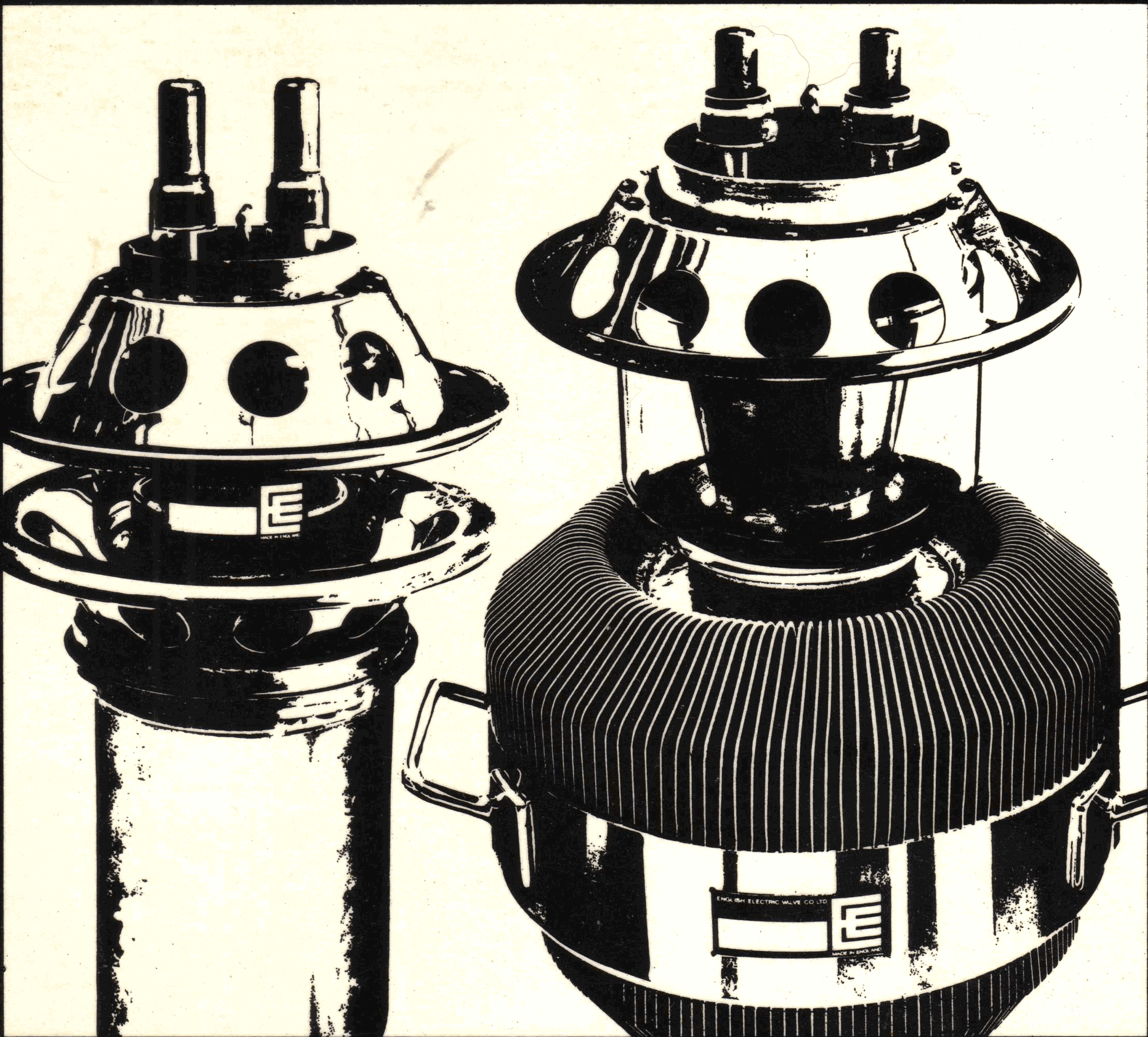
ENGLISH
ELECTRIC
VALVE
CO LTD

Product Data

Triodes

1970



POWER TRIODES

GENERAL SECTION

MEDIUM POWER TRIODES

HIGH POWER TRIODES

POWER TRIODE ACCESSORIES

The Valve Data Book comprises ten bound volumes, made up as follows:

- **IGNITRONS**
  RECTIFIERS
  INDUSTRIAL THYRATRONS
  COLD CATHODE TUBES
- **TRIODES**
- **TETRODES AND PENTODE**
- **MODULATORS**
  - **Hydrogen Thyratrons**
  - **Pulse Tetrodes**

  SPARK GAPS
- **MAGNETRONS**
- **AMPLIFIER KLYSTRONS**
- **OSCILLATOR KLYSTRONS**
  TRAVELLING WAVE TUBES
  BACKWARD WAVE OSCILLATORS
- **DUPLEXER DEVICES**
  MONITOR DIODES
  MICROWAVE SWITCHES
- **LIGHT CONVERSION DEVICES**
  - **Television Camera Tubes**
  - **Storage Cathode Ray Tubes**
  - **Laser and Flash Tubes**
  - **Glow Modulators**
- **VACUUM CAPACITORS**

These bound volumes replace the previous loose-leaf books and will be re-issued at intervals. When the most recent data are required for equipment design purposes, the individual sheets should be obtained.

Power Triodes

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May 1970

General Section

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Vietnam	International Group Ltd.	Saigon

EQUIVALENTS INDEX

Type to be replaced	EEV replacement
3–25D3*	3C24
3C24	3C24
3C/800E	B1153
3F10TA*	BW179
3F10TR*	BR179
3F15TR*	BR161
3J/192E*	BR1165
3J/202E*	BR1162
3L5T*	BR1162
3V5T*	BW1162
7C24	5762
8T71R*	BR189
9C25*	BR1102
25T*	3C24
25TG*	3C24
5671*	BR189
5762	5762
5762/7C24	5762
5762A	5762
5923	BW1165

Type to be replaced	EEV replacement
5924	BR1165
6421*	BR1124
6696*	BW194
6961	BR1162
ACT14*	BR140
ACT70	BR1160
AX9904	BW1165
AX9904R	BR1165
B1109	3C24
B1152	B1152
B1153	B1153
BR140	BR140
BR161	BR161
BR179	BR179
BR189	BR189
BR191B	5762
BR194	BR194
BR1102	BR1102
BR1106	BR1106
BR1115	BR1115

* Near equivalent

Type to be replaced	EEV replacement
BR1121	BR1121
BR1122	BR1122
BR1124	BR1124
BR1126	BR1126
BR1143	BR1143
BR1151*	BR1161
BR1160	BR1160
BR1161	BR1161
BR1162	BR1162
BR1165	BR1165
BR1169	BR1181
BR1181	BR1181
BR1182	BR1182
BR1183	BR1183
BTL3–1*	5762
	BR1160
BTL6–1*	BR179
	BR1106
	BR1124
BTL15–2*	BR161
	BR1102
BW140	BW140
BW161	BW161
BW179	BW179
BW189	BW189

Type to be replaced	EEV replacement
BW194	BW194
BW1102	BW1102
BW1102J2	BW1102J2
BW1121	BW1121
BW1121J1	BW1121J1
BW1121J2	BW1121J2
BW1122	BW1122
BW1124	BW1124
BW1124J1	BW1124J1
BW1124J2	BW1124J2
BW1143	BW1143
BW1143J2	BW1143J2
BW1144	BW1144
BW1156	BW1156
BW1162	BW1162
BW1162J3	BW1162J3
BW1165	BW1165
BW1165J3	BW1165J3
BW1169J3	BW1181J3
BW1176J1	BW1176J1
BW1176J2	BW1176J2
BW1181J3	BW1181J3
BW1182J1	BW1182J1
BW1183J1	BW1183J1
BW1190J4	BW1190J4

* Near equivalent

Type to be replaced	EEV replacement
BW4027	BW4027
BW4028	BW4028
BW4029	BW4029
BW4034	BW4034
BW4035	BW4035
BW4050	BW4050
BW4070	BW4070
BW4088A	BW4088A
BY189A	BY189A
BY194	BY194
BY1102	BY1102
BY1121	BY1121
BY1122	BY1122
BY1124	BY1124
BY1143	BY1143
BY1144	BY1144
BY1144L	BY1144L
BY1151*	BY1161
BY1156	BY1156
BY1161	BY1161
BY4030	BY4030
BY4031	BY4031
BY4032	BY4032
BY4033	BY4033
BY4036	BY4036

Type to be replaced	EEV replacement
BY4037A	BY4037A
BY4038	BY4038
BY4038A	BY4038A
BY4039	BY4039
BY4048A	BY4048A
BY4049	BY4049
BY4060	BY4060
BY4063	BY4063
BY4064	BY4064
BY4093	BY4093
CAT6	BW140
CV789	3C24
CV2322	BR161
CV2323	BR179
CV2383	5762
CV2736	3C24 (in pairs)
CV2871	BW140
CV3926	BR1165
CV5218	BR189
CV5239	BR1162
CV5289	5762
CV8730	BR1160
CV9343	BR1161
CV10368	BR1122
ESA1500*	BR1126

* Near equivalent

Type to be replaced	EEV replacement
FTL3–2*	5762
	BR1160
FTL8–1*	BR1124
GL-5762	5762
HK24G*	3C24
ML–7C24	5762
ML–6421*	BR1124
PE130A*	3C24
RS635*	B1153
RS726	BR1161
RS822*	BY189A
	BY1102
RS826	BY1161
RS833*	BY1122
TB4/1500	B1152
TB5/2500	B1153
TBL6/6000	BR1165

Type to be replaced	EEV replacement
TBL6/6000B	BR1160
TBL7/8000	BR1162
TBW6/6000	BW1165
TBW7/8000	BW1162
TX12–12W*	BW140
TY5–500	B1152
TY6–800	B1153
TY6–3000A	BR1126
TY6–5000A	BR1165
TY6–5000B	BR1160
TY6–5000W	BW1165
TY7–6000A	BR1162
TY7–6000H	BW1162J3
TY7–6000W	BW1162
TYS5–3000*	BW1190J4
YD1120	BR1160
YD1230	BR1126

* Near equivalent

TABULATED DATA

POWER TRIODES

NATURAL COOLED

EEV type	Anode dissipation max (W)	Output power (kW)⊕	Anode voltage max (kV)	Frequency (MHz)‡
3C24	25	0.1	2.0	60/100
B1152*	1000△ 500	2.4△ 1.5	5.0	50
B1153*	1500△ 800	4.6△ 2.7	6.0	50

FORCED-AIR COOLED

EEV type	Anode dissipation max (kW)	Output power (kW)⊕	Anode voltage max (kV)	Frequency (MHz)‡
5762	3.0	6.0	6.2	30/220
BR140	8.0	–	12	15/40
BR161	15	50	12	30/50
BR179	8.0	17	8.5	50/110
BR189	27	80	15	5/50

Continued on page 2

⊕ ‡ △ * **See foot of page 4**

FORCED-AIR COOLED — continued

EEV type •	Anode dissipation max (kW)	Output power (kW)⊕	Anode voltage max (kV)	Frequency (MHz)‡
BR194	40	115	15	5/30
BR1102*	20	53	12	50
BR1106	10	15.5	6.6	30/220
BR1115†	3.0	7.0	6.0	30/110
BR1121*	15	50	10	50
BR1122	10	29	12	5/110
BR1124*	10	20	8.5	100
BR1126*	3.0	7.0	6.0	30/110
BR1143*	20	77.5	10	10
BR1160	5.0	6.9	6.0	75/220
BR1161	35	100	14	10/30
BR1162*	6.0	10	7.2	30/85
BR1165	5.0	6.9	6.0	75/220
BR1181*	10	26	8.0	100
BR1182*	15	50	10	50
BR1183*	20	70	10	50

⊕ ‡ † * **See foot of page 4**

WATER COOLED

EEV type •	Anode dissipation max (kW)	Output power (kW)⊕	Anode voltage max (kV)	Frequency (MHz)‡
BW140	12	–	12	15/40
BW161	20	50	12	30/50
BW179	10	17	8.5	50/110
BW189	35	80	15	5/50
BW194	50	115	15	5/30
BW1102 series*	20	53	12	50
BW1121 series*	15	50	10	50
BW1122	10	29	12	5/110
BW1124 series*	10	20	8.5	100
BW1126*	3.0	7.0	6.0	30/110
BW1143 series*	30	77	10	10
BW1144	100	200	14	27
BW1156*	175	250	14	27
BW1162 series*	6.0	10	7.2	30/85
BW1165 series	6.0	7.0	6.0	75/220
BW1176 series*	20	70	10	20
BW1181J3*	12	26	8.0	100
BW1182 series*	15	50	10	50
BW1183J1*	20	70	10	50
BW1190J4*	3.5	9.0	6.0	12/20

⊕ ‡ * **See foot of page 4**

VAPOUR COOLED

EEV type	Anode dissipation max (kW)	Output power (kW)⊕	Anode voltage max (kV)	Frequency (MHz)‡
BY189A	35	80	15	5/50
BY194*	50	115	15	5/30
BY1102*	25	53	12	50
BY1121*	18	50	10	50
BY1122	10	29	12	5/110
BY1124*	10	20	8.5	100
BY1143*	35	77	10	10
BY1144* **BY1144L***	125	200	14	27
BY1156*	125	250	14	27
BY1161	60	120	14	10/30

⊕ Under class C unmodulated conditions.

‡ Where two values are given, the lower value is the maximum frequency for full ratings. Derating is necessary for operation at the higher value.

† Maintenance type. Not recommended for new equipment.

* Recommended for industrial heating service.

△ Intermittent operation.

POWER TRIODES and their ACCESSORIES

Valve	Filament lead	Grid connector	Water jacket or boiler unit	Other accessories
5762	Integral	MA66A	–	–
BR140	MA135,A,B	–	–	–
BR161	MA131,A	MA66	–	–
BR179	MA135,A,B	MA66A	–	–
BR189	MA130,A	MA66	–	–
BR194	MA130,A	MA66	–	BR4044 air duct
BR1102	MA131,A	MA66	–	–
BR1106	MA131,A	–	–	–
BR1115	Integral	MA66A	–	–
BR1121	MA131,A MA319,A	MA66	–	BR4045 air duct
BR1122	MA135,A,B	MA66A	–	–
BR1124	MA135,A,B	MA66A	–	BR4080 air duct
BR1126	Integral	MA66A	–	–
BR1143	MA130,A	MA66	–	–
BR1161	Integral	–	–	–
BR1162	MA146A,B	MA147A MA148A	–	MA149A pedestal
BR1165	MA146A	MA147A MA148A	–	MA149A pedestal

Valve	Filament lead	Grid connector	Water jacket	Other accessories
BR1181	• MA208A MA208B	MA208	–	–
BR1182	MA291C MA291D	–	–	–
BR1183	MA291C MA291D	–	–	–
BW140	MA135,A,B	–	–	MA248 sealing ring
BW161	MA131,A	MA66	BW4028	MA251 sealing ring
BW173	MA135,A,B	–	–	–
BW179	MA135,A,B	MA66A	BW4029	MA252 sealing ring
BW189	MA130,A	MA66	BW4050	MA254 sealing ring
BW194	MA130,A	MA66	BW4027	MA254 sealing ring
BW1102	MA131,A	MA66	BW4028	MA251 sealing ring
BW1102J2	MA131,A	MA66	Integral	–
BW1115	Integral	MA66A	BW4123	MA315 sealing ring
BW1121	MA131	MA66	BW4034	MA251 sealing ring
BW1121J1,J2	MA131	MA66	Integral	MA250 sealing ring
BW1122	MA135,A,B	MA66A	BW4070	MA252 sealing ring

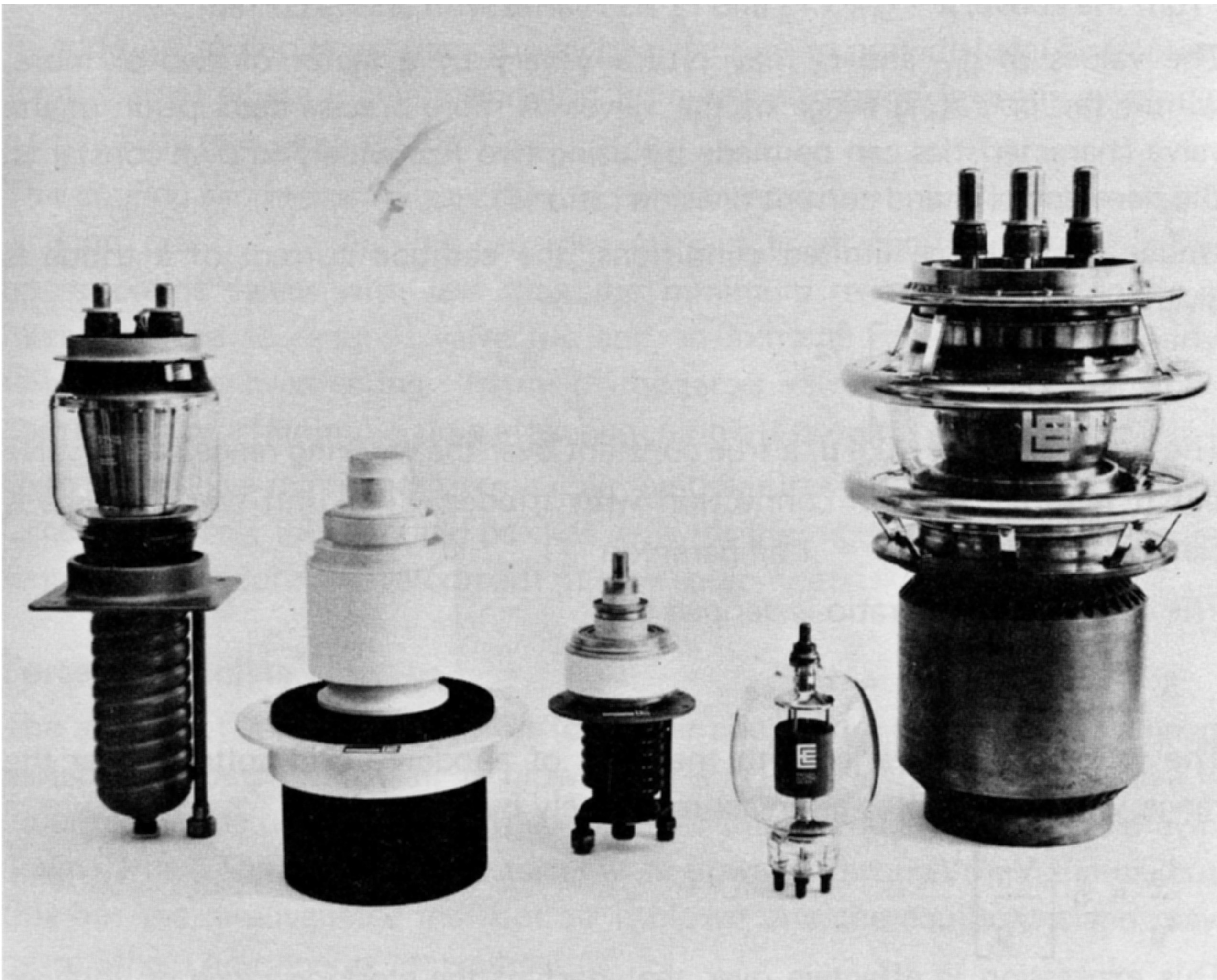
Valve	Filament lead	Grid connector	Water jacket	Other accessories
BW1124	MA135,A,B	MA66A	BW4029	MA252 sealing ring
BW1124J1,J2	MA135,A,B	MA66A	Integral	MA256 sealing ring
BW1126	Integral	MA66A	BW4123	MA315 sealing ring
BW1143	MA130,A	MA66	BW4050	MA254 sealing ring
BW1144	MA130,A	MA66B	BW4035	MA243 sealing ring
BW1156	MA130,A	MA66B	BW4035	MA243 sealing ring
BW1162	MA146A,B	MA147A MA148A	BW4088A	MA314 sealing ring
BW1162J3	MA146A,B	MA147A MA148A	Integral	–
BW1165	MA146A	MA147A MA148A	BW4088A	MA314 sealing ring
BW1165J3	MA146A	MA147A MA148A	Integral	–
BW1176J1,J2	MA131,A	MA66	Integral	–
BW1181J3	MA208A MA208B	MA208	Integral	MA85E
BW1182J1,J2	MA291C MA291D	–	Integral	–
BW1183J1	MA291C MA291D	–	Integral	–
BW1190J4	Integral	Integral	Integral	–

Valve	Filament lead	Grid connector	Boiler unit	Other accessories
BY189A	MA130,A	MA66	BY4037A BY4038 BY4038A	MA255 sealing ring
BY194	MA130,A	MA66	BY4039 BY4039A BY4049	MA255 sealing ring
BY1102	MA131,A	MA66	BY4030 BY4031	MA246 ring MA150A exp. coil assy.
BY1121	MA131,A	MA66	BY4032 BY4033 BY4063	MA246 sealing ring MA326 ring
BY1122	MA135,A,B	MA66A	BY4048A BY4064	MA253 sealing ring
BY1124	MA135,A,B	MA66A	BY4048A BY4064	MA253 sealing ring
BY1143	MA130,A	MA66	BY4037A BY4038 BY4038A	MA255 ring MA150B exp. coil assy.
BY1144	MA64B	MA66B	BY4036 BY4060	MA260 sealing ring
BY1156	MA130,A	MA66B	BY4036 BY4060	MA260 sealing ring
BY1161	Integral	—	BY4059 BY4093	MA245 sealing ring

INTRODUCTION

The EEV range of power triodes consists mainly of external-anode valves designed for broadcast transmitter service or industrial heating. Most of these types are available with a choice of cooling method and in many cases water, forced-air or vapour cooled versions can be supplied with the same electrical characteristics.

Several types with pure tungsten filaments are made for replacement purposes but the directly heated, thoriated tungsten filament is used in all current designs.



A selection from the range of EEV triodes

BASIC TRIODE CHARACTERISTICS

The electrical characteristics of a triode are usually specified by the amplification factor (μ) and mutual conductance (g_m). These are defined by:

$$\mu = \frac{\partial V_a}{\partial V_g}$$

The amplification factor is a true constant and for triodes, has a value in the range 5 to 100.

$$g_m = \frac{\partial I_a}{\partial V_g}$$

The mutual conductance varies with the anode current, so that the conditions under which it is measured need to be quoted.

Another characteristic, most often used with small valves, is the differential anode resistance (r_a). This is defined by:

$$r_a = \frac{\partial V_a}{\partial I_a}$$

From the above, $\mu = g_m \times r_a$ and r_a also varies with anode current.

The values of g_m and r_a may typically vary by a factor of two or more, within the operating range of the valve. A more precise description of the valve characteristics can be made by using two less widely known constants, the perveance (P) and current division ratio (δ).

Under space-charge limited conditions, the cathode current of a triode is given by:

$$I_k = P\left[V_g + \frac{V_a}{\mu}\right]^{3/2}$$

The perveance P is, like μ, a true constant over the working range of the valve but it is rarely used in connection with triodes. The unit of perveance is called the perv (1 perv = 1 ampere/volt$^{3/2}$).

The current division ratio is defined by:

$$\delta = \frac{I_a}{I_g} \text{ when } V_a = V_g.$$

The value of I_a/I_g varies with the ratio of anode to grid voltage; over the range $V_g < V_a < 4V_g$ it is given approximately by:

$$\frac{I_a}{I_g} = \delta\left[\frac{V_a}{V_g}\right]^{1/2}$$

This expression is effective over that part of the working range of voltages where most of the grid current occurs, but like perveance it is little used in practice.

COOLING METHODS

When a valve is operating, a proportion of the power fed into it is dissipated as heat within the valve. The filament power alone may amount to several kilowatts in the largest types, and to this must be added the dissipation at grid and anode, and resistive losses wherever currents flow. The majority of this heat appears at the anode.

For dissipation levels up to approximately 1000W, the anode may be mounted within a glass envelope and cooled by radiation. The envelope of such a valve will be relatively large and will require at least unhindered air convection around it to prevent excessive glass temperatures. Some valves of this type may have higher ratings which can be used if forced-air cooling is applied to the envelope.

Valves operating at higher power levels, and certain lower power types with small overall dimensions, are designed with the anode forming part of the external vacuum envelope. This permits direct cooling of the anode by forced-air, water or vapour.

In addition to anode cooling, it may be necessary to provide local air cooling for the areas where filament and grid terminals are sealed into the envelope; a small blower is required for this purpose.

The cooling requirements specified in data sheets are minimum values and it is good practice to provide generous margins in all cooling systems. The operation of valves with less than the minimum recommended cooling is likely to lead to reduced valve life and, in extreme cases, can cause early failure due to overheating. Many of the larger valves require cooling to be continued for a minimum time after switching off power to the valve.

Data sheets give maximum permissible temperatures for the bulb and seals of large valves, and these should be checked with thermocouples or temperature sensitive paint during development of new equipments.

Forced-air Cooling

The anodes of valves intended for forced-air cooling are provided with finned radiators through which air is blown. In a typical installation the valve is mounted anode down, seated in an insulator tube through which air is drawn downwards. The alternative is to blow air upwards through the radiator, but this has the disadvantage that hot air is blown into the equipment and may cause other components to overheat.

Characteristic curves are published giving the airflow required for various values of anode plus grid dissipation and inlet temperature. Other curves give the air pressure across the radiator at various flow rates. These are primarily for use in the initial choice of a fan or blower, and should not be used uncorrected for making exact measurements of anode dissipation (see page 11). In deciding upon the required fan output it is necessary to take into account pressure drops in the system additional to that across the valve radiator. These include losses in the air ducting, bends and sudden changes in cross section. These problems are discussed by A. G. Nekut (Ref. 1) and W. E. Pannett (Ref. 2).

The valve must be insulated from the vibration of the blower; this may be achieved with a length of flexible ducting, or a short break in a rigid duct, but will introduce further losses.

The pressure across the radiator may be checked by the use of a water manometer connected into the air duct close to the radiator on the fan or blower side. If the valve is run under dead loss conditions, i.e. not oscillating and without grid current, then all the input power appears as heat and if the temperatures of air entering and leaving the radiator are measured, the airflow can be calculated from:

$$\text{airflow in ft}^3/\text{min} = \frac{T_{in} \times (\text{anode + filament dissipation in watts})}{164 \times (\text{temperature rise across radiator in } ^\circ\text{C})}$$

where T_{in} = absolute temperature of inlet air in °K.

The airflow-pressure characteristic can thus be corrected and the manometer may then be used as an airflow monitor provided it is recalibrated from time to time, since dirt in the airstream may clog the radiator passages.

It must be understood that the flow rates given in data sheets apply to sea-level pressures. The cooling effect is proportional to the temperature rise across the radiator and the mass flow rate of air, so that operation in a less dense atmosphere at high altitude will call for higher volumetric flow rates. The performance of the blower will also vary with altitude and the blower manufacturer should be consulted for information on this point.

The air density at a given pressure and ambient temperature can be calculated from:

$$\text{density in lb/ft}^3 = \frac{0.737 \times \text{pressure in inches of mercury}}{\text{absolute temperature in } ^\circ\text{K}}$$

Unless the air in the inlet region is particularly dust-free, filtering will be necessary to prevent blocking of the radiator. The inlet air should also be free of corrosive fumes such as exhaust gases.

Interlocks The anode and filament supplies should be fitted with cut-outs to prevent application of power until the airflow is established, and to remove all power immediately if any of the following conditions should occur:

a) radiator airflow less than minimum – to be sensed by a vane in the air-stream between blower and radiator.

b) excessive inlet air temperature

c) failure of the blower motor, or of the filament terminals blower if fitted.

Water Cooling

Water cooling is normally applied to the anode only, a small air blower usually being required for the filament terminals. Two distinct types of water cooling jacket may be used:

1) an integral water jacket, which may be either a continuous tube soldered to the outer surface of the anode, or a light concentric enclosure fitted to the valve during manufacture. These types carry pipe unions for water connection and valve replacement is almost as simple as for air-cooled types.

2) a separate water jacket, which is normally a casting and forms a permanent part of the cooling installation. The valve is retained in the jacket by clamps, with flexible sealing rings to prevent water loss. This method can give the lowest possible cost for spare valves but replacement takes a little longer than with other methods.

The cast jacket and the spun integral jacket have helical ridges on the inner surface, so that the water flow follows a helical course around the anode from the bottom to the top of the jacket. The inlet must be at the bottom to prevent air pockets developing within the jacket; the coiled-tube type of integral jacket is not affected in this way and can use either direction of flow.

Water Connections The water jacket is necessarily at anode voltage, so that in addition to an insulated mounting it is necessary to use insulating hose connections, long enough to reduce leakage currents through the water to acceptable levels. A length of 1 metre per kV anode voltage is normally adequate but if shorter hoses are used the electrolytic corrosion caused by leakage currents may become significant. The leakage current is a function of pipe length, pipe bore and water conductivity. If very pure water is used the insulating pipe lengths can be considerably reduced.

Water Purity The water used in the cooling system should have a resistivity of at least 3.3kΩ-cm, an inorganic solids content less than 30 parts per million and a low dissolved oxygen content. If water of low resistivity is used, considerable corrosion and scaling must be expected; the resistivity should preferably exceed 10kΩ-cm. If an ample supply of soft water meeting these conditions is available, this may be used but most installations consist of a closed circuit cooling system filled with distilled or demineralized water. The use of water not meeting the purity standards given will result in excessive scale formation on the valve anode, and possibly other components, and may result in early valve failure.

The closed circuit system requires a continuously operating pump, a reservoir and heat exchanger; it may be possible for a number of valves to share some of these components provided that the flow rate and temperature at each valve are individually monitored.

Flow Rate The flow rate, temperature rise and dissipation are related by the following expression:

$$\text{flow in litres/minute} = \frac{15 \times (\text{anode + filament dissipation in kW})}{\text{temperature rise across jacket in } ^\circ\text{C}}$$

this can be used as a calibration check when an installation is tested.

Interlocks The anode and filament supplies should be fitted with cut-outs to prevent application of power until the water flow is established, and to remove all power immediately if any of the following conditions should occur:

a) water flow less than minimum

b) excessive water outlet temperature

c) failure of the filament terminals blower if fitted.

Vapour Cooling The vapour cooling system uses the latent heat of boiling water to remove heat from the valve anode. A valve designed for vapour cooling has a thick-walled copper anode block with vertical cooling passages. The anode is immersed in water in a container referred to as the boiler and the water in the cooling passages boils, generating steam in proportion to the anode dissipation. There are two main types of system for condensing the steam generated:

1) an internal condenser, consisting of a coiled tube through which cooling water flows from an external source (see Fig. 1). The quantity of cooling water required is very much less than would be needed for a water-cooled valve of the same power, and the system is so simple and compact that double boiler-condenser units are made to hold two valves.

   This type of boiler is sealed to prevent steam loss, and normally operates at slightly above atmospheric pressure. A cut-out is fitted to switch off the valve if the water level falls or if internal pressure becomes excessive.

2) a separate condenser; there are two variants of this type of boiler:

a) upward steam exit (see Fig. 2). This is the usual type and has the advantage that it operates by natural convection, so that it has almost no moving parts. It is quiet in operation and extremely reliable.

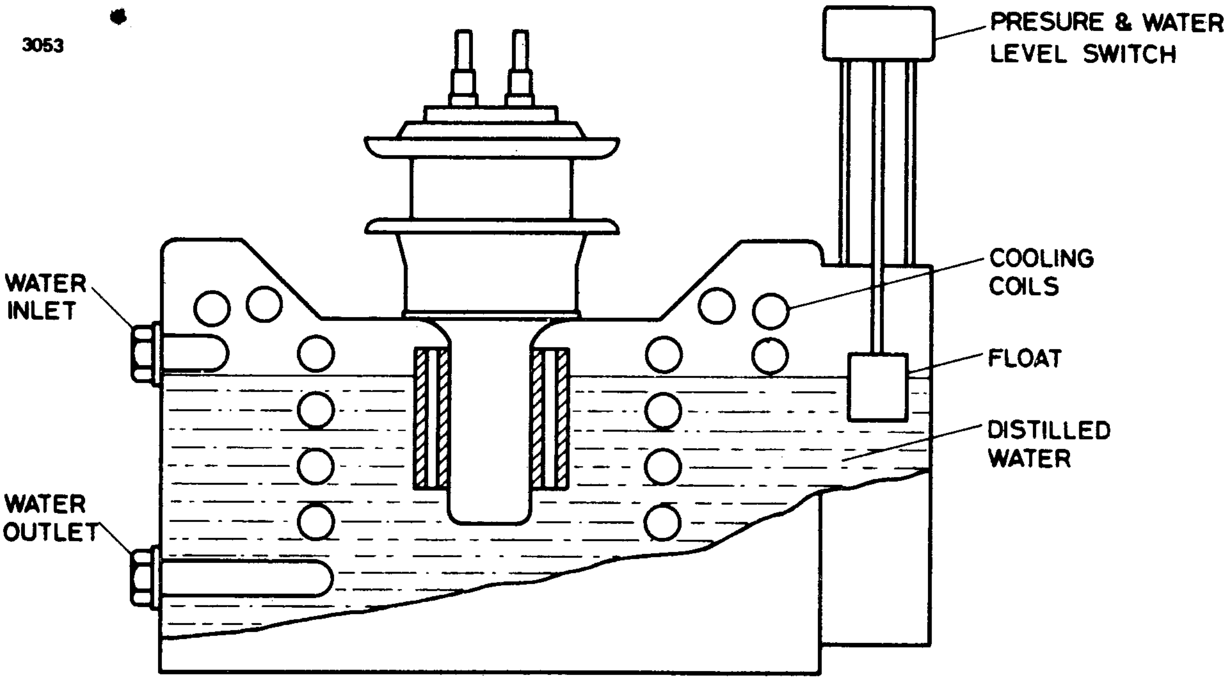


Fig. 1. Integral boiler-condenser unit

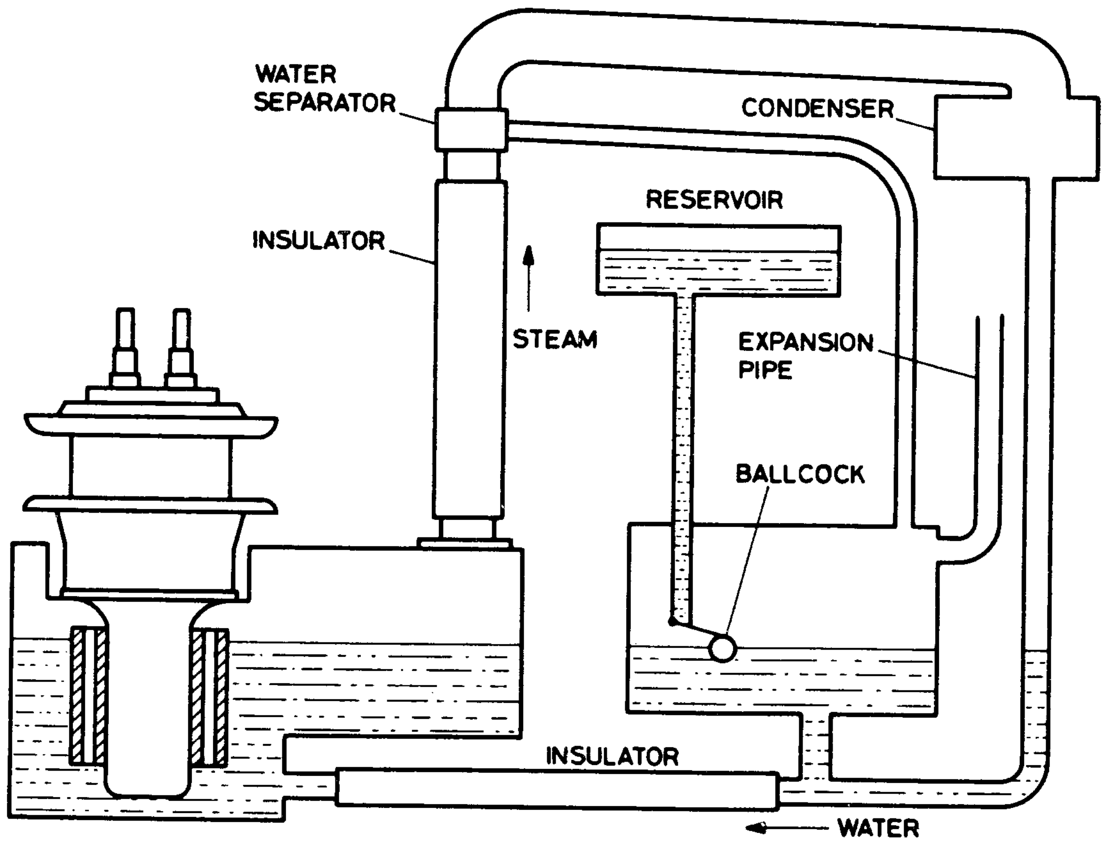


Fig. 2. Upward steam exit to separate condenser

b) downward steam exit (see Fig. 3). This is sometimes found to give a more convenient layout of components, and it may be preferred for high frequency applications, but it requires the use of a low pressure circulating pump. The pump feeds an excess of water to the boiler, so that the water level is maintained at the top of the internal weir. One advantage of this system is that the presence of the weir makes it possible to use a single condenser for any number of valves mounted at different levels.

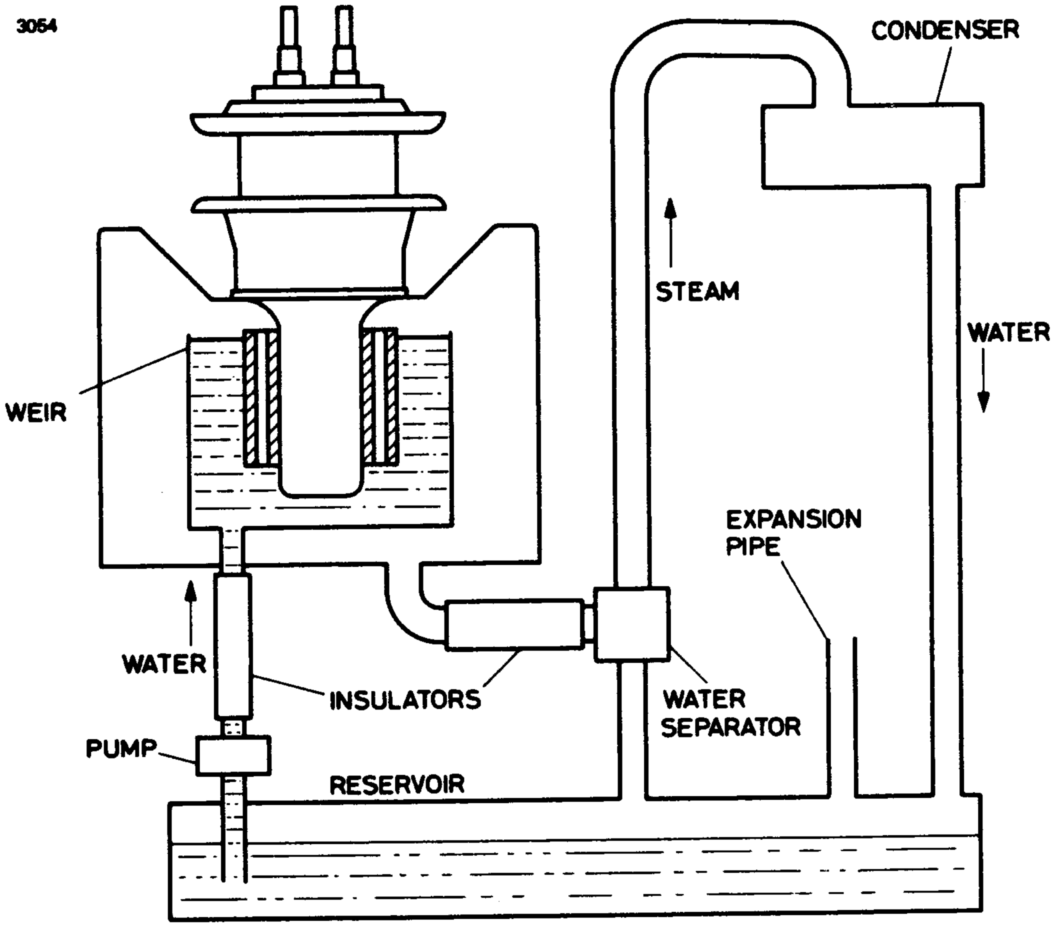


Fig. 3. Downward steam exit to separate condenser

Both types of separate condenser system are vented to atmospheric pressure at a point where steam will not be lost.

Distilled or demineralized water must be used in all types of boiler but the total quantity needed is not large and only occasional topping up should be necessary. The boiler units are at anode voltage and insulating pipes are again required for water connections. Any convenient supply of clean water may be used for the internal condenser.

Choice of Cooling Method

In deciding between the alternative methods of cooling, several points must be considered.

Water cooled valves are less costly than their air cooled counterparts but their running costs may be higher unless there is a cheap supply of clean water available. The necessity for de-scaling must be borne in mind unless a closed circulating system is employed. Using a mains water supply, the valve and its water cooling equipment should take less space than a similar air-cooled installation.

Forced-air cooled valves require no external supplies for cooling. The whole method is cleaner, though it may require more space. Noise from the blower could be a deciding factor in some locations. Air filters will be necessary in dirty atmospheres, and frequent periodic cleaning will be essential under extreme conditions.

Vapour cooling is able to handle very high powers, and in some cases a vapour cooled valve has higher ratings than air or water cooled versions of the same basic type. Coupled with this is high overload capacity, which is particularly valuable for industrial oscillators. Noise, maintenance and running costs are reduced to a minimum and valve replacement is quicker than with water cooled types.

OPERATING NOTES

Filament Supplies

Modern high power triodes use thoriated tungsten filaments, which must always be operated at the correct temperature for optimum life and performance. The filament voltage should be maintained as close as possible to the value given in the data sheet; deviations from this value should never exceed ±5% and still closer control to within ±1% is advisable.

Certain valve types having pure tungsten filaments are still in use and for these the optimum filament voltage varies with the peak cathode current required. In general, reducing the filament voltage will give increased life provided that the available emission is still high enough for the particular operating conditions. Each valve is marked with the filament voltage required to give the rated maximum cathode current at 90% saturation and details of the voltage reduction appropriate to lower currents are given in the data.

Measurements of filament voltage must always be made at the filament terminals of the valve, since significant voltage drops can occur in flexible leads and connectors. If the waveform is not sinusoidal it is essential to measure the true r.m.s. value.

In addition to accurate voltage control, the filament supply must, in most cases, incorporate a means of limiting the surge current drawn by a cold filament on starting. The valve data sheets include a maximum rating for the surge current and a typical value for the cold resistance of the filament. The necessary current limiting may be achieved by a resistance in the filament transformer primary circuit, shorted out by a delay switch. Alternative methods include a transformer with high leakage reactance and the use of a fully variable transformer, manually controlled. An additional facility often used with pure tungsten filaments is voltage reduction during standby operation; a reduction of 20% during short periods is typical.

Cathode Current

The total cathode current is the sum of the anode and grid currents; for most valves maximum ratings are quoted for both the mean anode current and the peak usable cathode current. The peak usable cathode current is determined by the emission capability of the cathode and if this rating is exceeded in service the cathode life will be reduced.

Grid Parameters

Grid Voltage When valves are to be used in parallel or push-pull circuits, each valve should have a separate grid resistor. Even if the valves are closely matched when new, unequal sharing of the load is certain to occur during life unless the grid bias can be individually adjusted. If this is not done the anode current rating should be reduced by 10%.

Grid Current The grid current values and ratings given in data sheets are as measured with a meter in the grid lead; the valve user is not required to make allowance for the effect of secondary emission by the grid. The actual value of grid current may vary appreciably between valves of the same type; this is not important provided the maximum rating is observed.

Grid Driving Power The driving power is the sum of the powers dissipated in the grid and the bias source.

The grid driving power may be taken as approximately the product of the peak value of the exciting grid voltage and the d.c. grid current. The peak value of the exciting grid voltage may be calculated as the sum of the bias voltage and the peak positive voltage swing, which may be measured with a peak-reading valve voltmeter. The effective driving power may be greater than the calculated value as a result of tolerances in valve characteristics, electron transit-time losses and other factors.

Anode Voltage

The anode voltage is normally supplied by a multiphase rectifier with some form of voltage regulation. For broadcast amplifiers smoothing filters will be required but in most other cases the ripple content of a 3-phase full wave or equivalent rectifier is acceptable.

Anode Dissipation

The anode dissipation is the difference between the anode input power and the output power. For water or forced-air cooled valves the anode dissipation can be determined from the temperature rise and flow rate of the coolant.

Output Power

The output power can be measured at several places, the lowest value appearing at the ultimate load. The value given in a data sheet is the total r.f. power developed in the anode circuit. For an oscillator:

$$P_{load} = \eta_a(P_{out} - P_{drive})$$

where P_{load} = power delivered to load

P_{out} = output power of valve to anode circuit

P_{drive} = drive power fed back to grid circuit

and η_a = anode circuit efficiency.

For an amplifier, the term P_{drive} is zero, since the grid drive power is not derived from the anode circuit.

Efficiency

The efficiency is the ratio of the output power of a valve to the d.c. input power. The values given in data sheets are derived from calculations of typical operating conditions.

Valve Life

Early catastrophic failure is unusual in large triodes but may result from exceeding the ratings, or mechanical shocks or impact. Most of these valves exhibit a gradual loss of cathode emission towards the end of their life and this eventually results in the output power falling below the required level.

The ratings of each valve type are chosen to give a long operating life, but in all cases the life expectancy can be considerably increased by operating at reduced anode current levels. For pure tungsten filament types it is necessary to reduce the filament voltage accordingly.

Protection Devices

It is most important that large power valves are adequately protected against the failure of associated components and incorrect operating conditions.

Cooling systems in particular must be interlocked so that no voltages can be applied to the valve unless all cooling supplies are operating correctly. The filament power of large valves is sufficient to damage the valve in the absence of normal anode cooling, so that both h.t. and filament supplies must be cut off if the cooling fails. The nature of the safety devices depends on the cooling method involved; for air cooling the flow rate is the essential factor and the air outlet temperature can also be checked. Similarly for water cooled anodes the flow rate and outlet temperature should be interlocked while with vapour cooling there will be water level and steam pressure trips. In some cases it is also advisable to have a direct check on the valve temperature, and some of the larger EEV types are fitted with thermal fuses for this purpose.

Abnormal load conditions, or the failure of associated circuit components, may result in valve failure due to excessive current or dissipation in the grid or anode. Interlocks should remove h.t. supplies if the anode or grid currents exceed the maximum ratings. In many cases the anode dissipation will be excessive if the grid bias is insufficient and an interlock which operates if the grid current falls below a minimum value will give protection against this hazard.

MAXIMUM RATINGS

Unless otherwise stated all the maximum ratings in the data are absolute ratings. This means that the equipment designer is responsible for ensuring that they are not exceeded, even momentarily, under any conditions of mains fluctuations, surges or component tolerances. See British Standard Code of Practice CP 1005: 1962 'The Use of Electronic Valves'.

Maximum Anode Voltage

In most cases this is an absolute rating, but valves intended for industrial use may be given a nominal rating which allows for normal mains voltage fluctuations and component tolerances in the equipment.

Current Ratings

The maximum anode current rating applies to the mean value of the anode current. Where a maximum grid current rating is given this also applies to the mean value, as measured by a normal mean-reading meter.

The peak usable cathode current is the highest peak cathode current (i.e. the sum of the peak anode and grid currents) which may be used. Currents in excess of this figure will seriously curtail life even though the electrode dissipations may be within their limits.

Maximum Anode Dissipation

This is the maximum permissible steady anode dissipation. Due to the large thermal capacity of the anode, valves having dissipation ratings above 1 kW may dissipate higher powers for periods up to 15 seconds. The permissible anode dissipation specified is ample for normal use and is not usually the limiting factor.

Maximum Grid Dissipation

This is the maximum grid dissipation which may be used. If this value is exceeded the grid structure may become distorted and change the characteristics of the valve. In addition to this effect, evolution of gas and the onset of grid emission may shorten the operating life.

Maximum Frequency

The ratings for each valve include a maximum frequency, above which the other ratings must be reduced. In some cases information on the reduction required is given and for other types, English Electric Valve Company Ltd. should be consulted if operation at higher frequencies is intended.

Derating for Different Operating Conditions

When the data sheet for a valve gives ratings only for class C unmodulated operation and it is required to use a different class of operation, English Electric Valve Company Ltd. should be consulted. For preliminary design purposes, the derating factors in the following table may be used as a guide.

Operating condition	Anode voltage	Anode current	Input power	Anode dissipation	Grid current
Class C telegraphy	1	1	1	1	1
Anode modulation	0.8	0.833	0.67	0.67	1
Class B r.f.	1	0.833	0.833	1	1
Class A or B audio amplifier	1	1	1	1	1

Unfiltered Power Supplies

The power supplies used in industrial oscillators often consist of the minimum essentials. The h.t. may be unregulated, unfiltered and even unrectified and each of these factors requires a reduction in the nominal operating voltage and current levels, so that the absolute limits are not exceeded under worst-case conditions. Where the derating for a particular type of supply to be used is not specified in the data sheet, English Electric Valve Company Ltd. should be consulted. For preliminary design purposes, the following table may be used as a guide to the derating factors necessary, relative to the ratings for class C telegraphy.

Power supply	Anode voltage	Anode current	Input power	Anode dissipation	Grid current
Regulated, filtered and fully protected	0.95	0.95	0.9	0.95	0.9
No overload protection	0.8	0.8	0.65	0.6	0.8
Single-phase full wave, no regulation, filtering or overload protection	0.7	0.7	0.5	0.6	0.7
Self-rectifying	0.8 (r.m.s.)	0.4	0.3	0.6	0.4

CALCULATION OF OPERATING CONDITIONS

In the curves normally employed for depicting valve characteristics the various electrode currents are plotted against anode voltage or grid voltage. Such curves do not lend themselves readily to the graphical determination of the operating conditions of oscillators or amplifiers biased beyond anode current cut-off, since the operating line then takes the form shown in Fig. 4.

In order to facilitate calculations, the data sheets for EEV triodes usually include constant current curves on which the operating line is straight.

Various authors, including Sarbacher (Ref. 3), have dealt with methods of using this operating line as a basis from which the performance of oscillators or class C amplifiers can be obtained by graphical means. The EEV Calculator for oscillators and class C amplifiers presents the results of such work in a form most likely to be useful to equipment designers and others. The calculator is supplied in a separate envelope, together with blank design sheets and instructions for use.

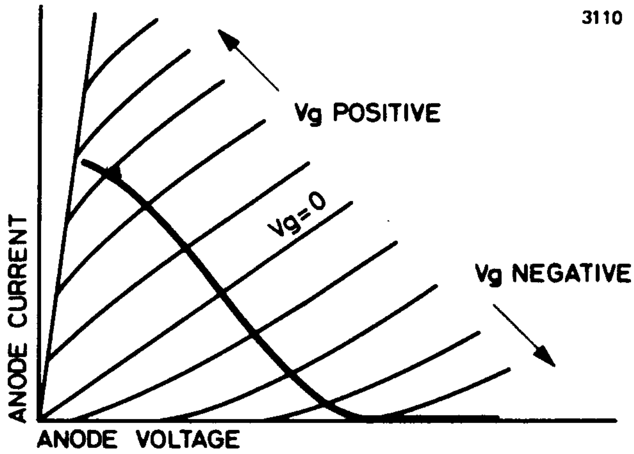


Fig. 4. Typical I_a-V_a characteristics with operating line

Selection of an Operating Line

This is likely to be a process of successive approximation since, although the cut-off end of the line may be decided quite easily, the peak anode current end may require several test calculations to be carried out before the optimum position is selected.

D.C. Grid Bias The anode supply voltage is decided first, then the corresponding grid cut-off voltage can be found from the curves. For most class C applications, best results are obtained with a bias voltage 1.6 to 2 times the cut-off voltage. The values selected for anode voltage and grid bias fix one end of the operating line.

Peak Anode Current A good method of determining the peak anode current is as follows:

(a) Assume a reasonable efficiency, say 75% for an oscillator. This means that three quarters of the input power becomes output power leaving one quarter to be dissipated in heat at the valve anode. Thus,

(b) Input power = 4 x rated anode dissipation.

(c) D.C. anode current $I_a = \dfrac{\text{Input power}}{V_a}$

I_a must not exceed the maximum anode current rating.

(d) The ratio of peak to d.c. anode current is of the order of 3.5 to 4.5 depending upon the angle of flow adopted and upon the law obeyed by the anode current. It is a good starting point to assume that:

Peak anode current = 4 x I_a

Minimum Anode Voltage The value of peak anode current defines a locus on which the end of the operating line will lie. The actual position is given approximately by two further considerations:

a) the minimum anode voltage should usually be 10 to 15% of the d.c. anode supply voltage.

b) the peak positive grid voltage should be minimized, for a low grid current.

D.C. Anode Current Having drawn an operating line, the anode current can be calculated, using the design sheet and calculator. The result may differ appreciably from the previously assumed value and if it is not satisfactory another test calculation is carried out with a different minimum anode voltage. It may be necessary, if variations in minimum anode voltage do not give the desired result, to modify the assumed value of peak anode current. When the operating line appears to be satisfactory, the formulae given with the calculator may be used to determine the other parameters, which must be compared with maximum ratings where appropriate.

How the EEV Calculator Works

If the operating line AG of an oscillator or class C amplifier is drawn on the constant current characteristics of the valve to be used (see Fig. 5) then any point on this line will give the conditions prevailing in the circuit at that

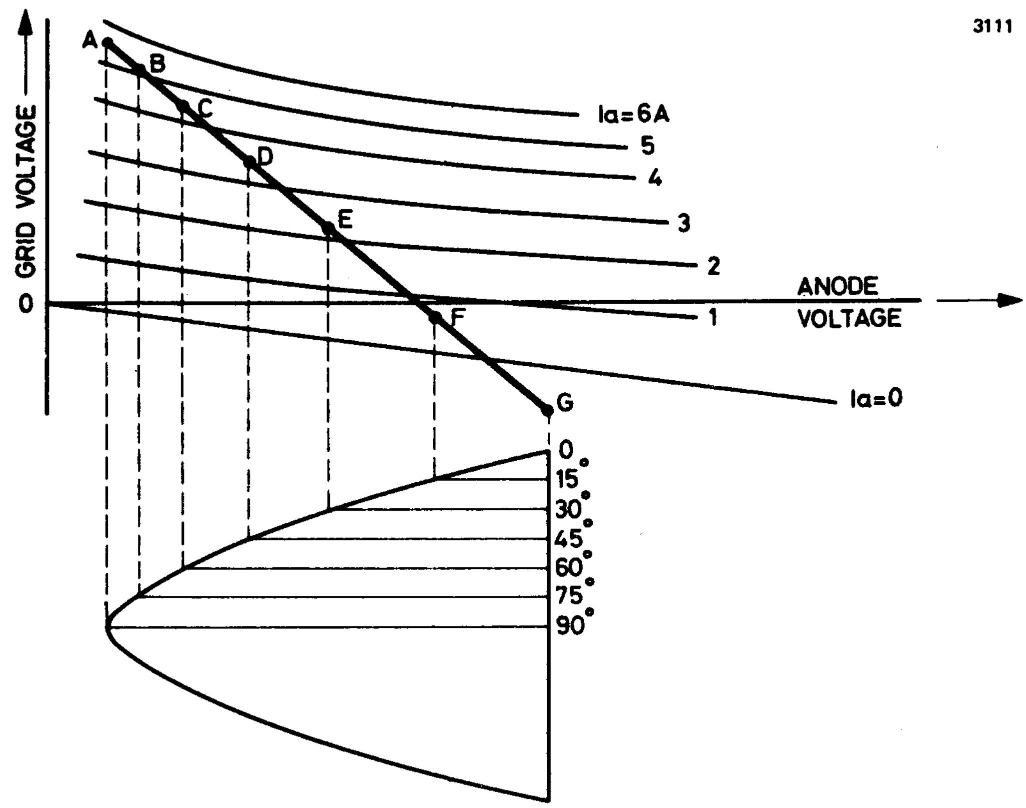


Fig. 5. Typical constant current characteristics with operating line

instant in the electrical cycle. That is to say the instantaneous currents in each electrode and the instantaneous values of the grid and anode voltages can be read off the curves at that point. If several such points A, B, C, D, E and F are considered, corresponding to 15° intervals in the electrical cycle, then it has been shown that by taking the instantaneous currents at these points and using them in the following formulae, the average or d.c. current over the whole cycle and the peak value of the fundamental current are readily obtained:

D.C. current = 1/12(0.5A + B + C + D + E + F)

Peak fundamental = 1/12(A + 1.93B + 1.73C + 1.41D + E + 0.52F)

The EEV Calculator is a simple device which enables the required values to be read off the curves without constructing the 15° intervals by hand. The design sheets supplied with it are arranged so that the current values and calculations can be written in logical sequence.

STORAGE, INSTALLATION AND MAINTENANCE

Storage

Valves should be stored in their original packing, or in suitable racks designed to protect the valves from excessive shock or vibration and to ensure that no stresses are imposed on the envelope or seals. When valves are stored in racks they should be vertical, with filament terminals up.

Stored valves must not be subjected to extremes of temperature; the ambient temperature should be maintained within the range 0 to +35°C. Valves must be shielded from draughts and strong sunlight, and must not be stored near volatile materials, acids etc. which might have harmful effects.

The external glass or ceramic envelopes of valves stored in racks should be shielded from dust and grit with plastic or fabric covers, or should be cleaned periodically. Care must be taken when cleaning to avoid scratching glass surfaces, or making permanent marks on ceramic parts.

Cold Filament Resistance This can be checked on delivery as a simple test for filament damage in transit. Most transmitting valves are accompanied by a card giving the value of cold filament resistance, measured with a Kelvin bridge at a relatively low filament current (0.1A or 1A). Fracture of a filament strand will increase the resistance by a proportion which depends on the number of parallel paths in the filament and for most types is 5% or more.

Installation

It is particularly important that large valves should be mounted accurately vertical; in general this will be determined by the construction of the equipment in which the valve is fitted and there may be no provision for adjustment, so this point should be checked when the equipment is first installed.

Once a valve is removed from its original packing, it must be handled carefully, to avoid mechanical damage to the envelope or the internal structure. When a valve is transferred from rack to bench, or fitted into an equipment, it must not be knocked on solid projections; tools must be used with care in the vicinity of the valve.

Water or vapour cooled valves are supplied with new sealing rings which should be used to replace the old ones.

Valves operating at high voltage will produce strong electric fields near the envelope, and when operating at r.f. there may be strong electro-magnetic fields not only around tuned circuits but in the general region of the valve. In general, the amount of material in these areas should be kept to a minimum; especially to be avoided are sharp edged conductors which might promote corona discharges, and closed conducting circuits which will dissipate power and reduce the efficiency. Where flexible leads are used for filament and grid connections, they should not have sharp bends, especially near the valve.

Conditioning Each valve is tested immediately before delivery, and if the subsequent storage period does not exceed 2 years it may be run at full power when first installed. Valves which have been stored longer than 2 years should be run for 15 minutes with filament power only, before applying anode power; all cooling supplies must be on while the filament is energized. Where a valve has been stored for more than four years it should be run for 30 minutes on filament power only. If the valve brings out the h.t. trips on application of full voltage, the voltage should be reduced to approximately 60% and the valve run for 15 minutes before re-application of full voltage.

Maintenance

Maintenance of the valve itself consists of occasional cleaning of the envelope and terminals; under good environmental conditions even this may not be necessary. For water or forced-air cooled types, regular attention to the cooling system may be required; radiators and water jackets may need cleaning, according to the impurity content of the air or water used.

The filaments of large valves tend to become more brittle with age, and after a few thousand hours life a valve should not be disturbed unnecessarily.

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Medium Power Triodes

R.F. POWER
TRIODE

Service Types CV789, CV2736 (matched pairs)

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Natural cooled power triode for use as an amplifier, oscillator or modulator

Anode dissipation	25	W max
Anode voltage	2.0	kV max
Frequency for full ratings	60	MHz max
Output power (class C unmodulated)	100	W

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage	6.3	V
Filament current	3.0	A
Amplification factor	25	
Mutual conductance (V_a = 1.0kV, I_a = 25mA)	2.5	mA/V
Inter-electrode capacitances:		
grid to anode	1.5	pF
grid to filament	1.7	pF
anode to filament	0.3	pF

Mechanical

Overall length	4.375 inches (111.1mm) max
Overall diameter	1.440 inches (36.6mm) max
Net weight	1½ ounces (42g) approx
Mounting position	vertical, either way up
Base	small UX4

Cooling . . . . natural

Heat dissipating connections of large area are necessary for anode and grid.

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
(Class B and Class AB)

MAXIMUM RATINGS (Absolute values)

Anode voltage	2000	V max
Anode current (maximum signal)	75	mA max
Anode dissipation	25	W max
Grid dissipation	7.0	W max

TYPICAL OPERATING CONDITIONS
(Class AB_2 – two valves)

Anode voltage	750	1000	1250	V
Grid voltage (see note 1)	−20	−30	−42	V
Anode current (zero signal)	43	32	24	mA
Anode current (maximum signal)	127	127	130	mA
Effective load (anode to anode)	12	17	21.4	kΩ
Peak a.f. grid voltage (per valve)	110	120	135	V
Peak driving power (maximum signal)	5.5	6.0	6.8	W
Nominal driving power (maximum signal)	2.8	3.0	3.4	W
Output power (maximum signal)	60	85	112	W

ANODE MODULATED R.F. POWER AMPLIFIER
(Class C telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	1600	V max
Anode current	60	mA max
Anode dissipation	17	W max
Grid dissipation	7.0	W max

TYPICAL OPERATING CONDITIONS

Anode voltage	1000	1250	1600	V
Grid voltage	−120	−140	−170	V
Anode current	60	60	52	mA
Grid current (approx)	14	13	11	mA
Anode dissipation	13	15	17	W
Grid dissipation	1.6	1.5	1.2	W
Driving power	3.3	3.3	3.1	W
Peak r.f. grid voltage	235	255	280	V
Output power	47	60	68	W

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C telegraphy, key-down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	2000	V max
Anode current	75	mA max
Anode dissipation	25	W max
Grid dissipation	7.0	W max

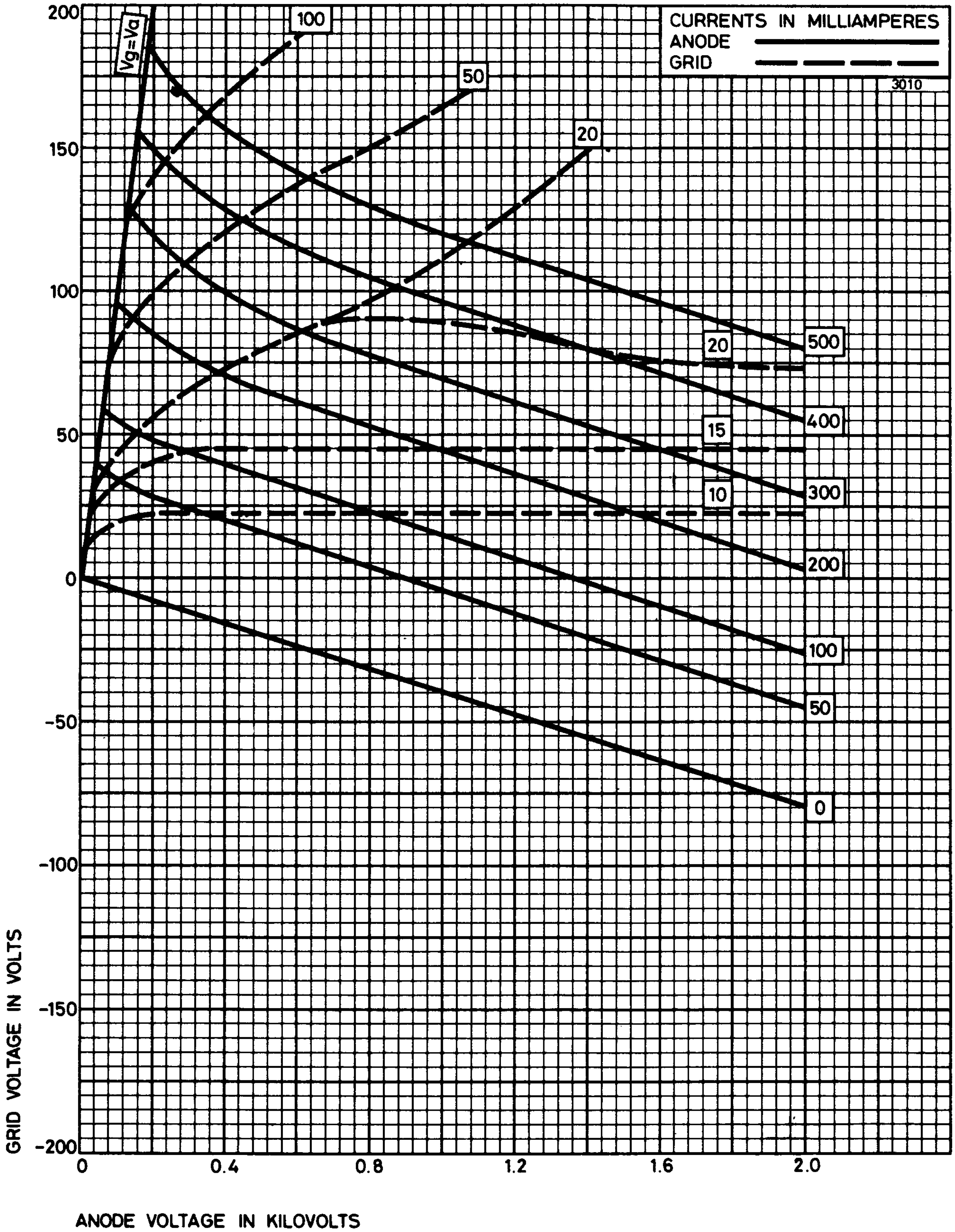
TYPICAL OPERATING CONDITIONS

Anode voltage	1000	1500	2000	V
Grid voltage	−70	−95	−130	V
Anode current	72	67	63	mA
Grid current (approx)	9.0	13	18	mA
Anode dissipation	25	25	25	W
Grid dissipation	0.9	1.3	2.1	W
Driving power	1.3	2.2	4.0	W
Peak r.f. grid voltage	170	195	245	V
Output power	47	75	100	W

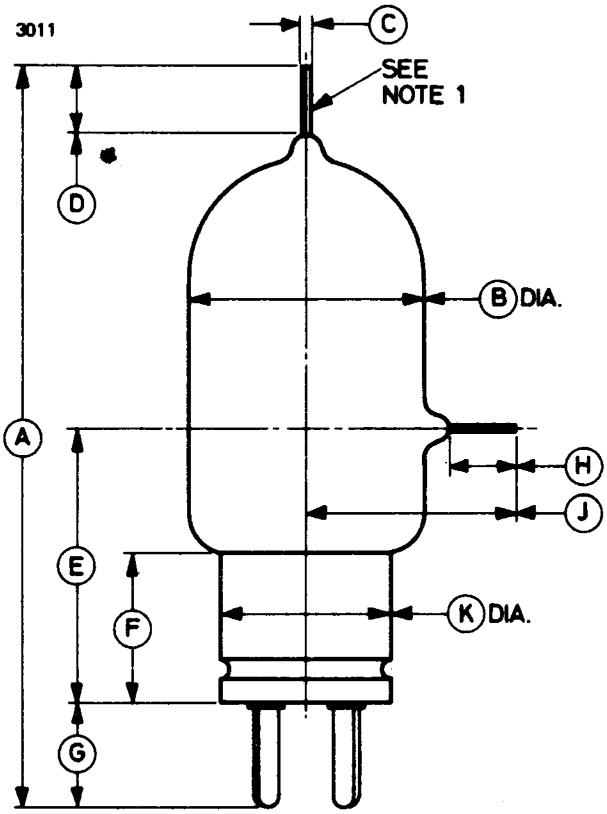
NOTES

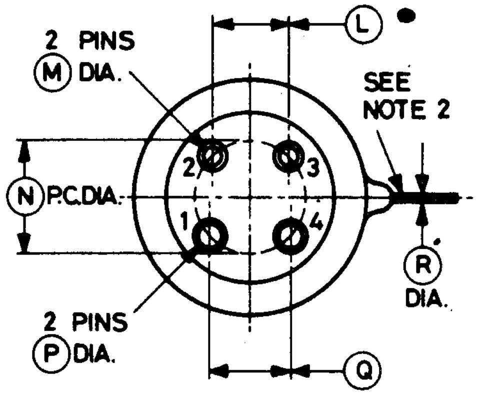
1. The grid voltage should be adjusted to give the stated zero-signal anode current.

TYPICAL CONSTANT CURRENT CHARACTERISTICS



OUTLINE (All dimensions without limits are nominal)





Pin	Element
1	Filament
2	No connection
3	No connection
4	Filament
Side lead	Grid
Top lead	Anode

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	4.187 ± 0.187	106.3 ± 4.8	J	1.200 ± 0.100	30.48 ± 2.54
B	1.375 ± 0.065	34.93 ± 1.65	K	1.151 ± 0.015	29.24 ± 0.38
C	0.048 ± 0.003	1.219 ± 0.076	L	0.437	11.10
D	0.375 ± 0.065	9.53 ± 1.65	M	0.125 ± 0.003	3.175 ± 0.076
E	1.562 ± 0.125	39.67 ± 3.18	N	0.640	16.26
F	0.843	21.41	P	0.156 ± 0.003	3.962 ± 0.076
G	0.596 max	15.14 max	Q	0.468	11.89
H	0.375 ± 0.065	9.53 ± 1.65	R	0.048 ± 0.003	1.219 ± 0.076

Millimetre dimensions have been derived from inches.

Outline Notes

1. The centre line through the anode pin will not deviate more than 0.125 inch (3.18mm) from the centre line of the tube and base.
2. Deviation from base centre line 3° max.

B1152

R.F. POWER TRIODE

ABRIDGED DATA

R.F. power triode of glass construction, radiation cooled anode, inte primarily for industrial service.

Anode dissipation:		
continuous operation, forced-air cooling	0.5	kW
duty factor 0.2, natural cooling	1.0	kW
Anode voltage (d.c. supply)	5.0	kV
Frequency for full ratings	50	MHz
Output power (class C oscillator):		
duty factor 1.0	1.5	...
duty factor 0.5	2.0	kW
duty factor 0.2	2.4	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	5.0	V
Filament current	32.5	A
Amplification factor (V_a = 4.0kV, I_a = 120mA)	24	
Mutual conductance (V_a = 1.0kV, I_a = 2.3A)	10	mA/V
Mutual conductance (V_a = 3.3kV, I_a = 120mA)	3.3	mA/V
Inter-electrode capacitances:		
grid to anode	5.6	pF
grid to filament	9.3	pF
anode to filament	0.35	pF

Mechanical

Overall length	240mm (9.45 inches) max
Overall diameter	130mm (5.12 inches) max
Net weight	0.5kg (1.1 pounds) approx
Base (see note 2)	special
Mounting position	vertical only, base down

COOLING

The bulb and seal temperatures must not exceed the values given below:

bulb temperature	350	°C
seal temperature	220	°C

For continuous operation a low velocity air flow is necessary to limit the bulb and seal temperatures. Natural cooling is normally adequate when the valve is operated intermittently or with reduced input.

R.F. POWER OSCILLATOR (Class C, d.c. anode supply)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	5.0	5.0	5.0	kV max
Anode current	560	780	1100	mA max
Anode dissipation	500	700	1000	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation)	210	290	420	mA max
Grid dissipation	85	95	110	W max
Grid to filament resistance	15	15	15	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	**Natural Cooling**		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Anode voltage	4.0	4.0	4.0	kV
Grid voltage	−380	−380	−410	V
from grid resistor	2.7	2.0	1.7	kΩ
Anode current	490	650	825	mA
Grid current (approx)	140	190	240	mA
Anode dissipation	450	630	900	W
Anode load resistance	4.7	3.4	2.7	kΩ
Feedback ratio (see note 3)	0.2	0.22	0.24	
Output power	1.5	2.0	2.4	kW
Efficiency	77	76	73	%
Effective output power to load (see note 4)	1.2	1.6	1.9	kW

R.F. POWER OSCILLATOR

(Class C, anode supply from unfiltered single phase, full-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	4.5	4.5	4.5	kV max
Anode current	450	630	900	mA max
Anode dissipation	500	700	1000	W max
Grid voltage (negative value)	850	850	850	V max
Grid current (at maximum anode dissipation)	190	195	380	mA max
Grid dissipation	85	95	110	W max
Grid to filament resistance	15	15	15	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	Natural Cooling		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Output voltage (r.m.s.) from transformer	4.5	4.5	4.5	kV
Anode voltage	4.05	4.05	4.05	kV
Grid voltage	–340	–365	–355	V
from grid resistor	2.7	2.2	1.7	kΩ
Anode current	400	530	675	mA
Grid current (approx)	125	165	210	mA
Anode dissipation	450	630	900	W
Anode load resistance	5.9	4.3	3.5	kΩ
Feedback ratio (see note 3)	0.16	0.17	0.18	
Output power	1.53	2.0	2.46	kW
Efficiency	77	76	73	%
Effective output power to load (see note 4)	1.25	1.5	2.0	kW

R.F. POWER OSCILLATOR

(Class C, anode supply from unfiltered three phase, half-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	5.0	5.0	5.0	kV max
Anode current	560	780	1100	mA max
Anode dissipation	500	700	1000	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation)	210	290	420	mA max
Grid dissipation	85	95	110	W max
Grid to filament resistance	15	15	15	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	**Natural Cooling**		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Output voltage (r.m.s.) from transformer	3.4	3.4	3.4	kV
Anode voltage	4.0	4.0	4.0	kV
Grid voltage	–380	–380	–410	V
from grid resistor	2.7	2.0	1.7	kΩ
Anode current	480	640	820	mA
Grid current (approx)	140	190	240	mA
Anode dissipation	450	630	900	W
Anode load resistance	4.7	3.4	2.7	kΩ
Feedback ratio (see note 3)	0.2	0.22	0.24	
Output power	1.5	2.0	2.4	kW
Efficiency	77	76	73	%
Effective output power to load (see note 4)	1.2	1.6	1.9	kW

R.F. POWER OSCILLATOR

(Class C, anode supply unrectified a.c.)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Output voltage (r.m.s.) from transformer	5.0	5.0	5.0	kV max
Anode current	320	450	640	mA max
Anode dissipation	500	700	1000	W max
Grid voltage (negative value)	–850	–850	–850	V max
Grid current (at maximum anode dissipation)	110	155	220	mA max
Grid dissipation	85	95	110	W max
Grid to filament resistance	15	15	15	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	**Natural Cooling**		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Output voltage (r.m.s.) from transformer	4.5	4.5	4.5	kV
Grid voltage	–215	–215	–220	V
from grid resistor	2.7	1.8	1.3	kΩ
Anode current (see note 5)	280	420	600	mA
Grid current (approx) (see note 5)	80	120	170	mA
Anode dissipation	380	500	800	W
Anode load resistance	4.3	2.9	2.0	kΩ
Feedback ratio (see note 3)	0.18	0.22	0.25	
Output power	1.08	1.6	2.2	kW
Efficiency	77	76	73	%
Effective output power to load (see note 4)	0.9	1.3	1.7	kW

NOTES

1. Temporary fluctuations up to +5% or −10% in filament voltage are permissible.

2. The design of the base socket must ensure that no strain is applied to the glass to metal seals. Where clamps are used for connecting to the base pins or top cap, the leads must be flexible. Allowance must be made for variations of up to 3% in the specified pin positions in any direction.

3. The feedback ratio is defined as $\frac{V_{g(pk)}}{V_{a(pk)}}$

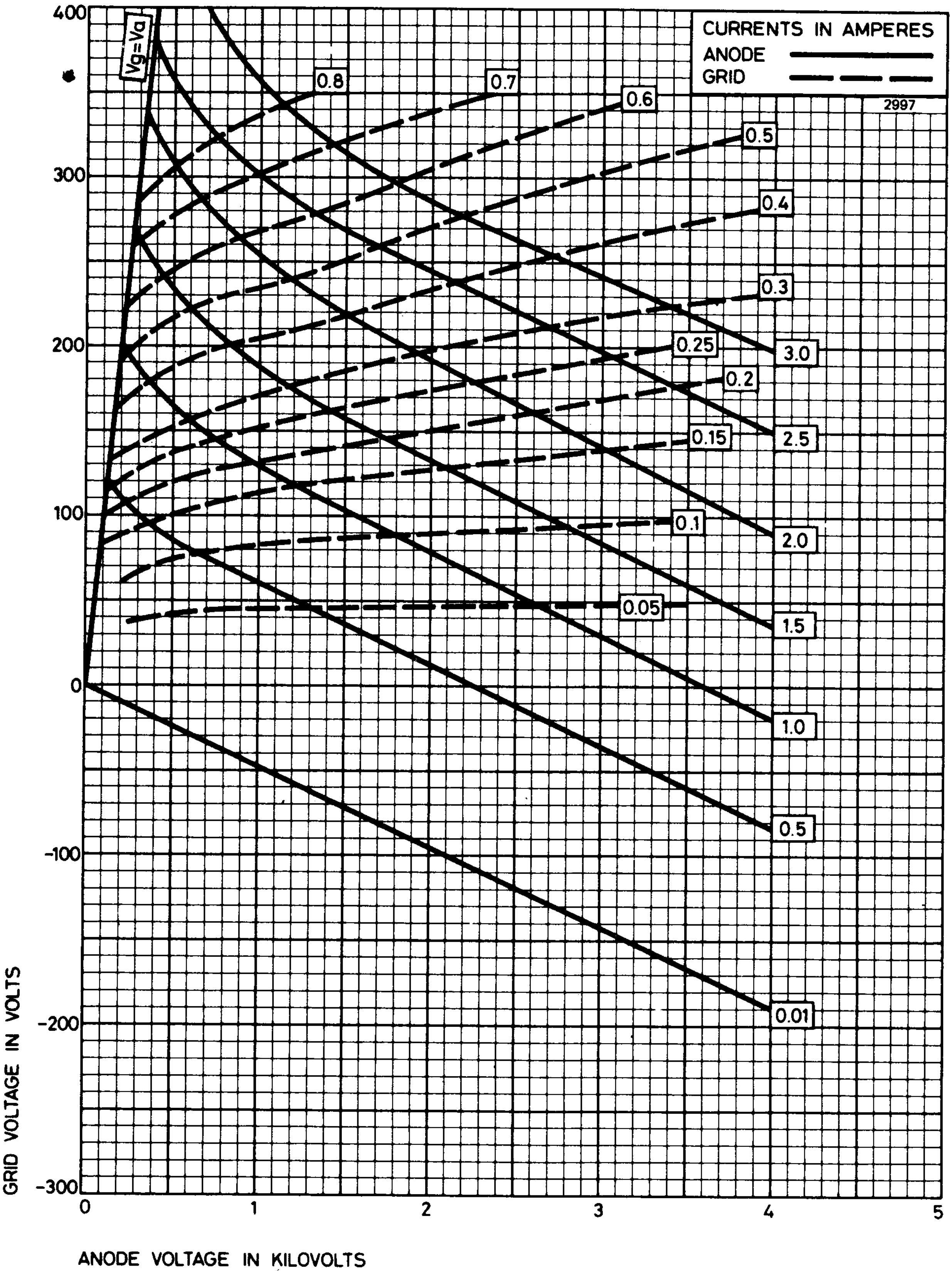
   where $V_{g(pk)}$ = peak r.f. grid voltage in volts
   and $V_{a(pk)}$ = peak r.f. anode voltage in volts.

4. Effective output power to load = $\eta_a (P_{out} - P_{drive})$

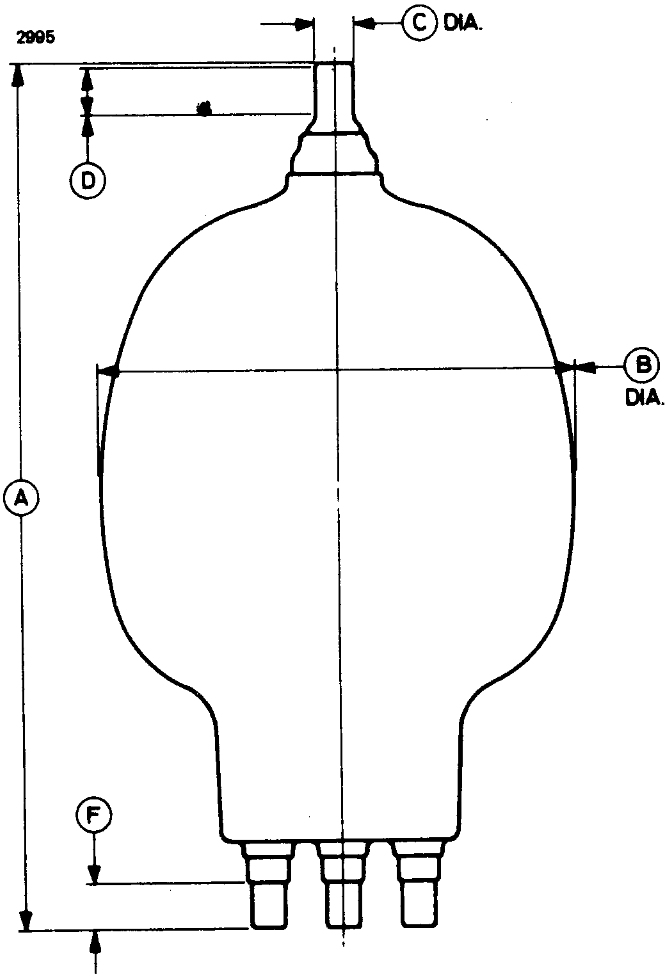
   where η_a = efficiency of anode circuit = 85%
   P_{out} = output power of valve to anode circuit
   P_{drive} = drive power fed back to grid circuit.

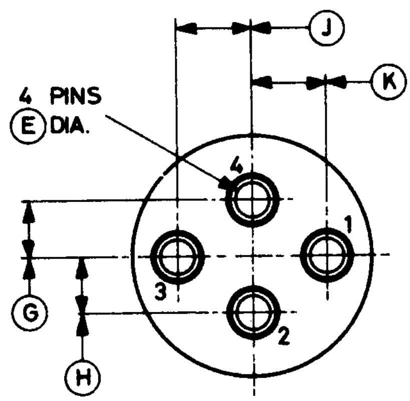
5. Averaged over one cycle of supply frequency.

TYPICAL CONSTANT CURRENT CHARACTERISTICS



OUTLINE (All dimensions without limits are nominal)





Pin	Element
1	Grid
2	Filament
3	Grid
4	Filament
Cap	Anode

Ref	Millimetres	Inches
A	240.0 max	9.450 max
B	130.0 max	5.118 max
C	9.50	0.374
D	12.70 min	0.500 min
E	9.00	0.354

Ref	Millimetres	Inches
F	12.00	0.472
G*	15.00	0.591
H*	15.00	0.591
J*	20.00	0.787
K*	20.00	0.787

Inch dimensions have been derived from millimetres.

* Allowance must be made for variations of up to 3% in the specified pin positions in any direction.

B1153

R.F. POWER TRIODE

ABRIDGED DATA

R.F. power triode of glass construction, radiation cooled anode, intended primarily for industrial service.

Anode dissipation:		
continuous operation, forced-air cooling	0.8	kW max
duty factor 0.2, natural cooling	1.5	kW max
Anode voltage	6.0	kV max
Frequency for full ratings	50	MHz max
Output power (class C oscillator):		
duty factor 1.0	2.7	kW
duty factor 0.5	3.7	kW
duty factor 0.2	4.6	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	6.3	V
Filament current	32.5	A
Amplification factor (V_a = 4.0kV, I_a = 190mA)	22	
Mutual conductance (V_a = 1.0kV, I_a = 3.0A)	9.0	mA/V
Mutual conductance (V_a = 4.0kV, I_a = 190mA)	5.1	mA/V
Inter-electrode capacitances:		
grid to anode	6.2	pF
grid to filament	10.5	pF
anode to filament	0.25	pF

Mechanical

Overall length	251mm (9.900 inches) max
Overall diameter	155mm (6.102 inches) max
Net weight	0.7kg (1½ pounds) approx
Base (see note 2)	special
Mounting position	vertical only, base down

COOLING

The bulb and seal temperatures must not exceed the values given below:

bulb temperature	350	°C
seal temperature	220	°C

For continuous operation a low velocity air flow is necessary to limit the bulb and seal temperatures. Natural cooling is normally adequate when the valve is operated intermittently or with reduced input.

R.F. POWER OSCILLATOR (Class C, d.c. anode supply)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	6.0	6.0	6.0	kV max
Anode current	750	1100	1400	mA max
Anode dissipation	800	1200	1500	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation)	300	375	400	mA max
Grid dissipation	120	150	175	W max
Grid to filament resistance	10	10	10	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	Natural Cooling		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Anode voltage	5.0	5.0	5.0	kV
Grid voltage	–565	–530	–620	V
from grid resistor	2.22	1.93	1.75	kΩ
Anode current	700	960	1200	mA
Grid current (approx)	255	275	355	mA
Anode dissipation	788	1100	1380	W
Anode load resistance	3.8	2.8	2.2	kΩ
Feedback ratio (see note 3)	0.2	0.22	0.23	
Output power	2.7	3.7	4.6	kW
Efficiency	77.5	77	77	%
Effective output power to load (see note 4)	2.3	3.1	3.9	kW

R.F. POWER OSCILLATOR

(Class C, anode supply from unfiltered single phase, full-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	5.4	5.4	5.4	kV max
Anode current	670	1000	1250	mA max
Anode dissipation	800	1200	1500	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation)	270	400	500	mA max
Grid dissipation	120	150	175	W max
Grid to filament resistance	10	10	10	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	**Natural Cooling**		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Anode voltage	4.5	4.5	4.5	kV
Grid voltage	–375	–375	–385	V
from grid resistor	2.2	1.5	1.4	kΩ
Anode current	600	760	870	mA
Grid current (approx)	170	250	275	mA
Anode dissipation	750	1100	1400	W
Anode load resistance	3.8	3.3	2.6	kΩ
Feedback ratio (see note 3)	0.17	0.2	0.2	
Output power	2.55	3.13	3.6	kW
Efficiency	77	74	72	%
Effective output power to load (see note 4)	2.2	2.6	3.0	kW

R.F. POWER OSCILLATOR

(Class C, anode supply from unfiltered three phase, half-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Duty factor	**1.0**	**0.5**	**0.2**	
Averaging time	–	10	5.0	s max
Anode voltage	6.0	6.0	6.0	kV max
Anode current	750	1100	1400	mA max
Anode dissipation	800	1200	1500	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation)	300	450	560	mA max
Grid dissipation	120	150	175	W max
Grid to filament resistance	10	10	10	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	**Natural Cooling**		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Output voltage (r.m.s.) from transformer	4.25	4.25	4.25	kV
Anode voltage	5.0	5.0	5.0	kV
Grid voltage	–400	–410	–400	V
from grid resistor	2.16	2.10	1.65	kΩ
Anode current	700	740	900	mA
Grid current (approx)	185	195	240	mA
Anode dissipation	780	960	1200	W
Anode load resistance	3.8	3.4	2.4	kΩ
Feedback ratio (see note 3)	0.16	0.17	0.17	
Output power	2.7	2.74	3.3	kW
Efficiency	78	74	73	%
Effective output power to load (see note 4)	2.3	2.32	2.8	kW

R.F. POWER OSCILLATOR
(Class C, anode supply unrectified a.c.)

MAXIMUM RATINGS (Absolute values)

Duty factor	1.0	0.5	0.2	
Averaging time	–	10	5.0	s max
Output voltage (r.m.s.) from transformer	5.6	5.6	5.6	kV max
Anode current (see note 5)	400	600	750	mA max
Anode dissipation	800	1200	1500	W max
Grid voltage (negative value)	1.25	1.25	1.25	kV max
Grid current (at maximum anode dissipation) (see note 5)	160	240	300	mA max
Grid dissipation	120	150	175	W max
Grid to filament resistance	10	10	10	kΩ max
Operating frequency	50	50	50	MHz max

TYPICAL OPERATING CONDITIONS

	Forced-air Cooling	Natural Cooling		
Duty factor	1.0	0.5	0.2	
On period	–	5.0	1.0	s
Off period	–	5.0	4.0	s
Output voltage (r.m.s.) from transformer	5.2	5.2	5.2	kV
Grid voltage	−180	−180	−180	V
from grid resistor	1.56	1.06	0.82	kΩ
Anode current (see note 5)	360	540	675	mA
Grid current (approx) (see note 5)	115	170	220	mA
Anode dissipation	520	870	1170	W
Anode load resistance	3.2	2.2	1.7	kΩ
Feedback ratio (see note 3)	0.15	0.2	0.23	
Output power	1.56	2.24	2.73	kW
Efficiency	75	72	70	%
Effective output power to load (see note 4)	1.3	1.9	2.3	kW

NOTES

1. Temporary fluctuations up to +5% or −10% in filament voltage are permissible.

2. The design of the base socket must ensure that no strain is applied to the glass to metal seals. Where clamps are used for connecting to the base pins or top cap, the leads must be flexible. Allowance must be made for variations of up to 3% in the specified pin positions in any direction.

3. The feedback ratio is defined as $\dfrac{V_{g(pk)}}{V_{a(pk)}}$

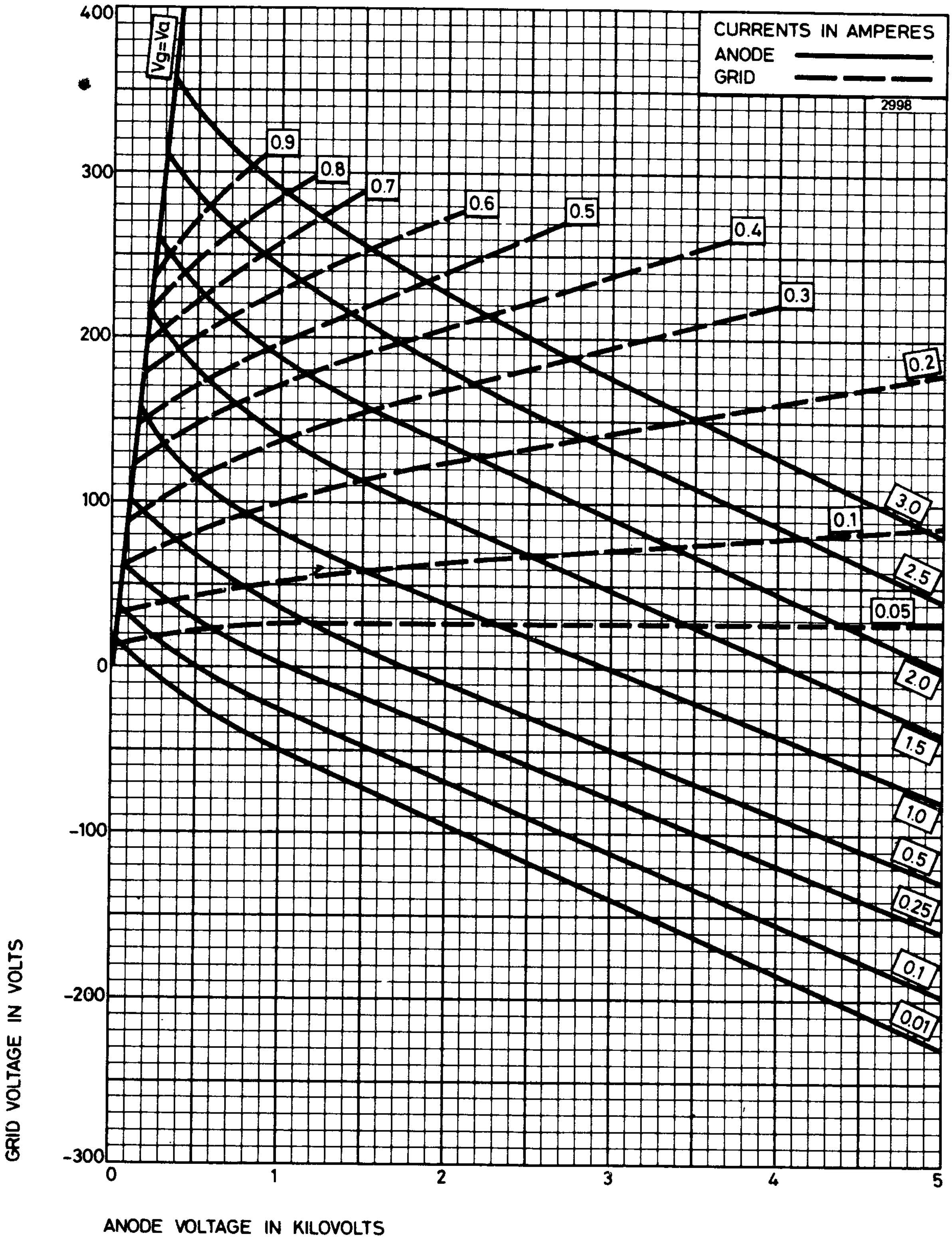
   where $V_{g(pk)}$ = peak r.f. grid voltage in volts
   and $V_{a(pk)}$ = peak r.f. anode voltage in volts.

4. Effective output power to load = $\eta_a (P_{out} - P_{drive})$

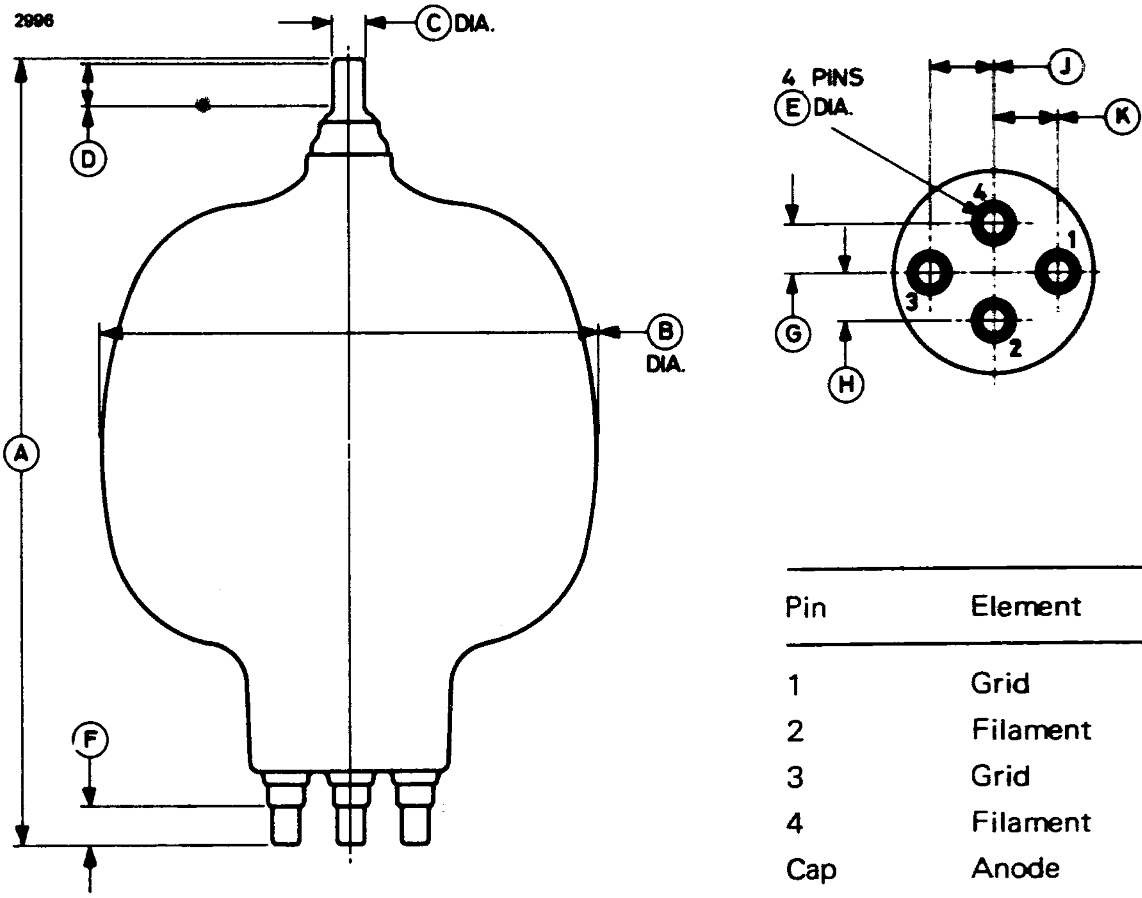
   where η_a = efficiency of anode circuit = 85%
   P_{out} = output power of valve to anode circuit
   P_{drive} = drive power fed back to grid circuit.

5. Averaged over one cycle of supply frequency.

TYPICAL CONSTANT CURRENT CHARACTERISTICS



OUTLINE (All dimensions without limits are nominal)



Pin	Element
1	Grid
2	Filament
3	Grid
4	Filament
Cap	Anode

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	251.0 max	9.900 max	F	12.00	0.472
B	155.0 max	6.102 max	G*	15.00	0.591
C	9.50	0.374	H*	15.00	0.591
D	12.70 min	0.500 min	J*	20.00	0.787
E	9.00	0.354	K*	20.00	0.787

Inch dimensions have been derived from millimetres.

