
Z22										229
KTZ41	4.0	1.5	250	250	12.0	-1.5	65	18.0	5.25	229
MS4	4.0	1.0	200	70	1.1	-1.5	550	2.4	0.3	228
MS4B	4.0	1.0	200	80	3.2	-1.0	250	3.4	1.2	228
MSP4	4.0	1.0	200	100	2.4	-1.75	400	3.0	1.0	228
MSP41	4.0	1.0	250	240	3.2	-4.0	330	8.5	3.5	229
VMP4G	4.0	1.0	250	100	2.7	-2.0	150	8.0	5.0	229
VMS4	4.0	1.0	250	80	2.1	-1.0	50	11.0	2.5	228
VMS4B	4.0	1.0	250	80	2.4	-1.0	150	5.2	1.1	228
W42	4.0	0.6	250	125	1.5	-3.0	300	7.6	1.9	229
WD40	4.0	1.0	250	100	2.6	-1.0	100	7.7	4.7	231
KTW73	6.0	0.16	250	100	1.7	-3.0	300	6.5	1.3	230
KTZ73	6.0	0.16	250	100	1.5	-3.0	1000	2.0	0.25	230
W81	6.3	0.3	250	100	2.8	-3.0	270	9.6	3.6	231
Z62	6.3	0.45	300	150	7.5	-2.0	160	10.0	2.3	230
KTW74	13.0	0.16	250	100	1.5	-3.0	300	7.6	1.5	230
W30	13.0	0.3	250	250	4.0	-1.0	100	8.0	3.0	229
W31	13.0	0.3	250	100	2.7	-2.0	150	8.0	5.0	229
W76	12.0	0.16	250	250	1.5	-3.0	330	7.6	1.9	230
WD30	13.0	0.3	250	100	2.6	-1.0	100	7.7	4.7	231
DS	16.0	0.25	200	70	1.1	-1.5	500	2.4	0.3	228
DSB	16.0	0.25	200	80	3.2	-1.0	220	3.4	1.2	228
VDS	16.0	0.25	200	80	2.4	-0.5	50	11.0	1.2	228
VDSB	16.0	0.25	200	80	3.0	-1.0	150	5.5	0.6	228
W101	19.0	0.1	250	100	2.8	-3.0	300	8.0	2.7	231

Summarised Data of Obsolete Types—continued.

DIODES AND DIODE TRIODES (see note page 227)

Type	Description	Filament		D (Directly) or I (Indirectly) Heated	Anode Volts Max.	Amplification Factor
		Volts	Amps.			
D41	Double Diode	4.0	0.3	I	—	—
D42	} Single Diode	4.0	0.6	I	75 R.M.S.	—
D43						
HD14	Diode Triode	1.4	0.05	D	90	66
HD22	Double Diode Triode	2.0	0.2	D	150	27
HD23	Double Diode Triode	2.0	0.15	D	150	40
HD24	Double Diode Triode	2.0	0.1	D	150	40
MHD4	Double Diode Triode	4.0	1.0	I	250	40
DH42	Double Diode Triode	4.0	0.6	I	250	70
DH73	Double Diode Triode	6.0	0.16	I	250	44
DH81	Double Diode Triode	6.3	0.3	I	250	70
DL82	Double Diode Triode	6.3	0.3	I	250	24
DH30	Double Diode Triode	13.0	0.3	I	200	80
DH74	Double Diode Triode	13.0	0.16	I	250	70
DH76	Double Diode Triode	13.0	0.16	I	250	70
DL74	Double Diode Triode	13.0	0.16	I	250	37
DHD	Double Diode Triode	16.0	0.25	I	200	40
DH101	Double Diode Triode	19.0	0.1	I	250	70

Summarised Data of Obsolete Types—*continued.*

Impedance Ohms	Mutual Conductance mA/V.	As Amplifier under conditions of Max. Anode Volts				Base See page.	Type
		Approx. Grid Bias Volts	Bias Resistor Ohms	Average Anode Current mA.	Optimum Load Megohm		
—	—	—	—	—	—	228	D41
—	—	—	—	—	—	228	D42
							D43
240,000	0.275	0	—	0.14	1.0	230	HD14
18,000	1.5	—3	—	1.75	0.075	228	HD22
28,600	1.4	—1.5	—	1.7	0.15	228	HD23
28,600	1.4	—1.5	—	1.7	0.15	228	HD24
18,200	2.2	—4.0	1000	4.0	0.03	229	MHD4
58,000	1.2	—3.0	2700	1.1	0.2	229	DH42
22,000	2.0	—3.0	1000	4.5	0.1	230	DH73
58,000	1.2	—0.68	680	1.0	0.15	231	DH81
17,000	1.4	—3.0	—	—	0.15	231	DL82
18,000	4.5	—2.0	680	2.8	0.03	229	DH30
58,000	1.2	—3.0	2000	1.0	0.25	230	DH74
58,000	1.2	—3.0	2000	1.1	0.25	230	DH76
22,400	1.65	—3.0	—	5.0	—	230	DL74
18,200	2.2	—3.0	1000	2.5	—	229	DHD
58,000	1.2	—1.3	3300	0.4	0.2	231	DH101

Summarised Data of Obsolete Types—continued.

TRIODES (see note page 227)

Type	Filament		D (Directly) or I (Indirectly) Heated	Anode Volts Max.	Amplification Factor	Impedance Ohms	Mutual Conductance mA/V.
	Volts	Amps.					
†B21	2.0	0.2	D	150	—	—	—
H210	2.0	0.1	D	150	35	50,000	0.7
HL2	2.0	0.1	D	150	27	18,000	1.5
L21	2.0	0.1	D	150	16	8,900	1.8
LP2	2.0	0.2	D	150	15	4,170	3.6
P2	2.0	0.2	D	150	7.5	2,150	3.5
A537	4.0	0.4	I	150	15.5	10,000	1.55
H42	4.0	0.6	I	250	100	66,000	1.5
MH4	4.0	1.0	I	250	40	11,100	3.6
MH40	4.0	1.0	I	200	45	18,750	2.4
MH41	4.0	1.0	I	200	80	13,300	6.0
MHL4	4.0	1.0	I	250	20	8,000	2.5
ML4	4.0	1.0	I	250	12	2,860	4.2
DA30	4.0	2.0	D	500	4	580	6.9
DA60	6.0	4.0	D	500	2.5	835	3.0
H30	13.0	0.3	I	250	80	13,300	6.0
L30	13.0	0.3	I	200	12	2,860	4.2
DH	16.0	0.25	I	200	40	10,800	3.7
DL	16.0	0.25	I	200	12	2,660	4.5

† Double Triode.

Summarised Data of Obsolete Types—*continued.*

As Amplifier under conditions of Max. Anode Volts					Base. See page	Type
Approx. Grid Bias Volts	Bias Resistor Ohms	Average Anode Current mA.	Optimum Load Ohms	Power Output (Single Valve) Watts.		
— 6	—	7.5	12,000	—	229	B21
— 1.5	—	1.0	—	—	228	H210
— 3.0	—	1.75	—	—	228	HL2
— 6.0	—	2.2	40,000	—	228	L21
— 4.5	—	10.0	—	—	228	LP2
— 10.5	—	19.0	—	—	228	P2
— 6.0	—	3.3	—	—	Special base	A537
— 2.0	2000	1.0	200,000	—	229	H42
— 4.0	750	5.0	50,000	—	228	MH4
— 3.0	1000	2.7	50,000	—	228	MH40
— 1.5	400	5.2	30,000	—	228	MH41
— 8.0	1000	8.0	50,000	—	228	MHL4
— 16.0	1000	14.0	7,000	—	228	ML4
— 145	—	50 to 110	3,400*	44*	228	DA30
— 135	1150	120	3,000	10.5	Special base	DA60
— 1.7	300	5.5	20,000	—	229	H30
— 8.0	500	25	6,000	—	229	L30
— 3.0	500	6.0	30,000	—	228	DH
— 3.2	1000	3.2	7,000	—	228	DL

* 2 valves, Class AB1

Summarised Data of Obsolescent Types—continued.

FREQUENCY CHANGERS (see note page 227)

Type	Description	Filament		D (Directly or I (Indirectly) Heated	Conversion Conductance $\mu\text{A/V}$	Anode Volts Max.	Screen Volts Max.
		Volts	Amps.				
X14	Heptode	1.4	0.05	D	250	90	45
X21	Heptode	2.0	0.1	D	240	150	70
X22	Heptode	2.0	0.15	D	350	150	70
X23	Triode Hexode	2.0	0.3	D	250	150	60
X24	Triode Hexode	2.0	0.2	D	250	150	60
MX40	Heptode	4.0	1.0	I	500	250	100
X41	Triode Hexode	4.0	1.2	I	640	250	80
X42	Heptode	4.0	0.6	I	490	250	100
X62	Triode Hexode	6.3	1.27	I	1750	250	120
X64	Heptode	6.3	0.3	I	310	250	150
X73	Heptode	6.0	0.16	I	500	250	80
X81	Triode Hexode	6.3	0.3	I	650	250	100
X71	Triode Hexode	13.0	0.16	I	620	250	100
X76	Triode Hexode	13.0	0.16	I	620	250	100
X30	Heptode	13.0	0.3	I	750	250	100
X31	Triode Hexode	13.0	0.3	I	640	250	80
X101	Triode Hexode	19.0	0.1	I	650	250	100

Summarised Data of Obsolescent Types—continued.

Oscillator Anode Volts Max.	Under conditions of Max. Anode, Screen and Osc. Anode Volts					Base. See page	Type
	Total Cathode Current mA	Control Grid Volts	Oscillator Grid Peak Volts	Bias Resistor Ohms	Conversion Impedance Megohms		
90	2.5	0	10	—	0.6	230	X14
90	1.9	0	10	—	2.0	229	X21
150	9.0	0	20	—	0.65	229	X22
150	4.5	—1.5	6	—	1.0	229	X23
150	4.5	—1.5	6	—	1.0	229	X24
150	5.85	—3.0	10	500	0.5	229	MX40
150	8.5	—1.5	12	180	0.75	229	X41
200	9.5	—3.0	25	300	0.31	229	X42
250	18.0	—1.5	5	100	0.33	230	X62
—	12.0	—6.0	18	350	1.0	230	X64
250	8.0	—3.0	10	350	0.4	230	X73
100	9.0	—2.0	10	220	1.0	231	X81
250	10.0	—3.0	15	300	0.7	230	X71
100	10.0	—3.0	15	300	0.7	230	X76
150	9.1	—3.0	10	250	—	229	X30
150	7.6	—1.5	12	200	0.75	229	X31
100	9.0	—2.0	10	220	1.0	231	X101

Summarised Data of Obsolescent Types—continued.

RECTIFIERS (see note page 227)

Type	Type of Rectification	D (Directly) or I (Indirectly) Heated	Filament	
			Volts	Amps.
GU1	Mercury Vapour, Half Wave	D	4·0	3·0
GU5	Mercury Vapour, Half Wave	D	4·0	3·0
U5	Bi-Phase, Half Wave	D	5·0	1·6
U8	Bi-Phase, Half Wave	D	7·5	2·4
U10	Bi-Phase, Half Wave	D	4·0	1·0
U15	Single Phase, Half Wave	D	6·0	2·0
U16	Single Phase, Half Wave	D	2·0	1·0
U17	Single Phase, Half Wave	D	4·0	1·0
U30	Single Phase, Half Wave	I	26 13	0·3 0·6
	Bi-Phase, Half Wave			
	Voltage Doubler			
U71	Single Phase, Half Wave	I	30	0·16
U74	Single Phase, Half Wave	I	30	0·16
U76	Single Phase, Half Wave	I	30	0·16
U81	Bi-Phase, Half Wave	I	6·3	1·6
U82	Bi-Phase, Half Wave	I	6·3	0·6
U84	Bi-Phase, Half Wave	D	4·0	1·0
U101	Single Phase, Half Wave	I	50	0·1

Summarised Data of Obsolete Types—continued.

Anode Volts Max R.M.S.	Max. D.C. Output Volts at Max. Current	Output Current Max. D.C. mA.	D.C. Output at Half Current Volts	Reservoir Capacitor μF.	Base. See page.	Type
1000	1100*	250	1150*	—	228	GU1
1500	1325*	250	1350*	—	228	GU5
400	—	45	—	4·0	228	U5
500	—	120	—	4·0	228	U8
250	225	100	275	8·0	228	U10
1500	1400	200	1800	—	Special base	U15
5000	6800	2·0	6950	0·25	228	U16
2500	2950	30·0	3050	1·0	228	U17
250	260	120	295	32·0	} 229	U30
250	—	120	—	4·0		
250	—	75	—	8·0		
250	250	75	—	—	230	U71
250	245	75	285	32·0	230	U74
250	225	100	270	32·0	230	U76
500	540	150	585	8·0	231	U81
325	350	75	390	4·0	231	U82
250	240	75	270	8·0	231	U84
250	225	100	275	32·0	231	U101

* 2 valves Bi-Phase circuit.