* Allowance must be made for variations of up to 3% in the specified pin positions in any direction.

High Power Triodes

5762
(BR191B)

R.F. POWER TRIODE

Service Type CV2383, CV5289

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Forced-air cooled r.f. transmitting triode

Anode dissipation	4.0	kW max
Anode voltage	6.2	kV max
Frequency for full ratings	30	MHz max
Frequency at reduced ratings	220	MHz max
Output power (class C telegraphy)	6.0	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1):		
at frequencies up to 70MHz	12.6	V
at frequencies above 70MHz	11.8	V
Filament current	29	A
Surge filament current (peak) (see note 2)	175	A max
Filament cold resistance	52	mΩ
Peak usable cathode current	10	A
Amplification factor	29	
Inter-electrode capacitances:		
grid to anode	18.5	pF
grid to filament	19	pF
anode to filament	0.5	pF

Mechanical

Overall length (excluding flexible leads)	180mm (7.09 inches) max
Overall diameter	119mm (4.69 inches) max
Net weight	7 pounds (3.2kg) approx
Mounting position	vertical, either way up

COOLING

Anode

The air cooling requirements are shown on page 11. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The inlet air temperature must not exceed 45°C and the radiator temperature, measured on the core at the end opposite to the incoming air, must not exceed 180°C.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 180°C. A flow of air of 10ft^3/min (0.28m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR (Class B)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.2	kV max
Anode current	1.5	A max
Anode input power	8.7	kW max
Anode dissipation	4.0	kW max

TYPICAL OPERATING CONDITIONS (Class B, 2 valves)

Anode voltage	4.7	kV
Grid voltage	−200	V
Peak a.f. input voltage (grid to grid)	900	V
Maximum-signal anode current	2 x 1.4	A
Zero-signal anode current	2 x 0.15	A
Effective load (anode to anode)	3640	Ω
Drive power	195	W
Output power	8.8	kW

R.F. POWER AMPLIFIER
CLASS B TELEVISION SERVICE U.S.A. SYSTEM
(Synchronising level conditions unless otherwise stated)

MAXIMUM RATINGS (Absolute values)

	54 to 216MHz	
Anode voltage	4.5	kV max
Anode current	2.0	A max
Grid current (pedestal level)	0.325	A max
Anode input power	9.0	kW max
Anode dissipation	4.0	kW max

TYPICAL OPERATION IN GROUNDED-GRID CIRCUIT

Bandwidth	10	8.5	MHz
Anode voltage	3.0	3.2	kV
Grid voltage	−105	−110	V
Peak r.f. grid drive voltage:			
synchronising level	380	435	V
pedestal level	290	310	V
Anode current:			
synchronising level	1.8	1.8	A
pedestal level	1.36	1.35	A
Grid current:			
synchronising level	0.265	0.4	A
pedestal level	0.115	0.130	A
Driving power (see note 3):			
synchronising level	625	770	W
Output power:			
synchronising level	3.150	4.0	kW
pedestal level	1.8	2.3	kW

GRID MODULATED R.F. POWER AMPLIFIER
CLASS C TELEVISION SERVICE – U.S.A. SYSTEM
(Synchronising level conditions unless otherwise stated)

MAXIMUM RATINGS (Absolute values)

	54 to 216MHz	
Anode voltage	3.7	kV max
Grid voltage (white level)	–800	V max
Anode current	1.9	A max
Grid current (pedestal level)	0.225	A max
Anode input power	6.5	kW max
Anode dissipation	4.0	kW max

TYPICAL OPERATION IN GROUNDED-GRID CIRCUIT

Bandwidth	8.5	MHz
Anode voltage	3.2	kV
Grid voltage:		
synchronising level	–110	V
pedestal level	–220	V
white level	–520	V
Peak r.f. grid drive voltage	435	V
Anode current:		
synchronising level	1.8	A
pedestal level	1.25	A
Grid current (approx):		
synchronising level	0.40	A
pedestal level	0.13	A
Driving power (see note 3):		
synchronising level	770	W
Output power (approx):		
synchronising level	4.0	kW
pedestal level	2.3	kW

ANODE MODULATED R.F. POWER AMPLIFIER

(Class C telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

	up to 30MHz	at 110MHz	at 220MHz	
Anode voltage	5.0	4.2	3.6	kV max
Grid voltage (negative value)	1.0	1.0	0.6	kV max
Anode current	1.0	1.0	1.0	A max
Grid current	0.3	0.3	0.25	A max
Anode input power	5.0	4.2	3.6	kW max
Anode dissipation	2.7	2.7	2.7	kW max

TYPICAL OPERATION IN GROUNDED-FILAMENT CIRCUIT

	up to 30MHz	at 110MHz	
Anode voltage	4.7	4.0	kV
Grid voltage	−400	−350	V
from grid resistor	1425	1460	Ω
Peak r.f. grid drive voltage (see note 4)	675	600	V
Anode current	0.96	0.93	A
Grid current (approx)	0.28	0.24	A
Driving power (approx)	170	130	W
Output power (approx)	3.7	2.8	kW

TYPICAL OPERATION IN GROUNDED-GRID CIRCUIT

	up to 30MHz	at 110MHz	
Anode voltage	4.7	4.0	kV
Grid voltage	−400	−350	V
from grid resistor	1425	1460	Ω
Peak r.f. grid drive voltage	675	600	V
Anode current	0.96	0.93	A
Grid current (approx)	0.28	0.24	A
Driving power (approx)	720	600	W
Output power (approx)	4.2	3.2	kW

R.F. POWER AMPLIFIER OR OSCILLATOR

(Class C telegraphy – see note 5 – and class C f.m. telephony)

MAXIMUM RATINGS (Absolute values)

	up to 30MHz	at 110MHz	at 220MHz	
Anode voltage	6.2	5.2	4.4	kV max
Grid voltage	−1.0	−1.0	−0.6	kV max
Anode current	1.4	1.4	1.4	A max
Grid current	0.3	0.3	0.25	A max
Anode input power	8.7	7.3	6.2	kW max
Anode dissipation	4.0	4.0	4.0	kW max

TYPICAL OPERATION IN GROUNDED-FILAMENT CIRCUIT

	up to 30MHz	at 110MHz	
Anode voltage	6.0	5.0	kV
Grid voltage	−550	−525	V
from grid resistor	1900	1725	Ω
and cathode resistor	360	340	Ω
Peak r.f. grid drive voltage	875	850	V
Anode current	1.25	1.25	A
Grid current (approx)	0.29	0.29	A
Driving power (approx)	225	225	W
Output power (approx)	6.0	4.8	kW

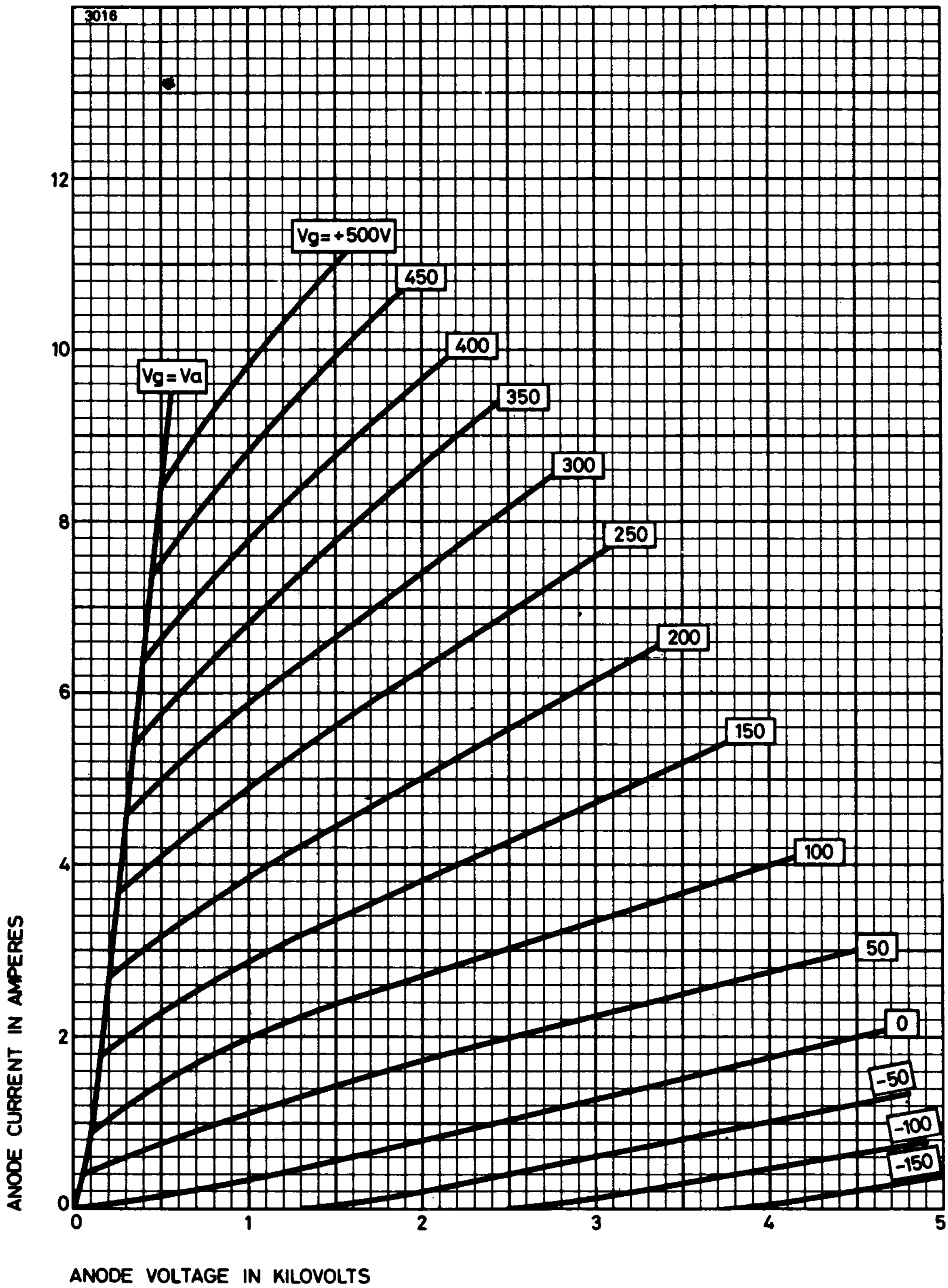
TYPICAL OPERATION IN GROUNDED-GRID CIRCUIT

	up to 30MHz	at 110MHz	at 220MHz	
Anode voltage	6.0	5.0	4.3	kV
Grid voltage	−550	−1000	−200	V
from grid resistor	1900	4100	807	Ω
and cathode resistor	360	740	134	Ω
Peak r.f. grid drive voltage	875	1350	432	V
Anode current	1.25	1.1	1.25	A
Grid current (approx)	0.290	0.245	0.25	A
Driving power (approx)	1225	1680	542	W
Output power (approx)	7.0	5.5	4.0	kW

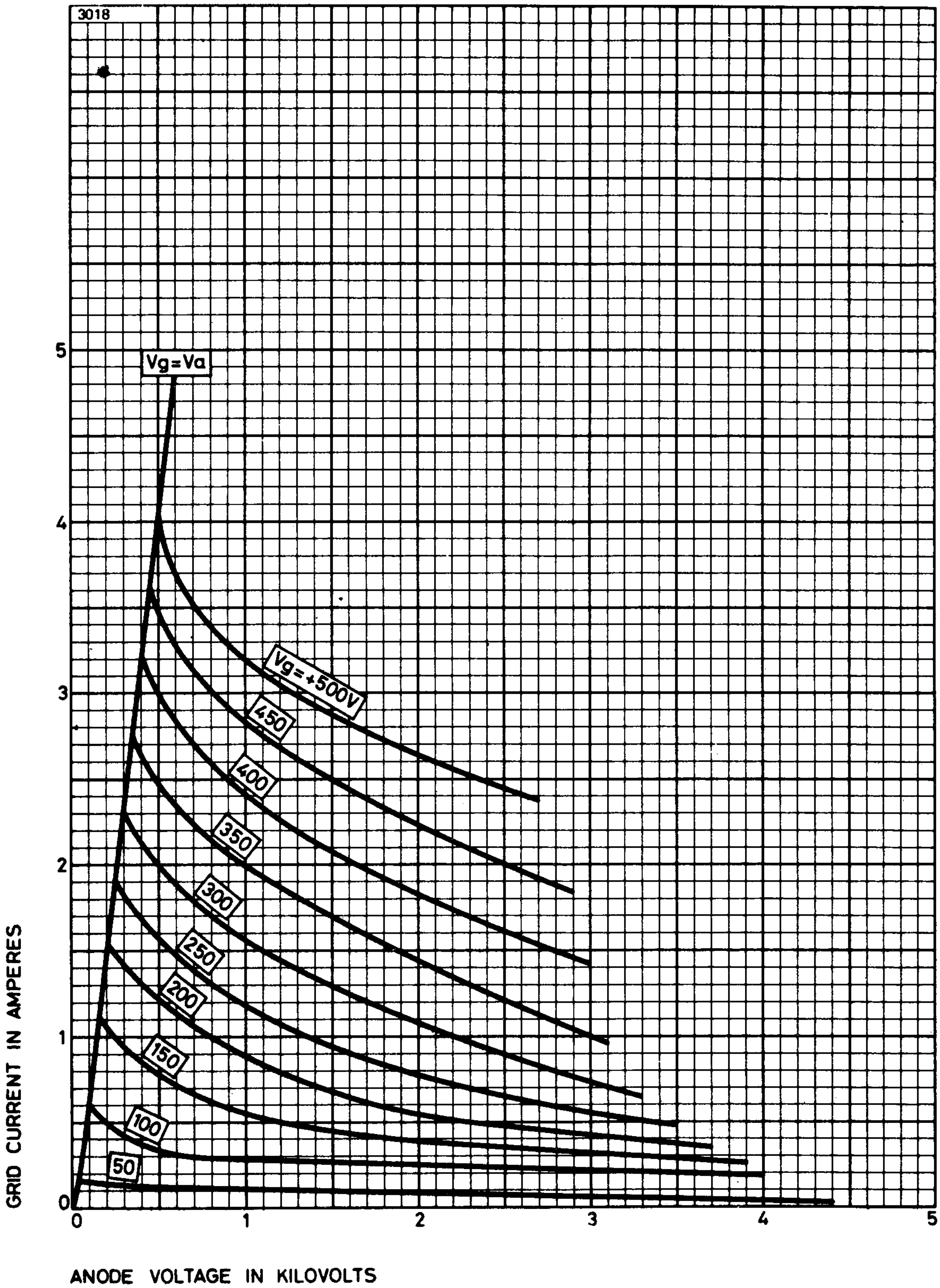
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%. The centre tap lead may be used for the anode current return but must not be used for the filament current supply.
2. The filament current must not exceed 175A, even momentarily, at any time.
3. Computed value to supply grid losses and feed-through power. Additional power will be required to supply circuit losses.
4. Driver modulated approximately 30%.
5. Key-down conditions per valve without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio frequency envelope does not exceed 115% of the carrier conditions.

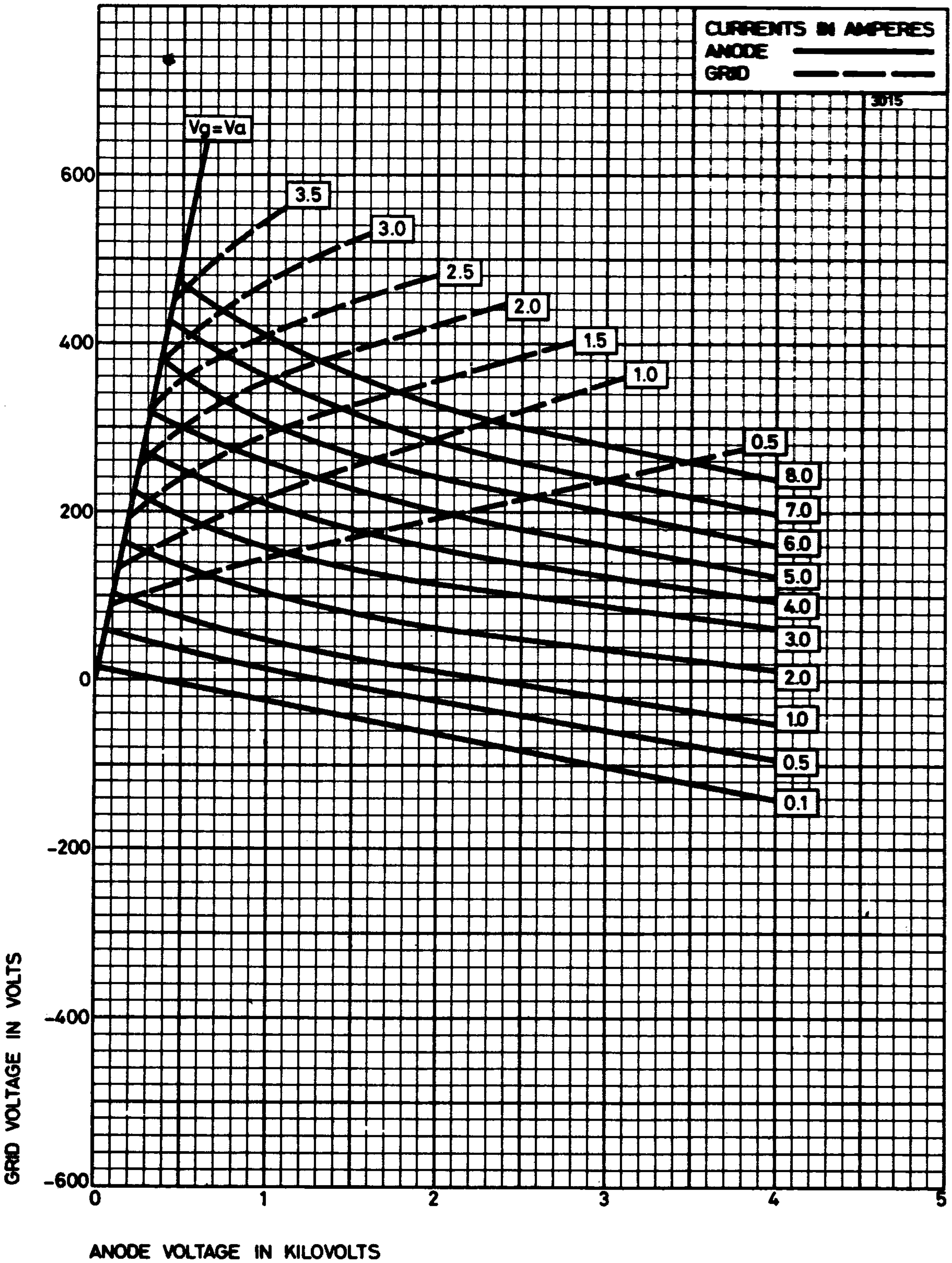
TYPICAL ANODE CHARACTERISTICS



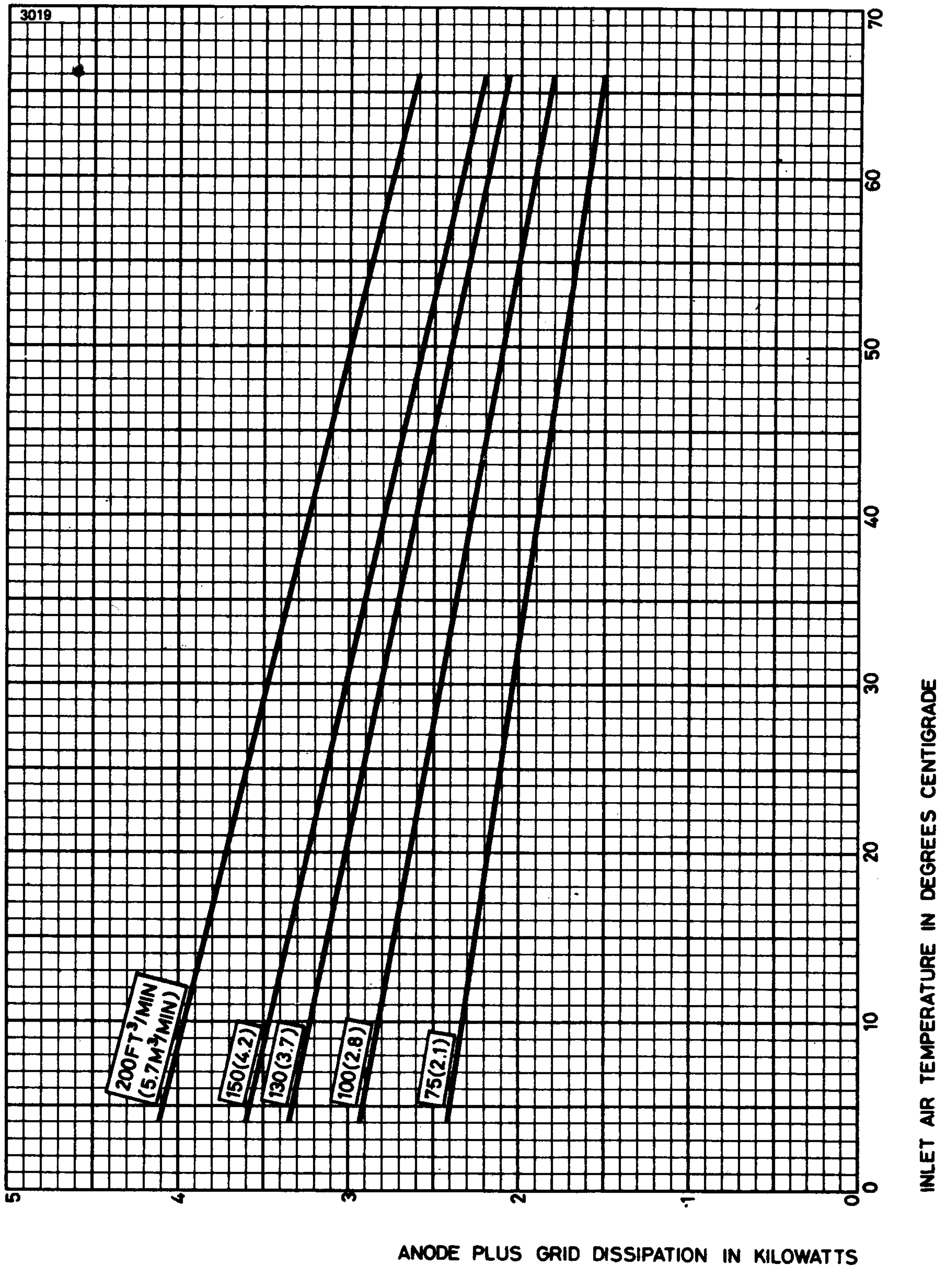
TYPICAL GRID CHARACTERISTICS



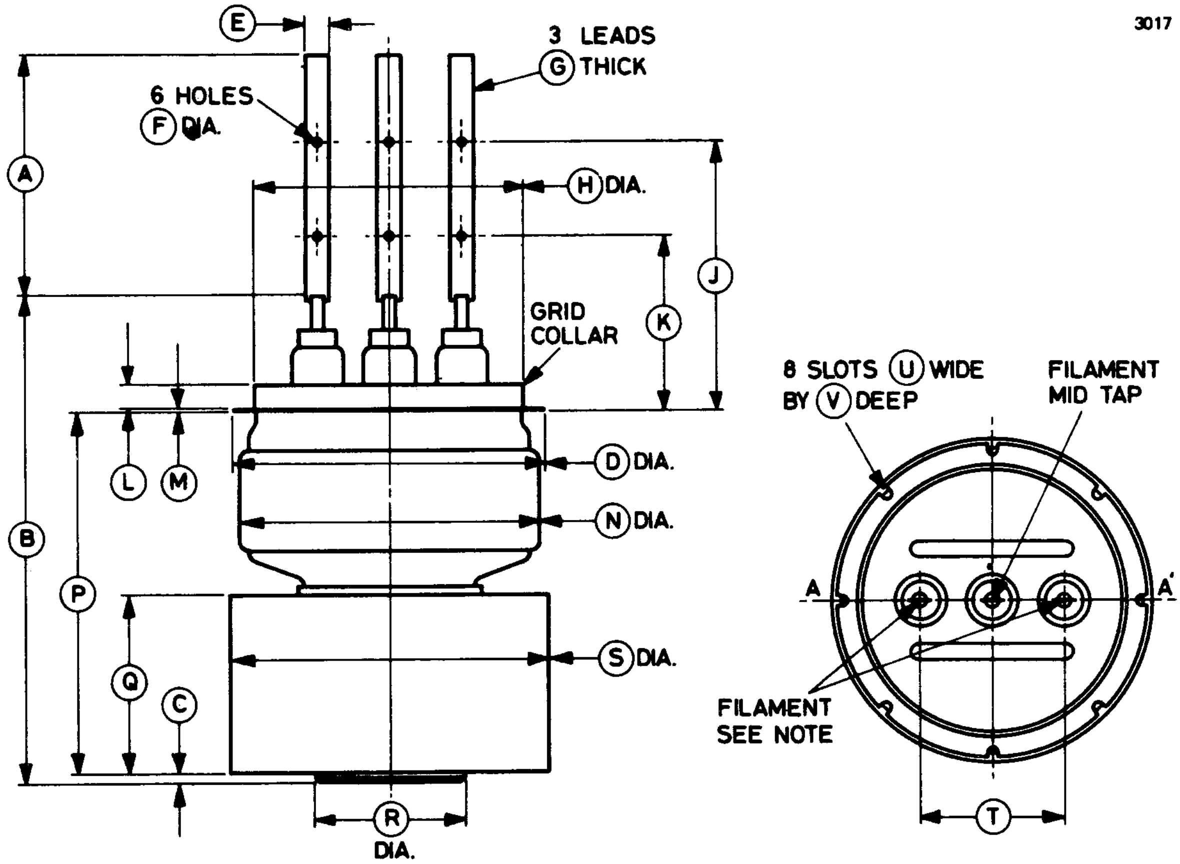
TYPICAL CONSTANT CURRENT CHARACTERISTICS



AIR COOLING REQUIREMENTS



OUTLINE



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	89.0 ± 2.0	3.504 ± 0.079	L	9.5	0.375
B	180.0 max	7.087 max	M	1.5 ± 0.2	0.059 ± 0.008
C	4.75 max	0.187 max	N	116.0 max	4.567 max
D	116.0 ± 0.5	4.567 ± 0.020	P	133.5 ± 3.0	5.256 ± 0.118
E	8.0 ± 0.5	0.315 ± 0.020	Q	70.0 max	2.756 max
F	3.6 ± 0.1	0.142 ± 0.004	R	57.0 max	2.244 max
G	4 x 0.25	4 x 0.010	S	117.5 ± 1.5	4.626 ± 0.059
H	100.0 max	3.937 max	T	54.0 ± 2.5	2.126 ± 0.098
J	100.0 ± 8.0	3.937 ± 0.315	U	4.62 ± 0.10	0.182 ± 0.004
K	65.0 ± 8.0	2.559 ± 0.315	V	5.2 ± 0.2	0.205 ± 0.008

Inch dimensions have been derived from millimetres.

Note The plane of the filament leads will be parallel to plane A-A' to within 3½°.

BR/BW140

R.F. POWER TRIODES

Service Type CV2871 (BW140)

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. transmitting triodes differing only in anode dissipation and the method of anode cooling.

Anode cooling:		
BR140		forced-air
BW140		water; separate jacket
Anode dissipation:		
BR140	8.0	kW max
BW140	12	kW max
Anode voltage	12	kV max
Frequency for full ratings	15	MHz max
Frequency at reduced ratings	40	MHz max

GENERAL

Electrical

Filament		tungsten
Filament voltage (see note 1)	19	V
Filament current	75	A
Surge filament current (peak) (see note 2)	113	A max
Filament cold resistance	22.5	mΩ
Peak usable cathode current	see note 1 and page 7	
Amplification factor (V_a = 9.0kV, I_a = 1.0A)	45	
Mutual conductance (V_a = 8.0kV, I_a = 1.5A)	9.0	mA/V
Inter-electrode capacitances:		
grid to anode	30	pF
grid to filament	27	pF
anode to filament	2.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR140	46 pounds (21kg) approx
BW140	6 pounds (2.7kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads MA135
Sealing ring (supplied with BW140) MA248

COOLING

Anode

The BR140 air cooling requirements are shown on pages 8 and 9. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously. The anode temperature must not exceed 180°C.

The anode of the BW140 must be fitted into a water jacket for cooling, the flow necessary being 3 to 4 imp.gal/min (13.5 to 18 l./min). The temperature of the cooling water at the outlet must not exceed 65°C nor must the temperature rise across the jacket exceed 15°C. The anode temperature must not exceed 140°C.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. In some cases it may be necessary to blow air on to the header to maintain the seal temperatures within this limit. A suitable arrangement is to blow 10 to 30ft^3/min (0.3 to 0.9m^3/min approx) of air through a 1-inch (25mm) diameter nozzle directed on to the header before and during the application of any voltages.

MAXIMUM RATINGS (Absolute values)

Anode voltage . . . . see table below
Anode dissipation:
BR140 . . . . 8.0 kW max
BW140 . . . . 12 kW max
Grid dissipation . . . . 0.8 kW max

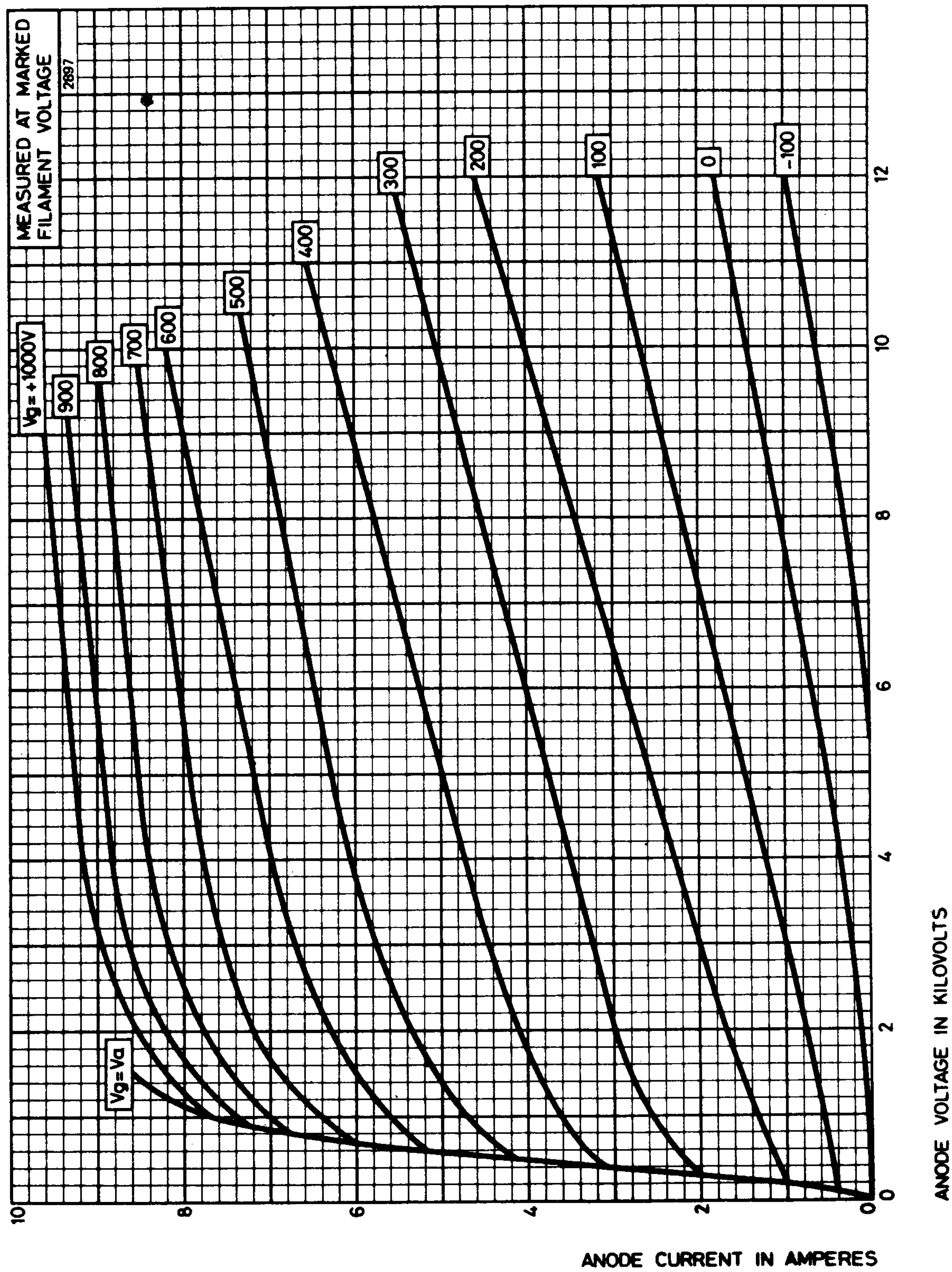
Maximum Anode Voltage against Frequency

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
15	12.0	10.0
20	10.2	8.5
25	7.8	6.5
40	4.2	3.5

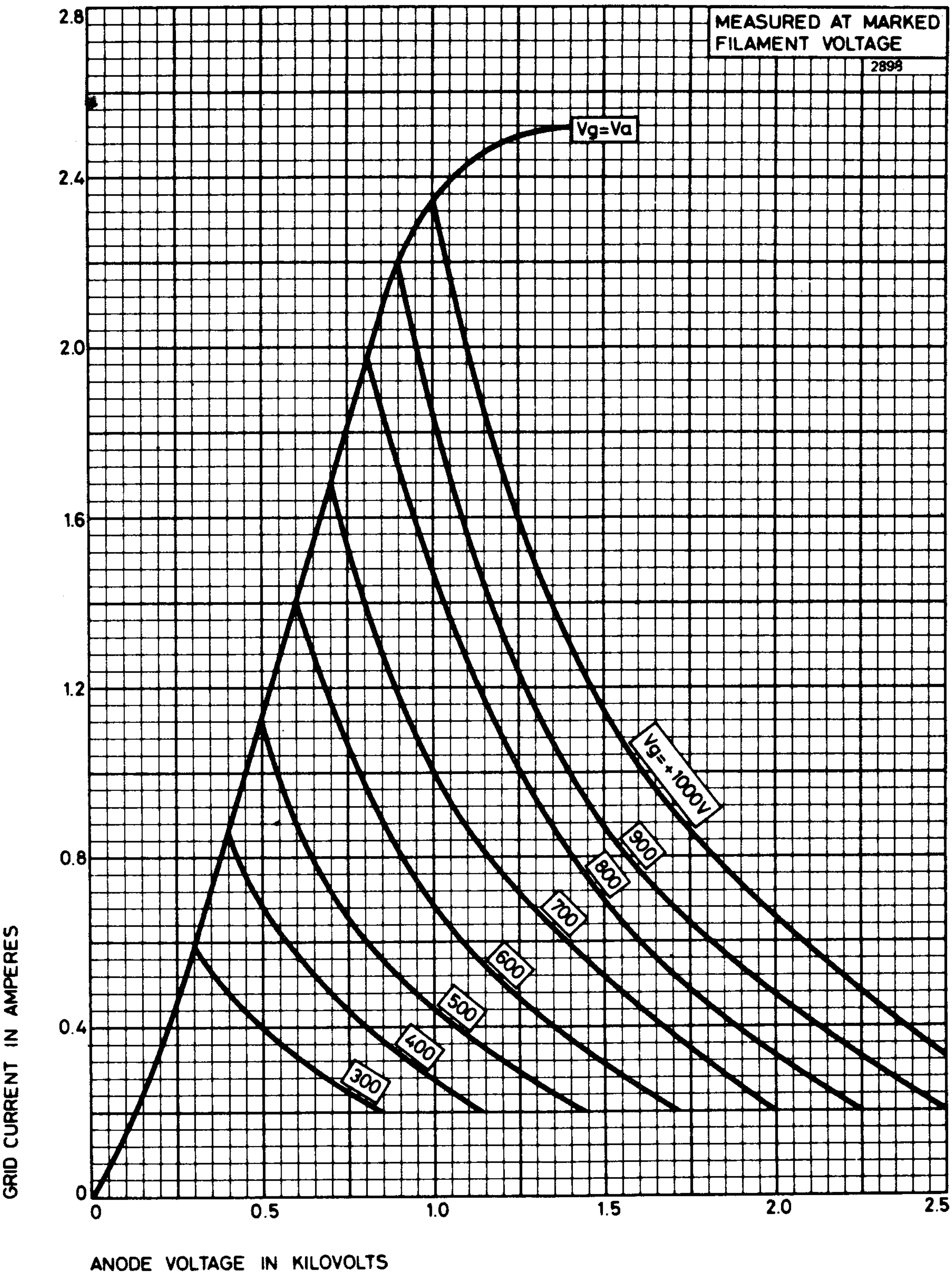
NOTES

1. Marked filament voltage. Each valve is marked with the filament voltage required to give 10A peak emission at 90% saturation. Longer filament life may be obtained if the filament is operated at a reduced temperature and a correspondingly reduced anode current (see Emission Characteristic on page 7) but care must be taken to keep the anode dissipation within the maximum rating.
2. The filament current must not exceed 113A, even momentarily, at any time.

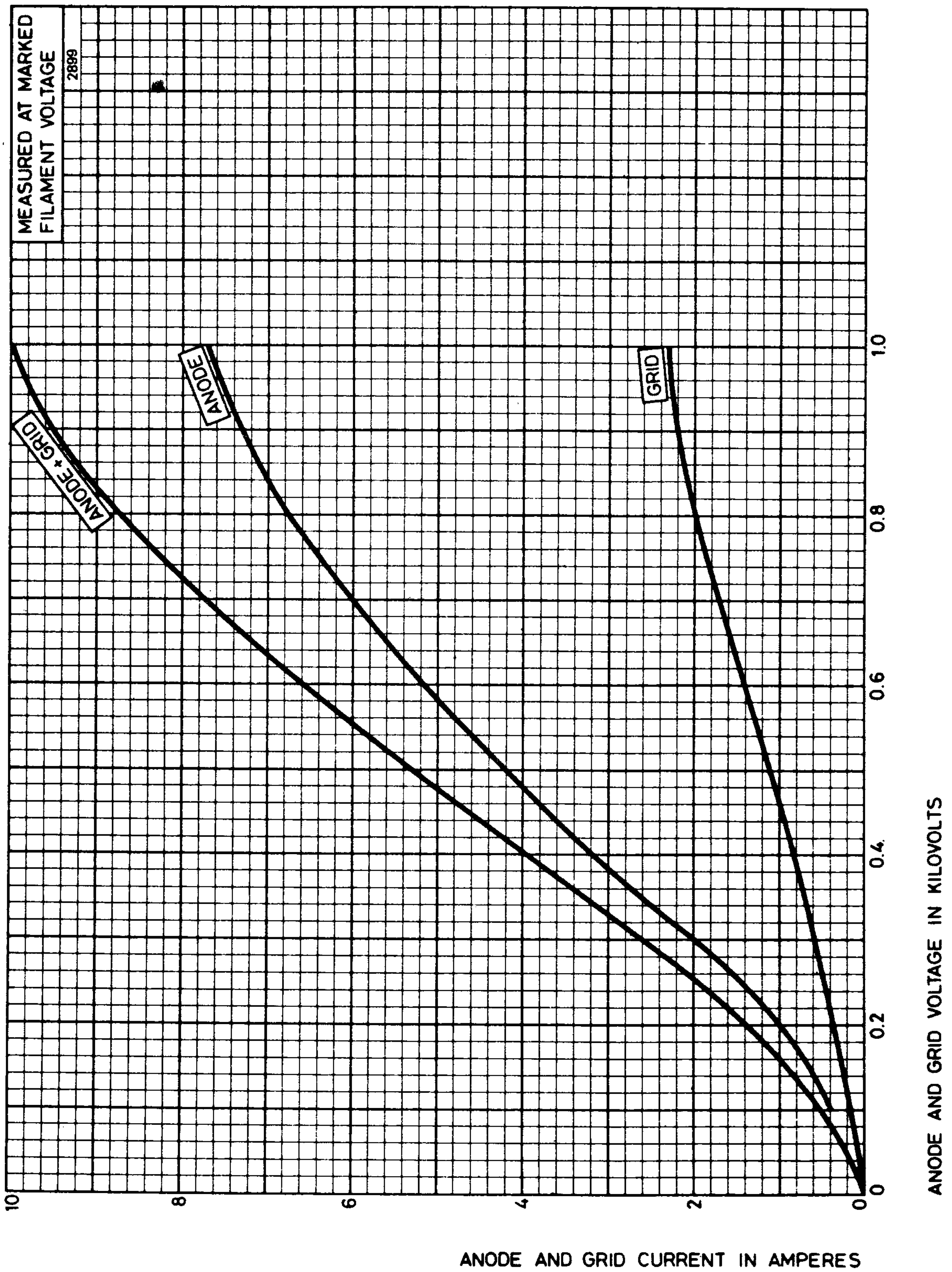
TYPICAL ANODE CHARACTERISTICS



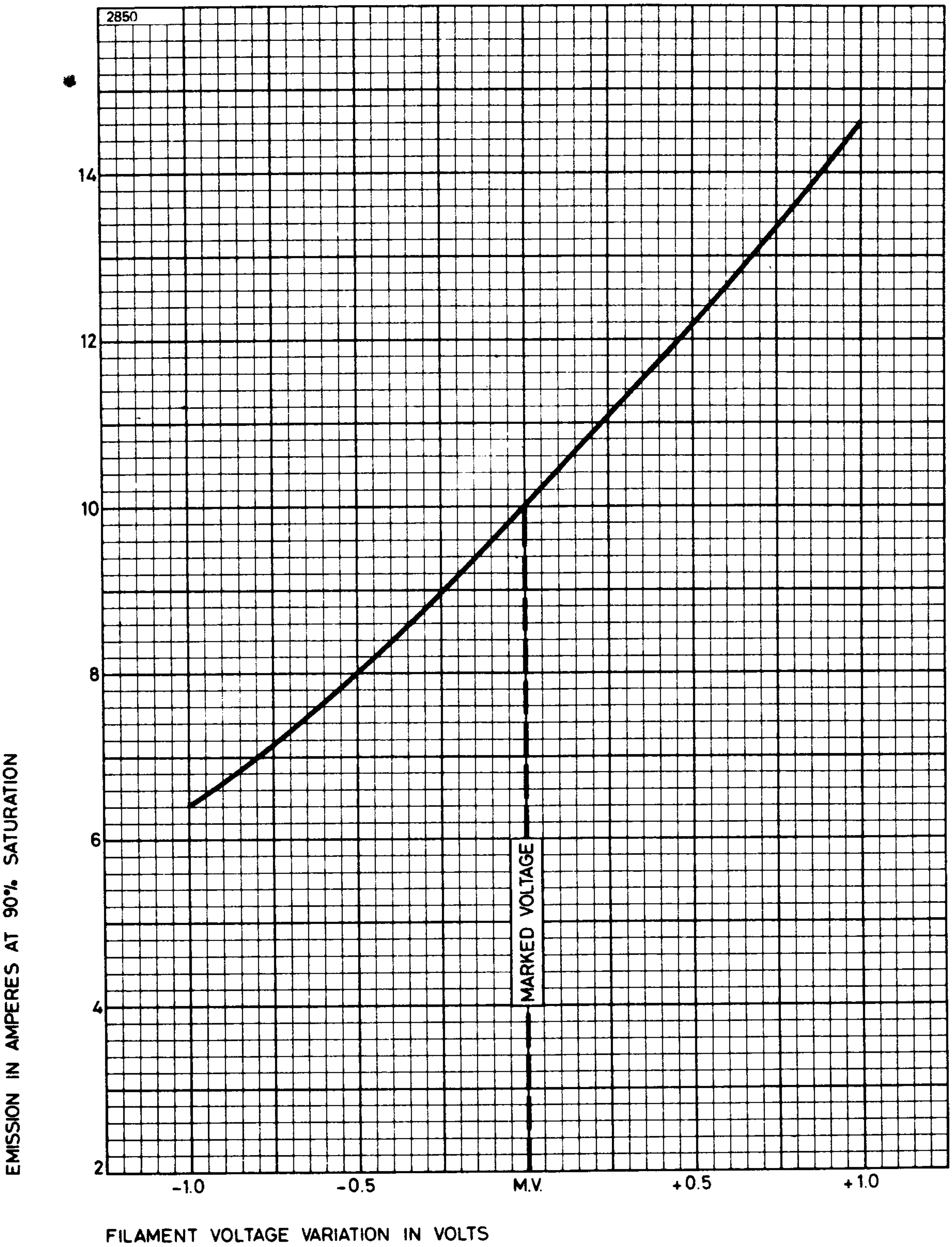
TYPICAL GRID CHARACTERISTICS



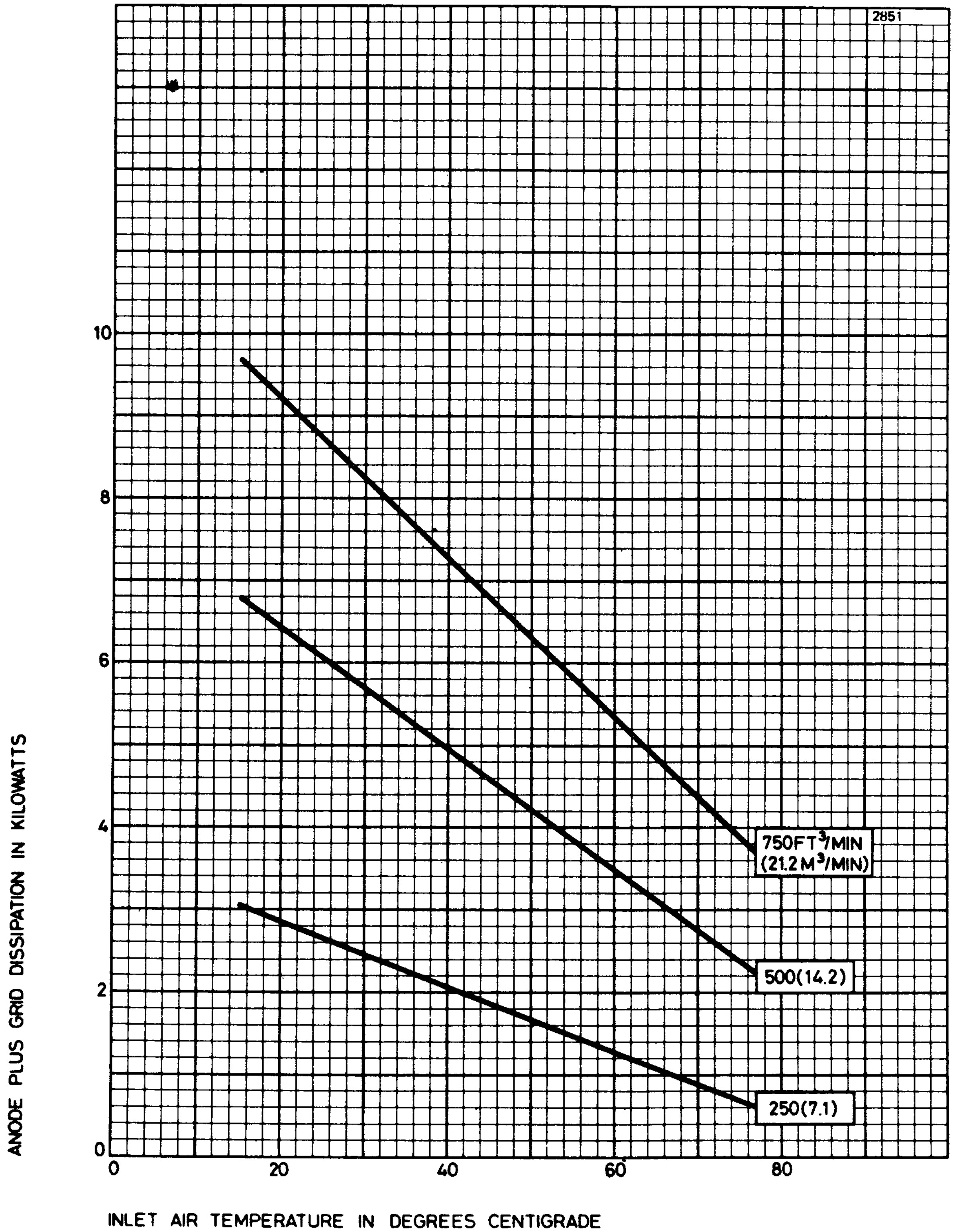
TYPICAL STRAPPED CHARACTERISTICS



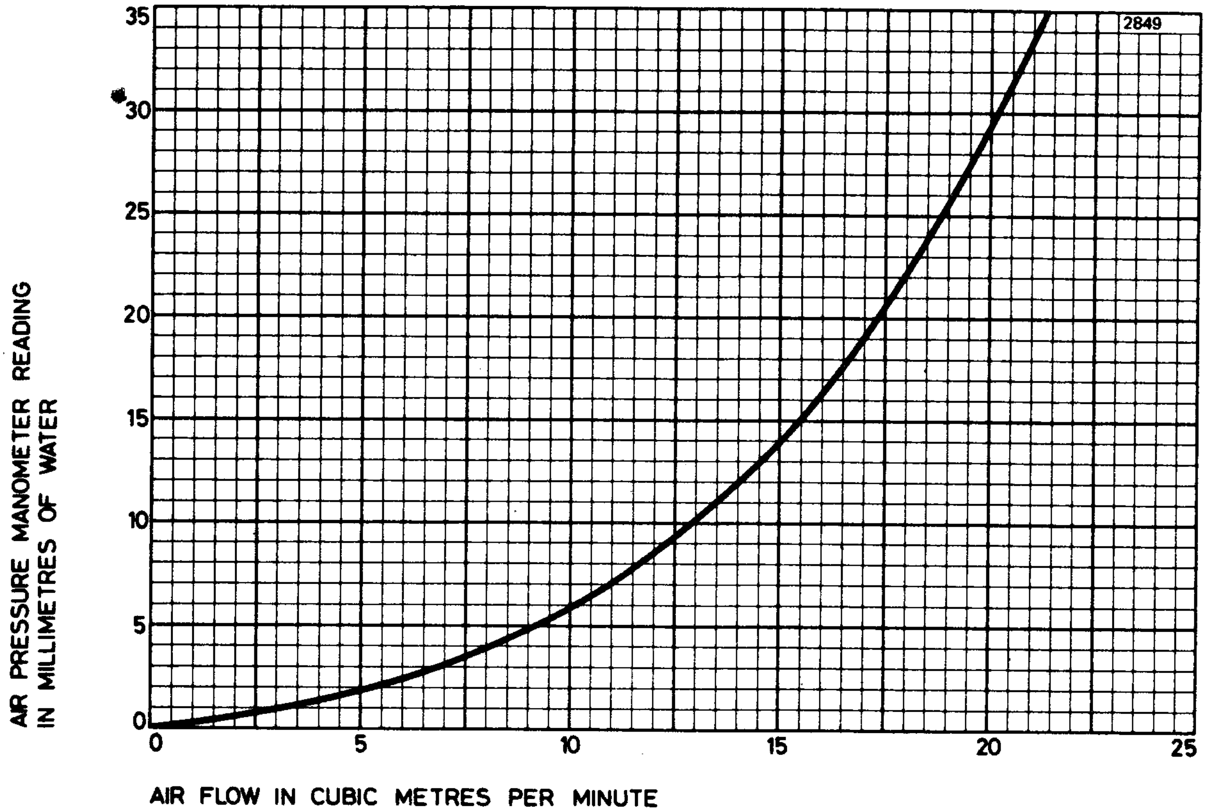
TYPICAL EMISSION CHARACTERISTIC

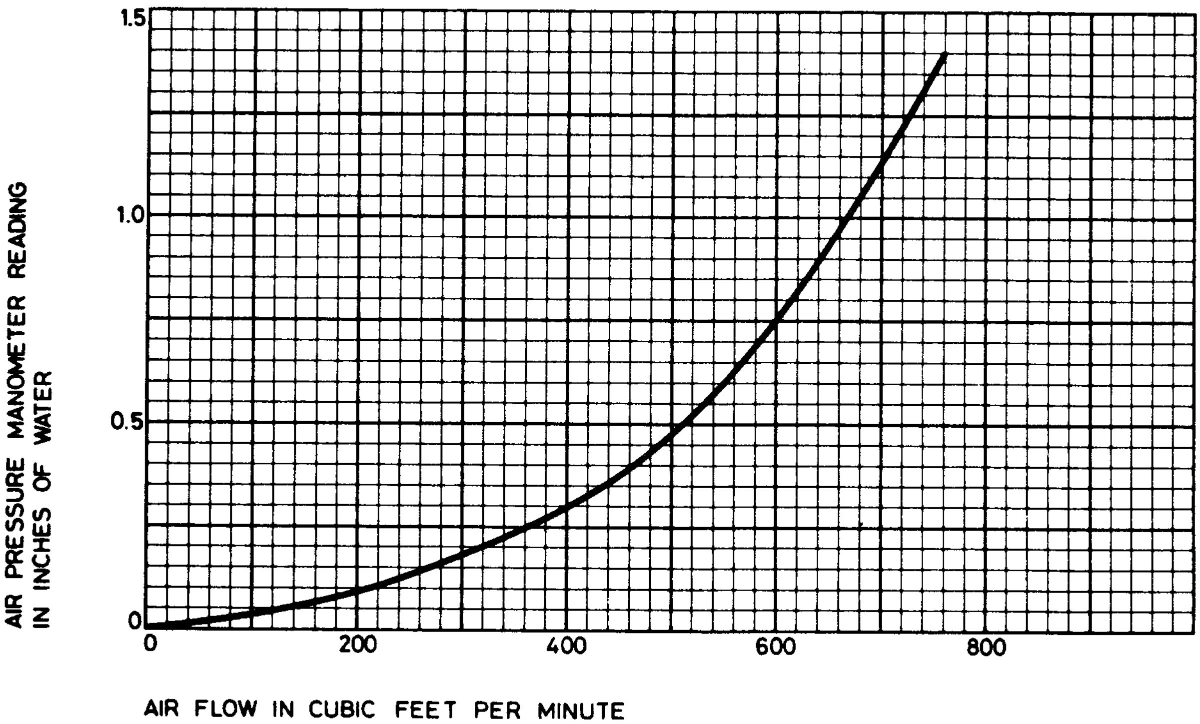


AIR COOLING REQUIREMENTS FOR BR140

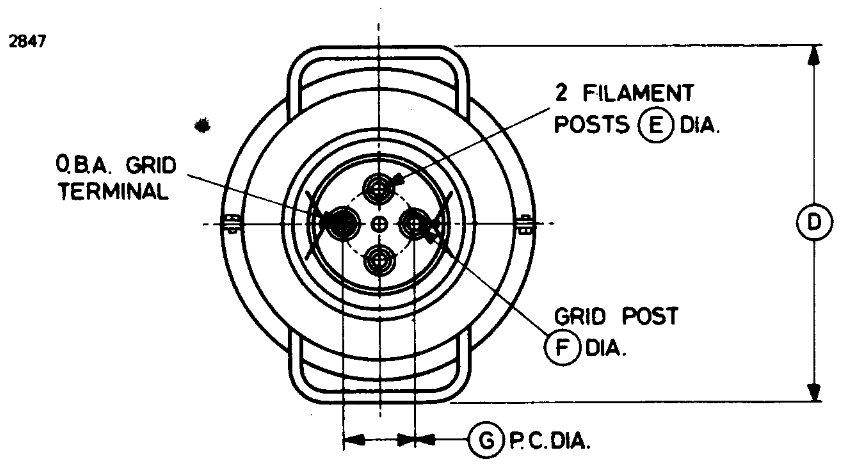


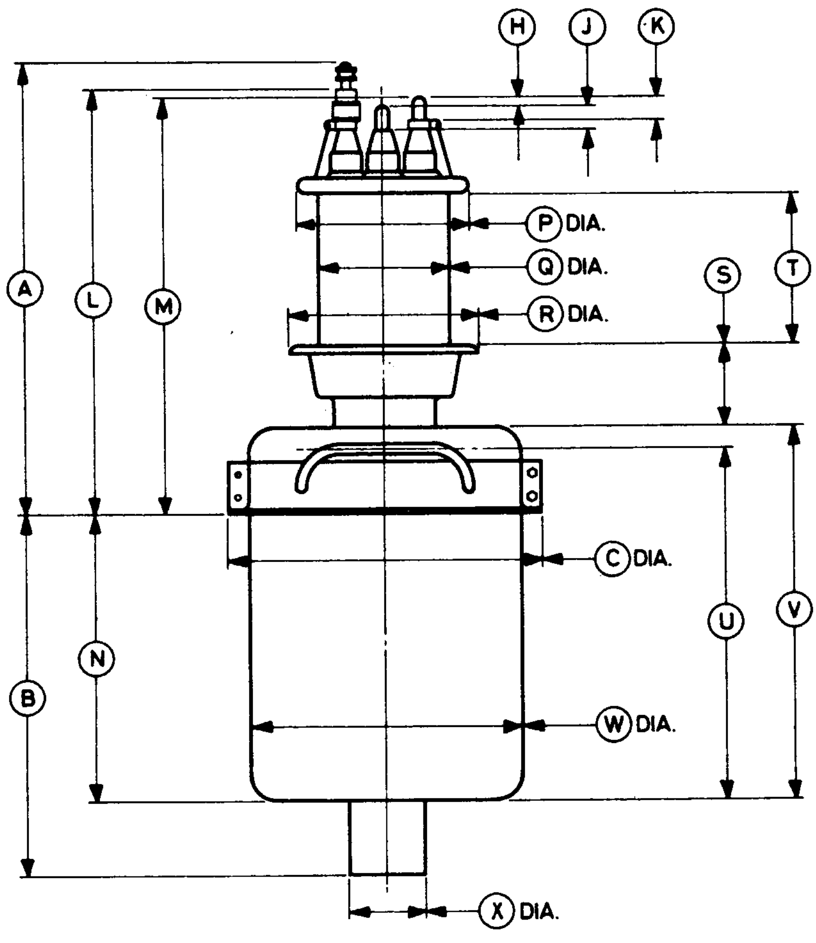
TYPICAL AIR FLOW CHARACTERISTIC FOR BR140





OUTLINE FOR BR140



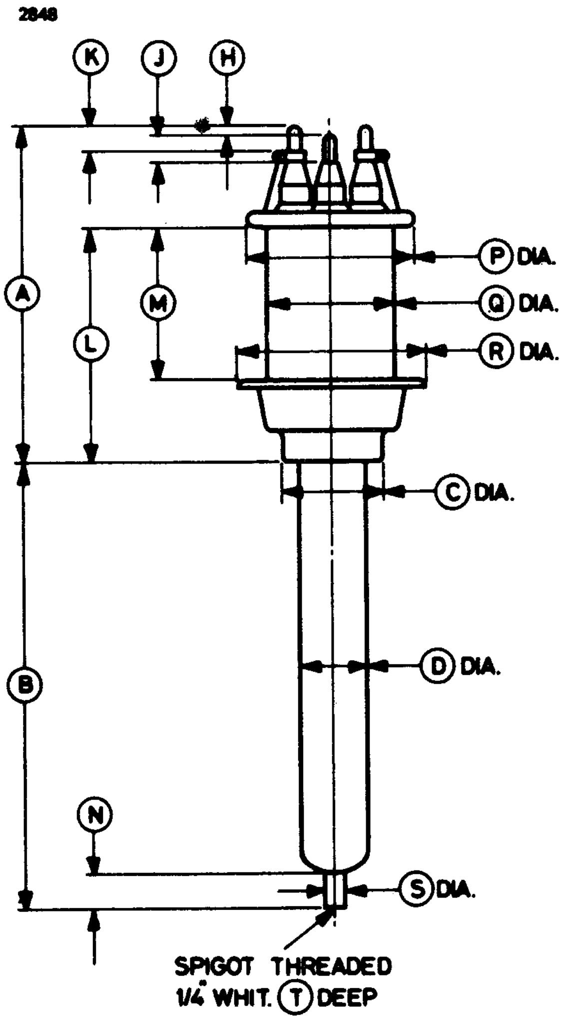


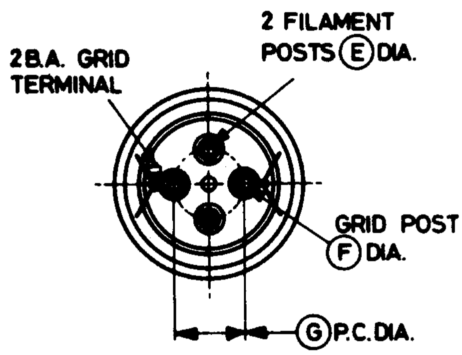
Dimensions for BR140 (All dimensions without limits are nominal)

Ref	Inches	Millimetres
A *	13.625 max	346.1 max
B	10.750	273.1
C	9.250 max	235.0 max
D	11.625 max	295.3 max
E	0.437	11.10
F	0.437	11.10
G	2.125	53.98
H	0.250	6.35
J	0.875	22.23
K	0.687	17.45
L	13.000 max	330.2 max
M	12.500 max	317.5 max
N	8.500	215.9
P	5.000	127.0
Q	3.600	91.44
R	5.500	139.7
S	2.375	60.33
T	4.563 ± 0.063	115.9 ± 1.6
U	10.750 max	273.1 max
V	11.000	279.4
W	8.125 max	206.4 max
X	2.250	57.15

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW140 (All dimensions without limits are nominal)





Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.625 ± 0.125	244.5 ± 3.2	K	0.687	17.45
B	13.000	330.2	L	6.813 ± 0.063	173.1 ± 1.6
C	3.000 max	76.20 max	M	4.437 ± 0.063	112.7 ± 1.6
D	2.000	50.80	N	1.000	25.40
E	0.437	11.10	P	5.000	127.0
F	0.437	11.10	Q	3.600	91.44
G	2.125	53.98	R	5.500	139.7
H	0.250	6.35	S	0.625	15.88
J	0.875	22.23	T	0.875	22.23

Millimetre dimensions have been derived from inches.

BR/BW161

R.F. POWER
TRIODES

Service Type (BR161) CV2322

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. transmitting triodes differing only in anode dissipation and the method of anode cooling. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BR161		forced-air
BW161		water; separate jacket
Anode dissipation:		
BR161	15	kW max
BW161	20	kW max
Anode voltage	12	kV max
Frequency for full ratings	30	MHz max
Frequency at reduced ratings	50	MHz max
Output power (class C telegraphy)	50	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	9.0	V
Filament current	175	A
Surge filament current (peak) (see note 2)	450	A max
Filament cold resistance	5.9	mΩ
Peak usable cathode current	45	A
Perveance	2.1	$mA/V^{3/2}$
Amplification factor (V_a = 9.0kV, I_a = 2.0A)	45	
Mutual conductance (V_a = 10kV, I_a = 1.5A)	23	mA/V
Inter-electrode capacitances:		
grid to anode	37	pF
grid to filament	57	pF
anode to filament	1.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR161	77 pounds (35kg) approx
BW161	11½ pounds (5.3kg) approx
Mounting position	vertical, filament pins up

Accessories

Filament leads	MA131
Grid connector	MA66
Water jacket for BW161	BW4028
Sealing ring (supplied with BW161)	MA251

COOLING

Anode

The BR161 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW161 must be fitted into a water jacket for cooling, the recommended jacket being type BW4028. A flow of water of 8imp. gal/min (36.4 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER OR OSCILLATOR

(Class C telegraphy, key down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	12	kV max
Anode dissipation:		
BR161	15	kW max
BW161	20	kW max
Grid dissipation	1.0	kW max
Operating frequency (for full ratings)	30	MHz max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	10	12	kV
Grid voltage	−530	−575	V
Peak r.f. grid drive voltage	1090	1135	V
Anode current	5.2	5.25	A
Grid current (approx)	1.5	1.45	A
Anode dissipation	12	13	kW
Grid dissipation	700	700	W
Driving power	1500	1530	W
Output power	40	50	kW
Efficiency	77	79	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 9.0V	163	192	A
Amplification factor (V_a = 9.0kV, I_a = 2.0A)	37	48	
Mutual conductance (V_a = 10kV, I_a = 1.5A)	21.5	29	mA/V
Grid voltage (negative value) (V_a = 8.0kV, I_a = 0.35A)	158	222	V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	275	V
Anode current (V_a = 2.0kV, V_g = +250V)	7.0	12	A
Anode current (V_a = 4.0kV, V_g = +250V)	9.5	14.5	A
Grid current (V_a = 2.0kV, V_g = +250V)	0.5	4.0	A
Grid current (V_a = 4.0kV, V_g = +250V)	0	2.5	A
Inter-electrode capacitances:			
grid to anode	32	42	pF
grid to filament	50	62	pF

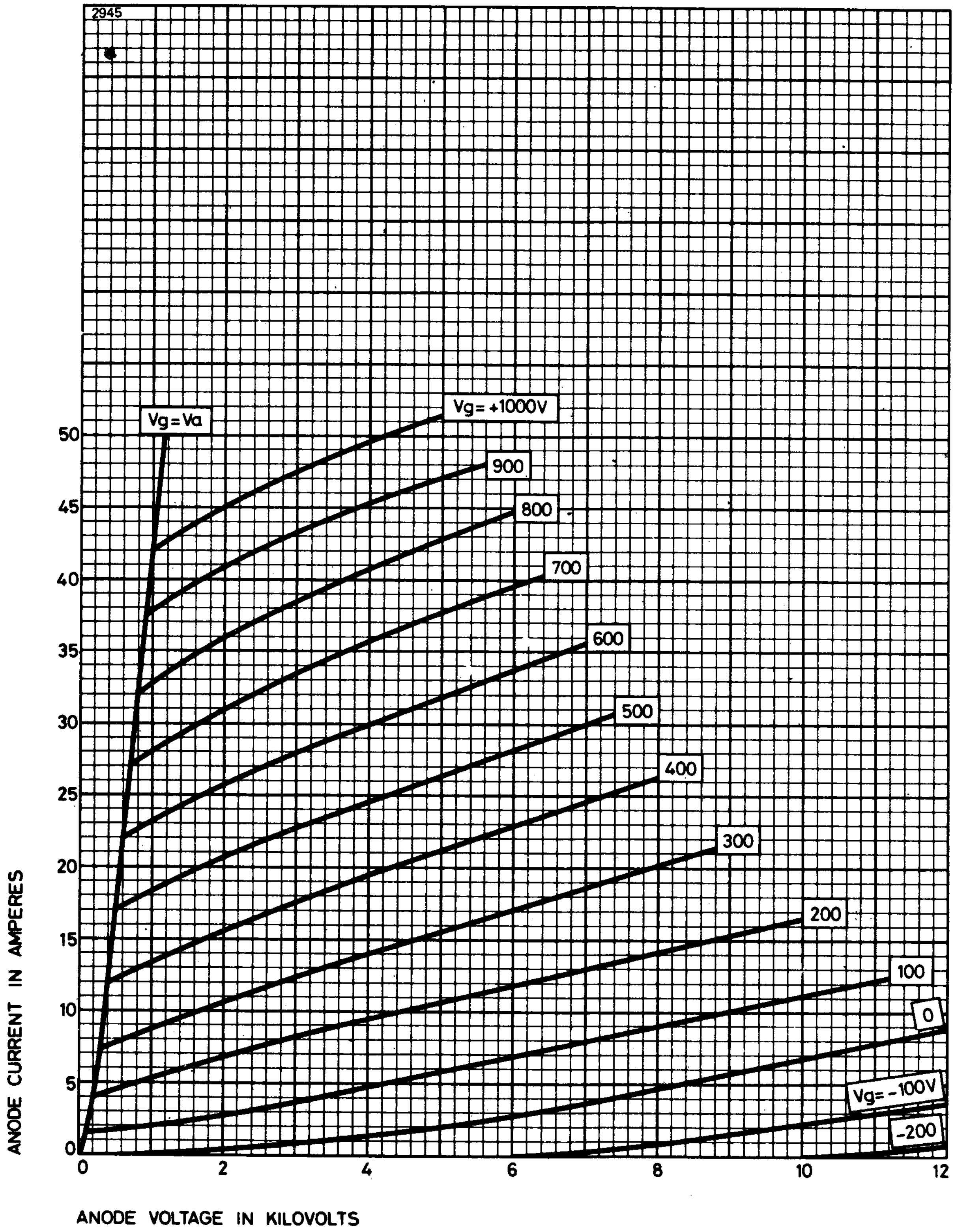
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
30	12.0	9.6
50	9.0	7.2

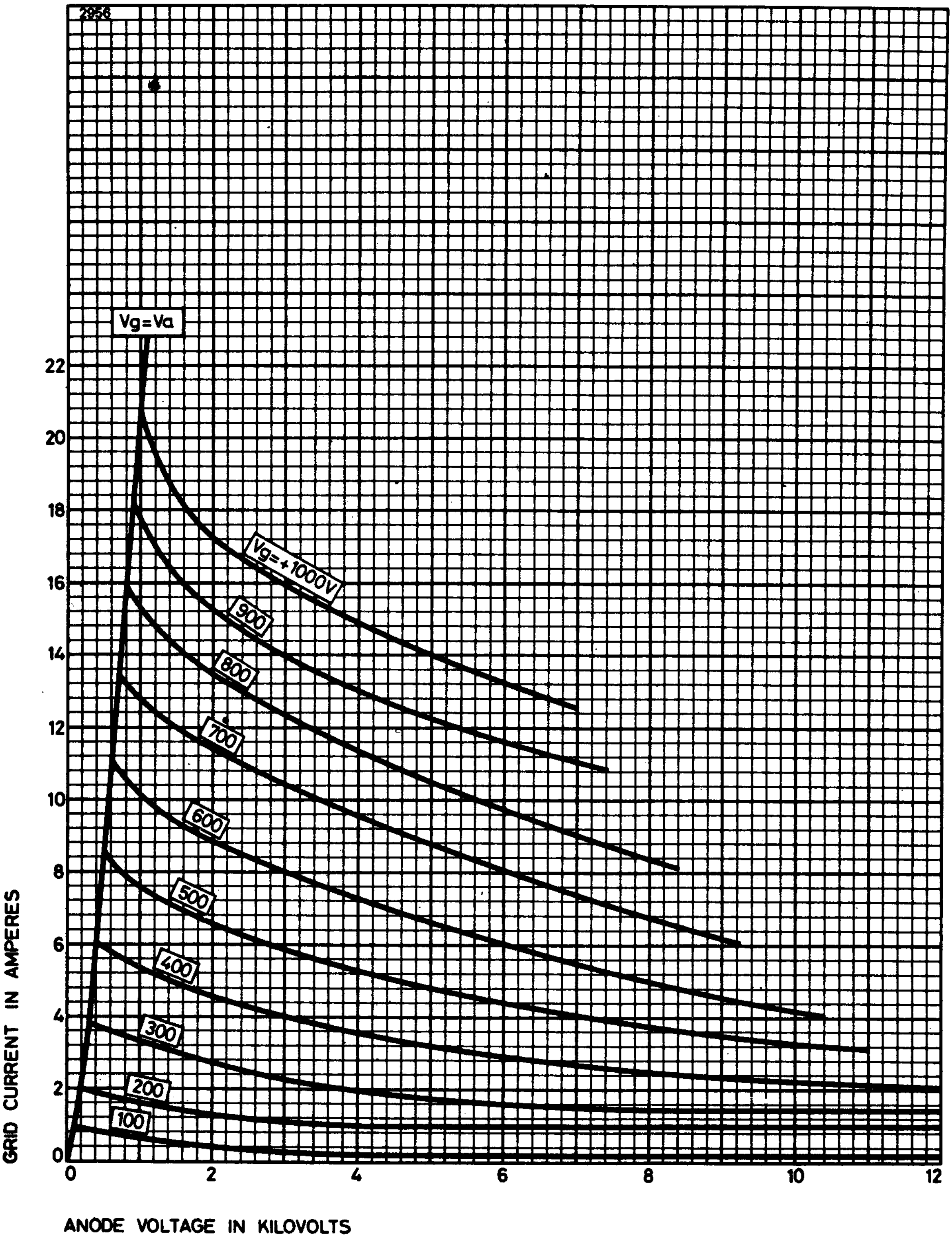
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 450A, even momentarily, at any time.

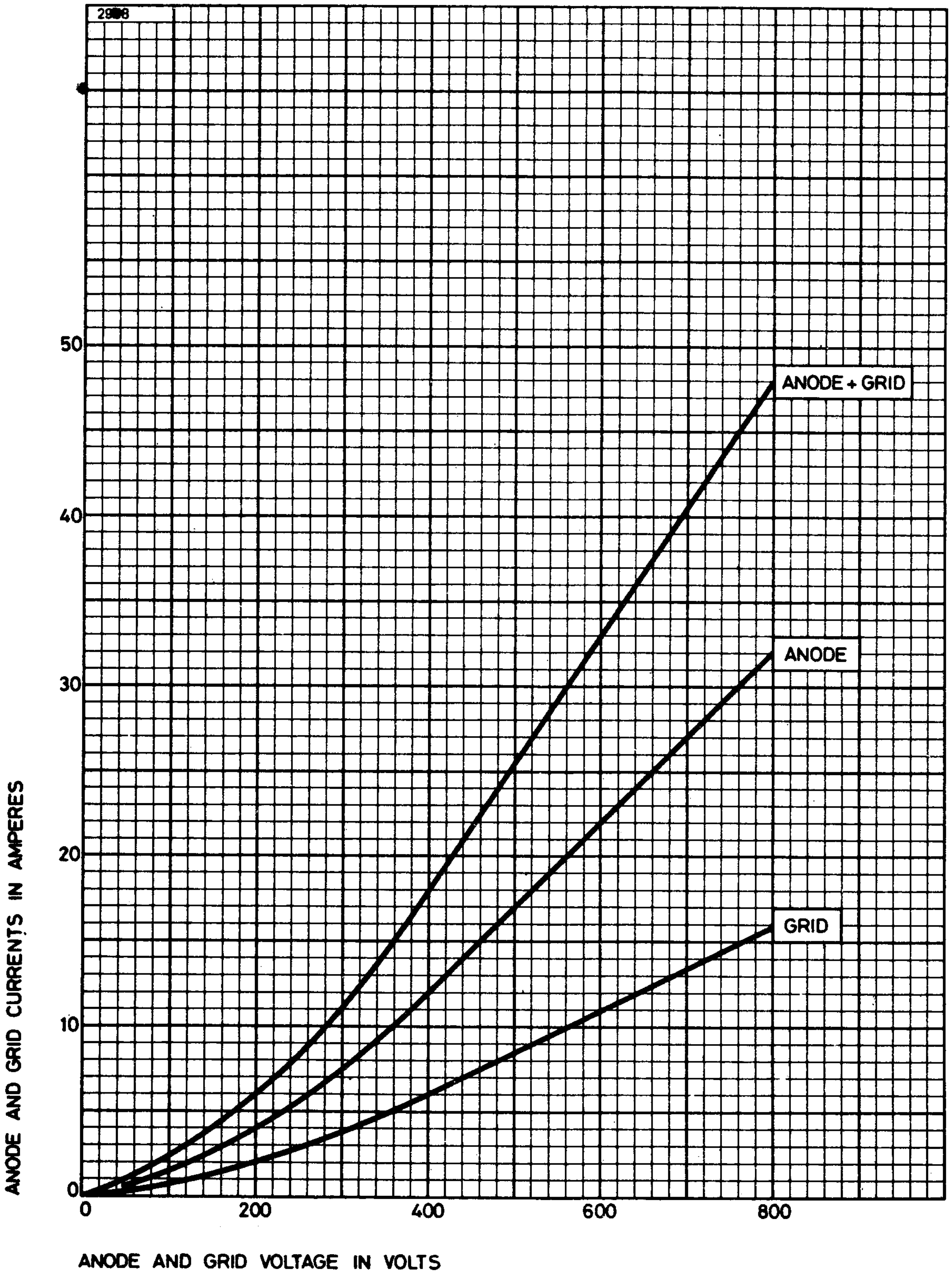
TYPICAL ANODE CHARACTERISTICS



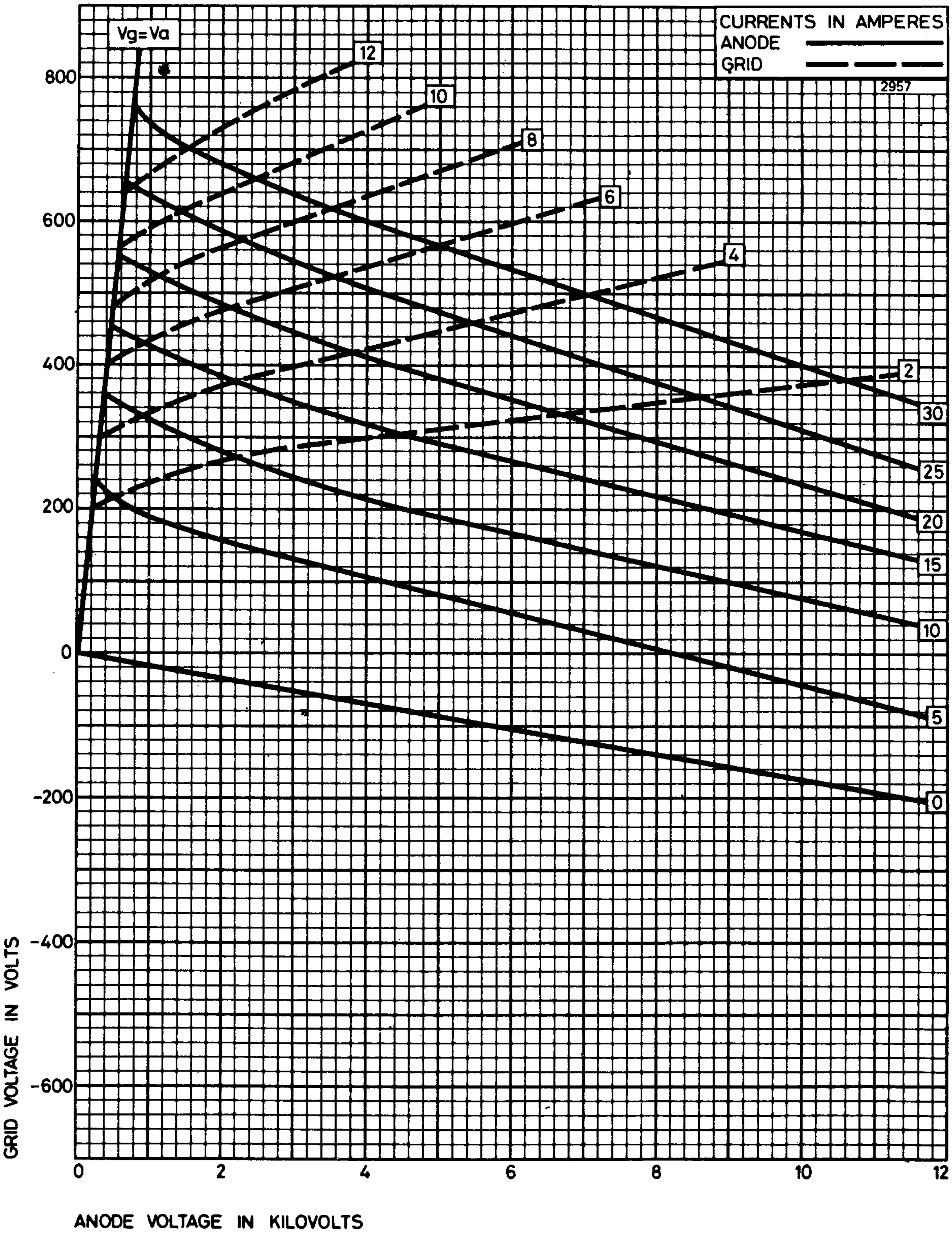
TYPICAL GRID CHARACTERISTICS



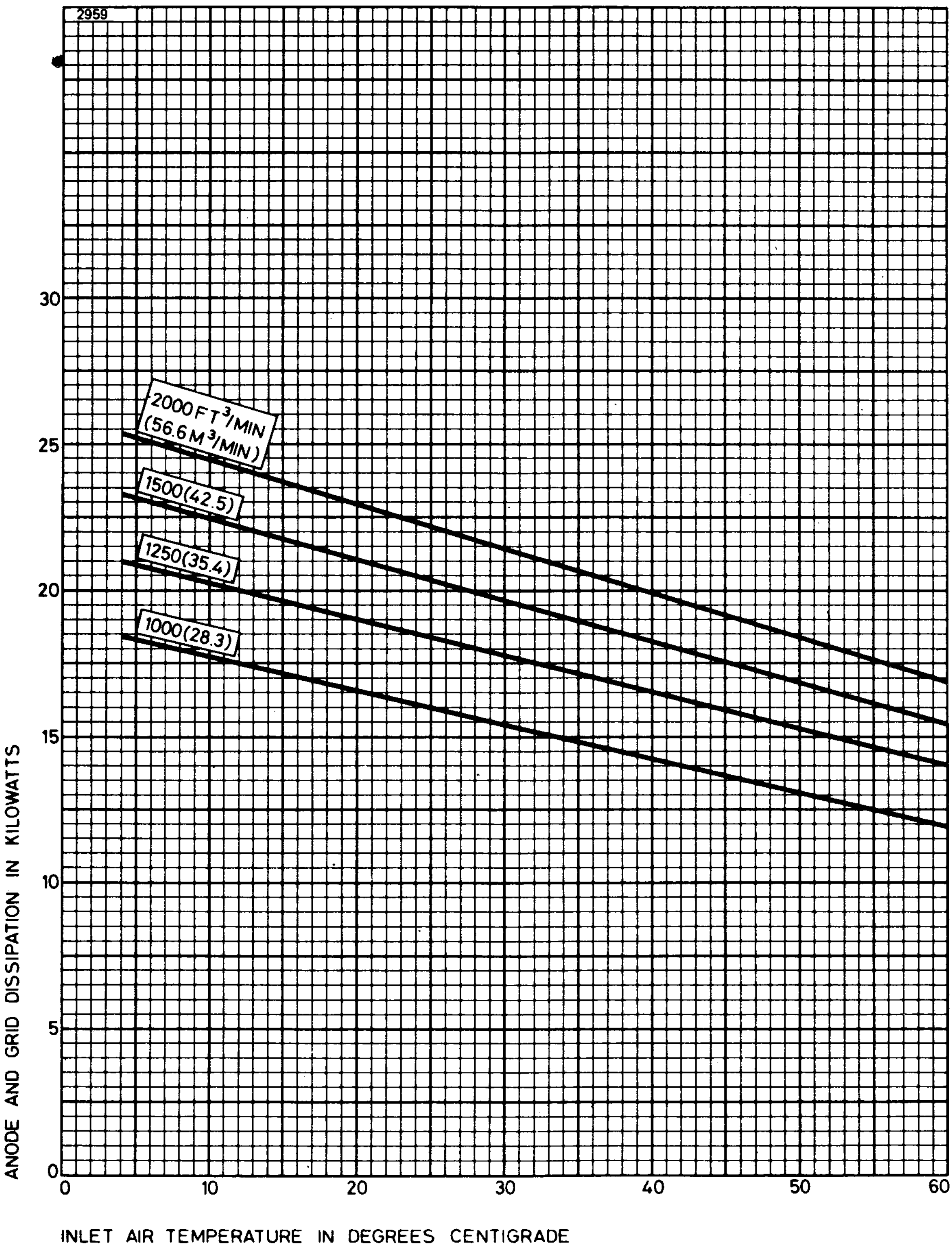
TYPICAL STRAPPED CHARACTERISTICS



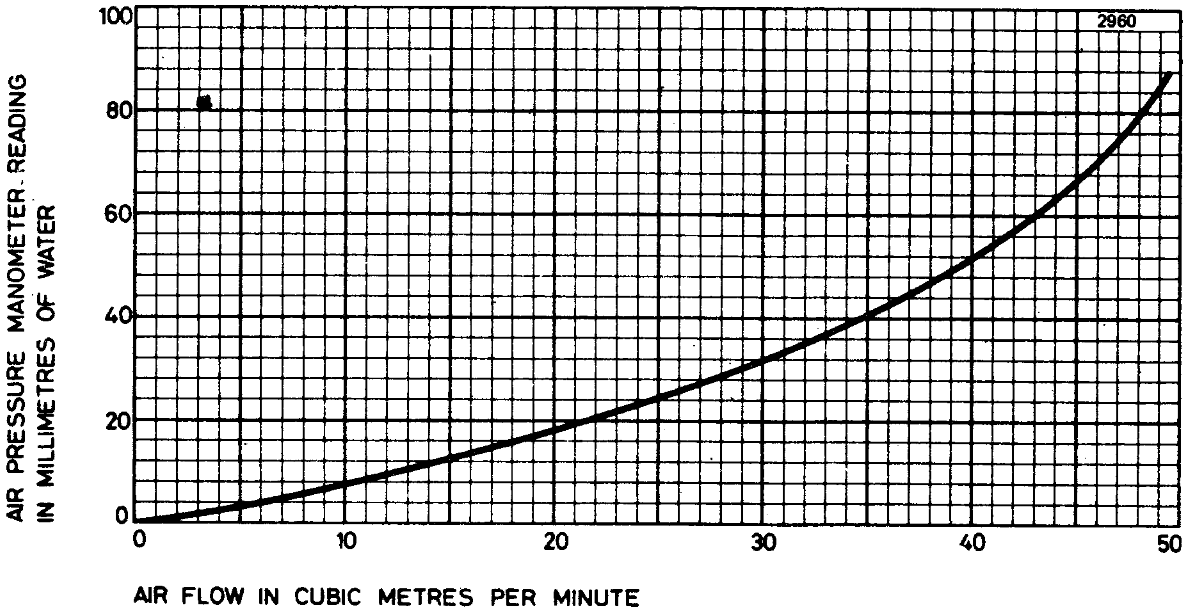
TYPICAL CONSTANT CURRENT CHARACTERISTICS

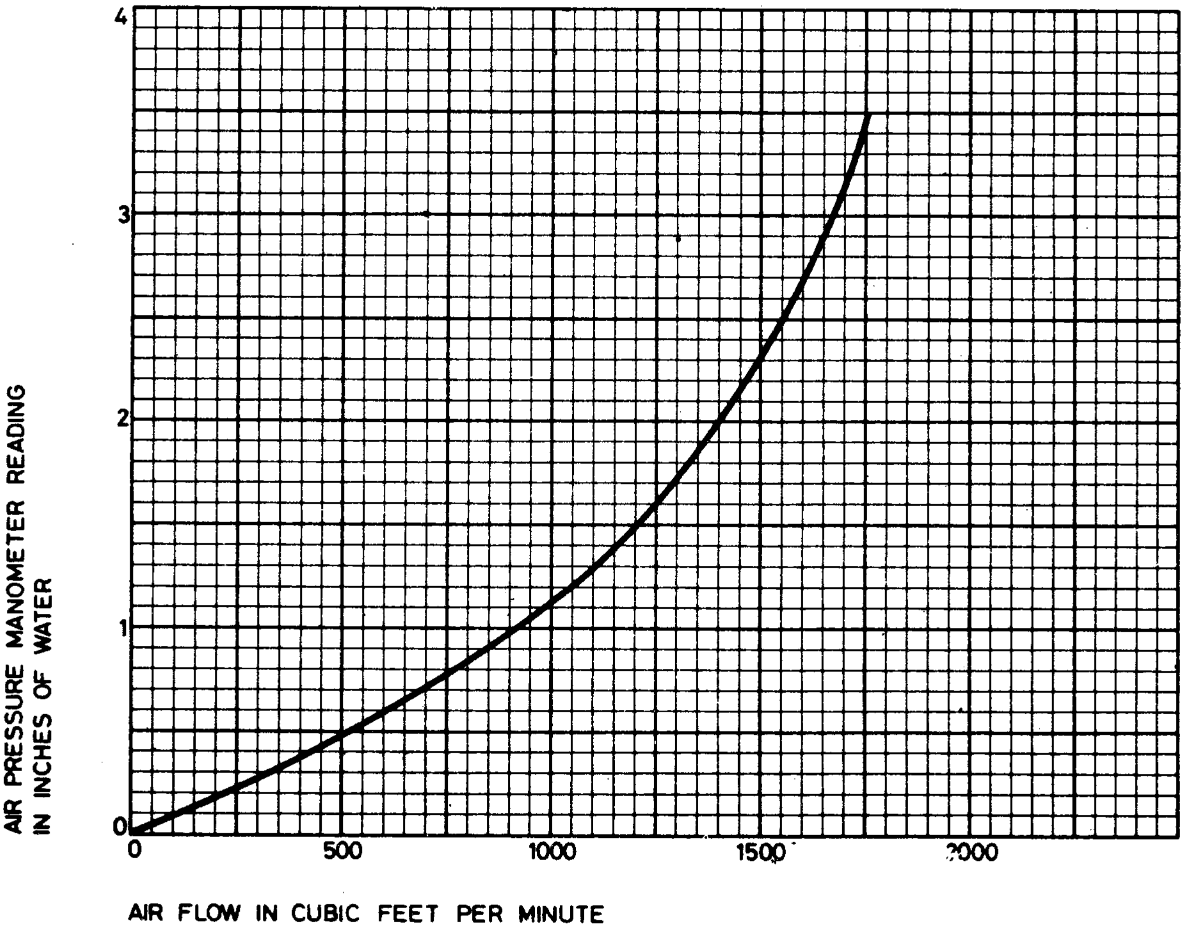


AIR COOLING REQUIREMENTS FOR BR161

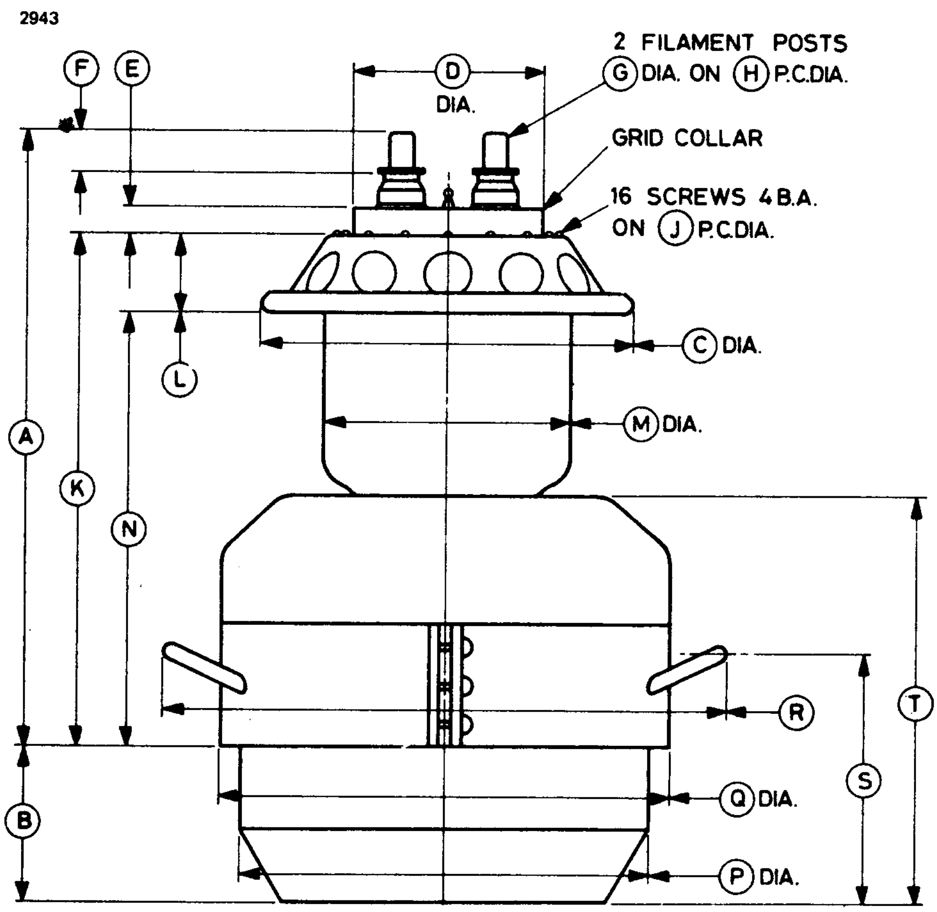


TYPICAL AIR FLOW CHARACTERISTIC FOR BR161





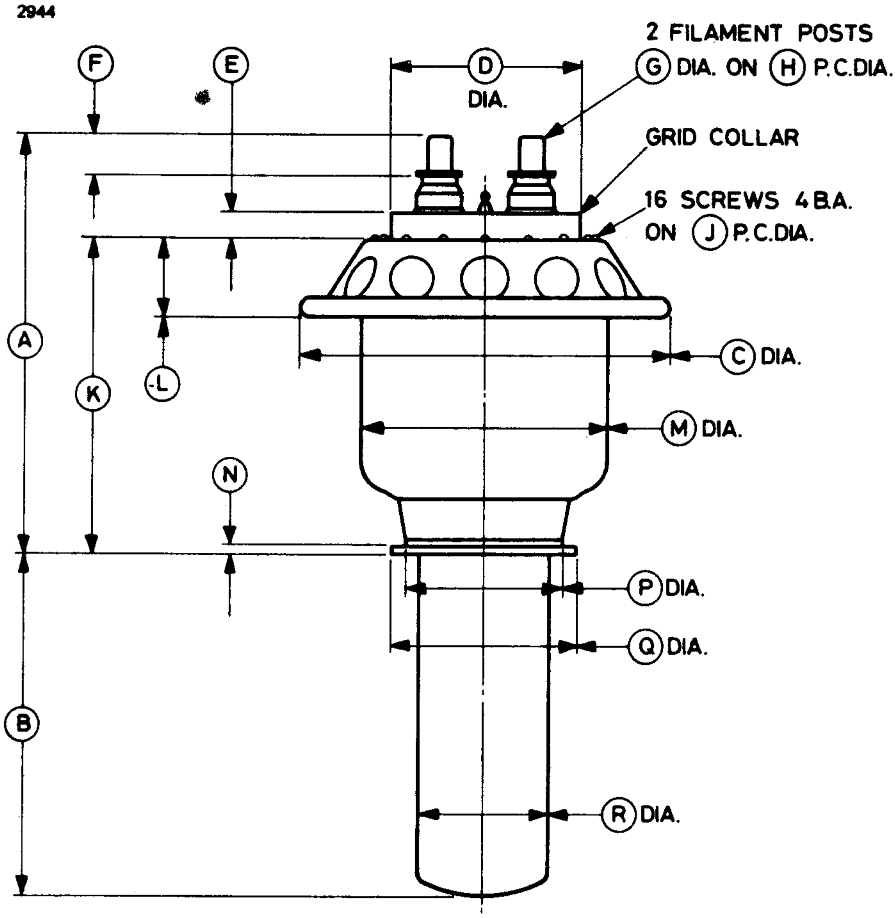
OUTLINE FOR BR161 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	15.188 max	385.8 max	K	12.688 max	322.3 max
B	3.812	96.82	L	1.875	47.63
C	9.250 max	235.0 max	M	6.000 max	152.4 max
D	4.703	119.5	N	10.572 ± 0.250	268.5 ± 6.4
E	0.687	17.45	P	10.062 max	255.6 max
F	1.000	25.40	Q	11.000	279.4
G	0.625	15.88	R	14.000 max	355.6 max
H	2.250	57.15	S	6.125	155.6
J	5.375	136.5	T	10.062	255.6

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW161 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.500 max	266.7 max	J	5.375	136.5
B	8.250	209.6	K	8.000 max	203.2 max
C	9.250 max	235.0 max	L	1.875	47.63
D	4.703	119.5	M	6.000 max	152.4 max
E	0.687	17.45	N	0.250	6.35
F	1.000	25.40	P	3.875	98.43
G	0.625	15.88	Q	4.500	114.3
H	2.250	57.15	R	3.250	82.55

Millimetre dimensions have been derived from inches.

BR/BW179

R.F. POWER TRIODES

Service Type (BR179) CV2323

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. transmitting triodes differing only in anode dissipation and the method of anode cooling. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BR179		forced-air
BW179		water; separate jacket
Anode dissipation:		
BR179	8.0	kW max
BW179	10	kW max
Anode voltage	8.5	kV max
Frequency for full ratings	50	MHz max
Frequency at reduced ratings	110	MHz max
Output power (class C telegraphy)	17	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	6.6	V
Filament current	90	A
Surge filament current (peak) (see note 2)	195	A max
Filament cold resistance	8.4	mΩ
Peak usable cathode current	16	A
Amplification factor (V_a = 5.0kV, I_a = 1.0A)	28	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A)	10	mA/V
Inter-electrode capacitances:		
grid to anode	32	pF
grid to filament	33	pF
anode to filament	1.0	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR179	25 pounds (11.5kg) approx
BW179	5 pounds (2.3kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA135
Grid connector	MA66A
Water jacket for BW179	BW4029
Sealing ring (supplied with BW179)	MA252

COOLING

Anode

The BR179 air cooling requirements are shown on pages 8 and 9. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW179 must be fitted into a water jacket for cooling, the recommended jacket being type BW4029. A flow of water of 4 to 5 imp. gal/min (18.2 to 22.7 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 15ft^3/min (0.43m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C telegraphy, key down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	8.5	kV max
Anode dissipation:		
BR179	8.0	kW max
BW179	10	kW max
Grid dissipation	600	W max
Operating frequency (for full ratings)	50	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	6.0	8.0	kV
Grid voltage	−705	−775	V
Peak r.f. grid drive voltage	1605	1675	V
Anode current	2.92	2.94	A
Grid current (approx)	0.42	0.38	A
Anode dissipation	5.5	6.2	kW
Grid dissipation	350	325	W
Driving power	650	620	W
Output power	12	17.3	kW
Efficiency	69	73.5	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 6.6V	83	97	A
Amplification factor (I_a = 1.0A, V_g = −50V)	25	32	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A)	7.5	12.5	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	400	V
Grid voltage (negative value) (V_a = 5.0kV, I_a = 1.0A)	15	55	V
Anode current (V_a = 2.0kV, V_g = +200V)	2.2	3.0	A
Grid current (V_a = 2.0kV, V_g = +200V)	0	0.3	A
Inter-electrode capacitances:			
grid to anode	28	36	pF
grid to filament	28	38	pF

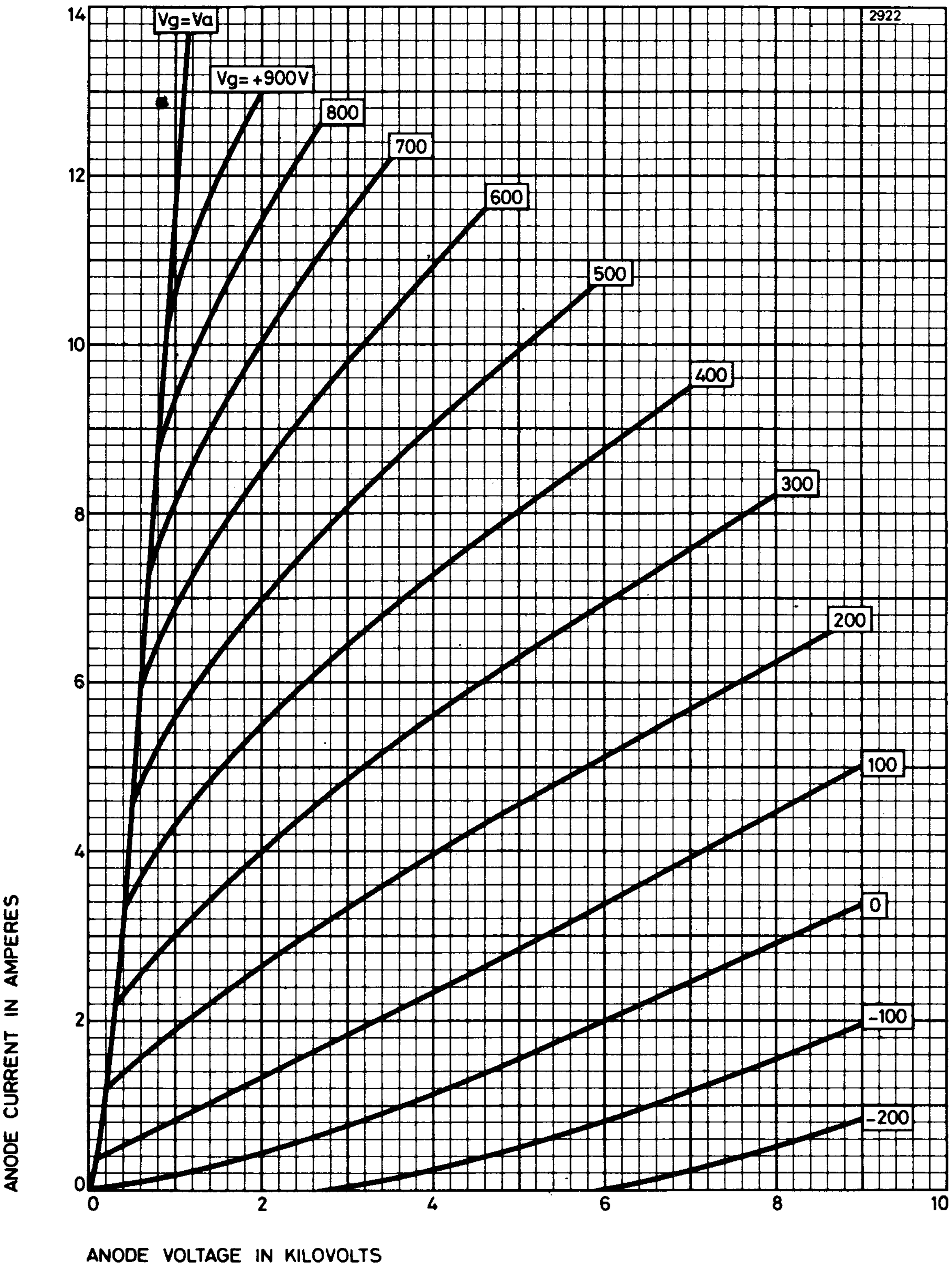
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
50	8.5	6.0
110	6.5	5.2

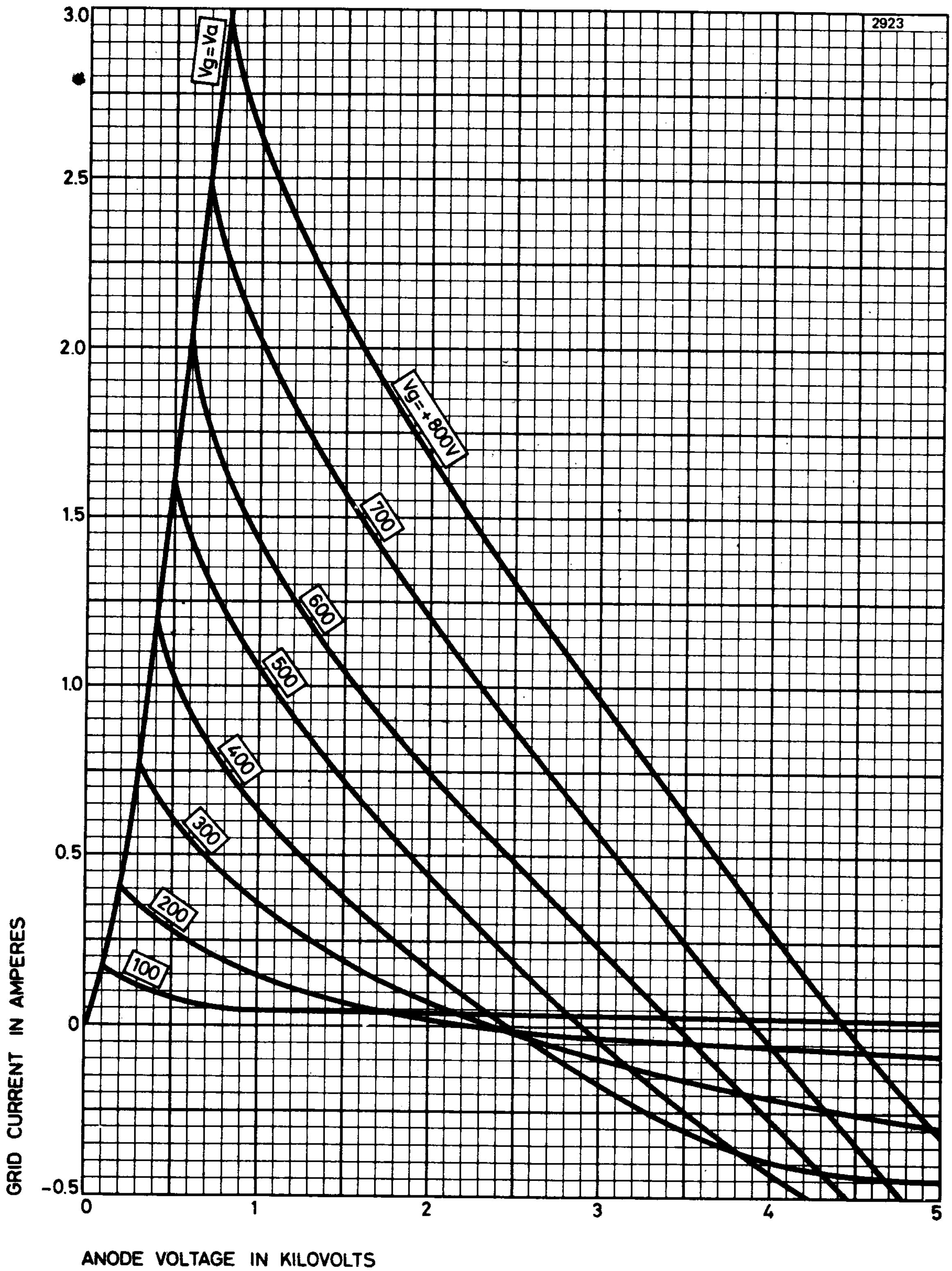
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 195A, even momentarily, at any time.

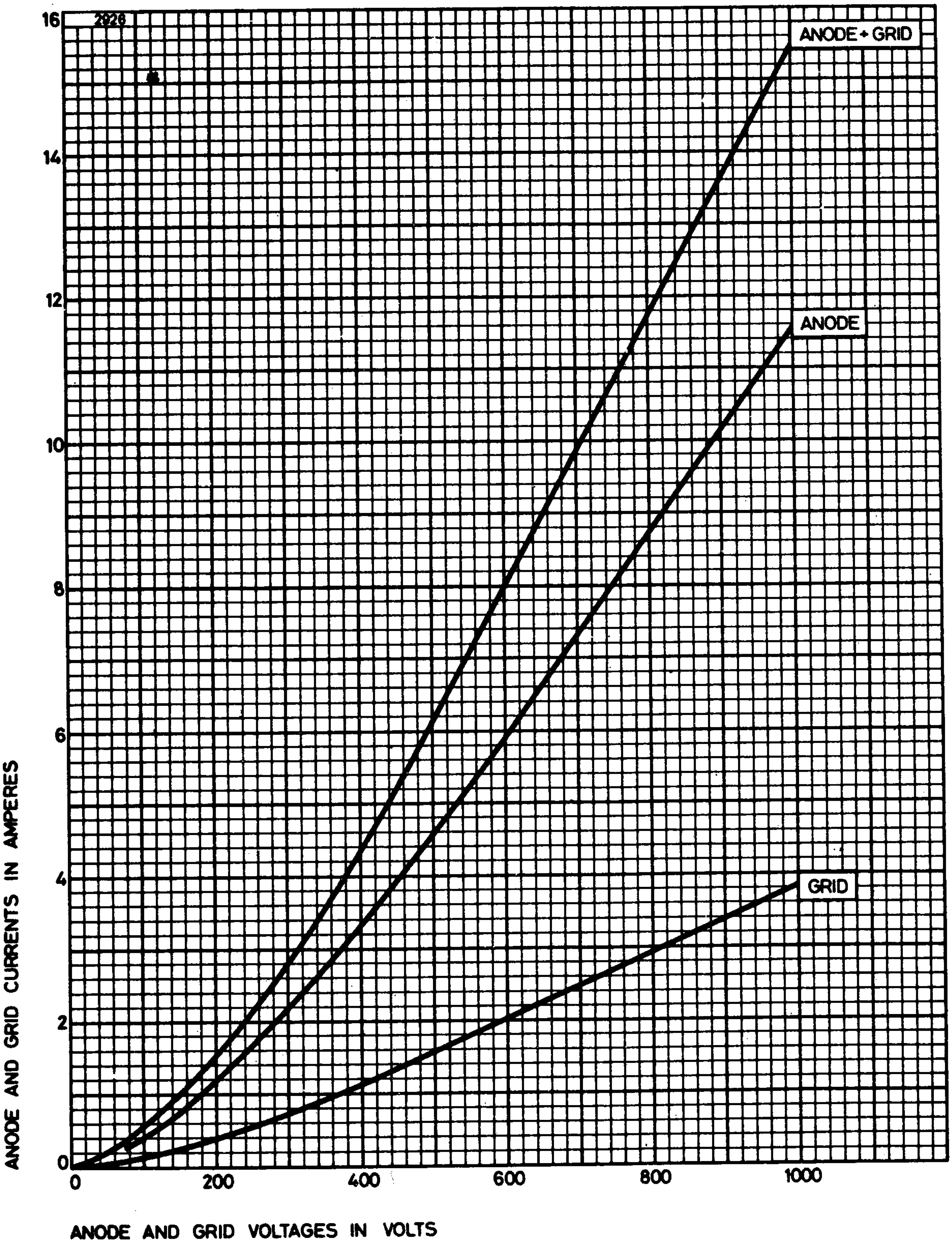
TYPICAL ANODE CHARACTERISTICS



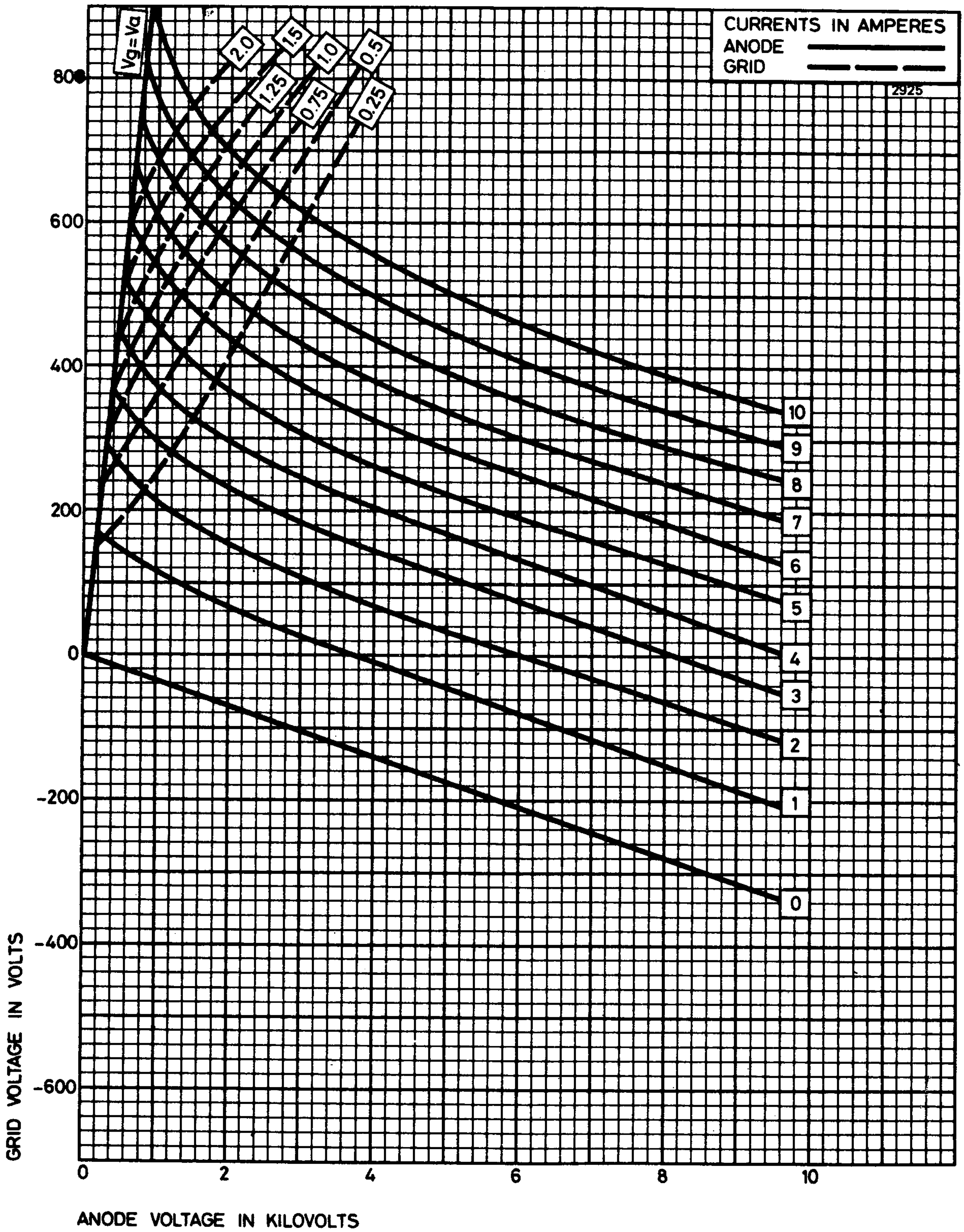
TYPICAL GRID CHARACTERISTICS



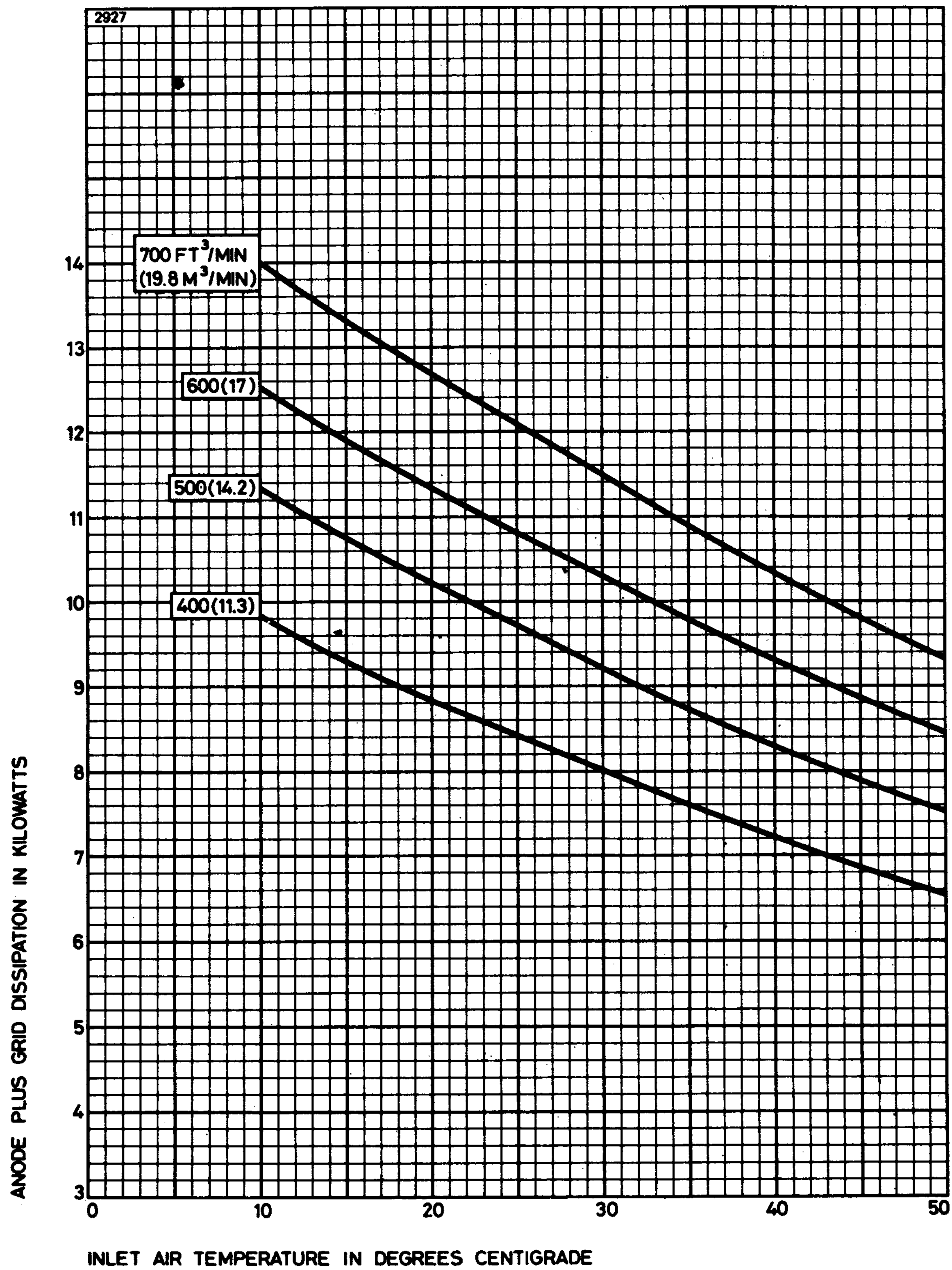
TYPICAL STRAPPED CHARACTERISTICS



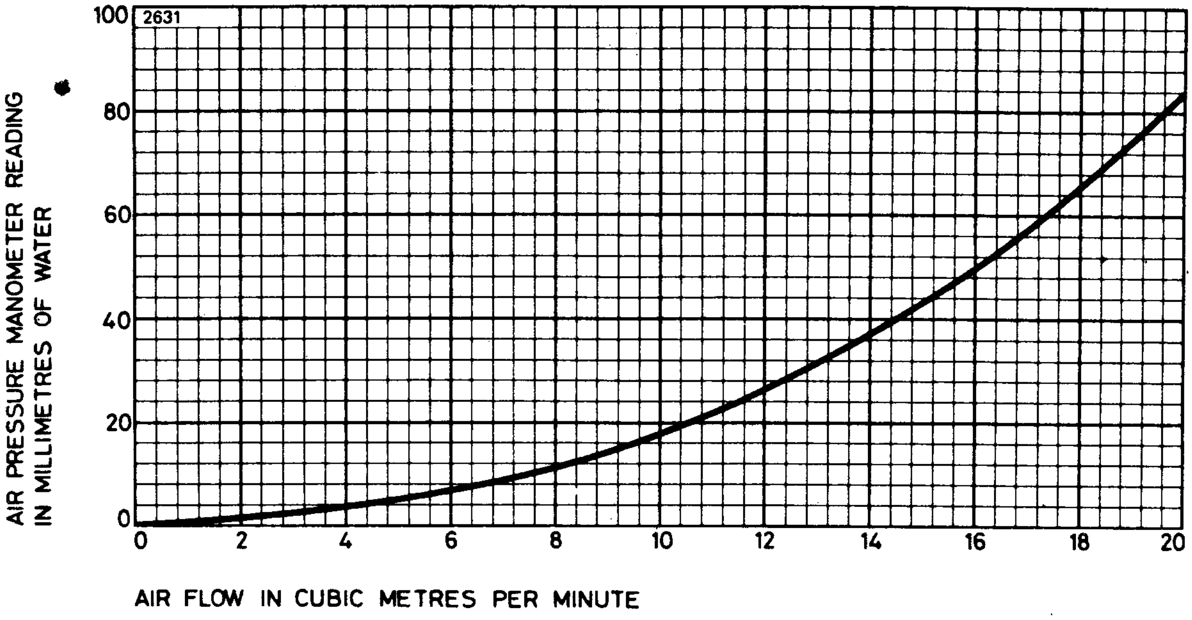
TYPICAL CONSTANT CURRENT CHARACTERISTICS

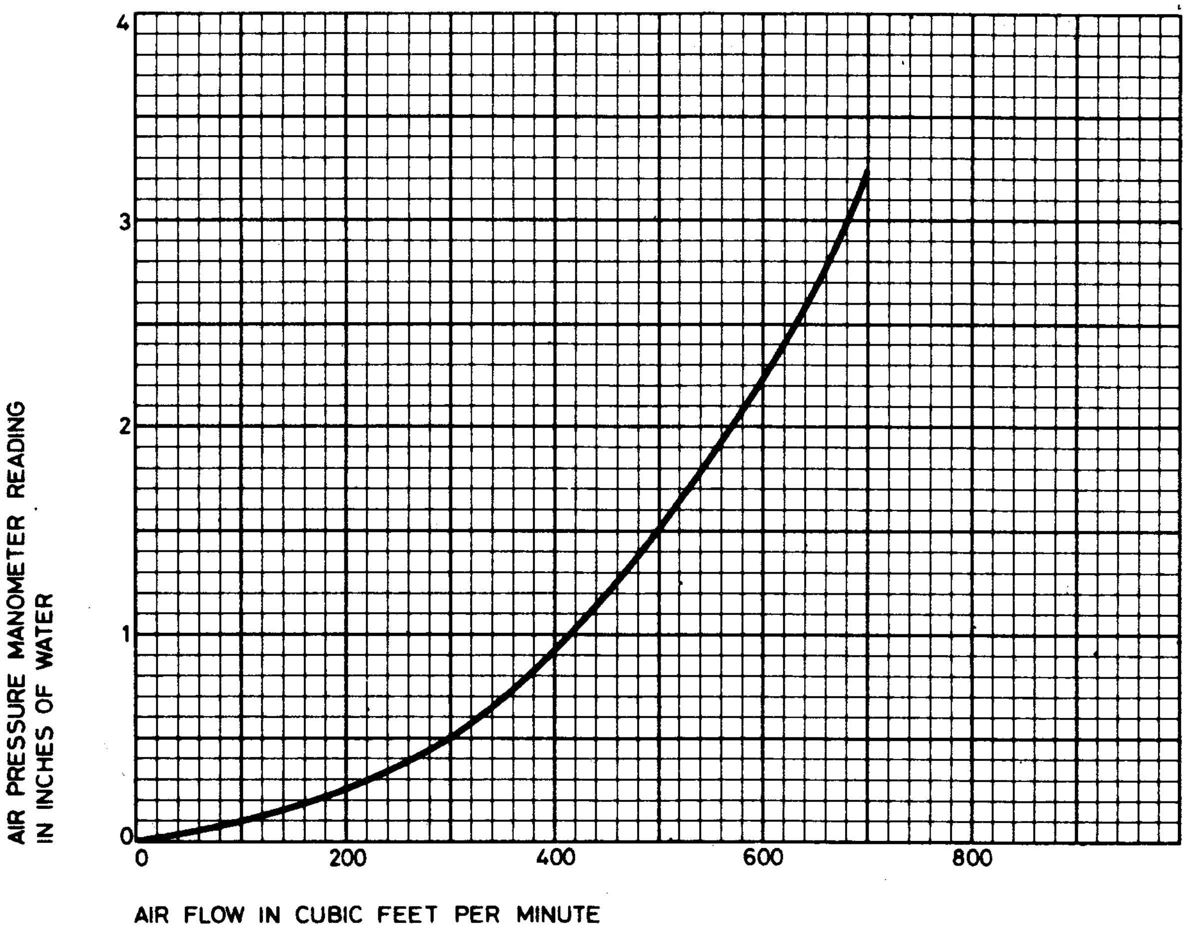


AIR COOLING REQUIREMENTS FOR BR179

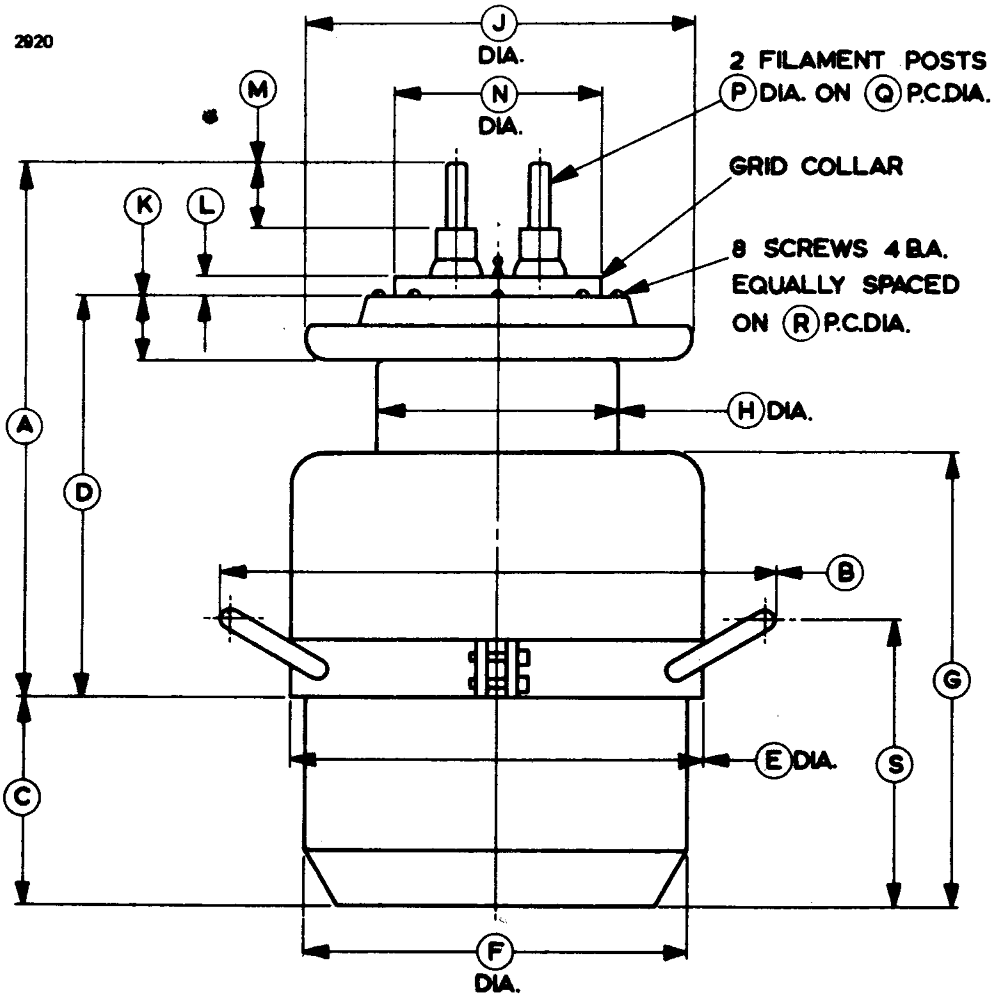


TYPICAL AIR FLOW CHARACTERISTIC FOR BR179





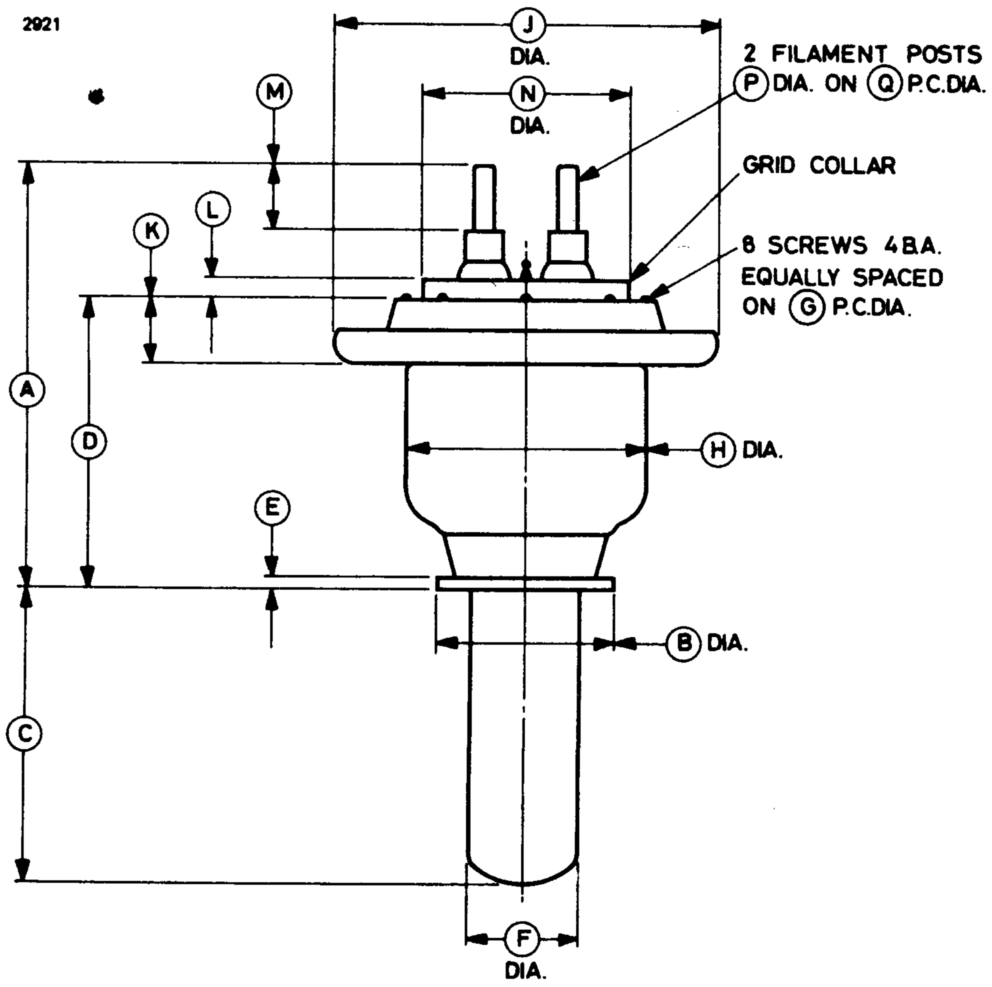
OUTLINE FOR BR179 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.000 max	254.0 max	K	1.187	30.15
B	10.125	257.2	L	0.328	8.33
C	3.812	96.82	M	1.187	30.15
D	7.531 max	191.3 max	N	3.750	95.25
E	7.625 max	193.7 max	P	0.437	11.10
F	7.062 max	179.4 max	Q	1.500	38.10
G	8.312	211.1	R	4.375	111.1
H	4.437	112.7	S	5.250	133.4
J	7.125	181.0			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW179 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.125 max	206.4 max	J	7.125	181.0
B	3.250	82.55	K	1.187	30.15
C	5.375	136.5	L	0.328	8.33
D	5.625 max	142.9 max	M	1.187	30.15
E	0.250	6.35	N	3.750	95.25
F	2.000	50.80	P	0.437	11.10
G	4.375	111.1	Q	1.500	38.10
H	4.437	112.7			

Millimetre dimensions have been derived from inches.

BR/BW189
BY189A

R.F. POWER TRIODES

Service Type (BR189) CV5218

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. transmitting triodes differing only in anode dissipation and the method of anode cooling. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BR189	forced-air	
BW189	water; separate jacket	
BY189A	vapour; separate boiler unit	
Anode dissipation:		
BR189	27	kW max
BW189, BY189A	35	kW max
Anode voltage	15	kV max
Frequency for full ratings	5.0	MHz max
Frequency at reduced ratings	50	MHz max
Output power (class C telegraphy)	80	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	9.0	V
Filament current	240	A
Surge filament current (peak) (see note 2)	600	A max
Filament cold resistance	4.6	mΩ
Peak usable cathode current	70	A
Perveance	1.6	$mA/V^{3/2}$
Amplification factor ($V_a = 9.0kV$, $I_a = 2.0A$)	34	
Mutual conductance ($V_a = 9.0kV$, $I_a = 2.0A$)	27.5	mA/V
Inter-electrode capacitances:		
grid to anode	61	pF
grid to filament	68	pF
anode to filament	1.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR189	109 pounds (50kg) approx
BW189	23 pounds (10.5kg) approx
BY189A	70 pounds (32kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA130
Grid connector	MA66
Water jacket for BW189	BW4050
Sealing ring (supplied with BW189)	MA254
Single boiler unit, separate condenser required, for BY189A	BY4037A
Single boiler unit, integral condenser, for BY189A	BY4038
Double boiler unit, integral condenser, for BY189A	BY4038A
Sealing ring (supplied with BY189A)	MA255
Thermal fuse, 2 supplied with BY189A	MA85C

COOLING

Anode

The BR189 air cooling requirements are shown on pages 10 and 11. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW189 must be fitted into a water jacket for cooling, the recommended jacket being type BW4050. A flow of water of 10 to 15imp.gal/min (45 to 68 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

The BY189A is vapour cooled and may be operated either singly in boiler unit BY4037A or BY4038, or in pairs in boiler unit BY4038A. In BY4038 and BY4038A, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4037A is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Two thermal fuses (part number MA85C) are provided with each BY189A to give protection against anode overheating; only one fuse at a time need be used. Alternative positions for mounting the thermal fuse are provided by four threaded holes equally spaced round the top surface of the anode ring. It should be screwed into the desired position and connected by a non-conducting cord passing over the anode corona ring to a suitable switching device; a tension of about 1 lb (450g) should be applied to the fuse via the cord. If the temperature exceeds a safe limit, the fuse core is pulled outwards; this should actuate the switching device and remove all electrical supplies from the valve. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20ft^3/min (0.57m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C. The BW189 anode seal requires cooling and this may be done via holes in a corona ring fitted to the water jacket, when an air pressure of 1-inch (25mm) water gauge should provide sufficient flow.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C telegraphy, key down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	15	kV max
Anode current	7.0	A max
Anode dissipation:		
BR189	27	kW max
BW189, BY189A	35	kW max
Grid dissipation	1.25	kW max
Operating frequency (for full ratings)	5.0	MHz max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	12	15	kV
Grid voltage	−900	−900	V
Peak r.f. grid drive voltage	1650	1650	V
Anode current	6.4	6.6	A
Grid current (approx)	0.83	0.7	A
Anode dissipation	15	18	kW
Grid dissipation	640	530	W
Driving power	1370	1150	W
Output power	62	80	kW
Efficiency	80	80	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 9.0V . .	217	256	A
Amplification factor (V_a = 9.0kV, I_a = 2.0A) . .	30	38	
Mutual conductance (V_a = 9.0kV, I_a = 2.0A) . .	22.5	29.5	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	380	V
Grid voltage (negative value) (V_a = 9.0kV, I_a = 2.0A)	125	193	V
Anode current (V_a = 4.0kV, V_g = +400V)	18	24	A
Grid current (V_a = 4.0kV, V_g = +400V)	–1.2	–	A

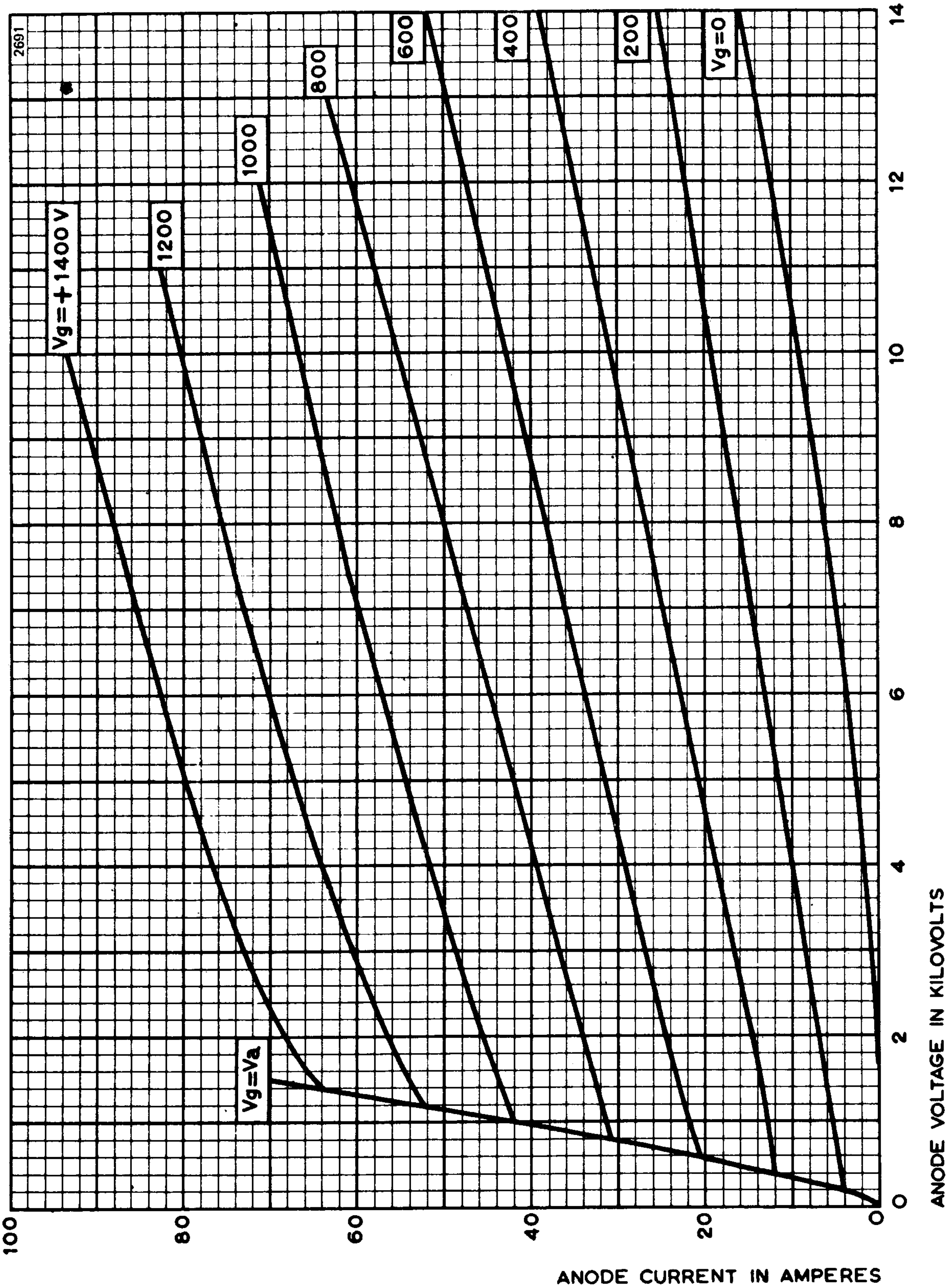
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
5	15	13.5
30	13.5	12
50	8.0	6.5

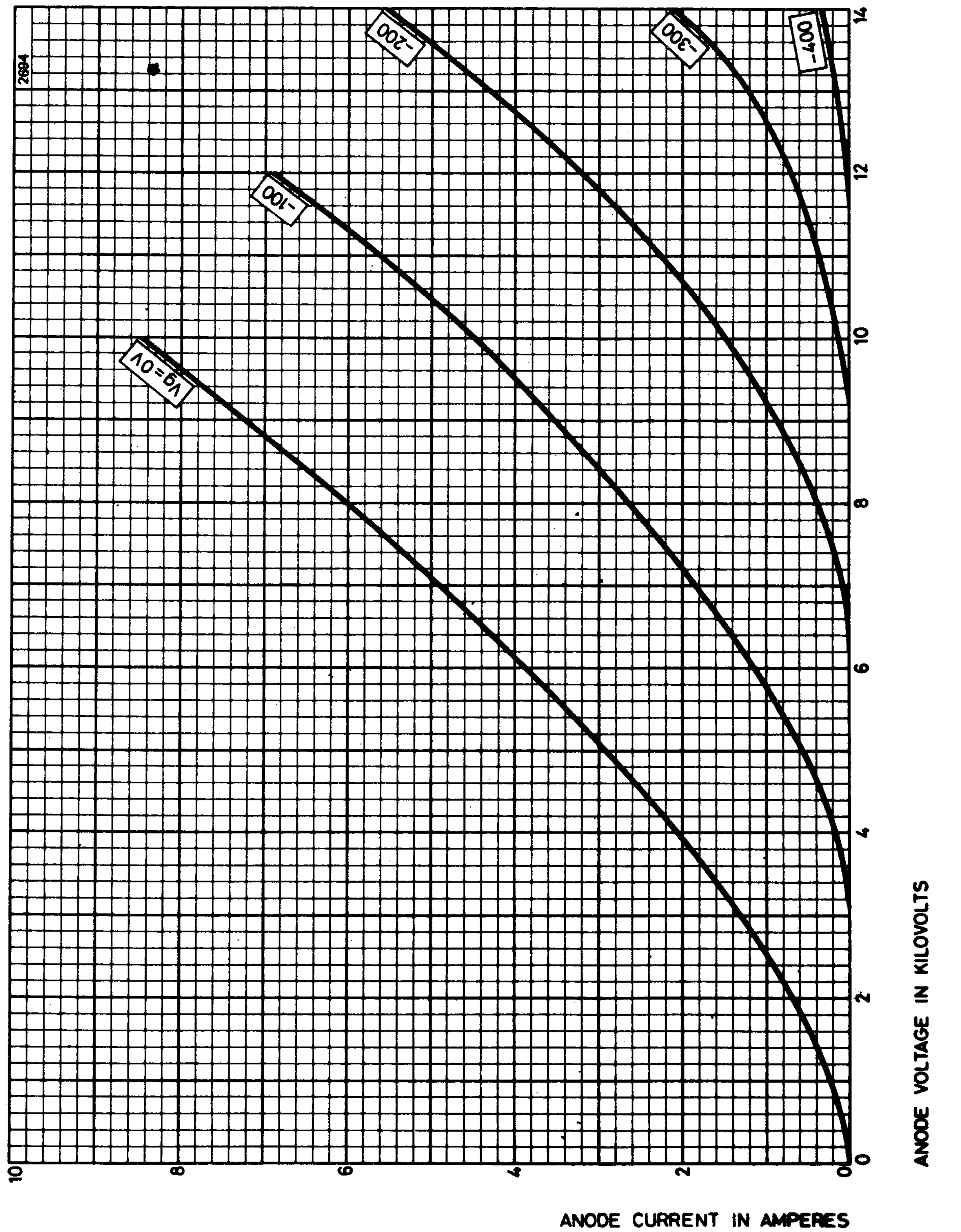
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.

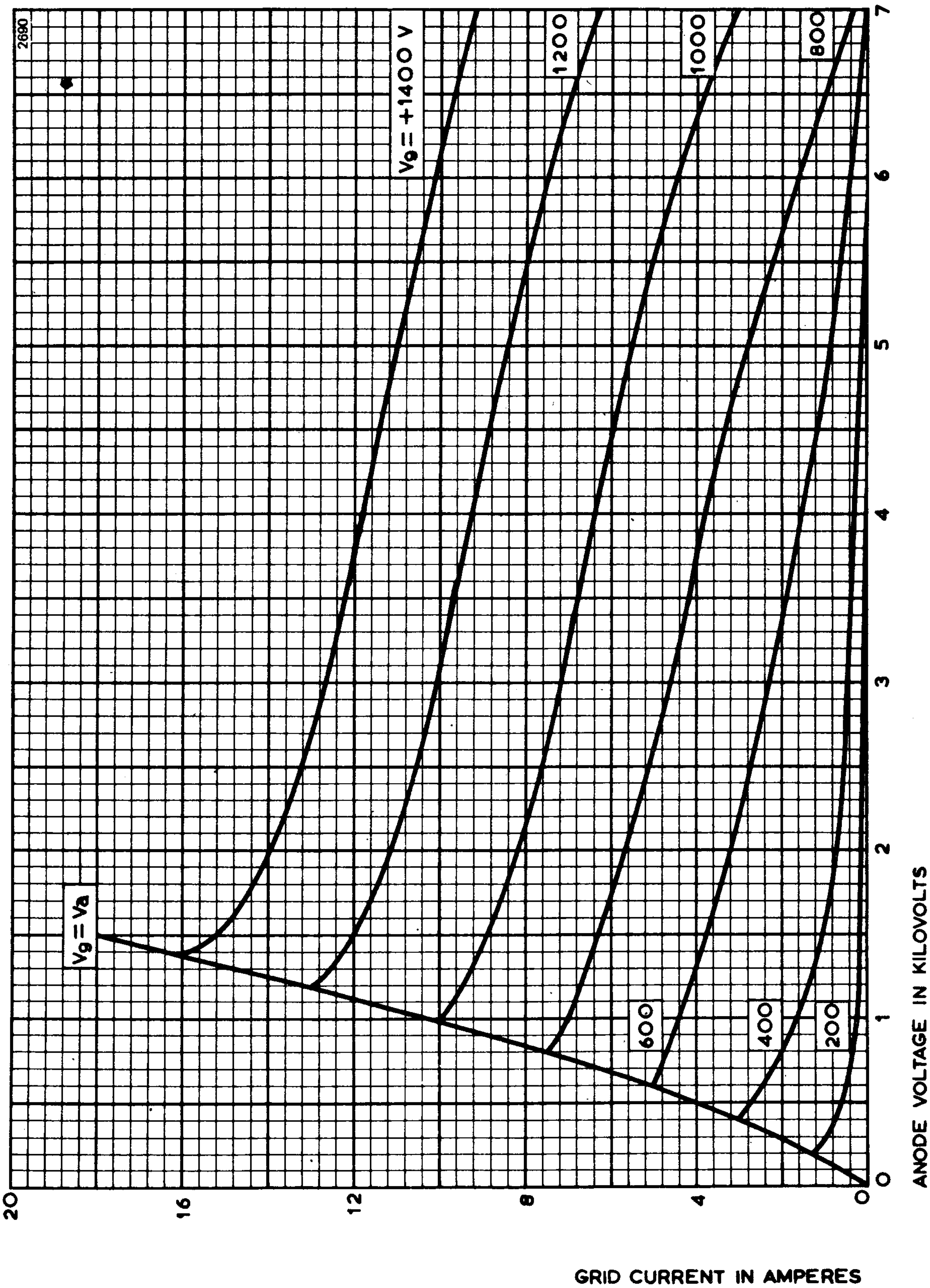
TYPICAL ANODE CHARACTERISTICS



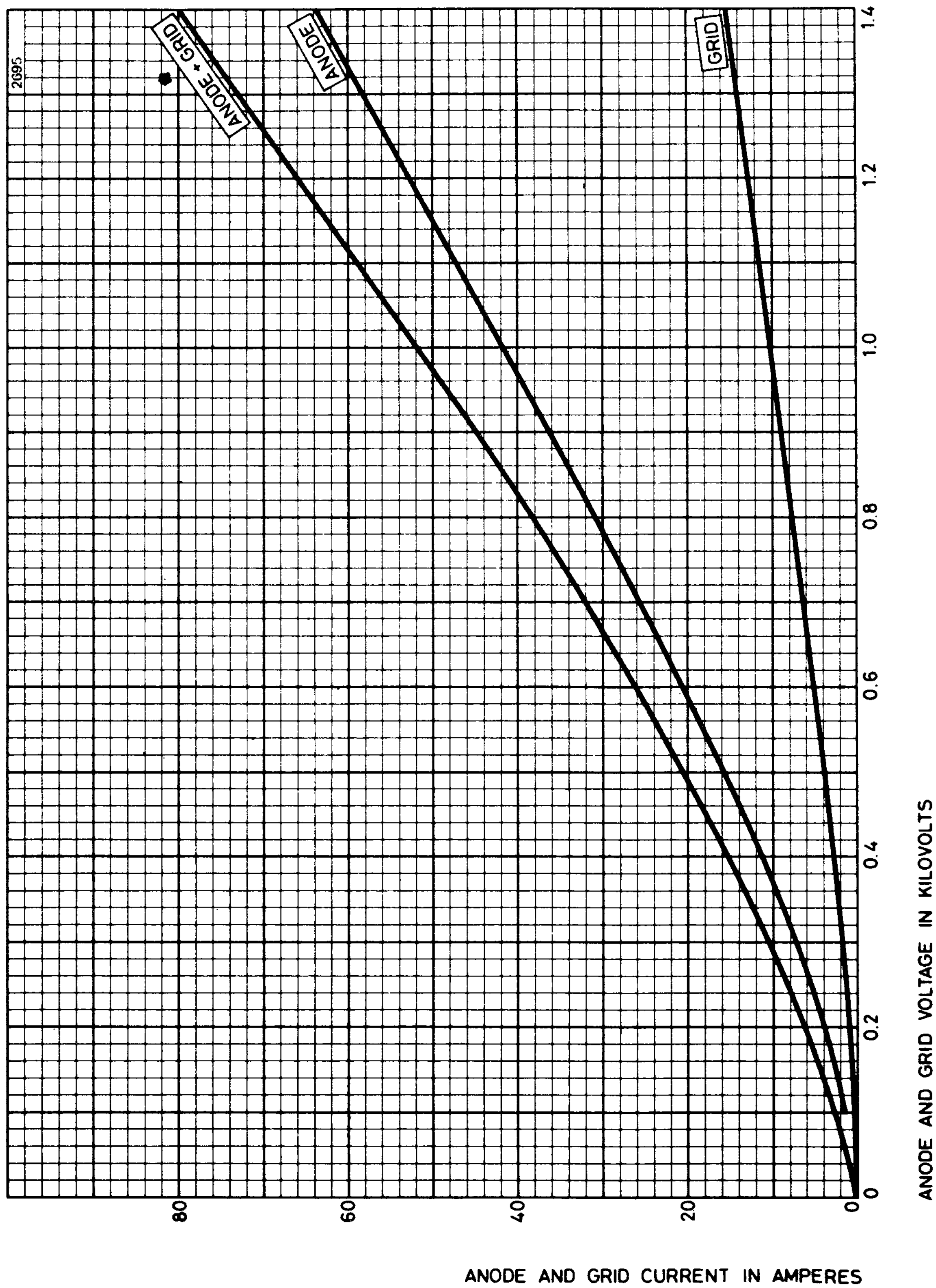
TYPICAL ANODE CHARACTERISTICS (Negative Grid)



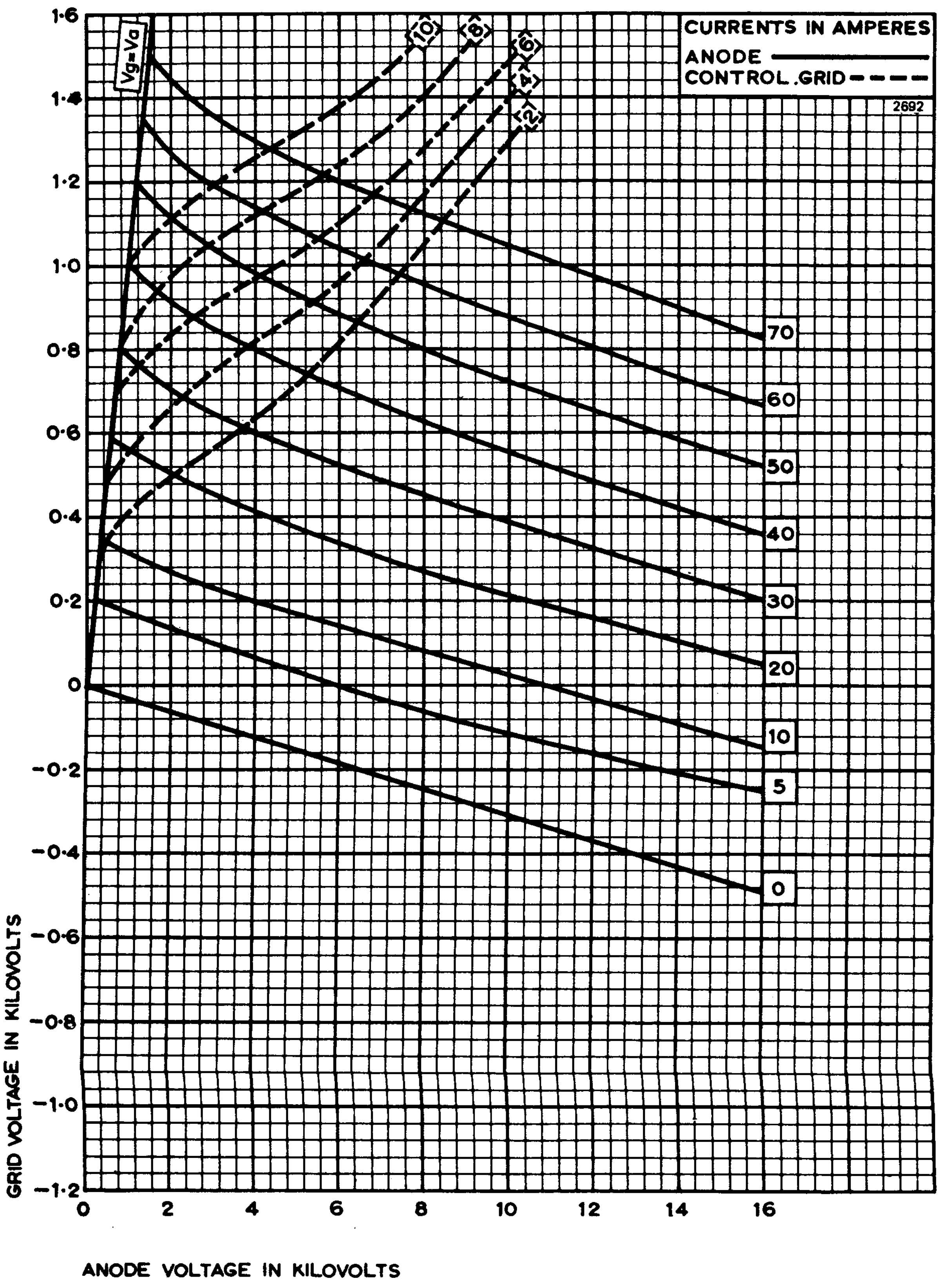
TYPICAL GRID CHARACTERISTICS



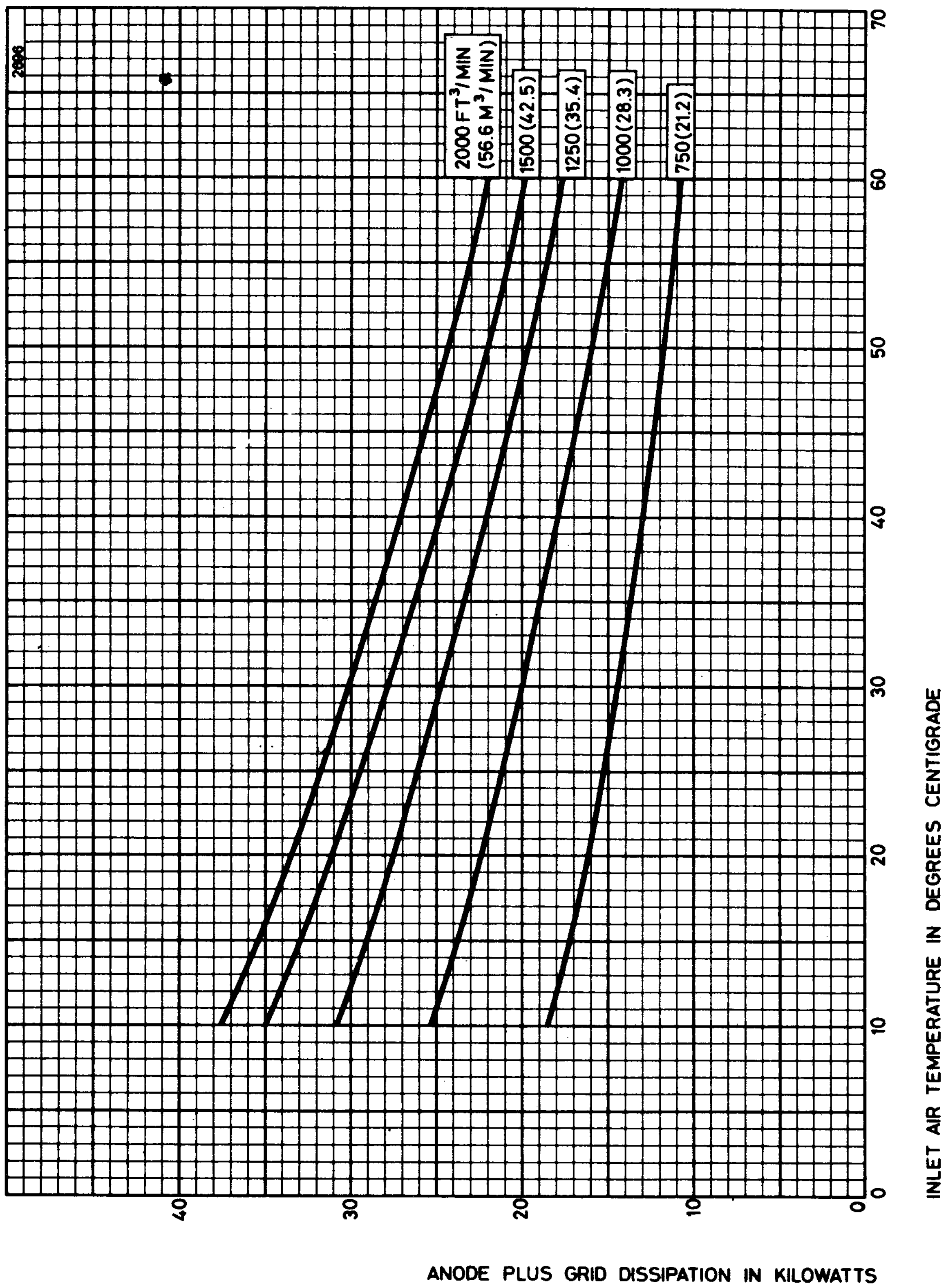
TYPICAL STRAPPED CHARACTERISTICS



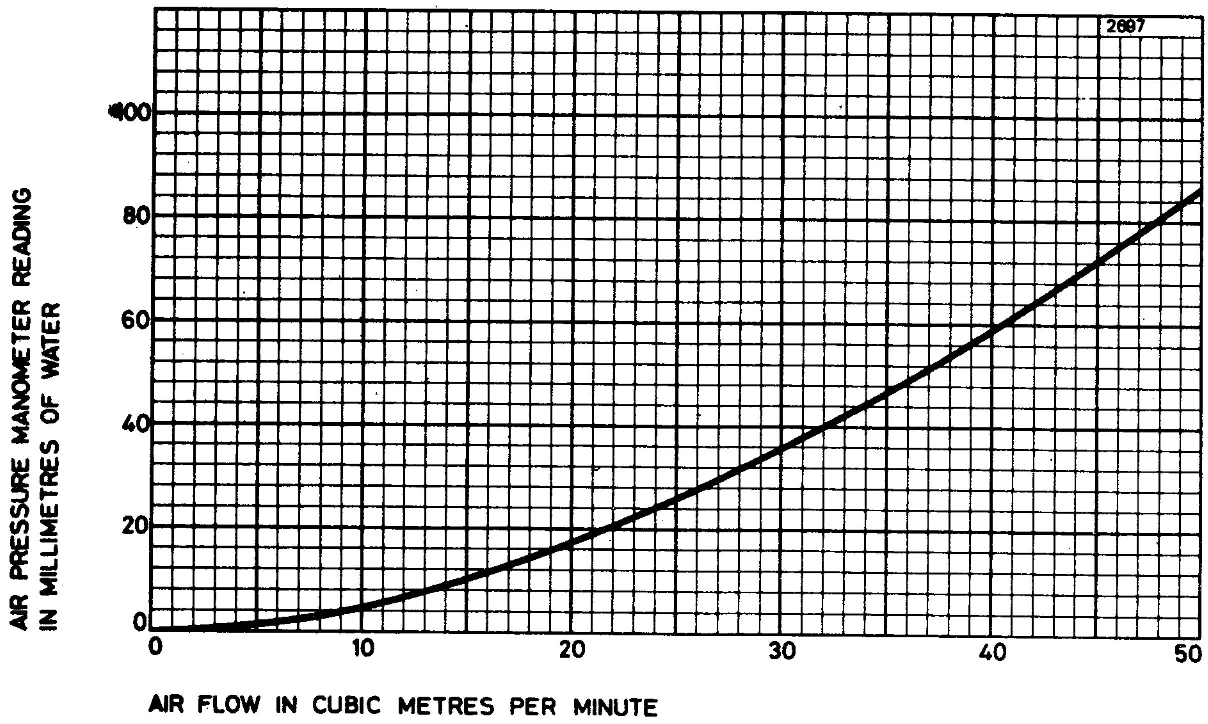
TYPICAL CONSTANT CURRENT CHARACTERISTICS

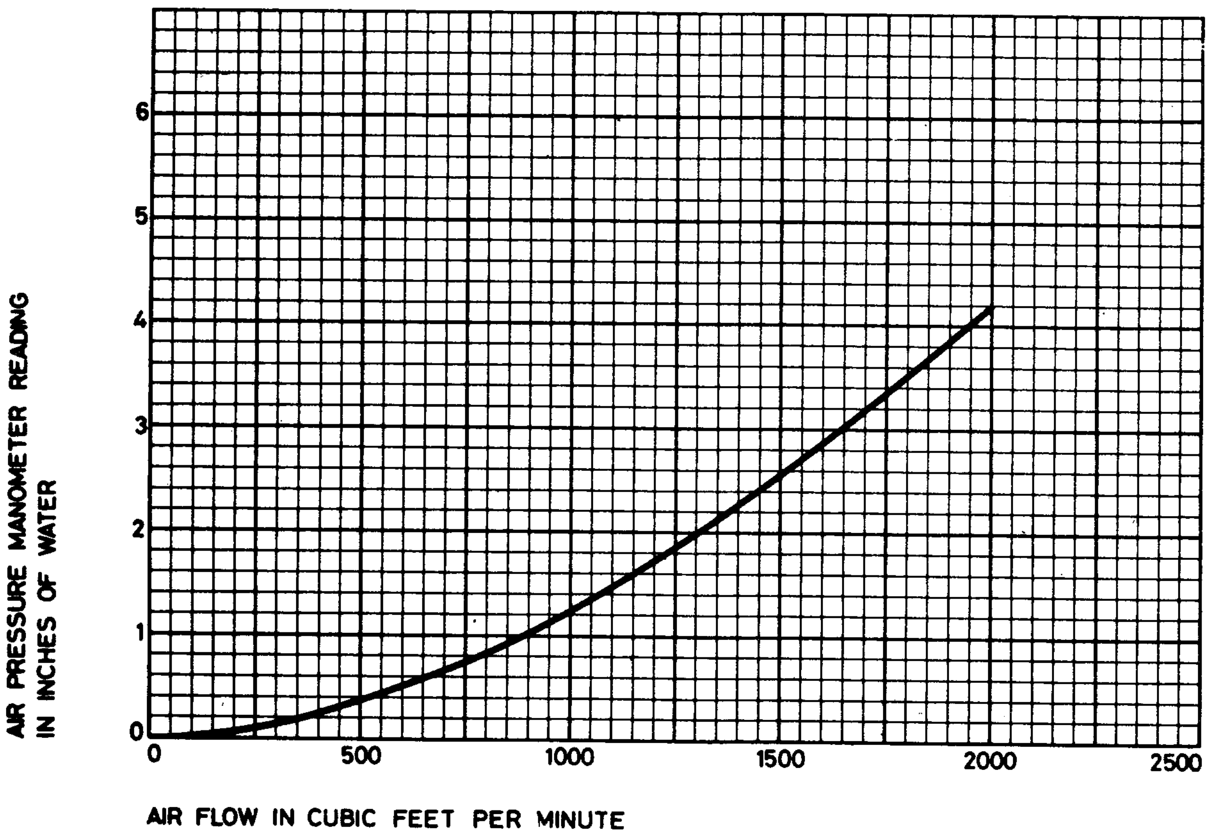


AIR COOLING REQUIREMENTS FOR BR189

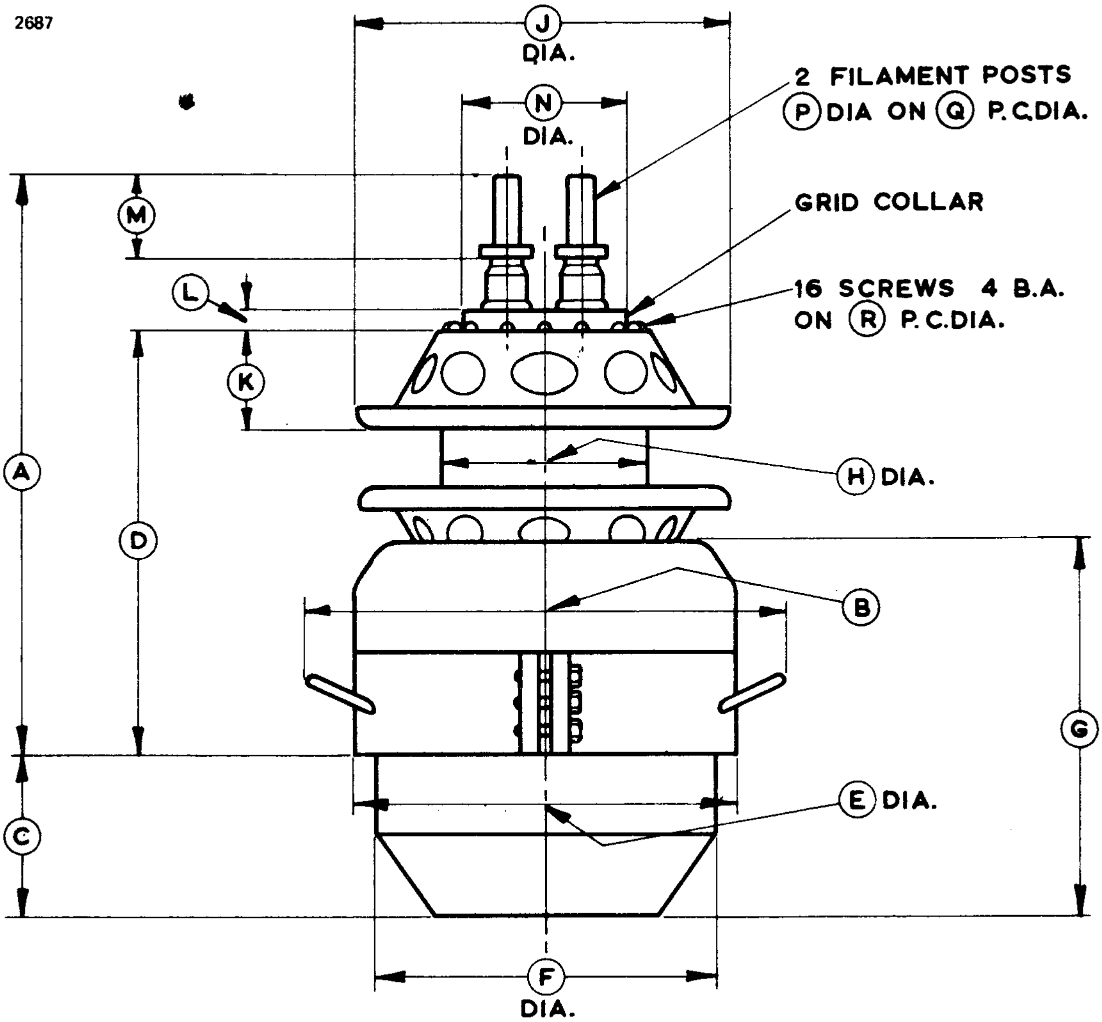


AIR FLOW CHARACTERISTIC FOR BR189





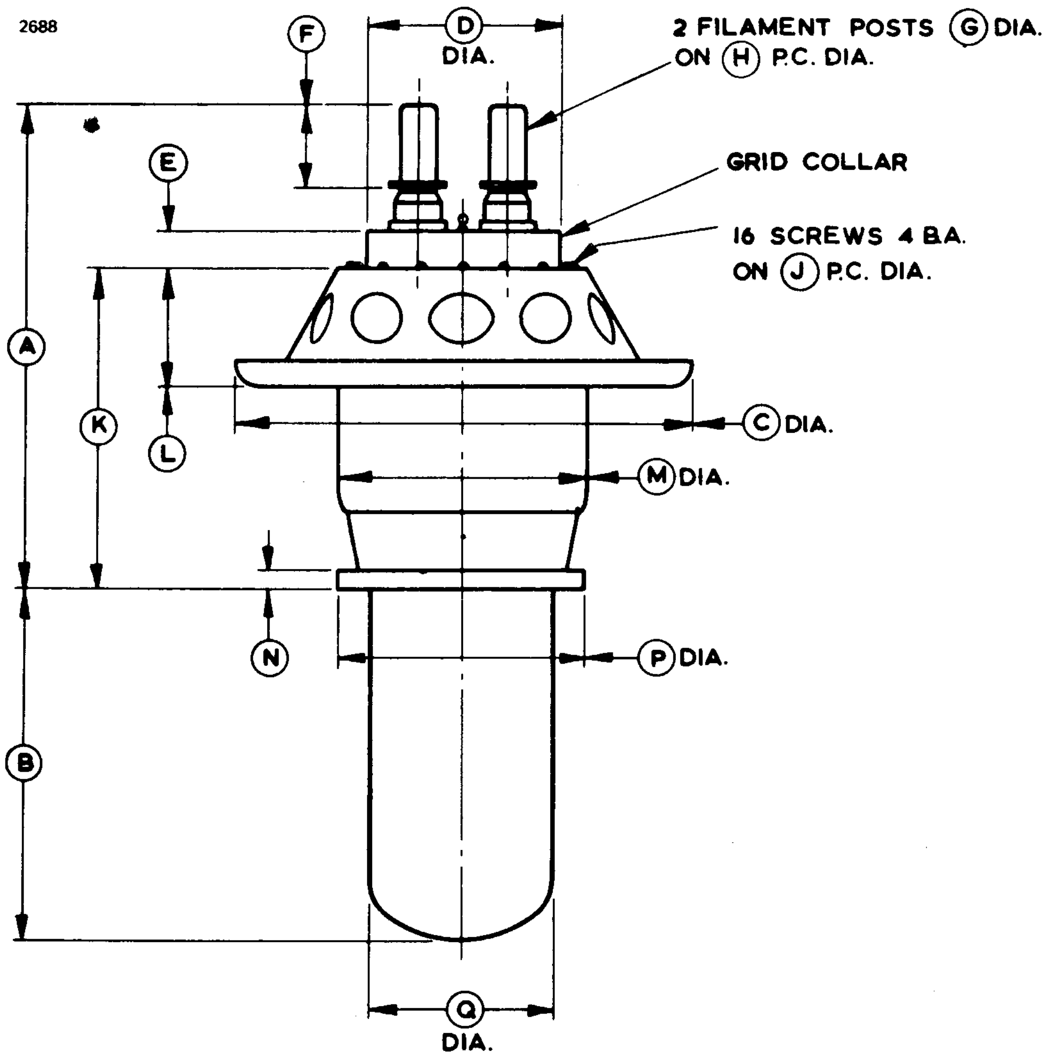
OUTLINE FOR BR189 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	16.750 max	425.5 max	J	11.000 max	279.4 max
B	14.000 max	355.6 max	K	2.906 max	73.81 max
C	4.750	120.7	L	0.687	17.45
D	12.875 max	327.0 max	M	2.000	50.80
E	11.000	279.4	N	4.703	119.5
F	10.062 max	255.6 max	P	0.875	22.23
G	11.000	279.4	Q	2.250	57.15
H	6.000	152.4	R	5.375	136.5

Millimetre dimensions have been derived from inches.

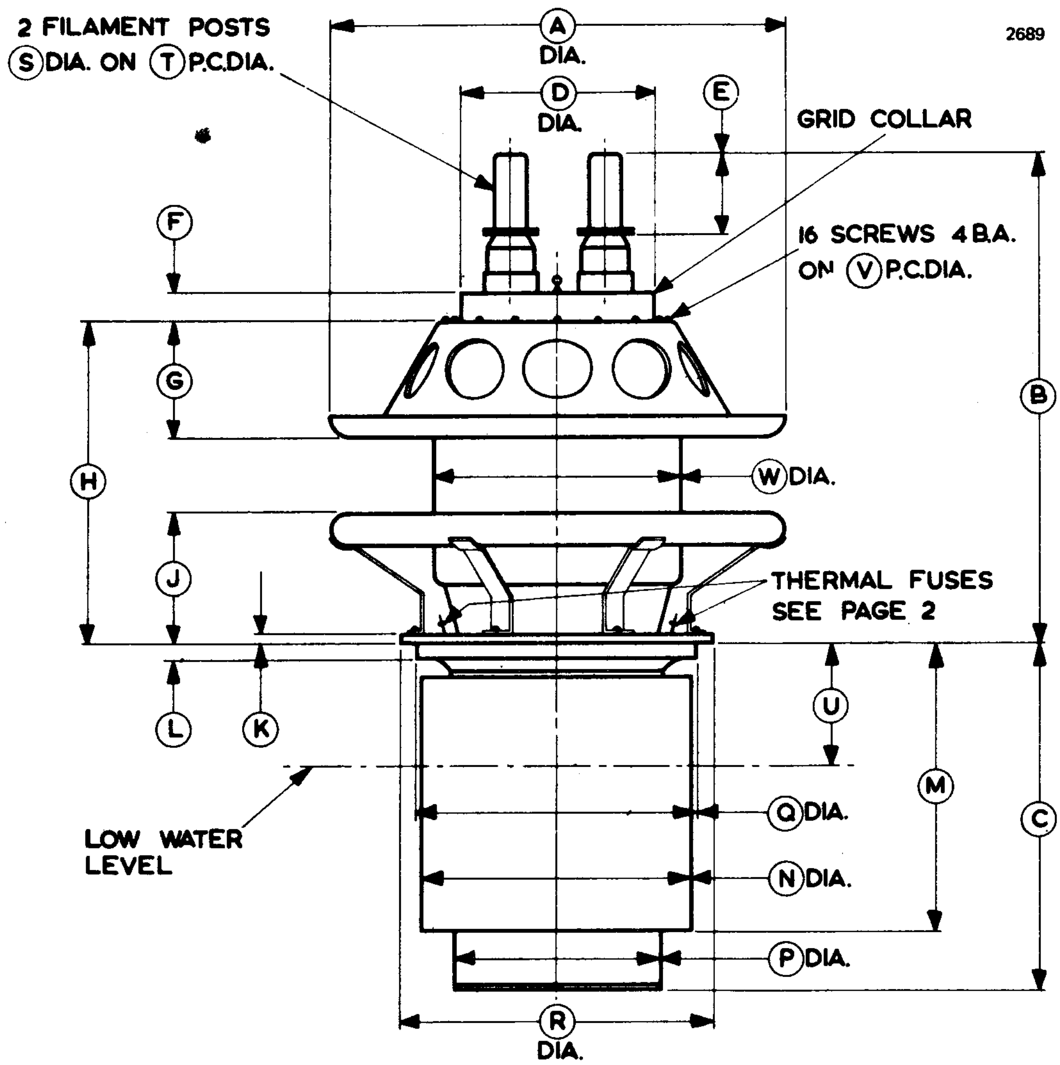
OUTLINE FOR BW189 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	12.000 max	304.8 max	J	5.375	136.5
B	8.625	219.1	K	7.875 max	200.0 max
C	11.000 max	279.4 max	L	2.906 max	73.81 max
D	4.703	119.5	M	6.000	152.4
E	0.687	17.45	N	0.500	12.70
F	2.000	50.80	P	5.760 max	146.3 max
G	0.875	22.23	Q	4.500	114.3
H	2.250	57.15			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY189A (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.000 max	279.4 max	M	7.000	177.8
B	12.109 max	307.6 max	N	6.562	166.7
C	8.452	214.7	P	5.240	133.1
D	4.703	119.5	Q	6.937	176.2
E	2.000	50.80	R	7.500	190.5
F	0.687	17.45	S	0.875	22.23
G	2.906 max	73.81 max	T	2.250	57.15
H	8.053 max	204.5 max	U	3.000	76.20
J	3.326 max	84.48 max	V	5.375	136.5
K	0.250	6.35	W	6.000	152.4
L	0.375	9.53			

Millimetre dimensions have been derived from inches.

BR/BW/BY194 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. power triodes differing only in the method of anode cooling and in anode dissipation. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BR194		forced-air
BW194		water; separate jacket
BY194		vapour; separate boiler unit
Anode dissipation:		
BR194	40	kW max
BW194, BY194	50	kW max
Anode voltage	15	kV max
Frequency for full ratings	5.0	MHz max
Frequency at reduced ratings	30	MHz max
Typical output power (class C telegraphy)	115	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	13	V
Filament current	240	A
Surge filament current (peak) (see note 2)	600	A max
Filament cold resistance	6.0	mΩ
Peak usable cathode current	100	A
Perveance	2.17	$mA/V^{3/2}$
Amplification factor (V_a = 7.5kV, I_a = 3.0A)	34	
Mutual conductance (V_a = 9.0kV, I_a ≑ 4.0A)	43	mA/V
Inter-electrode capacitances:		
grid to anode	60	pF
grid to filament	95	pF
anode to filament	1.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR194	64 pounds (29kg) approx
BW194	28 pounds (12.8kg) approx
BY194	88 pounds (40kg) approx
Mounting position	vertical, filament pins up

Accessories

Filament leads	MA130
Grid connector	MA66
Water jacket for BW194	BW4027
Sealing ring (supplied with BW194)	MA254
Single boiler unit, integral condenser, for BY194	BY4039
Single boiler unit, separate condenser required, for BY194	BY4049
Sealing ring (supplied with BY194)	MA255

COOLING

Anode

The radiator of the BR194 is designed for use in conjunction with a specially designed air duct ensuring correct distribution of cooling air. The required quantity of air is indicated on the graphs (pages 9 and 10) and this must be supplied not only during but also before the application of any voltages to the valve.

The anode of the BW194 must be fitted into a water jacket for cooling, the recommended jacket being type BW4027. A flow of water of 20 to 25imp. gal/min (91 to 114 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

The BY194 is vapour cooled and may be operated either in boiler unit BY4039 or BY4049. In BY4039, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4049 is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C Telegraphy, key down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	15	kV max
Anode current	10	A max
Anode dissipation:		
BR194	40	kW max
BW194, BY194	50	kW max
Grid dissipation	1.8	kW max
Operating frequency (for full ratings)	5.0	MHz max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	10	15	kV
Grid voltage	–900	–900	V
Peak r.f. grid drive voltage	1620	1620	V
Anode current	8.8	9.6	A
Grid current (approx)	1.2	1.2	A
Anode dissipation	18	26	kW
Grid dissipation	870	850	W
Output power	70	115	kW
Efficiency	78	80	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 13V	225	255	A
Amplification factor (V_a = 7.5kV, I_a = 3.0A)	31	37	
Mutual conductance (V_a = 9.0kV, I_a = 4.0A)	38	48	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 3.0A)	173	195	V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	345	V
Anode current (V_a = 2.0kV, V_g = +200V)	7.0	11	A
Anode current (V_a = 4.0kV, V_g = +400V)	22	32	A
Grid current (V_a = 2.0kV, V_g = +200V)	–0.15	+0.25	A
Grid current (V_a = 4.0kV, V_g = +400V)	–2.0	+0.5	A
Inter-electrode capacitances:			
grid to anode	60	78	pF
grid to filament	84	96	pF
anode to filament	–	2.0	pF

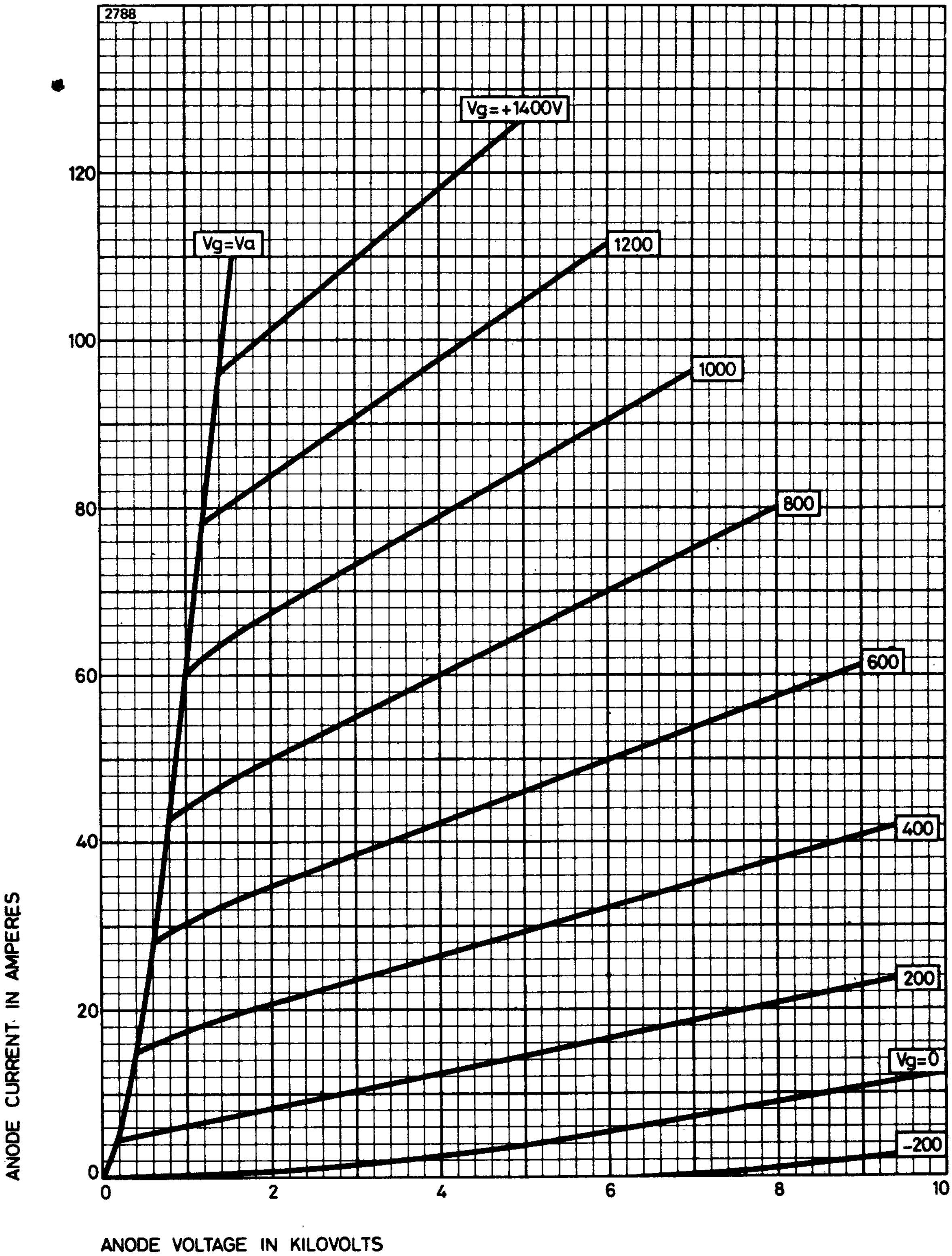
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
5	15	12
30	10	8.0

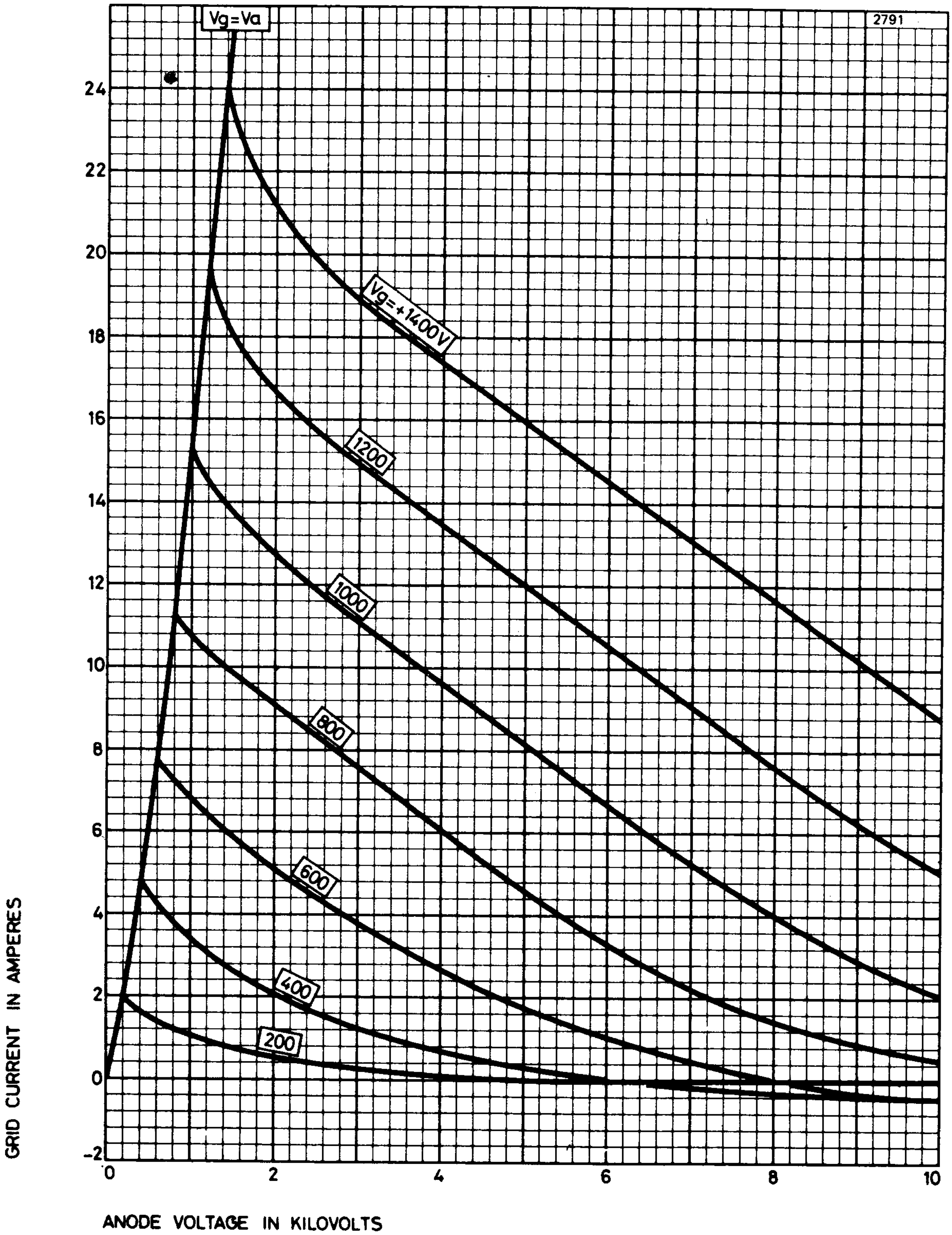
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuations in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.