Summarised Data of Obsolete Types—*continued.*

OUTPUT TETRODES AND PENTODES (see note page 227)

Type	Description	Filament		D (Directly or I (Indirectly Heated)	Anode Volts Max.	Screen Volts Max.	Mutual Conduct- ance mA/V.
		Volts	Amps.				
N14	Pentode	1.4	0.1	D	150	90	1.55
N15	Pentode	1.4 2.8	0.1 0.05	D	150	90	1.55
N16	Pentode	1.4 2.8	0.1 0.05	D	90	90	2.1
KT2	Tetrode	2.0	0.2	D	150	150	2.5
KT21	Tetrode	2.0	0.3	D	150	150	5.3
KT24	Tetrode	2.0	0.2	D	150	150	3.2
QP21	Double Pentode	2.0	0.4	D	150	150	2.3
KT41	Tetrode	4.0	2.0	I	250	250	10.5
KT42	Tetrode	4.0	1.0	I	250	250	2.5
MKT4	Tetrode	4.0	1.0	I	250	225	3.0
N43	Pentode	4.0	2.0	I	250	250	10.0
PT4	Pentode	4.0	1.0	D	250	250	2.85
PT25	Pentode	4.0	2.0	D	400	200	4.0
PT25H	Pentode	4.0	2.0	D	400	400	6.5
KT81	Tetrode	6.3	0.95	I	250	250	10.8
KT73	Tetrode	6.0	0.4	I	175	175	2.5
KT30	Tetrode	13.0	0.3	I	250	250	3.9
KT74	Tetrode	15.0	0.16	I	175	175	2.5
KT76	Tetrode	15.0	0.16	I	175	175	2.5
KT72	Tetrode	15.0	0.16	I	175	175	2.5
DPT	Pentode	16.0	0.25	I	200	200	3.0
KT31	Tetrode	26.0	0.3	I	200	200	10.0
KT35	Tetrode	26.0	0.3	I	200	200	10.0
KT71	Tetrode	48.0	0.16	I	200	200	10.0
KT101	Tetrode	80.0	0.1	I	200	200	10.0
DN41	Double Diode Pentode	4.0	2.3	I	250	200	10.0

Summarised Data of Obsolete Types—continued.

Average Anode Current mA.	Average Screen Current mA.	Approx. Grid Bias Volts	Bias Resistor Ohms	Optimum Load Ohms	Approx. Power Output Watts	Base. See page	Type
7.0	1.7	— 7	—	8,000	0.25	230	N14
7.0	1.7	— 7	—	8,000	0.25	230	N15
9.5	1.3	— 4.5	—	8,000	0.27	230	N16
7.5	1.7	— 4.5	—	17,000	0.5	228	KT2
5.0	1.2	— 2.5	—	19,000	0.75	228	KT21
10.0	2.0	— 3.2	—	10,000	0.8	228	KT24
3.5	0.9	— 9.0	—	25,000	1.0	229	QP21
40.0	8.5	— 4.4	90	6,000	4.2	229	KT41
34.0	5.5	— 16.5	420	7,000	2.5	229	KT42
32.0	5.0	— 13.5	365	8,000	2.5	228/9	MKT4
40.0	10.0	— 4.5	90	5,400	4.0	229	N43
32.0	8.0	— 16.0	420	7,500	2.0	228	PT4
62.5	10.6	— 22.0	330	6,000	—	228	PT25
62.5	12.5	— 16.0	250	5,000	6.0	228	PT25H
40.0	7.5	— 4.4	90	6,000	4.3	231	KT81
33.0	6.0	— 12.5	300	6,000	2.0	230	KT73
32.0	8.0	— 15.0	375	7,500	—	229	KT30
30.0	6.0	— 13.0	300	5,000	2.0	230	KT74
30.0	6.0	— 13.0	300	5,000	2.0	230	KT76
30.0	6.0	— 13.0	300	6,000	2.0	230	KT72
40.0	6.5	— 10.0	230	8000	—	228	DPT
40.0	10.6	— 4.0	80	5,500	—	229	KT31
60.0	10.0	— 13.3	190	3,000	5.0	230	KT35
70.0	12.0	— 9.8	120	2,500	5.0	230	KT71
63.0	10.0	— 12.6	180	3,000	5.0	231	K1101
32.0	8.0	— 3.5	90	7,800	—	229	DN41

Summarised Data of Obsolescent Types—continued.

TELEVISION CATHODE RAY TUBES (see note page 227)

Type	Description	Heater		First Anode Voltage	Second Anode Voltage (Focussing)	Third Anode Voltage Max. (Final)
		Volts	Amps.			
4301	9" Electrostatic	4·0	1·0	800	650	2750
4602	12" Electrostatic	4·0	1·0	1700	1400	6000
4603	12" Electrostatic	4·0	1·0	1700	1400	6000
6501	9" Electromagnetic	6·3	0·5	—	—	6000
6502	9" Electromagnetic	6·3	0·5	—	—	7000
6503	9" Electromagnetic	10·5	0·3	—	—	7000
6504	9" Electromagnetic	6·3	0·5	—	—	7000
6505	9" Electromagnetic	10·5	0·3	—	—	7000

OSCILLOGRAPHIC CATHODE RAY TUBES (see note page 227)

Type	Description	Heater		First Anode Voltage	Second Anode Voltage
		Volts	Amps.		
4053	1½" Electrostatic	4·0	0·8	50 to 100	250 to 500
4081	2¼" Electrostatic	4·0	0·8	80 to 200	400 to 800
4081A	2¾" Electrostatic	4·0	1·1	Connected to Third Anode	60 to 150
E4102/B/7	2¾" Electrostatic	4·0	1·0	Connected to Third Anode	VA3 × 0·15 mean

TUNING INDICATORS (see note page 227)

Type	Heater		Anode Voltage Max.	Target Voltage Max.	Target Voltage Min.	Target Current mA.	Triode Current mA.	Grid Voltage for 0° Shadow Angle	Base. See page
	Volts	Amps.							
Y62	6·3	0·3	250	250	80	4·5	0·24	—22	230
Y64	6·3	0·3	250	250	80	4·5	0·25	—22	230
Y73	6·0	0·16	180	180	80	4·5	0·25	—21	230

Summarised Data of Obsolete Types—continued.

Modulator Voltage for Cut-off	Sensitivity mm/V		Grid Drive Peak Volts	Beam Current μ A	Picture Brightness E.F.C.	Base. see page	Type
	L.F.	H.F.					
$-0.025 \times V_{a1}$	950	850	15	50	1.0	232	4301
$-0.03 \times V_{a1}$	1400	1100	30	150	12.0	232	4602
$-0.03 \times V_{a1}$	800	1100	25	100	8.0	232	4603
$-0.007 \times V_a$	—	—	25	200	10.0	232	6501
$-0.007 \times V_a$	—	—	20	200	10.0	232	6502
$-0.007 \times V_a$	—	—	20	200	10.0	232	6503
$-0.007 \times V_a$	—	—	20	200	10.0	232	6504
$-0.007 \times V_a$	—	—	20	200	10.0	232	6505

Third Anode Voltage		Modulator Voltage Max.	Sensitivity mm/V.		Base see page	Type
Min.	Max.		X	Y		
—	—	—20	$\frac{120}{V_{a2}}$	$\frac{120}{V_{a2}}$	232	4053
—	—	—30	$\frac{150}{V_{a2}}$	$\frac{150}{V_{a2}}$	232	4081
400	800	—20	$\frac{170}{V_{a3}}$	$\frac{170}{V_{a3}}$	232	4081A
600	1500	$-V_{a3} \times .025$	$\frac{170}{V_{a3}}$	$\frac{170}{V_{a3}}$	232	E4102/B/7

NOTE.—Many of the valves and tubes listed on pages 215—217 are obsolete and no longer available. The brief technical data given is for the information of service engineers only but in some cases substitutes can be made. Further guidance for maintenance of obsolete equipment is given on pages 236—239.

PIN CONNECTION OF OBSOLESCENT TYPES

4 or 5 Pin Bases

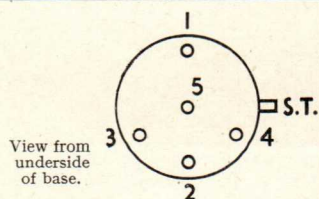
Type	Pin Number					Top Cap	Side Terminal
	1	2	3	4	5		
D41	D ₁	D ₂	H	H	C (M)	—	—
D43	—	C	H	H	X	A	—
DA30	A	G ₁	F	F	X	—	—
DH, DL	A	G ₁	H	H	C (M)	—	—
DPT	A	G ₁	H	H	C	—	G ₂
DS, DSB	G ₂	G ₁	H	H	C (M)	A	—
GU1	A	—	F	F	X	—	—
GU5	—	—	F	F	X	A	—
H210, HL2	A	G ₁	F	F	X	—	—
HD22, HD23, HD24	A	D ₁	F (M)	F	D ₂	G ₁	—
D42	A	C	H	H	X	—	—
KT2, KT21, KT24	A	G ₁	F	F	G ₂	—	—
L21, LP2	A	G ₁	F	F	X	—	—
MH4, MH40 MH41, MHL4 ML4	A	G ₁	H	H	C (M)	—	—
MKT4*	A	G ₁	H	H	C	—	G ₂
MS4, MS4B	G ₂	G ₁	H	H	C (M)	A	—
MSP4*	G ₂	G ₁	H	H	C, G ₃ , M	A	—
P2	A	G ₁	F	F	X	—	—
PT4, PT25, PT25H	A	G ₁	F	F	G ₂	—	—
S23, S24	G ₂	G ₁	F	F	X	A	—
U5, U8, U10	A ₁	A ₂	F	F	X	—	—
U16, U17	—	—	F	F	X	A	—
VDS, VDSB VMS4, VMS4B	G ₂	G ₁	H	H	C (M)	A	—
VS24	G ₂	G ₁	F	F	X	A	—
W21*	G ₂	G ₁	F (M) G ₃	F	X	A	—
Z21	G ₂	G ₁	F (M) G ₃	F	X	A	—

KEY

A : Anode
C : Cathode
D₁ : A.V.C. Diode
D₂ : Signal Diode
F : Filament
H : Heater

G₁ : Control Grid
G₂ : Screen Grid
G₃ : Suppressor Grid
M : Metallising
X : Pin omitted
— : Pin not connected

* Also supplied on 7 pin base.



Pin Connections of Obsolescent Types—continued.

7 Pin Base

Type	Pin Number							Top Cap
	1	2	3	4	5	6	7	
B21	G ₁ a	G ₁ b	Ab	F	F	—	Aa	—
DH30, DHD	D ₁	M	D ₂	H	H	C	A	G ₁
DH42	D ₁	—	D ₂	H	H	C	A	G ₁
DN41	D ₁	A	D ₂	H	H	C	G ₂	G ₁
H30	M	—	—	H	H	C	A	G ₁
H42	—	—	—	H	H	C	A	G ₁
KT30, KT31, KT41, KT42	—	G ₁	G ₂	H	H	C, G ₃	A	—
KTZ41	—	A	—	H	H	C, G ₃	G ₂	G ₁
L30	—	G ₁	—	H	H	C	A	—
MHD4	D ₁	M	D ₂	H	H	C	A	G ₁
MKT4*	—	G ₁	G ₂	H	H	C	A	—
MSP4*, MSP41	M	G ₁	G ₃	H	H	C	G ₂	A
MX40	Ao	Go	Gs	H	H	C, M	A	Gc
N43	—	—	G ₂	H	H	C	A	G ₁
QP21	Ga	Gb	Ab	F, G ₃	F	G ₂	Aa	—
U30	Hct	Aa	Ca	H	H	Cb	Ab	—
VMP4G	M	G ₁	G ₃	H	H	C	G ₂	A
VP21	M	G ₁	G ₃	F	F	—	G ₂	A
W21*	M	G ₁	—	F, G ₃	F	—	G ₂	A
W30, W31	(M)	G ₁	G ₃	H	H	C	G ₂	A
W42	—	A	G ₃	H	H	C	G ₂	G ₁
X21, X22 X23, X24	Ao	Go	Gs	F	F	M	A	Gc
X30, X31 X41, X42	Ao	Go	Gs	H	H	C (M)	A	Cc
Z22	M	G ₁	G ₃	F	F	—	G ₂	A

KEY

- A : Anode

C : Cathode

D₁ : A.V.C. Diode

D₂ : Signal Diode

F : Filament

H : Heater

Hct: Heater centre tap

G₁ : Control Grid
- G₂ : Screen Grid

G₃ : Suppressor Grid

Ao : Oscillator Anode

Go : Oscillator Grid

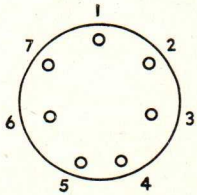
Gs : Screen Grid

Gc : Control Grid

M : Metallising

— : Pin not connected

* Also supplied on 5 pin base.



View from underside of base.

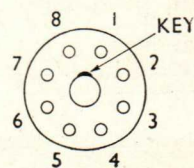
Pin Connections of Obsolescent Types—continued.