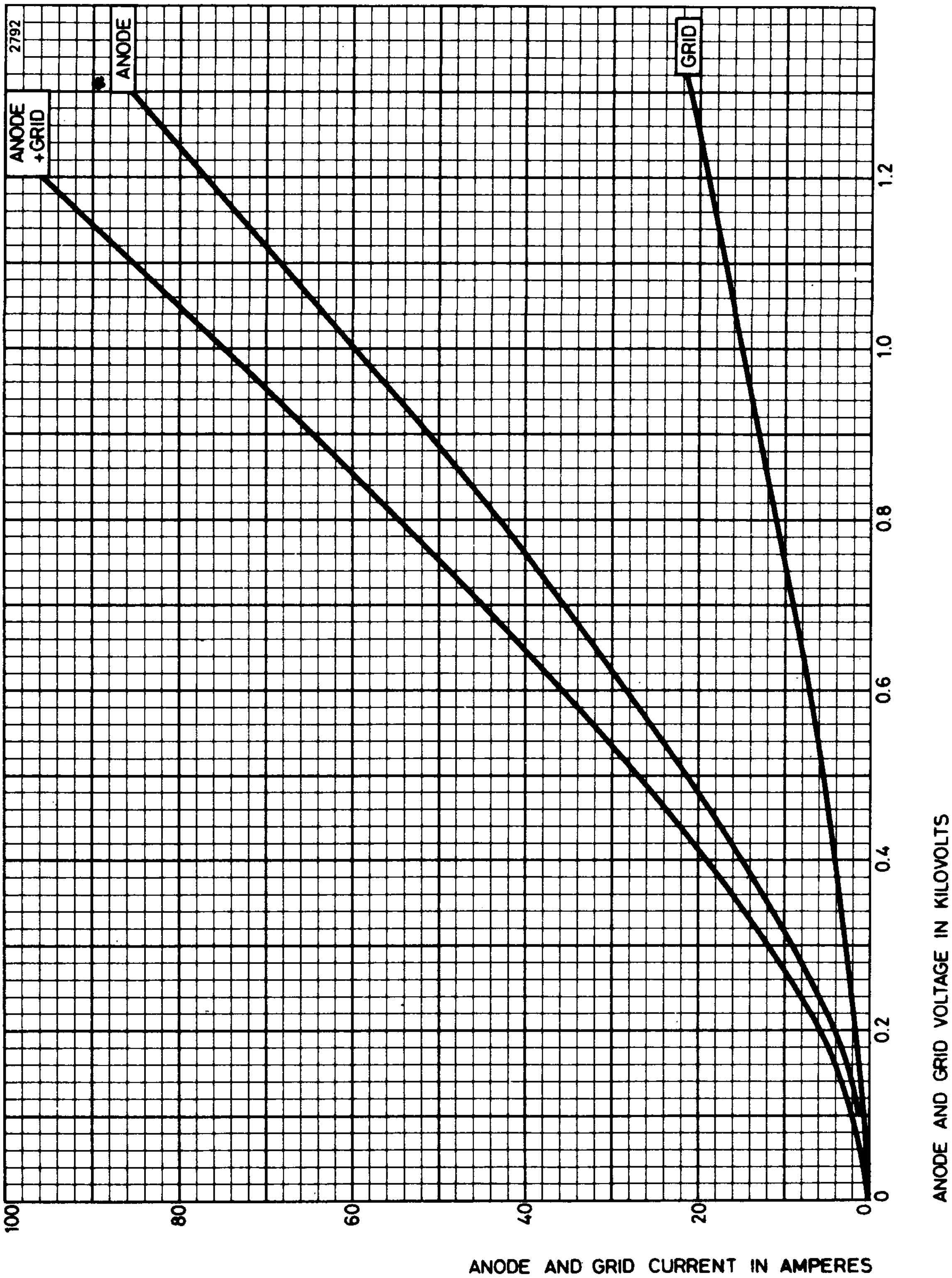
TYPICAL ANODE CHARACTERISTICS



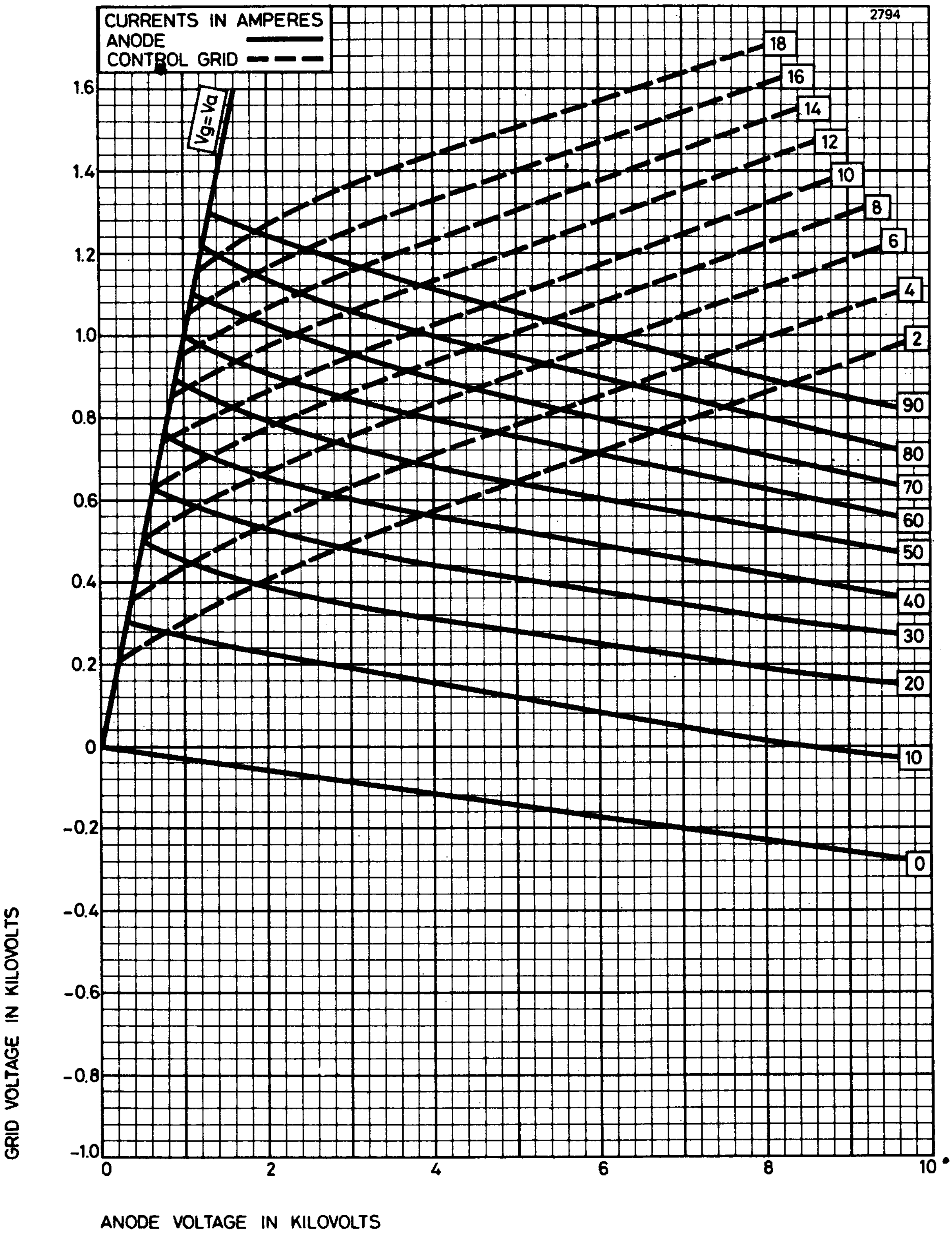
TYPICAL GRID CHARACTERISTICS



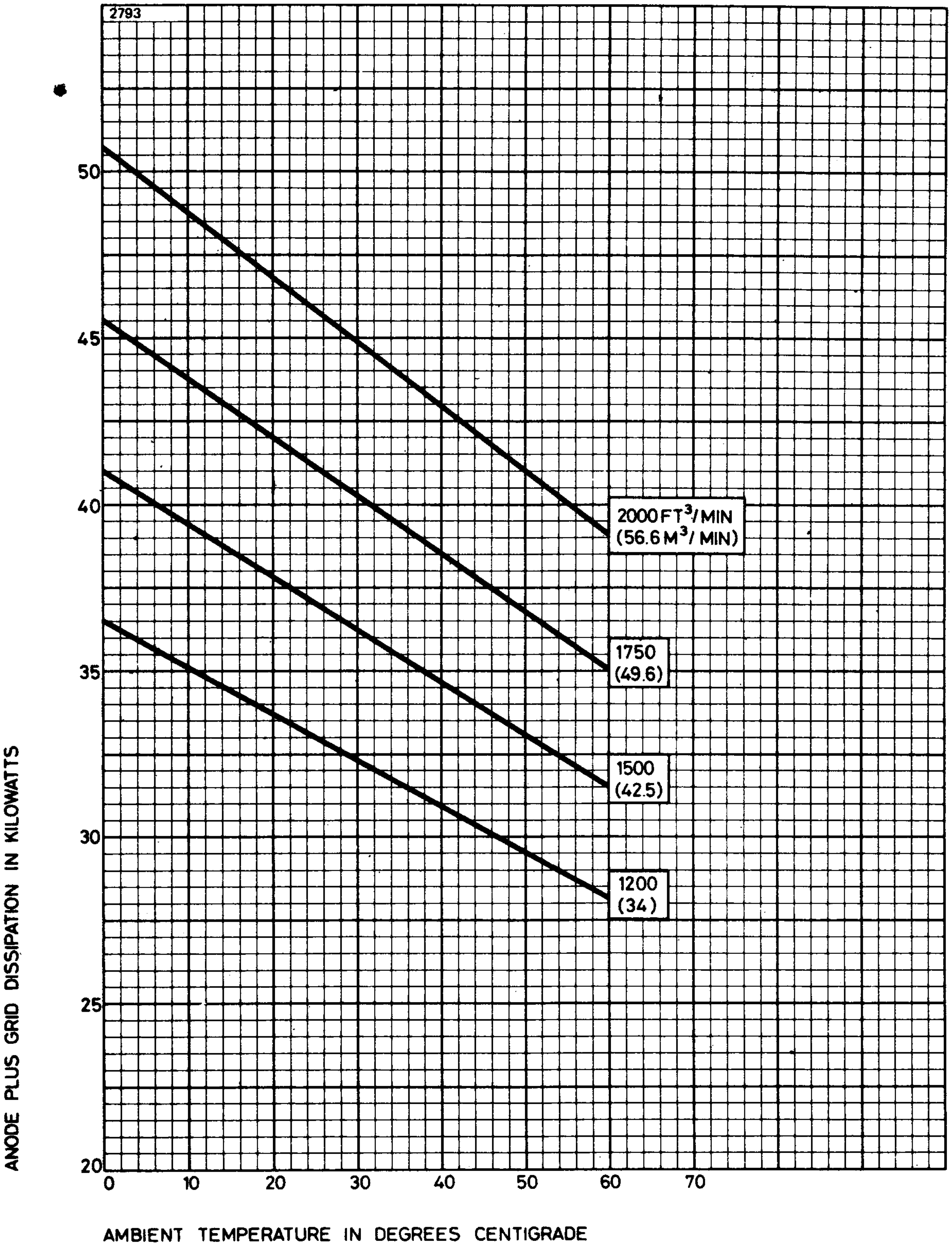
TYPICAL STRAPPED CHARACTERISTICS



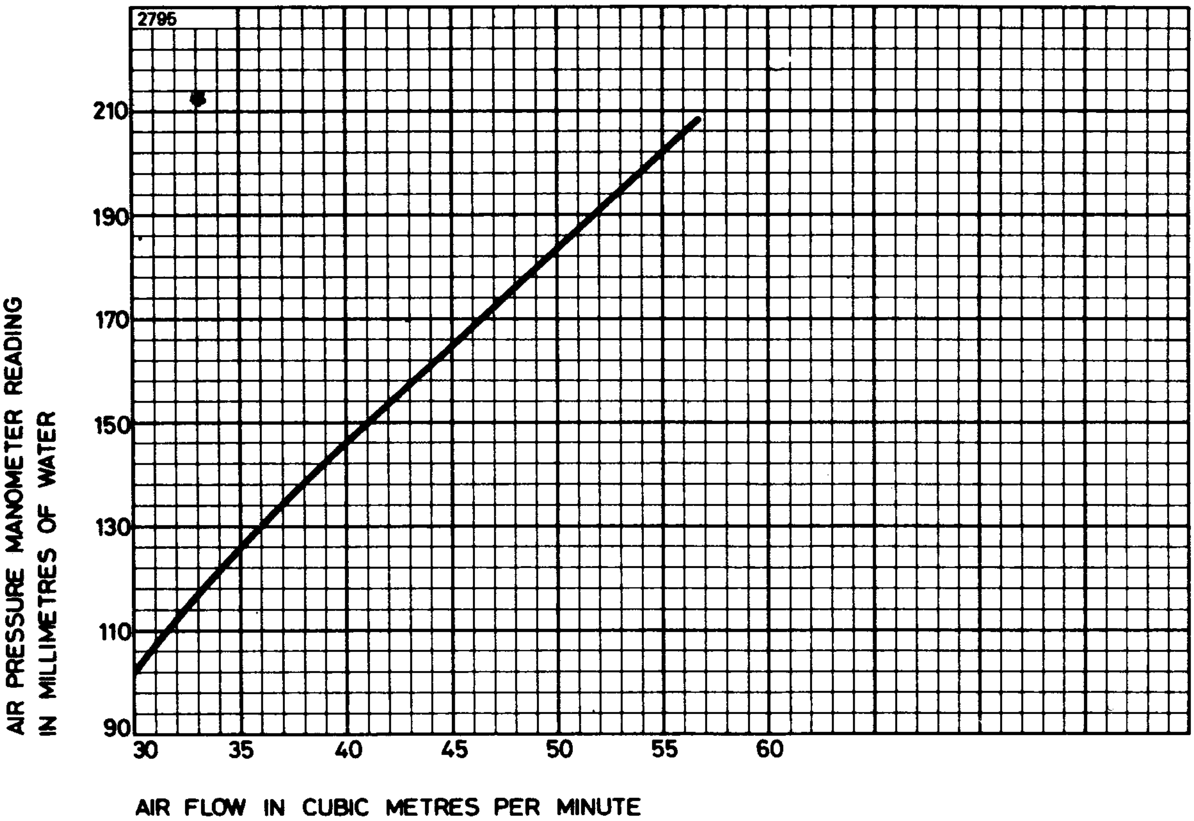
TYPICAL CONSTANT CURRENT CHARACTERISTICS

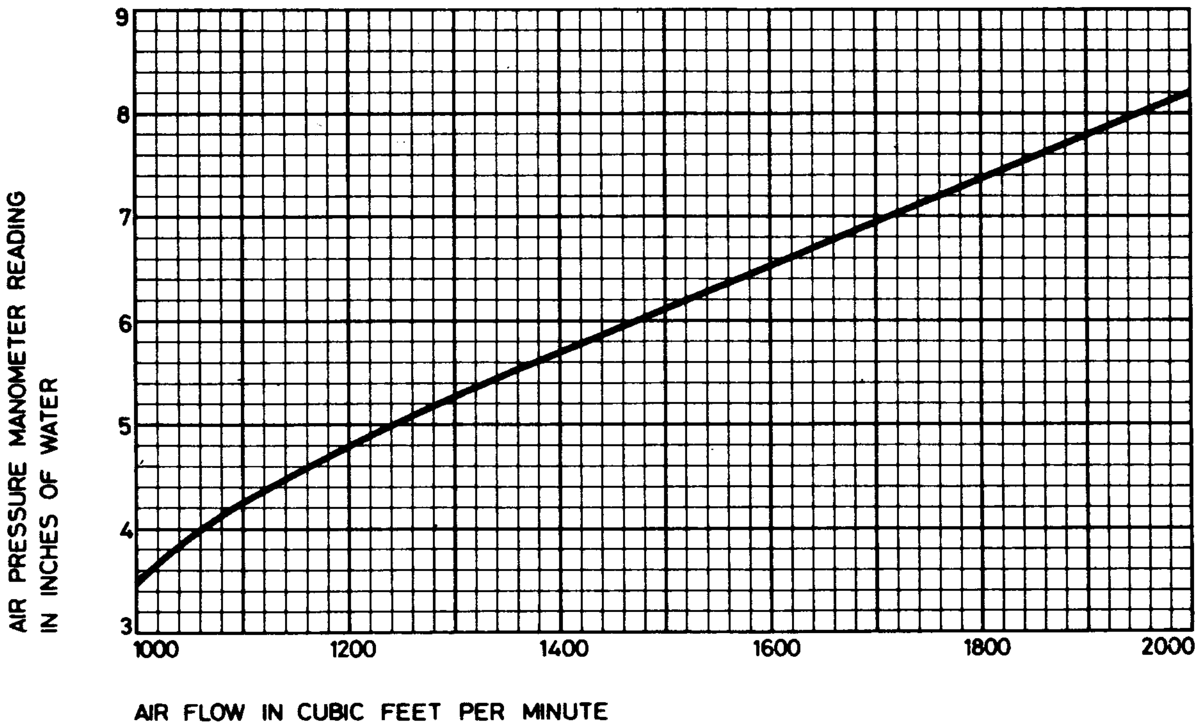


AIR COOLING REQUIREMENTS FOR BR194

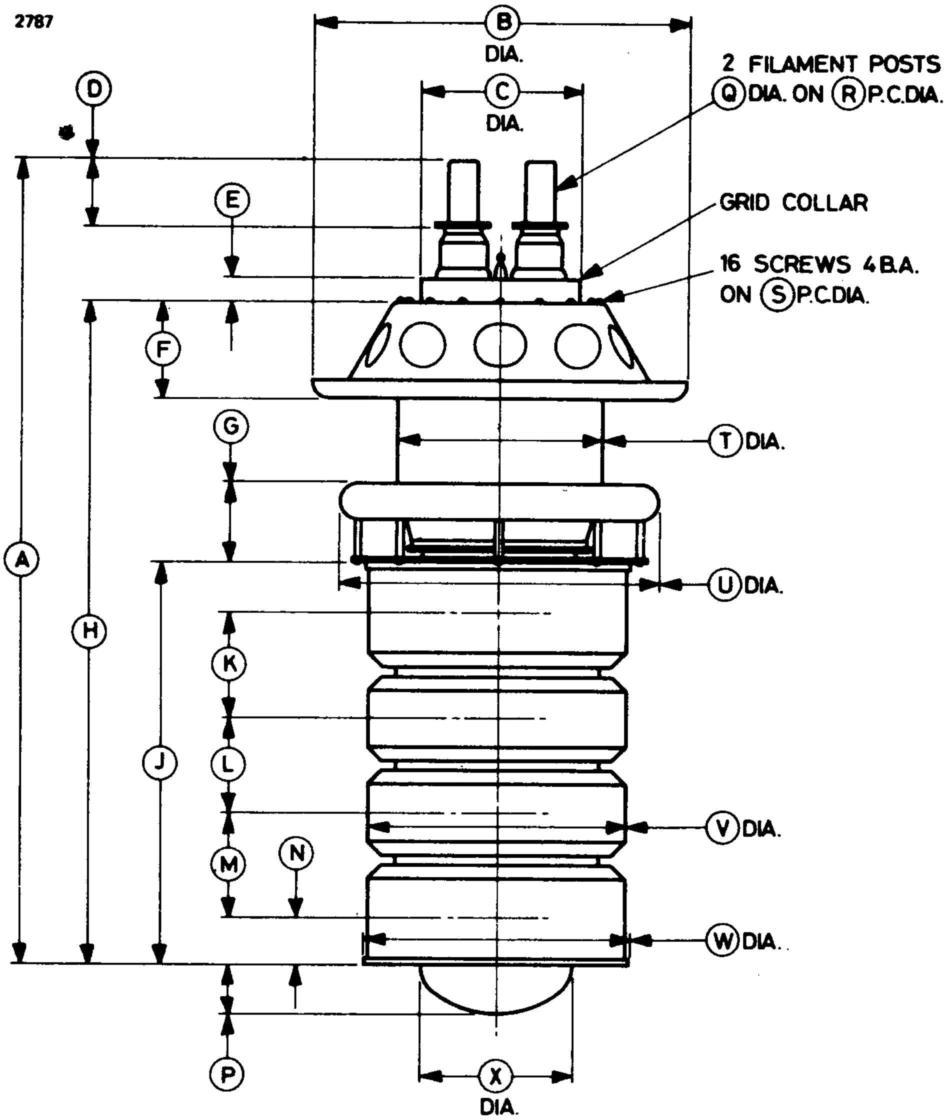


TYPICAL AIR FLOW CHARACTERISTIC FOR BR194





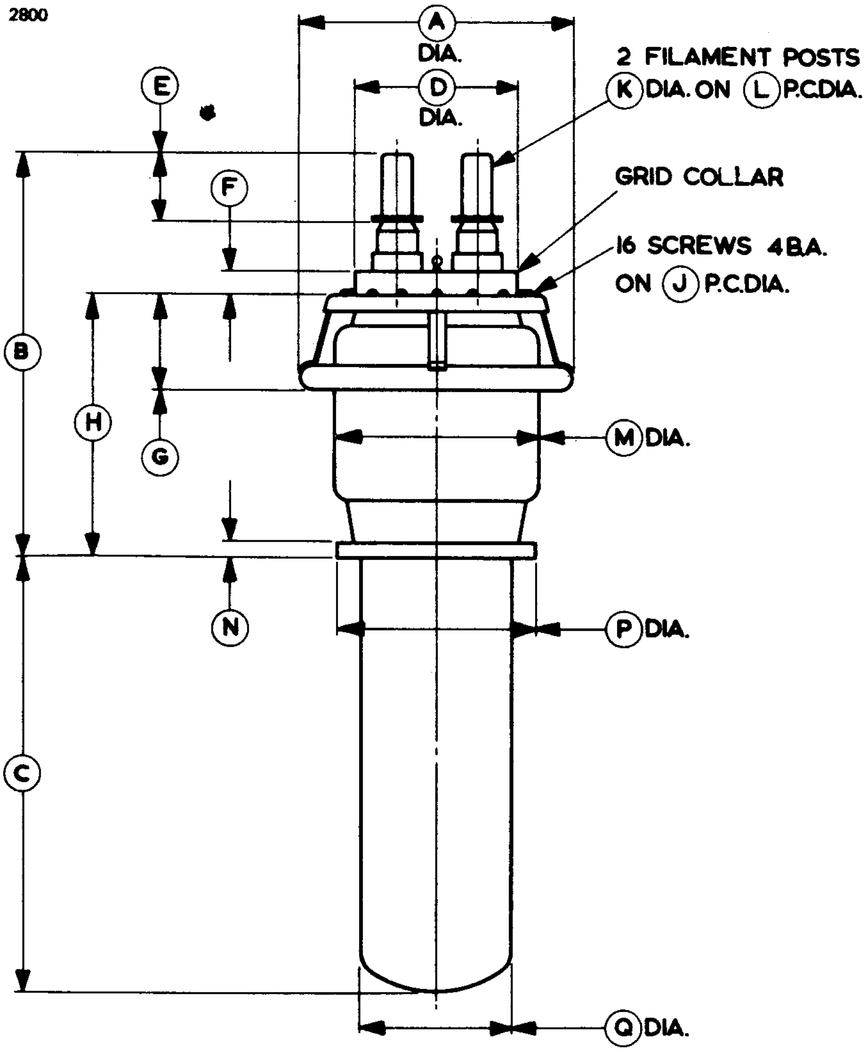
OUTLINE FOR BR194 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	24.125 max	612.8 max	M	3.091 $\pm$ 0.062	78.51 $\pm$ 1.57
B	11.000 max	279.4 max	N	1.432 $\pm$ 0.062	36.37 $\pm$ 1.57
C	4.703	119.5	P	1.437 max	36.50 max
D	2.000	50.80	Q	0.875	22.23
E	0.687	17.45	R	2.250	57.15
F	2.906 max	73.81 max	S	5.375	136.5
G	2.298	58.37	T	6.000 max	152.4 max
H	20.000 max	508.0 max	U	9.385 max	238.4 max
J	11.893 $\pm$ 0.187	302.1 $\pm$ 4.75	V	7.666 $\pm$ 0.031	194.7 $\pm$ 0.8
K	3.091 $\pm$ 0.062	78.51 $\pm$ 1.57	W	7.750 $\pm$ 0.031	196.9 $\pm$ 0.8
L	2.786 $\pm$ 0.062	70.76 $\pm$ 1.57	X	4.531 max	115.1 max

Millimetre dimensions have been derived from inches.

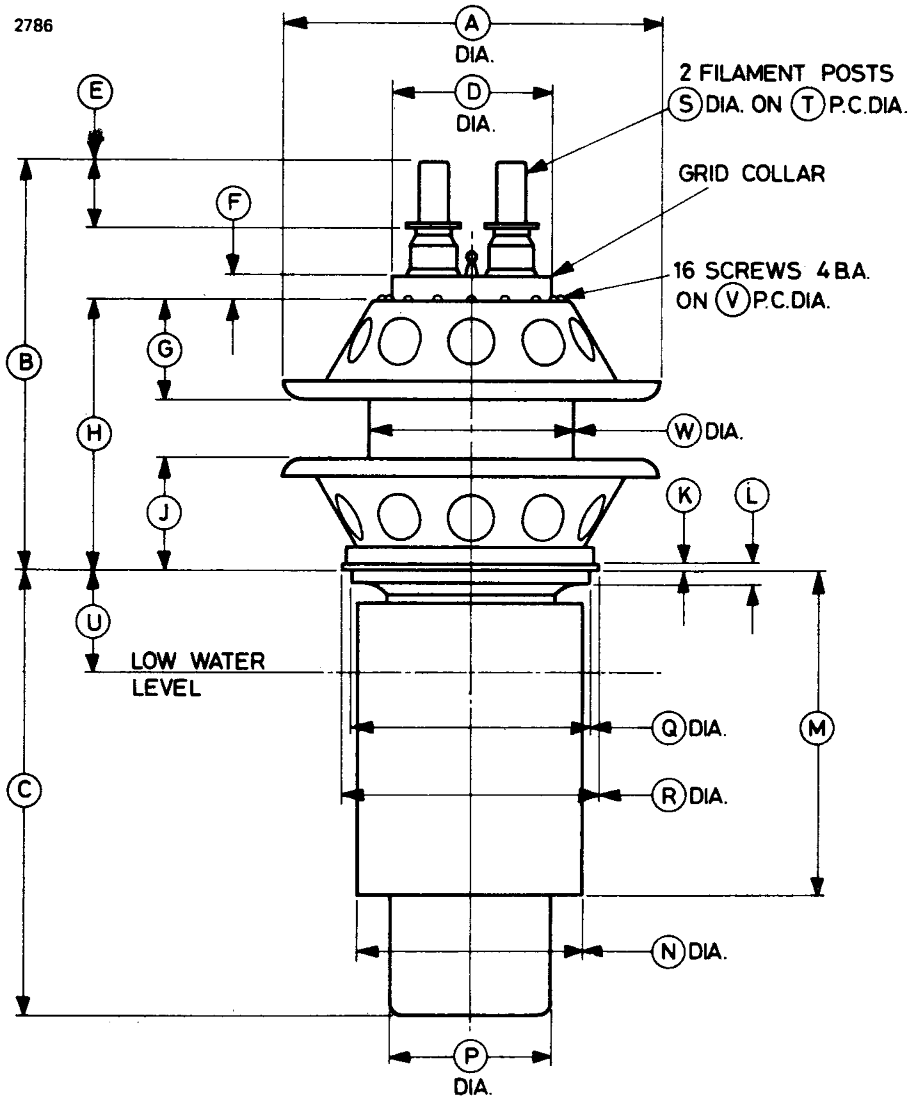
OUTLINE FOR BW194 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.062 max	204.8 max	J	5.375	136.5
B	11.875 max	301.6 max	K	0.875	22.23
C	12.750 max	323.9 max	L	2.250	57.15
D	4.703	119.5	M	6.000	152.4
E	2.000	50.80	N	0.500	12.70
F	0.687	17.45	P	5.760 max	146.3 max
G	2.906 max	73.81 max	Q	4.500	114.3
H	7.750 max	196.9 max			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY194 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.000 max	279.4 max	M	9.500	241.3
B	12.109 max	307.6 max	N	6.562	166.7
C	13.000 ± 0.062	330.2 ± 1.6	P	4.750	120.7
D	4.703	119.5	Q	6.937	176.2
E	2.000	50.80	R	7.500	190.5
F	0.687	17.45	S	0.875	22.23
G	2.950 max	74.93 max	T	2.250	57.15
H	8.053 max	204.5 max	U	3.000	76.20
J	3.326 max	84.48 max	V	5.375	136.5
K	0.250	6.35	W	6.000	152.4
L	0.625	15.88			

Millimetre dimensions have been derived from inches.

BR/BW/BY1102 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Four r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling and in anode dissipation.

Anode cooling:		
BR1102		forced-air
BW1102		water; separate jacket
BW1102J2		water; integral jacket
BY1102		vapour; separate boiler unit
Anode dissipation:		
BR1102, BW1102, BW1102J2	20	kW max
BY1102	25	kW max
Anode voltage	12	kV max
Frequency for full ratings	50	MHz max
Typical output power (class C unmodulated)	53	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	8.2	V
Filament current	230	A
Surge filament current (peak) (see note 2)	600	A max
Filament cold resistance	4.3	mΩ
Peak usable cathode current	45	A
Perveance	1.25	$mA/V^{3/2}$
Amplification factor (V_a = 9.0kV, I_a = 2.0A)	42	
Mutual conductance (V_a = 10kV, I_a = 1.5A)	20	mA/V
Inter-electrode capacitances:		
grid to anode	37	pF
grid to filament	49	pF
anode to filament	0.6	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR1102	41 pounds (19kg) approx
BW1102	10¼ pounds (4.7kg) approx
BW1102J2	15 pounds (6.8kg) approx
BY1102	41 pounds (19kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA131
Grid connector	MA66
Water jacket for BW1102	BW4028
Sealing ring (supplied with BW1102)	MA251
Single boiler unit, integral condenser, for BY1102	BY4031
Double boiler unit, integral condenser, for BY1102	BY4030
Sealing ring (supplied with BY1102)	MA246

COOLING

Anode

The BR1102 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW1102 must be fitted into a water jacket for cooling, the recommended jacket being type BW4028. A flow of water of 5imp.gal/min (23 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C. Type BW1102J2 has an integral water jacket (see outline drawing, page 14). Minimum water cooling requirements are shown on page 11; higher rates of flow should be used where possible.

The BY1102 is vapour cooled and may be operated either singly in boiler unit BY4031 or in pairs in boiler unit BY4030. In both units, the steam generated by the anode is condensed by means of an internal water cooled condenser.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	12	kV max
Anode current	7.5	A max
Anode dissipation (see note 4):		
BR1102, BW1102, BW1102J2	20	kW max
BY1102	25	kW max
Grid dissipation	1.0	kW max
Operating frequency (for full ratings)	50	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	9.0	12	kV
Grid voltage	−655	−720	V
Grid resistor	625	720	Ω
Peak r.f. grid drive voltage	1455	1520	V
Anode current	5.85	5.85	A
Grid current (approx)	1.05	1.0	A
Anode dissipation	15.6	17.2	kW
Grid dissipation	735	720	W
Output power	37	53	kW
Efficiency	70	75.5	%
Load-resistance	700	1020	Ω

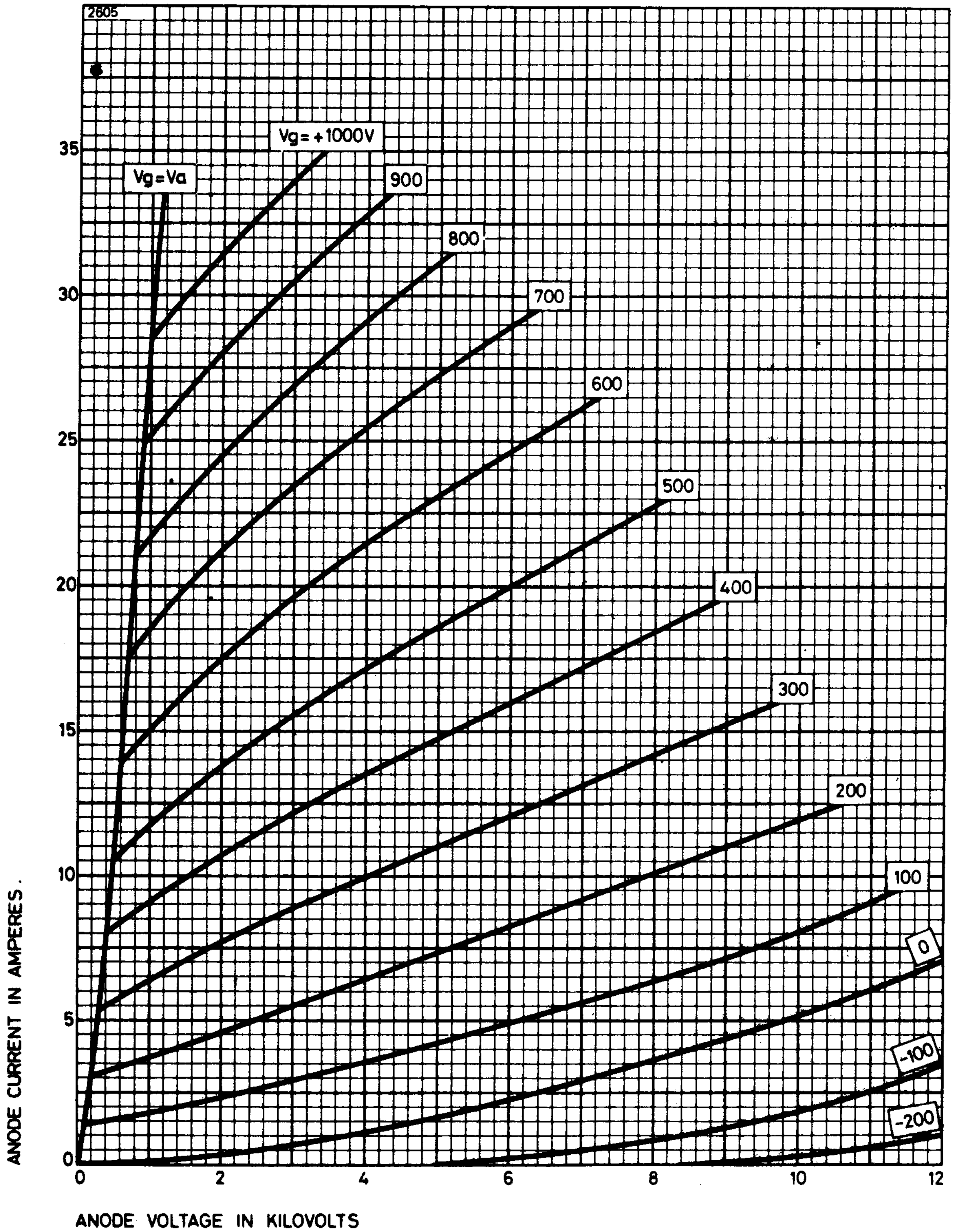
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 8.2V	207	253	A
Amplification factor (V_a = 9.0kV, I_a = 2.0A)	35.5	48.5	
Mutual conductance (V_a = 10kV, I_a = 1.5A)	15.5	24.5	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	340	V
Grid voltage (negative value) (V_a = 10kV, I_a = 2.0A)	95	135	V
Anode current (V_a = 2.0kV, V_g = +250V)	3.8	8.8	A
Grid current (V_a = 2.0kV, V_g = +250V)	0.25	–	A
Anode current (V_a = 4.0kV, V_g = +250V)	6.2	10.4	A
Grid current (V_a = 4.0kV, V_g = +250V)	–0.1	0.5	A
Inter-electrode capacitances:			
grid to anode	32	42	pF
grid to filament	44	54	pF

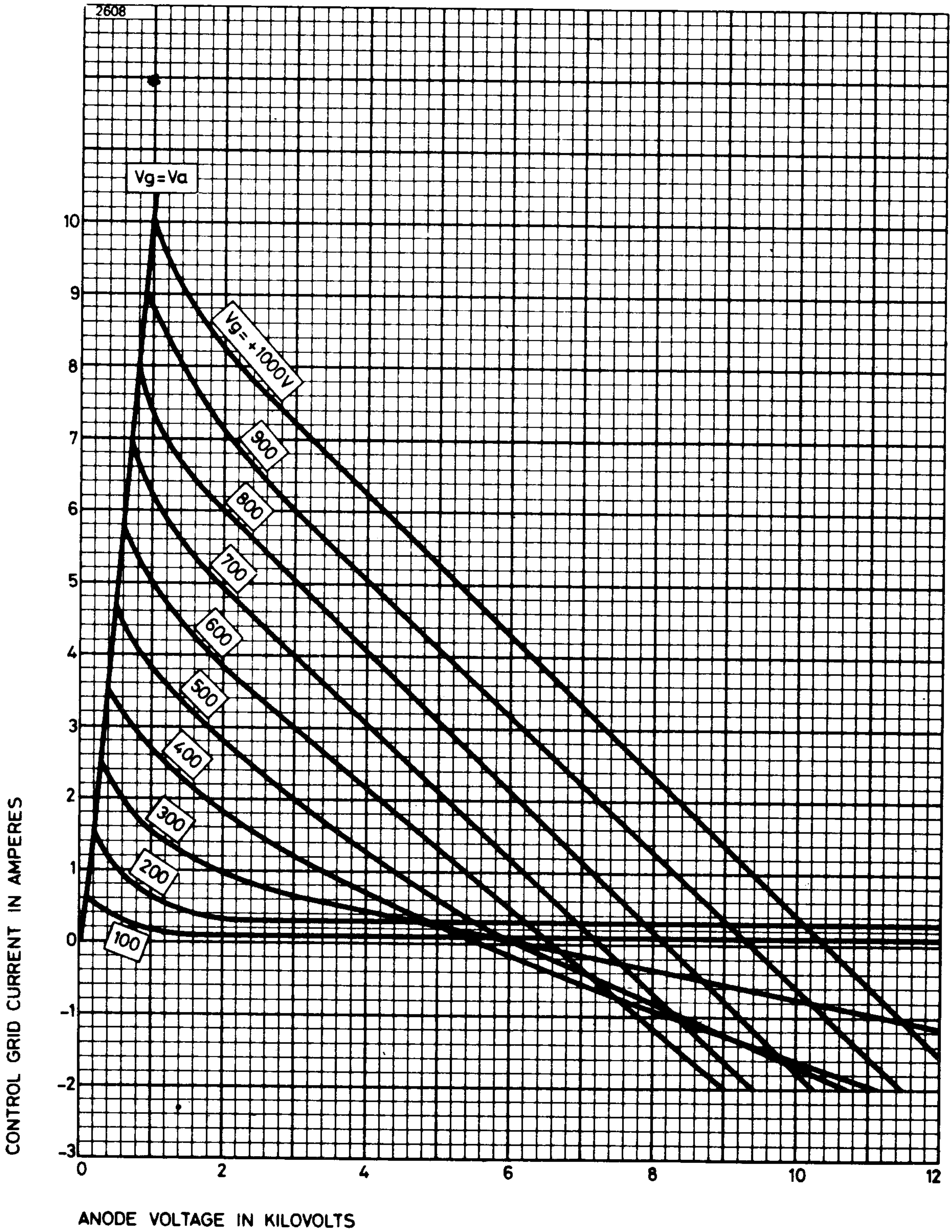
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed this value, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.

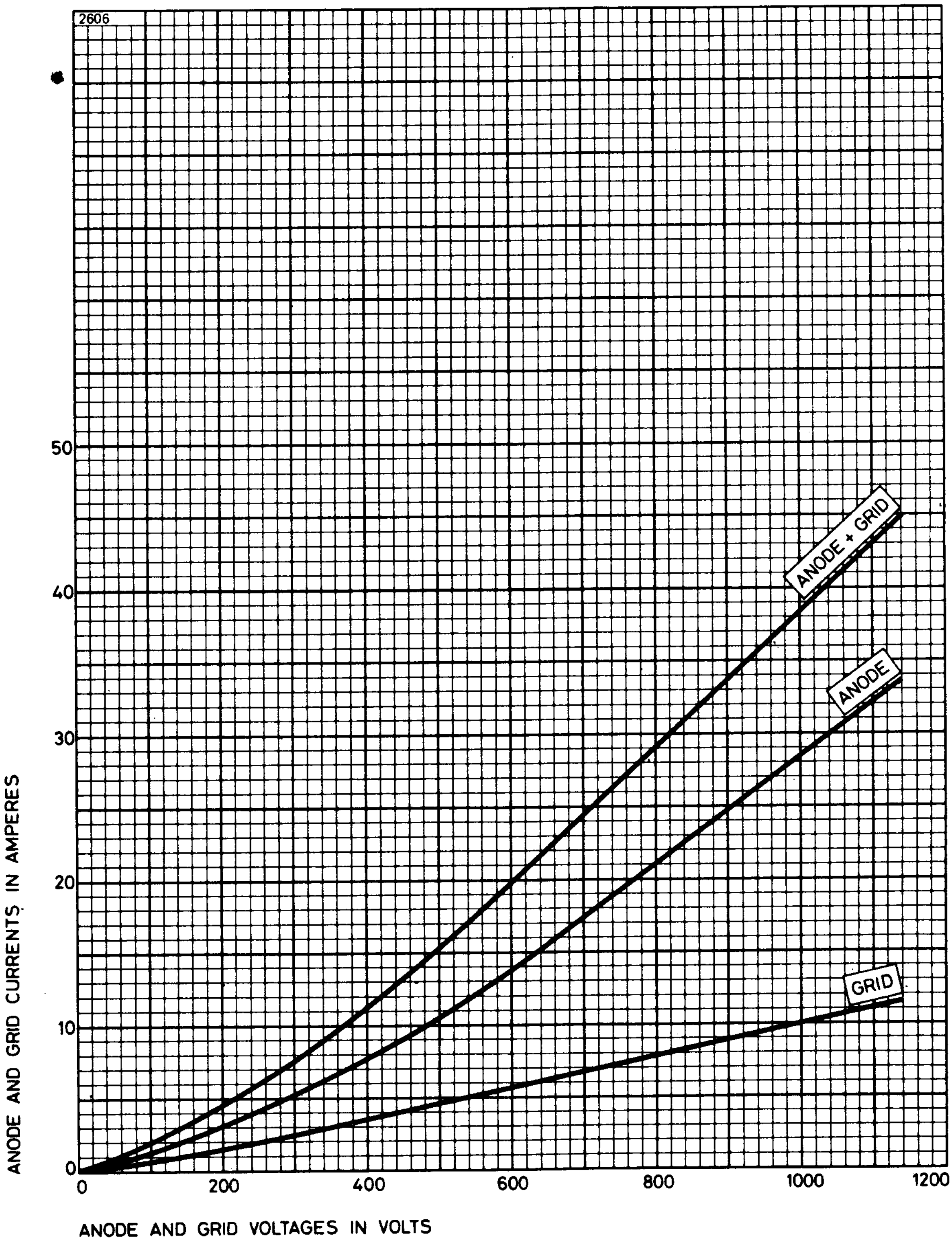
TYPICAL ANODE CHARACTERISTICS



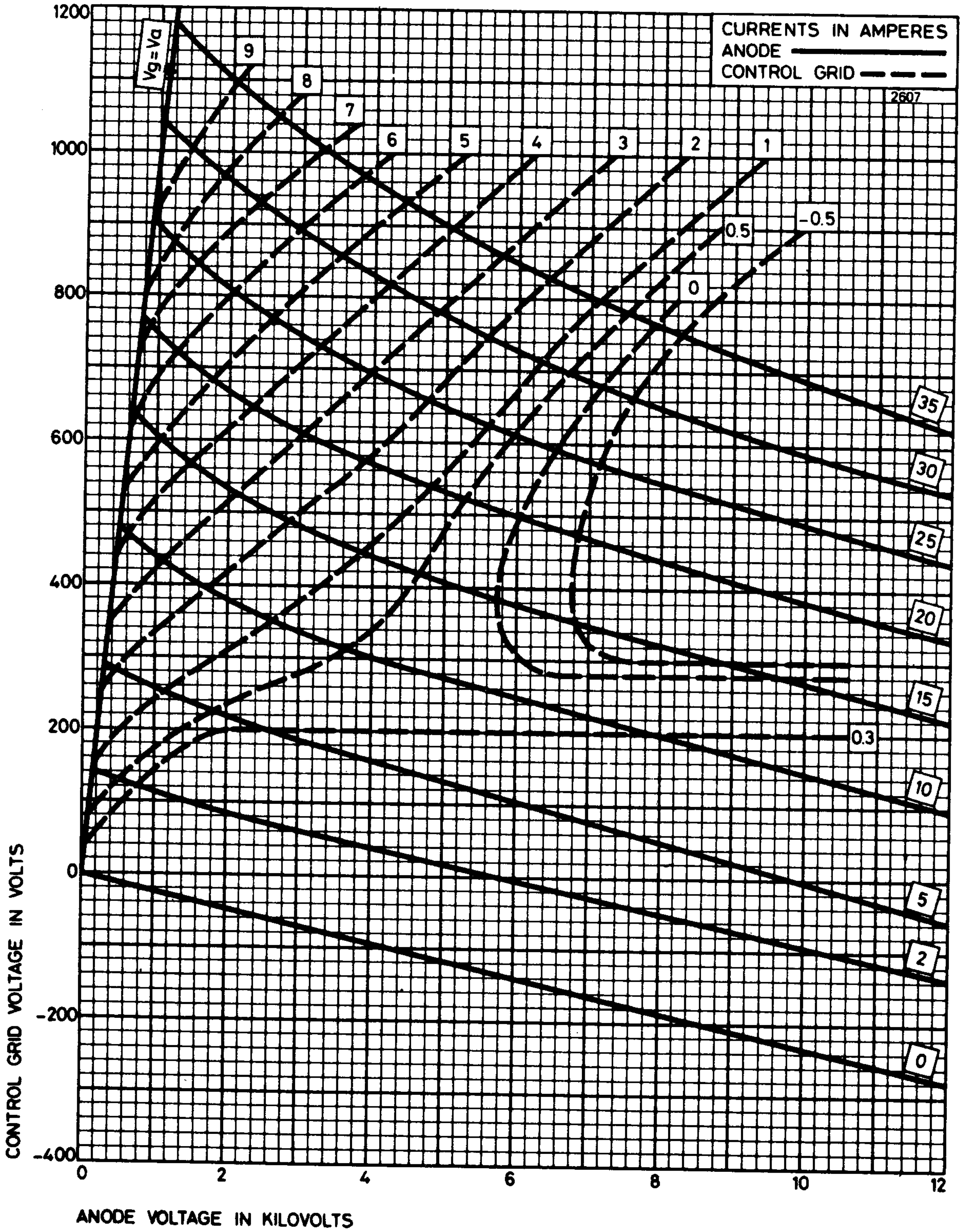
TYPICAL GRID CHARACTERISTICS



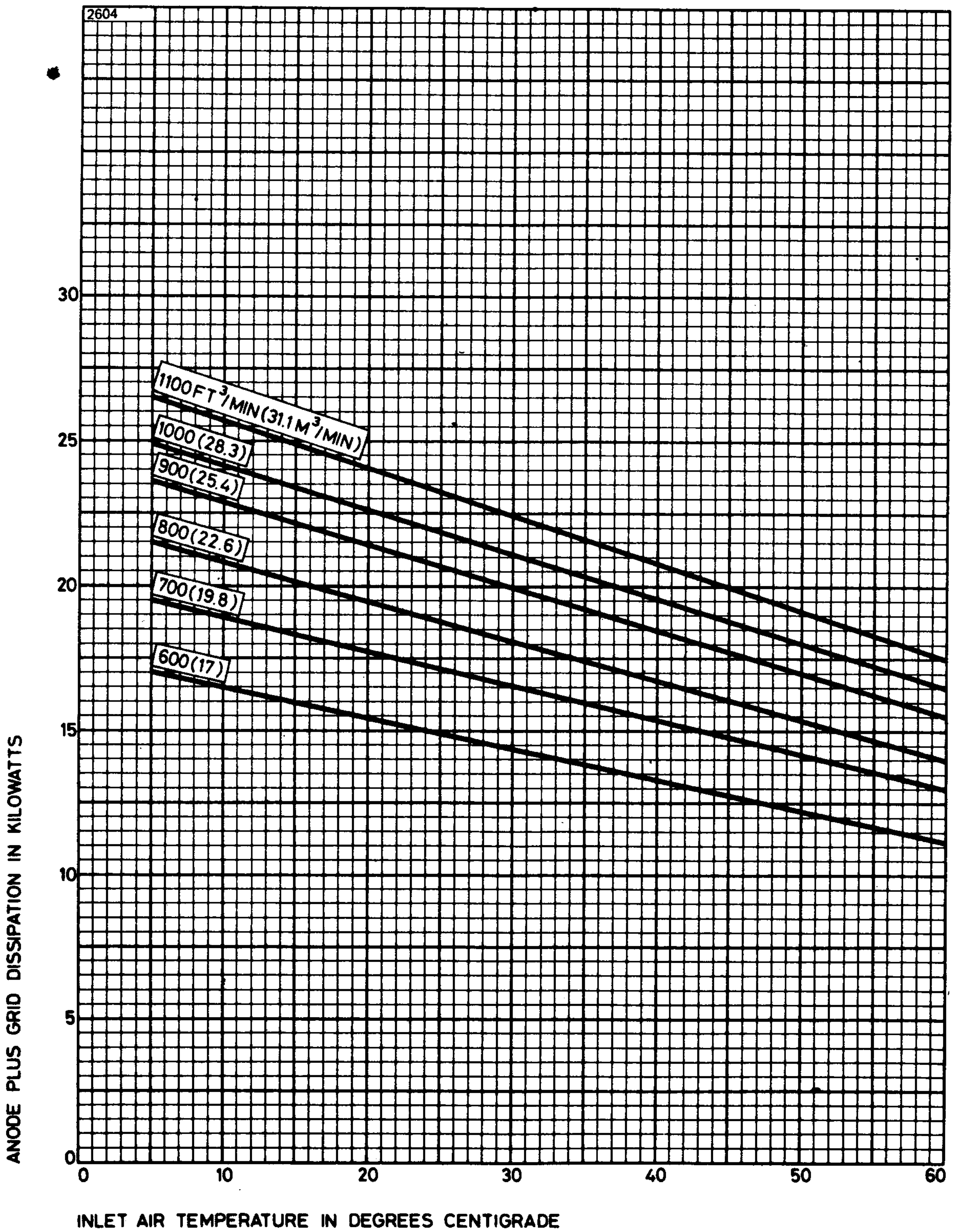
TYPICAL STRAPPED CHARACTERISTICS



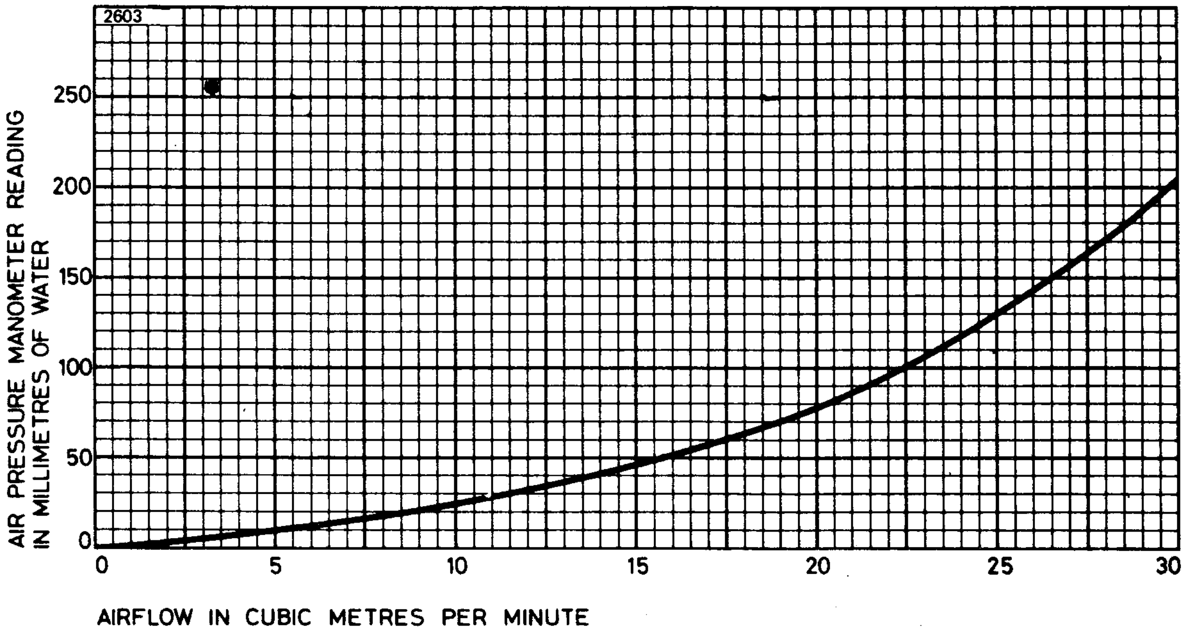
TYPICAL CONSTANT CURRENT CHARACTERISTICS

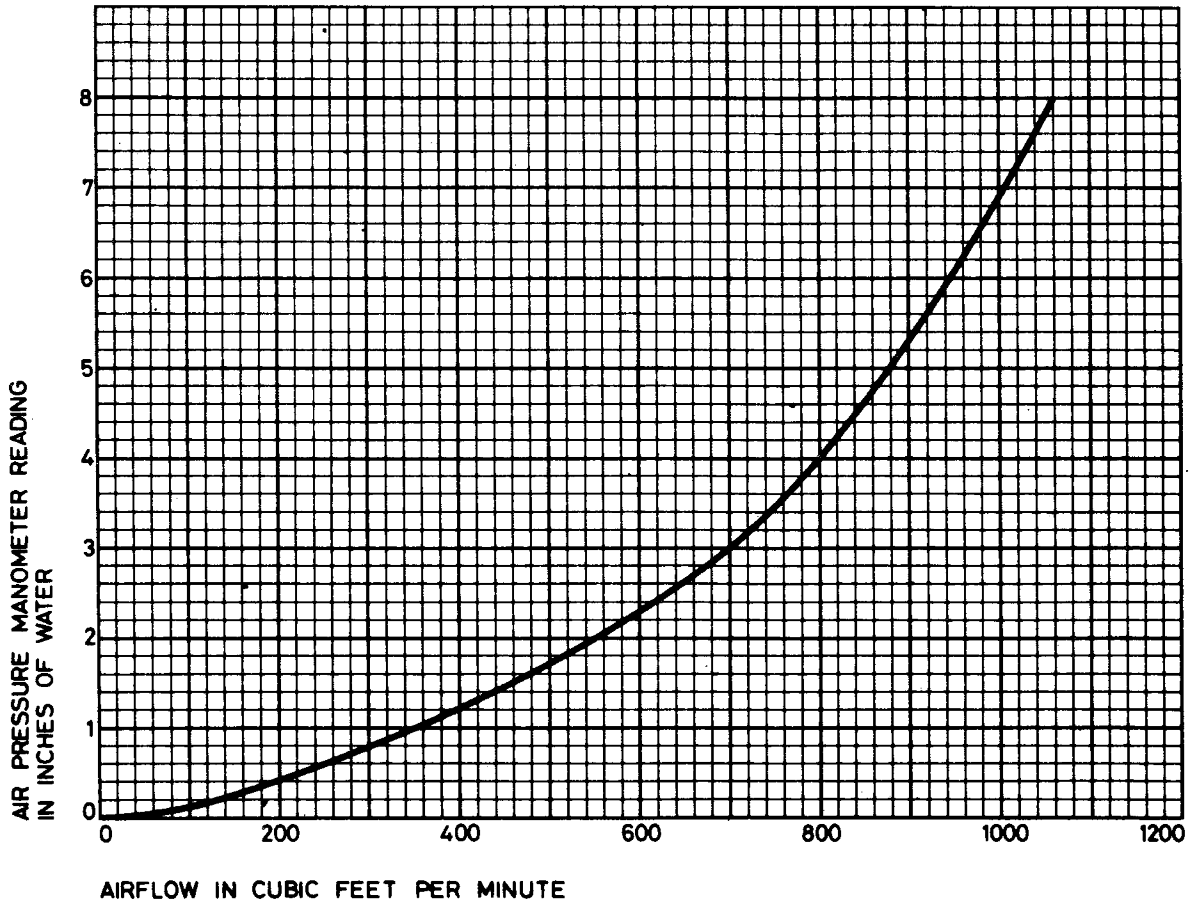


AIR COOLING REQUIREMENTS FOR BR1102



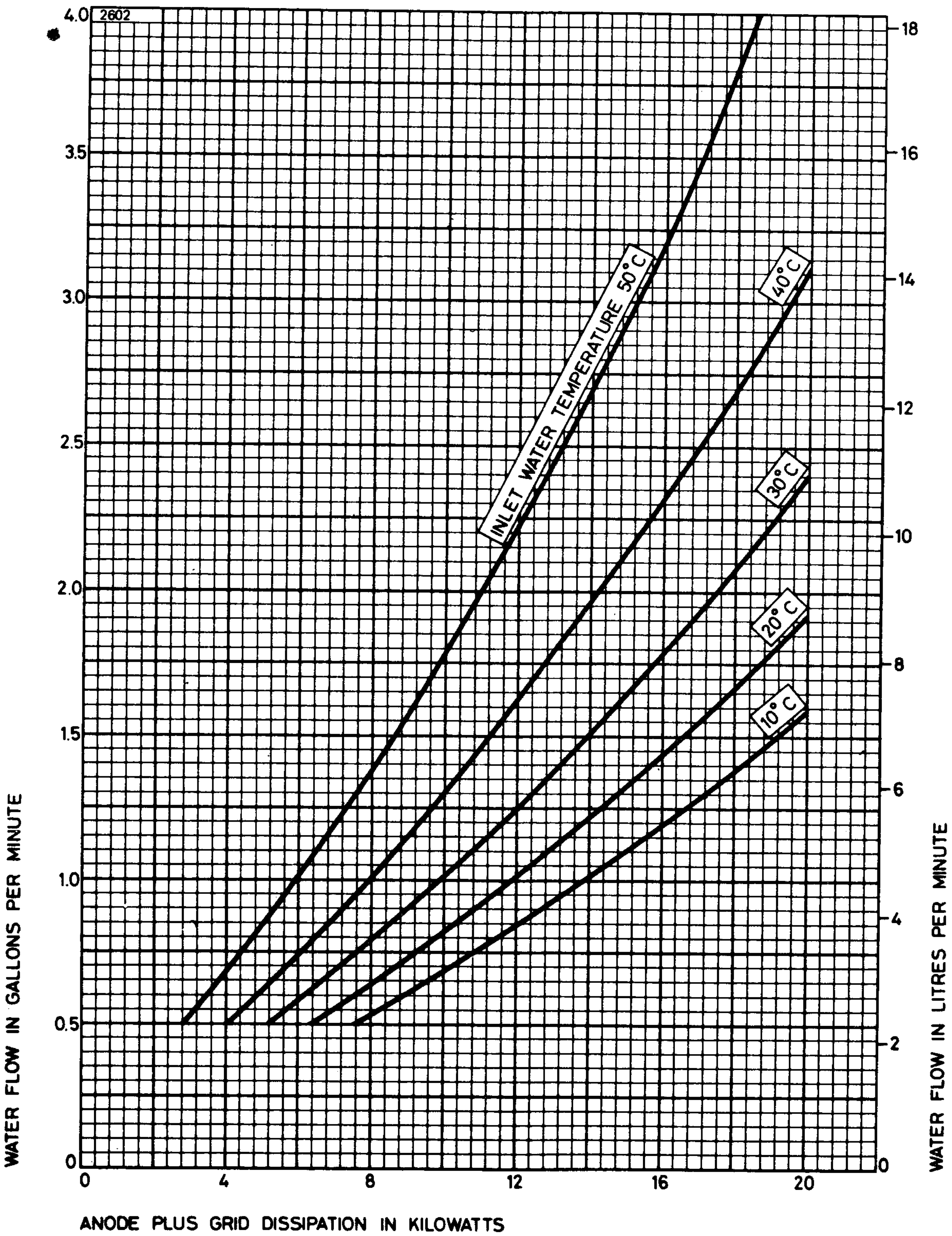
AIR FLOW CHARACTERISTIC FOR BR1102



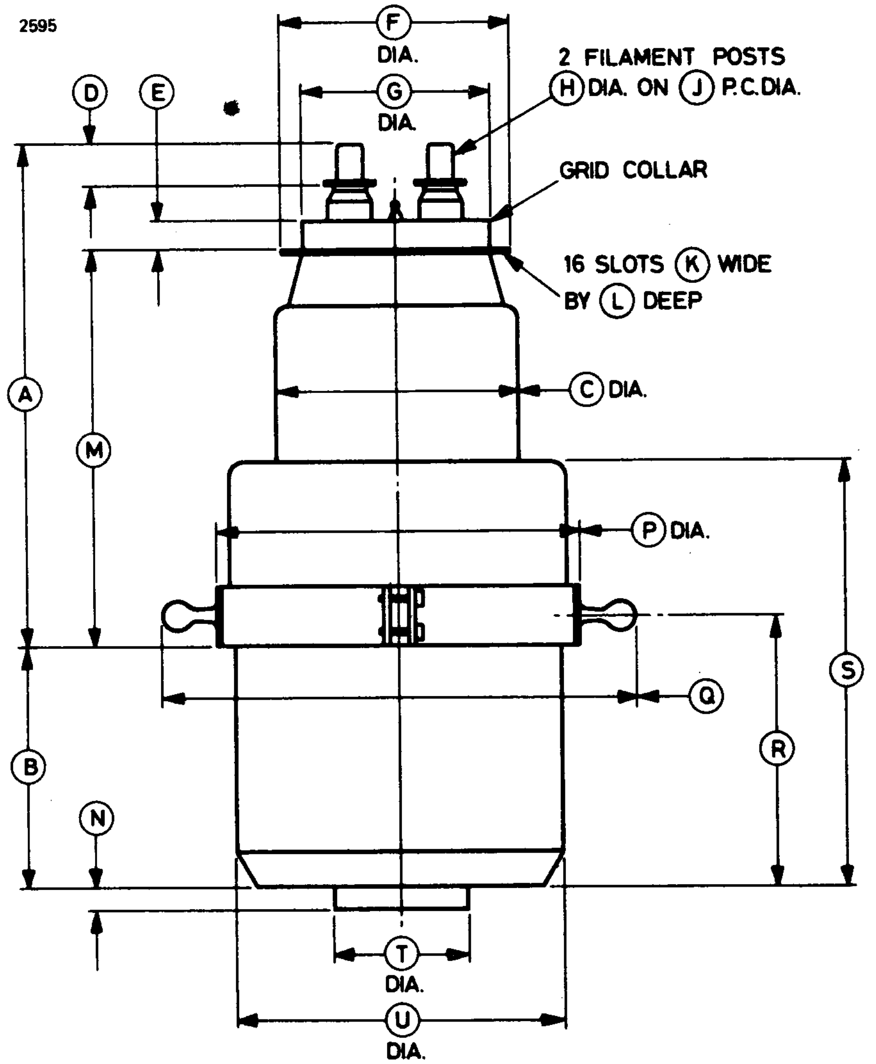


MINIMUM WATER COOLING REQUIREMENTS FOR BW1102J2

(Higher rates of flow should be used where possible)



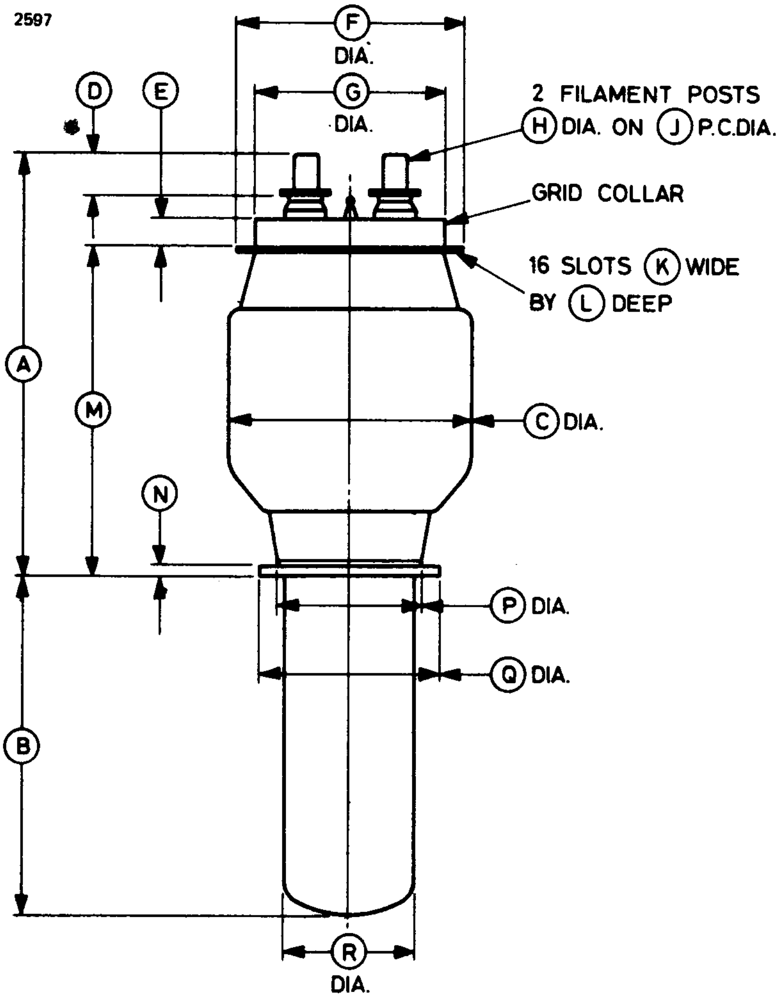
OUTLINE FOR BR1102



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	12.500 max	317.5 max	L	0.205	5.21
B	5.937	150.8	M	10.000 max	254.0 max
C	6.000 max	152.4 max	N	0.562	14.27
D	1.000	25.40	P	9.500 max	241.3 max
E	0.734	18.64	Q	11.813 max	300.1 max
F	5.630	143.0	R	6.687	169.8
G	4.703	119.5	S	10.437	265.1
H	0.625	15.88	T	3.570 max	90.68 max
J	2.250	57.15	U	8.375 max	212.7 max
K	0.153	3.89			

Millimetre dimensions have been derived from inches.

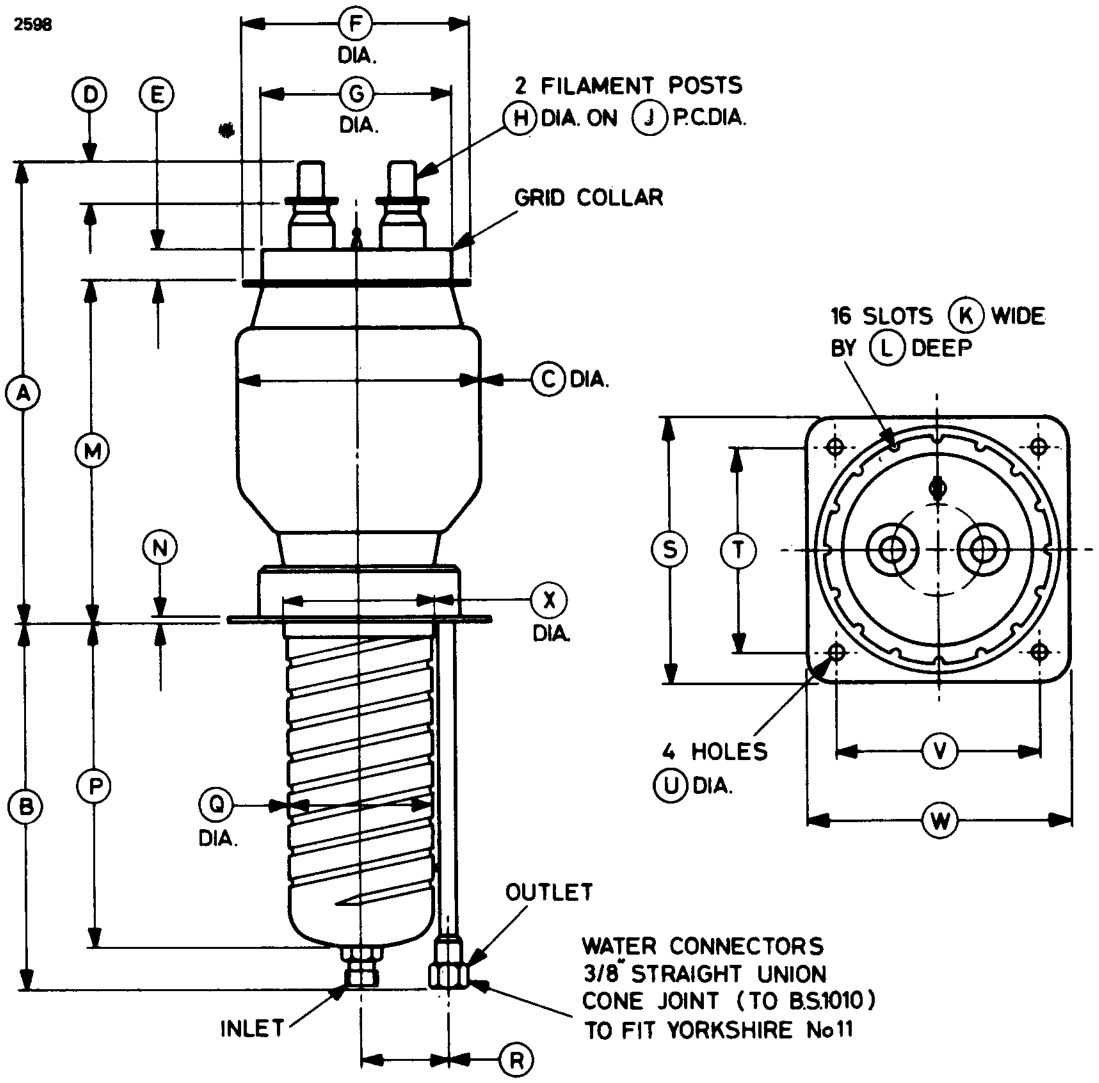
OUTLINE FOR BW1102



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.375 max	263.5 max	J	2.250	57.15
B	8.250	209.6	K	0.153	3.89
C	6.000 max	152.4 max	L	0.205	5.21
D	1.000	25.40	M	7.875 max	200.0 max
E	0.734	18.64	N	0.250	6.35
F	5.630	143.0	P	3.875	98.43
G	4.703	119.5	Q	4.500 max	114.3 max
H	0.625	15.88	R	3.250	82.55

Millimetre dimensions have been derived from inches.

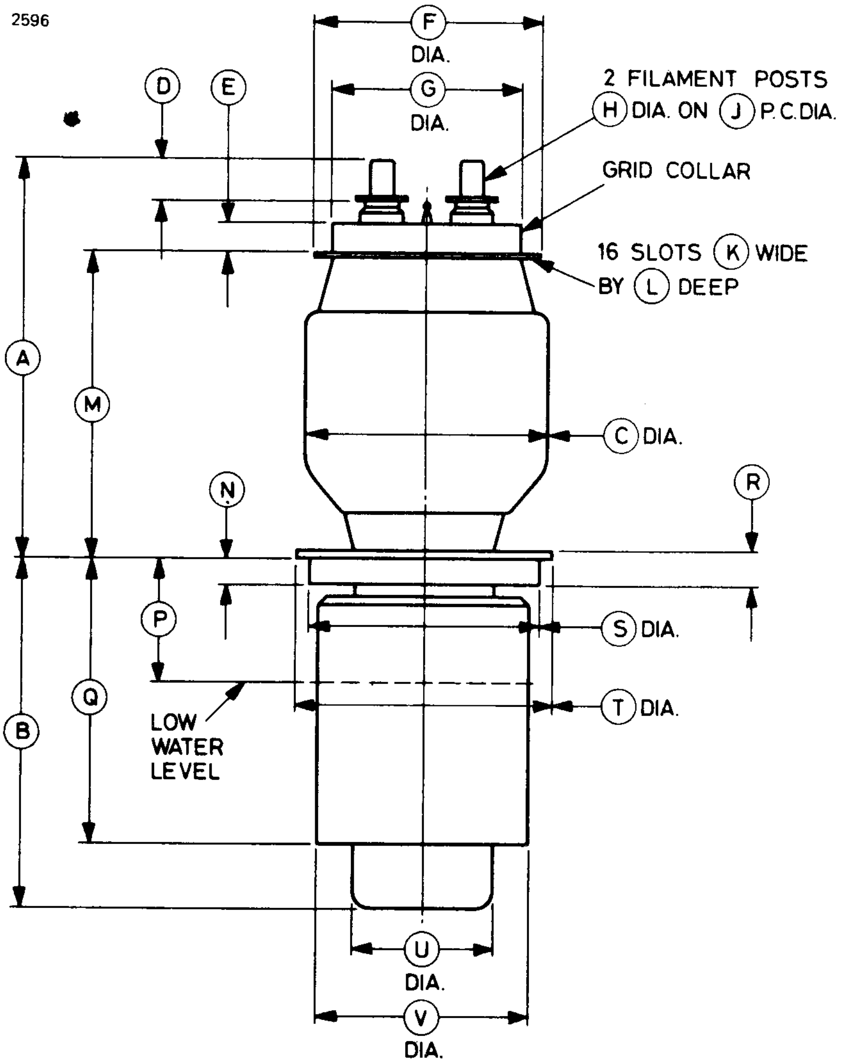
OUTLINE FOR BW1102J2



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.200 max	284.5 max	M	8.375	212.7
B	8.750	222.3	N	0.125	3.18
C	6.000 max	152.4 max	P	7.866	199.8
D	1.000	25.40	Q	3.562	90.47
E	0.734	18.64	R	2.000	50.80
F	5.630	143.0	S	6.500	165.1
G	4.703	119.5	T	5.000	127.0
H	0.625	15.88	U	0.375	9.53
J	2.250	57.15	V	5.000	127.0
K	0.153	3.89	W	6.500	165.1
L	0.205	5.21	X	4.000 max	101.6 max

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1102



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250 max	260.4 max	L	0.205	5.21
B	8.562 ± 0.062	217.5 ± 1.57	M	7.750 max	196.9 max
C	6.000 max	152.4 max	N	0.625	15.88
D	1.000	25.40	P	3.000	76.20
E	0.734	18.64	Q	6.937	176.2
F	5.630	143.0	R	0.875	22.23
G	4.703	119.5	S	5.750	146.1
H	0.625	15.88	T	6.375	161.9
J	2.250	57.15	U	3.500	88.90
K	0.153	3.89	V	5.312	134.9

Millimetre dimensions have been derived from inches.

BR1106

R.F. POWER TRIODE

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Forced-air cooled transmitting triode with grid terminal suitable for cathode drive operation.

Anode dissipation	10	kW max
Anode voltage	6.6	kV max
Frequency for full ratings	30	MHz max
Frequency at reduced ratings	220	MHz max
Output power (class C telegraphy)	15.5	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	5.0	V
Filament current	175	A
Surge filament current (peak) (see note 2)	400	A max
Filament cold resistance	3.8	mΩ
Peak usable cathode current	20	A
Perveance	2.0	$mA/V^{3/2}$
Amplification factor (V_a = 6.5kV, I_a = 1.0A)	30	
Mutual conductance (V_a = 5.0kV, I_a = 1.5A)	28	mA/V
Inter-electrode capacitances:		
grid to anode	24	pF
grid to filament	44	pF
anode to filament	0.75	pF

Mechanical

Overall length	11.062 inches (281mm) max
Overall diameter	6.406 inches (162.7mm) max
Net weight	18 pounds (8.2kg) approx
Mounting position	vertical, either way up

Accessories

Filament leads	MA131

COOLING

Anode

The air cooling requirements are shown on pages 8 and 9. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20ft^3/min (0.57m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER OR OSCILLATOR

(Class C telegraphy, key down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see page 3)	6.6	kV max
Anode dissipation	10	kW max
Grid dissipation	300	W max
Operating frequency		see page 3

TYPICAL OPERATING CONDITIONS (below 30MHz)

Anode voltage	6.0	kV
Grid voltage	430	V
Peak r.f. grid drive voltage	830	V
Anode current	3.72	A
Grid current (approx)	0.44	A
Anode dissipation	6.82	kW
Grid dissipation	150	W
Output power	15.5	kW
Efficiency	69.5	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 5.0V . . .	162	185	A
Amplification factor (V_a = 6.5kV, I_a = 1.0A) .	26	34	
Mutual conductance (V_a = 5.0kV, I_a = 1.5A) .	24	32	mA/V
Anode current (V_a = 2.0kV, V_g = +200V) . .	7.9	9.1	A
Grid current (V_a = 2.0kV, V_g = +200V)	0	0.6	A
Inter-electrode capacitances:			
grid to anode	22	26.5	pF
grid to filament	41.75	45.75	pF
anode to filament	0.45	0.9	pF

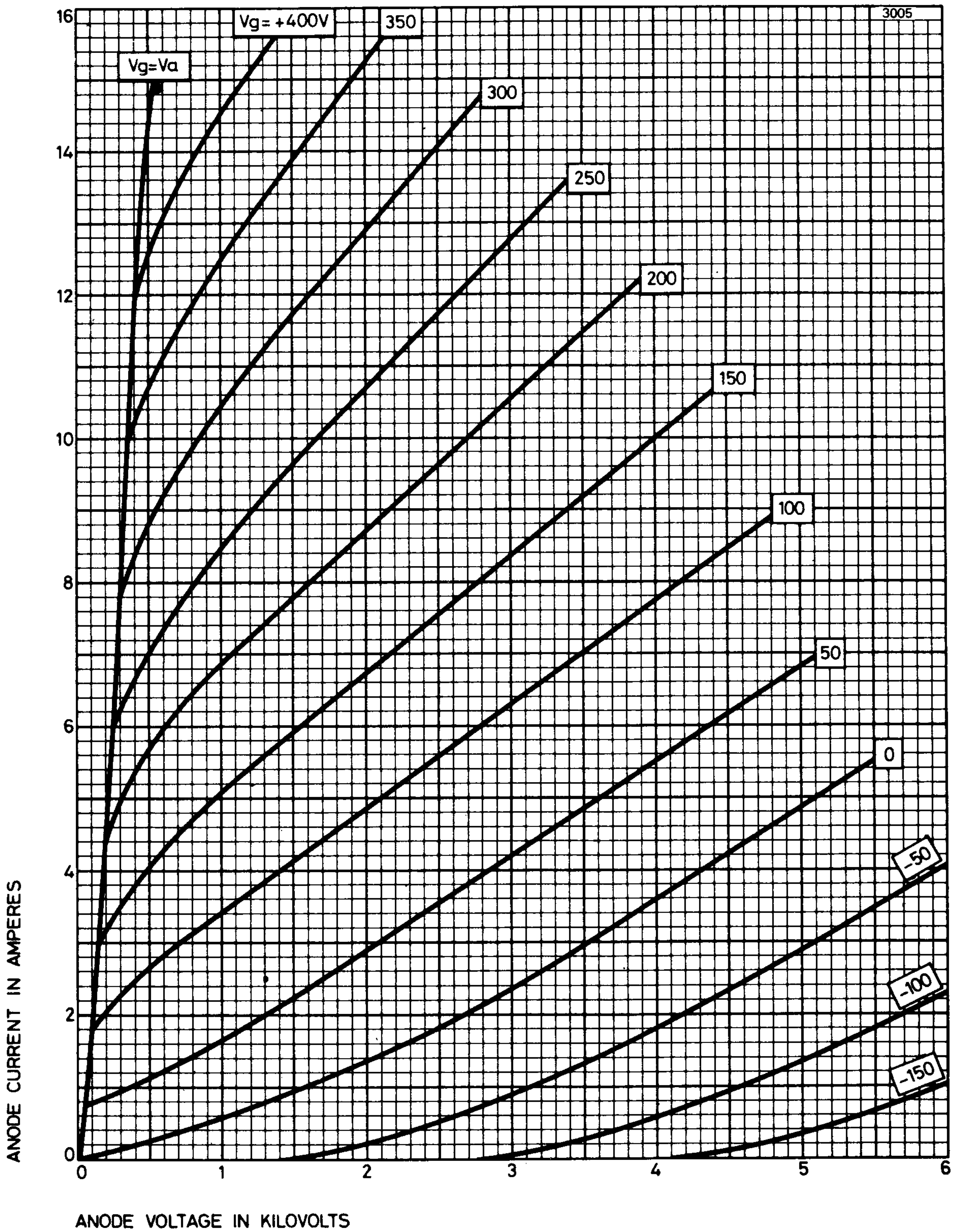
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
30	6.6	5.3
220	6.0	4.8

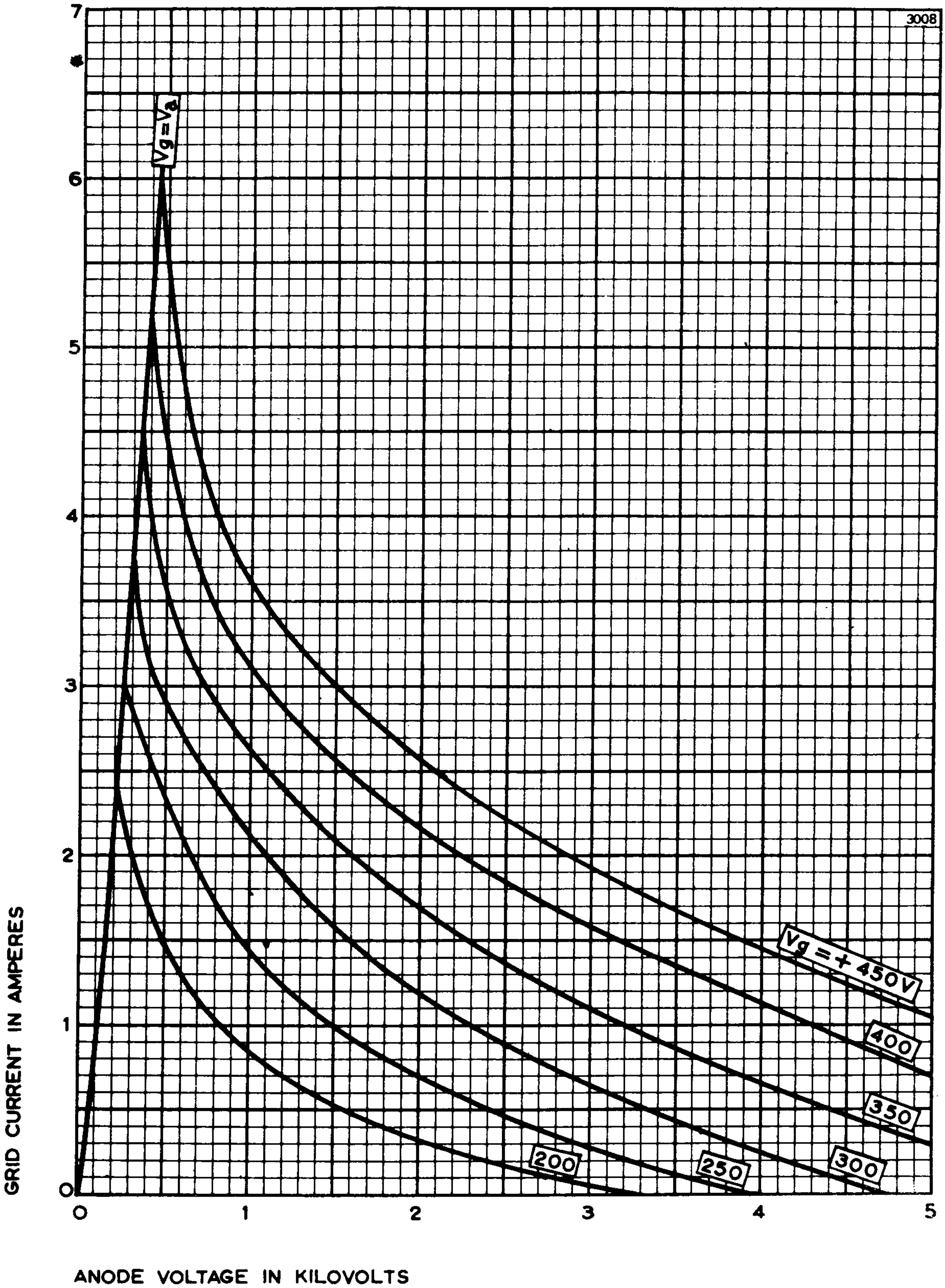
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 400A, even momentarily, at any time.

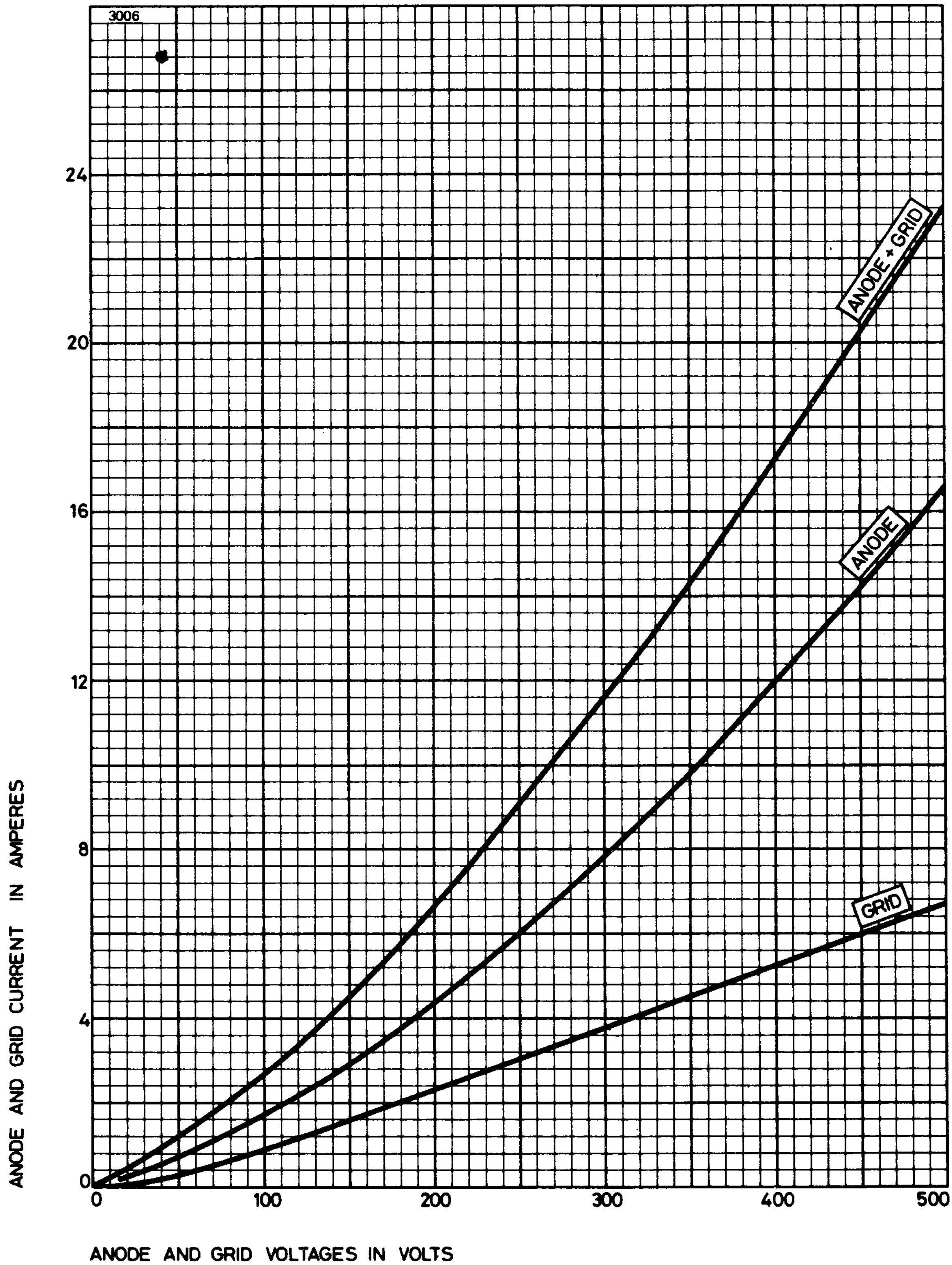
TYPICAL ANODE CHARACTERISTICS



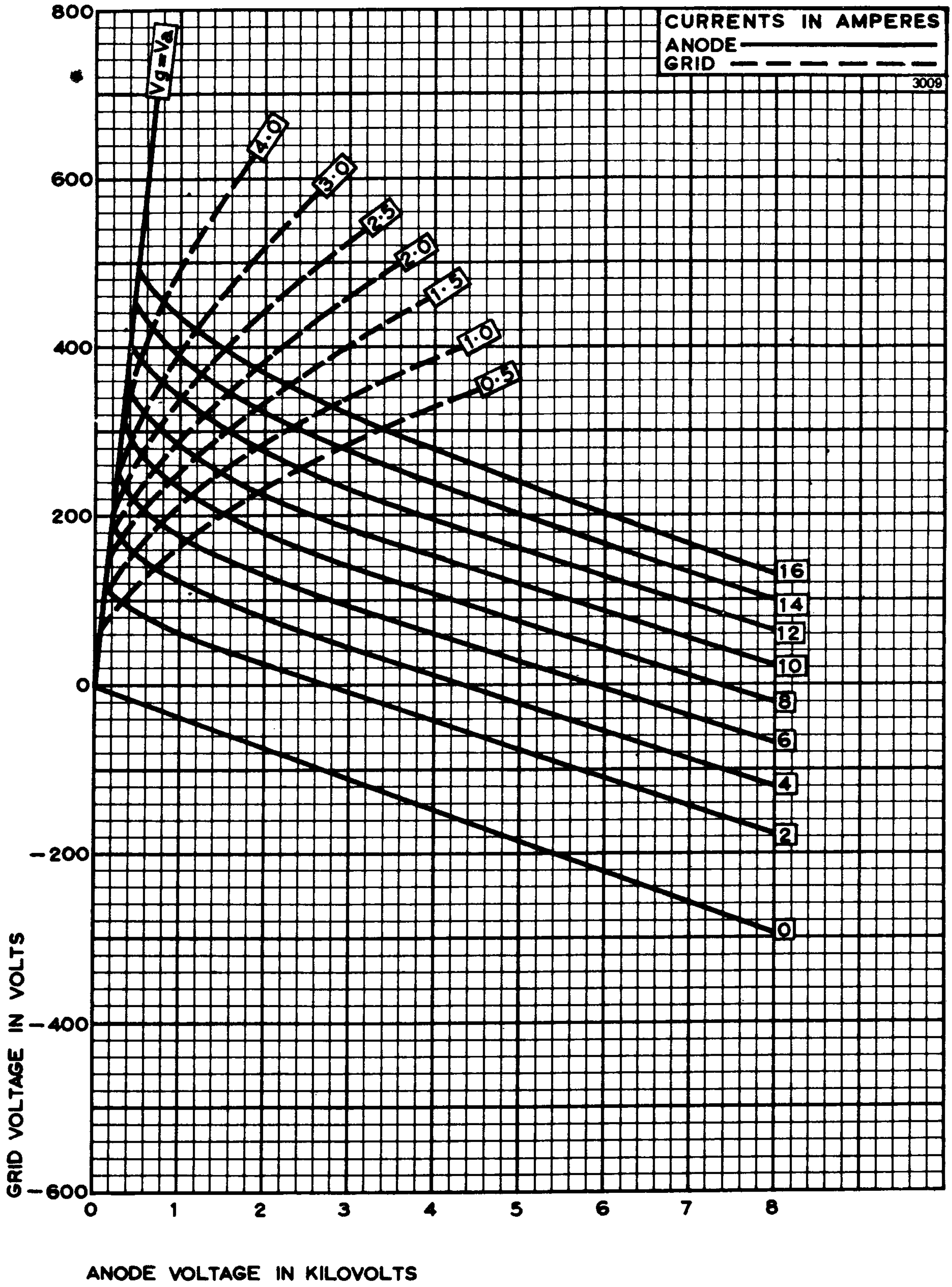
TYPICAL GRID CHARACTERISTICS



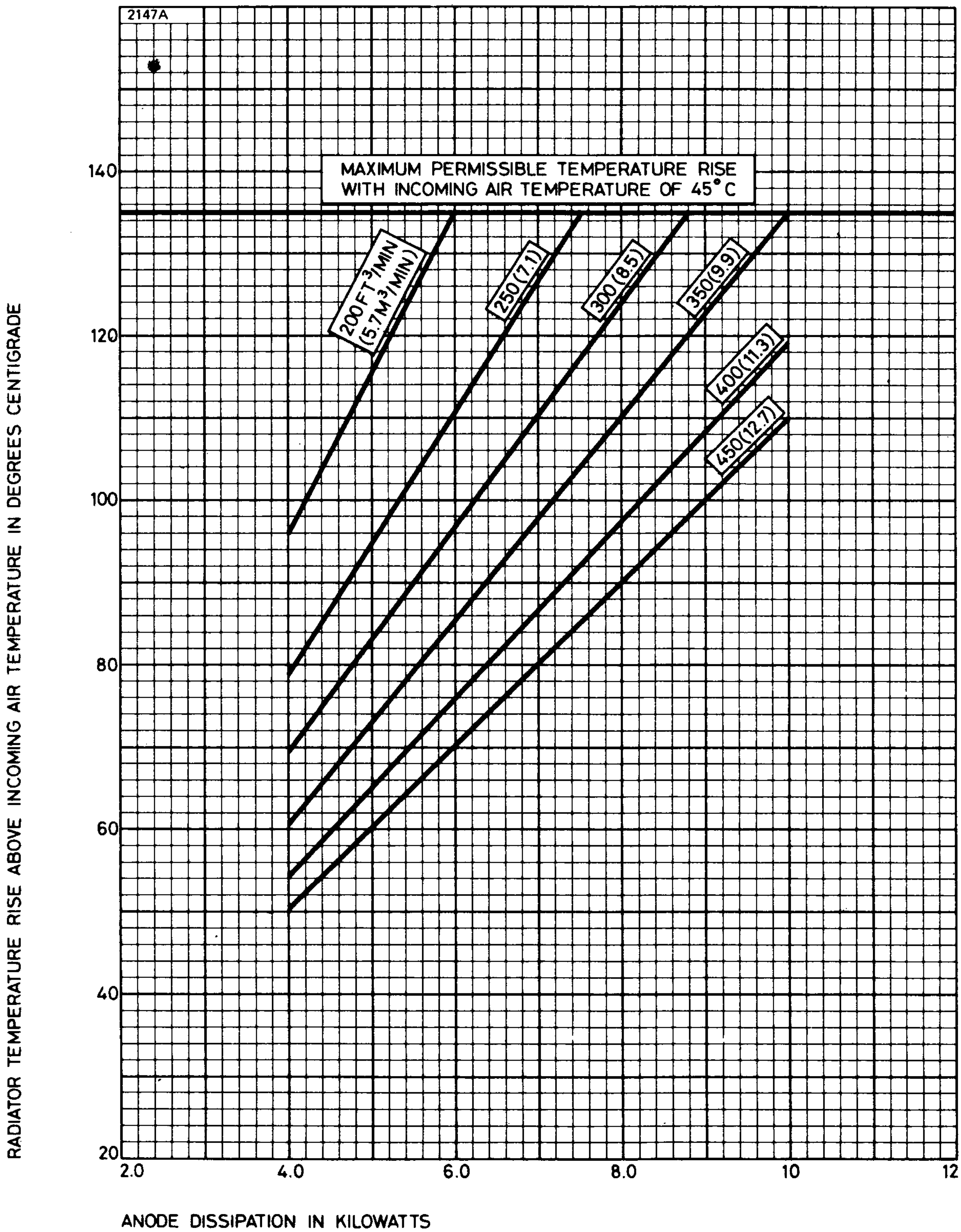
TYPICAL STRAPPED CHARACTERISTICS



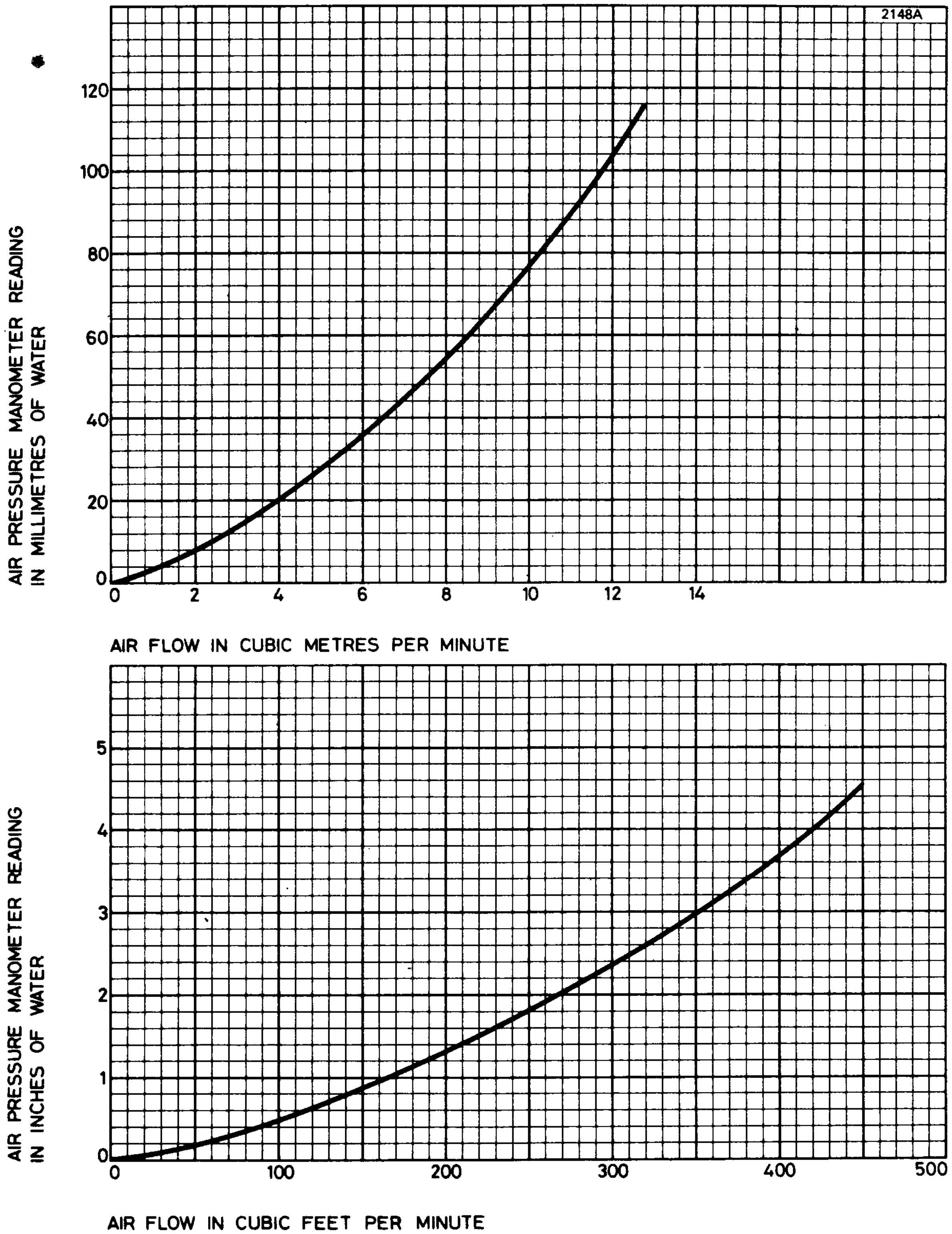
TYPICAL CONSTANT CURRENT CHARACTERISTICS



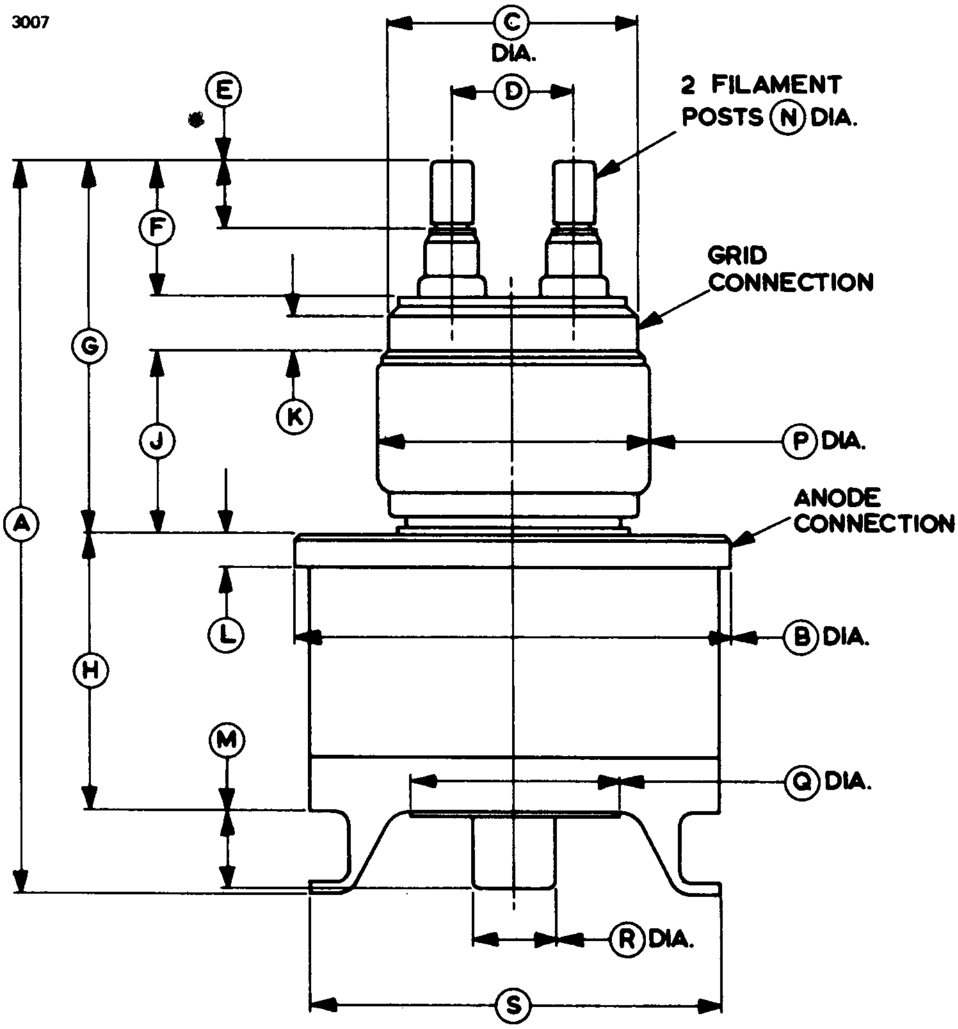
AIR COOLING REQUIREMENTS



TYPICAL AIR FLOW CHARACTERISTIC



OUTLINE



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.062 max	281.0 max	K	0.500 min	12.70 min
B	6.375 $\pm$ 0.031	161.9 $\pm$ 0.8	L	0.500 $\pm$ 0.031	12.70 $\pm$ 0.79
C	3.685 $\pm$ 0.025	93.60 $\pm$ 0.64	M	1.150 max	29.21 max
D	1.710 $\pm$ 0.040	43.43 $\pm$ 1.02	N	0.625 $\pm$ 0.002	15.875 $\pm$ 0.051
E	0.812 min	20.62 min	P	4.125 max	104.8 max
F	1.907 min	48.44 min	Q	3.375 max	85.73 max
G	5.421 $\pm$ 0.140	137.7 $\pm$ 3.6	R	1.187	30.15
H	4.094 max	104.0 max	S	6.000 $\pm$ 0.094	152.4 $\pm$ 2.4
J	2.656 $\pm$ 0.093	67.46 $\pm$ 2.36			

Millimetre dimensions have been derived from inches.

BR1115

R.F. POWER TRIODE

GENERAL

The BR1115 is a forced-air cooled triode designed primarily for industrial service. It is a maintenance type and therefore only abridged data are given on this sheet. **Full information is available on request.**

Filament	thoriated tungsten	
Filament voltage	15	V
Filament current	39	A
Peak usable cathode current	14	A
Perveance	2.0	$mA/V^{3/2}$
Amplification factor (V_a = 4.0kV, I_a = 1.0A)	30	
Mutual conductance (V_a = 4.0kV, I_a = 1.0A)	20	mA/V
Grid connector		MA66A

R.F. POWER AMPLIFIER OR OSCILLATOR

(Class C unmodulated conditions, one valve)

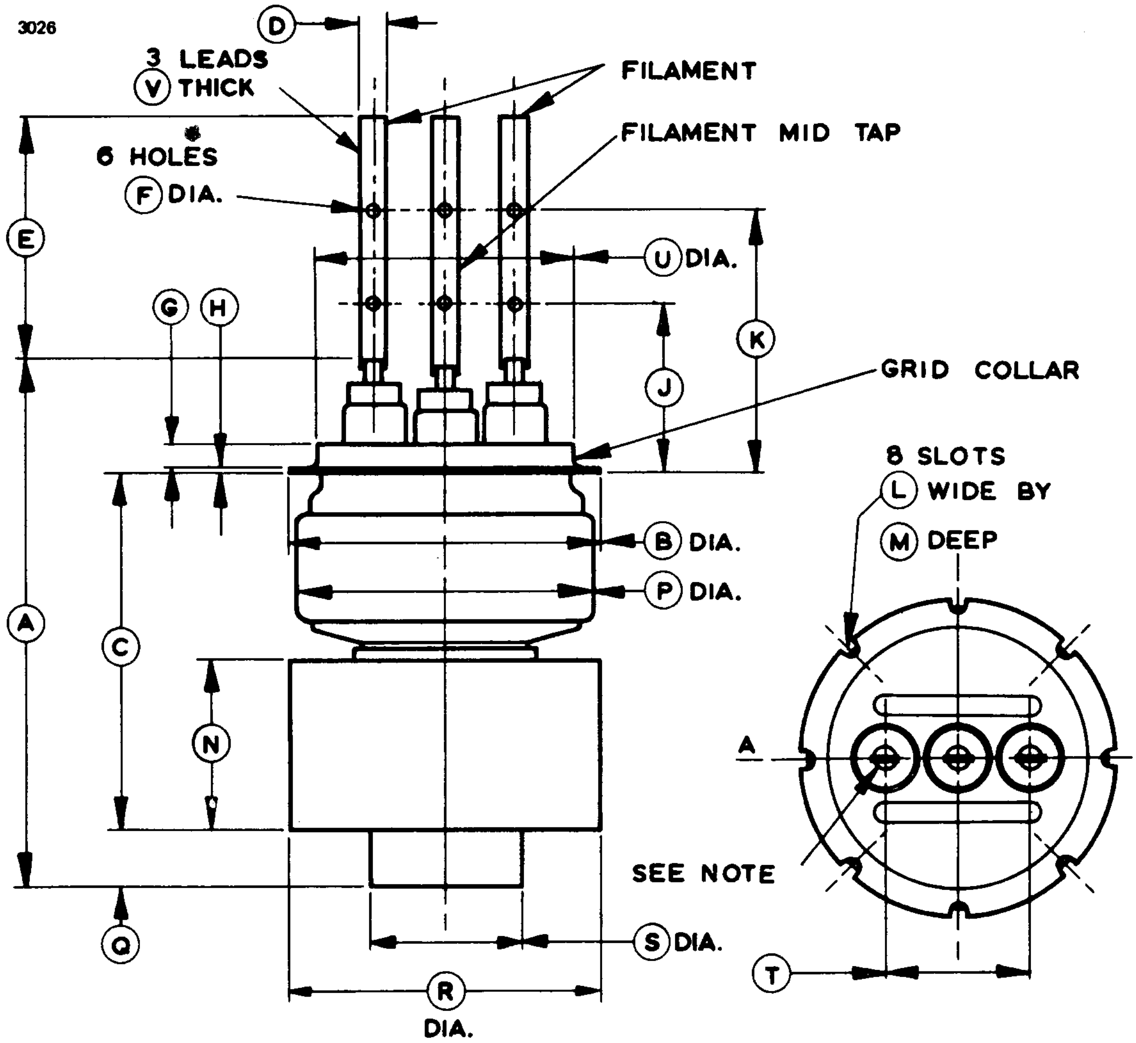
MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.75	A max
Anode dissipation	3.0	kW max
Grid voltage	−1.0	kV max
Grid current	0.35	A max

TYPICAL OPERATING CONDITIONS

Anode voltage	4.0	6.0	kV
Grid voltage	−300	−400	V
Grid resistor	880	1150	Ω
Peak r.f. grid drive voltage	550	660	V
Anode current	1.54	1.64	A
Grid current (approx)	0.342	0.347	A
Anode dissipation	2.22	2.7	kW
Grid dissipation	85	90	W
Driving power	188	229	W
Output power	3.94	7.15	kW
Efficiency	64	72	%
Load resistance	1065	1150	Ω

OUTLINE



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	200.0 max	7.874 max	L	4.62 ± 0.1	0.182 ± 0.004
B	116.0 ± 0.5	4.567 ± 0.020	M	5.2 ± 0.2	0.205 ± 0.008
C	133.5 ± 3.0	5.256 ± 0.118	N	70.0 max	2.756 max
D	8.0 ± 0.5	0.315 ± 0.020	P	116.0 max	4.567 max
E	89.0 ± 2.0	3.504 ± 0.079	Q	24.0 max	0.945 max
F	3.6 ± 0.1	0.142 ± 0.004	R	117.5 ± 1.5	4.626 ± 0.059
G	9.5	0.375	S	57.5 max	2.264 max
H	1.5 ± 0.2	0.059 ± 0.008	T	54.0 ± 2.5	2.126 ± 0.098
J	65.0 ± 8.0	2.559 ± 0.315	U	100.0 max	3.937 max
K	100.0 ± 8.0	3.937 ± 0.315	V	4 x 0.25	4 x 0.010

Inch dimensions have been derived from millimetres.

Note The plane of the filament leads will be parallel to plane A-A' to within 3½°.

BR/BW/BY1121 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Five r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling and in anode dissipation.

Anode cooling:		
BR1121		forced-air
BW1121		water; separate jacket
BW1121J1		water; integral jacket
BW1121J2		water; integral jacket
BY1121		vapour; separate boiler unit
Anode dissipation:		
BR1121, BW1121, BW1121J1, BW1121J2	15	kW max
BY1121	18	kW max
Anode voltage	10	kV max
Frequency for full ratings	50	MHz max
Output power (class C unmodulated conditions)	50	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	6.6	V
Filament current	230	A
Surge filament current (peak) (see note 2)	600	A max
Filament cold resistance	3.5	mΩ
Peak usable cathode current	45	A
Perveance	2.3	$mA/V^{3/2}$
Amplification factor (V_a = 6.0kV, I_a = 3.0A)	38	
Mutual conductance (V_a = 7.0kV, I_a = 3.0A)	45	mA/V
Inter-electrode capacitances:		
grid to anode	54	pF
grid to filament	85	pF
anode to filament	0.8	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1121	35 pounds (16kg) approx
BW1121	10 pounds (4.6kg) approx
BW1121J1, BW1121J2	14½ pounds (6.6kg) approx
BY1121	31 pounds (14.1kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA131
Grid connector	MA66
Water jacket for BW1121	BW4034
Sealing ring (supplied with BW1121)	MA251
Double boiler unit, integral condenser, for BY1121	BY4032
Single boiler unit, integral condenser, for BY1121	BY4033
Single boiler unit, separate condenser required, for BY1121	BY4063
Sealing ring (supplied with BY1121)	MA246

COOLING

Anode

The BR1121 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW1121 must be fitted into a water jacket for cooling, the recommended jacket being type BW4034. Minimum water cooling requirements for the BW1121 in a BW4034 water jacket are shown on page 11. The rates of flow given apply to valves with clean anode surfaces; higher values should be used where possible.

Types BW1121J1 and BW1121J2 have integral water jackets and differ only in the location of the water inlet and outlet connectors (see outline drawings, pages 14 and 15). Minimum water cooling requirements are shown on page 11; higher rates of flow should be used where possible.

The BY1121 is vapour cooled and may be operated either singly in boiler unit BY4033 or BY4063, or in pairs in boiler unit BY4032. In BY4032 and BY4033, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4063 is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperatures of the seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	10	kV max
Anode current	6.5	A max
Anode dissipation:		
BR1121, BW1121, BW1121J1, BW1121J2	15	kW max
BY1121	18	kW max
Grid dissipation	1.0	kW max
Frequency (for full ratings)	50	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	8.0	10	kV
Grid voltage	–420	–470	V
from grid resistor	510	746	Ω
Peak r.f. grid drive voltage	890	930	V
Anode current	6.4	6.4	A
Grid current (approx)	0.82	0.63	A
Anode dissipation	11.2	13	kW
Grid dissipation	386	290	W
Driving power	730	585	W
Output power	40	51	kW
Efficiency	78	80	%
Load resistance	665	830	Ω

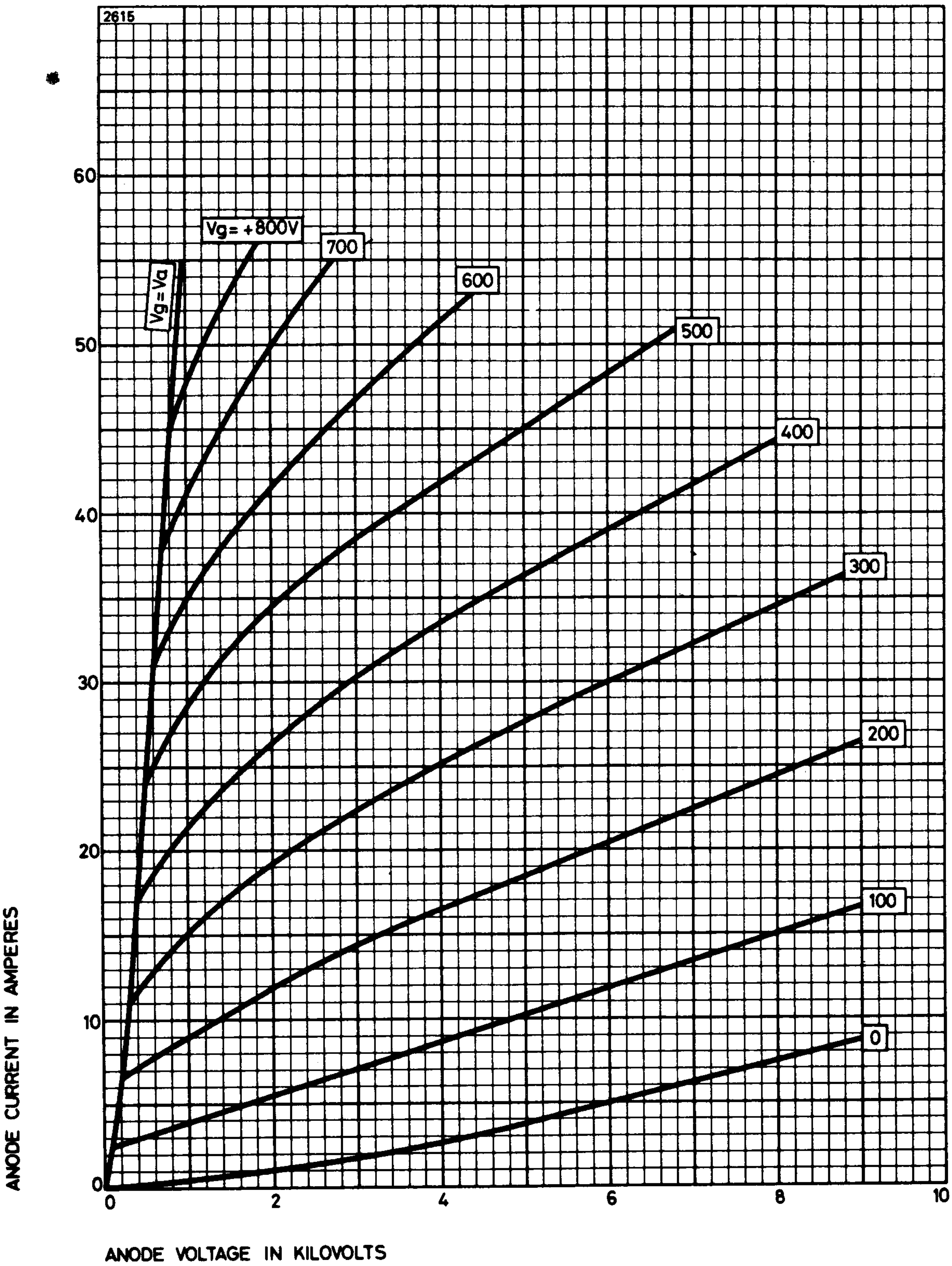
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 6.6V	216	244	A
Amplification factor (V_a = 6.0kV, I_a = 3.0A)	33	45	
Mutual conductance (V_a = 7.0kV, I_a = 3.0A)	40	50	mA/V
Grid voltage (negative value) (V_a = 6.0kV, I_a = 0.1A)	–	200	V
Anode current (V_a = 1.5kV, V_g = +600V)	31	40	A
Grid current (V_a = 1.5kV, V_g = +600V)	5.0	8.0	A

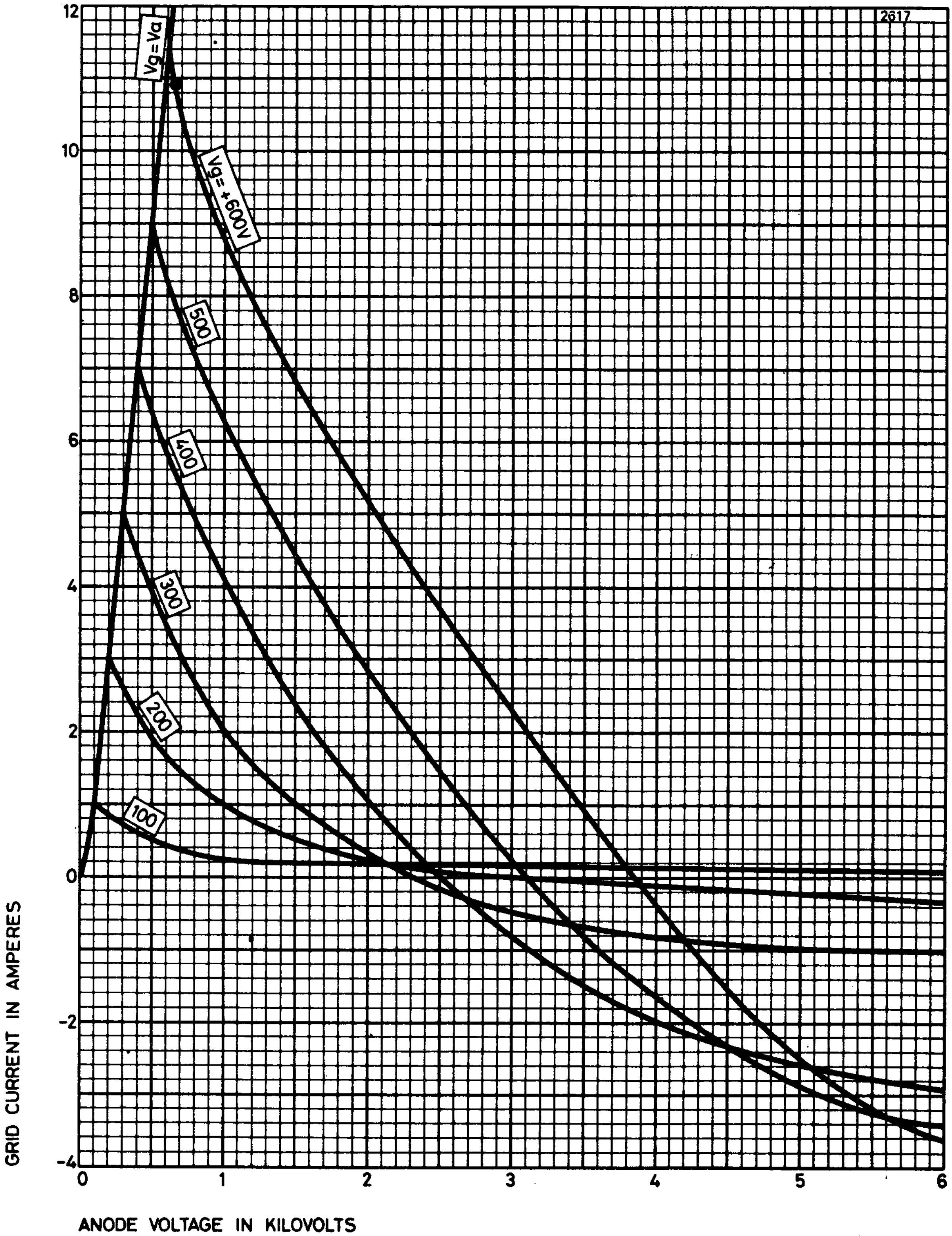
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.

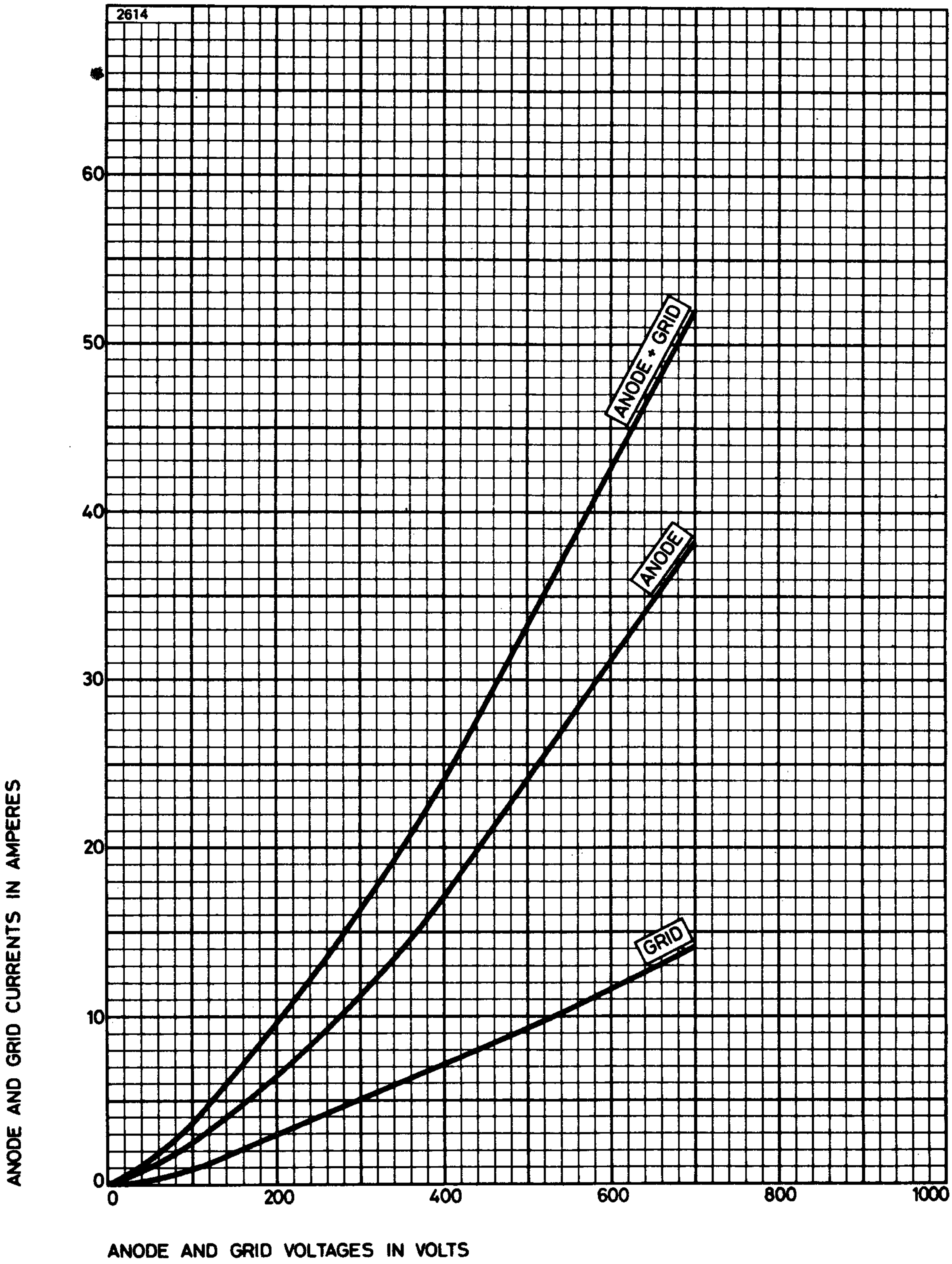
TYPICAL ANODE CHARACTERISTICS



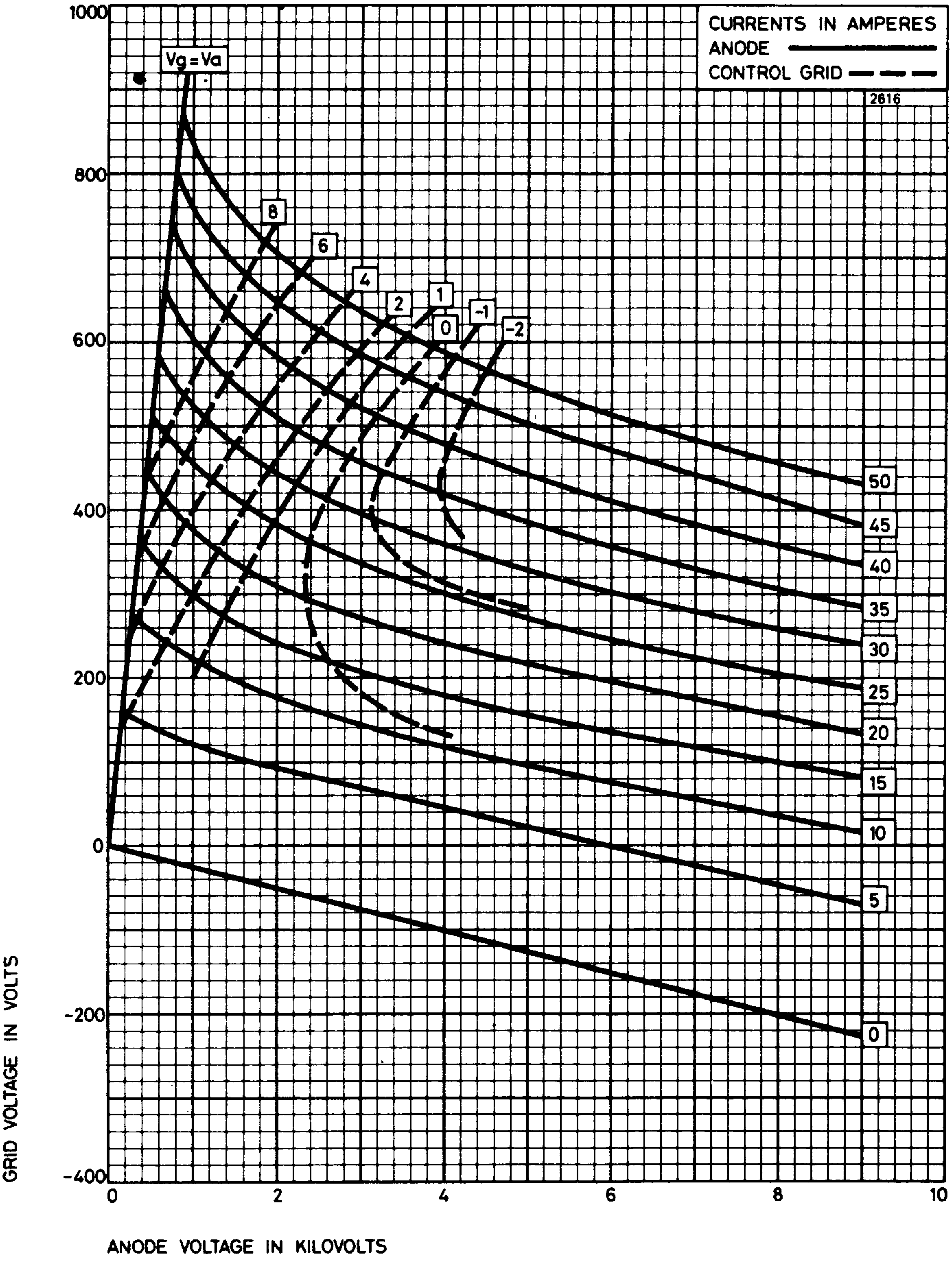
TYPICAL GRID CHARACTERISTICS



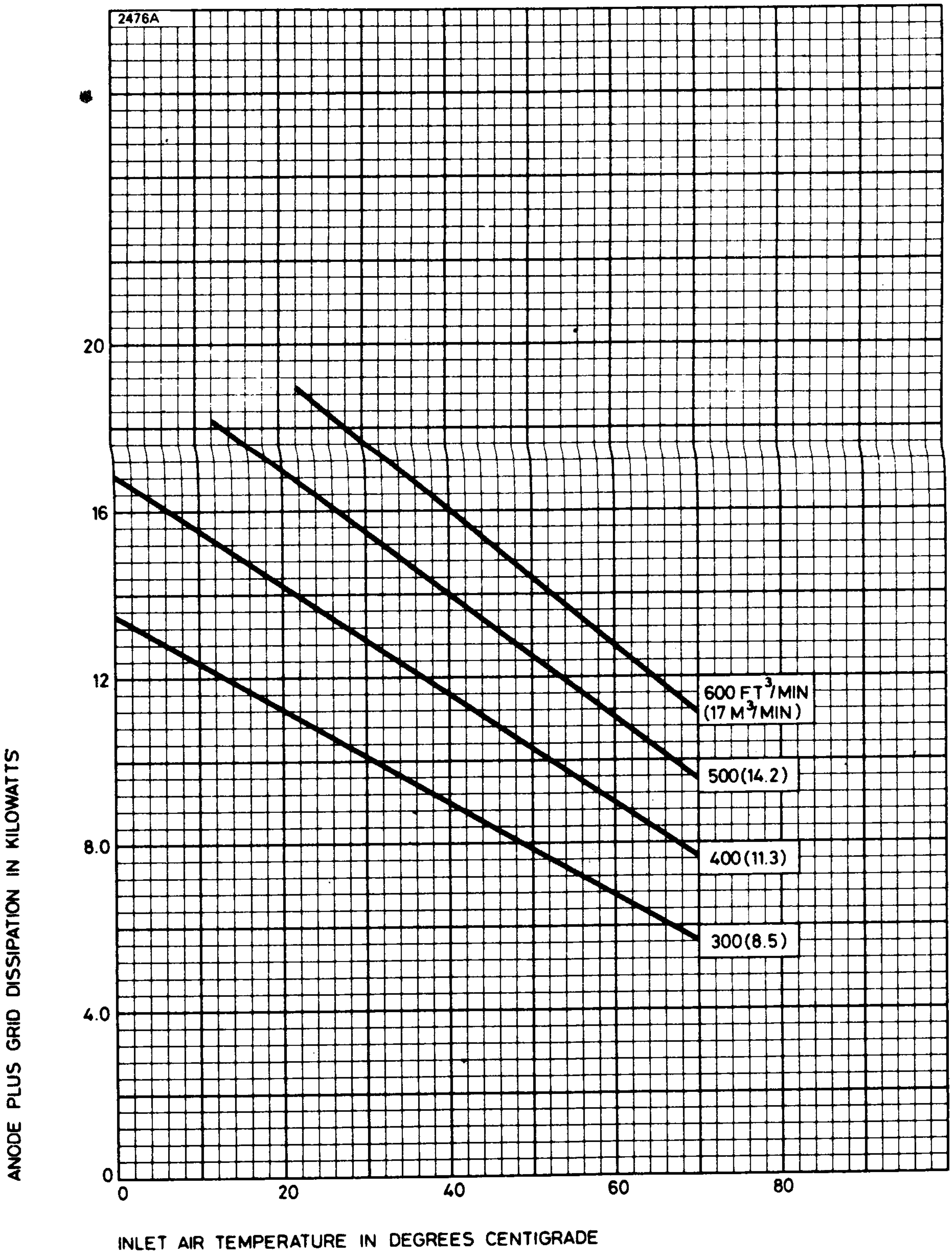
TYPICAL STRAPPED CHARACTERISTICS



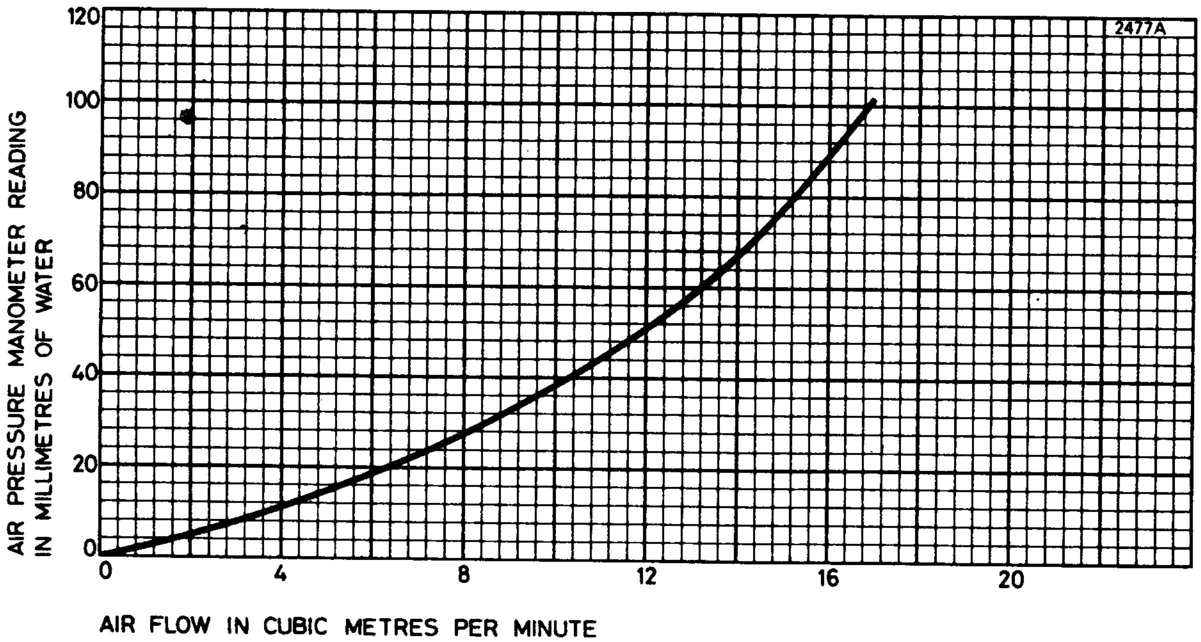
TYPICAL CONSTANT CURRENT CHARACTERISTICS

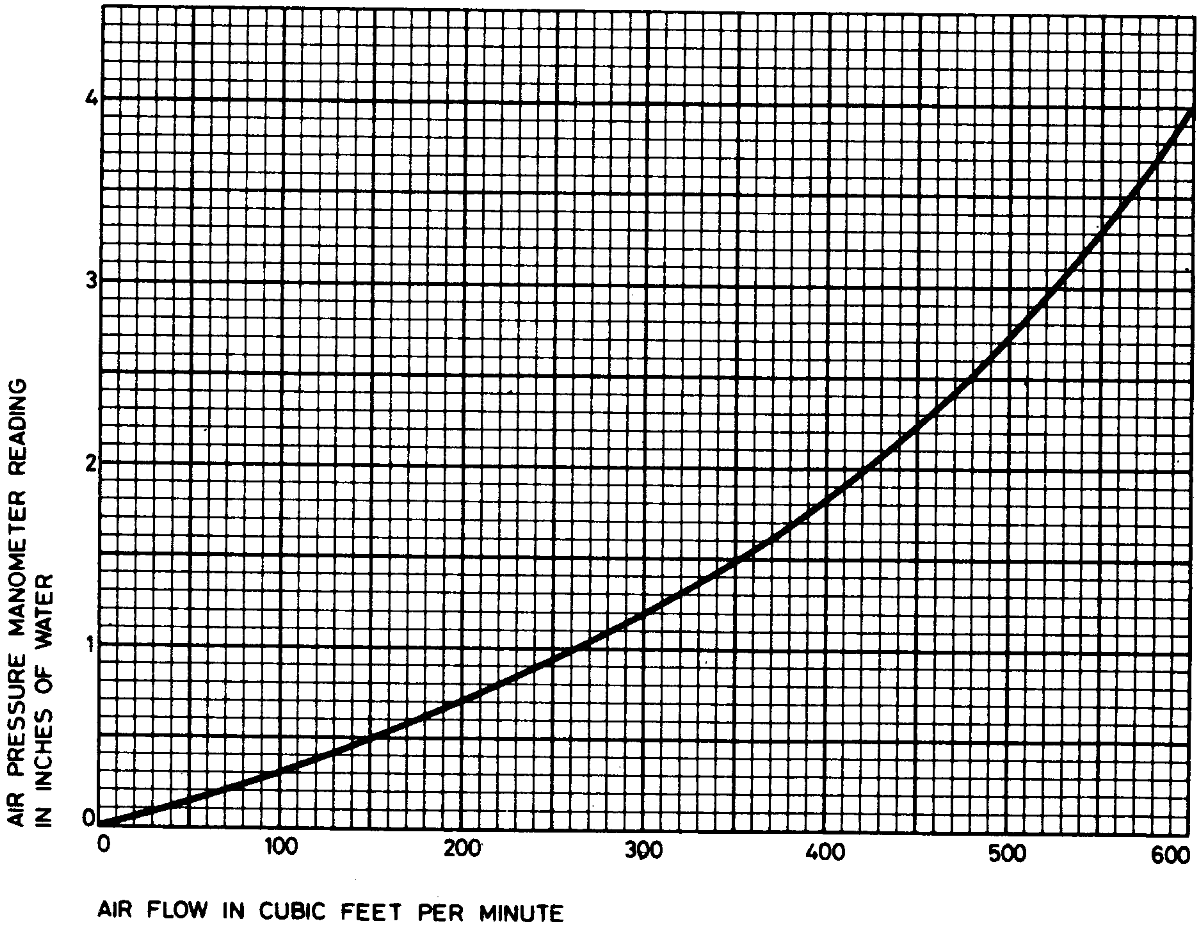


AIR COOLING REQUIREMENTS FOR BR1121



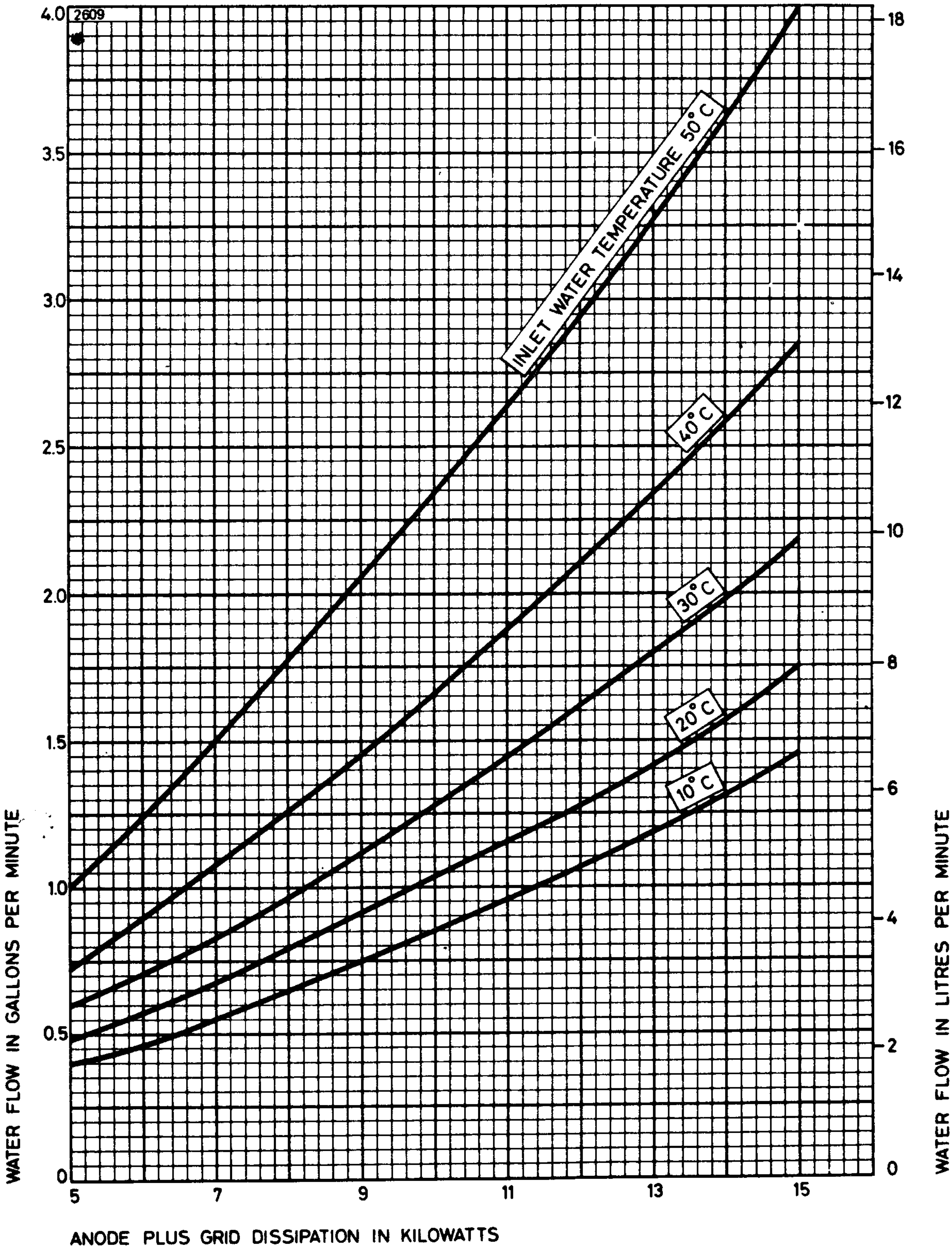
AIR FLOW CHARACTERISTIC FOR BR1121



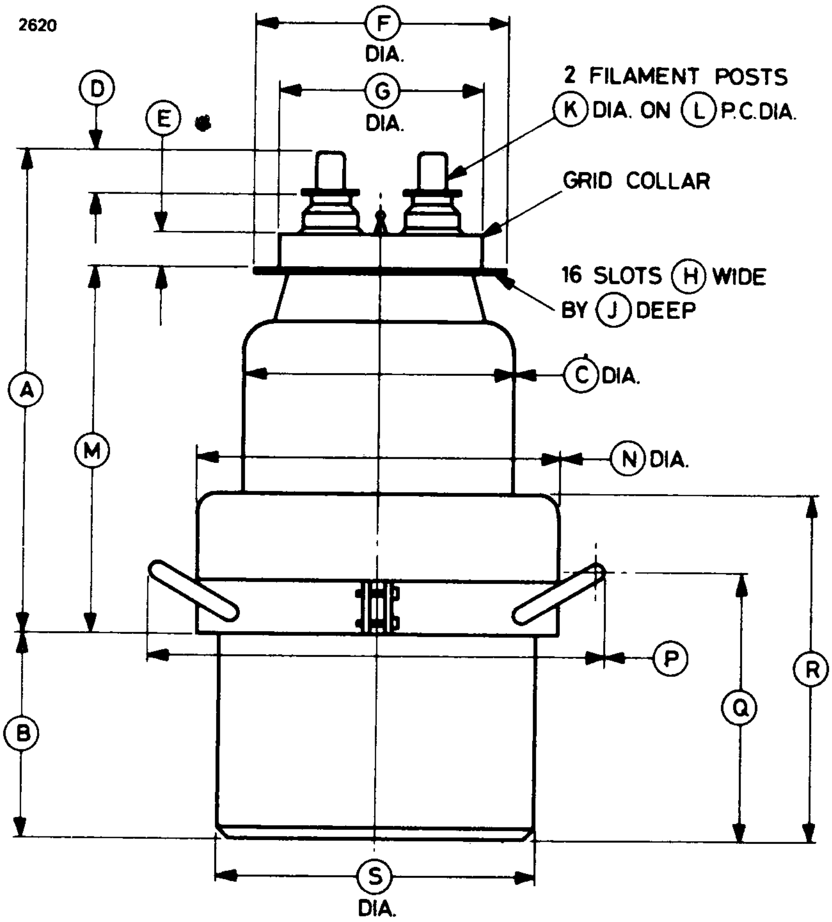


MINIMUM WATER COOLING REQUIREMENTS FOR BW1121/J1/J2

(Higher rates of flow should be used where possible)



OUTLINE FOR BR1121 (All dimensions without limits are nominal)

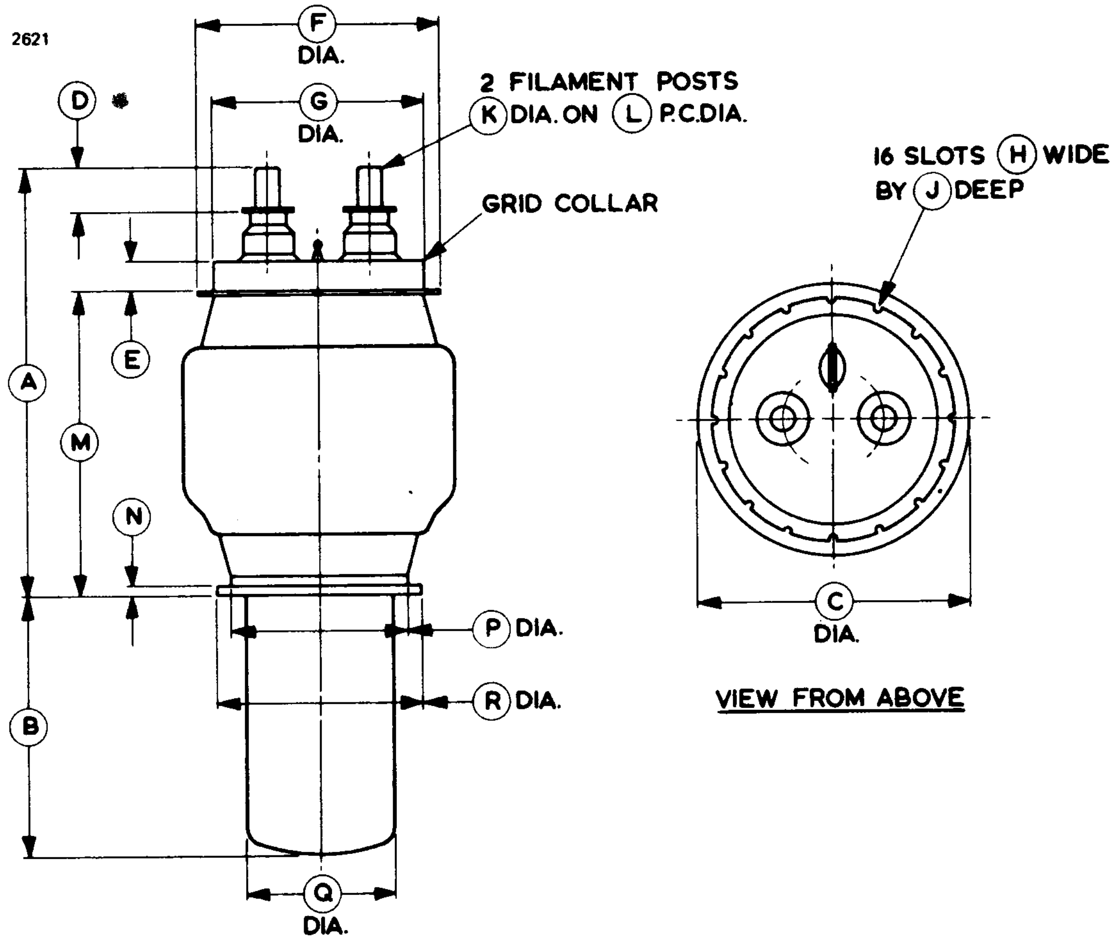


Ref	Inches	Millimetres
A	11.000 max	279.4 max
B	4.500	114.3
C	6.000 max	152.4 max
D	1.000	25.40
E	0.734	18.64
F	5.630	143.0
G	4.703	119.5
H	0.153	3.89
J	0.205	5.21

Ref	Inches	Millimetres
K	0.625	15.88
L	2.250	57.15
M	8.375 max	212.7 max
N	8.000 max	203.2 max
P	10.500 max	266.7 max
Q	5.937	150.8
R	7.625	193.7
S	7.062 max	179.4 max

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW1121 (All dimensions without limits are nominal)

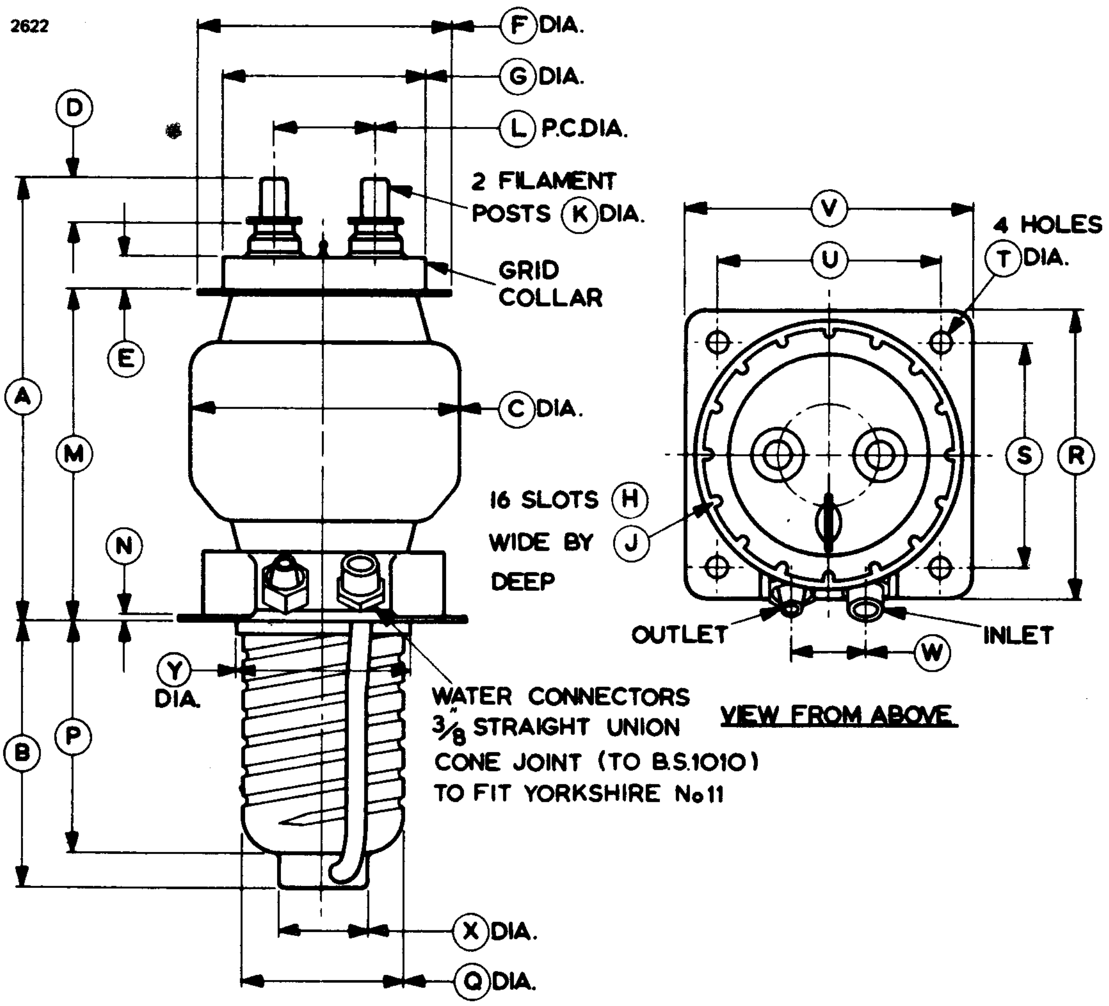


Ref	Inches	Millimetres
A	9.375 max	238.1 max
B	5.625	142.9
C	6.000 max	152.4 max
D	1.000	25.40
E	0.734	18.64
F	5.630	143.0
G	4.703	119.5
H	0.153	3.89

Ref	Inches	Millimetres
J	0.205	5.21
K	0.625	15.88
L	2.250	57.15
M	6.875 max	174.6 max
N	0.250	6.35
P	3.875	98.43
Q	3.250	82.55
R	4.500	114.3

Millimetre dimensions have been derived from inches.

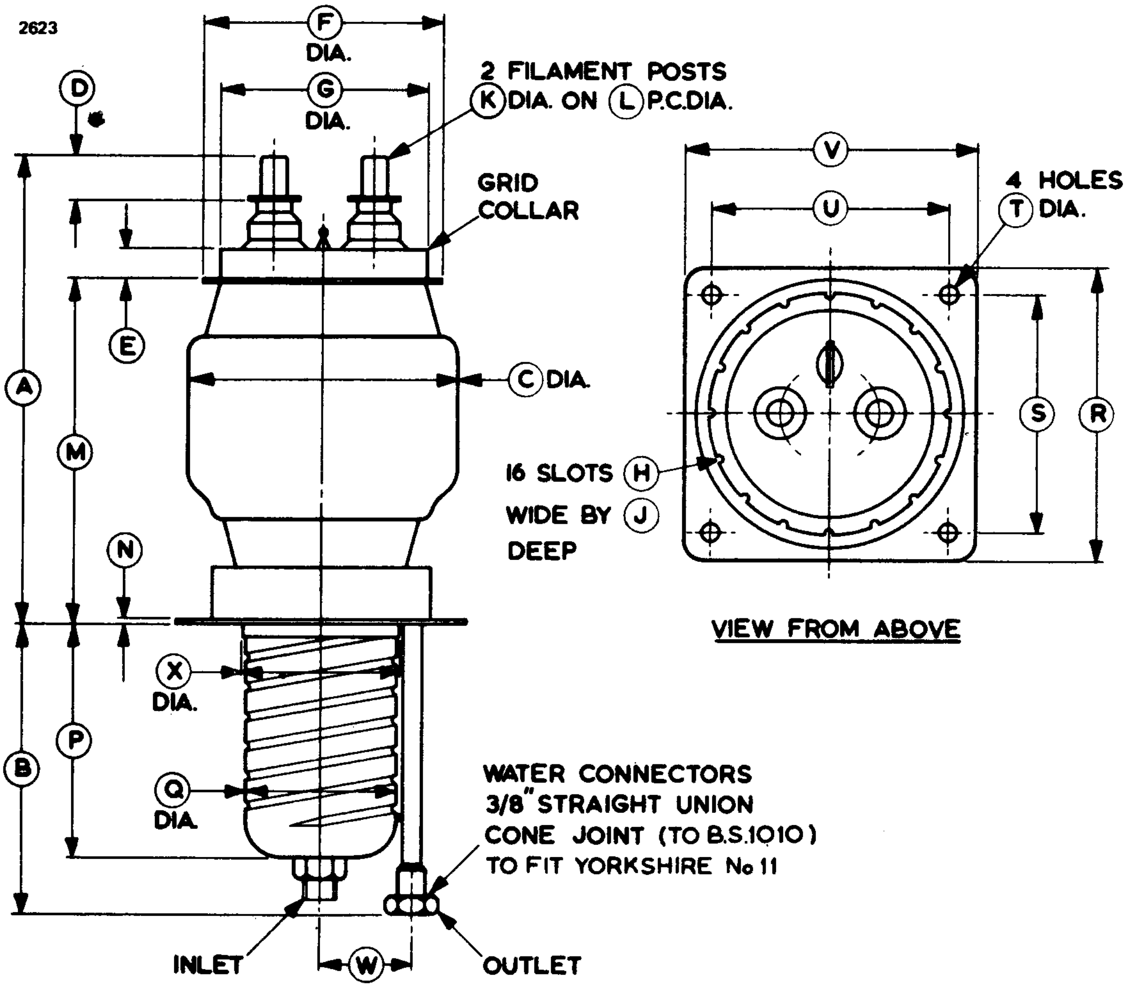
OUTLINE FOR BW1121J1 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250 max	260.4 max	N	0.125	3.18
B	6.250 max	158.8 max	P	5.150	130.8
C	6.000 max	152.4 max	Q	3.562	90.47
D	1.000	25.40	R	6.500	165.1
E	0.734	18.64	S	5.000	127.0
F	5.630	143.0	T	0.375	9.53
G	4.703	119.5	U	5.000	127.0
H	0.153	3.89	V	6.500	165.1
J	0.205	5.21	W	1.250	31.75
K	0.625	15.88	X	2.000	50.80
L	2.250	57.15	Y	4.000 max	101.6 max
M	7.750 max	196.9 max			

Millimetre dimensions have been derived from inches.

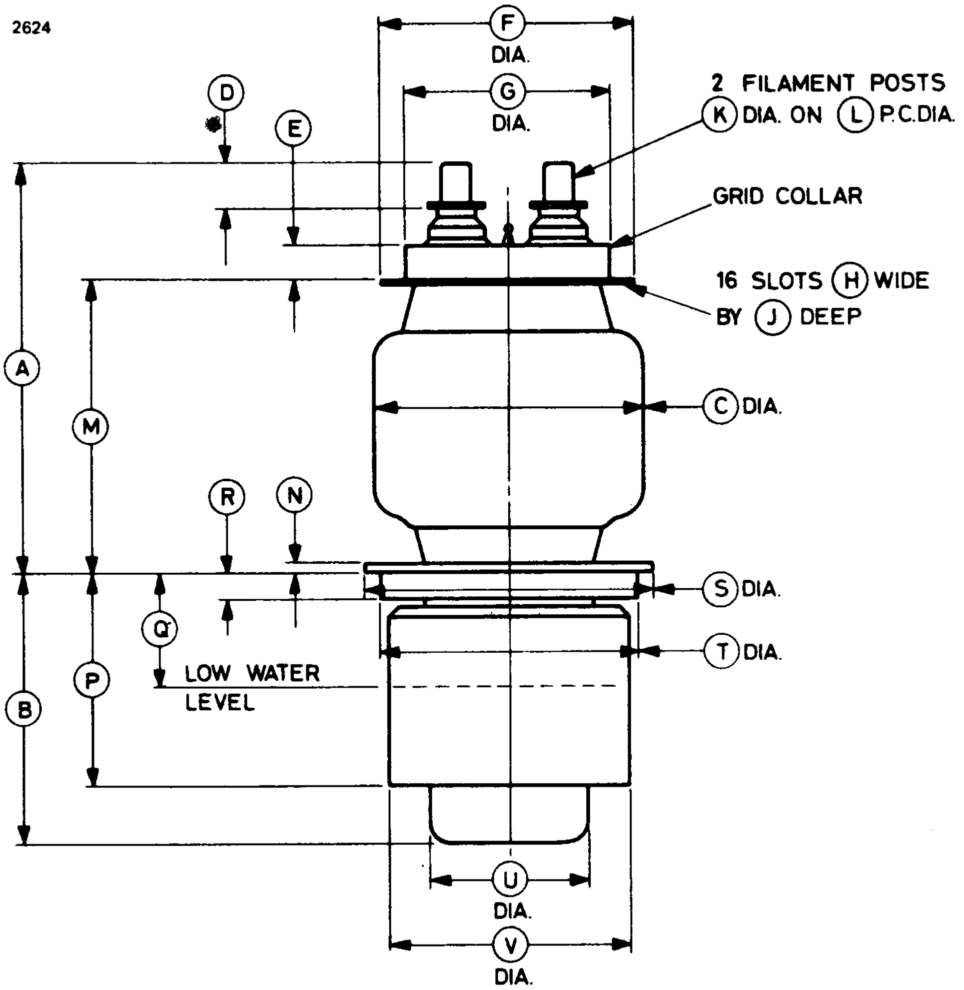
OUTLINE FOR BW1121J2 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250 max	260.4 max	M	7.750 max	196.9 max
B	6.250 max	158.8 max	N	0.125	3.18
C	6.000 max	152.4 max	P	5.240	133.1
D	1.000	25.40	Q	3.562	90.47
E	0.734	18.64	R	6.500	165.1
F	5.630	143.0	S	5.000	127.0
G	4.703	119.5	T	0.375	9.53
H	0.153	3.89	U	5.000	127.0
J	0.205	5.21	V	6.500	165.1
K	0.625	15.88	W	2.170	55.12
L	2.250	57.15	X	4.000 max	101.6 max

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1121 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.250 max	235.0 max	L	2.250	57.15
B	5.937 ± 0.062	150.80 ± 1.57	M	6.750 max	171.5 max
C	6.000 max	152.4 max	N	0.250	6.35
D	1.000	25.40	P	4.687	119.0
E	0.734	18.64	Q	2.500	63.50
F	5.630	143.0	R	0.625	15.88
G	4.703	119.5	S	6.375	161.9
H	0.153	3.89	T	5,750	146.1
J	0.205	5.21	U	3.500	88.90
K	0.625	15.88	V	5.312	134.9

Millimetre dimensions have been derived from inches.

BR/BW/BY1122 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. transmitting triodes differing only in the method of anode cooling. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BR1122		forced-air
BW1122		water; separate jacket
BY1122		vapour; separate boiler unit
Anode dissipation	10	kW max
Anode voltage	12	kV max
Frequency for full ratings	5.0	MHz max
Frequency at reduced ratings	110	MHz max
Output power (class C telegraphy)	29	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	6.0	V
Filament current	115	A
Surge filament current (peak) (see note 2)	260	A max
Filament cold resistance	6.0	mΩ
Peak usable cathode current	20	A
Perveance	1.4	$mA/V^{3/2}$
Amplification factor (V_a = 5.0kV, I_a = 1.0A)	37	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A)	19	mA/V
Inter-electrode capacitances:		
grid to anode	31	pF
grid to filament	41	pF
anode to filament	0.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR1122	25 pounds (11.5kg) approx
BW1122	5 pounds (2.3kg) approx
BY1122	17 pounds (7.7kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA135
Grid connector	MA66A
Water jacket for BW1122	BW4070
Sealing ring (supplied with BW1122)	MA252
Boiler unit, separate condenser required, for BY1122 . . .	BY4048A
Boiler unit, integral condenser, for BY1122	BY4064
Sealing ring (supplied with BY1122)	MA253

COOLING

Anode

The BR1122 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW1122 must be fitted into a water jacket for cooling, the recommended jacket being type BW4070. A flow of water of 2imp.gal/min (9.1 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

The BY1122 is vapour cooled and may be operated either in boiler unit BY4048A or BY4064. In BY4064, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4048A is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 15ft^3/min (0.43m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C Telegraphy, key-down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	12	kV max
Anode current	3.5	A max
Anode dissipation	10	kW max
Grid dissipation	500	W max
Operating frequency (for full ratings)	5.0	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	6.0	8.5	10	12	kV
Grid voltage	−300	−450	−550	−650	V
Peak r.f. grid drive voltage	820	950	1060	1150	V
Anode current	3.4	3.1	3.2	3.0	A
Grid current (approx)	0.47	0.44	0.3	0.21	A
Anode dissipation	5.4	6.4	7.0	7.0	kW
Grid dissipation	245	220	155	105	W
Output power	15	20	25	29	kW
Efficiency	73.5	76	78	80	%

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 6.0V	107	121	A
Amplification factor (V_a = 5.0kV, I_a = 1.0A)	34	42	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A)	15	23	mA/V
Grid voltage (negative value) (V_a = 5.0kV, I_a = 1.0A)	41	71	V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	380	V
Anode current (V_a = 2.0kV, V_g = +200V)	5.1	6.9	A

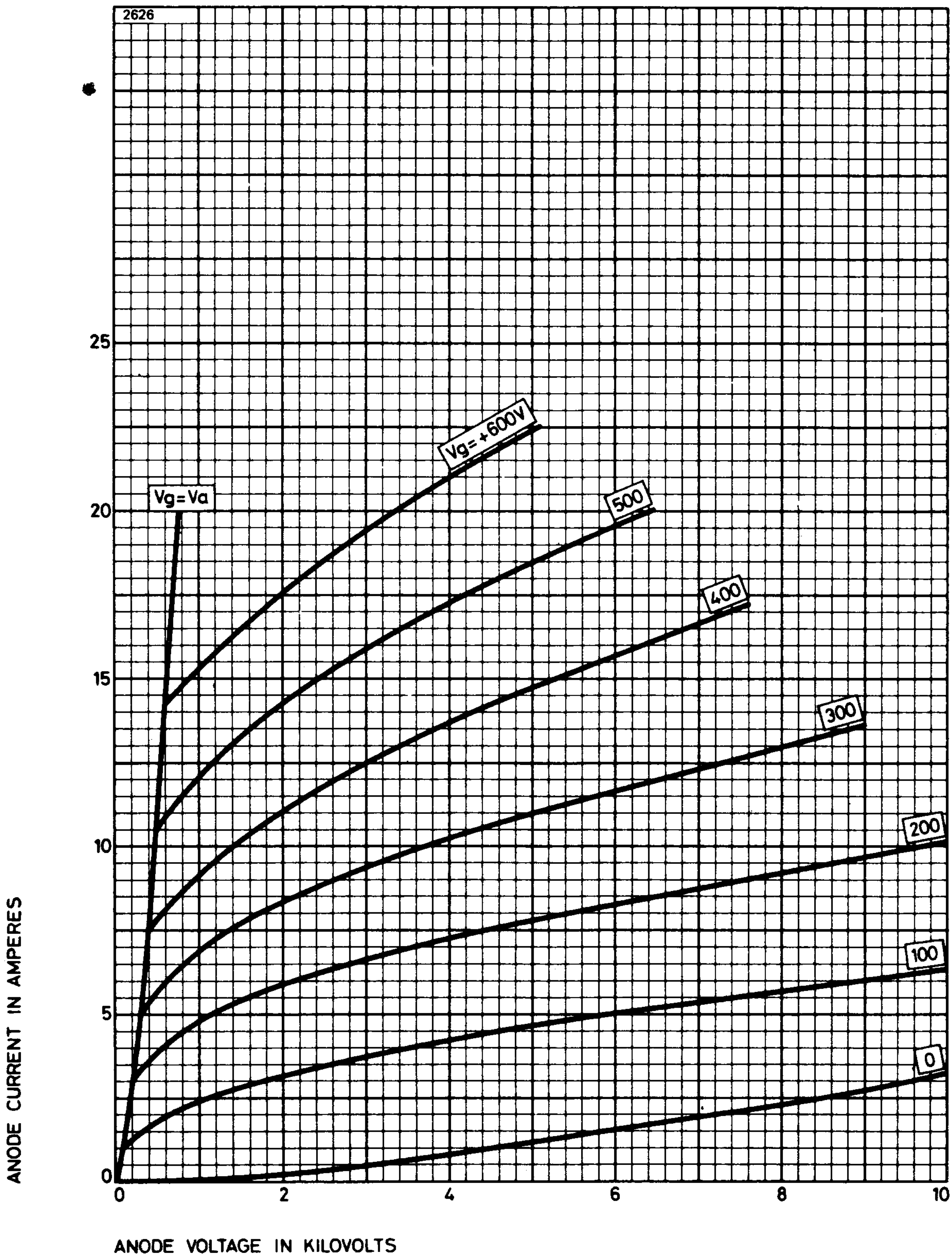
MAXIMUM ANODE VOLTAGE AGAINST FREQUENCY

Operating frequency (MHz)	Max anode voltage c.w. (kV)	Max anode voltage with anode modulation (kV)
5	12	10
20	10	8
50	8.5	6.7
110	6.5	5.3

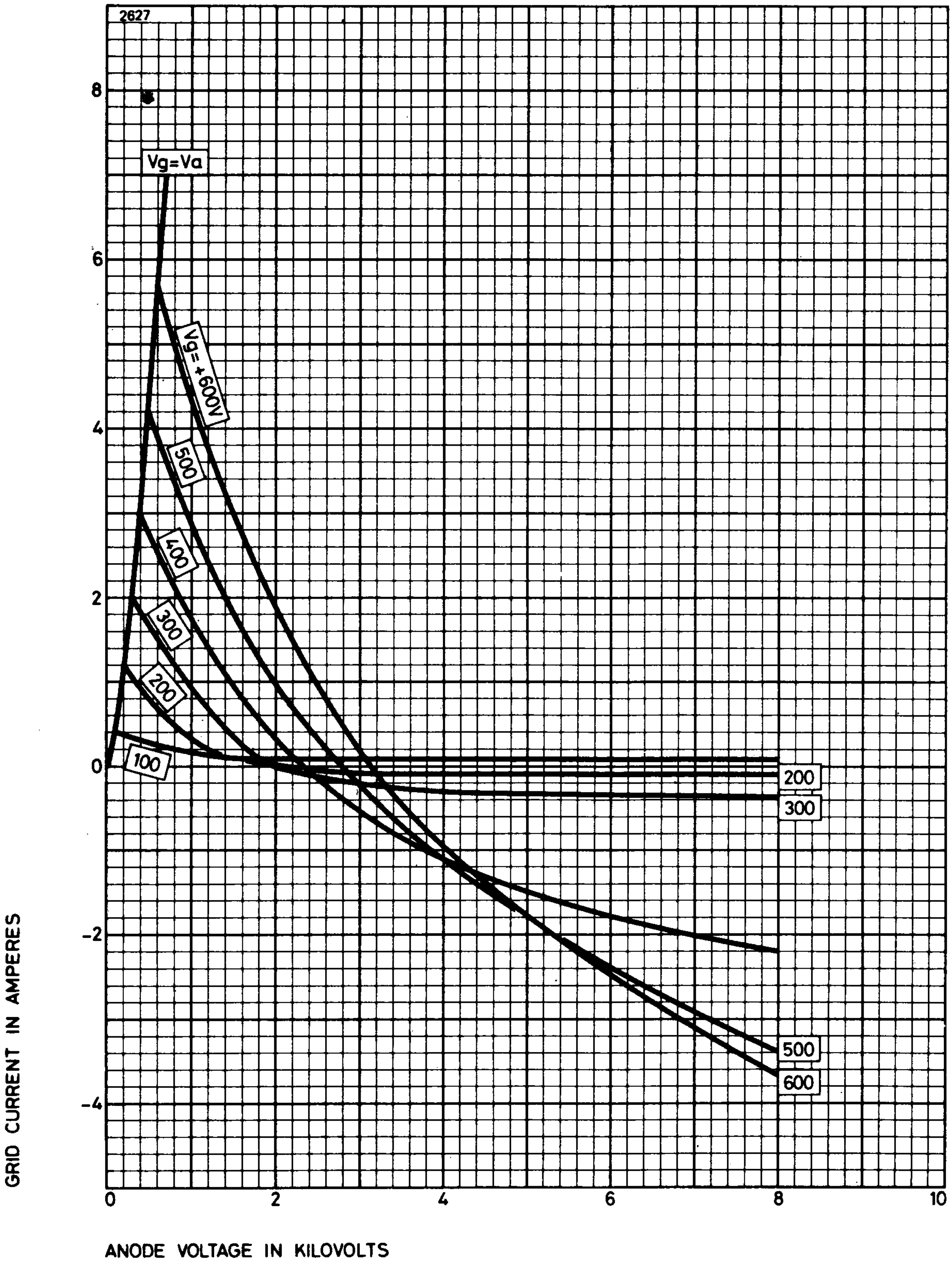
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed 5%.
2. The filament current must not exceed 260A, even momentarily, at any time.

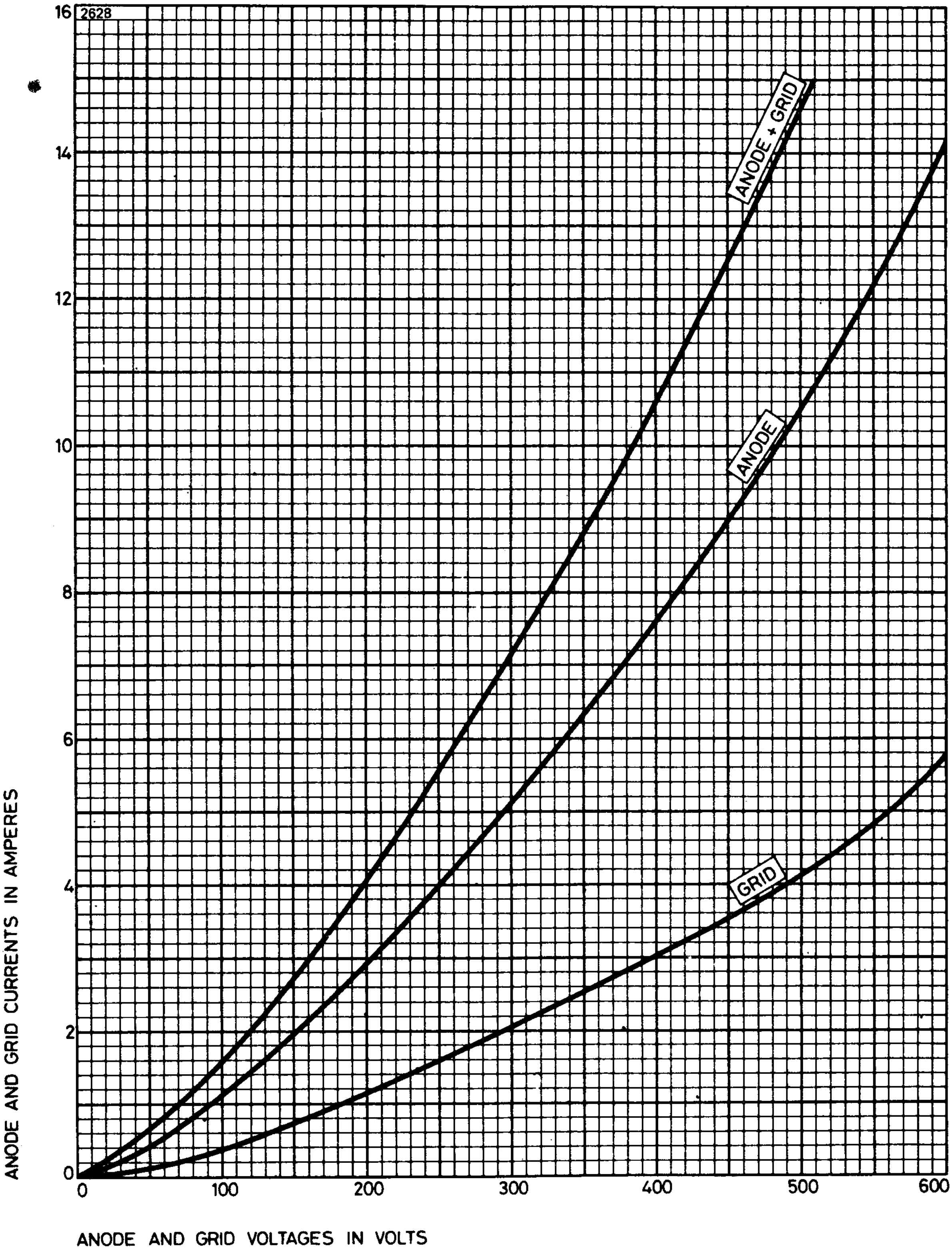
TYPICAL ANODE CHARACTERISTICS



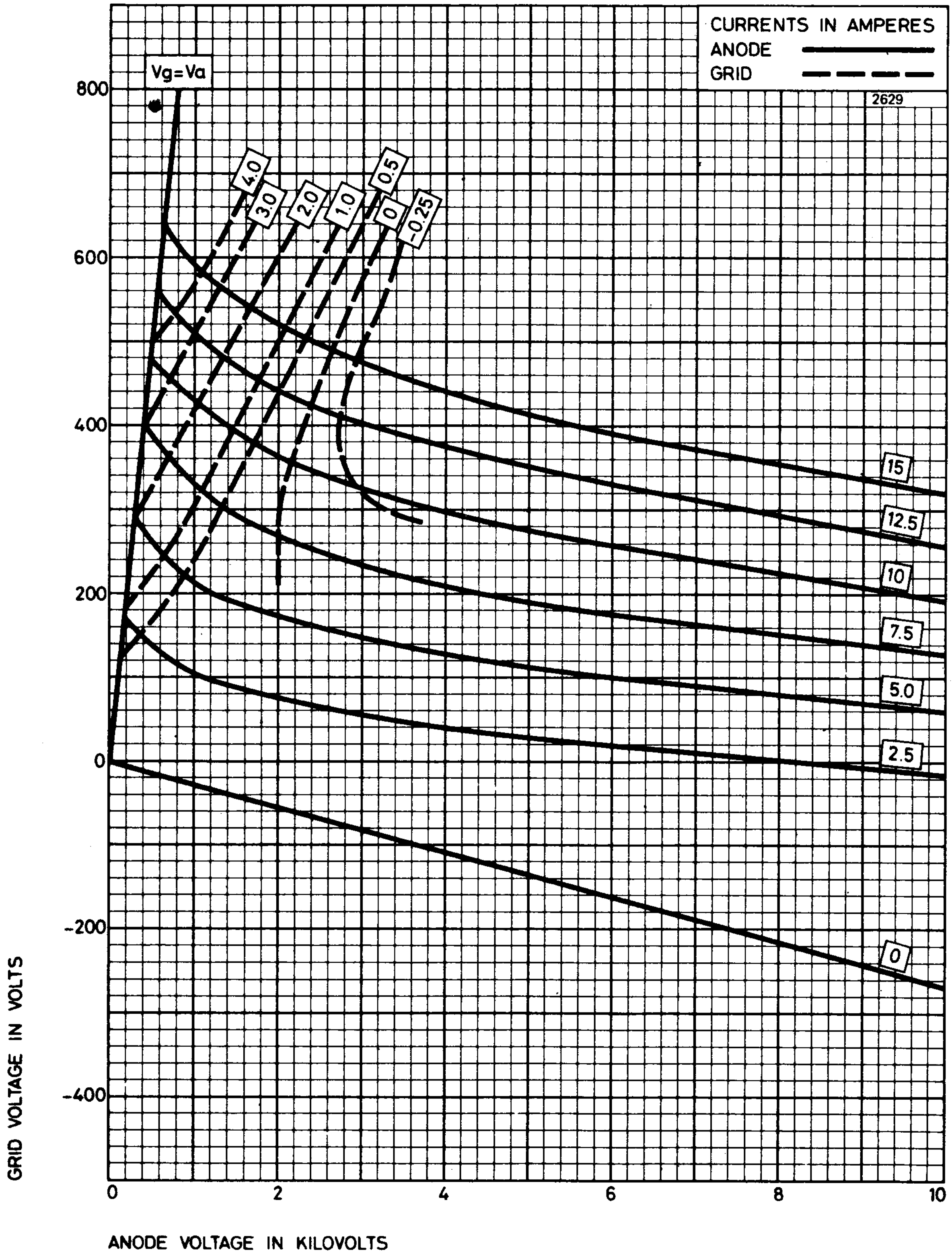
TYPICAL GRID CHARACTERISTICS



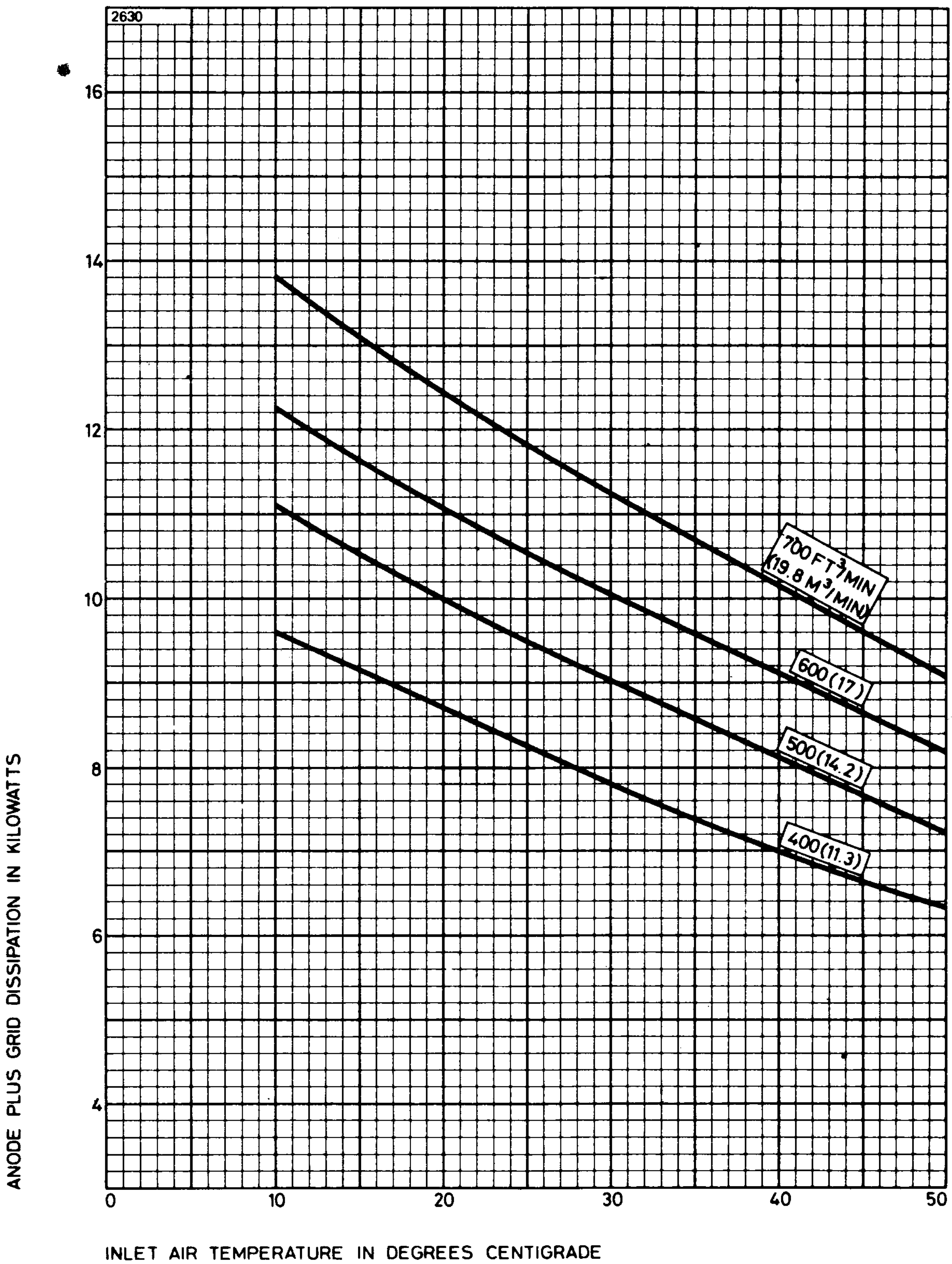
TYPICAL STRAPPED CHARACTERISTICS



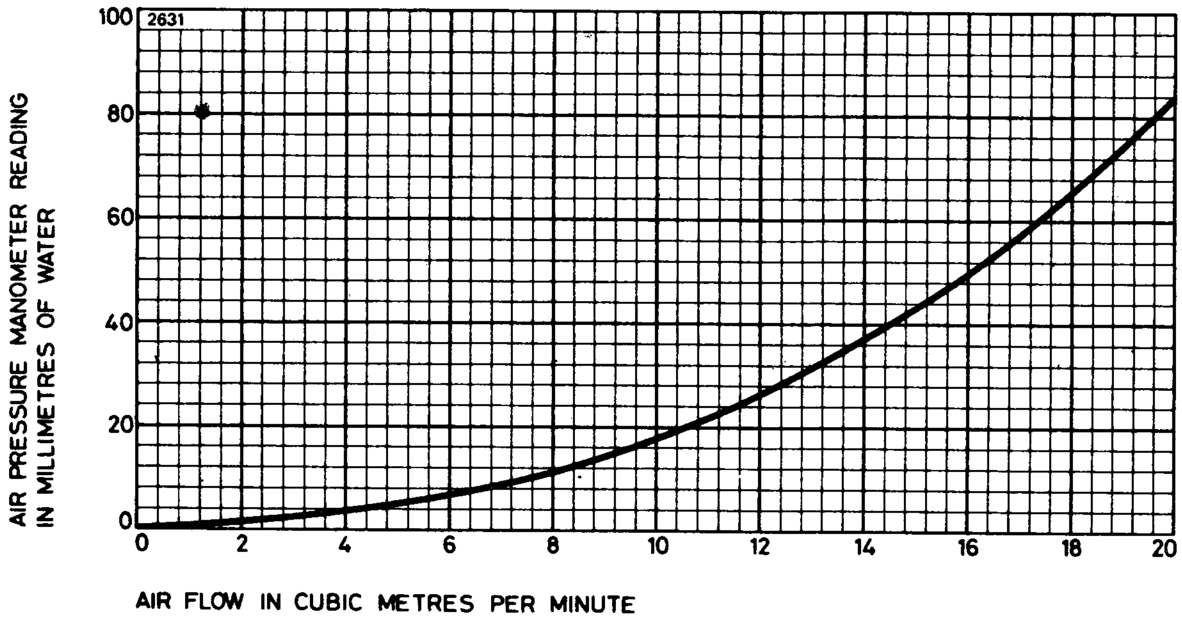
TYPICAL CONSTANT CURRENT CHARACTERISTICS

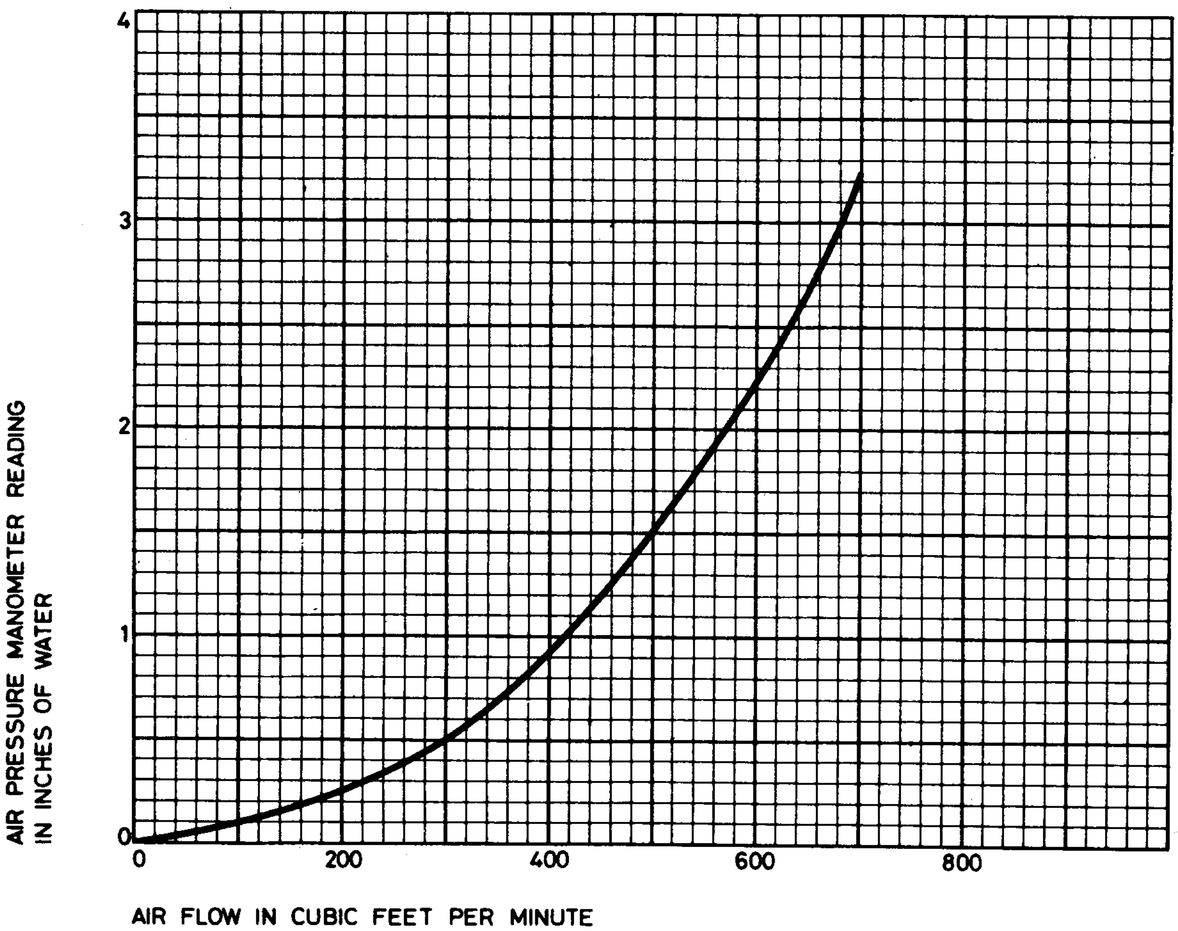


AIR COOLING REQUIREMENTS FOR BR1122



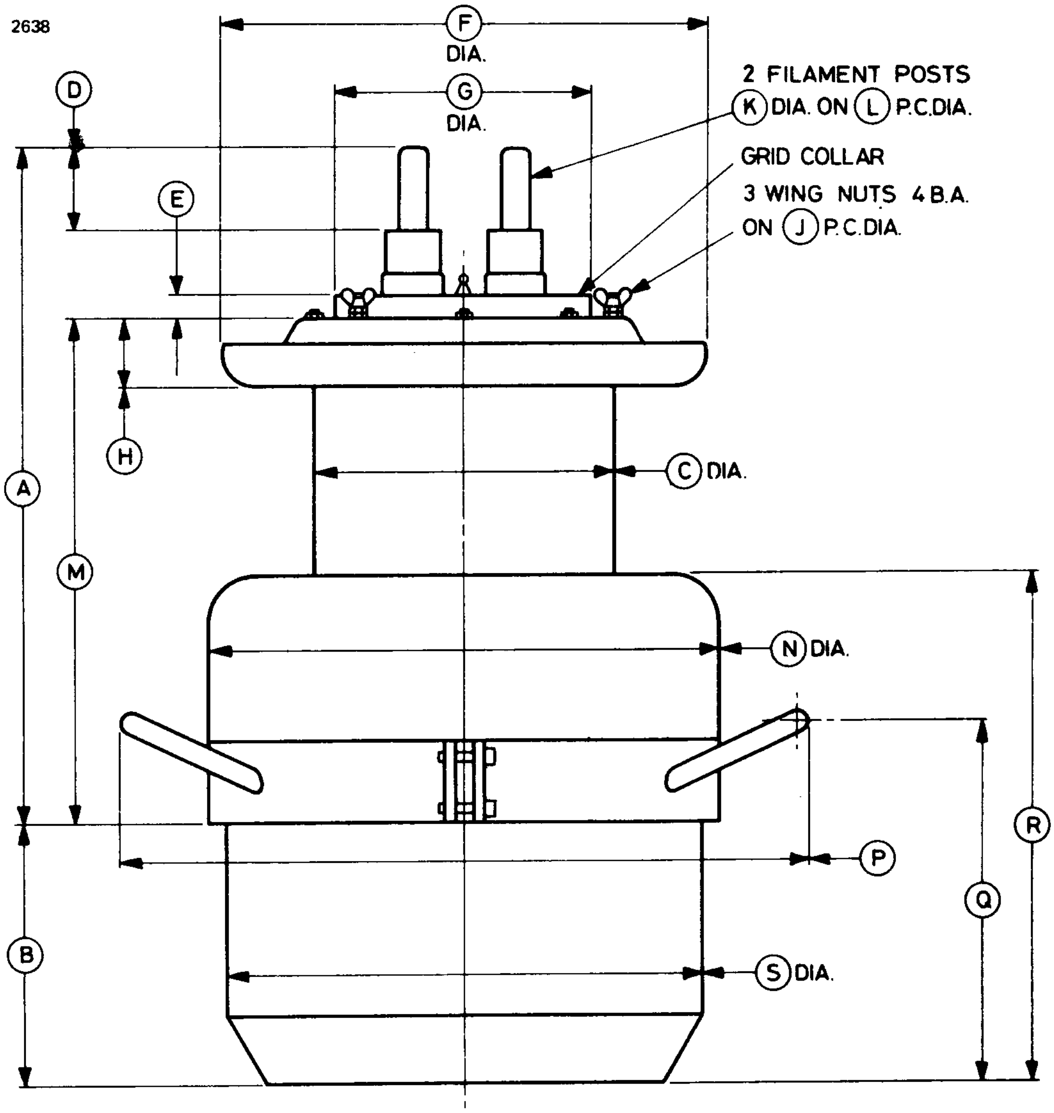
AIR FLOW CHARACTERISTIC FOR BR1122





OUTLINE FOR BR1122 (All dimensions without limits are nominal)

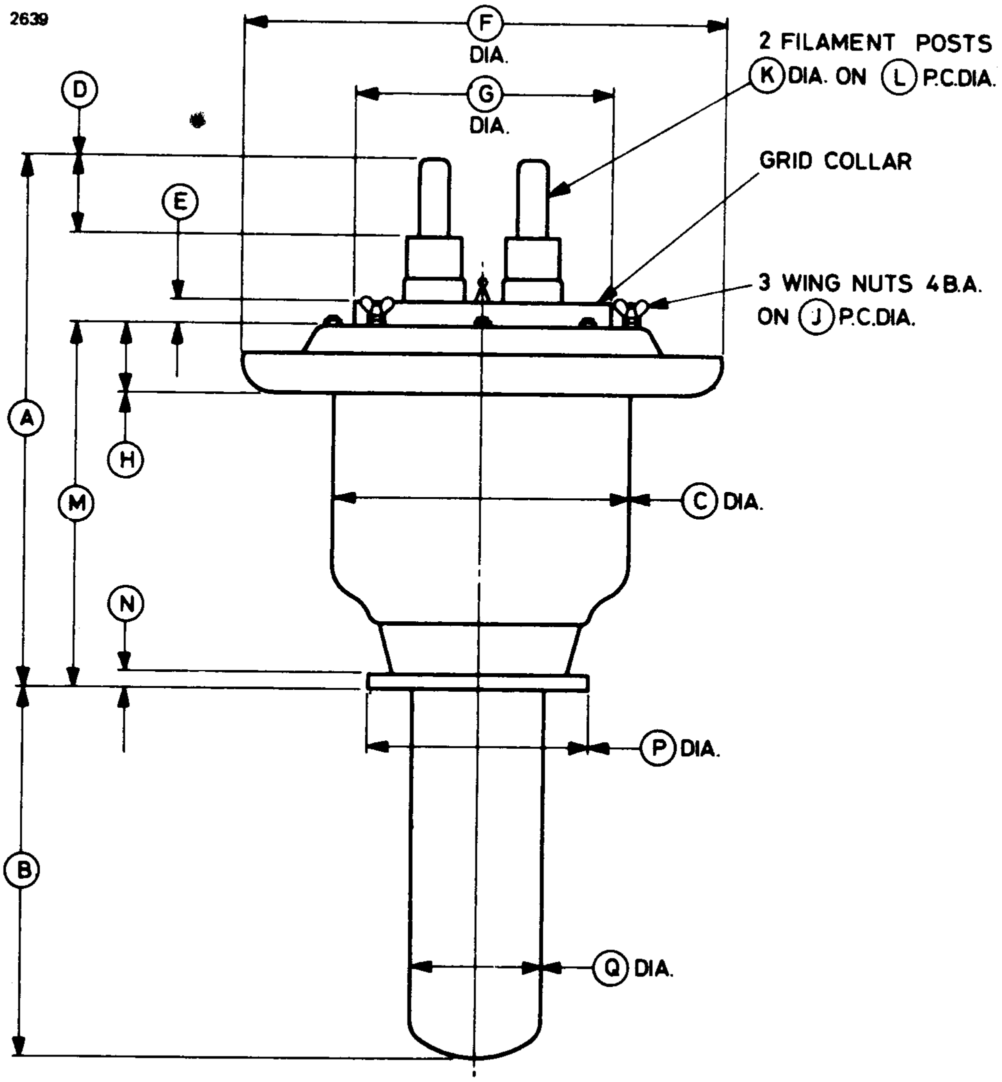
2638



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.062 max	255.6 max	K	0.437	11.10
B	3.812	96.82	L	1.500	38.10
C	4.500	114.3	M	7.813 max	198.5 max
D	1.125	28.58	N	7.625 max	193.7 max
E	0.328	8.33	P	10.125	257.2
F	7.125	181.0	Q	5.250	133.4
G	3.750	95.25	R	7.425	188.6
H	1.000	25.40	S	7.062 max	179.4 max
J	4.375	111.1			

Millimetre dimensions have been derived from inches.

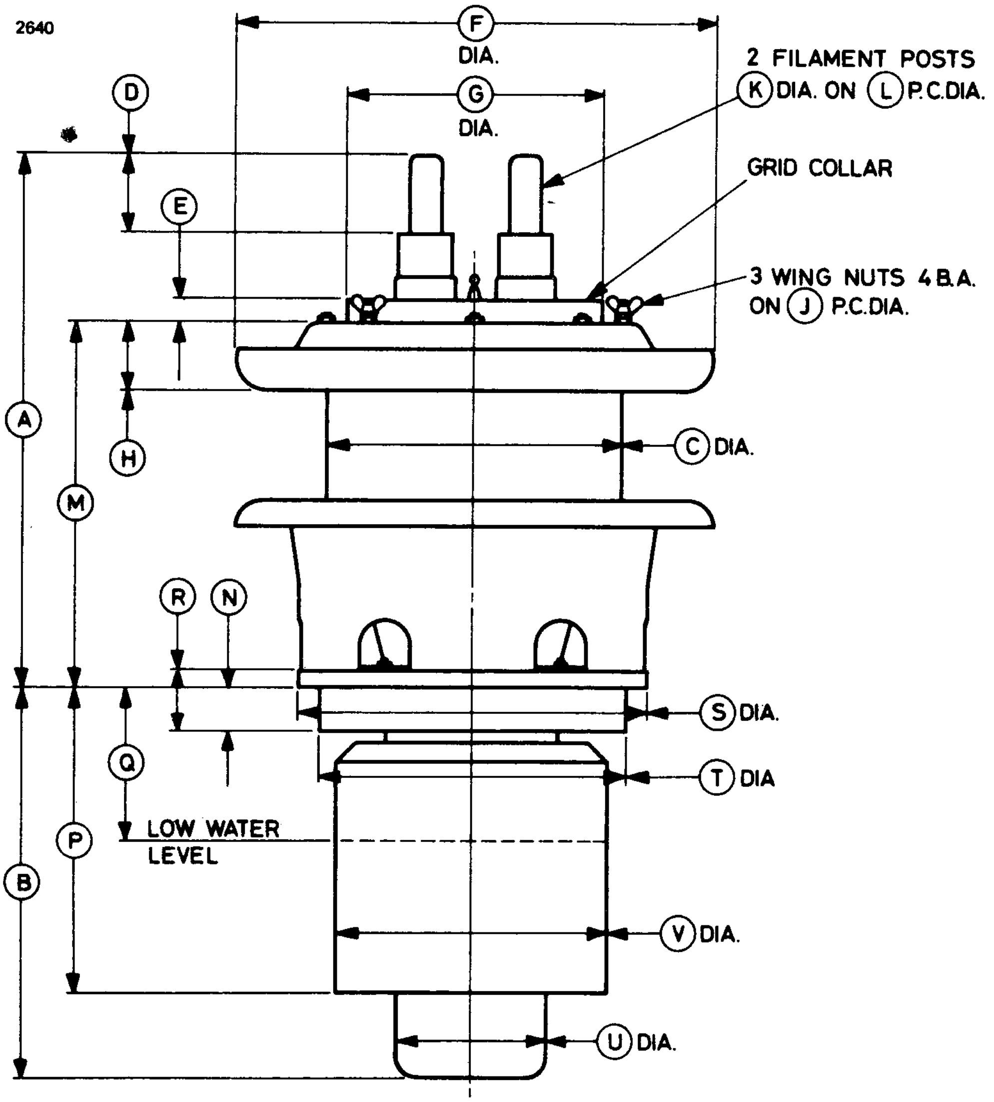
OUTLINE FOR BW1122 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.125 max	206.4 max	J	4.375	111.1
B	5.375	136.5	K	0.437	11.10
C	4.500	114.3	L	1.500	38.10
D	1.125	28.58	M	5.625 max	142.9 max
E	0.328	8.33	N	0.250	6.35
F	7.125	181.0	P	3.250	82.55
G	3.750	95.25	Q	2.000	50.80
H	1.000	25.40			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1122 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.000 max	203.2 max	L	1.500	38.10
B	5.687 ± 0.062	144.4 ± 1.6	M	5.500 max	139.7 max
C	4.500	115.0	N	0.625	15.88
D	1.125	28.58	P	4.438	112.7
E	0.328	8.33	Q	2.250	57.15
F	7.125	181.0	R	0.875	22.23
G	3.750	95.25	S	5.125 ± 0.020	130.2 ± 0.5
H	1.000	25.40	T	4.500 ± 0.020	114.3 ± 0.5
J	4.375	111.1	U	2.250	57.15
K	0.437	11.10	V	4.000	101.6

Millimetre dimensions have been derived from inches.

BR/BW/BY1124 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Five r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling.

Anode cooling:		
BR1124		forced-air
BW1124		water; separate jacket
BW1124J1		water; integral jacket
BW1124J2		water; integral jacket
BY1124		vapour; separate boiler unit
Anode dissipation	10	kW max
Anode voltage	8.5	kV max
Frequency for full ratings	100	MHz max
Output power (class C unmodulated conditions)	20	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	6.0	V
Filament current	115	A
Surge filament current (peak) (see note 2)	260	A max
Filament cold resistance	6.0	mΩ
Peak usable cathode current	20	A
Perveance	1.4	$mA/V^{3/2}$
Amplification factor (V_a = 5.0kV, I_a = 1.0A)	37	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A)	19	mA/V
Inter-electrode capacitances:		
grid to anode	31	pF
grid to filament	41	pF
anode to filament	0.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR1124	22 pounds (10kg) approx
BW1124 •	3½ pounds (1.6kg) approx
BW1124J1, BW1124J2	7½ pounds (3.4kg) approx
BY1124	15 pounds (6.8kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA135
Grid connector	MA66A
Water jacket for BW1124	BW4029
Sealing ring (supplied with BW1124)	MA252
Boiler unit, separate condenser required, for BY1124	BY4048A
Boiler unit, integral condenser, for BY1124	BY4064
Sealing ring (supplied with BY1124)	MA253

COOLING

Anode

The BR1124 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW1124 must be fitted into a water jacket for cooling, the recommended jacket being type BW4029. A flow of water of 2imp.gal/min (9.1 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

Types BW1124J1 and BW1124J2 have integral water jackets (see outline drawings). Minimum water cooling requirements are shown on page 11; higher rates of flow should be used where possible.