Octal Base

Type	Pin Number								Top Cap
	1	2	3	4	5	6	7	8	
DH73, DH74, DH76, DL74	M	H	A	D ₁	D ₂	X	H	C	G ₁
HD14	—	F+	A	—	D	X	F—	—	G ₁
KT35	Hct	H	A	G ₂	G ₁	X	H	C	—
KT71, KT72, KT73, KT74, KT76	—	H	A	G ₂	G ₁	X	H	C	—
KTW73,KTZ73, KTW74	M	H	A	G ₂	—	X	H	C, G ₃	G ₁
N14	—	F+	A	G ₂	G ₁	X	F—, G ₃	—	—
N15, N16	—	F+	A	G ₂	G ₁	X	F—, G ₃	Fct	—
U71, U74, U76	—	H	X	X	A	X	H	C	—
W76	S	H	A	G ₂	G ₃	X	H	C	G ₁
X14	—	F+	A	G _s	G _o	A _o	F—	—	G _c
X62	—	H	A	G _s	G _o	A _o	H	C	G _c
X64	—	H	A	G _s	G _o	X	H	C	G _c
X71, X76	M	H	A	G _s	G _o	A _o	H	C	G _c
X73	—	H	A	G _s	G _o	A _o	H	C	G _c
Y62, Y64, Y73	—	H	A	T	G ₁	X	H	C	—
Z14	—	F+	A	G ₂	—	X	F—	—	G ₁
Z62	—	H	A	G ₂	G ₃	X	H	C	G ₁

KEY

A : Anode	G ₃ : Suppressor Grid
C : Cathode	G _o : Oscillator Grid
D ₁ : A.V.C. Diode	A _o : Oscillator Anode
D ₂ : Signal Diode	G _s : Screen Grid
F : Filament	G _c : Control Grid
H : Heater	T : Target
Hct: Heater centre tap	M : Metallising
Fct: Filament centre tap	S : Shell
G ₁ : Control Grid	X : Pin omitted
G ₂ : Screen Grid	— : Pin not connected



View from underside of base.

Pin Connections of Obsolescent Types—continued.

B8B Base

Type	Pin Number							
	1	2	3	4	5	6	7	8
DH81, DL82 DH101	H	A	G ₁	IC	D ₂	D ₁	C	H
KT81, KT101	H	A	G ₂	IC	IC	G ₁	C	H
U81	IC	IC	A	IC	IC	A	H, C	H
U82	H	IC	A	IC	IC	A	C	H
U84	IC	IC	A	IC	IC	A	F	F
U101	H	A	IC	IC	IC	A	C	H
W81, W101	H	A	G ₂	G ₃	S	G ₁	C	H
X81, X101	H	A	A ₀	G ₀	G _s	G _c	C	H

KEY

- A : Anode

C : Cathode

D₁ : Signal Diode

D₂ : A.V.C. Diode

F : Filament

H : Heater

G₁ : Control Grid

G₂ : Screen Grid
- G₃ : Suppressor Grid

G₀ : Oscillator Grid

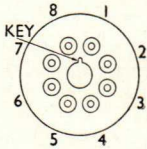
A₀ : Oscillator Anode

G_s : Screen Grid

G_c : Control Grid

S : Screen

IC : Indicates that no external connection should be made to this pin.



View from underside of base.

9 Pin Base

Type	Pin Number									Top Cap
	1	2	3	4	5	6	7	8	9	
WD30, WD40	G ₂	A	—	H	H	C	D ₁	D ₂	M	G ₁

KEY

- A : Anode

C : Cathode

D₁ : A.V.C. Diode

D₂ : Signal Diode

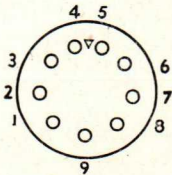
G₁ : Control Grid

G₂ : Screen Grid

H : Heater

M : Metallising

— : Pin not connected



View from underside of base.

Pin Connections of Obsolescent Types—continued.

CATHODE RAY TUBES

9 Pin Base

Type	Pin Number								
	1	2	3	4	5	6	7	8	9
4053	X ₁	Y ₁	A ₁	H, C	H	M	A ₂	Y ₂	X ₂
4081	X ₁	Y ₁	A ₁	H, C	H	M	A ₂	Y ₂	X ₂
4081A	X ₁	Y ₁	A ₂	H, C	H	M	A ₁ , A ₃	Y ₂	X ₂

KEY

- A₁ : First Anode

A₂ : Second Anode

A₃ : Third Anode

C : Cathode

H : Heater

M : Modulator
- X₁

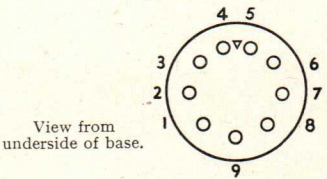
X₂

Y₁

Y₂

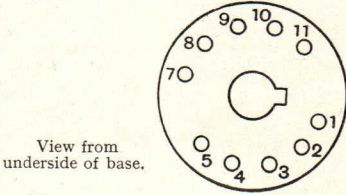
X :
- } Deflector Plates

Pin omitted



10 Pin Spigot Base

Type	Pin Number											
	1	2	3	4	5	6	7	8	9	10	11	12
E4102/B/7	C	M	H	H	A ₂	X	Y ₂	X ₂	A ₁ , A ₃	X ₁	Y ₁	X



Octal Base

Type	Pin Number								Side Terminal
	1	2	3	4	5	6	7	8	
6501/6502/6503/6504/6505	—	H	—	—	M	—	H	C	A

KEY

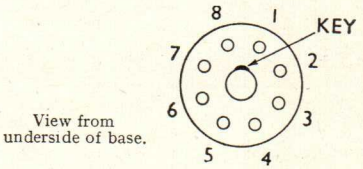
- A : Anode

C : Cathode

H : Heater

M : Modulator

— : Pin not connected



Large 12-Contact Base

Type	Pin Number											
	1	2	3	4	5	6	7	8	9	10	11	12
4301	M	—	C, H	H	A ₁	A ₂	IC	Y ₂	X ₂	A ₃	X ₁	Y ₁
4602								(L.F.)	(H.F.)		(H.F.)	(L.F.)
4603												

KEY

- A₁ : First Anode

A₂ : Second Anode

A₃ : Third Anode

C : Cathode

H : Heater

IC : Internal conductive coating
- M : Modulator

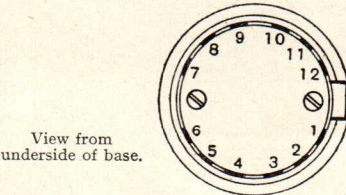
X₁

X₂

Y₁

Y₂

— : Contact not connected
- } Deflector Plates



COMPARATIVE TABLES

(In alphabetical order with Osram Valve equivalents).

Comparative Types	Osram Types	Comparative Types	Osram Types
AC/DD	D41	DL35	N14
AC/DDT	MHD4	DL92	N17
AC/HL	MH4	DL94	N19
AC/HLDD	MHD4	DO24	PX25
AC/HP	MSP4/5 or 7	DO30	DA30
AC/L	ML4	DT436	MHD4
ACO44	PX4	DW2	U10
AC/P	ML4	DW3	U14
AC/PEN	MKT4/7	DW4	U14
AC/SGVM	VMS4B	DW4/350	U14
AC/SH	MS4B	DW4/500	U14
AC/S2 PEN	MSP4/7	D4	MH4
AC/S2	MS4B	D400	D41
AC/TH1	X41	EB34	D63
AC/VP	VMP4G	EB91	D77
AC/VS	VMS4B	EBC33	DH63
AC/VP1	VMP4G	ECH35	X61M
AC/VS	VMS4B	EF91	Z77
AC/Y	MKT4/7	EF92	W77
AC/Z	KT41	EL33	KT61
AC/ZDD	DN41	EL37	KT66
AC2/HL	MH41	EL91	N77
AC2/PEN	KT41	E235	P2
AC2/PENDD	DN41	E446	MSP4
AF2	VMP4G	FC2	X22
APP4A	MKT4/7	FC4	MX40
APP4B	KT41	FW4/500	U18/20
APV4	MU14	FW4/800	U18/20
AS4120	MS4B	GN24	U14
AS4125	VMS4B	G431	U10
A11C	MU14	G470	U10
A11D	MU14	G4120	U14
A20B	D41	G4120N	MU14
A23A	MHD4	HLA2	MH4
A30B	MH41	HLB1	HL2
A30D	MH4	HL2	HL2
A40M	VMS4B	HL4G	MH4
A50A	MSP4/5 or 7	HL21DD	HD24
A50M	VMP4G	HL210	HL2
A50N	VMP4G	HP210/4	Z21
A70B	MKT4/7	HP210/7	Z22
A70C	KT41	HP210NC	Z21
A70D	KT41	HP211	W21
A80A	MX40	HP215	Z21
A430N	MH4	HP4101C	MSP4
B228	HL2	HP4106	VMP4G
DAC32	HD14	HP4115C	VMP4G
DAF91	ZD17	HR210	HL2
DD4	D41	H2	HL2
DD6	D77	H2D	HD24
DDL4	D41	H4D	MHD4
DDPP4B	DN41	H210	HL2
DDT	MHD4	1W3	MU14
DDT2	HD24	1W4/350	MU14
DDT4	MHD4	1W4/500	MU14
DF33	Z14	K23B	HD24
DF91	W17	K30	HL2
DK32	X14	K30A	HL2
DK91	X17	K30B	HL2
DL33	N16	K30C	HL2

Comparative Tables—continued.

Comparative Types	Osram Types	Comparative Types	Osram Types
K30G	LP2	QPT2	QP21
K30K	HL2	RG1/240	GU50
K40B	Z21	RV120/350	U14
K40N	W21/4	RV120/500	U14
K50M	W21/7	RV200/600	U18/20
K70B	KT2	R1	U10
K80A	X22	R2	MU14
LL2	HL2	R3	MU14
LL4	ML4	R4	U14
LP2	P2	R16	U37
LP4	PX4	R208	HL2
LP220	LP2	SD2	HL2
L2	HL2	SE211C	W21/4
MH4105	MX40	SGA1	MS4B
MM4V	VMS4B	SG215	Z21
MP/PEN	MKT4/5 or 7	SG215A	Z21
MSG/HA	MS4B	SG220	Z21
MSG/LA	MS4B	SP2	Z21
MS/PEN	MSP4/5 or 7	SP4	MSP4/5 or 7
MVSG	VMS4B	SP6	Z77
MVS/PEN	VMP4G	SP210	Z21
OM4	DH63	SP215	Z21
O406	MX40	SP220	P2
PB1	LP2	SPT4A	MSP4/5 or 7
PEN/A4	KT41	S4V	MS4B
PEN/B1	KT2	S4VA	MS4B
PEN/4VA	MKT4/7	S4VB	MS4B
PEN/4VB	KT41	S11A	U10
PEN220	KT2	S11D	U14
PEN231	KT24	S30C	PX4
PM1HF	HL2	S130	S130
PM1HL	HL2	S213	W21
PMILF	HL2	S215B	Z21
PM2A	LP2	S215VM	W21/4
PM2DX	HL2	S218	Z21
PM2HL	HL2	S434N	VMP4G
PM12	Z21	S435N	MSP4
PM12A	Z21	TDD2A	HD24
PM12M	W21/4	TDD4	MHD4
PM22A	KT2	TH2	X24
PM22D	KT24	TH4	X41
PM202	P2	TT4	ML4
PP2	KT2	TX4	X41
PP3/250	PX4	UD2	P2
PP5/400	PX25	UU3	MU14
PP220	LP2	UU4	MU14
PP222	KT2	UU5	MU14
PT2	KT2	UU120/350	MU14
PT4D	DN41	UU120/500	MU14
PV4	U14	VHT2	X22
PV495	U10	VHT4	MX40
PV/4200	U14	VO2	X22
PX5	PX25	VO4	MX40
PX41	PX4	VPT4	VMP4G
PX230	P2	VPT4B	VMP4G
P12/250	PX4	VP2	W21/7
P27/500	PX25	VP4A	VMP4G
P220	LP2	VP210	W21/7
P220A	P2	VP215	W21/7
P460	PX4	VS2	W21/4
P495	KT41	VS210	W21
QP22B	QP21	VS215	W21
QP230	QP21	VSGA1	VMS4B

Comparative Tables—continued.

Comparative Types	Osram Types	Comparative Types	Osram Types
V503	DA30	11A2	MHD4
V914	D41	12K7GT	W76
V1907	U27	12K8GT	X76M
Y220	KT2	12Q7GT	DH76
YD2	LP2	12SN7GT	B36
IA7G	X14	15A2	MX40
IA7VG	X14	20A1	X41
IC1	X17	25L6G	KT32
IC5G	N14	25Z4G	U31
IF3	W17	35Z4GT	U76
IFD9	ZD17	41FP	ML4
IH5G	HD14	51MH	MH41
IN5G	Z14	41MHF	MH4
IN5VG	Z14	41MHL	MH4
IP10	N17	41MP	ML4
IR5	X17	41MPG	MX40
IS5	ZD17	41STH	X41
IT4	W17	42MP/PEN	KT41
2D4A	D41	420T	KT41
3Q4	N18	420TDD	DN41
3Q5G	N16	431U	MU14
3S4	N17	441U	MU14
3V4	N19	50L6GT	KT71
4PAC	ML4	63ME	Y63
4XP	PX4	104V	ML4
4/100BU	U18/20	154V	MHL4
5B1	Z21	164V	MHL4
5U4G	U52	210DDT	HD24
5Y3G	U50	210DET	HL2
6AE8	X79	210HF	HL2
6AL5	D77	210HL	HL2
6AM6	D77	210HPT	KT2
6AT6	DH77	210PG	X22
6A8G	X63	210RC	HL2
6BJ5	N78	210SPT	Z22
6C4	L77	210VPT	W21/7
6C5G	L63	215SG	Z21
6D2	D77	220HPT	KT2
6F5G	H63	220/OT	KT2
6F6G	KT63	220P	LP2
6F12	Z77	220PA	LP2
6H6G	D63	220SG	Z21
6J5G	L63	220TH	X24
6J7G	Z63	220VS	W21/4
6K7G	W63	220VSG	W21/4
6K8G	X61M	230XP	P2
6P25	KT61	240QP	QP21
6Q7G	DH63	244V	MH4
6R7G	DL63	354V	MH4
6SN7GT	B65	420/OT	KT41
6U5G	Y61	431U	MU14
6U7G	W63	441U	MU14
6X4	U78	442BU	U14
7A2	MKT4/5 or 7	460BU	U14
7A3	KT41	506BU	U10
7B6	DH81	904V	MH41
7S7	X81	1561	U14
7Y4	U82	1821	U10
8A1	MSP4/5 or 7	1861	MU14
8D3	Z77	1867	MU14
9A1	VMP4G	7475	ST11
9D6	W77		

OBSOLETE TYPES AND REPLACEMENT GUIDE

It has become necessary to render obsolete certain types of OSRAM Valves which were used in the older type receivers, and receiving valve types not now available are listed below.