The BY1124 is vapour cooled and may be operated either in boiler unit BY4048A or BY4064. In BY4064, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4048A is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20ft^3/min (0.57m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of the seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C Telegraphy, key-down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	8.5	kV max
Anode current	3.5	A max
Anode dissipation (see note 4)	10	kW max
Grid dissipation	500	W max
Frequency (for full ratings)	100	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	6.0	8.5	kV
Grid voltage	−300	−450	V
Grid resistor	640	1025	Ω
Peak r.f. grid drive voltage	820	950	V
Anode current	3.4	3.1	A
Grid current (approx)	0.47	0.44	A
Anode dissipation	5.4	6.4	kW
Grid dissipation	245	220	W
Driving power	385	420	W
Output power (see note 5)	15	20	kW
Efficiency	73.5	76	%
Load resistance	900	1400	Ω

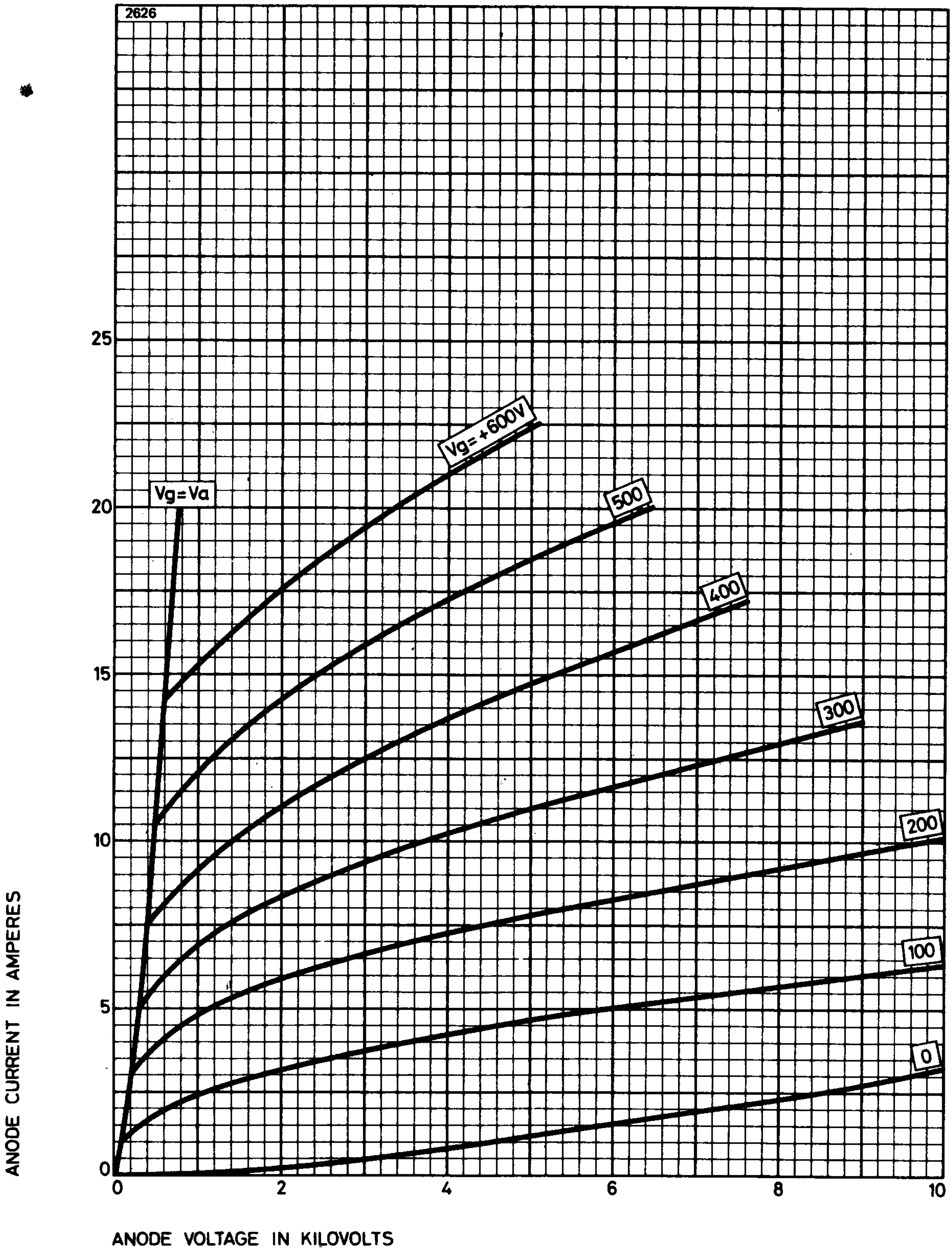
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 6.0V . .	107	121	A
Amplification factor (V_a = 5.0kV, I_a = 1.0A) .	34	42	
Mutual conductance (V_a = 5.0kV, I_a = 1.0A) .	15	23	mA/V
Grid voltage (negative value) (V_a = 5.0kV, I_a = 1.0A)	41	71	V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	380	V
Anode current (V_a = 2.0kV, V_g = +200V) . .	5.1	6.9	A

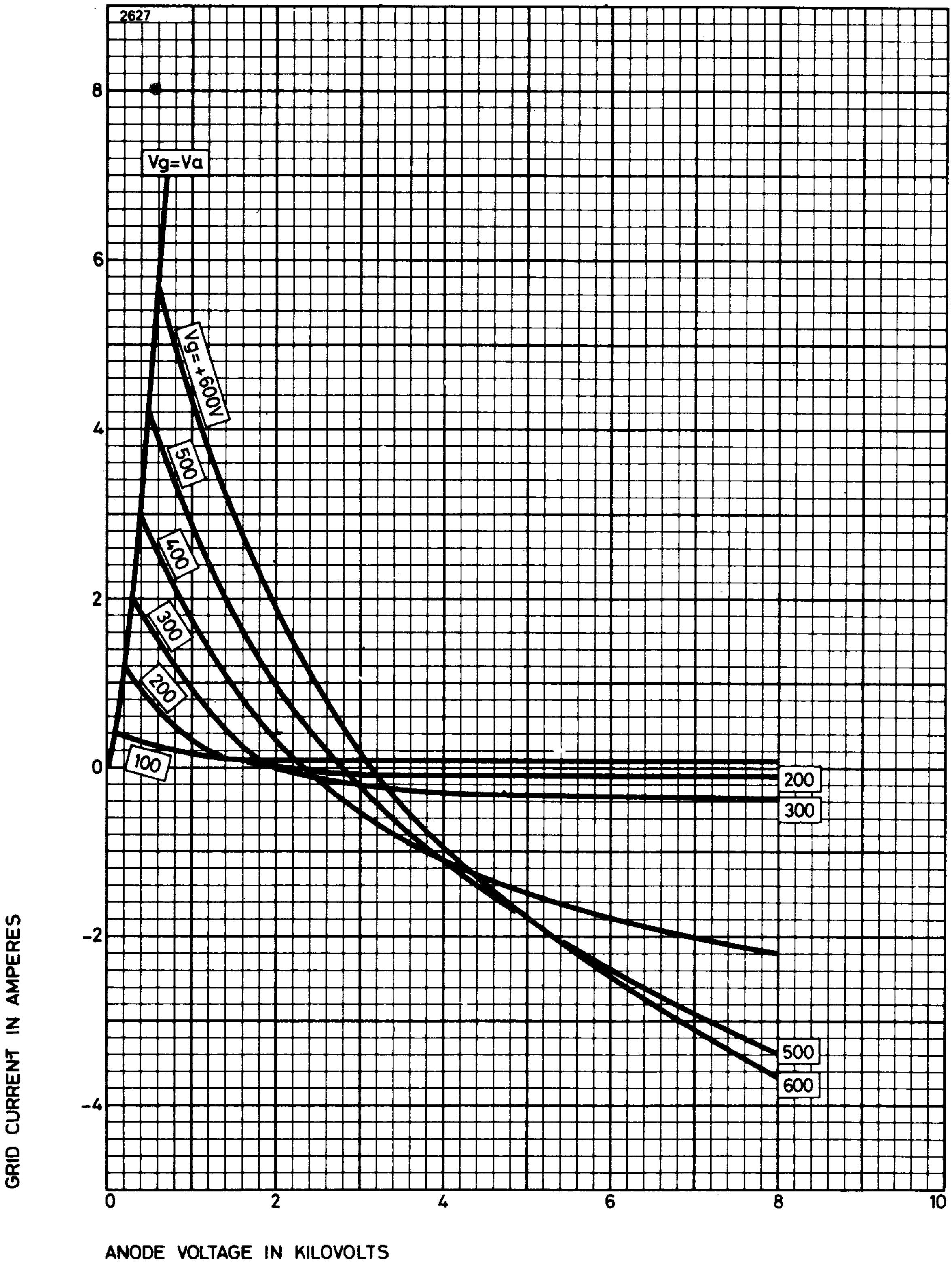
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 260A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.
5. The output power specified does not take into account the anode circuit efficiency.

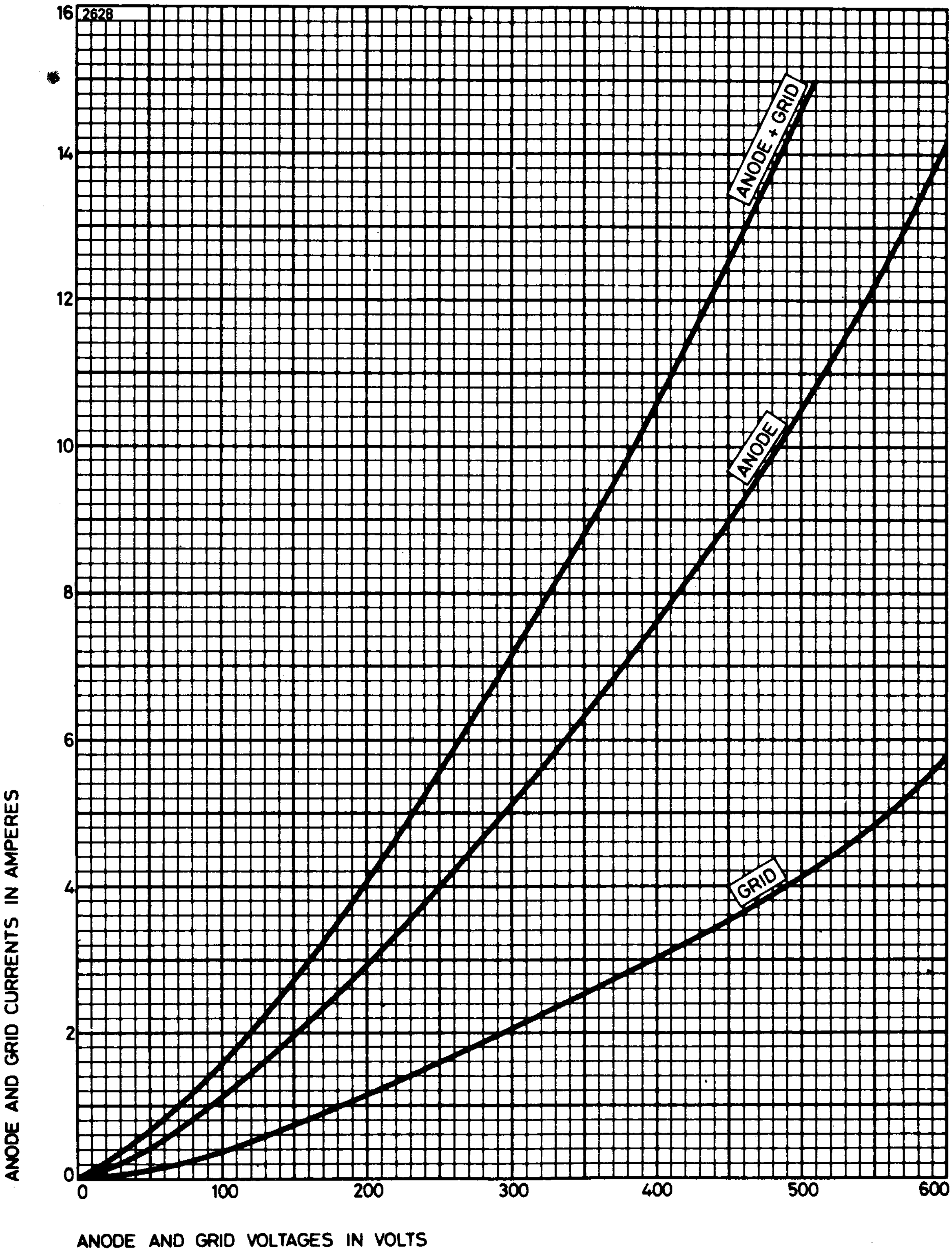
TYPICAL ANODE CHARACTERISTICS



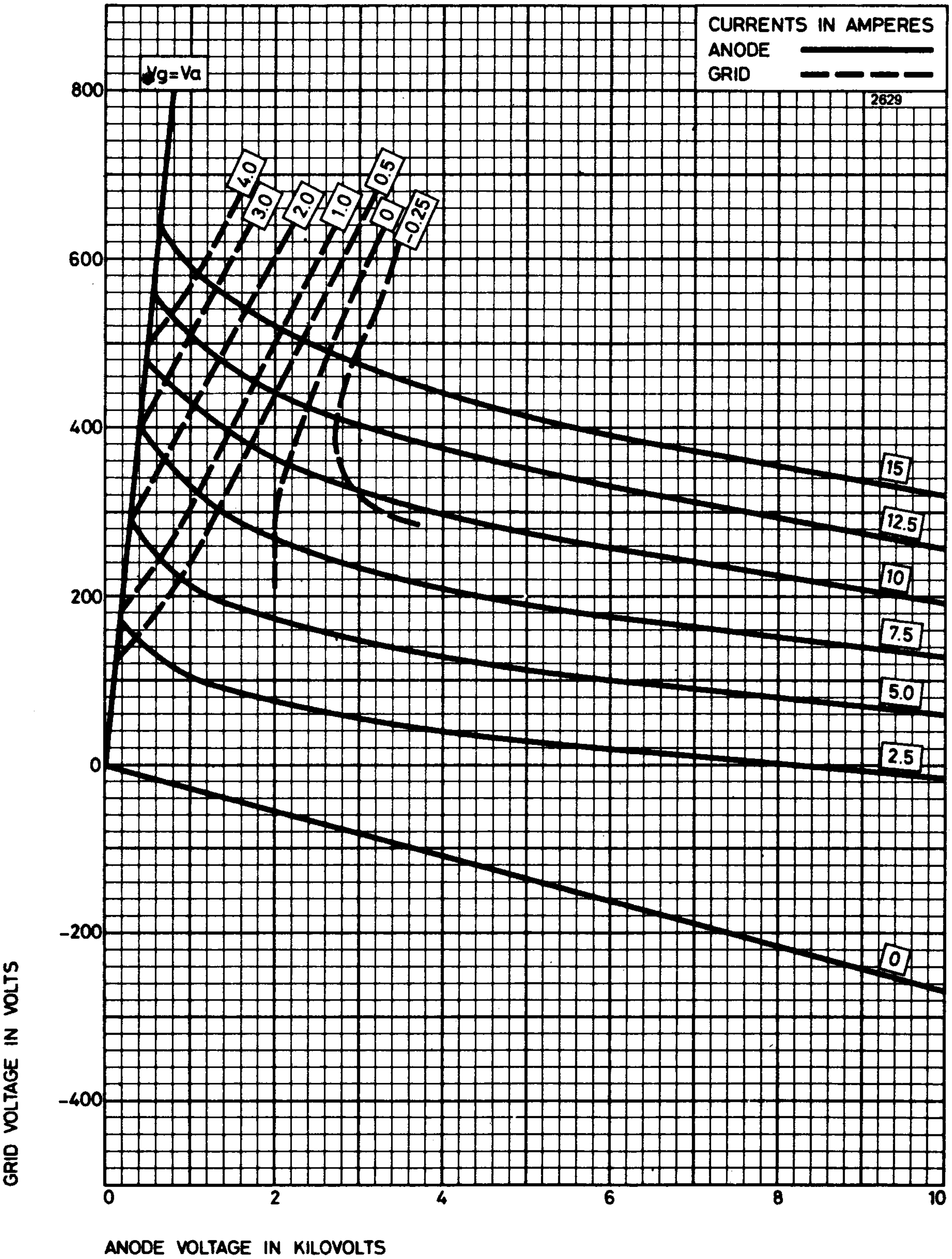
TYPICAL GRID CHARACTERISTICS



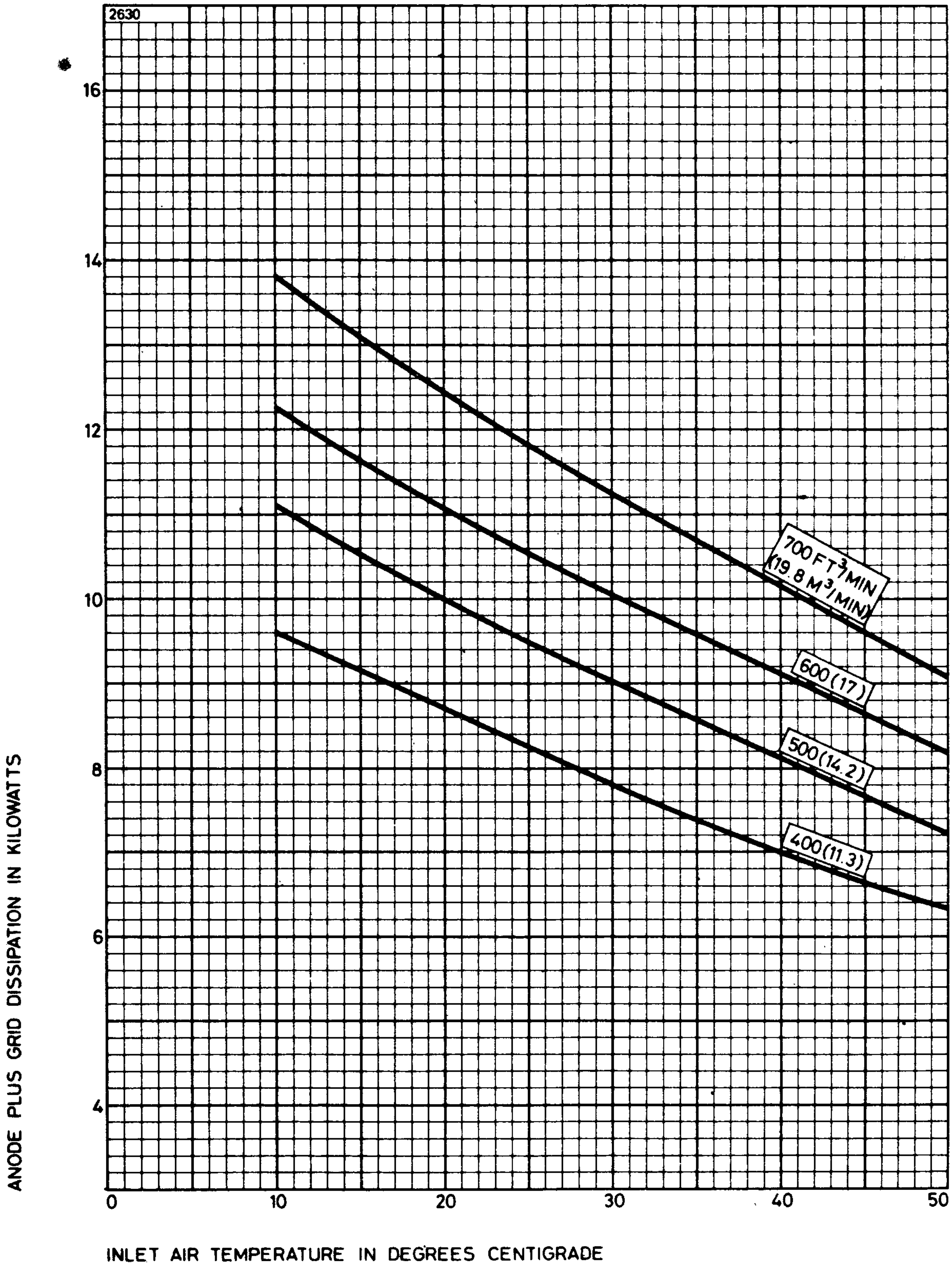
TYPICAL STRAPPED CHARACTERISTICS



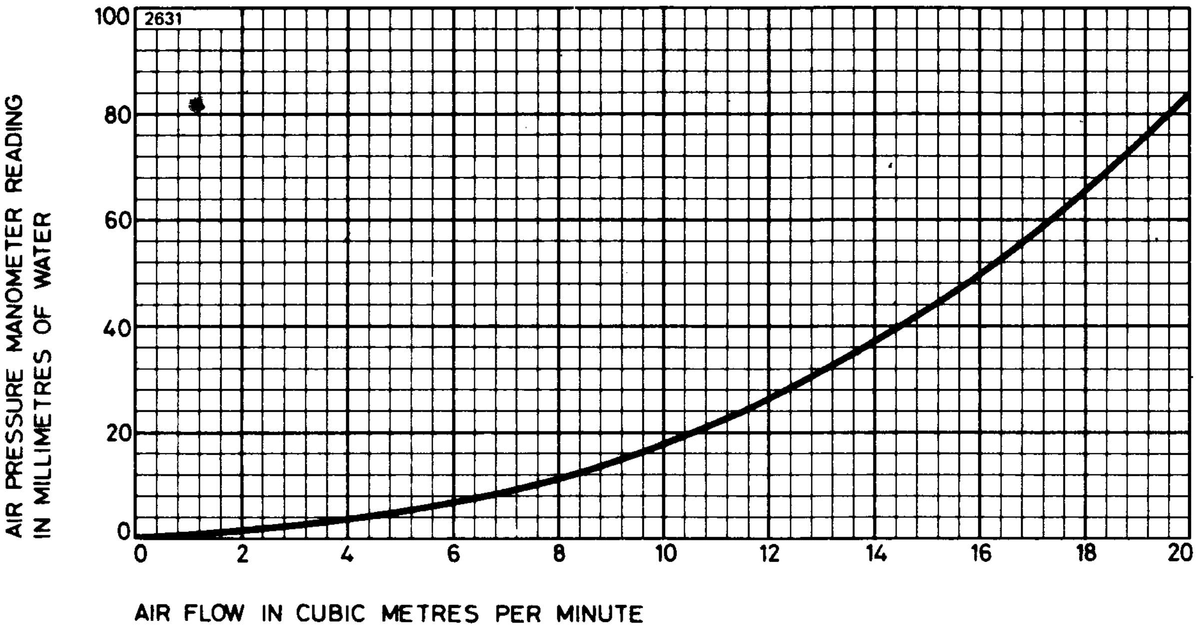
TYPICAL CONSTANT CURRENT CHARACTERISTICS

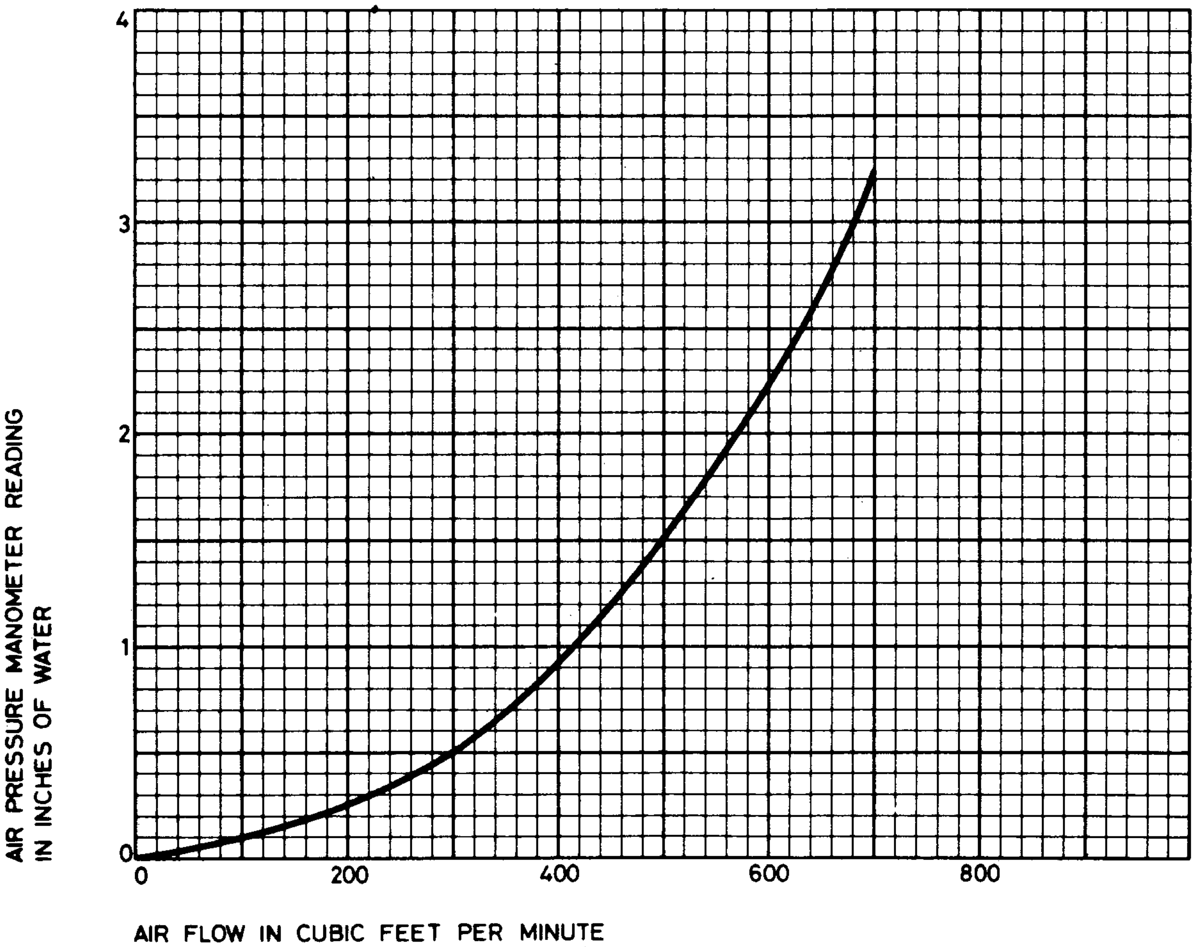


AIR COOLING REQUIREMENTS FOR BR1124

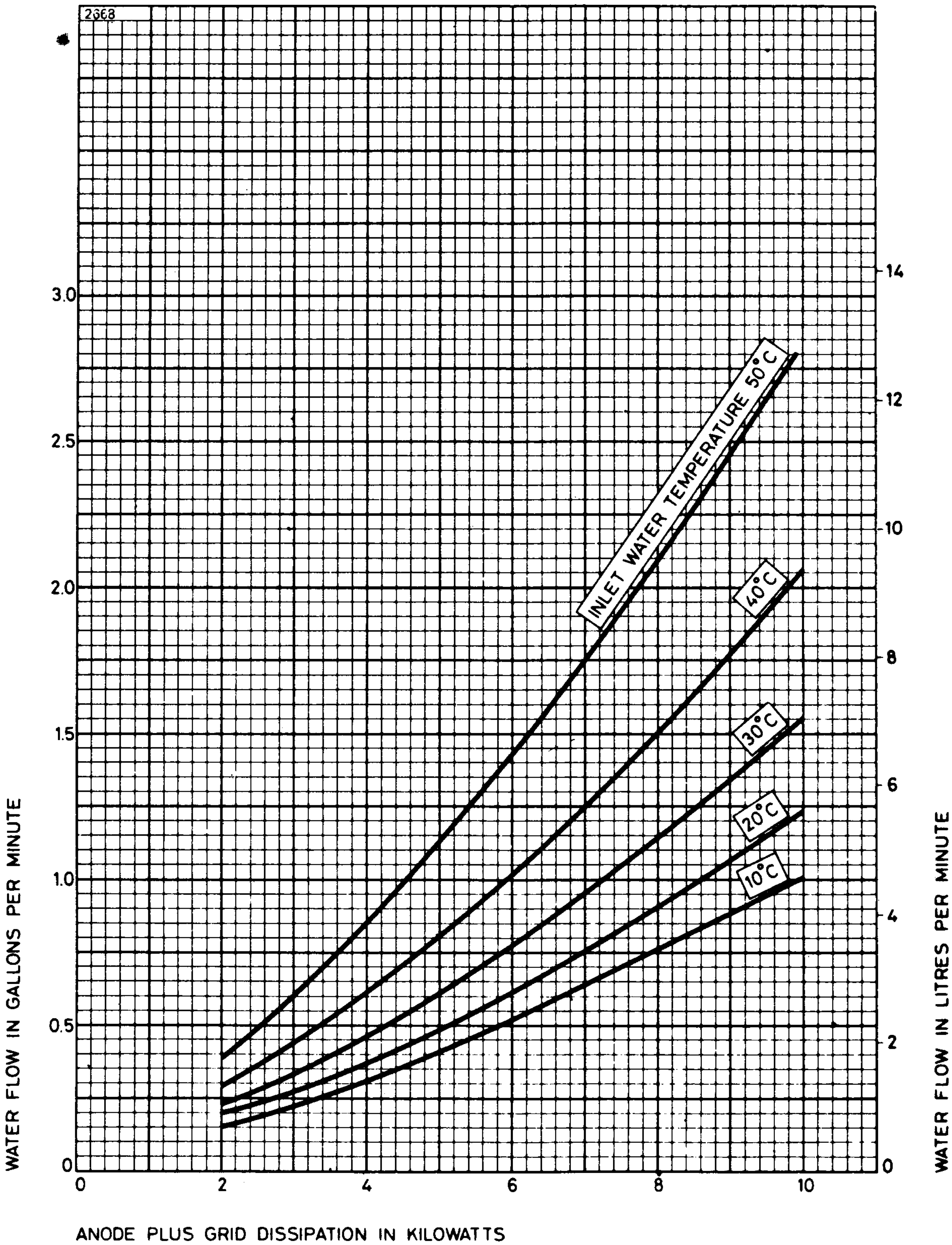


AIR FLOW CHARACTERISTIC FOR BR1124

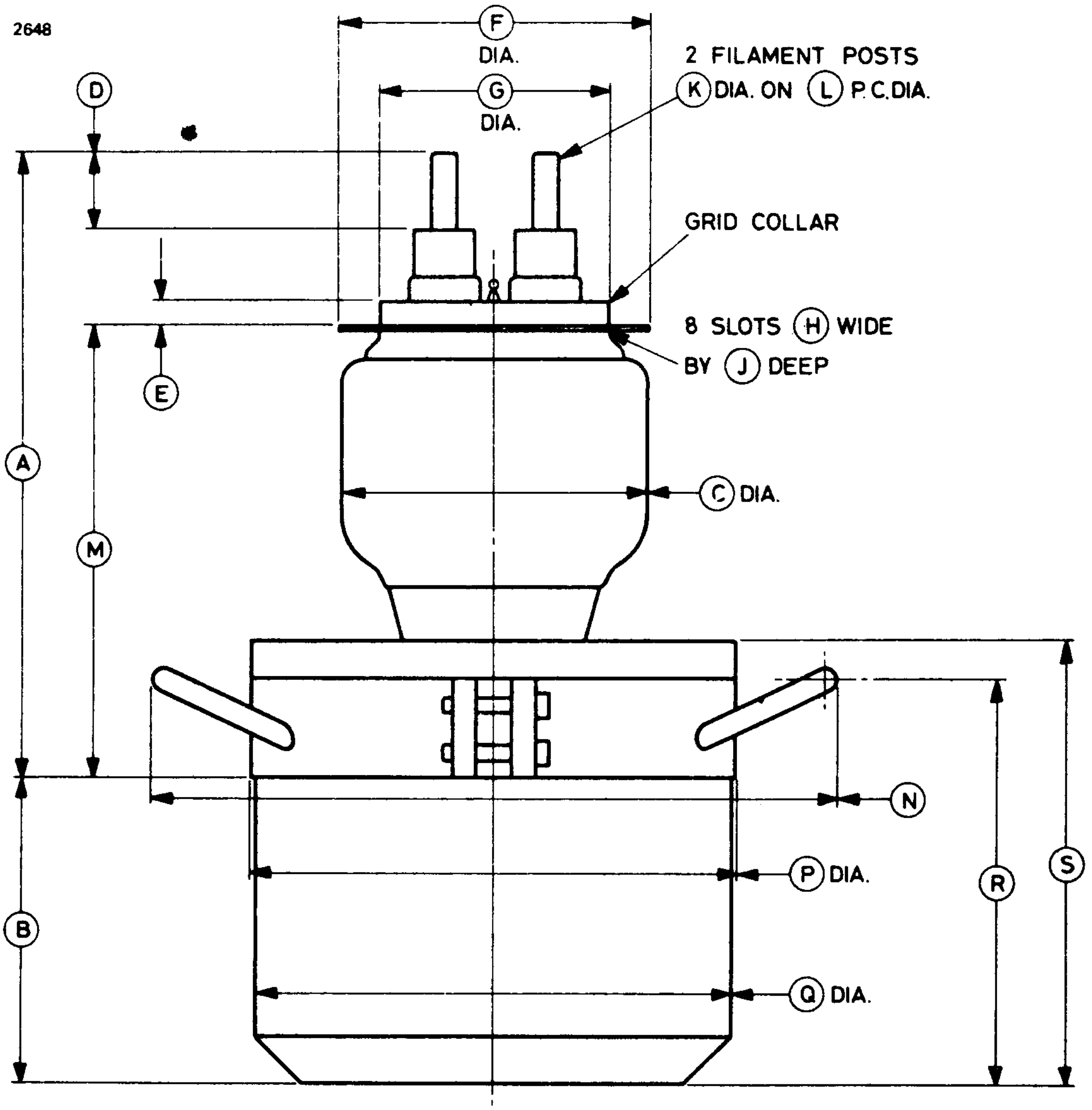




MINIMUM WATER COOLING REQUIREMENTS — BW1124J1, BW1124J2
(Higher rates of flow should be used where possible)



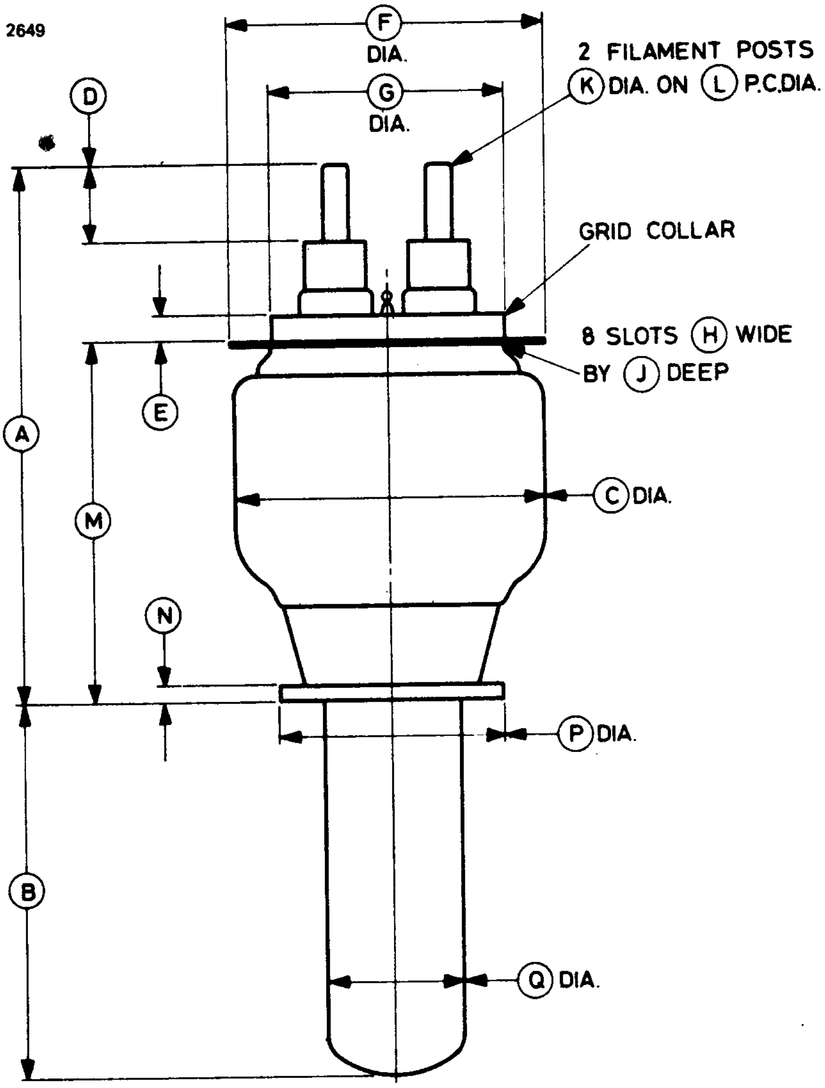
OUTLINE FOR BR1124 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.500 max	241.3 max	K	0.437	11.10
B	4.500	114.3	L	1.500	38.10
C	4.500	114.3	M	6.600 ± 0.200	167.6 ± 5.1
D	1.125	28.58	N	10.500 max	266.7 max
E	0.375	9.53	P	8.000 max	203.2 max
F	4.562	115.9	Q	7.062 max	179.4 max
G	3.750	95.25	R	5.937	150.8
H	0.182	4.62	S	6.500	165.1
J	0.205	5.21			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW1124 (All dimensions without limits are nominal)

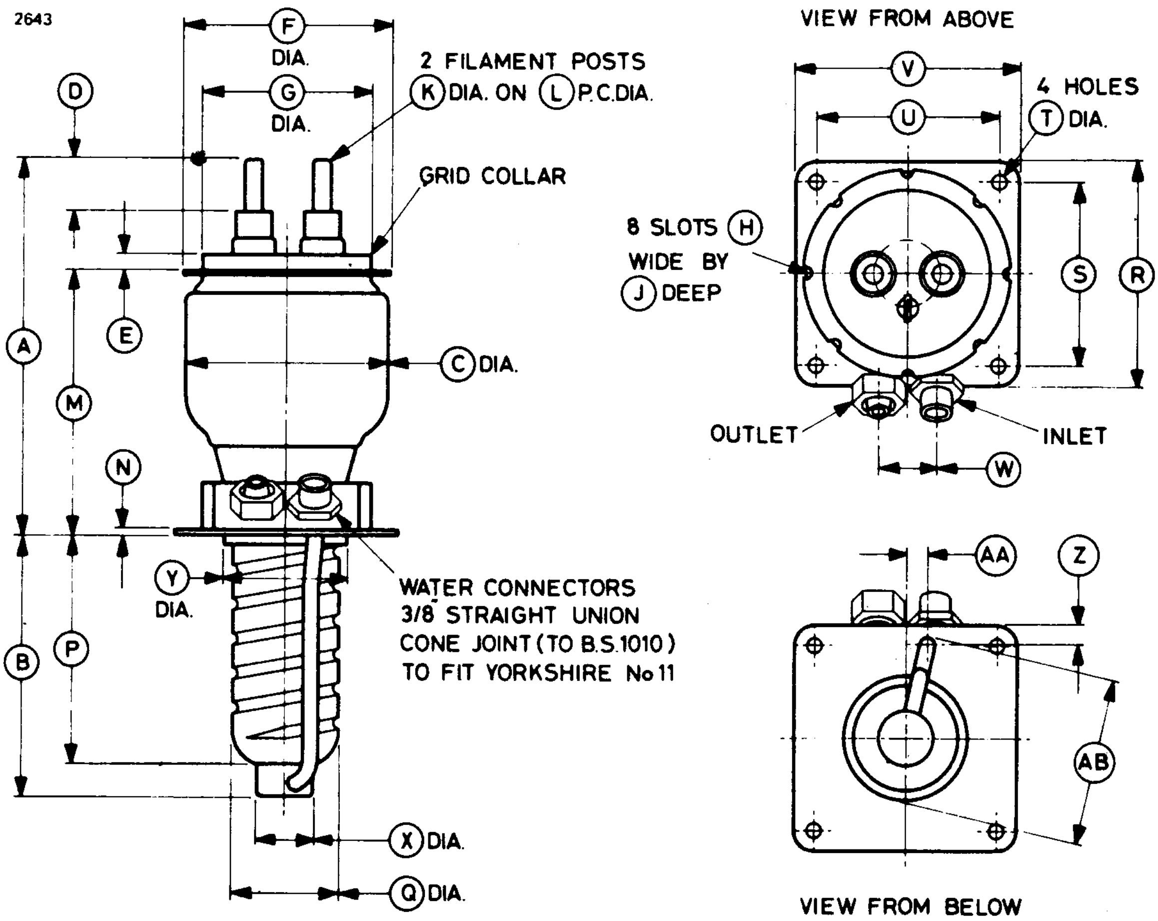


Ref	Inches	Millimetres
A	8.125 max	206.4 max
B	5.375	136.5
C	4.500	114.3
D	1.125	28.58
E	0.375	9.53
F	4.562	115.9
G	3.750	95.25
H	0.182	4.62

Ref	Inches	Millimetres
J	0.205	5.21
K	0.437	11.10
L	1.500	38.10
M	5.200 ± 0.200	132.1 ± 5.1
N	0.250	6.35
P	3.250	82.55
Q	2.000	50.80

Millimetre dimensions have been derived from inches.

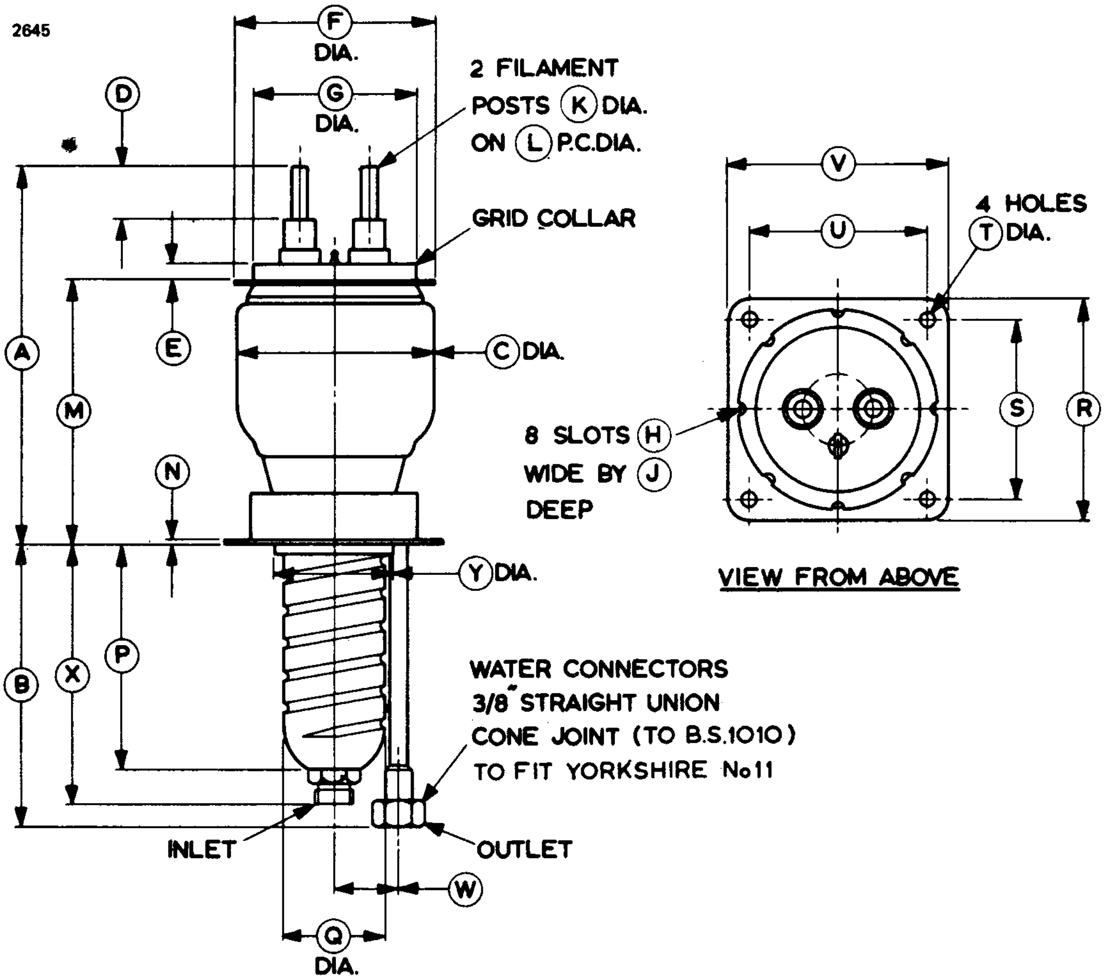
OUTLINE FOR BW1124J1 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.625 max	219.1 max	P	5.062	128.6
B	5.812	147.6	Q	2.306	58.57
C	4.500	114.3	R	5.000	127.0
D	1.125	28.58	S	4.000	101.6
E	0.375	9.53	T	0.257	6.53
F	4.562	115.9	U	4.000	101.6
G	3.750	95.25	V	5.000	127.0
H	0.182	4.62	W	1.250	31.75
J	0.205	5.21	X	1.250	31.75
K	0.437	11.10	Y	2.687	68.25
L	1.500	38.10	Z	0.469	11.91
M	5.896	149.8	AA	0.625	15.88
N	0.094	2.39	AB	3.625 max	92.08 max

Millimetre dimensions have been derived from inches.

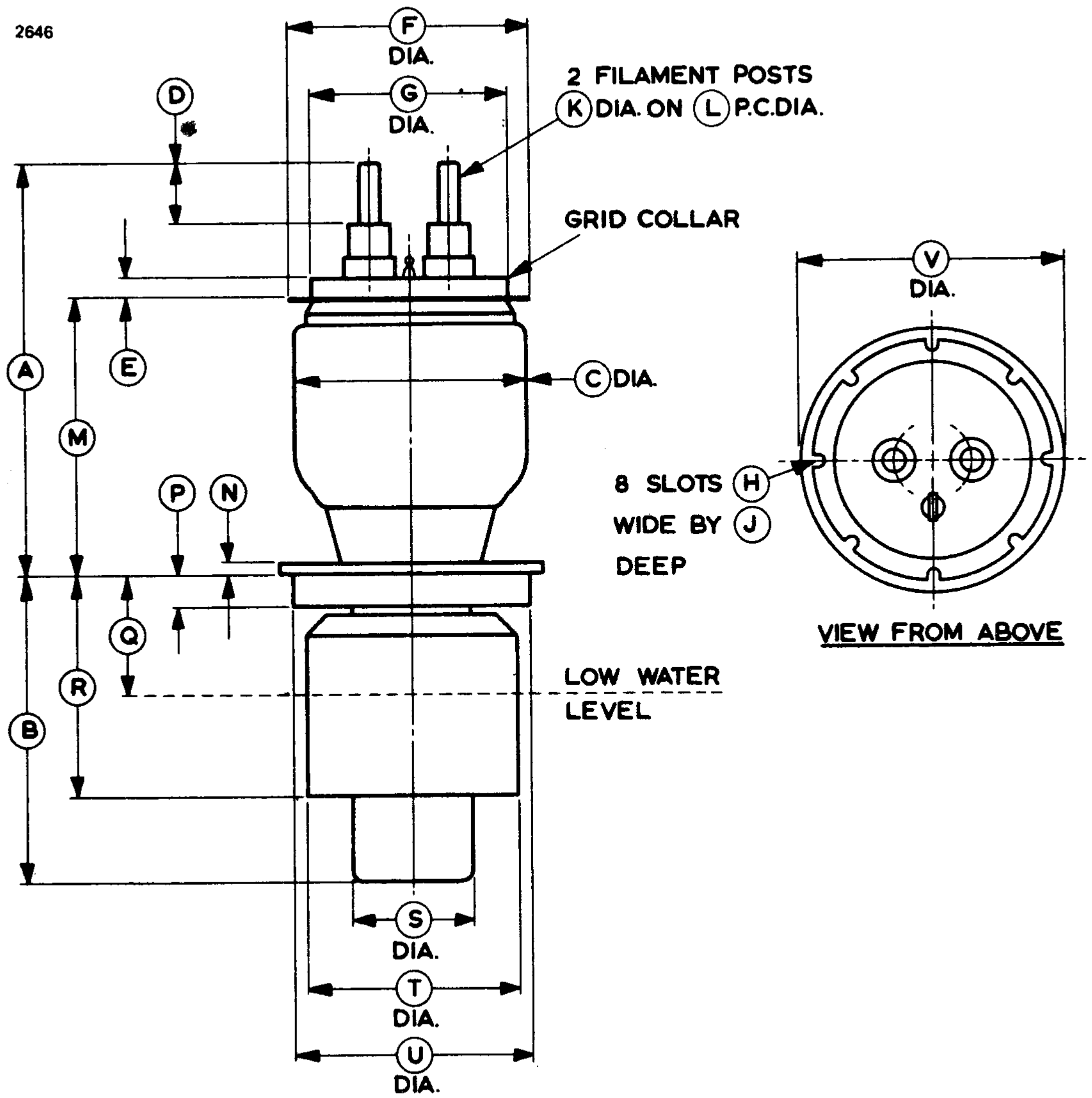
OUTLINE FOR BW1124J2 (All dimensions without tolerances are nominal)



Ref	Inches	Millimetres
A	8.625 max	219.1 max
B	6.250	158.8
C	4.500	114.3
D	1.125	28.58
E	0.375	9.53
F	4.562	115.9
G	3.750	95.25
H	0.182	4.62
J	0.205	5.21
K	0.437	11.10
L	1.500	38.10
M	5.896	149.8
N	0.094	2.39
P	5.000	127.0
Q	2.306	58.57
R	5.000	127.0
S	4.000	101.6
T	0.257	6.53
U	4.000	101.6
V	5.000	127.0
W	1.422	36.12
X	5.750	146.1
Y	2.687	68.25

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1124 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.000 max	203.2 max	L	1.500	38.10
B	5.813 max	147.7 max	M	5.350 max	135.9 max
C	4.500	114.3	N	0.250	6.35
D	1.125	28.58	P	0.625	15.88
E	0.375	9.53	Q	2.250	57.15
F	4.562	115.9	R	4.437	112.7
G	3.750	95.25	S	2.250	57.15
H	0.182	4.62	T	4.000	101.6
J	0.205	5.21	U	4.500	114.3
K	0.437	11.10	V	5.125	130.2

Millimetre dimensions have been derived from inches.

BR/BW1126

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling.

Anode cooling:		
BR1126		forced-air
BW1126		water; separate jacket
Anode dissipation	3.0	kW max
Anode voltage	6.0	kV max
Frequency for full ratings	30	MHz max
Frequency at reduced ratings	110	MHz max
Output power (class C unmodulated)	7.0	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	15	V
Filament current	39	A
Surge filament current (peak) (see note 2)	230	A max
Filament cold resistance	42	mΩ
Peak usable cathode current	14	A
Perveance	2.0	$mA/V^{3/2}$
Amplification factor (V_g = –25V, I_a = 0.75A)	30	
Mutual conductance (V_a = 2.5kV, I_a = 0.9A)	20	mA/V
Inter-electrode capacitances:		
grid to anode	23	pF
grid to filament	22.5	pF
anode to filament	0.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1126	9¾ pounds (4.45kg) approx
BW1126	4¼ pounds (2.0kg) approx
Mounting position	vertical, filament leads up

Accessories

Grid connector	MA66A
Water jacket for BW1126	BW4123
Sealing ring (supplied with BW1126)	MA315

COOLING

Anode

The BR1126 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously. The incoming air temperature must not exceed 45°C and the radiator temperature (measured on the core at the end away from the incoming air) must not exceed 180°C.

The anode of the BW1126 must be fitted into a water jacket for cooling, the recommended jacket being type BW4123. A flow of water of 1.5 to 2.0imp. gal/min (6.8 to 9.1 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 175°C and 150°C respectively. A flow of air of 10 to 15ft^3/min (0.28 to 0.43m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperatures of the seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 150°C.

R.F. POWER AMPLIFIER OR OSCILLATOR
(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	6.0	kV max
Anode current	1.75	A max
Anode dissipation (see note 4)	3.0	kW max
Grid voltage	−1.0	kV max
Grid current (see note 5)	0.35	A max
Operating frequency (for full ratings)	30	MHz max
Anode voltage for operation up to 110MHz	5.0	kV max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	4.0	6.0	kV
Grid voltage	−280	−350	V
Grid resistor	835	1130	Ω
Peak r.f. grid drive voltage	525	600	V
Anode current	1.54	1.63	A
Grid current (approx)	0.336	0.310	A
Anode dissipation	2.0	2.7	kW
Grid dissipation	69	66	W
Driving power	163	174	W
Output power	4.1	7.1	kW
Efficiency	66.5	72.5	%
Load resistance	1100	1750	Ω

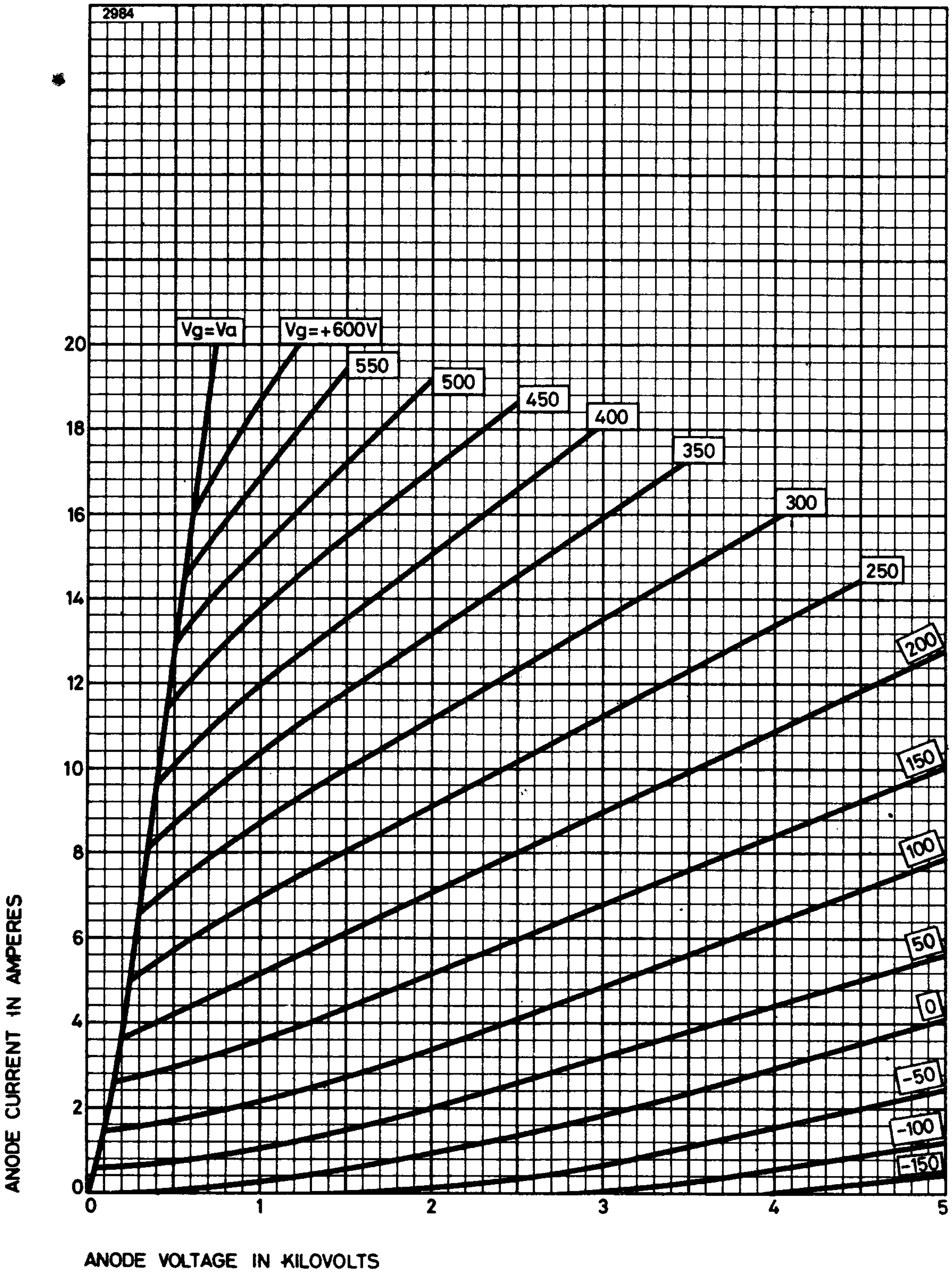
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 15V	36.6	41.3	A
Amplification factor (V_g = −25V, I_a = 0.75A)	25	35	
Mutual conductance (V_a = 2.5kV, I_a = 0.9A)	18	24	mA/V
Grid voltage (negative value) (V_a = 6.0kV, I_a = 50mA)	140	280	V
Grid voltage (negative value) (V_a = 6.0kV, I_a = 0.55A)	120	240	V
Anode current (V_a = 0.3kV, V_g = +150V)	2.13	3.24	A
Grid current (V_a = 0.3kV, V_g = +150V)	–	1.44	A
Inter-electrode capacitances:			
grid to anode	19.5	26.5	pF
grid to filament	18	27	pF
anode to filament	0.25	0.75	pF

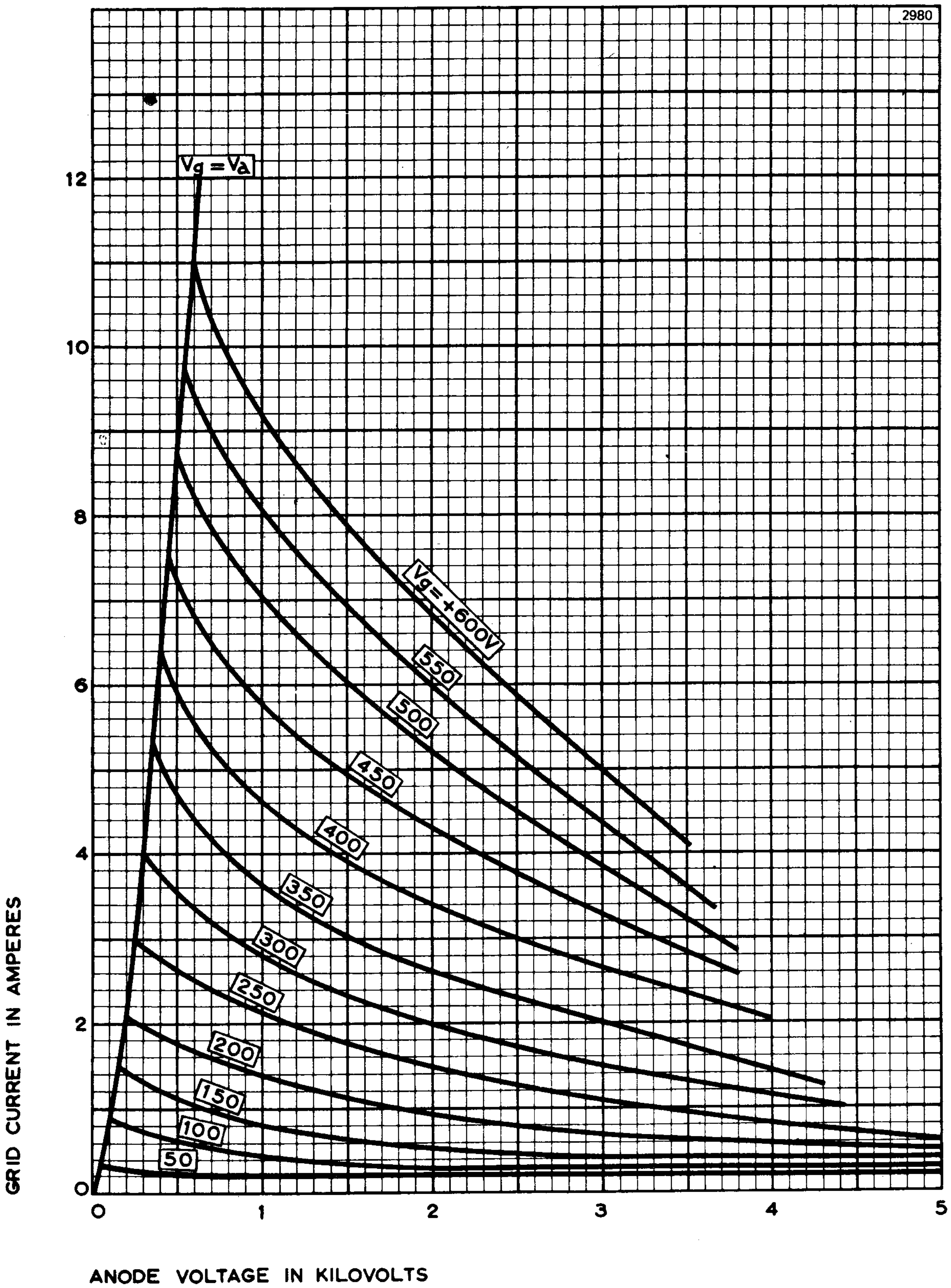
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed $\pm$5%. The centre-tap lead may be used for the anode current return but must not be used for the filament current supply.
2. The filament current must not exceed 230A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.
5. The customer should consult English Electric Valve Company Ltd. if the valve is to be used in r.f. oscillators operating at frequencies of 30MHz or more and where the direct grid current is likely to exceed 250mA.

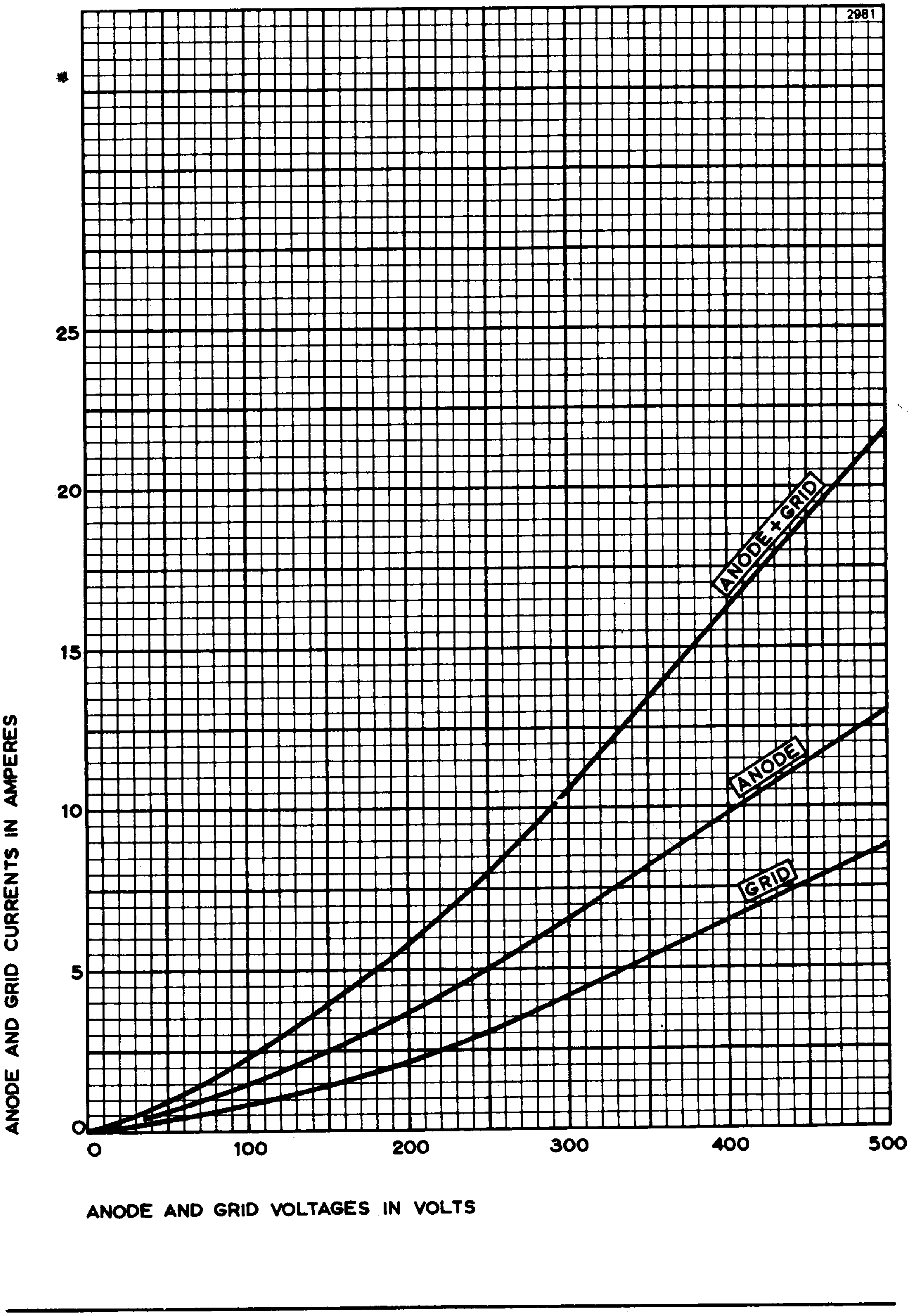
TYPICAL ANODE CHARACTERISTICS



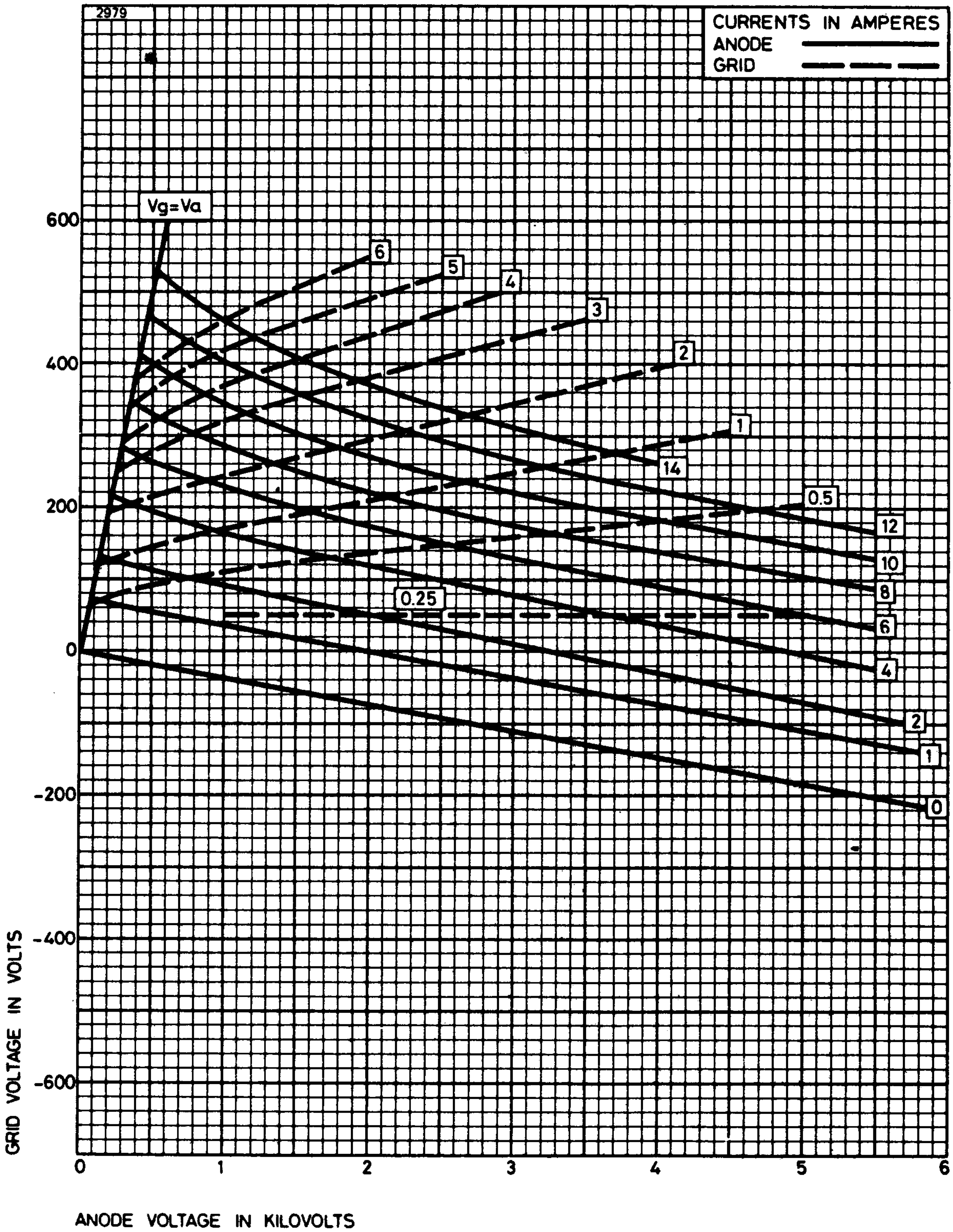
TYPICAL GRID CHARACTERISTICS



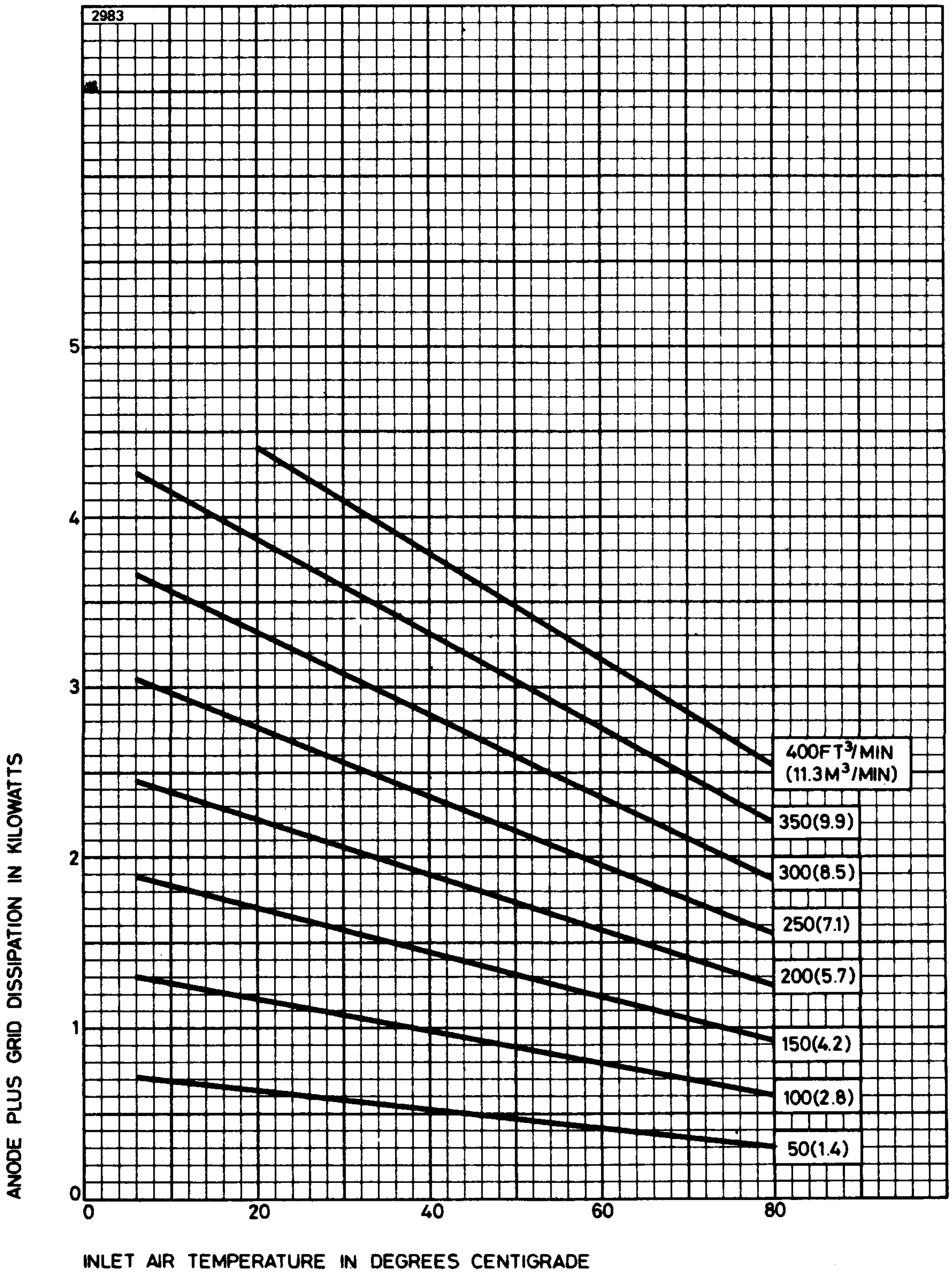
TYPICAL STRAPPED CHARACTERISTICS



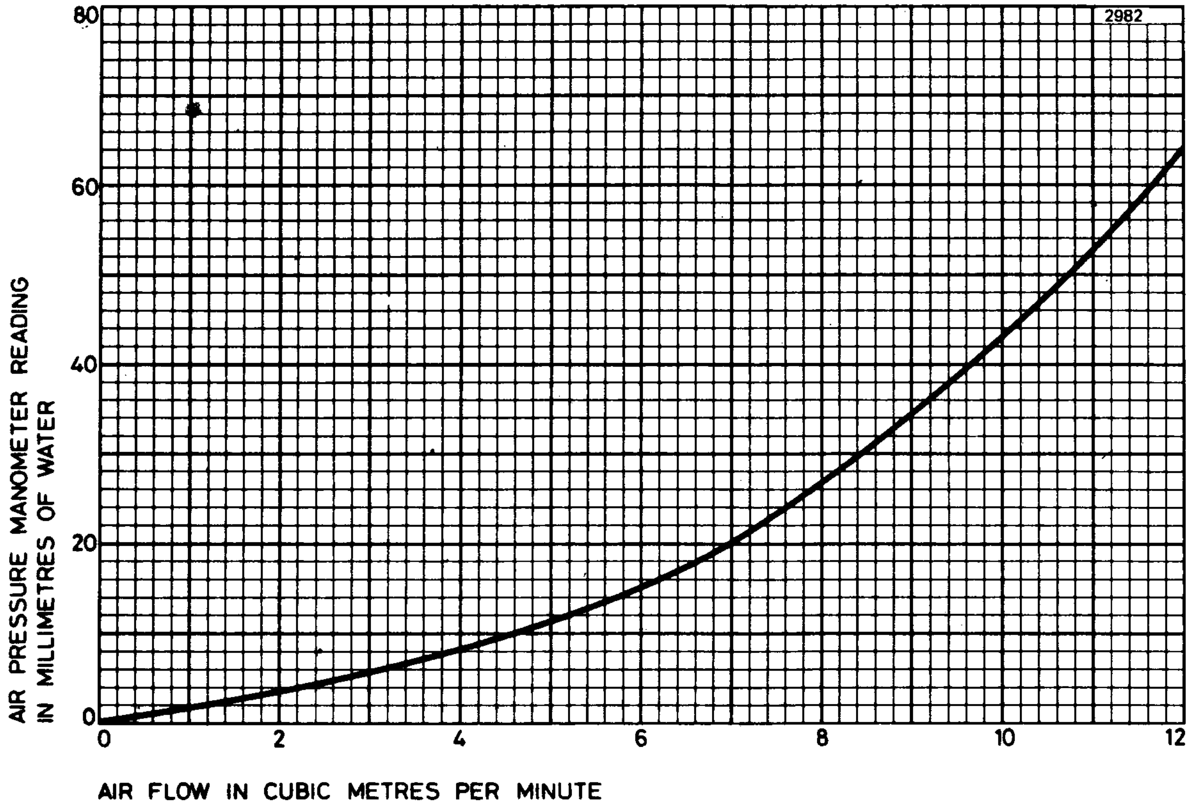
TYPICAL CONSTANT CURRENT CHARACTERISTICS

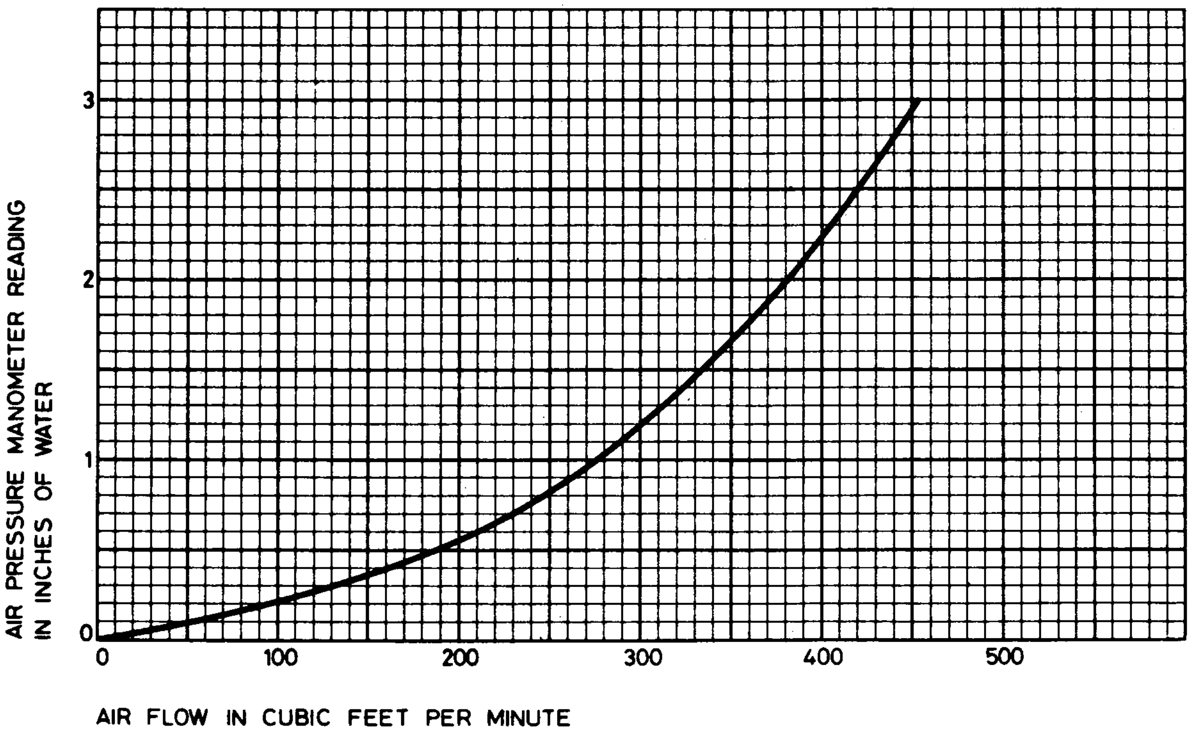


AIR COOLING REQUIREMENTS FOR BR1126

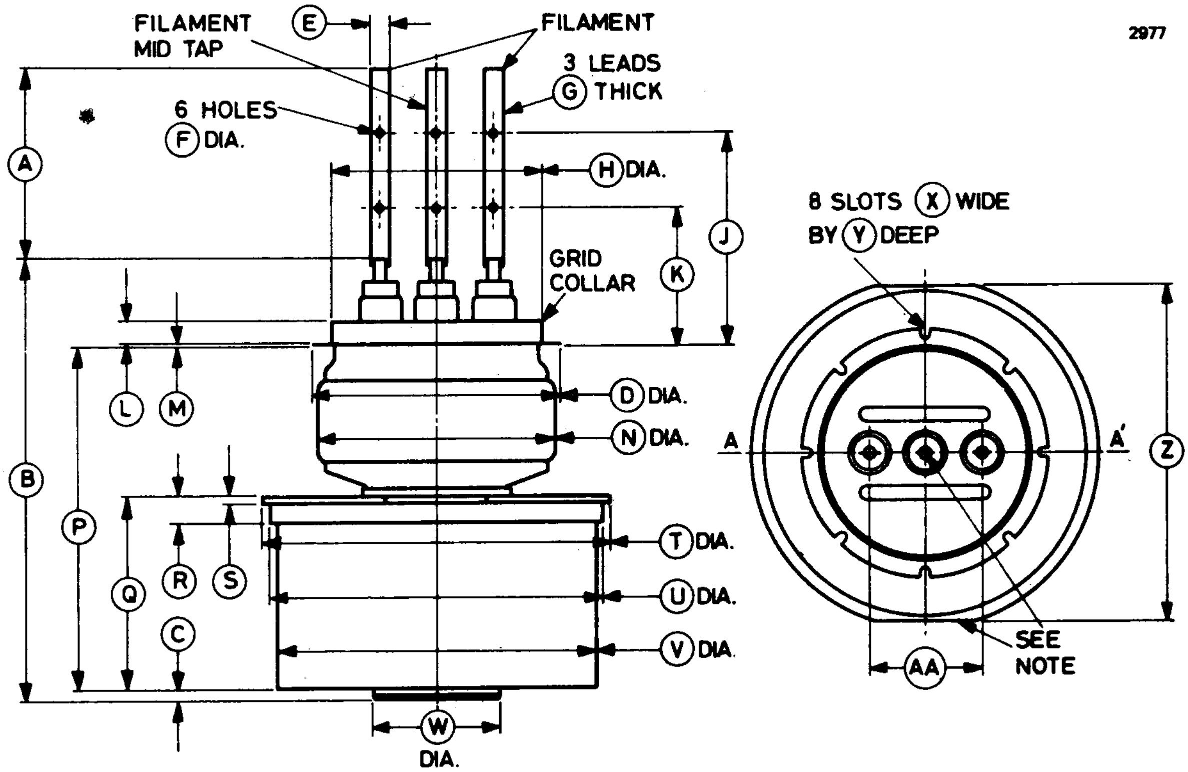


TYPICAL AIR FLOW CHARACTERISTIC FOR BR1126





OUTLINE FOR BR1126

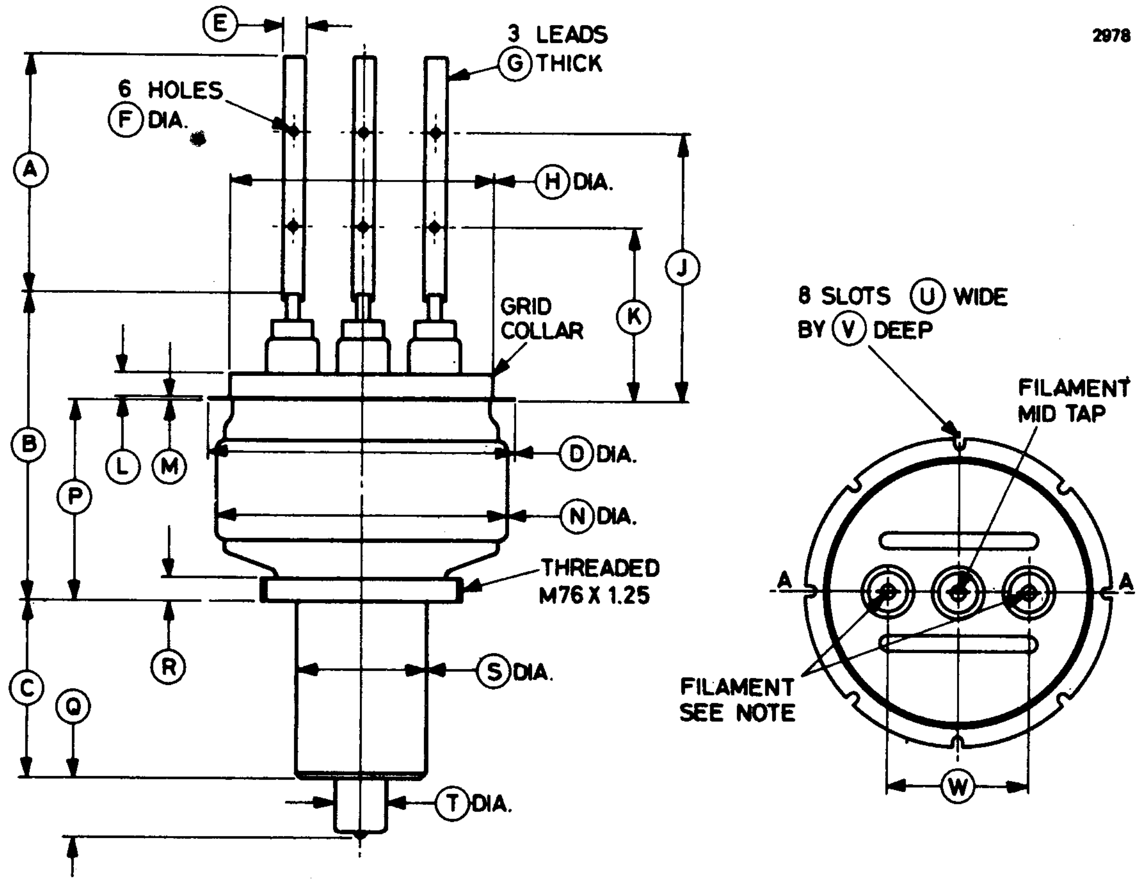


Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	89.0 ± 2.0	3.504 ± 0.079	P	153.5 ± 3.5	6.043 ± 0.138
B	200.0 max	7.874 max	Q	90.0 max	3.543 max
C	4.75 max	0.187 max	R	12.5 ± 0.5	0.492 ± 0.020
D	116.0 ± 0.5	4.567 ± 0.020	S	3.25 ± 0.25	0.128 ± 0.010
E	8.0 ± 0.5	0.315 ± 0.020	T	165.0 ± 0.5	6.496 ± 0.020
F	3.6 ± 0.1	0.142 ± 0.004	U	158.75 ± 0.25	6.250 ± 0.010
G	4 x 0.25	4 x 0.010	V	152.5 max	6.004 max
H	100.0 max	3.937 max	W	60.0 max	2.362 max
J	100.0 ± 8.0	3.937 ± 0.315	X	4.62 ± 0.1	0.182 ± 0.004
K	65.0 ± 8.0	2.559 ± 0.315	Y	5.2 ± 0.2	0.205 ± 0.008
L	9.5	0.375	Z	158.75 ± 0.25	6.250 ± 0.010
M	1.5 ± 0.2	0.059 ± 0.008	AA	54.0 ± 2.5	2.126 ± 0.098
N	116.0 max	4.567 max			

Inch dimensions have been derived from millimetres.

Note The plane of the filament leads will be parallel to the flats to within 5° and to plane A-A' to within 3½°.

OUTLINE FOR BW1126



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	89.0 ± 2.0	3.504 ± 0.079	M	1.5 ± 0.2	0.059 ± 0.008
B	116.0 max	4.567 max	N	116.0 max	4.567 max
C	66.5 ± 0.5	2.618 ± 0.020	P	75.0 ± 3.5	2.953 ± 0.138
D	116.0 ± 0.5	4.567 ± 0.020	Q	20.0 max	0.787 max
E	8.0 ± 0.5	0.315 ± 0.020	R	9.0 ± 0.25	0.354 ± 0.010
F	3.6 ± 0.1	0.142 ± 0.004	S	50.0 ± 1.0	1.969 ± 0.039
G	4 x 0.25	4 x 0.010	T	24.0 ± 0.5	0.945 ± 0.020
H	100.0 max	3.937 max	U	4.62 ± 0.1	0.182 ± 0.004
J	100.0 ± 8.0	3.937 ± 0.315	V	5.2 ± 0.2	0.205 ± 0.008
K	65.0 ± 8.0	2.559 ± 0.315	W	54.0 ± 2.5	2.126 ± 0.098
L	9.5	0.375			

Inch dimensions have been derived from millimetres.

Note The plane of the filament leads will be parallel to plane A-A′ to within 3½°.

BR/BW/BY1143 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Four r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling and in anode dissipation.

Anode cooling:		
BR1143	forced-air	
BW1143	water; separate jacket	
BW1143J2	water; integral jacket	
BY1143	vapour; separate boiler unit	
Anode dissipation:		
BR1143	20	kW max
BW1143, BW1143J2	30	kW max
BY1143	35	kW max
Anode voltage	10	kV max
Frequency for full ratings	10	MHz max
Output power (class C unmodulated)	77.5	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	12	V
Filament current	240	A
Surge filament current (peak) (see note 2)	625	A max
Filament cold resistance	5.9	mΩ
Peak usable cathode current	95	A
Amplification factor (V_a = 5.0kV, I_a = 5.0A)	37	
Mutual conductance (V_a = 6.0kV, I_a = 3.5A)	85	mA/V
Perveance	5.8	$mA/V^{3/2}$
Inter-electrode capacitances:		
grid to anode	105	pF
grid to filament	185	pF
anode to filament	2.7	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1143	109 pounds (50kg) approx
BW1143	23 pounds (10.5kg) approx
BW1143J2	32 pounds (14.5kg) approx
BY1143	70 pounds (32kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads	MA130
Grid connector	MA66
Water jacket for BW1143	BW4050
Sealing ring (supplied with BW1143)	MA254
Single boiler unit, separate condenser required, for BY1143	BY4037A
Single boiler unit, integral condenser, for BY1143	BY4038
Double boiler unit, integral condenser, for BY1143	BY4038A
Sealing ring (supplied with BY1143)	MA255

COOLING

Anode

The BR1143 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

The anode of the BW1143 must be fitted into a water jacket for cooling, the recommended jacket being type BW4050. BW1143J2 has an integral water jacket. Minimum water cooling requirements for both types are shown on page 11; higher values should be used where possible.

The BY1143 is vapour cooled and may be operated either singly in boiler unit BY4037A or BY4038, or in pairs in boiler unit BY4038A. In BY4038 and BY4038A, the steam generated by the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4037A is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20ft^3/min (0.57m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of the seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	10	kV max
Anode current	12	A max
Anode input power	100	kW max
Anode dissipation:		
BR1143	20	kW max
BW1143, BW1143J2	30	kW max
BY1143	35	kW max
Grid dissipation	1.75	kW max
Operating frequency (for full ratings)	10	MHz max

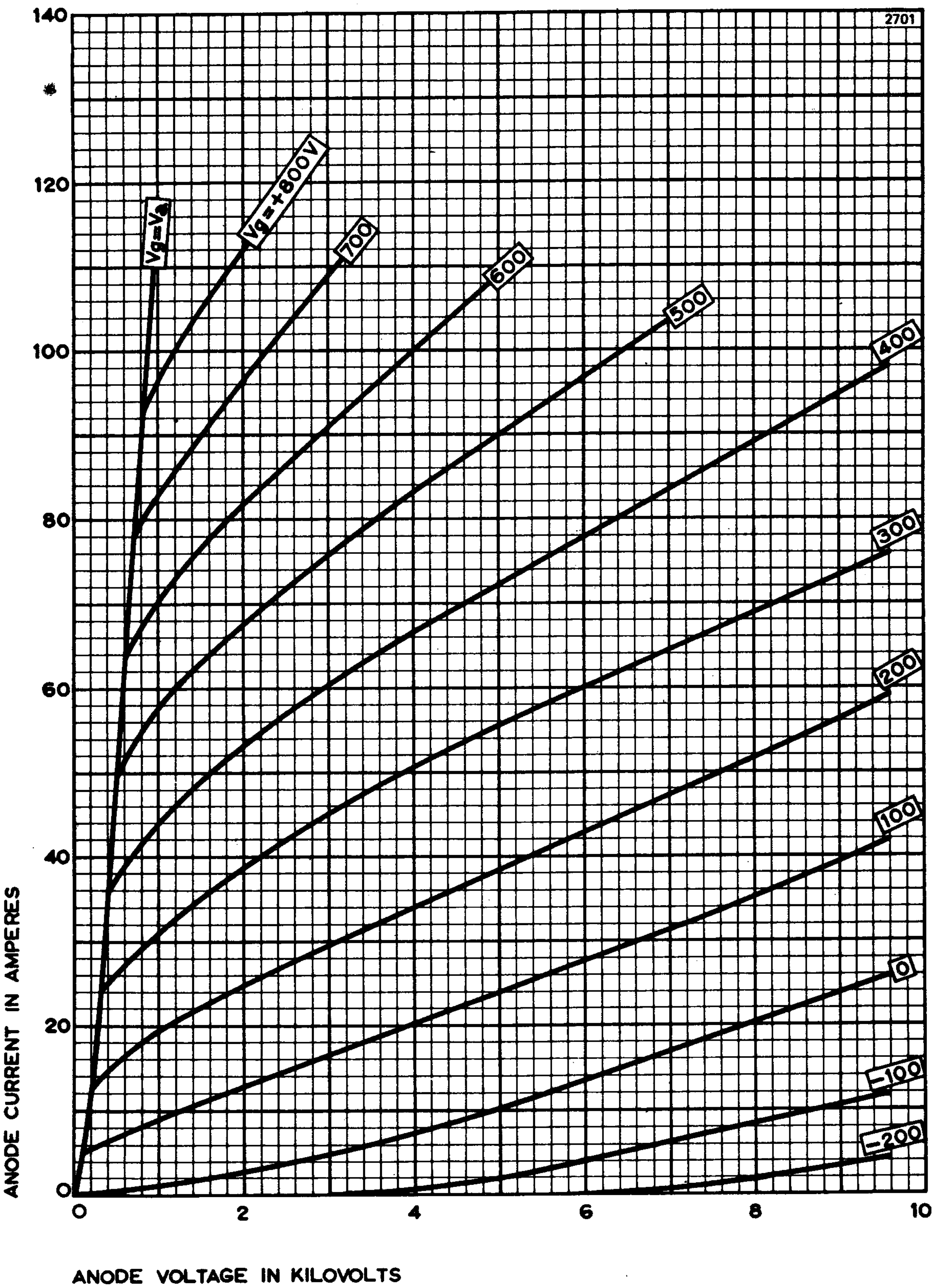
TYPICAL OPERATING CONDITIONS (for oscillator)

Anode voltage	6.0	10	kV
Grid voltage	−320	−540	V
Peak r.f. grid drive voltage	750	940	V
Anode current	11.2	9.4	A
Grid current (approx)	1.78	1.67	A
Anode dissipation	14.4	14.8	kW
Grid dissipation (approx)	760	670	W
Driving power (approx)	1330	1570	W
Output power (see note 3)	51.5	77.5	kW
Efficiency	78.5	84	%

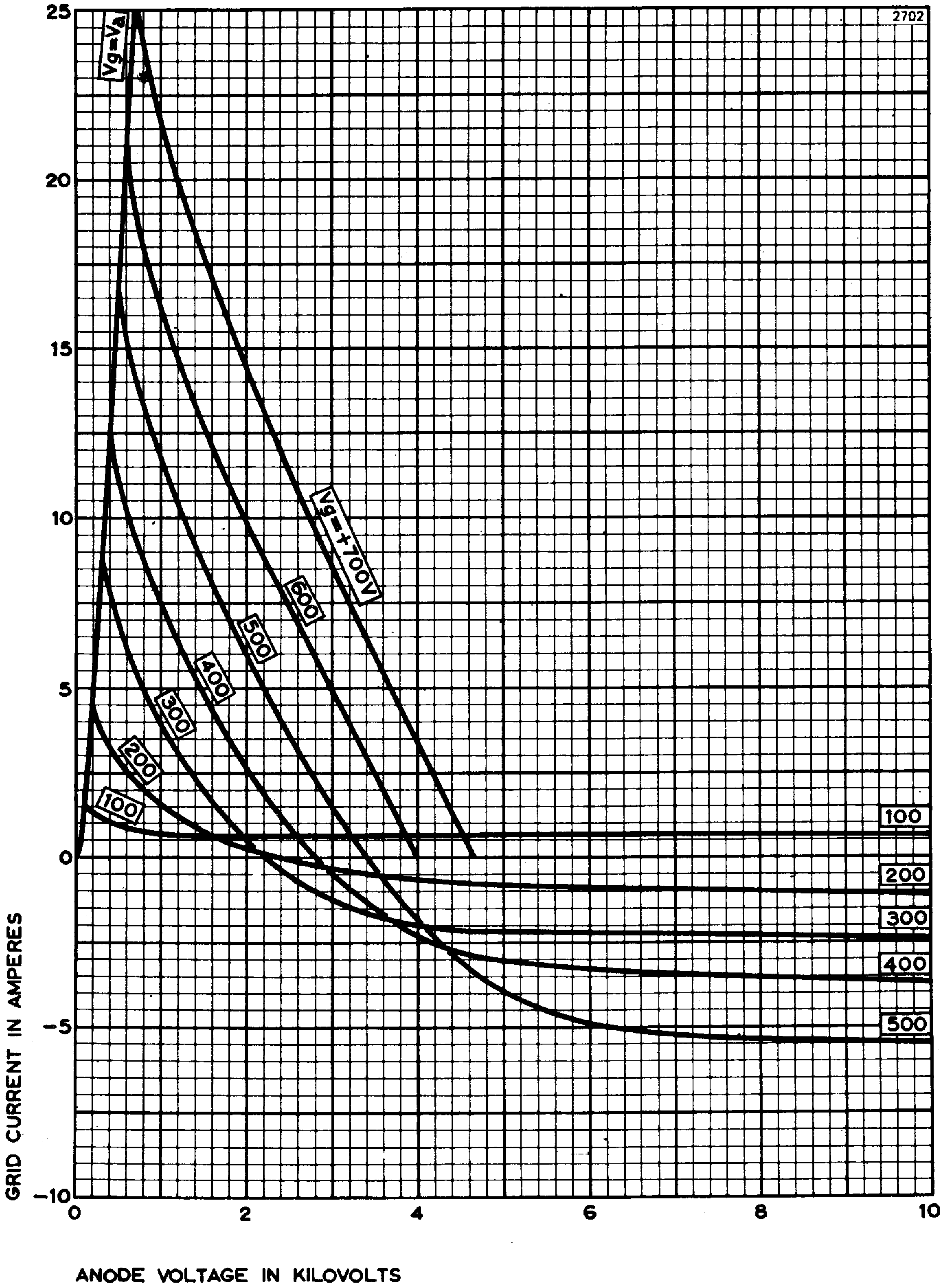
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 625A, even momentarily, at any time.
3. Power in anode circuit after the grid circuit driving power has been deducted. This does not take into account the anode circuit efficiency.

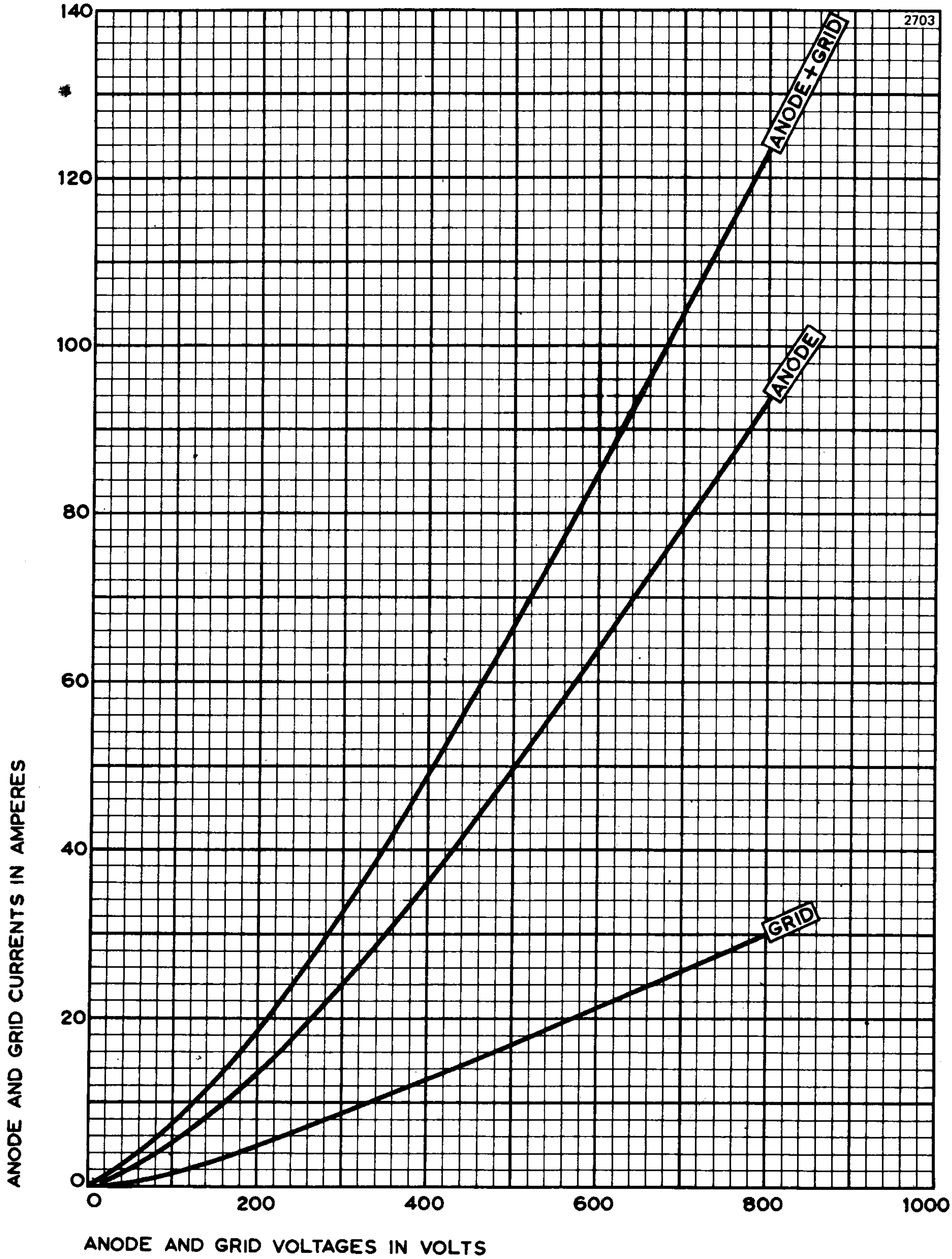
TYPICAL ANODE CHARACTERISTICS



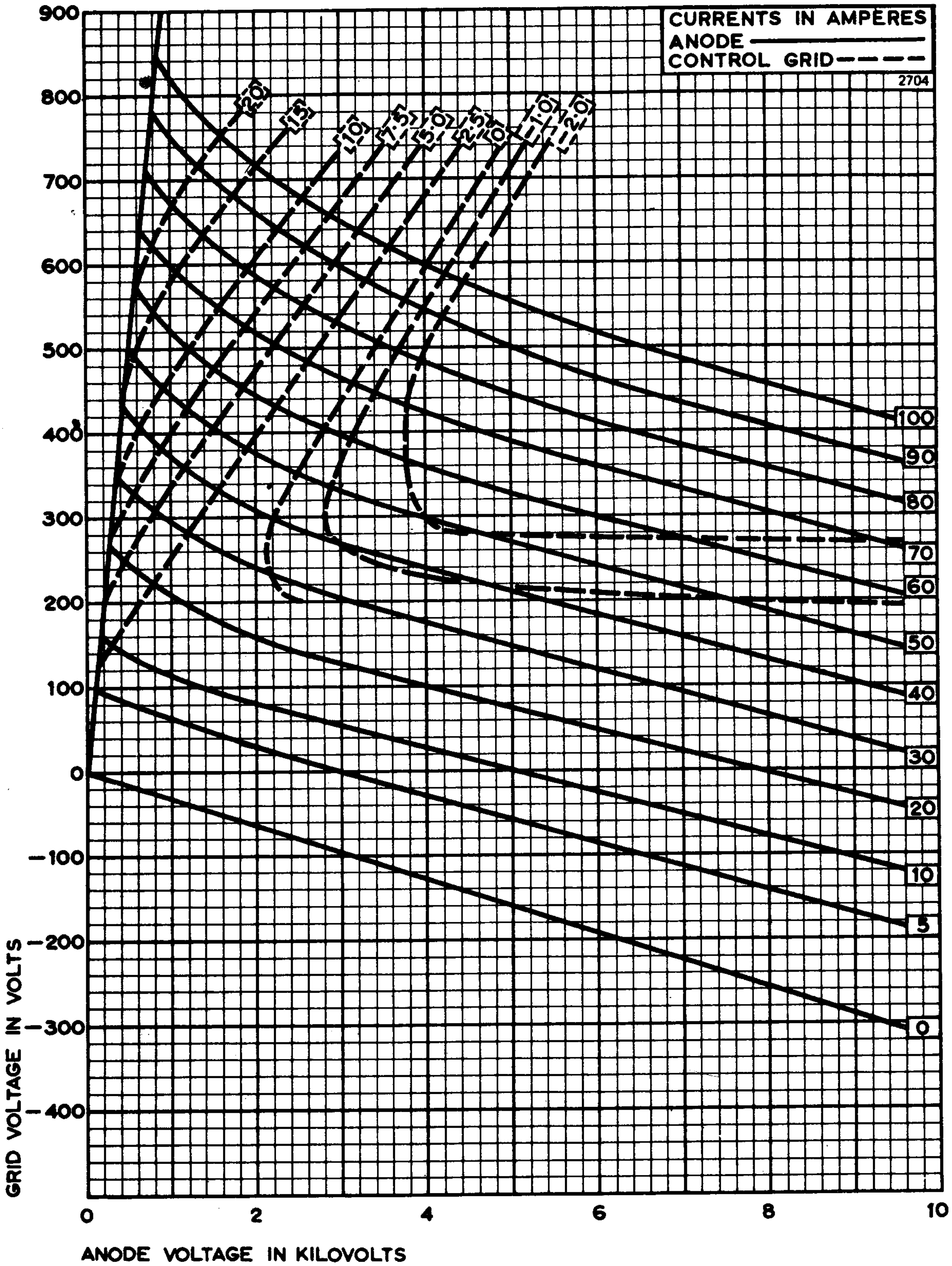
TYPICAL GRID CHARACTERISTICS



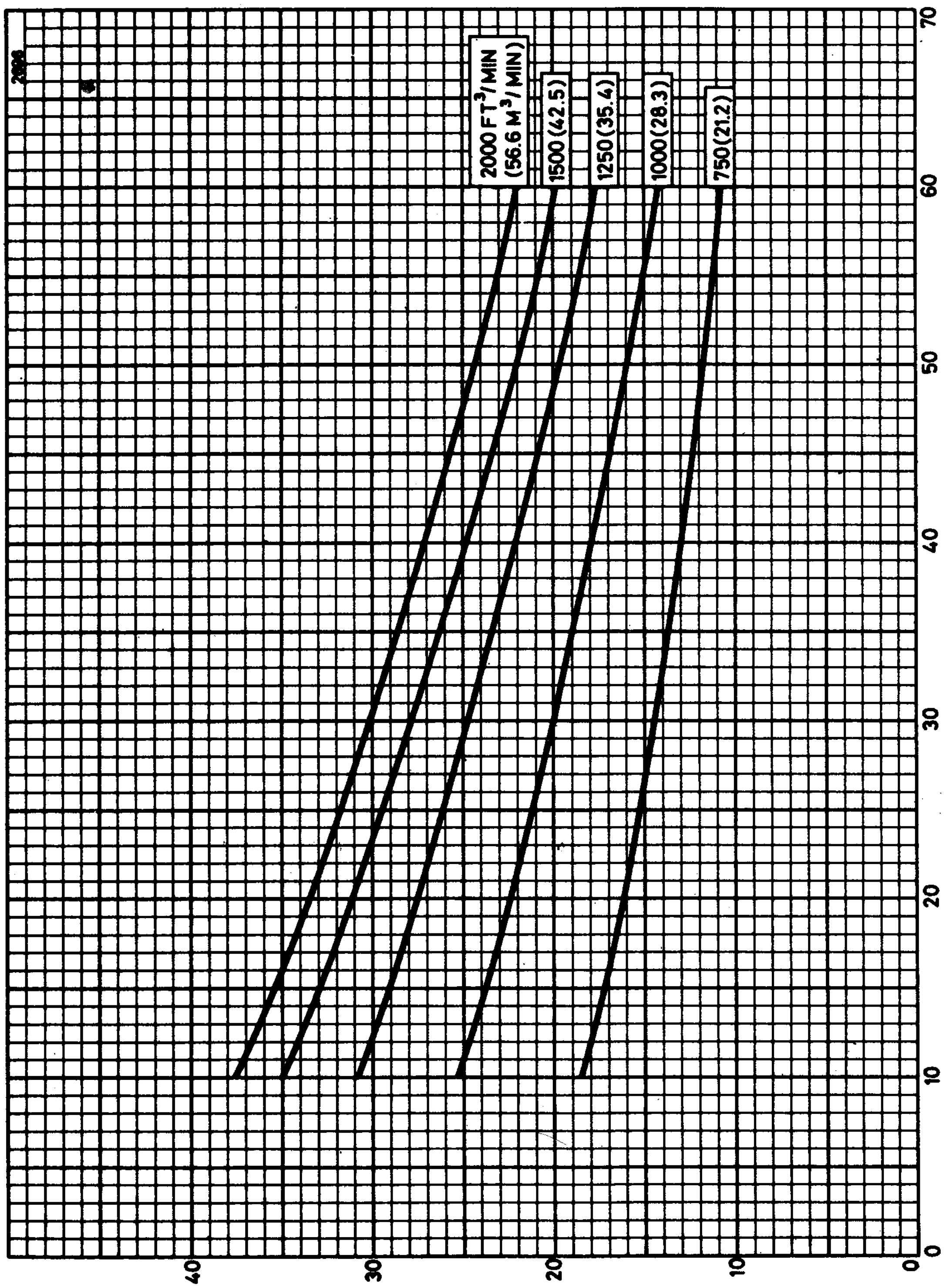
TYPICAL STRAPPED CHARACTERISTICS



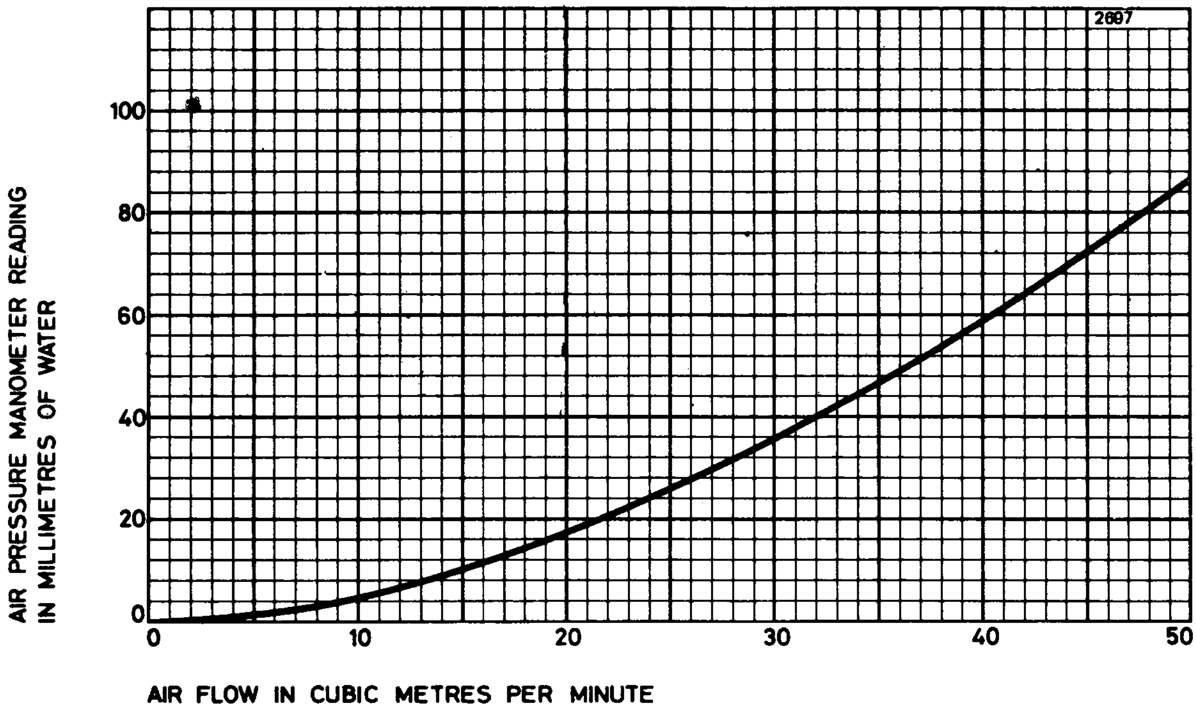
TYPICAL CONSTANT CURRENT CHARACTERISTICS

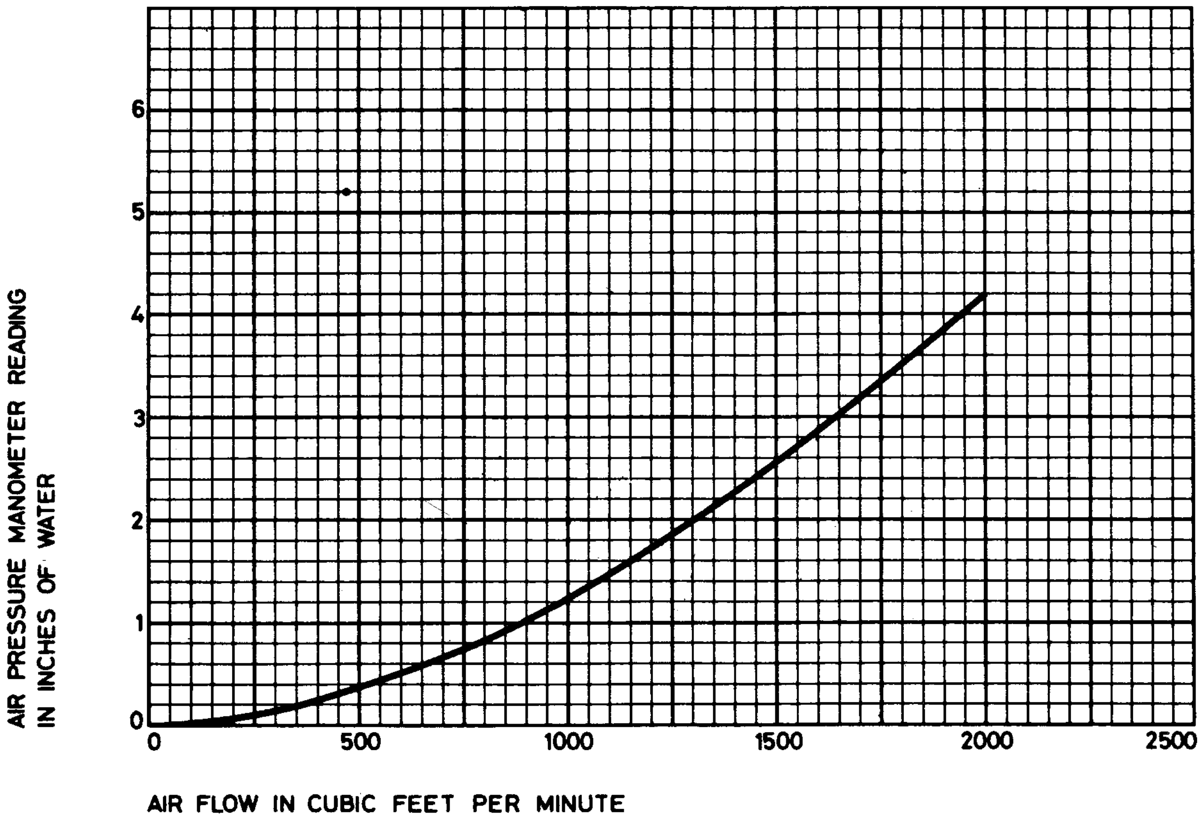


AIR COOLING REQUIREMENTS FOR BR1143

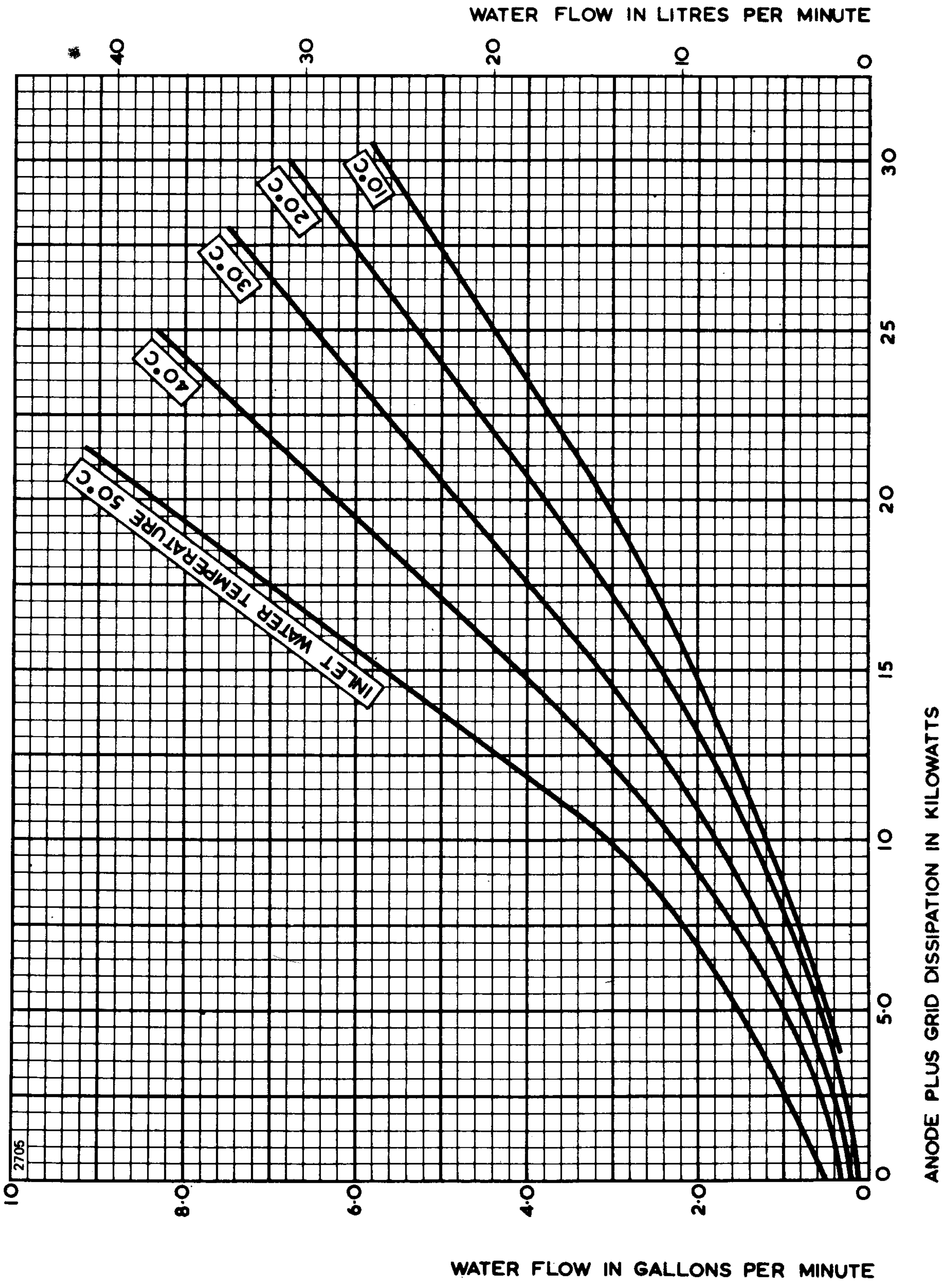


AIR FLOW CHARACTERISTIC FOR BR1143



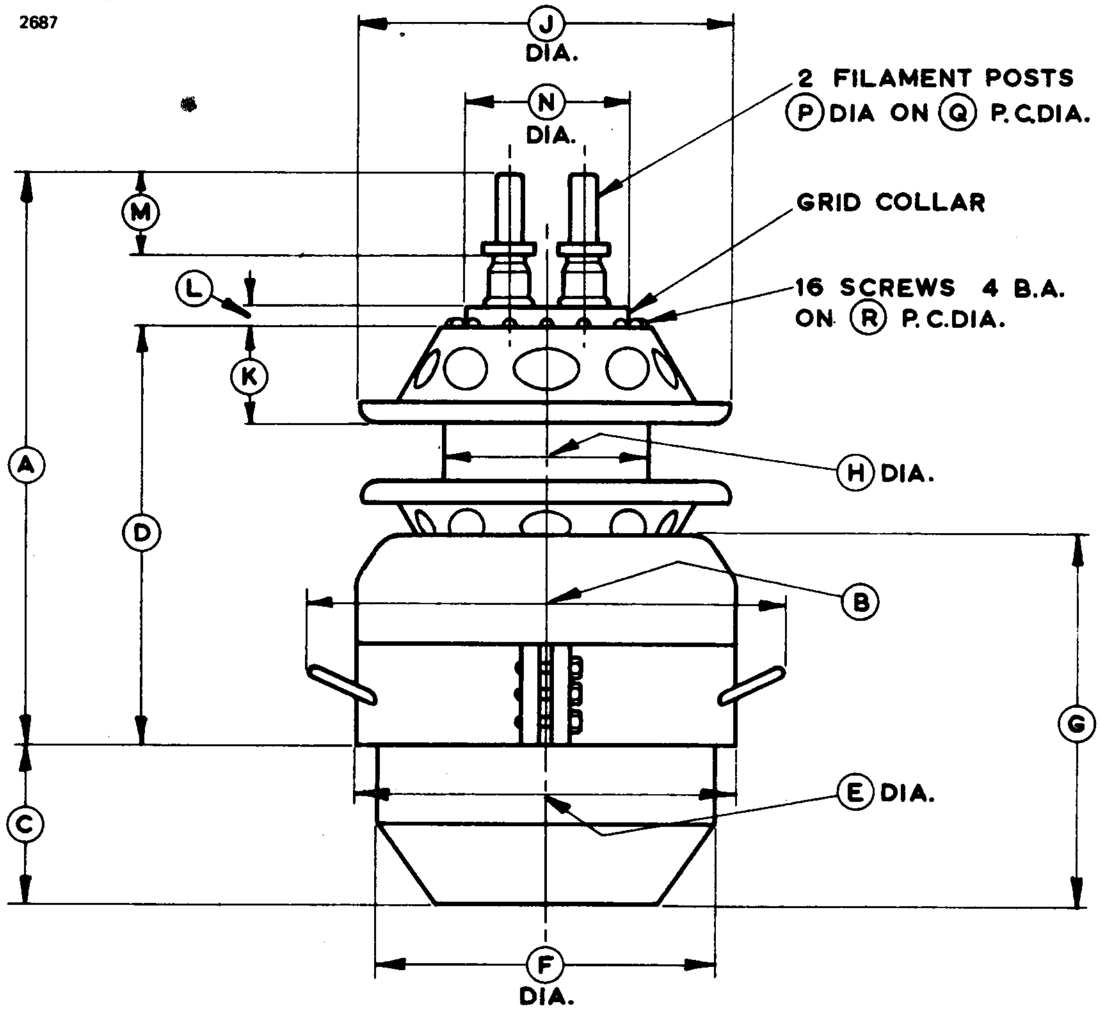


MINIMUM WATER COOLING REQUIREMENTS FOR BW1143, BW1143J2
(Higher rates of flow should be used where possible)



OUTLINE FOR BR1143 (All dimensions without limits are nominal)

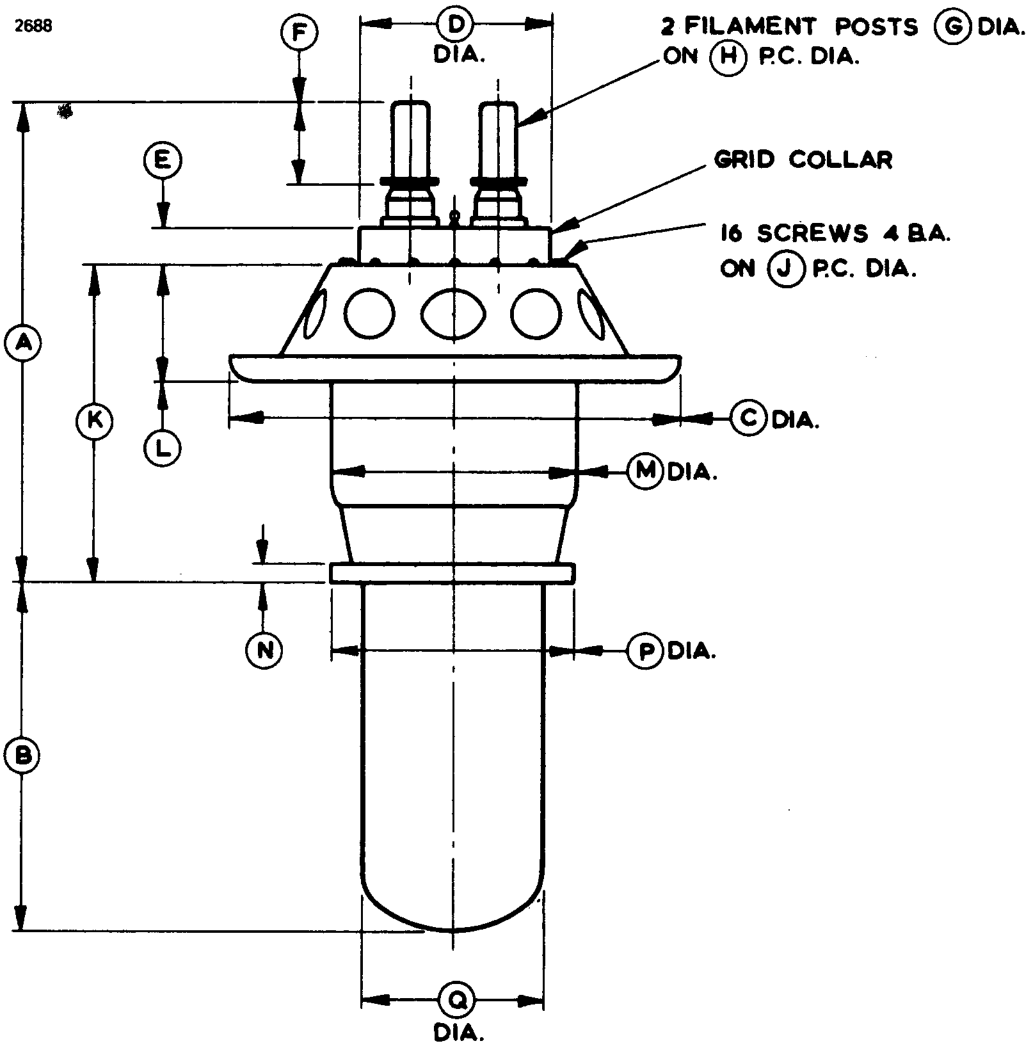
2687



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	16.750 max	425.5 max	J	11.000 max	279.4 max
B	14.000 max	355.6 max	K	2.906 max	73.81 max
C	4.750	120.7	L	0.687	17.45
D	12.875 max	327.0 max	M	2.000	50.80
E	11.000	279.4	N	4.703	119.5
F	10.062 max	255.6 max	P	0.875	22.23
G	11.000	279.4	Q	2.250	57.15
H	6.000	152.4	R	5.375	136.5

Millimetre dimensions have been derived from inches.

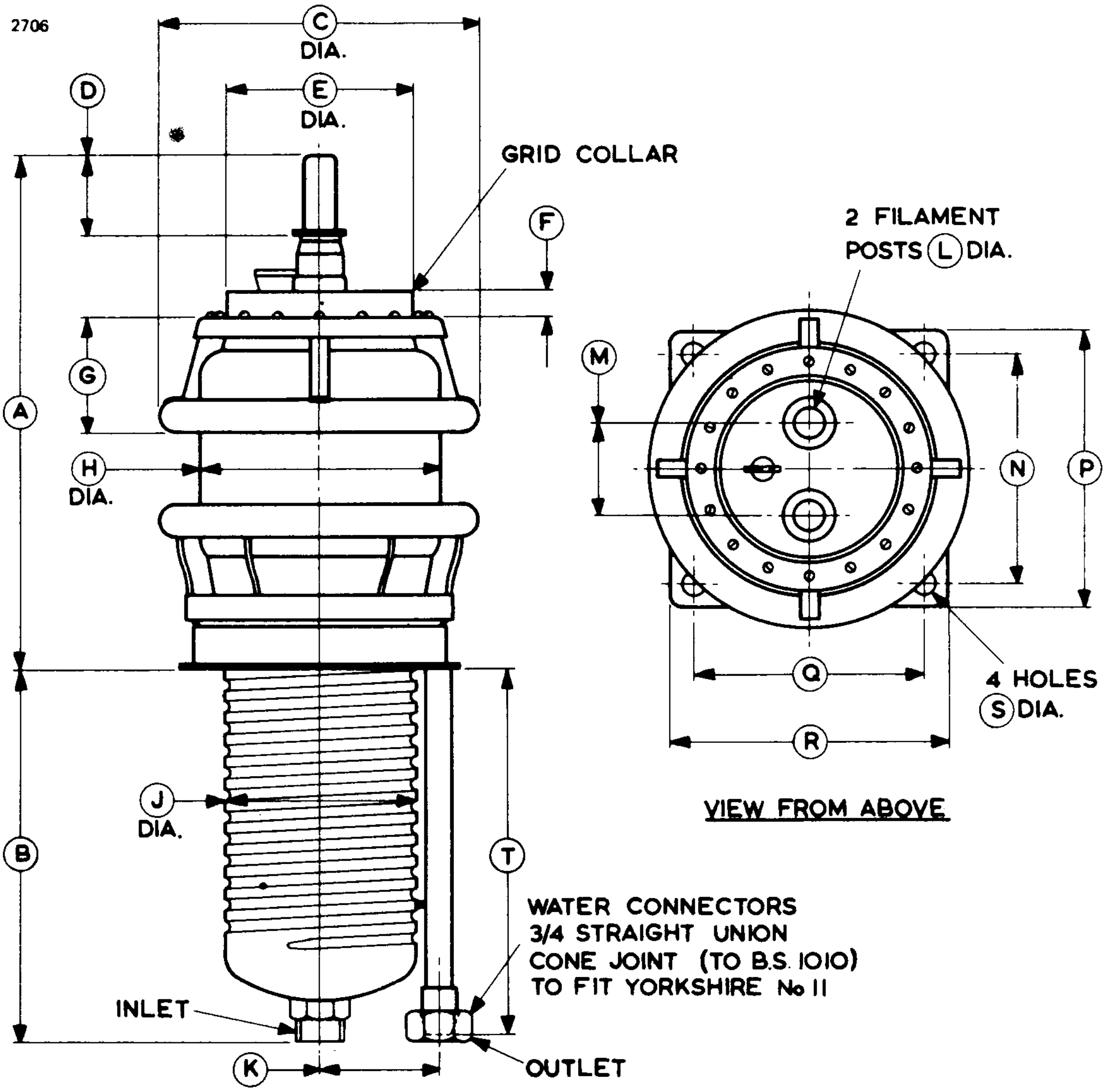
OUTLINE FOR BW1143 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	12.000 max	304.8 max	J	5.375	136.5
B	8.625	219.1	K	7.875 max	200.0 max
C	11.000 max	279.4 max	L	2.906 max	73.81 max
D	4.703	119.5	M	6.000	152.4
E	0.687	17.45	N	0.500	12.70
F	2.000	50.80	P	5.760 max	146.3 max
G	0.875	22.23	Q	4.500	114.3
H	2.250	57.15			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW1143J2 (All dimensions without limits are nominal)

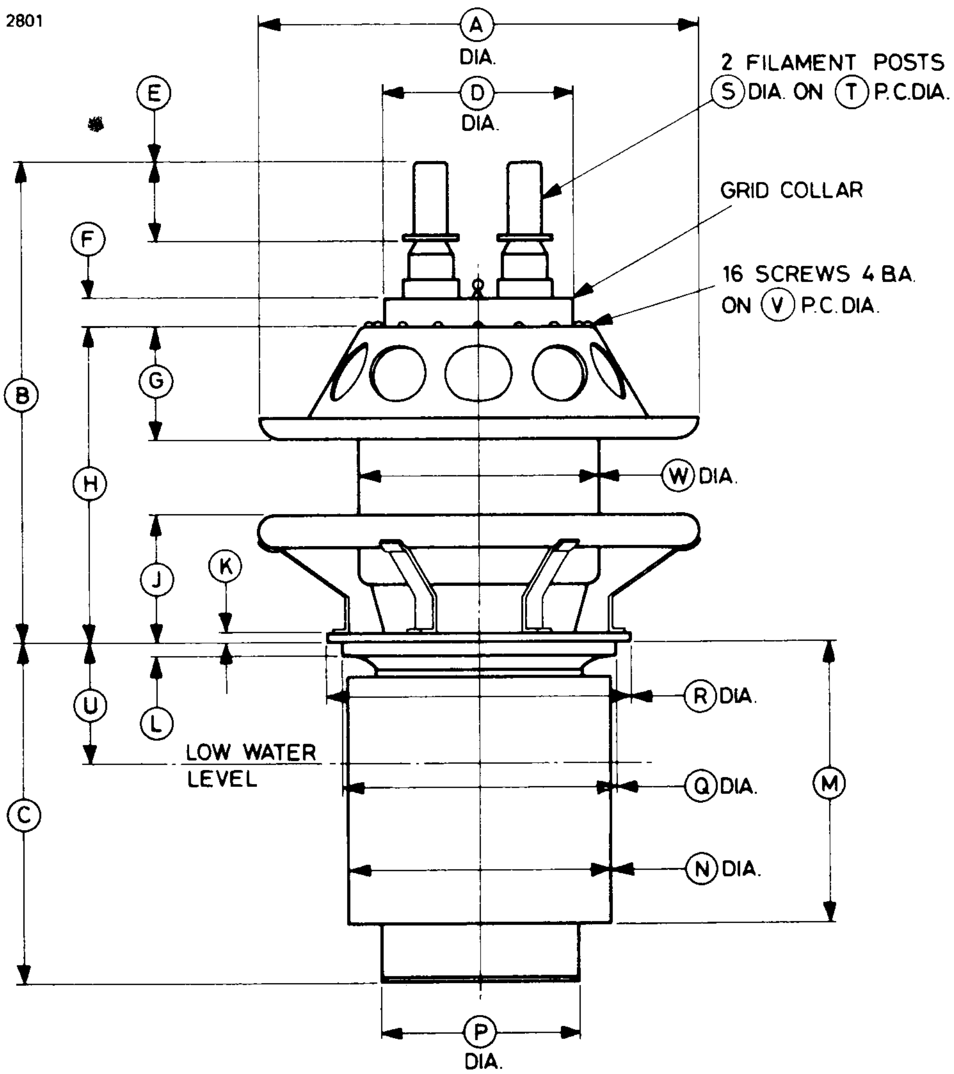


Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	12.889 max	327.4 max	K	2.937	74.60
B	9.375	238.1	L	0.875	22.23
C	8.062 max	204.8 max	M	2.250	57.15
D	2.000	50.80	N	5.750	146.1
E	4.703	119.5	P	7.000	177.8
F	0.687	17.45	Q	5.750	146.1
G	2.906 max	73.81 max	R	7.000	177.8
H	6.000	152.4	S	0.375	9.53
J	4.817 max	122.4 max	T	10.000	254.0

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1143 (All dimensions without limits are nominal)

2801



Ref	Inches	Millimetres
A	11.000 max	279.4 max
B	12.109 max	307.6 max
C	8.452	214.7
D	4.703	119.5
E	2.000	50.80
F	0.687	17.45
G	2.906 max	73.81 max
H	8.053 max	204.5 max
J	3.312 max	84.12 max
K	0.250	6.35
L	0.375	9.53

Ref	Inches	Millimetres
M	7.000	177.8
N	6.562	166.7
P	5.240	133.1
Q	6.937	176.2
R	7.500	190.5
S	0.875	22.23
T	2.250	57.15
U	3.000	76.20
V	5.375	136.5
W	6.000	152.4

Millimetre dimensions have been derived from inches.

BW/BY1144 Series

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. transmitting triodes differing in anode dissipation, method of anode cooling or filament terminals. The tubes have grid terminals suitable for cathode drive operation.

Anode cooling:		
BW1144	water; separate jacket	
BY1144, BY1144L	vapour; separate boiler unit	
Anode dissipation:		
BW1144	100	kW max
BY1144, BY1144L	125	kW max
Anode voltage	14	kV max
Frequency for full ratings	27	MHz max
Output power (class C telegraphy)	200	kW

The BY1144L is identical with BY1144 but is equipped with flexible leads on the four filament terminals (see outline drawing on page 11).

GENERAL

Electrical

Filament (two sections) (see note 1)	thoriated tungsten	
Filament voltage per section (see note 2)	9.6	V
Filament current per section	290	A
Surge filament current per section (peak) (see note 3)	700	A max
Filament cold resistance per section	4.0	mΩ
Peak usable cathode current	175	A
Perveance	6.0	$mA/V^{3/2}$
Amplification factor (V_a = 9.0kV, I_a = 5.0A)	34	
Mutual conductance (V_a = 9.0kV, I_a = 5.0A)	85	mA/V
Inter-electrode capacitances (average):		
grid to anode	108	pF
grid to filament	259	pF
anode to filament	3.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BW1144	56 pounds (25.5kg) approx
BY1144, BY1144L	125 pounds (57kg) approx
Mounting position	vertical, filament end up

Accessories

Filament leads for BW1144, BY1144	MA130
Grid connector	MA66B
Water jacket for BW1144	BW4035
Sealing ring (supplied with BW1144)	MA243
Boiler unit, integral condenser, for BY1144, BY1144L	BY4036
Boiler unit, separate condenser required, for BY1144, BY1144L	BY4060
Sealing ring (supplied with BY1144, BY1144L)	MA260
Thermal fuse (2 supplied with BY1144, BY1144L)	MA85D

COOLING

Anode

The anode of the BW1144 must be fitted into a water jacket for cooling, the recommended jacket being type BW4035. A flow of water of 22 to 25imp. gal/min (100 to 115 l./min) is required; the temperature of the cooling water at the outlet must not exceed 65°C, nor should the temperature rise across the jacket exceed 15°C.

The BY1144 and BY1144L are vapour cooled and may be operated either in boiler unit BY4036 or BY4060. In BY4036 the steam generated at the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4060 is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Two thermal fuses (part number MA85D) are provided with each BY1144 and BY1144L to give protection against anode overheating; only one fuse at a time need be used. Alternative positions for mounting the thermal fuse are provided by four threaded holes equally spaced round the top surface of the anode ring. The fuse should be screwed into the desired position and connected by a non-conducting cord passing over the anode corona ring to a suitable switching device; a tension of about 1 lb (450g) should be applied to the fuse via the cord. If the temperature exceeds a safe limit, the fuse core is pulled outwards; this should actuate the switching device and remove all electrical supplies from the valve. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of $60ft^3$/min ($1.7m^3$/min) directed into the filament header via a 2-inch (50mm approx) maximum diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

INSTALLATION

The BY1144 and BY1144L should be lifted by means of four lifting hooks hooked under the anode corona ring (see outline drawings and also page 12 for details of a suitable lifting hook), the hooks being connected by cables to a suitable spreader plate and lifting tackle.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C Telegraphy, key-down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 4)	14	kV max
Anode current	18	A max
Anode dissipation (see note 5):		
BW1144	100	kW max
BY1144, BY1144L	125	kW max
Grid dissipation	2.75	kW max
Operating frequency (for full ratings)	27	MHz max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	14	kV
Grid voltage	–765	V
Peak r.f. grid drive voltage	1305	V
Anode current	17.5	A
Grid current (approx)	3.1	A
Anode dissipation	45	kW
Grid dissipation (approx)	1.7	kW
Driving power (approx)	4.0	kW
Output power	200	kW
Efficiency	81	%

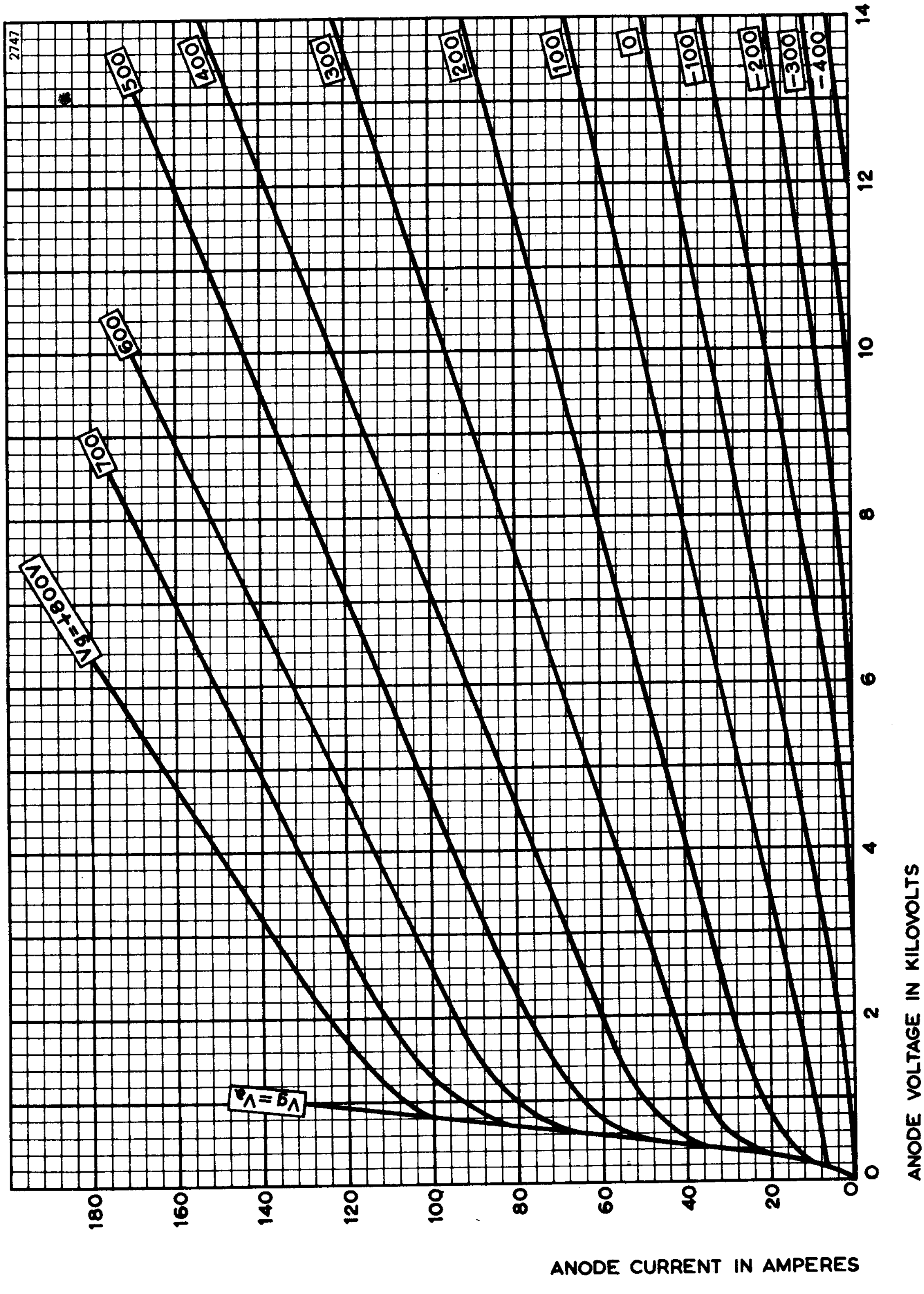
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current per section at filament voltage 9.6V	263	311	A
Filament current difference between sections . .	–	15	A
Amplification factor (V_a = 9.0kV, I_a = 5.0A) . .	31	39	
Mutual conductance (V_a = 9.0kV, I_a = 5.0A) . .	78	102	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	370	V
Grid voltage (V_a = 9.0kV, I_a = 5.0A)	145	222	V
Anode current (V_a = 1.5kV, V_g = +400V) . . .	48	72	A
Grid current (V_a = 1.5kV, V_g = +400V)	10	16	A
Anode current (V_a = 4.0kV, V_g = +400V) . . .	66	98	A
Grid current (V_a = 4.0kV, V_g = +400V)	2.0	10	A
Anode current (V_a = 10kV, V_g = +400V) . . .	90	138	A
Grid current (V_a = 10kV, V_g = +400V)	0	6.0	A

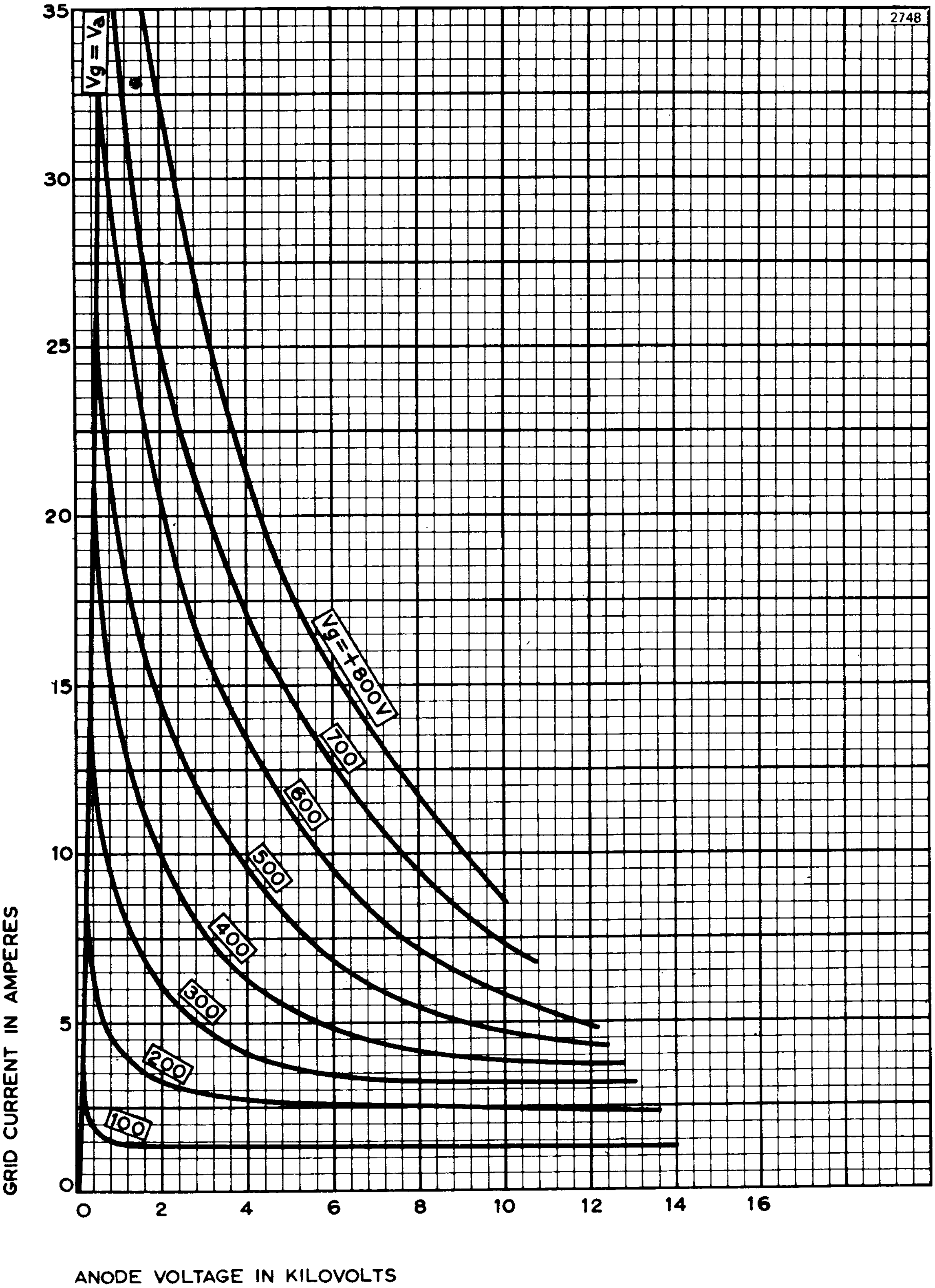
NOTES

1. The filament comprises two separate sections and these should be operated in phase quadrature. Each section is connected across diametrically opposite filament pins.
2. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
3. The filament current must not exceed 700A per section, even momentarily, at any time.
4. The maximum anode voltage for class C anode modulated operation (100% modulation) is 12kV.
5. The maximum anode dissipation for class C anode modulated operation is 67kW for BW1144 and 83kW for BY1144, BY1144L. These values correspond to 100kW and 125kW respectively at 100% sine wave modulation.

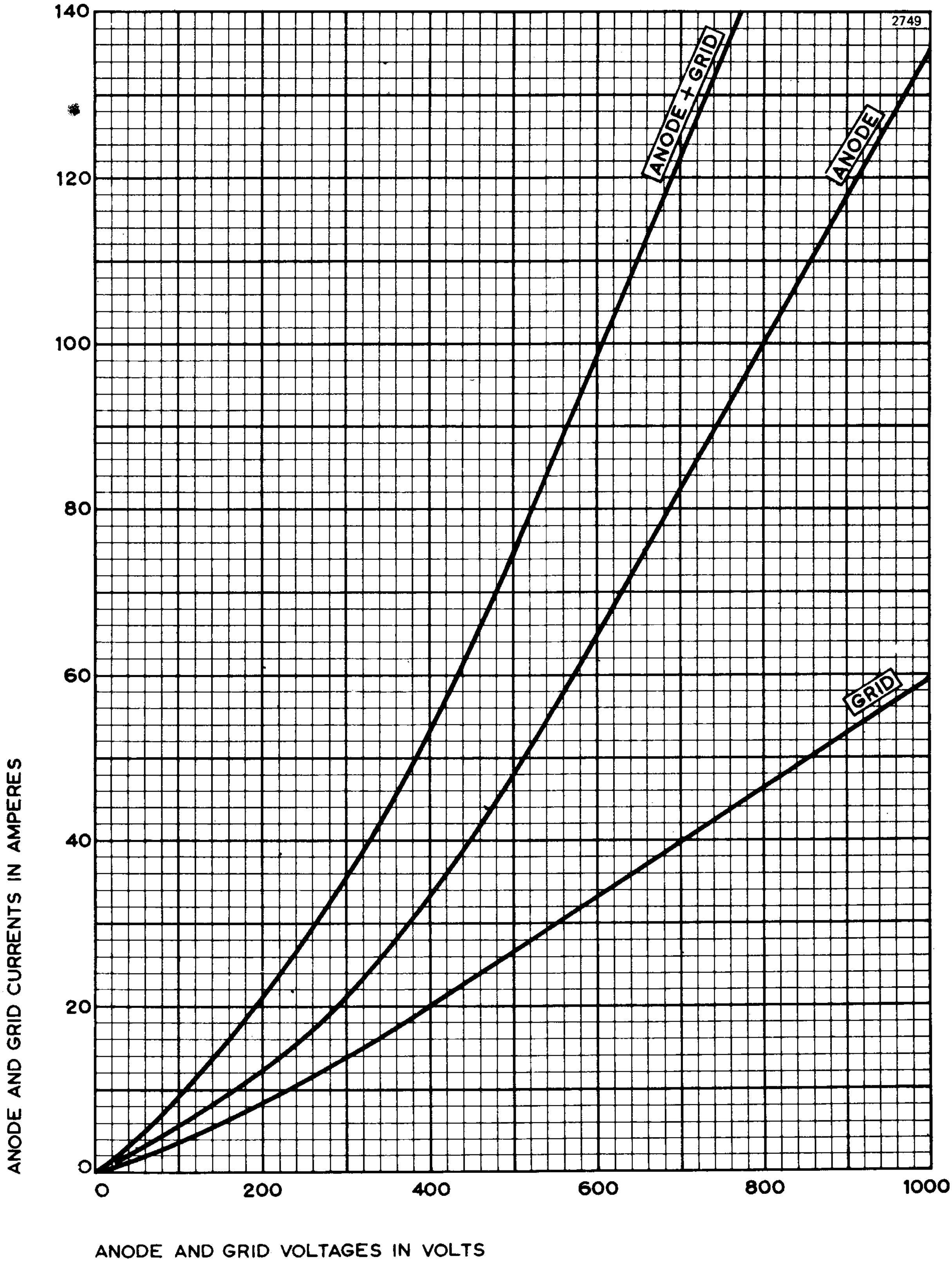
TYPICAL ANODE CHARACTERISTICS



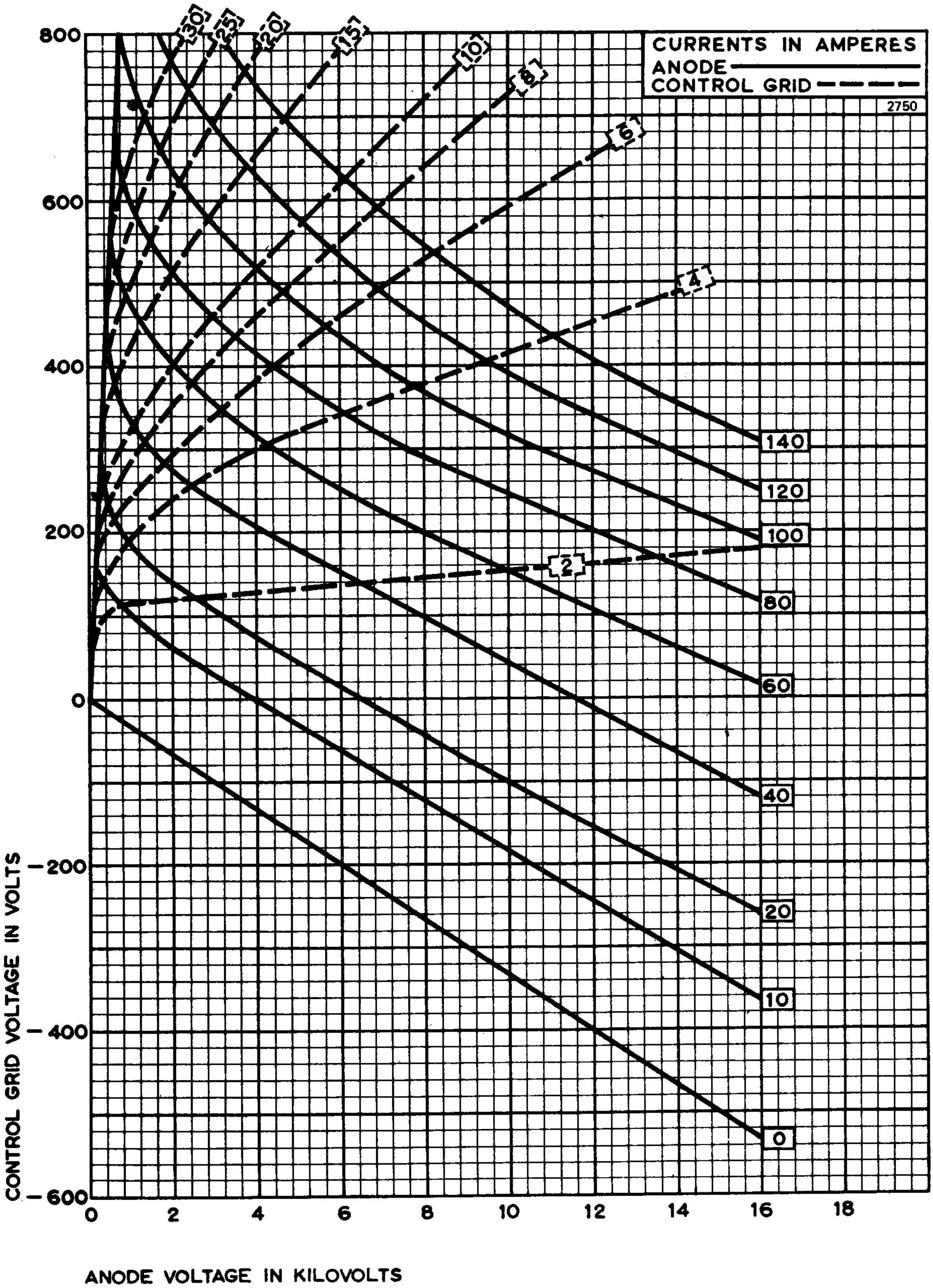
TYPICAL GRID CHARACTERISTICS



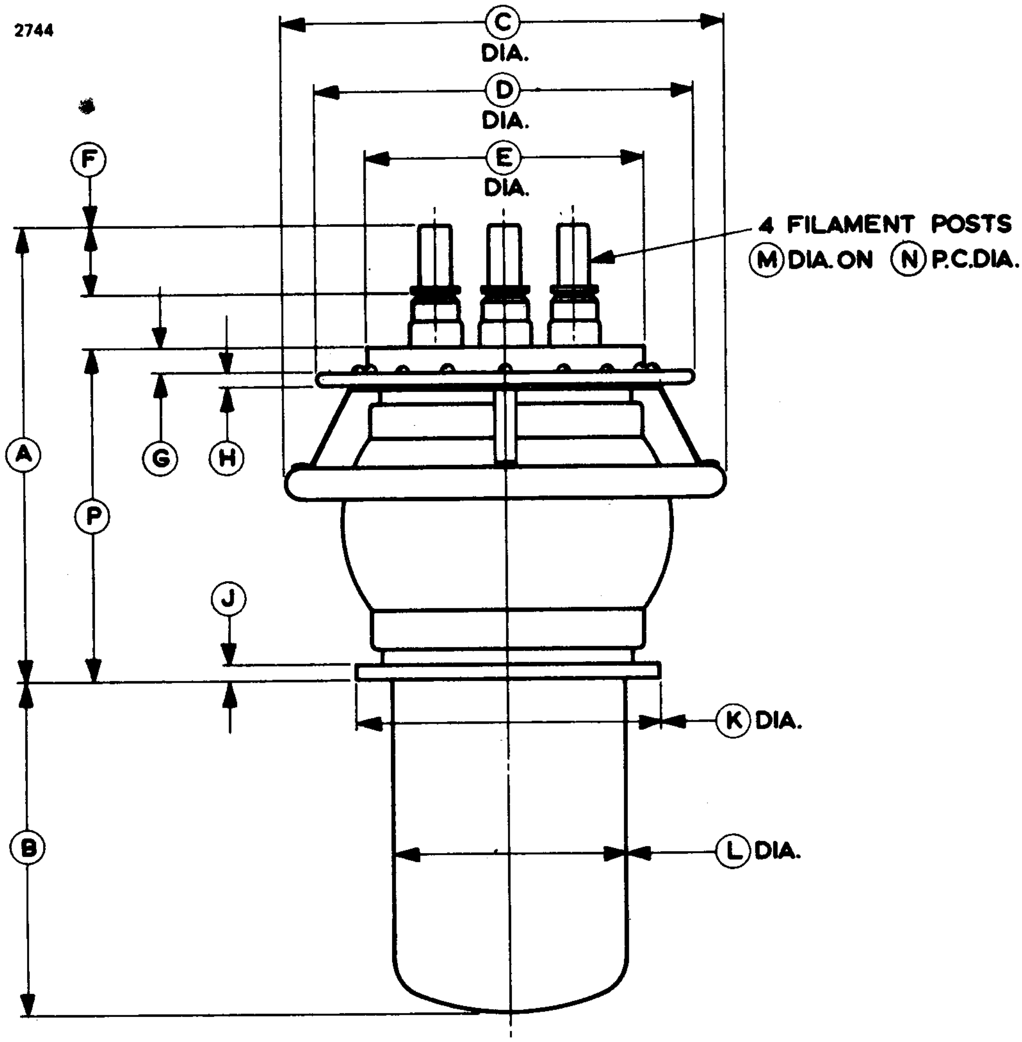
TYPICAL STRAPPED CHARACTERISTICS



TYPICAL CONSTANT CURRENT CHARACTERISTICS



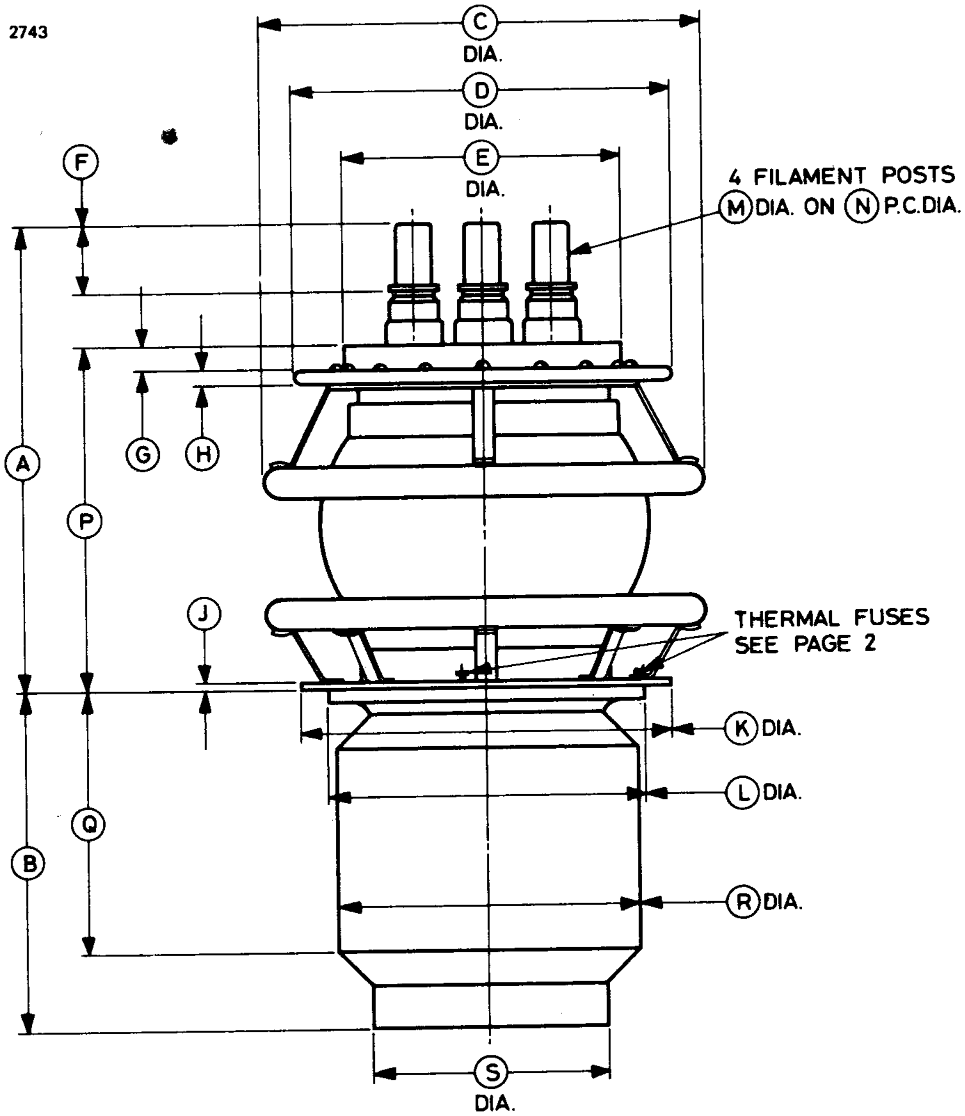
OUTLINE FOR BW1144 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	13.500 max	342.9 max	H	0.375 ± 0.031	9.53 ± 0.79.
B	9.938 ± 0.031	252.4 ± 0.8	J	0.500 ± 0.031	12.70 ± 0.79
C	13.062 max	331.8 max	K	9.000	228.6
D	11.125 ± 0.062	282.6 ± 1.6	L	6.915	175.6
E	8.086 ± 0.031	205.4 ± 0.8	M	0.875	22.23
F	2.000	50.80	N	4.000	101.6
G	0.750 min	19.05 min	P	9.919 ± 0.250	251.9 ± 6.4

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1144 (All dimensions without limits are nominal)

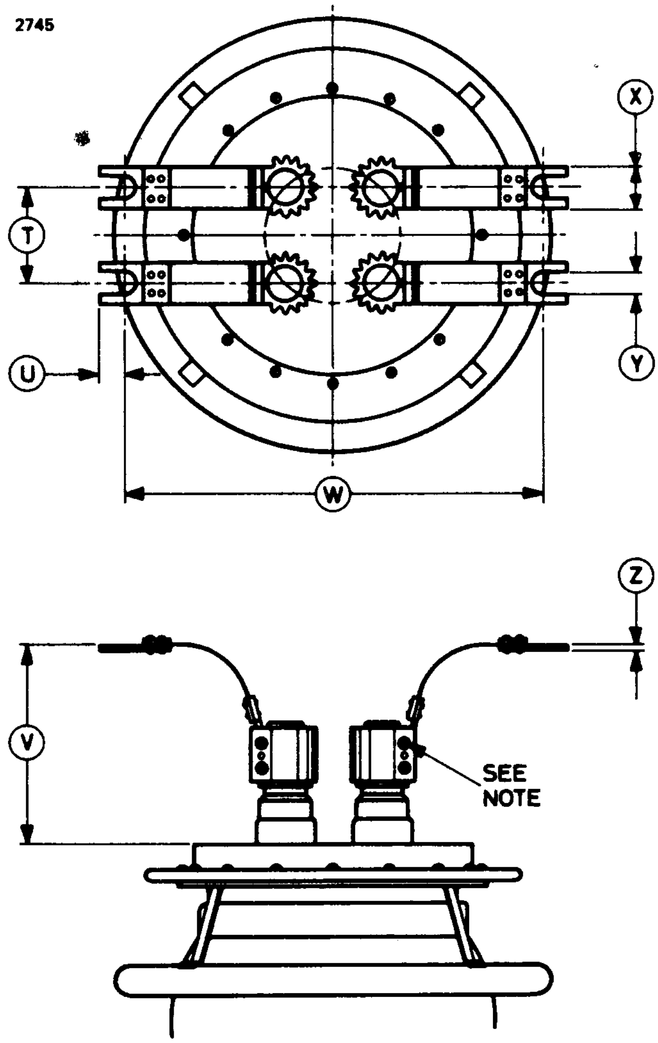


Ref	Inches	Millimetres
A	13.800 max	350.5 max
B	10.187 max	258.8 max
C	13.062 max	331.8 max
D	11.125 ± 0.062	282.6 ± 1.6
E	8.086 ± 0.031	205.4 ± 0.8
F	2.000	50.80
G	0.750 min	19.05 min
H	0.375 ± 0.031	9.53 ± 0.79
J	0.250 ± 0.031	6.35 ± 0.79

Ref	Inches	Millimetres
K	10.875 ± 0.031	276.2 ± 0.8
L	9.312 ± 0.015	236.5 ± 0.4
M	0.875	22.23
N	4.000	101.6
P	10.217 ± 0.250	259.5 ± 6.4
Q	7.781 max	197.6 max
R	9.000 max	228.6 max
S	6.875	174.6

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY1144L (All dimensions without limits are nominal)



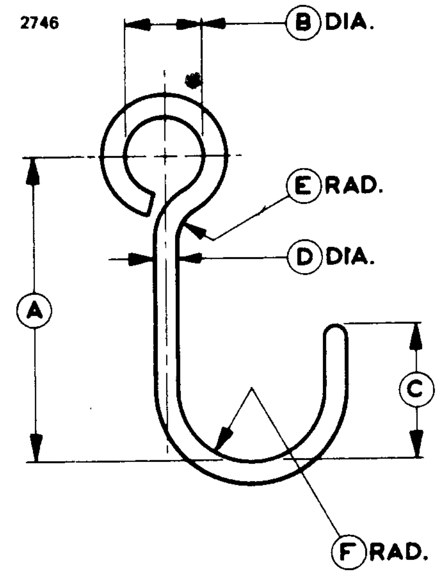
Ref	Millimetres	Inches	Ref	Millimetres	Inches
T*	71.83	2.828	X	31.5 ± 0.5	1.240 ± 0.020
U*	19.05	0.750	Y	14.5 ± 0.2	0.567 ± 0.008
V*	138.0	5.437	Z	3.15	0.124
W	297.0	11.687			

Inch dimensions have been derived from millimetres except where indicated thus *.

Note Two hexagon socket cap head screws 10–32UNF.

All other dimensions identical with BY1144

LIFTING HOOK (See page 3)



Ref	Inches	Millimetres
A	$2\frac{1}{4}$	57.2
B	$\frac{9}{16}$	14.3
C	1	25.4
D	$\frac{3}{16}$	4.8
E	$\frac{1}{4}$	6.4
F	$\frac{17}{32}$	13.5

Millimetre dimensions have been derived from inches.

BW/BY1156

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes intended primarily for industrial service. They differ only in the method of anode cooling and in anode dissipation.

Anode cooling:		
BW1156	water; separate jacket	
BY1156	vapour; separate boiler unit	
Anode dissipation:		
BW1156	175	kW max
BY1156	125	kW max
Anode voltage	14	kV max
Frequency for full ratings	27	MHz max
Output power (class C unmodulated)	250	kW

GENERAL

Electrical

Filament (two sections) (see note 1)	thoriated tungsten	
Filament voltage per section (see note 2)	12.2	V
Filament current per section	290	A
Surge filament current per section (peak) (see note 3)	700	A max
Filament cold resistance per section	5.0	mΩ
Peak usable cathode current	260	A
Perveance	8.0	$mA/V^{3/2}$
Amplification factor (V_a = 9.0kV, I_a = 5.0A)	23	
Mutual conductance (V_a = 9.0kV, I_a = 5.0A)	100	mA/V
Inter-electrode capacitances:		
grid to anode	110	pF
grid to filament	290	pF
anode to filament	5.0	pF

September 1969

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BW1156	60 pounds (27kg) approx
BY1156 *	125 pounds (57kg) approx
Mounting position	vertical, filament pins up

Accessories

Filament leads	MA130
Grid connector	MA66B
Water jacket for BW1156	BW4035
Sealing ring (supplied with BW1156)	MA243
Boiler unit, integral condenser, for BY1156	BY4036
Boiler unit, separate condenser required, for BY1156	BY4060
Sealing ring (supplied with BY1156)	MA260
Thermal fuse (2 supplied with BY1156)	MA85D

COOLING

Anode

The anode of the BW1156 must be fitted into à water jacket for cooling, the recommended jacket being type BW4035. With an anode dissipation of 175kW, the water flow necessary is 40imp.gal/min (182 l./min). The temperature of the cooling water at the outlet must not exceed 65°C nor should the temperature rise across the jacket exceed 15°C.

The BY1156 is vapour cooled and may be operated either in boiler unit BY4036 or BY4060. In BY4036 the steam generated at the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4060 is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Two thermal fuses (part number MA85D) are provided with each valve to give protection against anode overheating; only one fuse at a time need be used. Alternative positions for mounting the thermal fuse are provided by four threaded holes equally spaced round the top surface of the anode ring. The fuse should be screwed into the desired position and connected by a non-conducting cord passing over the anode corona ring to a suitable switching device; a tension of about 1 pound (450g) should be applied to the fuse via the cord. If the temperature exceeds a safe limit, the fuse cord is pulled outwards; this should actuate the switching device and remove all electrical supplies from the valve. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of $60 ft^3/min$ ($1.7 m^3/min$) directed into the filament header via a 2 inch (51mm) diameter nozzle before, during and after the application of any voltages is usually adequate for limiting the temperature of these seals.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 180°C.

INSTALLATION

The BY1156 should be lifted by means of four lifting hooks hooked under the anode corona ring (see outline drawing and also page 8 for details of a suitable lifting hook), the hooks being connected by cables to a suitable spreader plate and lifting tackle.

R.F. AMPLIFIER AND OSCILLATOR
(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	14	kV max
Anode current	28	A max
Anode dissipation:		
BW1156	175	kW max
BY1156	125	kW max
Grid dissipation	3.0	kW max
Operating frequency (for full ratings)	27	MHz max

TYPICAL OPERATING CONDITIONS (For amplifier)

Anode voltage	12	kV
Grid voltage	−1400	V
Peak r.f. grid drive voltage	2150	V
Anode current	27	A
Grid current (approx)	4.0	A
Anode dissipation (including filament and grid losses)	85	kW
Grid dissipation (approx)	3.0	kW
Driving power (approx)	9.5	kW
Output power	250	kW
Efficiency	76	%

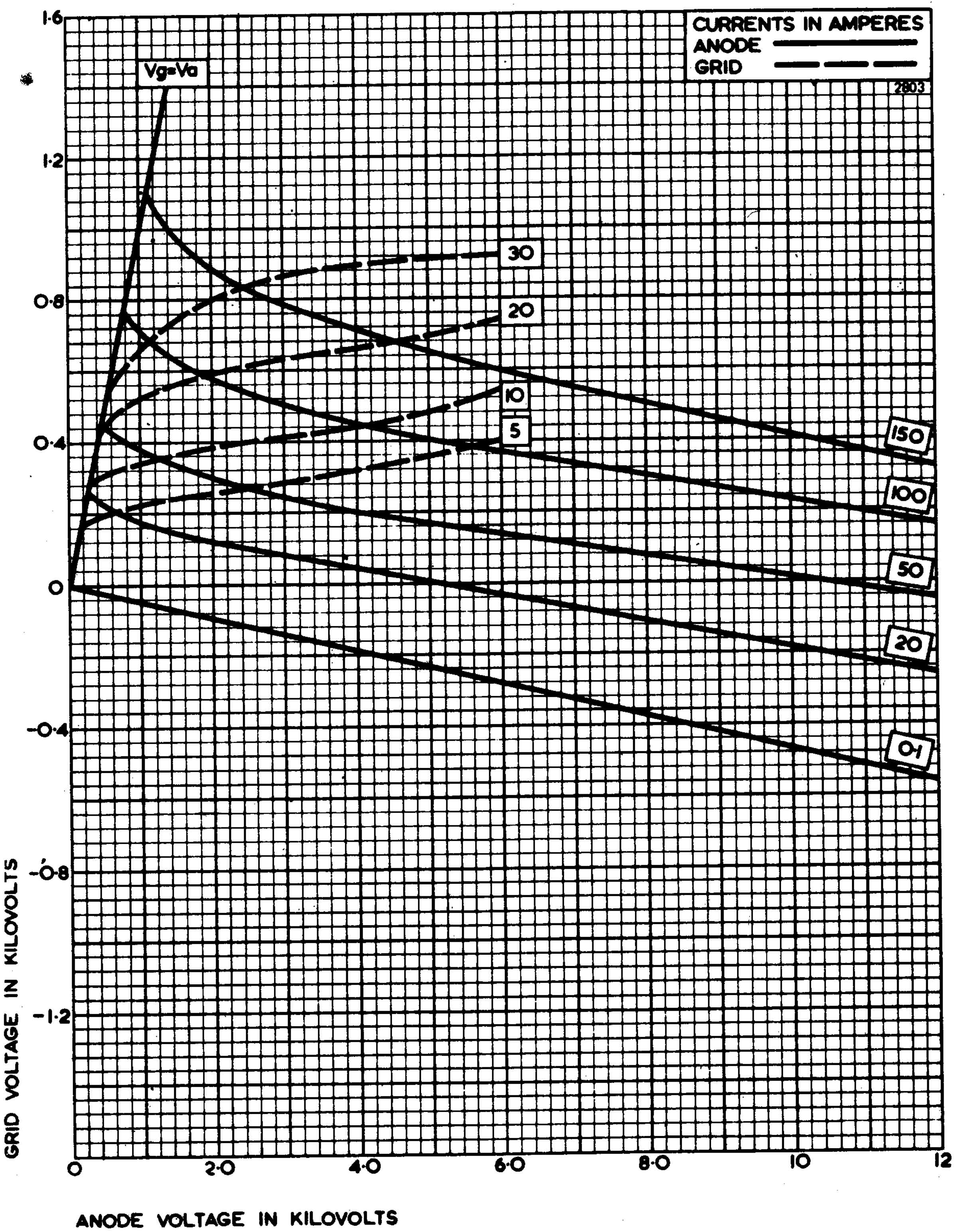
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current per section at filament voltage 12.2V	263	311	A
Filament current difference between sections	–	15	A
Amplification factor (V_a = 9.0kV, I_a = 5.0A) .	18	28	
Mutual conductance (V_a = 9.0kV, I_a = 5.0A) .	80	110	mA/V
Grid voltage (negative value) (V_a = 7.5kV, I_a = 0.1A)	–	400	V
Grid voltage (V_a = 9.0kV, I_a = 5.0A)	240	320	V
Anode current (V_a = 1.5kV, V_g = +600V) . .	75	125	A
Grid current (V_a = 1.5kV, V_g = +600V) . . .	20	40	A
Anode current (V_a = 1.5kV, V_g = +750V) .	120	160	A
Grid current (V_a = 1.5kV, V_g = +750V) . . .	25	55	A
Grid voltage (V_a = 1.5kV, I_a = 130A) . . .	600	850	V
Grid current (V_a = 1.5kV, I_a = 130A)	20	50	A

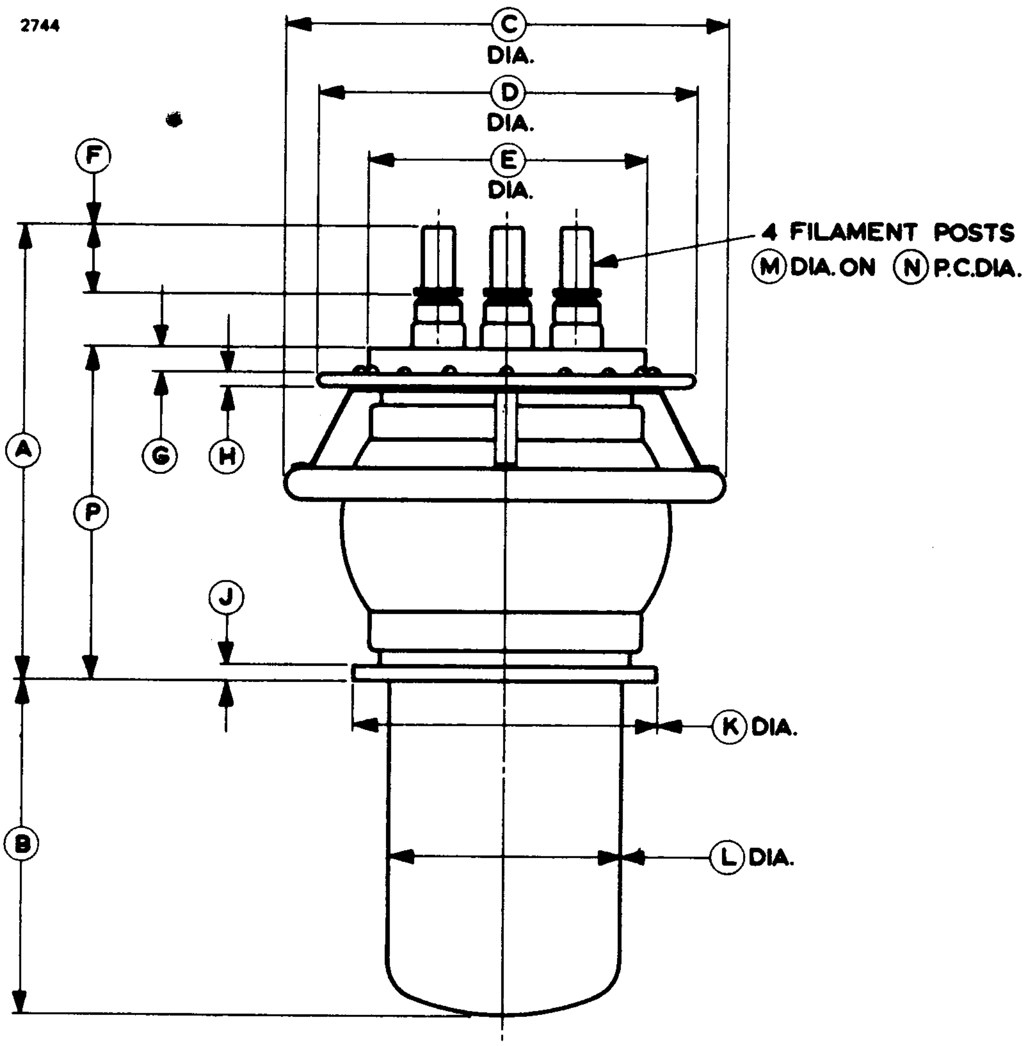
NOTES

1. The filament comprises two separate sections designed to operate in phase quadrature. Each section is connected across diametrically opposite filament pins. If desired the two sections may be connected in parallel.
2. The valve must be operated at the stated filament voltage. Fluctuations in filament voltage must not exceed ±5%.
3. The filament current must not exceed 700A per section, even momentarily, at any time.

TYPICAL CONSTANT CURRENT CHARACTERISTICS



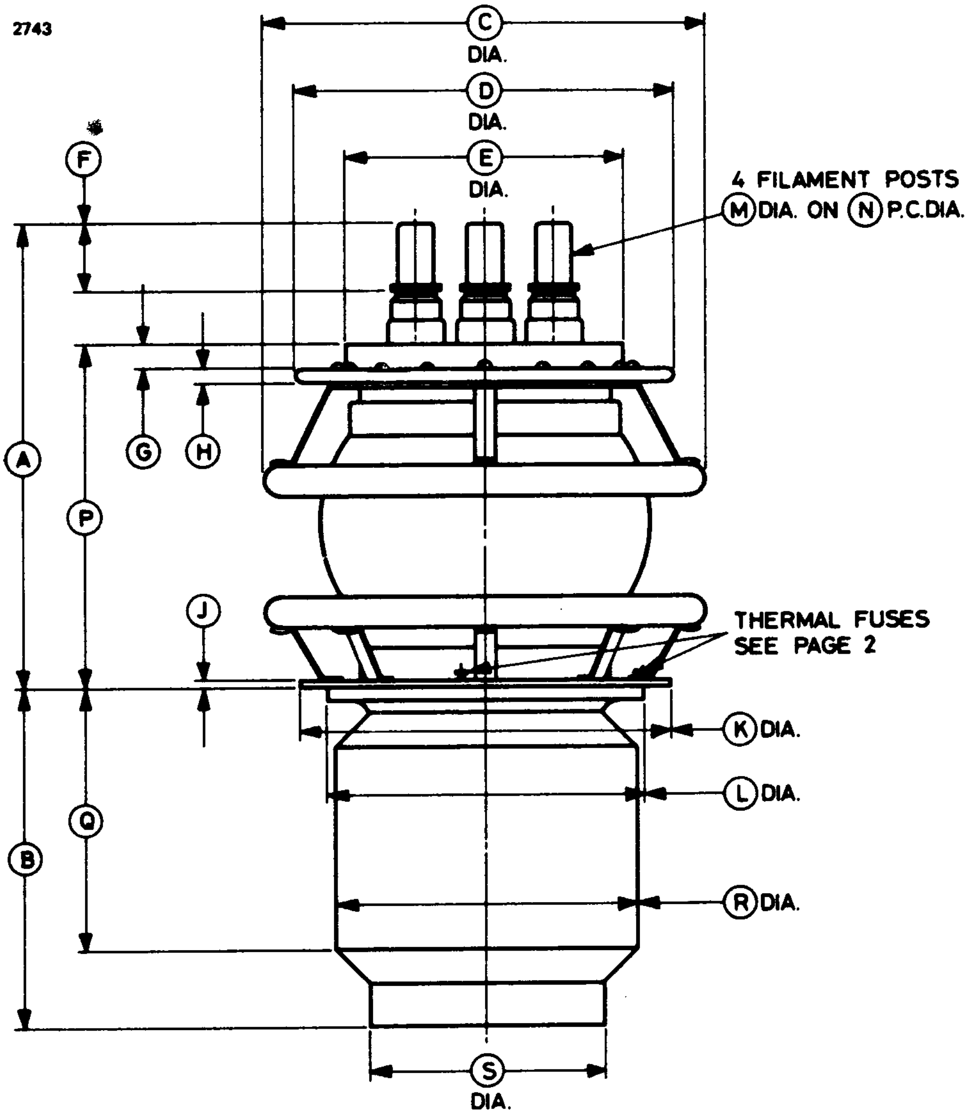
OUTLINE FOR BW1156 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	13.500 max	342.9 max	H	0.375 ± 0.031	9.53 ± 0.79
B	9.938 ± 0.031	252.4 ± 0.8	J	0.500 ± 0.031	12.70 ± 0.79
C	13.062 max	331.8 max	K	9.000	228.6
D	11.125 ± 0.062	282.6 ± 1.6	L	6.915	175.6
E	8.086 ± 0.031	205.4 ± 0.8	M	0.875	22.23
F	2.000	50.80	N	4.000	101.6
G	0.750 min	19.05 min	P	9.919 ± 0.250	251.9 ± 6.4

Millimetre dimensions have been derived from inches.

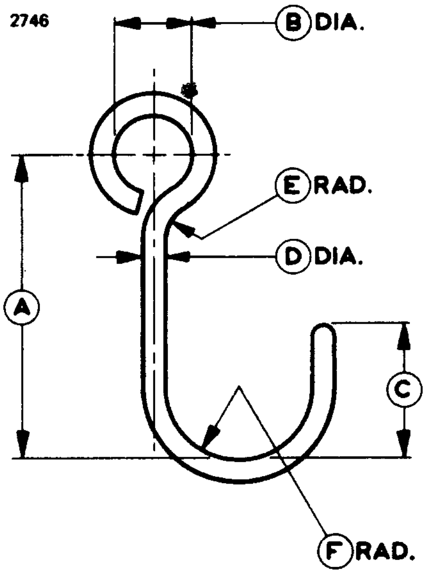
OUTLINE FOR BY1156 (All dimensions without limits are nominal)



Ref	Inches	Millimetres
A	13.800 max	350.5 max
B	10.187 max	258.8 max
C	13.062 max	331.8 max
D	11.125 ± 0.062	282.6 ± 1.6
E	8.086 ± 0.031	205.4 ± 0.8
F	2.000	50.80
G	0.750 min	19.05 min
H	0.375 ± 0.031	9.53 ± 0.79
J	0.250 ± 0.031	6.35 ± 0.79
K	10.875 ± 0.031	276.2 ± 0.8
L	9.312 ± 0.015	236.5 ± 0.4
M	0.875	22.23
N	4.000	101.6
P	10.217 ± 0.250	259.5 ± 6.4
Q	7.781 max	197.6 max
R	9.000 max	228.6 max
S	6.875	174.6

Millimetre dimensions have been derived from inches.

LIFTING HOOK (See page 3)



Ref	Inches	Millimetres
A	$2\frac{1}{4}$	57.2
B	$\frac{9}{16}$	14.3
C	1	25.4
D	$\frac{3}{16}$	4.8
E	$\frac{1}{4}$	6.4
F	$\frac{17}{32}$	13.5

Millimetre dimensions have been derived from inches.

BR1160

R.F. POWER TRIODE

Service Type CV8730

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Forced-air cooled r.f. triode for a.m., f.m. or television transmitters and for industrial applications.

Anode dissipation	5.0	kW max
Anode voltage	6.0	kV max
Operating frequency	220	MHz max
Output power:		
class B audio, per valve	6.65	kW
class C telegraphy, f.m. telephony	6.9	kW
class C television, per valve	4.5	kW
class C industrial oscillator	6.5	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	12.6	V
Filament current	33	A
Peak usable cathode current	8.5	A
Amplification factor (V_a = 4.0kV, I_a = 1.0A)	32	
Mutual conductance (V_a = 4.0kV, I_a = 1.0A)	17	mA/V
Inter-electrode capacitances:		
grid to anode	11	pF
grid to filament	16	pF
anode to filament	0.3	pF

Mechanical

Overall length (excluding flexible leads)	195mm (7.680 inches) max
Overall diameter	119mm (4.685 inches) max
Net weight	7½ pounds (3.4kg) approx
Mounting position	vertical, either way up

COOLING

Anode

The air cooling requirements for BR1160 are given in the following table. The air flow should be delivered immediately before and during the application of any voltages.

Anode dissipation (kW)	Height above sea level (m)	Inlet temperature (max) (°C)	Rate of flow of air (min) (m^3/min)	Pressure drop (mm water)
1.0	0	35	3.0	8.0
1.0	0	45	3.1	8.0
1.0	1500	35	3.7	9.0
1.0	3000	25	4.1	10
3.0	0	35	5.2	23
3.0	0	45	6.1	29
3.0	1500	35	6.2	26
3.0	3000	25	6.6	26
5.0	0	35	9.2	68
5.0	0	45	10.7	90
5.0	1500	35	11.2	81
5.0	3000	25	11.6	79

Filament and Grid Seals

It may be necessary to direct a flow of air on to the filament and grid seals in order to maintain their temperatures within the following limits.

Temperature of filament seals . . . . 220 °C max
Temperature of grid seal . . . . 180 °C max

Anode Seal

The anode seal temperature must not exceed 180°C.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR (Class B)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.5	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid dissipation	120	W max
Grid circuit resistance	15	kΩ max
Cathode current (peak)	5.7	A max

TYPICAL OPERATING CONDITIONS (Class B, 2 valves)

Anode voltage	3.0	3.5	4.0	kV
Grid voltage	−90	−100	−112	V
Peak a.f. grid drive voltage (per valve)	285	310	318	V
Anode current (zero signal)	2 x 65	2 x 75	2 x 100	mA
Anode current (maximum signal)	2 x 0.80	2 x 0.95	2 x 0.94	A
Grid current (maximum signal)	2 x 0.20	2 x 0.18	2 x 0.19	A
Effective load (anode to anode)	4.4	4.2	4.9	kΩ
Nominal driving power (maximum signal)	2 x 52	2 x 50	2 x 54	W
Anode dissipation	2 x 0.75	2 x 1.0	2 x 1.1	kW
Output power (maximum signal)	3.3	4.6	5.3	kW
Efficiency	69	70	71	%
Total distortion	3.3	2.9	2.6	%

Anode voltage	4.5	5.0	6.0	kV
Grid voltage	−125	−138	−165	V
Peak a.f. grid drive voltage (per valve)	327	330	455	V
Anode current (zero signal)	2 x 100	2 x 110	2 x 125	mA
Anode current (maximum signal)	2 x 0.92	2 x 0.91	2 x 1.50	A
Grid current (maximum signal)	2 x 0.19	2 x 0.14	2 x 0.28	A
Effective load (anode to anode)	6.1	6.4	4.9	kΩ
Nominal driving power (maximum signal)	2 x 27	2 x 42	2 x 115	W
Anode dissipation	2 x 1.15	2 x 1.25	2 x 2.35	kW
Output power (maximum signal)	6.0	6.6	13.3	kW
Efficiency	72	73	74	%
Total distortion	3.7	3.3	4.3	%

RADIO FREQUENCY POWER AMPLIFIER

(Class B telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.1	A max
Anode input power	6.6	kW max
Anode dissipation	5.0	kW max
Grid dissipation	120	W max
Cathode current (peak)	4.6	A max

TYPICAL OPERATING CONDITIONS (frequency 75MHz)

Anode voltage	5.0	6.0	kV
Grid voltage	−145	−180	V
Peak r.f. grid drive voltage	225	250	V
Anode current	900	990	mA
Grid current (100% modulation)	320	300	mA
Driving power (100% modulation)	160	170	W
Anode dissipation	3.0	4.0	kW
Output power	1.45	1.90	kW
Efficiency	32	32	%

RADIO FREQUENCY POWER AMPLIFIER

(Class C telegraphy, key down conditions, or F.M. telephony, per valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.5	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	1.0	kV max
Grid current	0.35	A max
Grid dissipation	120	W max
Cathode current (peak)	8.5	A max

TYPICAL OPERATING CONDITIONS
(Grounded Cathode)

Frequency	75	75	75	110	MHz
Anode voltage	4.0	5.0	6.0	5.0	kV
Grid voltage	–200	–300	–400	–300	V
Peak r.f. grid drive voltage	500	640	740	640	V
Anode current	1.37	1.50	1.50	1.25	A
Grid current	350	330	310	300	mA
Nominal driving power	190	240	275	250	W
Anode dissipation	1.5	1.9	2.1	1.45	kW
Output power	4.0	5.6	6.9	4.8	kW
Efficiency	73	75	76.5	70	%

TYPICAL OPERATING CONDITIONS
(Grounded Grid, 2 valves)

Frequency	75	110	110	220	MHz
Anode voltage	6.0	4.0	5.0	4.0	kV
Filament-grid voltage	400	200	300	200	V
Peak r.f. drive voltage, filament to filament	1480	1000	1280	900	V
Anode current	2 x 1.5	2 x 1.37	2 x 1.5	2 x 1.25	A
Grid current	2 x 310	2 x 350	2 x 330	2 x 220	mA
Nominal driving power	2 x 1190	2 x 705	2 x 965	2 x 395	W
Anode dissipation	2 x 2.1	2 x 1.7	2 x 2.2	2 x 2.5	kW
Output power (see note 2)	15.6	8.6	12	5.6	kW
Efficiency	77	69	71	50	%

ANODE MODULATED R.F. POWER AMPLIFIER

(Class C telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	5.0	kV max
Anode current	1.3	A max
Anode input power	6.5	kW max
Anode dissipation	3.4	kW max
Grid voltage (negative value)	1.0	kV max
Grid current	0.35	A max
Grid dissipation	120	W max
Cathode current (peak)	5.7	A max

TYPICAL OPERATING CONDITIONS

Frequency	75	75	75	MHz
Anode voltage	3.0	3.5	4.0	kV
Grid voltage	−250	−300	−300	V
Peak r.f. grid drive voltage	510	600	600	V
Anode current	1.0	1.2	1.2	A
Grid current	0.3	0.3	0.3	A
Nominal driving power	170	205	205	W
Anode dissipation	0.8	1.2	1.3	kW
Output power	2.2	3.0	3.5	kW
Efficiency	73	71.5	73	%

Frequency	75	75	110	MHz
Anode voltage	4.5	5.0	4.0	kV
Grid voltage	−350	−400	−350	V
Peak r.f. grid drive voltage	650	690	600	V
Anode current	1.2	1.2	0.93	A
Grid current	0.3	0.3	0.24	A
Nominal driving power	230	205	130	W
Anode dissipation	1.3	1.3	0.92	kW
Output power	4.1	4.7	2.8	kW
Efficiency	76	78	75	%

CLASS C TELEVISION SERVICE, GRID-MODULATED

MAXIMUM RATINGS (Absolute values)

Anode voltage:		
up to 75MHz	5.0	kV max
up to 220MHz	4.0	kV max
Anode current	1.9	A max
Anode input power	9.5	kW max
Anode dissipation (sync. level)	5.0	kW max
Grid voltage (negative value) (sync. level)	1.0	kV max
Grid current	0.25	A max
Grid dissipation (sync. level)	120	W max
Cathode current (peak)	10	A max

TYPICAL OPERATING CONDITIONS

(Negative modulation, positive synchronisation) (2 valves)

Frequency	48 to 75	170 to 220	MHz
Anode voltage	5.0	4.0	kV
Grid voltage:			
peak sync.	−200	−250	V
black level	−300	−225	V
white level	−550	−500	V
Peak r.f. grid to grid voltage (sync. level)	1.0	1.0	kV
Anode current:			
peak sync.	2 x 1.9	2 x 1.6	A
black level	2 x 1.3	2 x 1.3	A
Grid current:			
peak sync.	2 x 0.250	2 x 0.20	A
black level	2 x 0.175	2 x 0.11	A
Nominal driving power (sync. level)	2 x 250	2 x 400	W
Output power (sync. level)	9.0	6.0	kW
Power into load (sync. level) (see note 3)	6.3	4.2	kW
Bandwidth (see note 4):			
to −3db points	8.00	10	MHz
to −1.5db points	5.25	6.5	MHz

TYPICAL OPERATING CONDITIONS

(Positive modulation, negative synchronisation) (2 valves)

Frequency	48 to 75	MHz
Anode voltage	5.0	kV
Grid voltage:*		
white level	−200	V
black level	−460	V
peak sync.	−580	V
Peak r.f. grid to grid voltage (white level)	1.0	kV
Anode current:		
white level	2 x 1.9	A
black level	2 x 0.4	A
Grid current:		
white level	2 x 250	mA
black level	0	mA
Nominal driving power (white level)	2 x 250	W
Output power (white level)	9.0	kW
Power into load (white level) (see note 3)	6.3	kW
Bandwidth (see note 4):		
to −3db points	8.0	MHz
to −1.5db points	5.25	MHz

RADIO FREQUENCY OSCILLATOR FOR INDUSTRIAL SERVICE

(Class C, anode supply from unfiltered two-phase half-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Anode voltage	5.4	kV max
Anode current	1.35	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	900	V max
Grid current	0.31	A max
Grid dissipation	120	W max

TYPICAL OPERATING CONDITIONS

Output voltage (r.m.s.) from transformer	5.1	6.0	kV
Anode voltage	4.6	5.4	kV
Anode current	1.15	1.35	A
Grid current	0.27	0.31	A
Anode dissipation	1.84	2.3	kW
Grid resistor	1.1	1.3	kΩ
Nominal driving power	160	210	W
Output power	4.5	6.5	kW
Efficiency	70	72	%

RADIO FREQUENCY OSCILLATOR FOR INDUSTRIAL SERVICE

(Class C, anode supply unrectified a.c.)