1. TYPES DISCONTINUED—NO SUITABLE SUBSTITUTE

B21	D42	H210	L410	P610	WD30
B63	HA1	H410	L610	P625	WD40
DE5	HA2	H610	PT425	P625A	X64
DE5A	HL410	LS5	P410	S410	Y64
DE5B	HL610	LS5A	P415	S610	ZA1
DL	H12	LS5B	P425	S625	ZA2

NOTE—In cases of 4 volt and 6 volt battery valves, equivalent 2 volt types could be used provided that the filament voltage is corrected.

2. TYPES DISCONTINUED (OR NOT READILY AVAILABLE) WITH SUGGESTED SUBSTITUTES

Original type of Valve	Recommended substitute	Probable effect in apparatus	Modifications required
DH	L63	Decreased sensitivity	Octal socket ; heater voltage and current, circuit components if necessary
DH30	DL63	Slight reduction in sensitivity	Octal socket ; heater voltage
DH42	MHD4	Not noticeable	Reduce anode load resistor
DH73M	DH76	None	Heater voltage, increase bias resistor
DHD	DL63	Slight reduction in sensitivity	Octal socket ; heater voltage and current
DL74M	DH76	Probably none	Increase bias resistor
DPT	KT33C	Not noticeable	Octal socket ; heater voltage and current
DS } DSB }	Z63	Slight reduction in sensitivity	Octal socket ; heater voltage and current
GT1	GT1C	Probably none	None
GT1A	GT1C	Probably none	None
GT1B	GT1C	Not suitable at frequencies above 8 Kc/s.	None
GU1	GU50	None	Anode connection through insulated lead to top cap
GU5	GU50	None	None
H2	HL2	Slight reduction in sensitivity	None
H30	DH63	Slight reduction in sensitivity	Octal socket ; heater voltage, strap diodes to cathode
H42	MHD4	Slight reduction in sensitivity	Strap diodes to cathode ; adjust pin connections
HD21	HD24	Slight increase in sensitivity	None

Replacement Guide—continued

Original type of Valve	Recommended substitute	Probable effect in apparatus	Modifications required
HD22	HD24	Slight increase in sensitivity	None
HD23	HD24	None	None except in series operation where HD23 is essential
HL21	HL2	No change in sensitivity	Requires selection
HL210	HL2	Increased sensitivity	Probably none
KT21	KT2	Lower filament current; slight reduction in sensitivity	None
KT24	KT2	Slight reduction in sensitivity	None
KT30 } KT31 }	KT33C	Increased sensitivity	Octal socket; heater voltage; bias resistance
KT35	KT33C	None	None
KT42	MKT4/7-pin	Not noticeable	None
KT72	KT76	None	None
KT74	KT76	None	None
KTW73M	W76	None	Heater voltage, connect suppressor
KTW74M	W76	None	Connect suppressor
L21	HL2 or LP2	Depends on application	Alteration to grid bias
L210	HL2	Higher sensitivity	Alteration to grid bias
LS6A	PX25	Increased sensitivity; reduced signal handling capacity; greater output	Anode load; grid bias; filament voltage
MH40	MH4	None	Special selection
MPT4	MKT4	None	None
MS4	VMS4 or MS4B	MS4B gives higher sensitivity but may be unstable	Depends on circuit and layout
MU12	MU14	None	None
N15	N16	None	None
N30	KT33C	Increased sensitivity	Octal socket; heater voltage; bias resistor
N31	KT33C	None	Octal socket; bias resistor
N41	KT41	None	None
N42	MKT4/7-pin	Not noticeable	None
P215	LP2	Increased sensitivity	Reduce grid bias

Replacement Guide—continued

Original type of Valve	Recommended substitute	Probable effect in apparatus	Modifications required
P240	LP2	Increased sensitivity	Reduce grid bias
PT2	KT2	None	None
PT4	MKT4/5-pin	None	Screen lead to side terminal: 330 Ω bias resistor in cathode lead
PT25	PT25H	Slightly increased sensitivity	Increase screen voltage
PT625	KT63	Slightly increased sensitivity	Octal socket; bias resistor in cathode lead
PX25A	DA30	None	None
S21	Z21	Not noticeable	None
S22	Z21	Not noticeable	Probably none
S23	Z21	Slight reduction in sensitivity	None
S24	Z21	Reduction in sensitivity	Probably none
S215	Z21	Not noticeable	Probably none
U5	U50	None	Octal socket
U8	U14	None	Reduce filament voltage from 7.5 to 4.0
U9	U10	None	None
U12	U14	None	None
U23	U19	None	None
U30	U31 in DC/AC series operated sets	None	Octal socket; rewire as half-wave rectifier
U71	U76	None	None
U74	U76	None	None
VDS	KTW63	None	Octal socket; heater voltage and current; grid lead to top cap in place of anode lead
VDSB	KTW63	Reduced sensitivity	Octal socket; heater voltage and current; grid lead to top cap in place of anode lead
VMP4	VMP4G	None	7-pin base if required
VMS4/B	VMS4	None	None
VP21	W21/7-pin	Slightly increased sensitivity	None
VS2	W21/4-pin	Slightly increased sensitivity	None
VS24	W21/4-pin	None	None

Original type of Valve	Recommended substitute	Probable effect in apparatus	Modifications required
W30	W61	Reduced sensitivity	Octal socket, heater voltage ; grid lead to top cap in place of anode lead ; anode connection to pin 3 on octal socket ; reduction in screen voltage
W31	W61	Probably none	As for W30
X21	X22	None	None
X23	X24	None	None except in series operated receivers where X23 must be used
X30 } X32 }	X65	Reduced sensitivity	Octal socket ; heater voltage
X31	X61M	Probably none	Octal socket ; heater voltage
X42	MX40	Slight reduction in sensitivity on short waves	None
X71M	X76M	Probably none	None
X73M	X76M	Probably none	Heater voltage
Z62	Z66	Probably none	None

DETAILS OF MODIFICATION

16 volt 0.25 amp. D.C. Range

Receivers employing the 16 volt 0.25 amp. range of D.C. valves can in general be made to operate by substituting the range of 0.3 amp. octal base valves and changing heater current from 0.25 amp. to 0.3 amp. This necessitates changing the barretter or series resistance to another type of suitable value.

13 volt 0.3 amp. D.C./A.C. Range

Receivers employing 13 volt 0.3 amp. " Universal " range of valves can usually be made to operate by substituting the 0.3 amp. octal base range with suitable modifications as suggested.

4 volt A.C. Mains Range

A.C. mains receivers employing the 4 volt A.C. mains types can usually be maintained, or a substitute found in the 4 volt range with slight modification.

2 volt Battery Range

Receivers with 2 volt battery valves can usually be maintained without modification, except where the filaments are wired in series, where the original types are essential to maintain the original filament current.

O.16/0.17 amp. D.C./A.C. Ranges

The heater currents of the octal based universal valves are either 0.16 amp. or 0.17 amp. and from the heater current point of view all the valves are interchangeable.

The 76 range, used in conjunction with the 161 barretter, has a heater current rating of 0.16 amp. Where recommended valves of this range can be used as replacements for valves with 0.17 amp. heater current, with no alteration to the supply.

Similarly, the 161 barretter (0.16 amp.) will directly replace the earlier 171 barretter (0.17 amp.).

Successful operation of the replacement valves suggested above depends entirely on the equipment in which they are used. Generally speaking it is to be expected that the replacement will be satisfactory.

OSRAM VALVES IN G.E.C. RADIO RECEIVERS

RECEIVER	DESCRIPTION	OSRAM VALVES	OSRAM Dial Lamp	
O.M.M.3 O.M.M.4 OSRAM 4 OSRAM 33	} Music Magnēt	3-valve kit	S.23 H.210 LP.2 or P.2	OS.33†
		4-valve kit	} S.23(m) S.23(m) H.210 LP.2 or P.2	OS.33†
		4-valve kit		
		3-valve kit	S.23(m) S.23(m) LP.2 and increase screen resistance to 100,000 ohms.	OS.33†
BC 3140		4-valve A.C. straight	MS.4 MS.4 MH.4 PX.4 U.10	OS.7588
BC 3145		4-valve D.C. straight	S.24 S.24 H.210 PT.625 and increase screen resistance to 150,000 ohms.	—
BC 3160		Battery s.w. superhet	S.24 H.210 VS.24 VS.24 H.210 P.2 (Increase Grid Bias G.C.1 to —3v.)	—
BC 3161		Battery s.w. superhet	S.24 H.2(m) VS.24 VS.24 H.2(m) KT.2 and shorten valve stands on S.G. valves	—
BC 3235		Compact Three	MS.4 MH.4 PT.4 U.10	OS.55
BC 3240		Table Four	MS.4 MS.4 MH.4 PT.4 U.10	OS.55
BC 3335		Gala	MS.4B(m) MS.4B(m) PT.4 U.12/14	2/OS.55
BC 3336		Gala D.C.	DSB(m) DSB(m) DPT (5)	2/OS.55
BC 3338		Carnival	MS.4B(m) MS.4B(m) PT.4 U.12/14	2/OS.55
BC 3339		Carnival D.C.	DSB(m) DSB(m) DPT (5)	2/OS.55
BC 3340		4-valve A.C. straight	VMS.4(m) MS.4B(m) MS.4B(m) PT.4 U.12/14	2/OS.55
BC 3345		Nomad	DSB(m) DS(m) DSB(m) DPT(5)	—
BC 3358		A.C. Superhet	MS.4B(m) MH.4(m) VMS.4(m) MS.4B(m) PT.4 U.12/14	2/OS.55
BC 3360		Overseas	MS.4B(m) MH.4 MS.4B(m) MS.4B(m) PT.4 U.12/14	2/OS.55
BC 3436		M.C.3	HL.2 HL.2 P.2	OS.50†
BC 3440/1/2/4/8		A.C. Superhet 5	MS.4B VMS.4 MS.4B MKT.4(5) U.12/14	2/OS.55
BC 3445/3/9		D.C. Superhet 5	DSB VDS DSB DPT Barretter 251	2/OS.55
BC 3446		Superhet 6	S.24 L.21 VS.24 HL.2 L.21 B.21	3/OS.50†
BC 3460		Overseas Seven	VMP.4G(m) VMP.4G(m) ML.4 VMP.4G(m) MHD.4 MKT.4 U.12/14	2/OS.55
BC 3466		Battery	VS.24 LP.2 VS.24 VS.24 HD.22 L.21 B.21	3/OS.50†
BC 3480/4		Overseas Seven Superhet 8	VMS.4(m) VMS.4(m) ML.4 VMP.4G MHD.4 MH4 (uncanistered Catkin) MKT.4 U.12/14	2/OS.55
BC 3520		AC-DC.3	H.30 KT.30 U.30 Barretter 301	OS.75
BC 3536		Battery Compact 3	HL.2(m) HL.2(m) P.2	2/OS.50†
BC 3540/4/8/3558		Superhet AVC.5	X.30(m) W.30 DH.30 KT.30 MU.12/14	2/OS.55
BC 3545		Superhet DC.5	DSB VDS DSB DPT Barretter 251	2/OS.75
BC 3546		Battery CB.4	VS.24(m) VP.21(m) L.21 B.21	2/OS.50†
BC 3550/1		Droitwich Super 5	MX.40(m) VMP.4G MHD.4 MKT.4 U.12/14	2/OS.55
BC 3558		Shadow-Band	{ X.30(m) W.30 DH.30 KT.30 U.12/14 MX.40 VMP.4G MHD.4 MKT.4 U.12/14 }	} 2/OS.55
BC 3558R		Radiogram		
BC 3566		Superhet AVC.6	VS.24(m) X.21 VS.24(m) HD.22 L.21 B.21	3/OS.50†
BC 3630/1		A.C. Mains 4	VMS.4(m) MS.4B KT.41 U.12/14	—
BC 3636		Battery SG.3	VS.24(m) VP.21(m) KT.2	OS.50†
BC 3640		Superhet AC.4	MX.40(m) VMP.4G(m) DN.41 U.12/14	2/OS.36
BC 3645		Superhet DC-AC.4	X.30(m) W.31(m) D.41(m) N.31 U.30 Barretter 304	2/OS.75
BC 3650/1/8/9/L		Fidelity A.C.5	MX.40(m) VMP.4G(m) MHD.4 MKT.4 U.12/14 Tuneon	2/OS.55
BC 3657		Car Radio	W.30 X.30 W.30 DH.30 KT.30	OS.35
BC 3646		Battery Superhet 4	X.21 VS.24(m) HD.22 QP.21	3/OS.50†
BC 3730/L/31		AC.37	VMS.4B(m) VMS.4(m) KT.41 U.12/14	2/OS.55
BC 3736		Battery T.R.F.3	VS.24(m) VP.21(m) KT.2	OS.33†
BC 3740/L/48/L		A.C. Super 4	X.41(m) VMP.4G(m) D.41(m) KT.41 U.12/14	2/OS.55
BC 3745		Universal SW.4	X.31(m) W.31(m) D.41(m) KT.31 U.30 Barretter 304	2/OS.75
BC 3746		Battery Super 4	X.21(m) VS.24(m) HD.22 QP.21	3/OS.50†
BC 3750/L/58/L		Fidelity Short Wave 5	X.41(m) W.42 MHD.4 KT.41 U.12/14	2/OS.55
BC 3754/L		A.C. Transportable 5 (Superhet)	VMP.4G(m) X.41 VMP.4G(m) D.41(m) KT.41 U.12/14 Button Tuneon	4/OS.55
BC 3760/62		A.C. All-Wave 6 (Superhet)	W.42 X.41 W.42 DH.42 KT.42 U.12/14 Button Tuneon	4/OS.55
BC 3766		Fidelity All-Wave Battery Receiver (Superhet)	VS.24(m) X.21(m) VS.24(m) VS.24(m) HD.22 QP.21	3/OS.50†
BC 3780/81/82		Fidelity All-Wave	VMS.4 X.41(m) 2-VMP.4G MHD.4 2-MKT.4 U.12/14	2/OS.55
BC 3836		Battery SP.3 (T.R.F.)	W.21(m) VP.21(m) KT.2	—
BC 3846		Battery All-Wave 4 (Superhet)	X.22(m) W.21(m) HD.22 KT.2	2/OS.17
BC 3856		Battery All-Wave	X.22(m) W.21(m) HD.22 QP.21	2/OS.17
		Q.P.P.4		OS.50†
BC 3840/40L		AC.38 (T.R.F.)	KTW.63 KTW.63 KT.63 U.50	2/OS.75
BC 3850/50L		A.C. All-Wave 5 (Superhet)	X.42 W.42 DH.42 KT.42 U.12/14	2/OS.70
BC 3866		6-volt All-Wave 6	VS.24(m) X.21(m) VS.24(m) VS.24(m) HD.22 QP.21	2/OS.50
BC 3860/60L/68		A.C. All-Wave Super 6 (Superhet)	KTW.63 X.41 KTW.63 HD.63 KT.63 U.50 Y.63	2/OS.75
BC 3855/57		Universal All-Wave 5 (Superhet)	X.63 KTW.63 DH.63 KT.30 U.30 Barretter 302	2/OS.75
BC 3862/62L		A.C. All-Wave Super 6	KTW.63 X.65 KTW.63 DH.63 KT.63 U.50 Y.63	2/OS.75
BC 3865		} Universal All-Wave Super 6 (Superhet)	KTW.63 X.31 KTW.63 DH.63 KT.30 U.30 Barretter 304 Y.64	} 2/OS.75
BC 3867			KTW.63 X.65 KTW.63 DH.63 KT.30 U.30 Barretter 304 Y.64	
BC 3880/82/88/89		Fidelity All-Wave 8 Radiogram (Superhet)	VMS.4 X.41(m) VMP.4G(m) VMP.4G(m) MHD.4 2-MKT.4 U.12/14	4/OS.55

(m) indicates metallised valve.

(5) indicates 5-pin and side terminal base.

†used as fuse; ‡one used as fuse.

Osram Valves in G.E.C. Radio Receivers—continued

RECEIVER	DESCRIPTION	OSRAM VALVES	OSRAM Dial Lamp
BC 3890/90L ...	A.C. All-Wave Quality 8 (Superhet) ...	KTW.63 X.41 KTW.63 DH.63 KTW.63 2-PX4 U.50 Y63	2/OS.75
BC 3892/92L ...	A.C. All-Wave Quality 8	KTW.63 X.65 KTW.63 DH.63 KTW.63 2-KT.63 U.50 Y.63	2/OS.75
BC 3936 ...	Battery 3 ...	W.21(m) Z.21(m) KT.21	—
BC 3946 ...	Battery All-Wave 4 ...	X.22(m) W.21(m) HD.22 KT.21	{2/OS.17 OS.50†
BC 3956 ...	Battery Touchtune 5	X.22(m) W.21(m) HD.22 2-KT.2	{2/OS.17 OS.50†
BC 3910H	Fidelity All-Wave ...	} KTW.63 X.65 KTW.63 DH.63 KTW.63 2-KT.66 U.52 Y.63	4/OS.75
BC 3918H (R/Gram)	Super 10 ...		
BC 3940 ...	A.C.5 ...	X.63 KTW.63 DH.63 KT.63 U.50	2/OS.75
BC 3942 ...	"Overseas" A.C.5 ...	X.65 KTW.63 DH.63 KT.63 U.50	2/OS.75
BC 3950 ...	A.C. All Wave ...	} X.65 KTW.63 DH.63 KT.63 U.50	2/OS.75
BC 3960/4/8 ...	A.C. Touchtune 5 ...		
BC 3955/57(Overseas)	D.C./A.C. All Wave 5 ...	} X.65 KTW.63 DH.63 KT.32 U.31 Barretter 304	2/OS.75
BC 3965/7/9 ...	D.C./A.C. Touchtune 5 ...		
BC 3966 ...	6 Volt 6 ...	X.23 2-W.21(m)4 HD.23 2-KT.2	2/OS.50
BC 3970 ...	A.C. Selectalite 6 ...	KTW.63 X.65 KTW.63 DH.63 KT.66 U.50 Y.63	7/OS.75
BC 3972/8 ...	A.C. Fidelity All-Wave Super Seven ...	KTW.63 X.65 KTW.63 DH.63 KT.66 U.50 Y.63	2/OS.75
BC 3977/9 ...	D.C./A.C. Fidelity All-Wave Super Seven ...	KTW.63 X.65 KTW.63 DH.63 KT.33C Y.64 U.31 Barretter 304	2/OS.75
BC 4040/L ...	...	X.63 KTW.61 DL.63 KT.61 U.50	OS.75
BC 4045 ...	...	X.63 KTW.61 DL.63 KT.33C U.31 Barretter 304	OS.75
BC 4046 ...	...	X.22 W.21(m)4 HD.23 KT.21	OS.60†
BC 4050/L/54/L/58/L	...	X.41 KTW.61 DH.63 KT.61 U.50	2/OS.75
BC 4055/51/59 ...	...	X.31 KTW.61 DL.63 KT.33C U.31 Barretter 304	2/OS.75
BC 4056/66 ...	...	X.22 W.21(m)4 HD.23 2-KT.2	{2/OS.17 OS.50†
BC 4060 ...	...	X.41 KTW.61 DL.63 KT.61 U.50	4/OS.75
BC 4065 ...	...	X.31 KTW.61 DL.63 KT.33C U.31 Barretter 304	4/OS.75
BC 4070 ...	...	KTW.61 X.65 KTW.61 DL.63 KT.61 Y.63 U.50	4/OS.75
BC 4010/18 ...	Overseas Ten ...	KTW.61 X.65 KTW.61 KTW.61 DL.63 DL.63 Y63 2-KT.61 U.50	4/OS.75
BC 4141 ...	Battery ...	X.14 Z.14 HD.14 N.14	—
BC 4157 ...	A.C./D.C. ...	X.65 KTW.61 DL.63 KT.33C Barretter 304	—
BC 4166 ...	Battery ...	W.21/4 X.24 W.21/4 HD.24 2-KT.2	—
BC 4172/3-3L/8L-8RL	A.C. ...	KTW.61 X.65 KTW.61 DL.63 KT.66 Y.63 U.50	—
BC 4177/79R ...	A.C./D.C. ...	KTW.61 X.65 KTW.61 DL.63 KT.33C U.31 Y.64 Barretter 304	—
BC 4177U ...	A.C./D.C. ...	KTW.61 X.65 KTW.61 DL.63 KT.33C U.31 Y.64	—
BC 4237 ...	A.C./D.C. ...	X.71M KTW.73M DH.73M KT.72 U.71 Barretter 161	—
BC 4242-L/3 ...	A.C. ...	X.61M KTW.61 DL.63 KT.61 U.50	—
BC 4247 ...	A.C./D.C. ...	X.61M KTW.61 DL.63 KT.35 U.31 Barretter 304	—
BC 4262-L/3 ...	A.C. ...	KTW.61 X.61M KTW.61 DL.63 KT.61 U.50	—
BC 4367 ...	A.C./D.C. ...	KTW.61 X.61M KTW.61 DL.63 KT.35 U.31 Barretter 304	—
BC 4637 ...	A.C./D.C. ...	X.76M W.76 DH.76 KT.76 U.76 Barretter 161	—
BC 4641 ...	Battery ...	X.14 Z.14 HD.14 N.14	—
BC 4650-L/2/2L ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 4655/7 ...	A.C./D.C. ...	X.61M KTW.61 DH.63 KT.33C U.31 Barretter 304	—
BC 4666/V ...	Battery ...	W.21/4 X.24 W.21/4 HD.24 2-KT.2	—
BC 4672-L/3/8/L ...	A.C. ...	KTW.61 X.65 KTW.61 DH.63 KT.66 Y.61 U.50	—
BC 4677 ...	A.C./D.C. ...	KTW.61 X.65 KTW.61 DH.63 KT.33C U.31 Y.62 Barretter 304	—
BC 4750-L/8-8R ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 4835-R/7 ...	A.C./D.C. ...	X.76M W.76 DH.76 KT.76 U.76 Barretter 161	—
BC 4850-L ...	A.C. ...	X.61M KT.W61 DH.63 KT.61 U.50	—
BC 4855 ...	A.C./D.C. ...	X.61M KTW.61 DH.63 KT.33C U.31 Barretter 304	—
BC 4940-L ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 4941 ...	Battery ...	X.17 W.17 ZD.17 N.17	—
BC 4956 ...	Battery ...	X.24 W.21 HD.24 2-KT.2	—
BC 4962/72-R/78 ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 4967/77-R/79 ...	A.C./D.C. ...	X.61M KTW.61 DH.63 KT.33C U.31 Barretter 304	—
BC 5045 ...	A.C. ...	W.77 X.81 W.77 DH.77 2-KT.81 U.81	—
BC 5050-L/54 ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 5052-L ...	A.C. ...	X.61M KTW.61 DH.63 KT.61 U.50	—
BC 5055 ...	A.C./D.C. ...	X.61M KT.W61 DH.63 KT.33C U.31 Barretter 304	—
BC 5057 ...	A.C./D.C. ...	X.61M KTW.61 DH.63 KT.33C U.31 Barretter 304	—
BC 5060-L/68-L ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 5070-L ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 5076 ...	Battery ...	X.61M W.61 DH.63 2-KT.2	—
BC 5082-L/88L ...	A.C. ...	W.77 X.81 W.77 DH.77 2-KT.81 U.81	—
BC 5086 ...	Battery ...	W.77 X.81 W.77 DH.77 4-KT.2	—
BC 5087/89 ...	A.C./D.C. ...	W.107 X.101 W.107 DH.107 2-KT.101 2-U.101	—
BC 5243 ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 5441-L ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 5639 ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 5837 ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—
BC 6242 ...	A.C./D.C. ...	X.61M W.61 DH.63 KT.33C U.31 Barretter 304	—
BC 6638 ...	A.C./D.C. ...	X.61M W.61 DH.63 KT.33C U.31 Barretter 304	—
BC 2345 ...	Battery ...	X.61M W.61 DH.63 N.78	—
BC 2543 ...	Battery ...	X.61M W.61 DH.63 N.78	—
BC 9239 ...	A.C. ...	X.61M W.61 DH.63 KT.61 U.50	—

(m) indicates metallised valve.

†used as fuse.

OSRAM VALVES IN G.E.C. TELEVISION RECEIVERS

TELEVISION RECEIVER	OSRAM VALVES
BT 0070	5-KTZ.41 X.62 KTZ.63 2-BL.62 KT.44 U.134 U.16
BT 0091	5-KTZ.41 X.62 KTZ.63 KTW.61 DH.63 KT.61 2-BL.62 KT.44 U.134 U.16
BT 0092	As BT 0091
BT 0124	6-KTZ.41 2-X.41 D.42 MS.4B 2-KTW.61 D.63 2-GT.1B 2-KT.66 DH.63 KT.61 U.50 2-MU.14 U.16 CRT.4603
BT 1091 A-B-C/93	6-Z.77 4-L.63 2-D.77 2-KT.61 2-MU.14 W.77 DH.77 U.37 EL.38 (Mullard) CRT.6504A
BT 2147	7-Z.77 2-D.77 DH.77 2-N.37 B.36 KT.36 U.37 U.31 CRT.6505A
BT 3443	7-Z.77 3-D.1 (Mazda) 2-W.81 X.81 DL.82 2-KT.81 4-L.63 KT.45 2-MU.14 U.33 CRT.6504A
BT 3701	5-MSP.41 X.41 VMP.4G A.748 N.43 D.41 2-GT.1B. 4-MH.4 2-U.17 MU.14 CRT.4603
BT 3702	As BT 3701, but in addition : VMS.4 X.41 2-VMP.4G MHD.4 2-MKT.4 U.14
BT 3839	As BT 3443
BT 4640-C	As BT 1091A-B-C/93, but CRT.6703A
BT 5144	As BT 2147, but CRT.6704A
BT 7092/4	As BT 3443
BT 8090	X.41 4-MSP.41 VMP.4G 2-D.42 MS.4B 2-GT.1B 2-ML.4 MU.14 U.16 CRT.4301
BT 8121/61	2-VMP.4G X.41 KTW.63 DH.63 KT.63 2-MSP.41M 3-N.43 2-D.42 MS.4BM 2-GT.1B 2-KT.66 Y.63 U.50 U.16 (0.25 amp.) MU.14 CRT.4602
BT 9121	6-KTZ.41 X.41 D.42 MS.4B KTW.63 DH.63 KT.63 2-GT.1B 2-KT.66 2-MU.14 U.16 CRT.4603
BT 9122	As BT 9121
BT 9144-M	8-Z.77 3-D1 (Mazda), 2-W.81 X.81 DL.82 2-KT.81 4-L.63 KT.45 MU.14 U.81 U.33 CRT.6801A

OSRAM VALVES IN G.E.C. COMMUNICATION EQUIPMENT

CAT. NO.	DESCRIPTION	OSRAM VALVES
BRT 107	100 watt frequency modulated V.H.F. transmitter/receiver	22-Z.77 TT.15 3-DET.18 2-N.77 3-U.81 2-U.19
BRT 154	15/20 watt frequency modulated V.H.F. transmitter/receiver	22-Z.77 TT.15 2-N.77
BRT 205	15/20 watt frequency modulated V.H.F. transmitter/receiver	22-Z.77 TT.15 2-N.77 3-U.81
BRT 400	Communications receiver	4-W.81 X.81 N.77 DH.81 D.63 2-KT.81 2-Z.77 U.52 S.130
BRT 410	Spot frequency H.F. receiver	3-W.61 X.61M 3-Z.90 D.63M DH.63 2-KT.61 U.52
BRT 450	150 watt transmitter (single channel)	TT.11 KT.8 3-L.63 D.63 2-W.61 2-KT.66 2-DA.41 2-U.52 4-U.19 S.130
BRT 455	150 watt transmitter (two channel)	2-TT.11 2-KT.8 3-L.63 D.63 2-W.61 2-KT.66 2-DA.41 3-U.52 6-U.19 2-S.130
BRT 600	V.H.F. aircraft transmitter/receiver	8-Z.77 N.77 2-D.77
BRT 1000	1 kW. transmitter (grid modulated)	2-ACPT.8 3-D.63 4-H.63 2-KT.8 N.77 7-Z.77 2-L.63 2-W.61 2-KT.61 12-U.19 STV.280/80 STV.280/80A
BRT 1002	1 kW. transmitter (anode modulated)	2-ACPT.8 2-D.63 3-H.63 L.63 4-KT.8 N.77 8-Z.77 4-DA.250 2-KT.61 2-W.61 24-U.19 4-U.52 2-STV.280/40G
BRT 1010	Frequency modulated V.H.F. transmitter	7-ACT.19 6-Z.63 TT.11 KT.8 2-X.81 6-Z.66 2-D.63 CRT E.4412/B/9

TYPICAL CIRCUITS

The circuit information given in this publication does not imply any license under patents which may be involved.

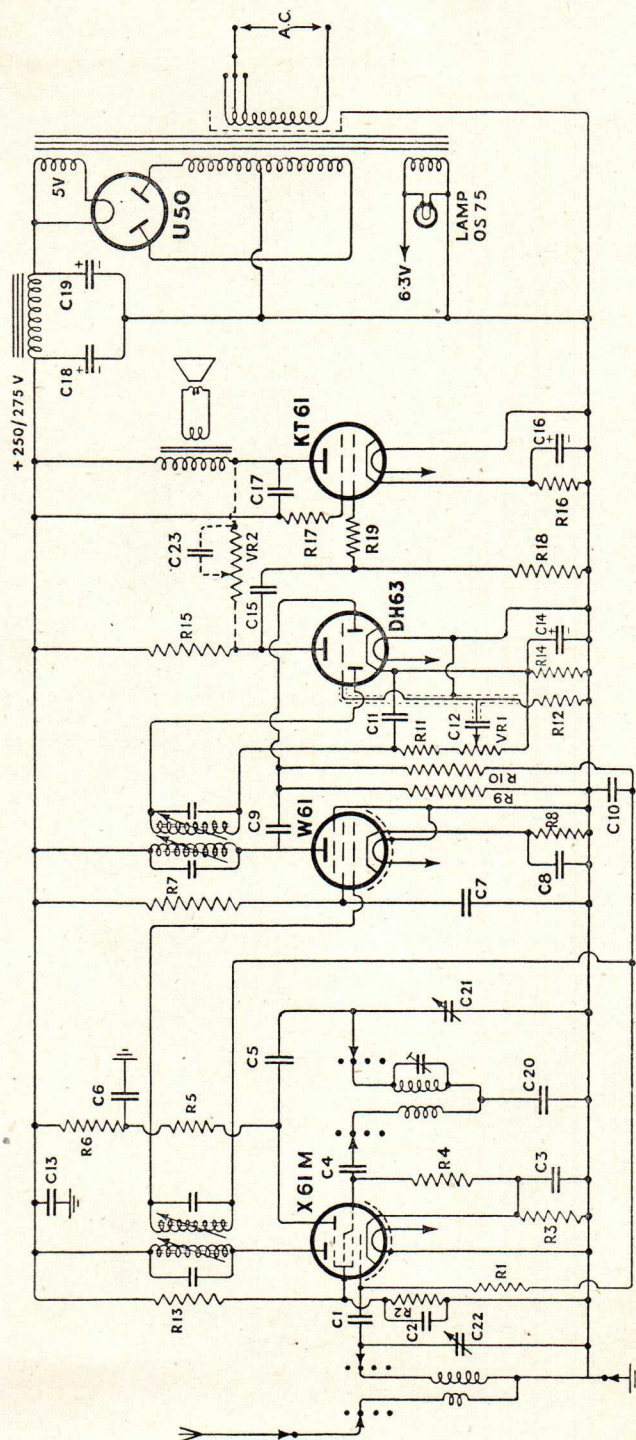
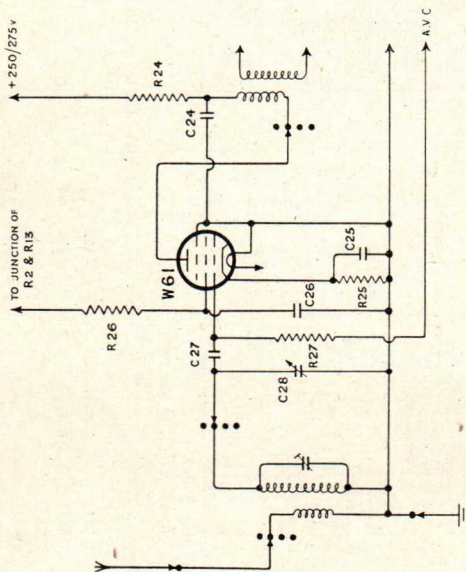


FIG. 1. CIRCUIT FOR 5 VALVE RECEIVER USING 61/63 RANGE VALVES

- | | | |
|--------------------|--------------------------|--------------------------------|
| R1. 1 MΩ | R12. 1 MΩ | C13. 0.1 μF. |
| R2. 10 KΩ | R13. 15 KΩ | C14. 50 μF. |
| R3. 220 Ω | R14. 2.2 KΩ | C15. .01 μF. |
| R4. 47 KΩ | R15. 220 KΩ | C16. 50 μF. |
| R5. 33 KΩ | R16. 100 Ω | C17. 2,000 pF. |
| R6. 22 KΩ | R17. 100 Ω | C18. 16 μF. |
| R7. 77 KΩ | R18. 470 KΩ | C19. 400v. Electrolytic |
| R8. 220 Ω | R19. 47 KΩ | C20. 400v. Electrolytic |
| R9. 560 KΩ | VR1. 0.5 MΩ taper | C21. 450 pF. |
| R10. 560 KΩ | VR2. 1 MΩ | C22. 450 pF. |
| R11. 47 KΩ | | C23. 200/500 pF. |

All resistors 1/2 watt unless otherwise stated.

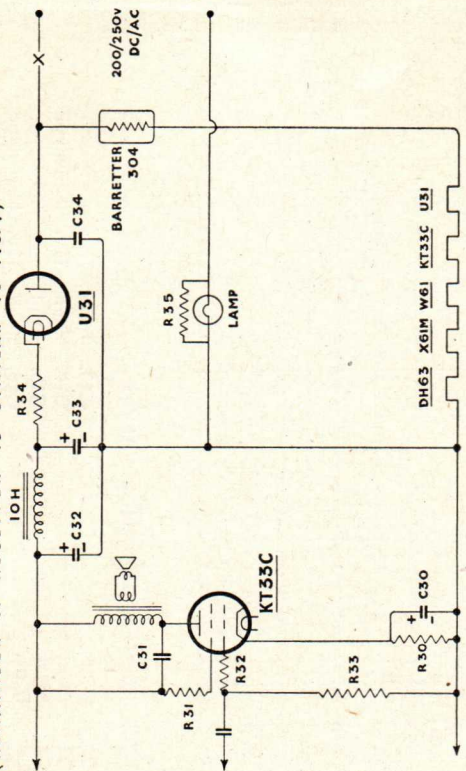
RF AMPLIFIER FOR USE WITH FIG. 1.



- R24. 2.2 K Ω
 R25. 220 Ω
 R26. 2.2 K Ω
 R27. 1 M Ω

- C24. 0.1 μ F.
 C25. 0.1 μ F.
 C26. 0.1 μ F.
 C27. 47 pF.
 C28. 450 pF.

OUTPUT STAGE & POWER SUPPLY FOR DC/AC RECEIVER
 (REMAINDER OF RECEIVER IS SIMILAR TO FIG. 1)



- R30. 220 Ω
 R31. 100 Ω
 R32. 47 K Ω
 R33. 470 K Ω
 R34. 100 Ω 3 watts
 R35. Lamp Shunt.

- C30. 25 μ F. 12v. Electrolytic
 C31. 2,000 pF.
 C32. 30 μ F. 350v. Electrolytic
 C33. 30 μ F. 350v. Electrolytic
 C34. 2,000 pF.

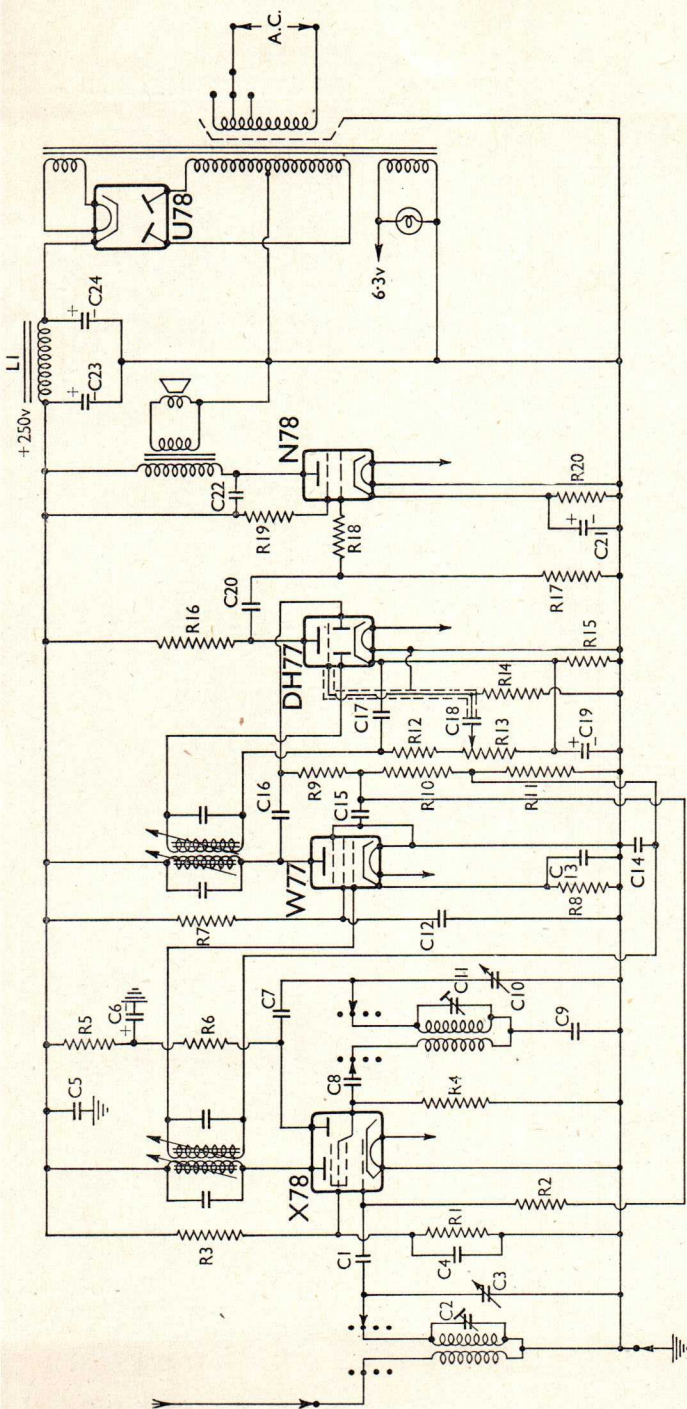


FIG. 2. CIRCUIT FOR 5 VALVE AC RECEIVER USING MINIATURE VALVES

- R1. 10 KΩ 1 watt
 R2. 1 MΩ
 R3. 15 KΩ 1 watt
 R4. 50 KΩ
 R5. 22 KΩ ½ watt
 R6. 33 KΩ ½ watt
 R7. 10 KΩ
 R8. 270 Ω
 R9. 220 KΩ
 R10. 560 KΩ
 R11. 560 KΩ

- R12. 47 KΩ
 R13. 500 KΩ
 R14. 1 MΩ
 R15. 2.2 KΩ
 R16. 220 KΩ
 R17. 470 KΩ
 R18. 47 KΩ
 R19. 100 Ω
 R20. 120 Ω

- L1. 10H 75 mA.

- C1. 47 pF.
 C2. 47 pF.
 C3. 500 pF. (Twin Gang)
 C4. 0.1 mfd.
 C5. 0.1 mfd.
 C6. 4 mfd. 350v. Electrolytic
 C7. 2,000 pF.
 C8. 47 pF.
 C9. Oscillator Padder.
 C10. 500 pF.
 C11. 0.1 mfd.
 C12. 0.1 mfd.

- C13. 0.1 mfd.
 C14. 0.1 mfd.
 C15. 0.05 mfd.
 C16. 47 pF.
 C17. 47 pF.
 C18. 0.01 mfd.
 C19. 50 mfd. 12v. Electrolytic
 C20. 0.01 mfd.
 C21. 50 mfd. 12v. Electrolytic
 C22. 2,000 pF.
 C23. 16 mfd. 350v. Electrolytic
 C24. 16 mfd. 350v. Electrolytic

All resistors 1/2 watt unless otherwise stated.

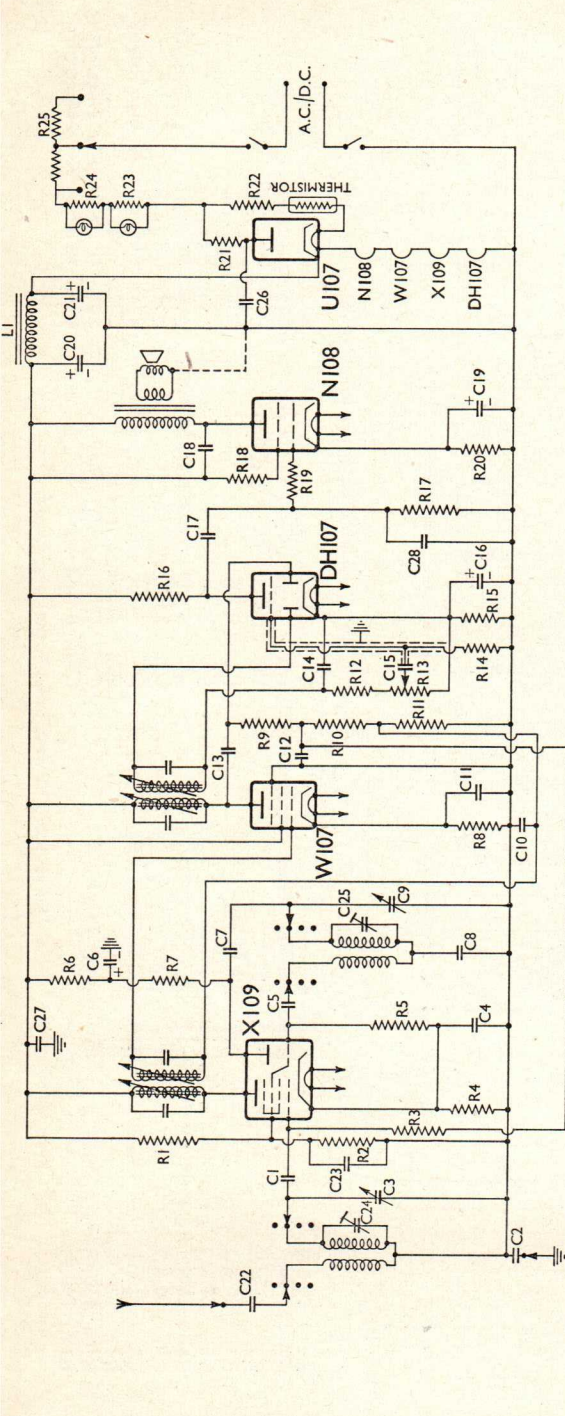


FIG. 3. CIRCUIT FOR 5 VALVE AC/DC RECEIVER USING MINIATURE VALVES

- R1. 15 K Ω 1 watt
 R2. 10K Ω 1 watt
 R3. 1 M Ω
 R4. 220 Ω
 R5. 47 K Ω
 R6. 22 K Ω $\frac{1}{2}$ watt
 R7. 33 K Ω $\frac{1}{2}$ watt
 R8. 270 Ω
 R9. 220 K Ω
 R10. 560 K Ω
 R11. 560 K Ω
 R12. 47 K Ω
 R13. 500 K Ω Taper Potentiometer

- R14. 1 M Ω
 R15. 2.2 K Ω
 R16. 220 K Ω
 R17. 470 K Ω
 R18. 100 Ω
 R19. 47 K Ω
 R20. 150 Ω
 R21. 100 Ω 2 watt
 R22. 600 Ω 10 watt
 R23. } Lamp Shunts
 R24. }
 R25. 500 K Ω Mains Voltage Adjustment

- C1. 47 pF.
 C2. 0.02 mfd.
 C3, C9 500 pF. (Twin Gang)
 C4. 0.1 mfd.
 C5. 47 pF.
 C6. 4 mfd. 350v. Electrolytic
 C7. 2,000 pF.
 C8. Oscillator Padder.
 C10. 0.1 mfd.
 C11. 0.1 mfd.

- C12. 0.05 mfd.
 C13. 47 pF.
 C14. 47 pF.
 C15. 0.01 mfd.
 C16. 50 mfd. 12v. Electrolytic
 C17. 0.01 mfd.
 C18. 2,000 pF.
 C19. 50 mfd. 12v. Electrolytic
 C20. 32 mfd. 350v. Electrolytic
 C21. 32 mfd. 350v. Electrolytic
 C22. 1,000 pF.
 C23. 0.1 mfd.
 C24. Aerial Circuit Trimmer
 C25. Oscillator Trimmer
 C26. 2,000 pF.
 C27. 0.1 mfd.
 C28. 100 pF.

- L1. 10H 75 mA.

All resistors $\frac{1}{3}$ watt unless otherwise stated.

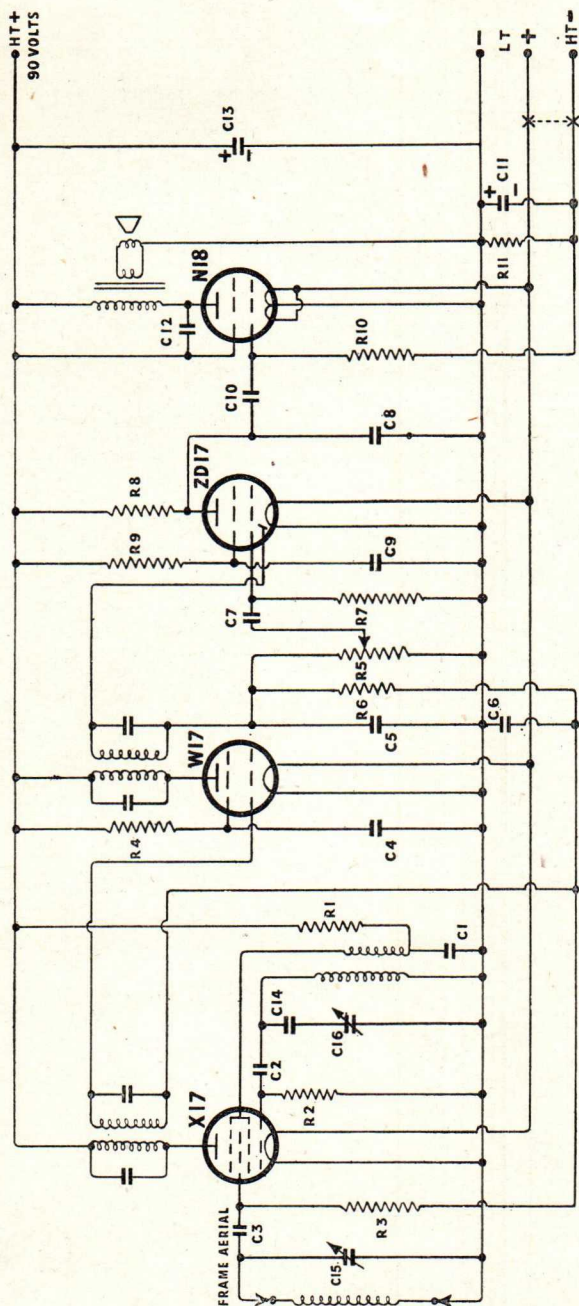


FIG. 4. TYPICAL CIRCUIT USING BATTERY MINIATURE VALVES

- R1.** 15 K Ω
R2. 100 K Ω
R3. 1 M Ω
R4. 15 K Ω
R5. 1 M Ω
R6. 2.2 M Ω
R7. 10 M Ω
R8. 1 M Ω
R9. 3.3 M Ω
R10. 2.2 M Ω

- R11.** 470 Ω

- C1.** 0.05 μ F.
C2. 47 pF.
C3. 47 pF.
C4. 0.05 μ F.
C5. 47 pF.
C6. 0.05 μ F.
C7. 2,000 pF.

- C8.** 47 pF.
C9. 0.05 μ F.
C10. 2,000 pF.
C11. 20 μ F.
C12. 2,000 pF.
C13. 8 μ F. 100v. Electrolytic
C14. 470 pF.
C15. 350 pF.
C16. 350 pF.

All resistors $\frac{1}{4}$ watt.

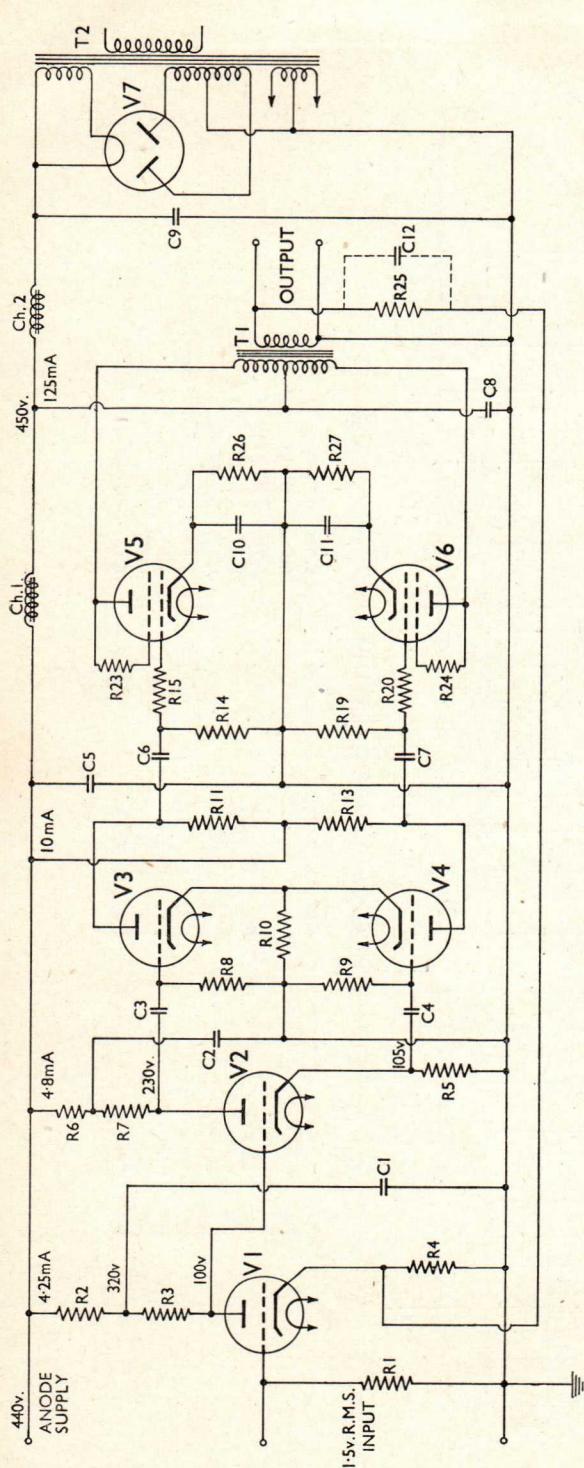


FIG. 5. QUALITY AMPLIFIER (A.C. MAINS)

R1. 1 MΩ
R2. 33 KΩ 1 watt
R3. 47 KΩ 1 watt
R4. 470 Ω
R5, R6, R7 22 KΩ 1 watt
R8, R9 0.47 MΩ

R10. 390 Ω
R11, R13 56 KΩ 2 watt
R14, R19. 0.1 MΩ
R15, R20. 1,000 Ω
R23, R24. 100 Ω ½ watt
R25. 1200 $\sqrt{s}$ Ω
 (s = speech coil impedance)
R26, R27. 500 Ω 5 watt

C1, C2, C5. 8 mfd. 450v. Electrolytic
C3, C4. 0.05 mfd.
C6, C7. 0.25 mfd.
C8. 8 mfd. 550v. Electrolytic
C9. 8 mfd. 600v. Electrolytic
C10, C11. 50 mfd. 50v. Electrolytic
C12. 30-300 pF.
T1. 20 watt output transformer,
 ratio $\sqrt{10,000^*}$
 s

CH1. 30 H. 20 mA.
CH2. 10 H. 150 mA.
V1, V2, V3. Osram L63 or B65
 (twin triode) for V1, V2 and
 V3, V4
V5, V6. Osram KT66.
V7. Osram U52.

T2. Power transformer, Secondary
 425-0-425v. 150 mA., 5v. 3A.,
 6.3v. 4A. CT.

All resistors ½ watt unless otherwise stated.

* Pure Class A condition. For maximum power output turns ratio = $\sqrt{\frac{4,000}{s}}$

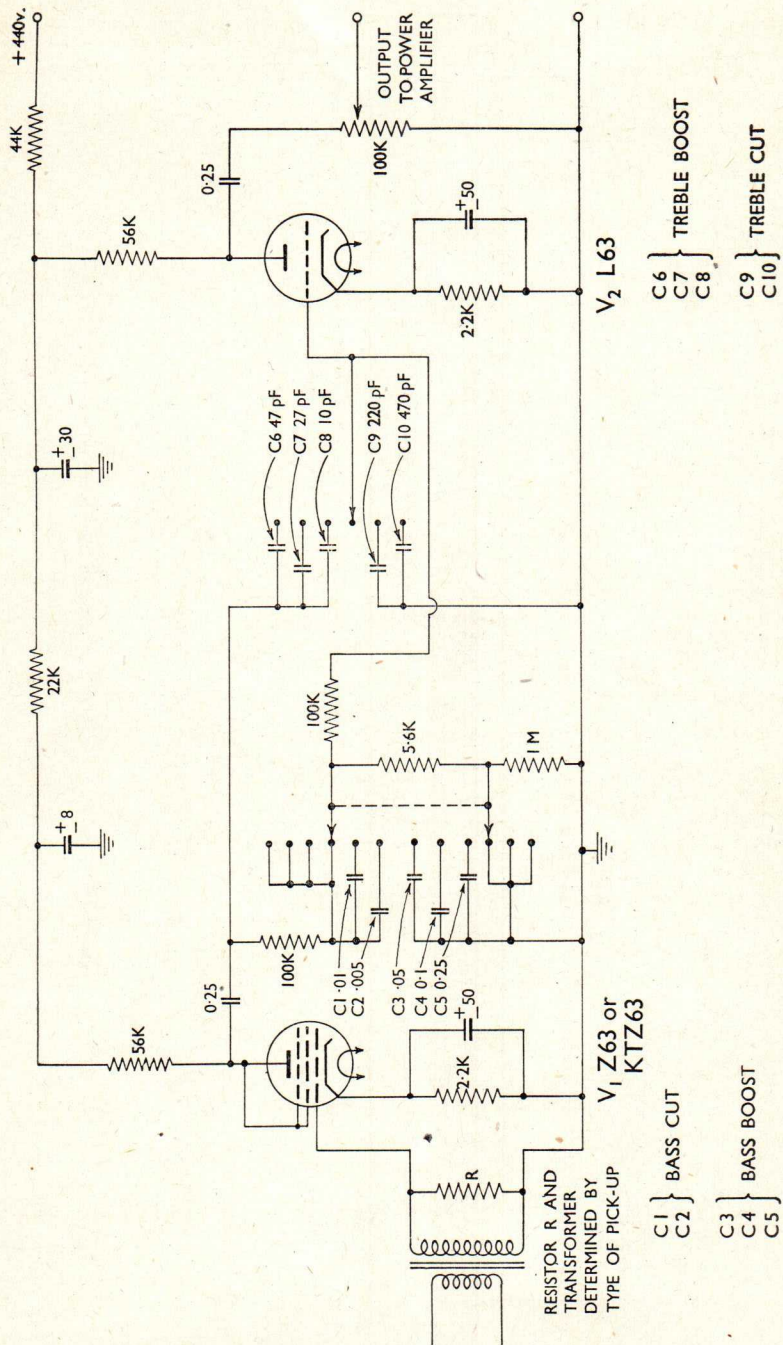


FIG. 6. TWO-STAGE INPUT AMPLIFIER, OVERALL GAIN 20 db, SUITABLE FOR USE WITH FIG. 5.

Fig. 7 shows the circuit diagram of a radio receiver intended for use with the quality amplifier shown in Fig. 5.

A well smoothed H.T. supply of 200/250 volts is required at 20 mA. The values given for R30, R31 assume a voltage of 450 for the main amplifier.

Variable selectivity is provided in the I.F. stage, the two bandwidths being about 5 and 16 kc/s. Switches S1, S2, S3 and S4 can conveniently be ganged to form a four pole, three position switch to provide radio reception with two bandwidths and gramophone.

Switch S8 enables either one or both sections of the B65 double triode to be put into circuit. The use of both sections should be restricted to pick-ups having a low output when used with long playing records, as otherwise distortion may result due to overloading the second half of the valve.

COMPONENTS LIST FOR FIG. 7

Resistors all $\frac{1}{2}$ watt unless otherwise stated.

R1.	33 K Ω	2 watt	C5.	100 pF.	
R2.	22 K Ω	1 watt	C6.	0.1 mfd.	
R3.	1 M Ω		C7.	0.1 mfd.	
R4.	220 Ω		C8.	2,000 pF.	
R5.	10 K Ω		C9.	100 pF.†	
R6.	2.2 K Ω		C10.	0.05 mfd.	
R7.	100 Ω		C11.	0.05 mfd.	
R8.	47 K Ω		C12.	2,000 pF.	
R9.	47 K Ω	1 watt	C13.	100 pF.†	
R10.	66 K Ω		C14.	200 pF.	
R11.	220 Ω		C15.	200 pF.	
R12.	47 K Ω		C16.	220 pF.	
R13.	depends on P.U. and transformer		C17.	750 pF.	Included in tuner*
R14.	1 M Ω		C18.	0.05 mfd.	
R15.	2.2 K Ω		C19.	100 pF.	Included in tuner*
R16.	22 K Ω		C20.	100 pF.	Included in tuner*
R17.	150 K Ω		C21.	100 pF.	
R18.	560 K Ω		C22.	0.05 mfd.	
R19.	560 K Ω		C23.	100 pF.	
R20.	560 K Ω		C24.	100 pF.	
R21.	2.2 M Ω		C25.	0.05 mfd.	
R22.	330 K Ω		C26.	30 mfd. 450v. Electrolytic	
R23.	10 K Ω		C27.	50 mfd. 12v. Electrolytic	
R24.	47 K Ω		C28.	0.05 mfd.	
R25.	47 K Ω	1 watt	C29.	0.05 mfd.	
R26.	1.5 K Ω		C30.	20 pF.	
R27.	1.5 K Ω		C31.	5,000 pF.	
R28.	47 K Ω	1 watt	C32.	2,000 pF.	
R29.	1 M Ω		C33.	0.1 mfd.	
R30.	5.6 K Ω	2 watt	C34.	0.05 mfd.	
R31.	5.6 K Ω	2 watt	C35.	0.02 mfd.	
R32.	27 K Ω		C36.	0.01 mfd.	
VR1.	100 K Ω pre-set		C37.	330 pF.	
VR2.	100 K Ω Volume Control		C38.	1,000 pF.	
VR3.	50 K Ω Wire Wound		C39.	50 mfd. 12v. Electrolytic	
C1.	15 pF.	Included in tuner*	C40.	0.02 mfd.	
C2.	200 pF.		C41.	0.25 mfd.	
C3.	220 pF.	Included in tuner*	C42.	16 mfd. 450v. Electrolytic	
C4.	0.05 mfd.		C43.	16 mfd. 450v. Electrolytic	
			C44.	2,000 pF.	
			C45.	2,000 pF.	

* A typical tuner unit is that manufactured by Electro Technical Assemblies, type TS41.

† Actual value depends upon the make of transformer used.

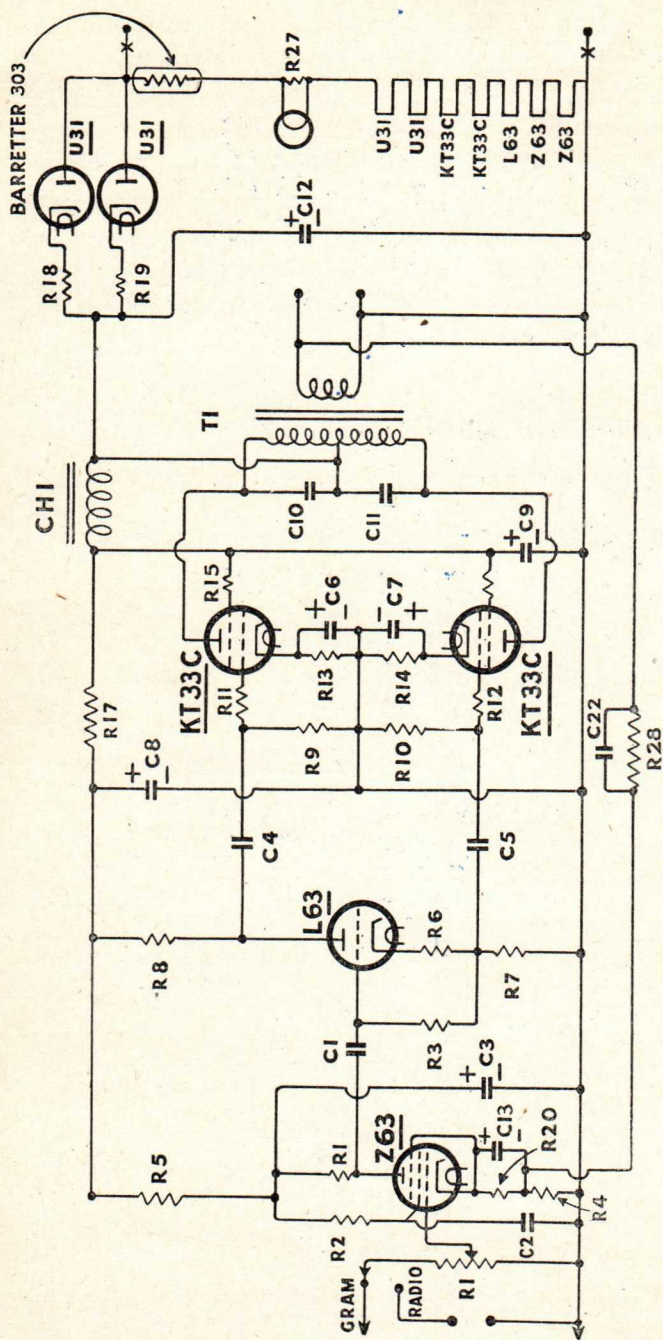


FIG. 8. DC/AC QUALITY AMPLIFIER USING OSRAM KT33C OUTPUT VALVES.

- | | | | |
|----------------------------|---|--------------------------------------|--|
| R1. 220 K Ω | R12. 15 K Ω | C1. 0.05 mfd. | C8. 30 mfd. 350v. Electrolytic |
| R2. 1 M Ω | R13. 220 Ω 1 watt | C2. 0.25 mfd. | C9. 30 mfd. 350v. Electrolytic |
| R3. 2.2 M Ω | R14. 220 Ω 1 watt | C3. 4 mfd. 350v. Electrolytic | C10. 1,500 pF. |
| R4. 47 Ω | R15. 100 Ω | C4. 0.1 mfd. | C11. 1,500 pF. |
| R5. 15 K Ω | R16. 100 Ω | C5. 0.1 mfd. | C12. 30 mfd. 450v. Electrolytic |
| R6. 1.5 K Ω | R17. 15 K Ω 1 watt | C6. 25 mfd. 25v. Electrolytic | C13. 50 mfd. 12v. Electrolytic |
| R7. 15 K Ω | R18. 100 Ω 5 watt | C7. 25 mfd. 25v. Electrolytic | C22. 0.05—0.002 mfd. |
| R8. 15 K Ω | R19. 100 Ω 5 watt | | |
| R9. 220 K Ω | R20. 2.2 K Ω | | |
| R10. 220 K Ω | R27. 22 Ω 3 watt | | |
| R11. 15 K Ω | R28. 150 $\sqrt{\text{speech coil impedance}}$ | | |

USEFUL FORMULÆ AND DATA

With the exception of symbols for voltage and current, symbols applying to a valve itself are denoted by letters in small type.

Symbols applying to associated circuits are denoted by letters in capital type.

R.M.S. voltage or current = peak voltage or current $\times 0.707$.

Peak voltage or current = R.M.S. voltage or current $\times 1.414$.

Mutual conductance = $g_m = \frac{\mu \times 1000}{r_a}$ mA/V

Amplification factor = $\mu = \frac{g_m \times r_a}{1000}$

Anode impedance = $r_a = \frac{\mu \times 1000}{g_m} \Omega$

Stage gain = $A = \frac{\mu \times R_a}{R_a + r_a}$ Where R_a = anode load resistance.

In the case of pentodes R_a is usually small compared with r_a . Hence for pentode stages :

$A = \frac{g_m \times R_a}{1000}$ gives an approximate result.

Automatic grid bias. The value required for the cathode resistor :

$R_k = \frac{V_g \times 1000}{I_k} \Omega$ where I_k is the cathode current in mA.

Conversion conductance (g_c) = Mutual conductance measured with oscillator operating under optimum conditions, with output frequency equal to the difference between input and oscillator frequencies.

Conversion gain = $\frac{\text{I.F. Output Voltage}}{\text{Signal Input Voltage}}$

Conversion impedance (Z_c) = Anode impedance measured with oscillator operating under optimum conditions, with output frequency equal to the difference between input and oscillator frequencies.

Equivalent noise resistance referred to control grid = the value of resistance placed between control grid and cathode which would give an equivalent noise if the valve were noise-free. It is found by a direct method using a 13 Mc/s. amplifier measuring the noise output from the valve under test, and then substituting a diode. The noise resistance can be calculated from the equivalent diode current.

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