MAXIMUM RATINGS (Absolute values)

Output voltage (r.m.s.) from transformer	6.8	kV max
Anode current	0.8	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	640	V max
Grid current	190	mA max
Grid dissipation	120	W max
Operating frequency	75	MHz max

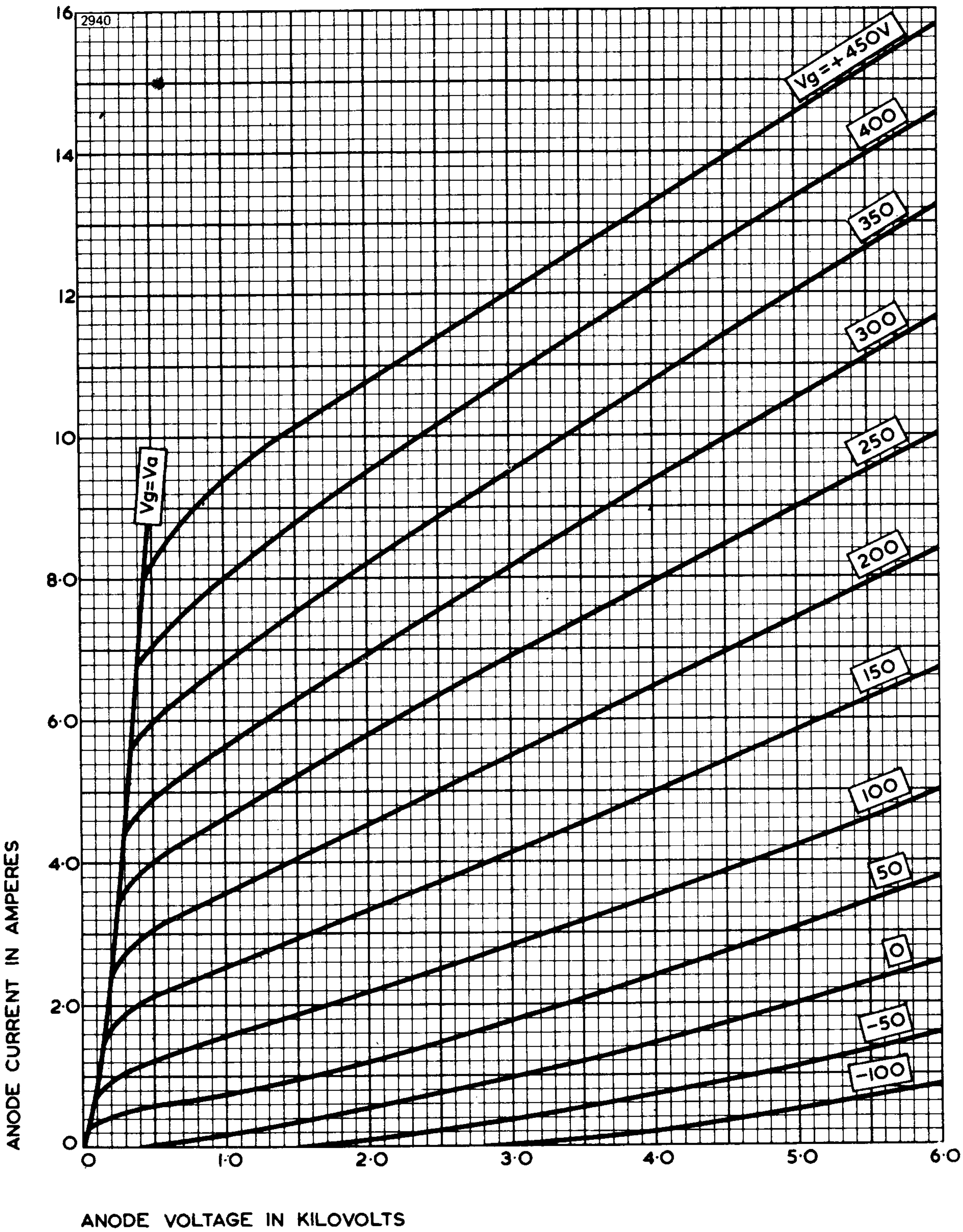
TYPICAL OPERATING CONDITIONS

Output voltage (r.m.s.) from transformer	5.9	6.8	kV
Grid voltage	−173	−200	V
from grid resistor	1050	1050	Ω
Anode current	0.7	0.8	A
Grid current (approx)	165	190	mA
Anode dissipation	1.24	1.5	kW
Output power	3.36	4.55	kW
Efficiency	73	75	%

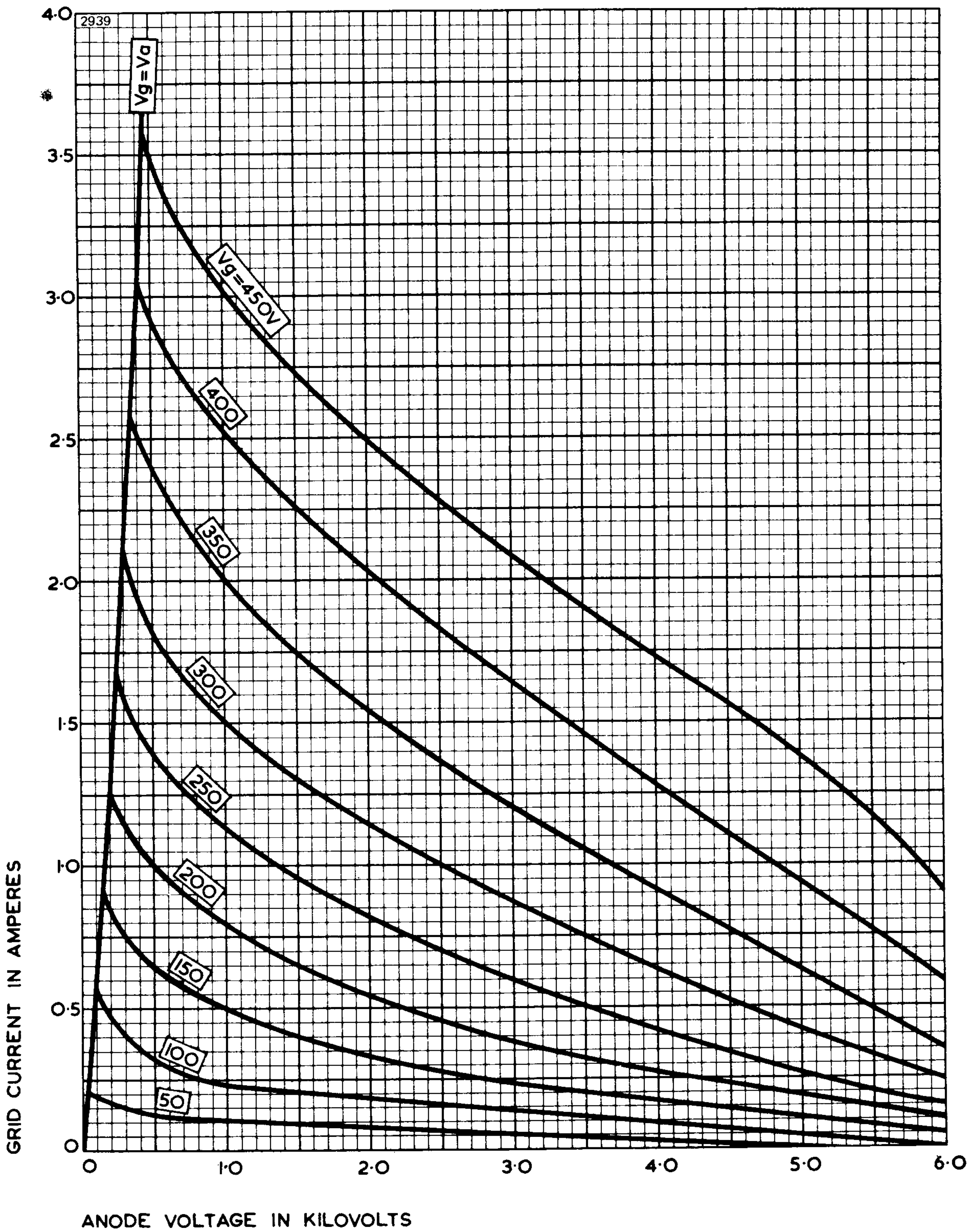
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed +5% or −10%. The centre-tap lead may be used for the anode current return but must not be used for the filament current supply. At frequencies above 30MHz, all three filament leads should be interconnected with suitable capacitors.
2. This includes the power transferred from the drive circuit.
3. Assuming circuit transfer efficiency of 70%.
4. For a bandwidth based on one inductor-capacitor circuit.

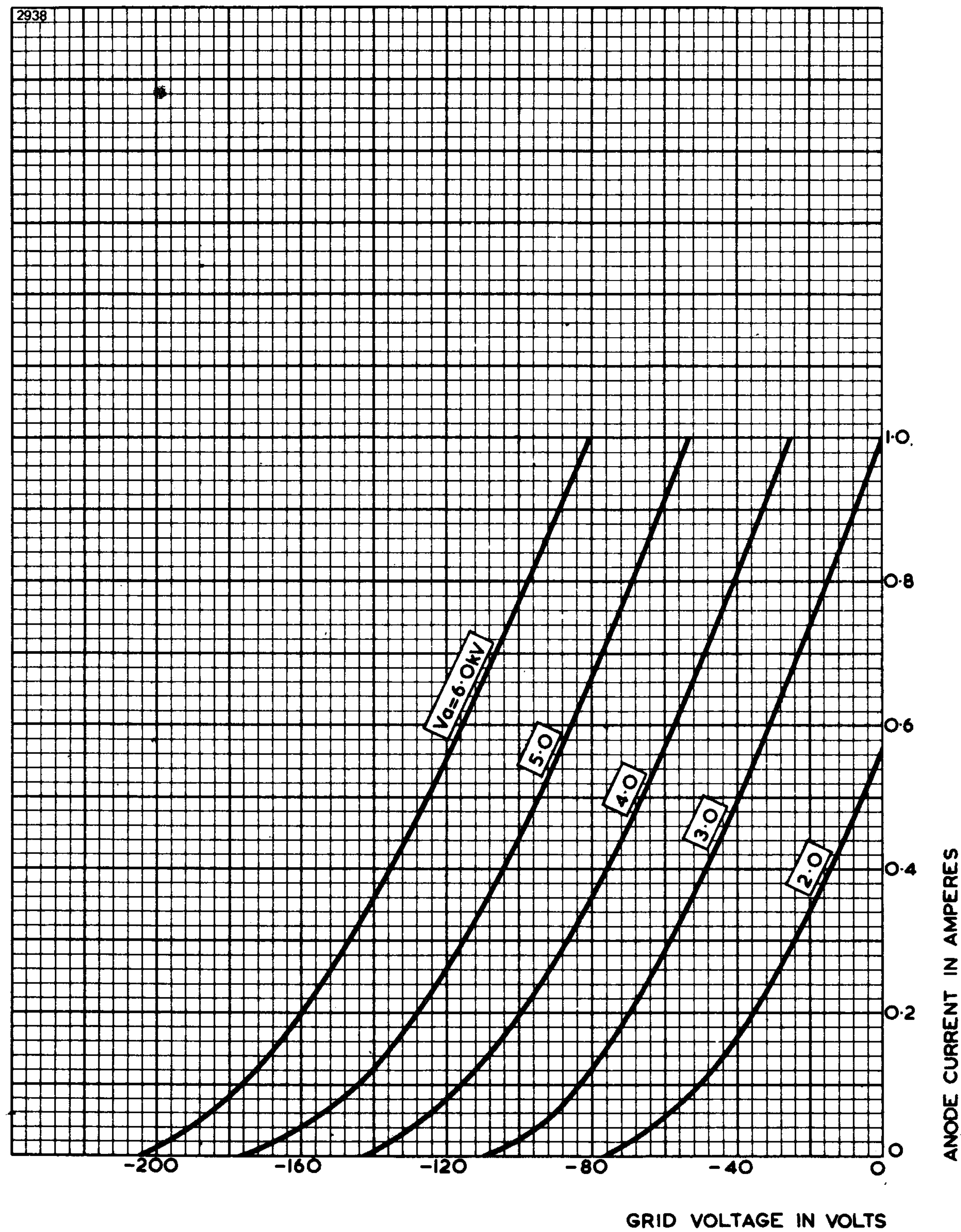
TYPICAL ANODE CHARACTERISTICS



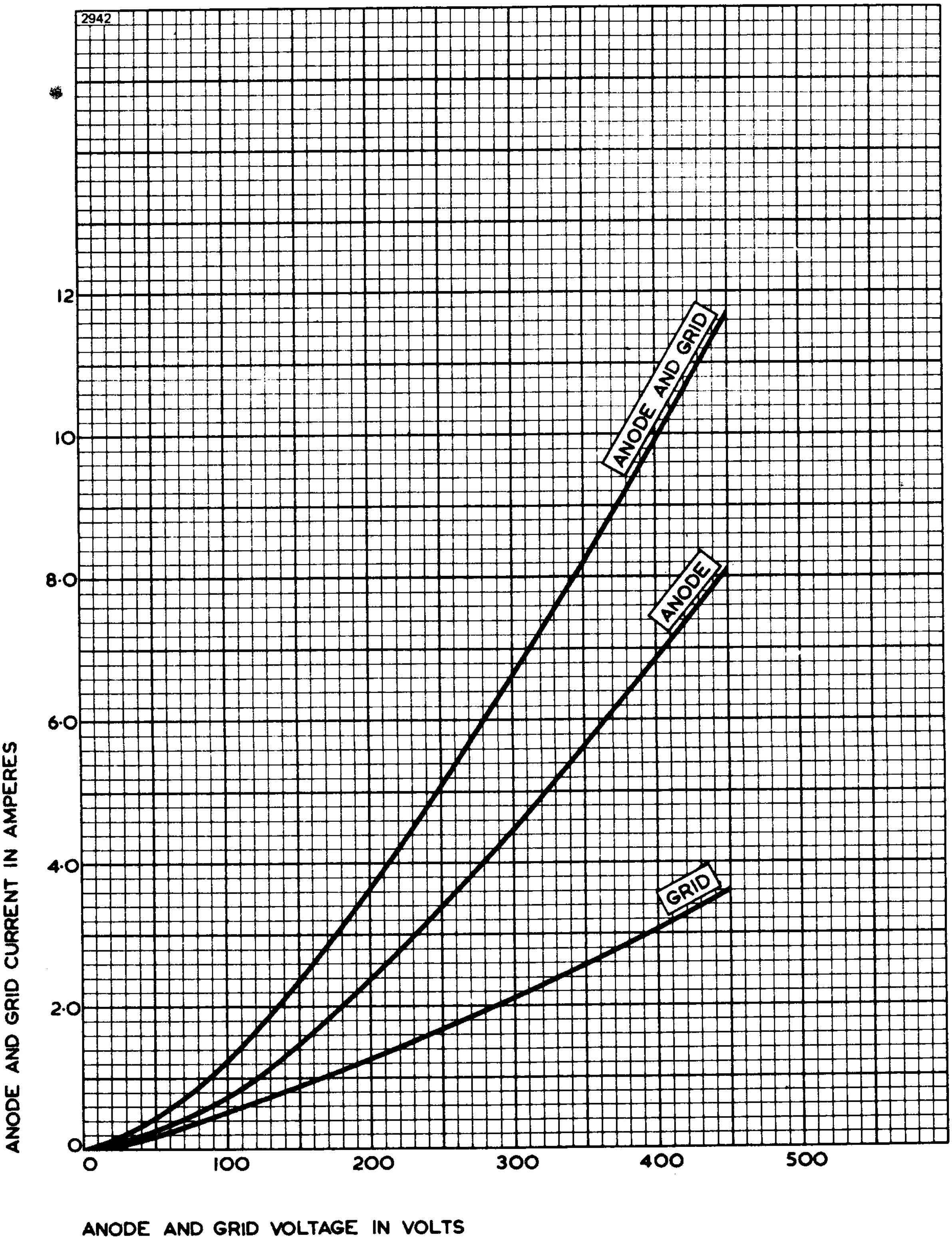
TYPICAL GRID CHARACTERISTICS



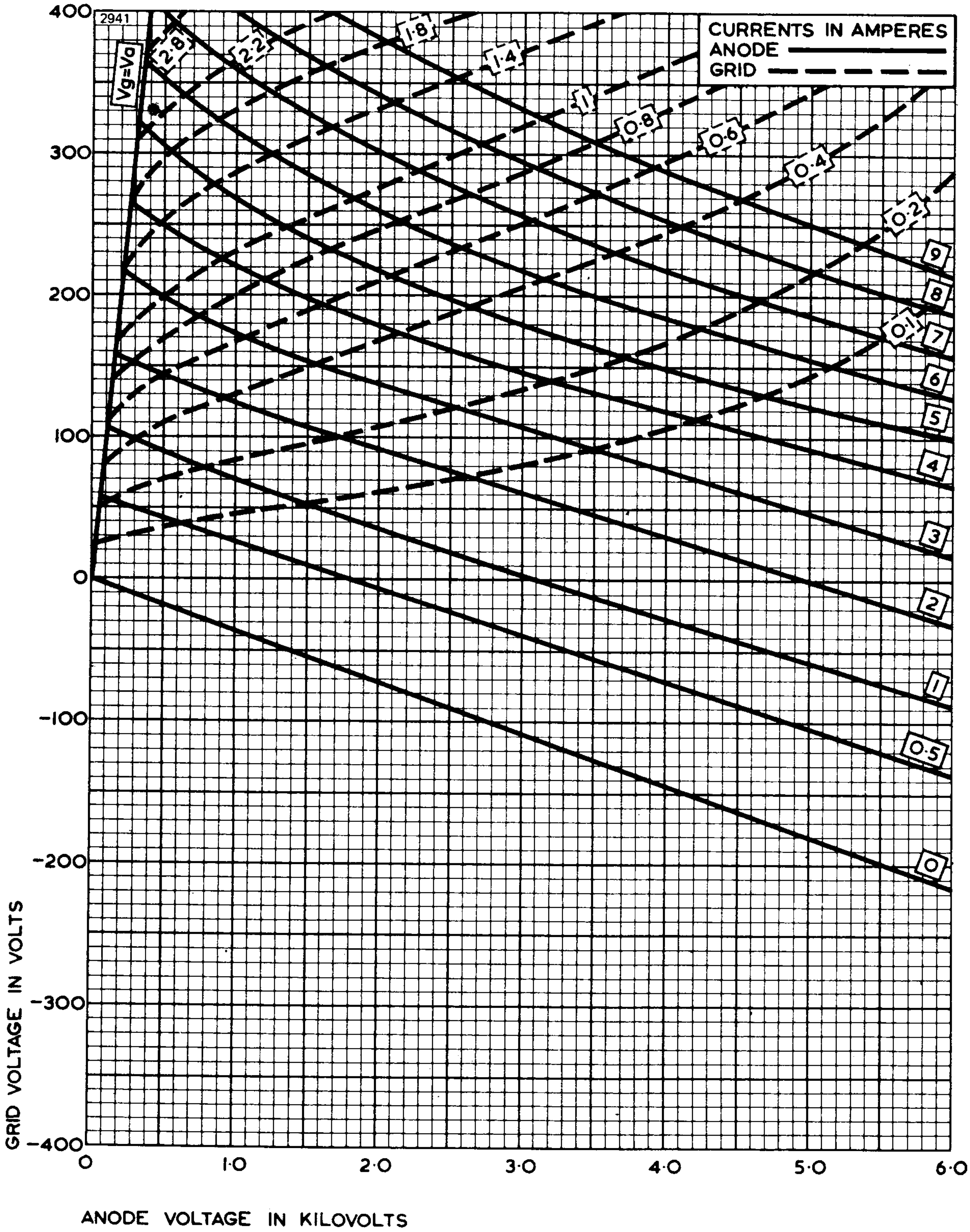
TYPICAL ANODE CURRENT – GRID VOLTAGE CHARACTERISTICS



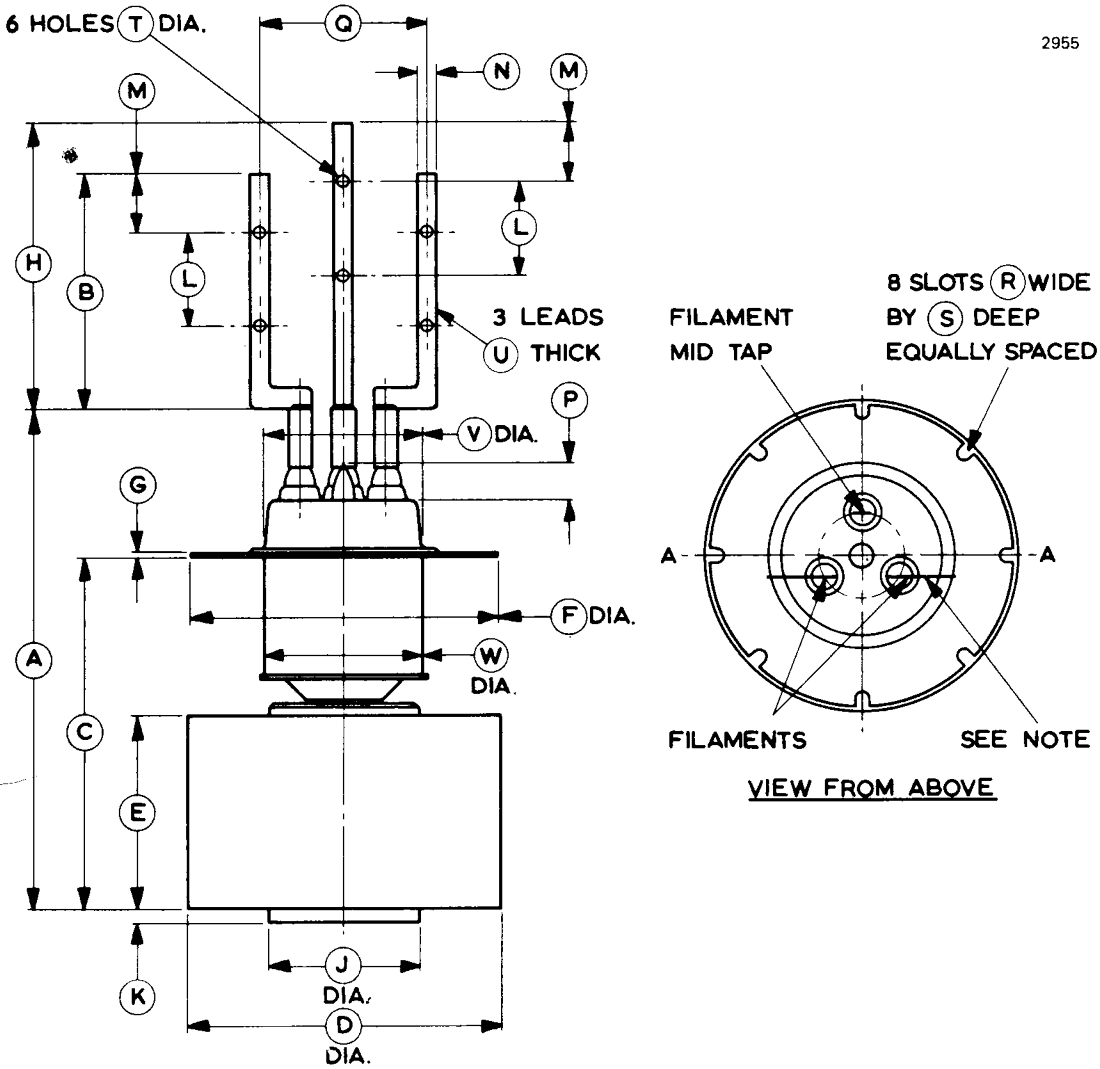
TYPICAL STRAPPED CHARACTERISTICS



TYPICAL CONSTANT CURRENT CHARACTERISTICS



OUTLINE



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	188.0 ± 2.0	7.402 ± 0.079	M	22.0 ± 2.0	0.866 ± 0.079
B	89.0 ± 2.0	3.504 ± 0.079	N	8.00 ± 0.50	0.315 ± 0.020
C	133.5 ± 3.5	5.256 ± 0.138	P	23.0 max	0.906 max
D	117.5 ± 1.5	4.626 ± 0.059	Q	62.5 ± 2.5	2.461 ± 0.098
E	73.0 max	2.874 max	R	4.62 ± 0.1	0.182 ± 0.004
F	116.0 ± 0.5	4.567 ± 0.020	S	5.20 ± 0.20	0.205 ± 0.008
G	1.50 ± 0.20	0.059 ± 0.008	T	3.60 ± 0.10	0.142 ± 0.004
H	108.0 ± 2.0	4.252 ± 0.079	U	4 x 0.25	4 x 0.010
J	57.0 max	2.244 max	V	59.0 max	2.323 max
K	4.50 ± 0.50	0.177 ± 0.020	W	64.0 max	2.520 max
L	35.0 ± 2.0	1.378 ± 0.079			

Inch dimensions have been derived from millimetres.

Note Plane of filament leads will be parallel to A-A to within 3½°

BR1161
BY1161

R.F. POWER TRIODES

Service Type CV9343 (BR1161)

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes intended primarily for transmitter service. They differ only in the method of anode cooling and in anode dissipation.

Anode cooling:		
BR1161		forced-air
BY1161		vapour, separate boiler unit
Anode dissipation:		
BR1161	35	kW max
BY1161	60	kW max
Anode voltage	14	kV max
Frequency for full ratings	10	MHz max
Frequency at reduced ratings	30	MHz max
Output power (class C unmodulated conditions):		
BR1161	100	kW
BY1161	120	kW

GENERAL

Electrical

Filament (see note 1)		thoriated tungsten
Filament voltage (see note 2)	11	V
Filament current	155	A
Surge filament current (peak) (see note 3)	300	A max
Filament cold resistance	8.0	mΩ
Peak usable cathode current	60	A
Amplification factor (V_a = 9.0kV, I_a = 3.0A)	90	
Mutual conductance (V_a = 10kV, I_a = 2.5A)	55	mA/V
Perveance	4.0	$mA/V^{3/2}$
Inter-electrode capacitances:		
grid to anode	75	pF
grid to filament	130	pF
anode to filament	1.0	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1161	88 pounds (40kg) approx
BY1161	53 pounds (24kg) approx
Mounting position	vertical, filament leads up

Accessories

Boiler unit for BY1161, external condenser required	BY4059
Boiler unit for BY1161, integral condenser	BY4093
Sealing ring (supplied with BY1161)	MA245
Thermal fuse (2 supplied with BY1161)	MA85D

COOLING

Anode

The BR1161 air cooling requirements are shown on pages 9 and 10. The required air flow should be delivered through the radiator before and during the application of any voltages.

The BY1161 is vapour cooled and may be operated either in boiler unit BY4059 or BY4093. In BY4093, the steam generated at the anode is condensed by means of an internal water cooled condenser. The steam produced in BY4059 is led away by suitably insulated tubing for condensation at some convenient point external to the boiler unit.

Two thermal fuses (part number MA85D) are provided with each BY1161 to give protection against anode overheating; only one fuse at a time need be used. Alternative positions for mounting the thermal fuse are provided by four threaded holes equally spaced round the anode ring. The fuse should be screwed into the desired position and connected by a non-conducting cord to a suitable switching device; a tension of about 1 pound (450g) should be applied to the fuse via a cord. If the temperature exceeds a safe limit, the fuse core is pulled outwards; this should actuate the switching device and remove all electrical supplies from the valve. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 170°C. A flow of air of 35ft^3/min (1.0m^3/min) directed into the filament header via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of these seals. The air flow should be maintained for at least 10 minutes after switching off the filament supply to the tube.

Anode Seal and Bulb

The anode seal and bulb temperatures must not exceed 170°C.

ANODE MODULATED R.F. POWER AMPLIFIER

(Class C telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage:		
operating frequency 10MHz	11	kV max
operating frequency 30MHz	10	kV max
Anode current (mean) (see note 4)	15	A max
Anode dissipation:		
BR1161 (see note 5)	24	kW max
BY1161 (see note 5)	40	kW max
Grid voltage (negative value)	750	V max
Grid dissipation	1.5	kW max

TYPICAL OPERATING CONDITIONS

Frequency	10	30	MHz
Anode voltage	11	10	kV
Grid voltage (fixed)	−150	−150	V
Grid resistor	250	250	Ω
Peak r.f. grid drive voltage	1200	1200	V
Anode current	6.0	6.0	A
Grid current (approx)	2.3	2.3	A
Anode dissipation	11	10	kW
Grid dissipation (approx)	1.1	1.1	kW
Driving power (approx)	2.8	2.8	kW
Output power	55	50	kW
Efficiency	83	83	%

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C telegraphy, key-down conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage:		
operating frequency 10MHz	14	kV max
operating frequency 30MHz	12	kV max
Anode current (mean) (see note 4)	15	A max
Anode dissipation:		
BR1161	35	kW max
BY1161	60	kW max
Grid voltage (negative value)	750	V max
Grid dissipation	1.5	kW max

TYPICAL OPERATING CONDITIONS (For amplifier)

	BY1161	BR1161	
Anode voltage	14	12	kV
Grid voltage	−350	−300	V
Peak r.f. grid drive voltage	910	820	V
Anode current	11.3	11	A
Grid current (approx)	2.4	2.4	A
Anode dissipation	38	32	kW
Grid dissipation (approx)	1.36	1.28	kW
Driving power (approx)	2.2	2.0	kW
Output power	120	100	kW
Efficiency	76	76	%

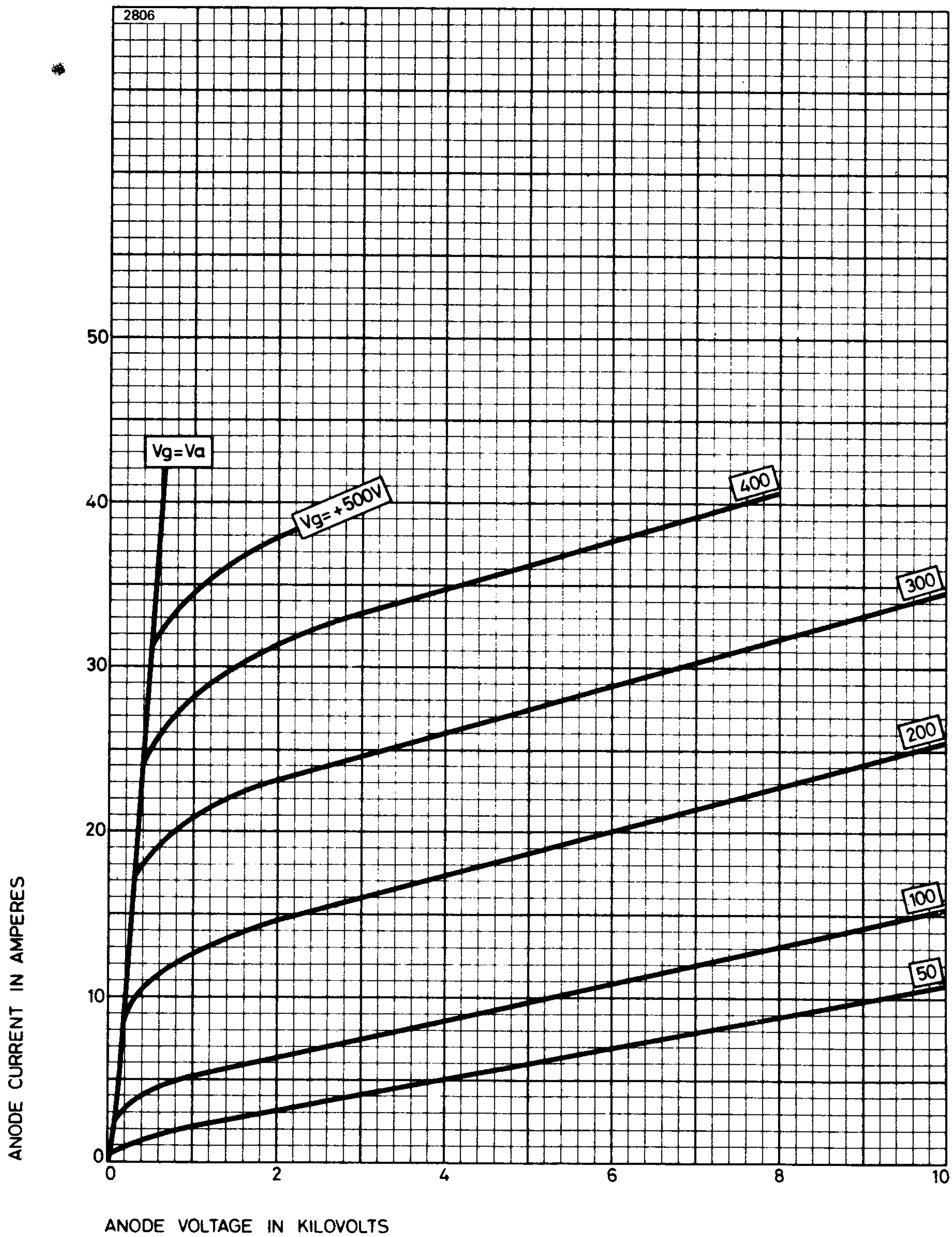
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 11V	145	165	A
Amplification factor (V_a = 9.0kV, I_a = 3.0A)	75	110	
Mutual conductance (V_a = 10kV, I_a = 2.5A)	45	–	mA/V
Grid voltage (negative value) (V_a = 10kV, I_a = 0.1A)	–	160	V
Grid current (V_a = 2.5kV, I_a = 44A)	–	17	A
Grid voltage (V_a = 2.5kV, I_a = 44A)	–	620	V
Grid current (V_a = 0.8kV, I_a = 40A)	–	27	A
Grid voltage (V_a = 0.8kV, I_a = 40A)	–	670	V

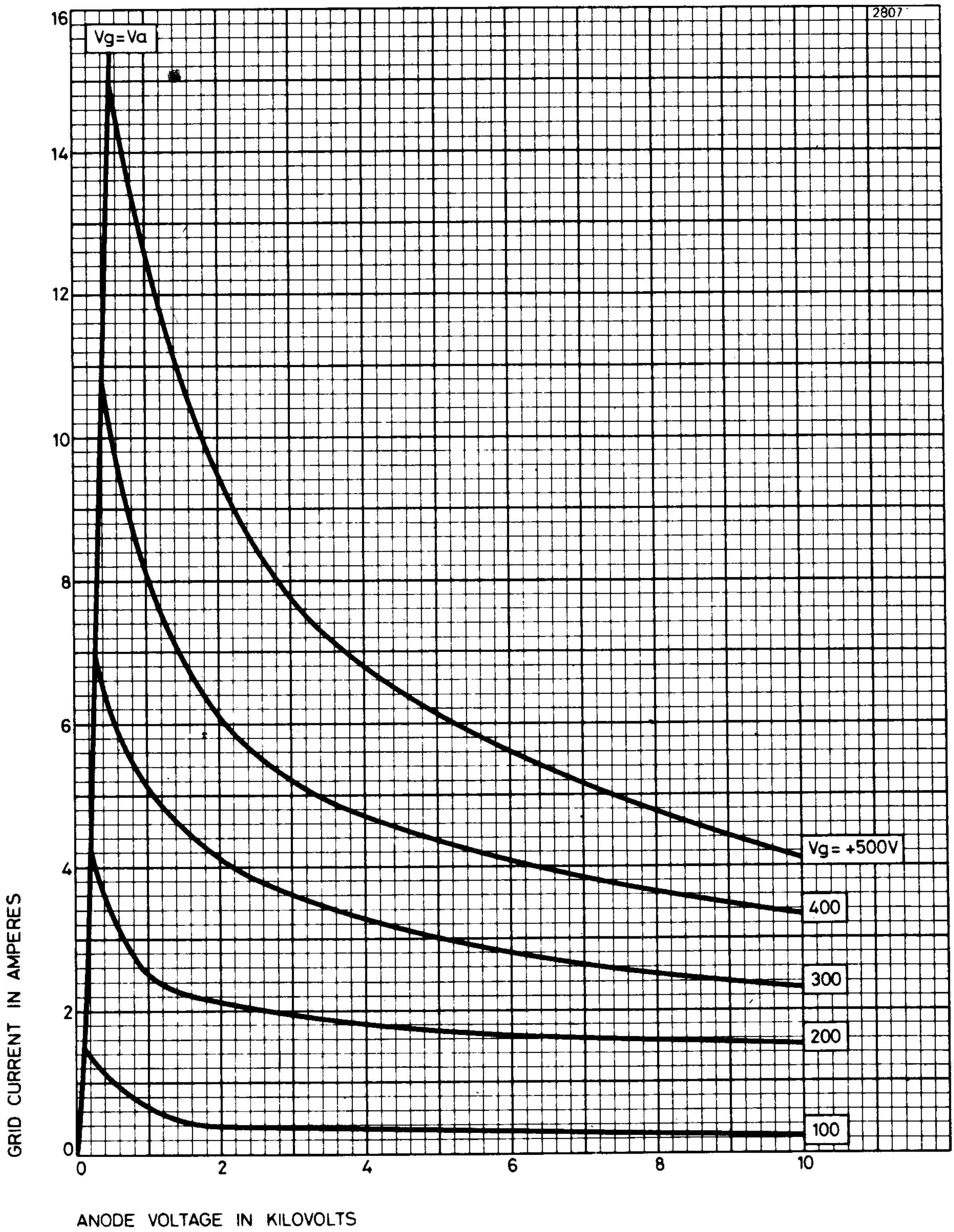
NOTES

1. Connections to the filament are normally made via the flexible leads fitted to the valve. Should r.f. connections be required, these should be made with flexible conductors to the terminals below the filament leads.
2. The valve must normally be operated at the stated filament voltage. When the operating grid dissipation is less than 400 watts the filament voltage should be increased to 11.5V. Fluctuation in filament voltage must not exceed ±5%.
3. The filament current must not exceed 300A, even momentarily, at any time.
4. It is recommended that a resistor of at least 25Ω should be connected in series with the anode to limit the surge current in case of flashover (unless adequate protection is already given by other circuit elements).
5. This corresponds to 35kW and 60kW anode dissipation respectively at 100% sine wave modulation.

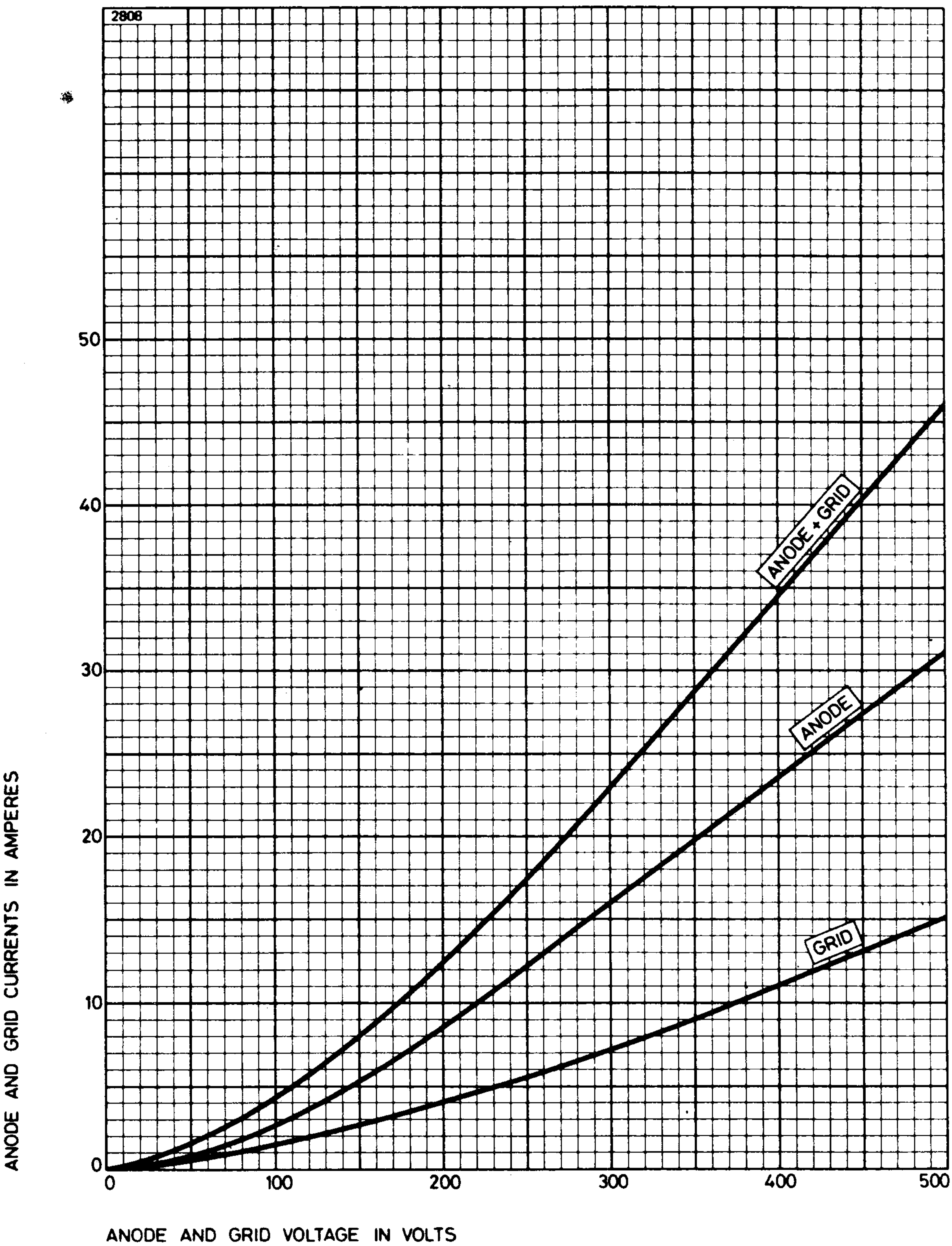
TYPICAL ANODE CHARACTERISTICS



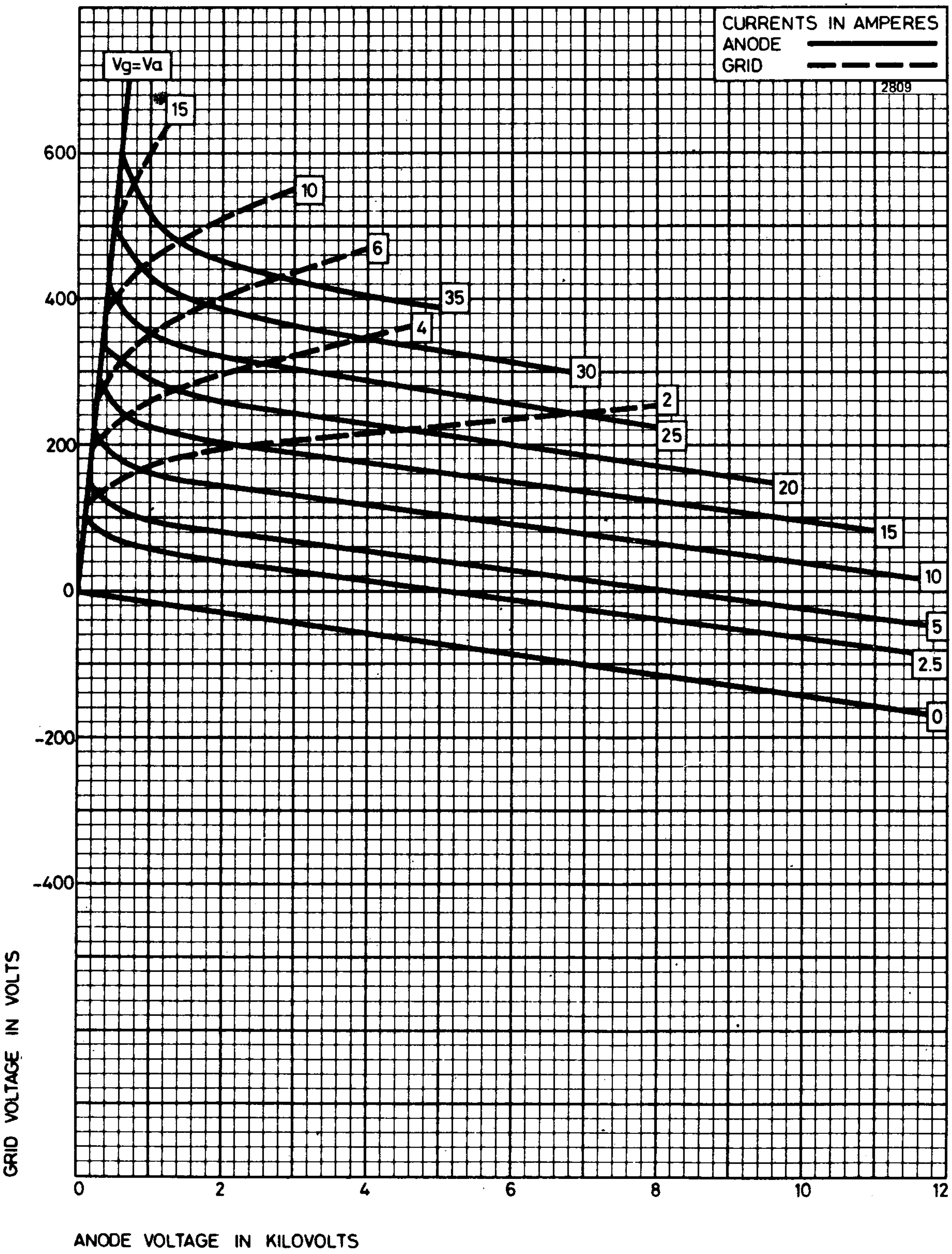
TYPICAL GRID CHARACTERISTICS



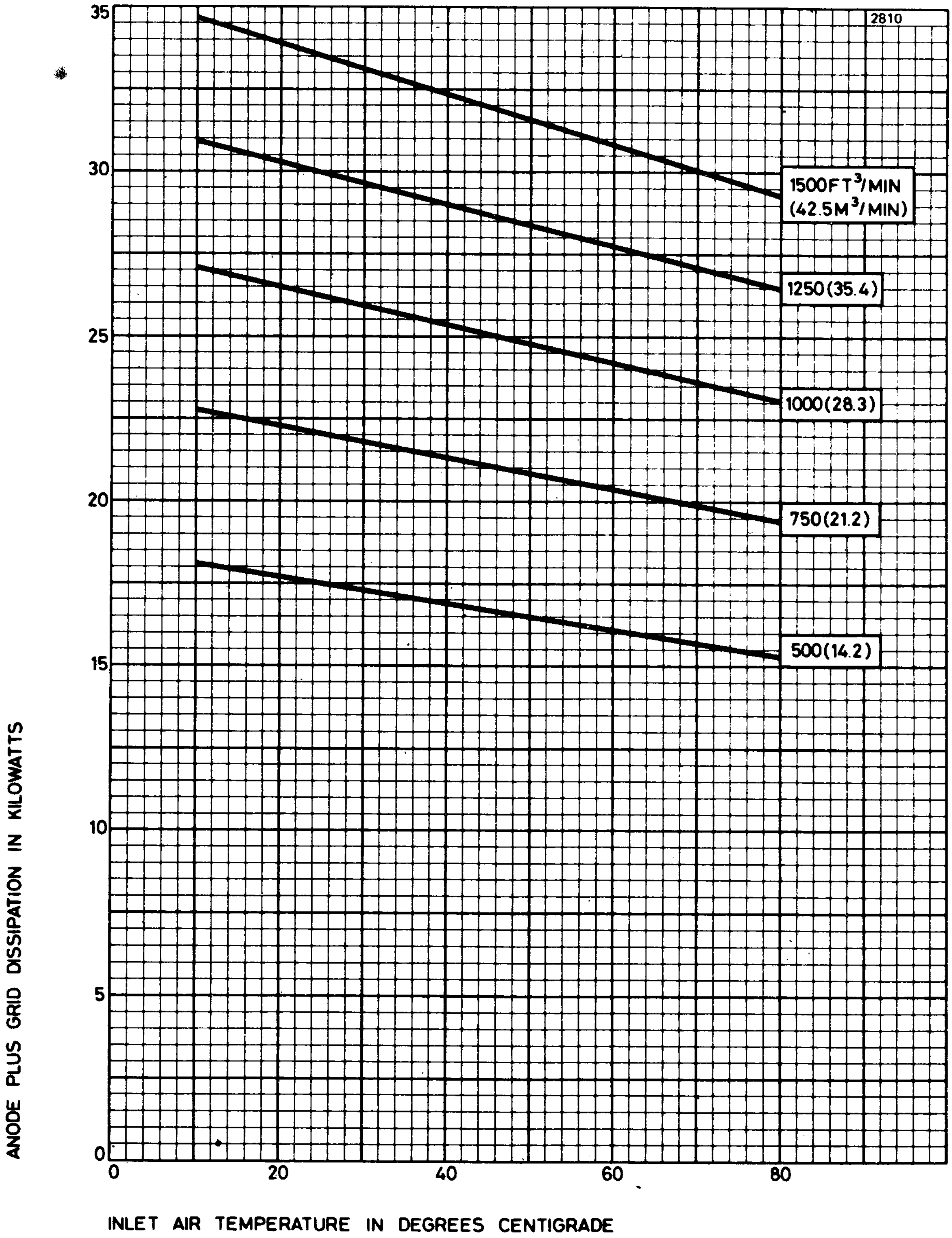
TYPICAL STRAPPED CHARACTERISTICS



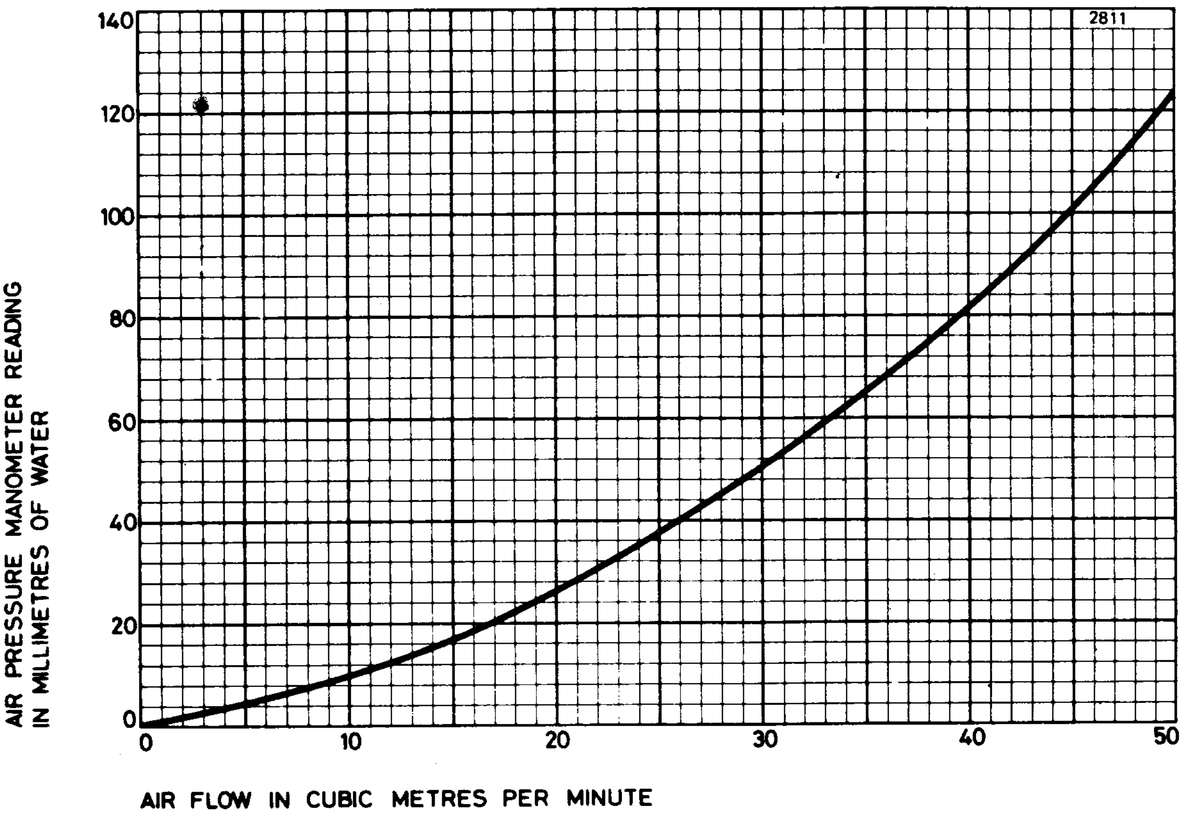
TYPICAL CONSTANT CURRENT CHARACTERISTICS

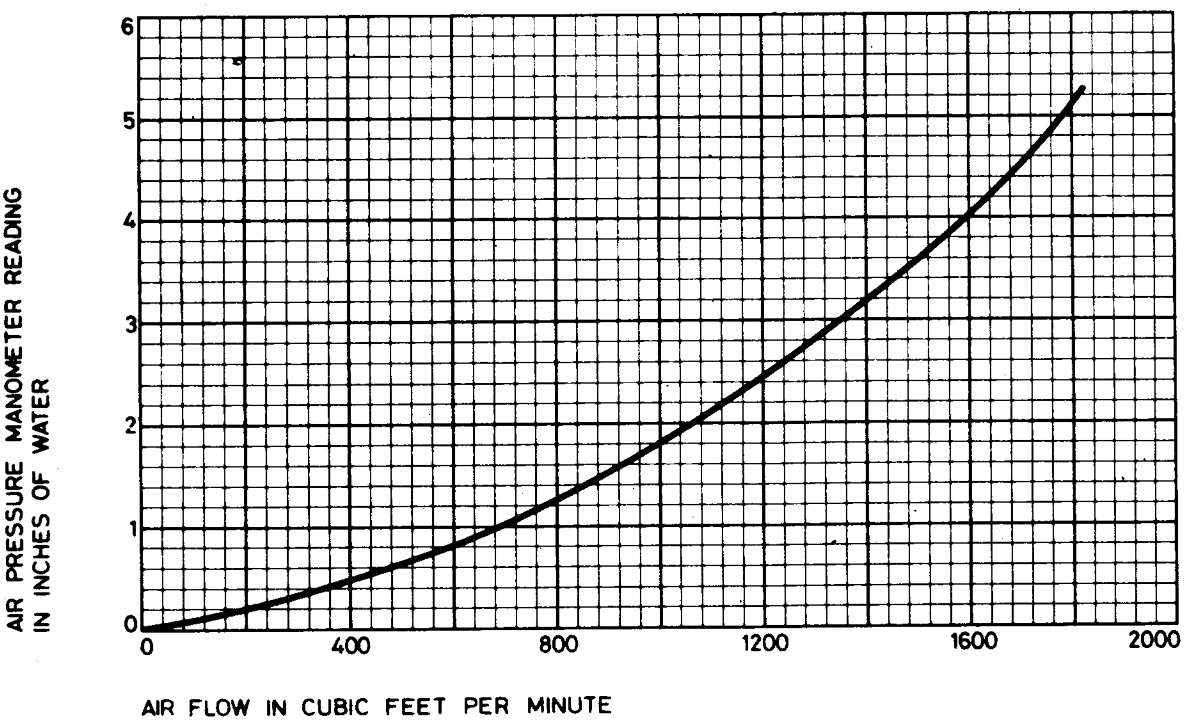


AIR COOLING REQUIREMENTS FOR BR1161

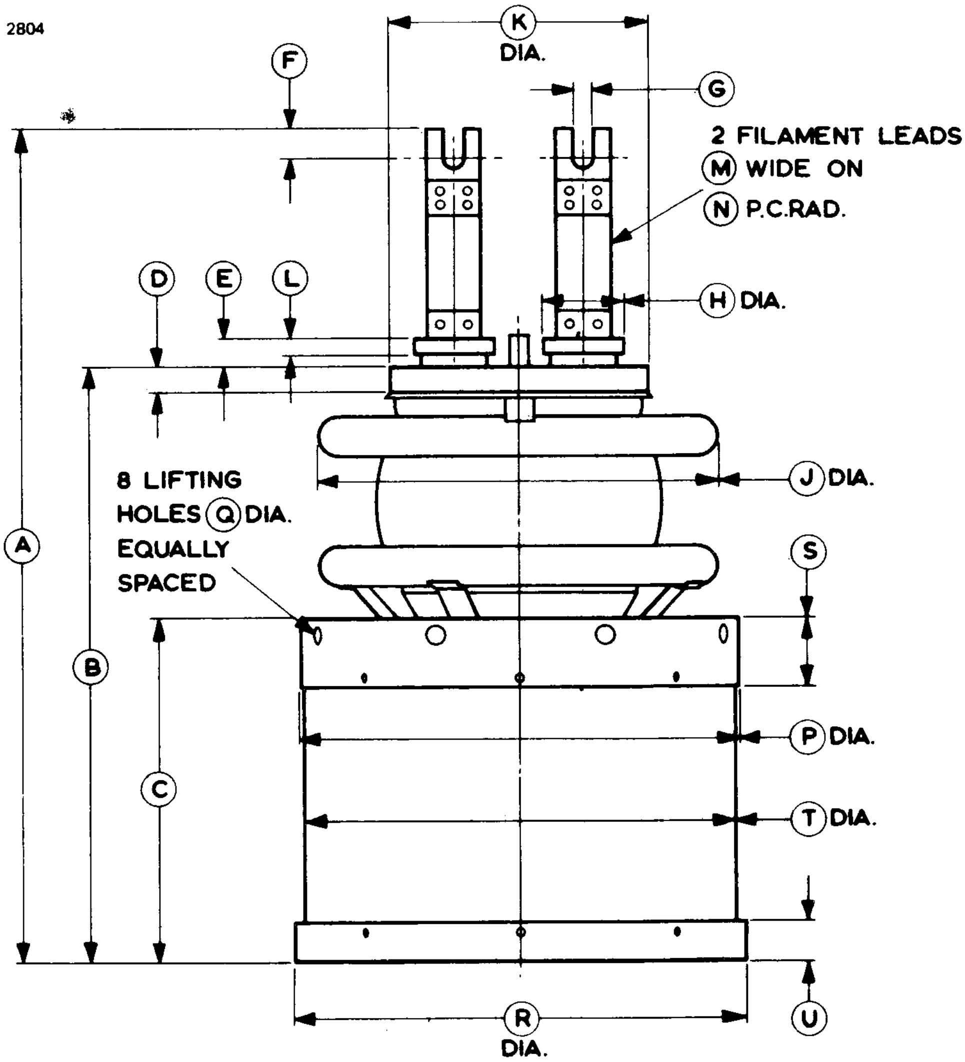


TYPICAL AIR FLOW CHARACTERISTIC FOR BR1161





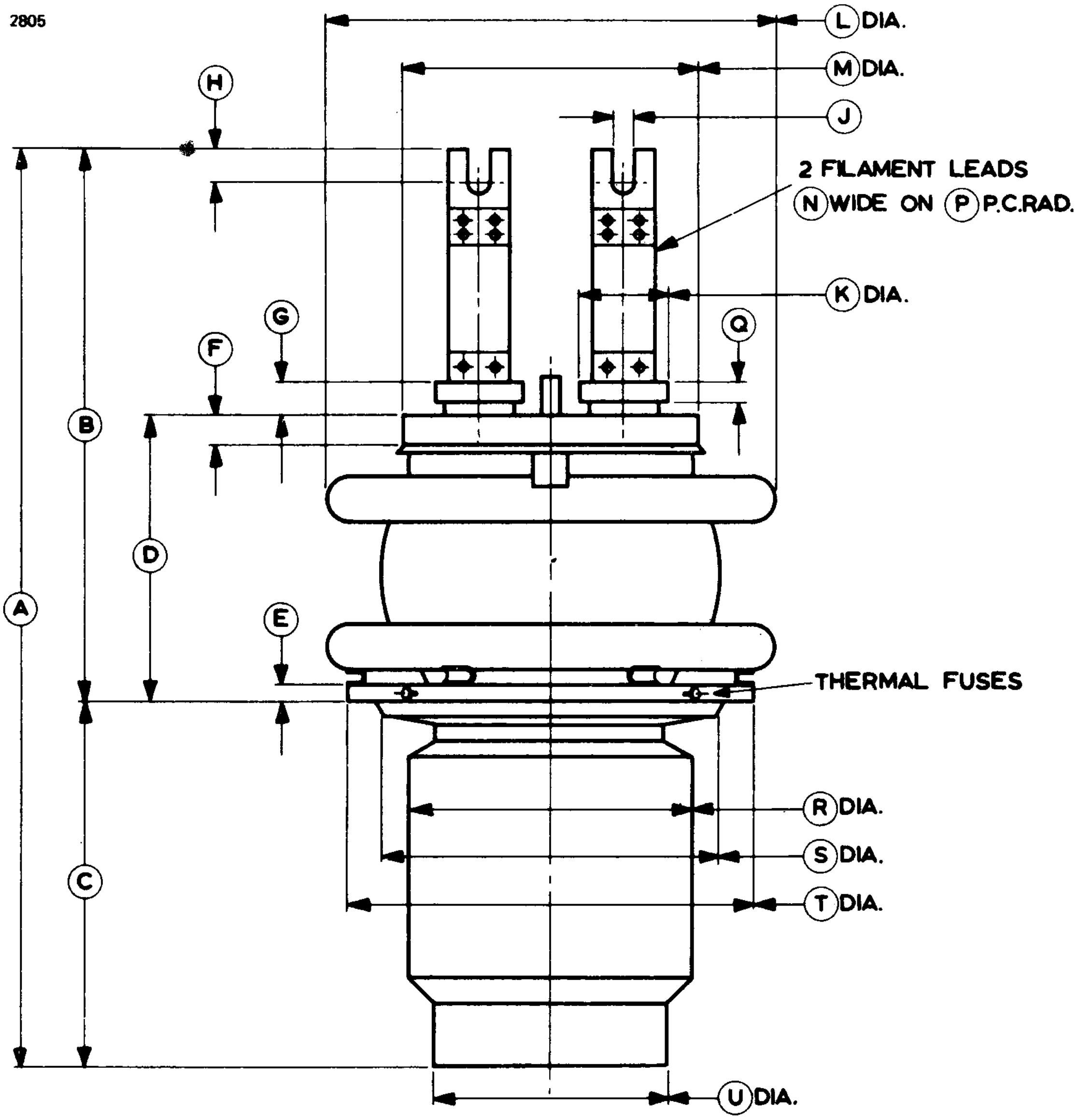
OUTLINE FOR BR1161 (All dimensions without limits are nominal)



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	526.0	20.710	L	12.0	0.472
B	375.0 ± 1.0	14.764 ± 0.040	M	35.0	1.378
C	217.0	8.543	N	40.0 ± 1.0	1.575 ± 0.040
D	17.0	0.670	P	$274.0^{+1.0}_{-0.5}$	$10.787^{+0.040}_{-0.020}$
E	19.0 ± 1.0	0.750 ± 0.040			
F	19.0	0.750	Q	12.0	0.472
G	11.0	0.433	R	282.0 ± 1.0	11.102 ± 0.040
H	50.0 ± 0.4	1.969 ± 0.016	S	45.0	1.772
J	251.5 max	9.902 max	T	270.0	10.630
K	164.5 ± 0.5	6.476 ± 0.020	U	25.0	0.984

Inch dimensions have been derived from millimetres.

OUTLINE FOR BY1161 (All dimensions without limits are nominal)



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	525.0 max	20.670 max	L	251.5 max	9.902 max
B	310.0	12.205	M	164.5 ± 0.5	6.476 ± 0.020
C	210.0	8.268	N	35.0	1.378
D	162.2 ± 2.0	6.378 ± 0.080	P	40.0 ± 1.0	1.575 ± 0.040
E	10.0 ± 0.2	0.394 ± 0.008	Q	12.0	0.472
F	17.0	0.670	R	158.0	6.220
G	19.0 ± 1.0	0.750 ± 0.040	S	192.0 ± 0.2	7.559 ± 0.008
H	19.0	0.750	T	225.0 ± 0.2	8.858 ± 0.008
J	11.0	0.433	U	130.0	5.118
K	50.0 ± 0.4	1.969 ± 0.016			

Inch dimensions have been derived from millimetres.

BR/BW1162 Series

R.F. POWER TRIODES

Service Type (BR1162) CV5239

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. power triodes intended for transmitter and industrial applications. They differ only in the method of anode cooling.

Anode cooling:		
BR1162		forced-air
BW1162		water, separate jacket
BW1162J3		water; integral jacket
Anode dissipation	6.0	kW max
Anode voltage	7.2	kV max
Operating frequency:		
class C telegraphy	30	MHz max
class C industrial oscillator	85	MHz max
Output power:		
class B audio, per valve	10	kW
class C telegraphy	10	kW
class C industrial oscillator	8.6	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	12.6	V
Filament current	33	A
Peak usable cathode current	14	A
Amplification factor (V_a = 6.0kV, I_a = 1.0A)	32	
Mutual conductance (V_a = 6.0kV, I_a = 1.0A)	15	mA/V
Inter-electrode capacitances:		
grid to anode	11	pF
grid to filament	16	pF
anode to filament	0.3	pF

Mechanical

Overall dimensions . . . . see outline drawings

Net weight:

BR1162 . . . . 10.1 pounds (4.6kg) approx

BW1162 . . . . 1 pound (0.45kg) approx

BW1162J3 . . . . 1.8 pounds (0.7kg) approx

Mounting position:

BR1162, BW1162J3 . . . . vertical, either way up

BW1162 . . . . vertical, filament pins up

Accessories

Filament connectors MA146A

Centre-tap dissipating connector MA146B

Grid connector (above 30MHz) MA147A

Grid connector (below 30MHz) MA148A

Insulating pedestal for BR1162 . . . . MA149A

Water jacket for BW1162 . . . . BW4088A

Sealing ring (supplied with BW1162) MA314

COOLING

Anode

The air cooling requirements for BR1162 are given in the following table. The air flow should be delivered immediately before and during the application of any voltages.

Anode dissipation (kW)	Height above sea level (m)	Inlet temperature (max) (°C)	Rate of flow of air (min) (m^3/min)	Pressure drop (mm water)
2.0	0	35	4.8	20
2.0	0	45	5.7	25
2.0	1500	35	5.7	23
2.0	3000	25	6.1	23
3.5	0	35	6.2	32
3.5	0	45	7.3	42
3.5	1500	35	7.3	36
3.5	3000	25	7.8	36
6.0	0	35	9.2	68
6.0	0	45	10.7	91
6.0	1500	35	11.2	81
6.0	3000	25	11.7	80

The BW1162 anode must be fitted into a water jacket for cooling, the recommended jacket being type BW4088A. The water cooling requirements are given in the following table.

Anode dissipation (kW)	Inlet temperature (°C)	Rate of flow of water l./min	gal/min	Pressure drop across jacket (atm)
1.0	20	2.5	0.55	0.08
1.0	50	5.0	1.10	0.10
2.0	20	2.5	0.55	0.08
2.0	50	5.0	1.10	0.10
4.0	20	4.0	0.88	0.18
4.0	50	9.0	1.98	0.90
6.0	20	6.0	1.32	0.4
6.0	50	14	3.08	2.5

The BW1162J3 has an integral water jacket. Minimum water cooling requirements are shown on page 11; higher rates of flow should be used where possible. A thermal fuse may be fitted (see page 15).

Filament, Grid and Anode Seals

It may be necessary to direct a flow of air on to the filament and grid seals in order to maintain their temperatures within the following limits.

Temperature of filament seals	210	°C max
Temperature of grid and anode seals	180	°C max

Filament Centre-tap Pin

A heat dissipating connector such as MA146B must be used on the filament centre-tap pin.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR (Class B)

MAXIMUM RATINGS (Absolute values)

Anode voltage	7.2	kV max
Anode current	2.2	A max
Anode input power	14	kW max
Anode dissipation	6.0	kW max
Grid dissipation	250	W max
Grid circuit resistance	15	kΩ max
Cathode current (peak)	10	A max

TYPICAL OPERATING CONDITIONS (Class B, 2 valves)

Anode voltage	4.0	5.0	5.0	7.0	kV
Grid voltage	−120	−145	−145	−210	V
Peak a.f. grid drive voltage (per valve)	445	342	415	605	V
Anode current (zero signal)	2 x 0.10	2 x 0.15	2 x 0.15	2 x 0.20	A
Anode current (maximum signal)	2 x 1.25	2 x 1.10	2 x 1.25	2 x 2.00	A
Grid current (maximum signal)	2 x 0.32	2 x 0.22	2 x 0.35	2 x 0.56	A
Effective load (anode to anode)	3.8	5.5	4.8	4.15	kΩ
Nominal driving power (maximum signal)	2 x 140	2 x 65	2 x 130	2 x 310	W
Anode dissipation	2 x 1.45	2 x 1.50	2 x 1.70	2 x 4.00	kW
Output power (maximum signal)	7.1	8.0	9.0	20	kW
Efficiency	71	72.5	72.5	71.5	%

ANODE MODULATED R.F. POWER AMPLIFIER

(Class C Telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	5.5	kV max
Anode current	1.8	A max
Anode dissipation	4.0	kW max
Grid voltage (negative value)	1.25	kV max
Grid current	0.6	A max
Grid dissipation	250	W max
Cathode current (peak)	12	A max
Frequency for above ratings	30	MHz max

TYPICAL OPERATING CONDITIONS (frequency 30MHz)

Anode voltage	4.0	5.0	5.0	kV
Grid voltage	−300	−400	−400	V
Peak r.f. grid drive voltage	680	730	800	V
Anode current	1.6	1.4	1.6	A
Grid current	0.6	0.5	0.5	A
Nominal driving power	367	328	432	W
Anode dissipation	1.4	1.4	1.6	kW
Output power	5.0	5.6	6.4	kW
Efficiency	78	80	80	%

RADIO FREQUENCY POWER AMPLIFIER

(Class C Telegraphy, key down conditions, or F.M. Telephony, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	7.2	kV max
Anode current	2.2	A max
Anode input power	14	kW max
Anode dissipation	6.0	kW max
Grid voltage (negative value)	1250	V max
Grid current	0.6	A max
Grid dissipation	250	W max
Cathode current (peak)	14	A max
Frequency for above ratings	30	MHz max

TYPICAL OPERATING CONDITIONS (frequency 30MHz)

Anode voltage	5.0	6.0	6.5	kV
Grid voltage	−300	−400	−450	V
Peak r.f. grid drive voltage	700	820	850	V
Anode current	2.0	2.0	2.0	A
Grid current	0.6	0.6	0.6	A
Nominal driving power	378	443	460	W
Anode dissipation	2.7	2.8	3.0	kW
Output power	7.3	9.2	10	kW
Efficiency	73	76.7	77	%

RADIO FREQUENCY POWER OSCILLATOR

(Class C, anode supply from unfiltered three phase half-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Anode voltage	7.0	kV max
Anode current	1.8	A max
Anode input power	11	kW max
Anode dissipation	6.0	kW max
Grid voltage (negative value)	1250	V max
Grid current (unloaded)	0.7	A max
Grid current (loaded)	0.5	A max
Grid dissipation	250	W max
Grid circuit resistance	10	kΩ max
Cathode current (peak)	11	A max
Operating frequency for full ratings	55	MHz max
Anode voltage for operation at 85MHz max	6.5	kV max

TYPICAL OPERATING CONDITIONS

Frequency	55	85	85	MHz
Output voltage (r.m.s.) from transformer	5.55	5.13	4.27	kV
Anode voltage	6.5	6.0	5.0	kV
Anode current	1.7	1.5	1.7	A
Grid current (unloaded)	0.7	0.7	0.7	A
Grid current (loaded)	0.5	0.4	0.45	A
Anode dissipation	2.4	2.5	2.4	kW
Anode load resistance	2.0	2.3	1.6	kΩ
Grid resistor	0.9	1.0	0.85	kΩ
Feedback ratio (see note 2)	0.15	0.15	0.19	
Nominal drive power	350	300	350	W
Output power	8.6	6.5	6.1	kW
Effective output power to load (see note 3)	7.0	5.5	5.0	kW
Efficiency	78	72	72	%

NOTES

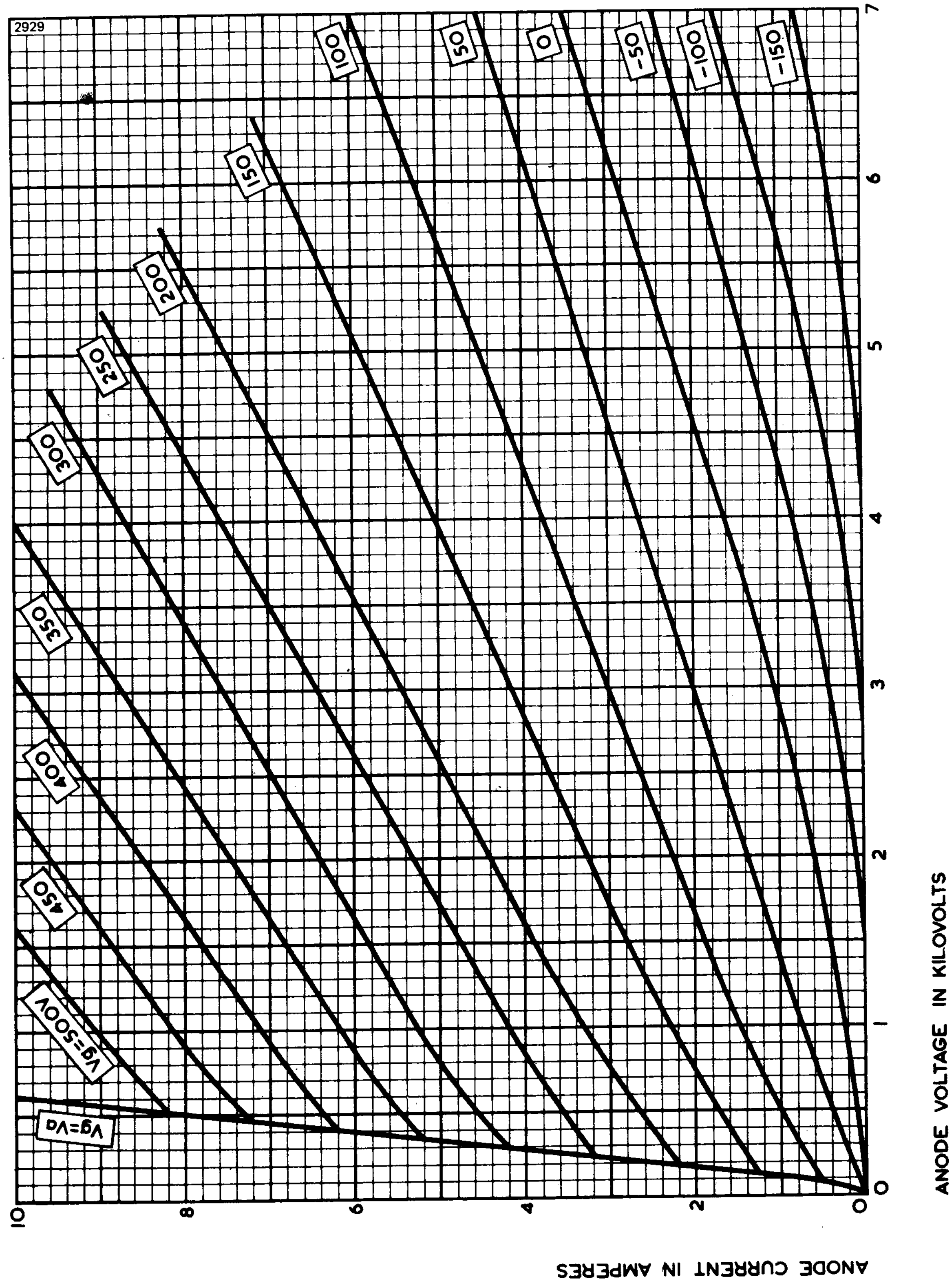
1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed +5% or −10%. The centre-tap pin may be used for the anode current return but must not be used for the filament current supply. At frequencies above 30MHz, all three filament pins should be interconnected with suitable capacitors.

2. The feedback ratio is defined as $\frac{v_{g\,(pk)}}{v_{a\,(pk)}}$

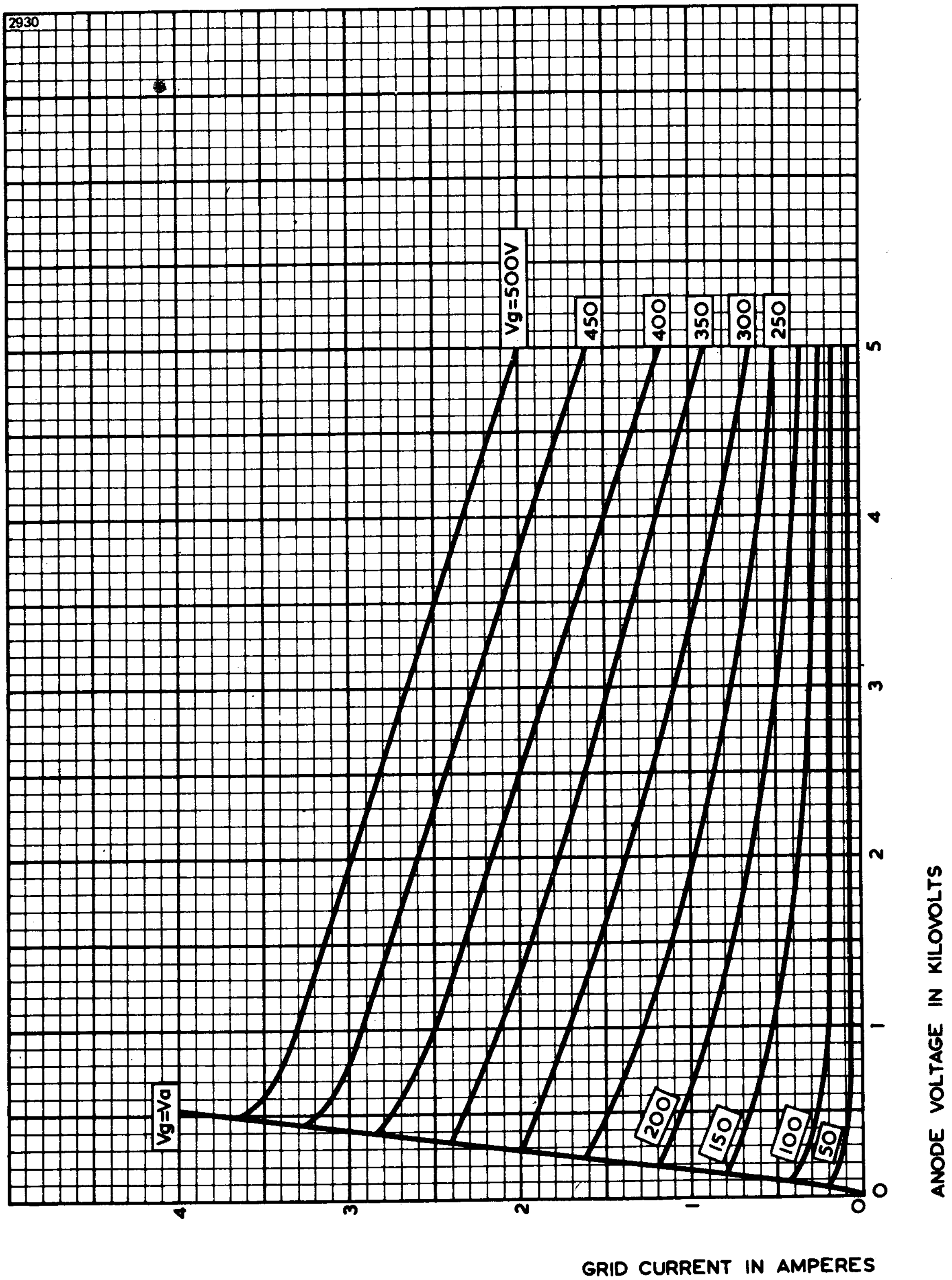
   where $v_{g\,(pk)}$ = peak r.f. grid voltage in volts
   and $v_{a\,(pk)}$ = peak r.f. anode voltage in volts.

3. Effective output power to load = $\eta_a\,(P_{out} - P_{drive})$
   where η_a = efficiency of anode circuit = 85% (typical value)
   P_{out} = output power of valve to anode circuit
   P_{drive} = drive power fed back to grid circuit.

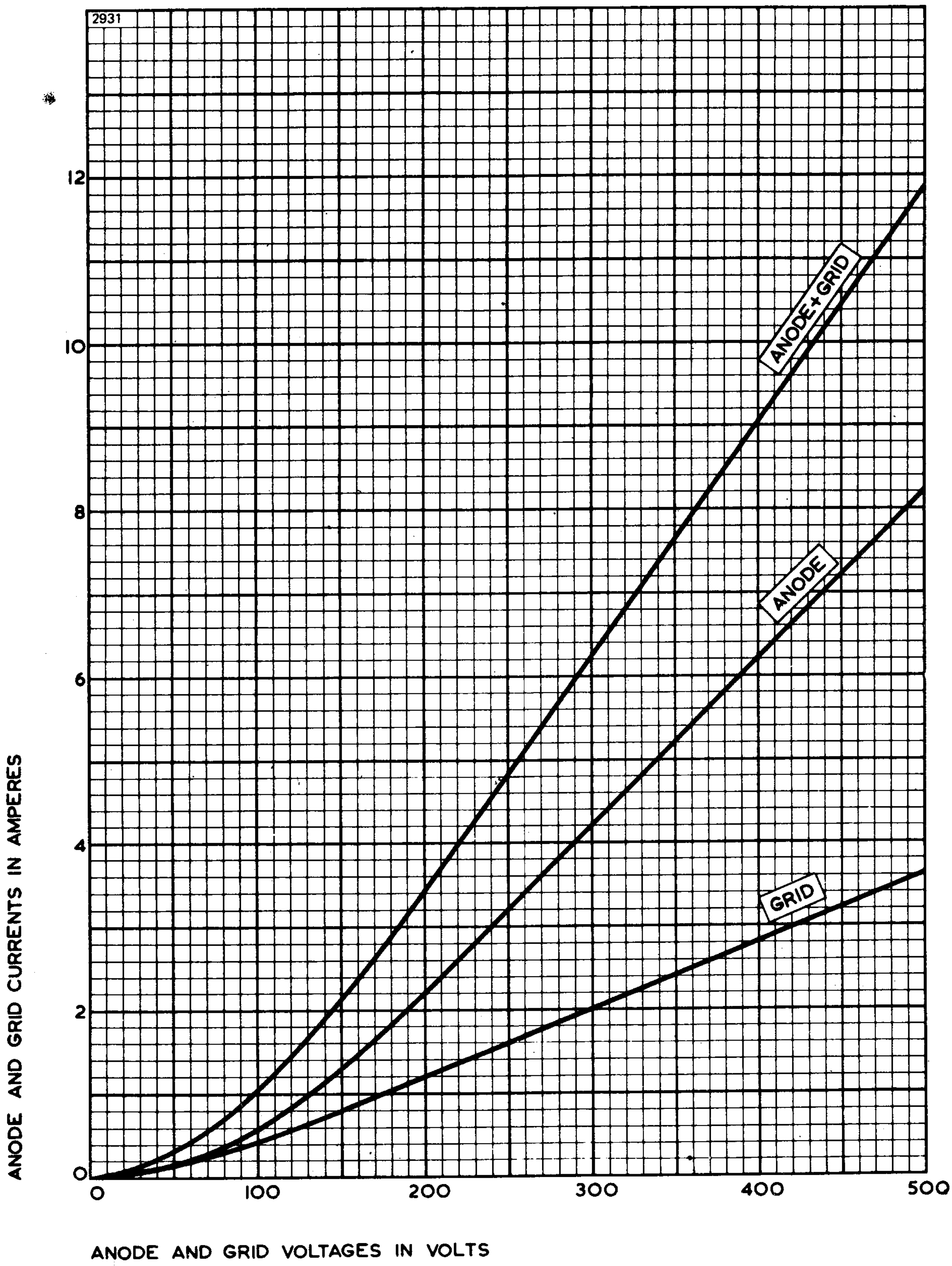
TYPICAL ANODE CHARACTERISTICS



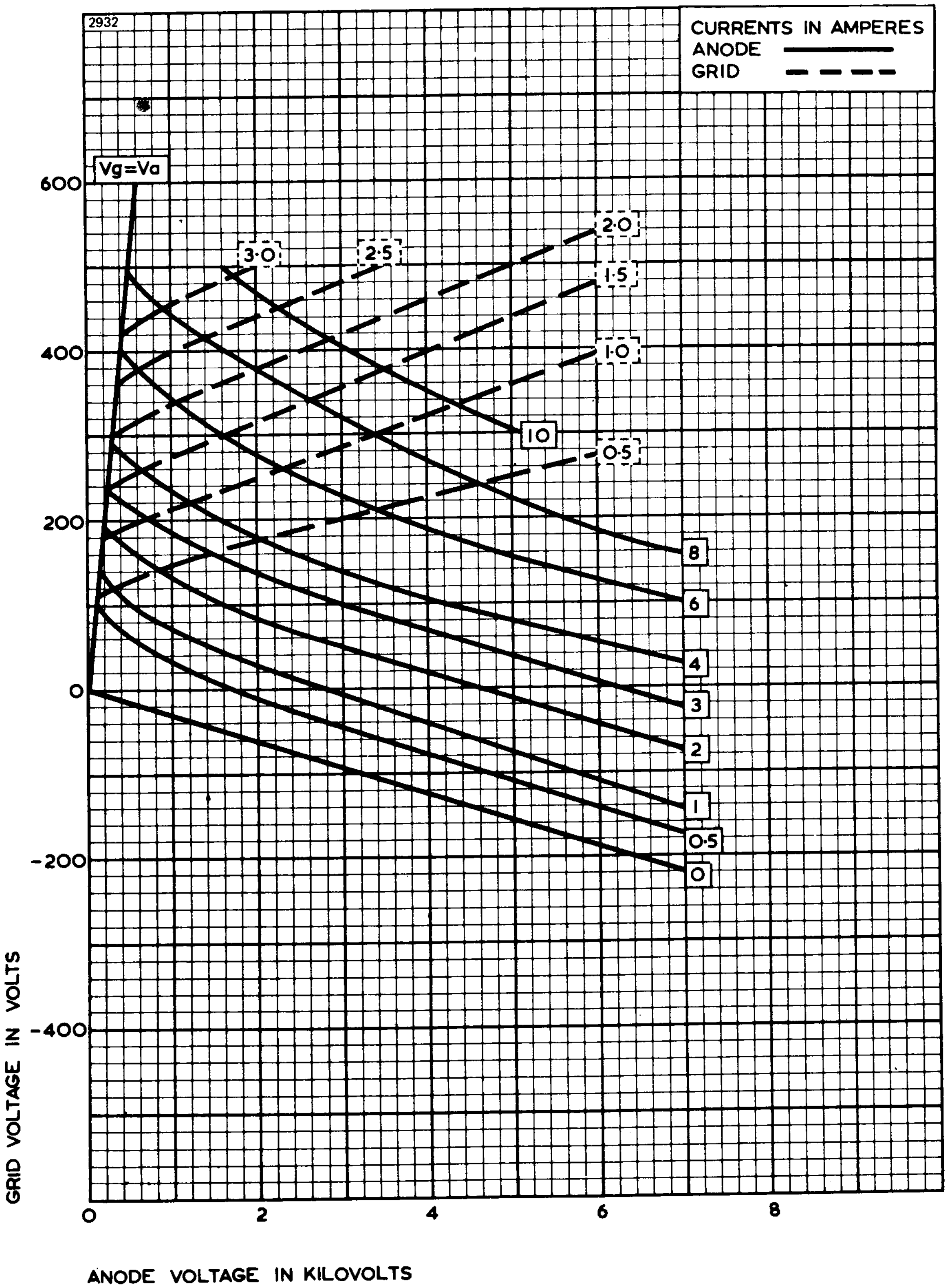
TYPICAL GRID CHARACTERISTICS



TYPICAL STRAPPED CHARACTERISTICS

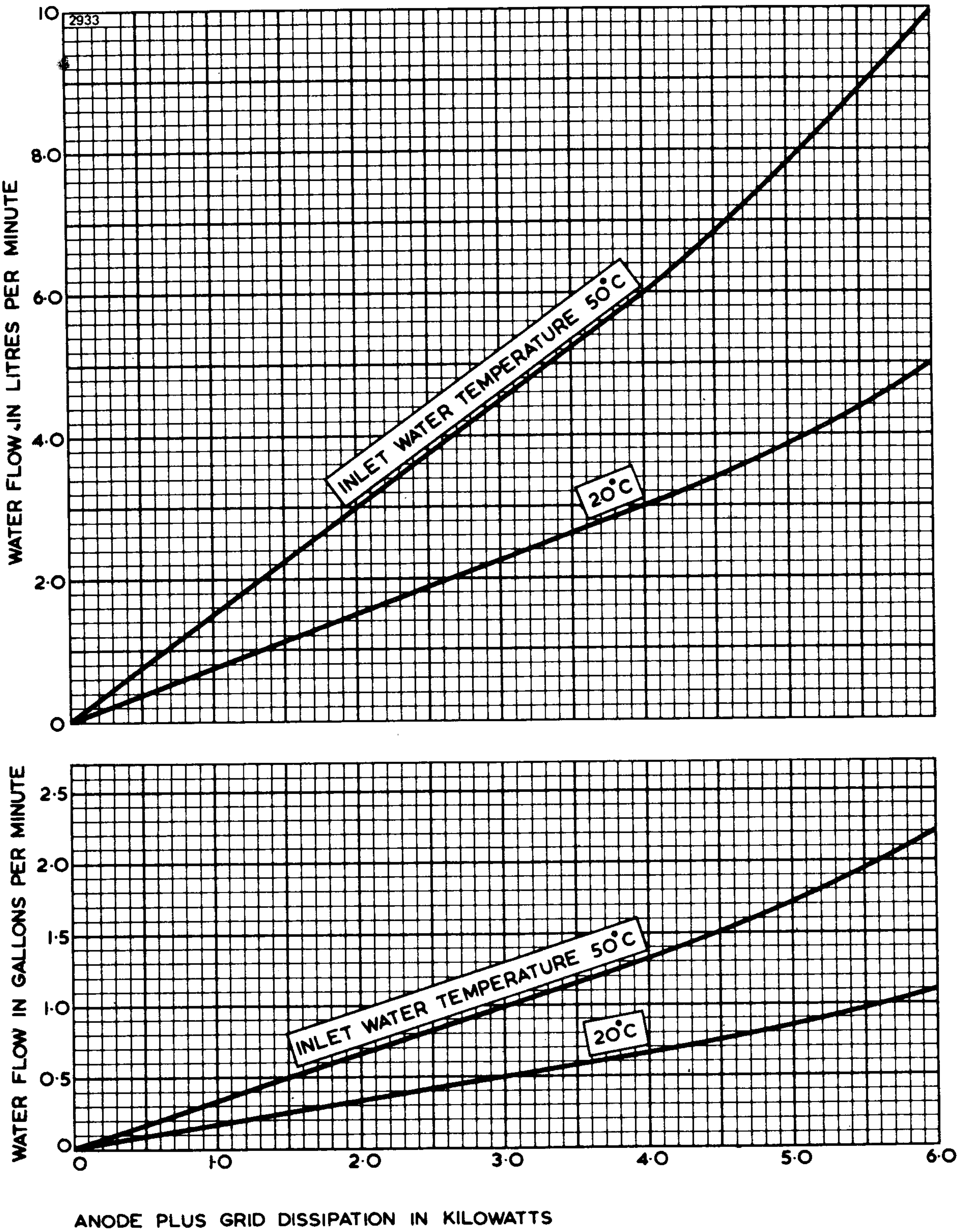


TYPICAL CONSTANT CURRENT CHARACTERISTICS

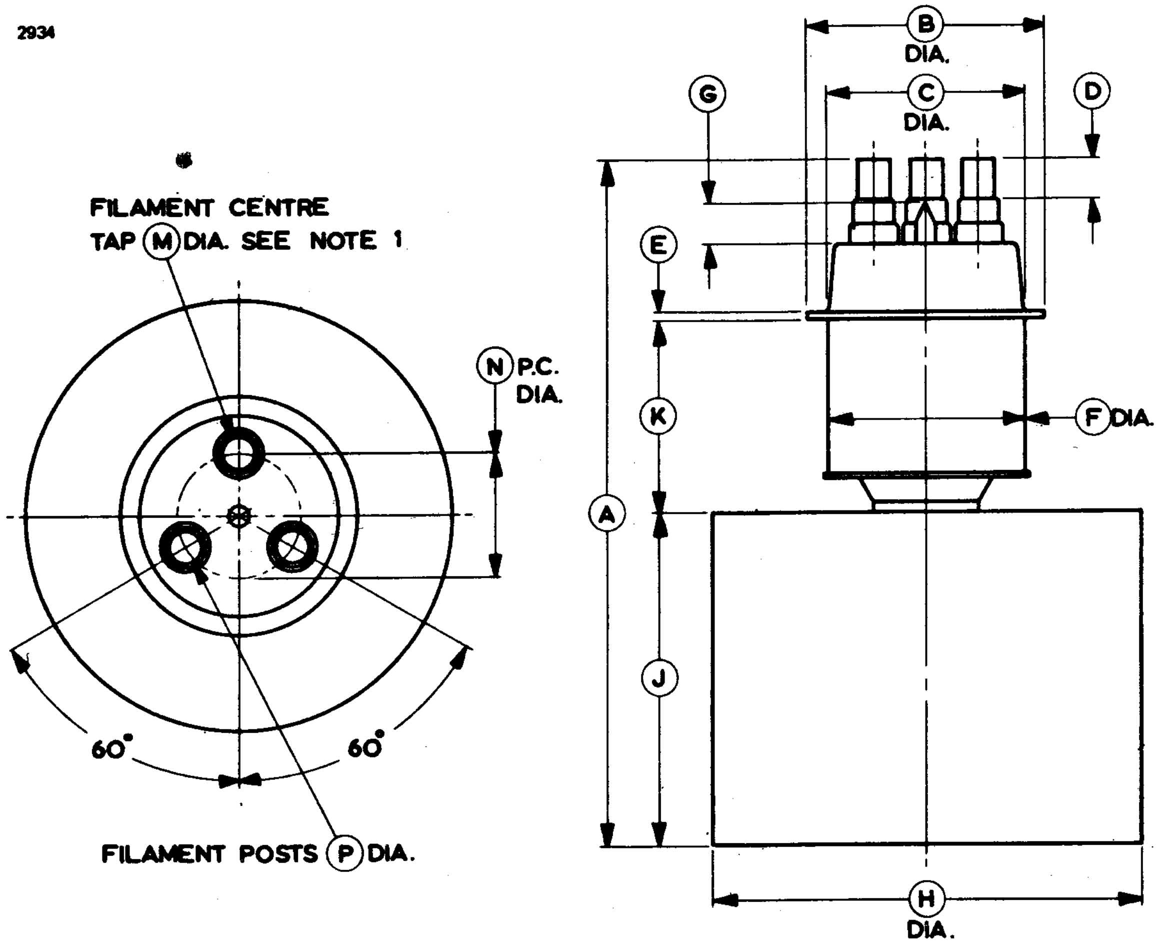


MINIMUM WATER COOLING REQUIREMENTS FOR BW1162J3

Higher rates of flow should be used where possible.



OUTLINE FOR BR1162 (All dimensions without limits are nominal)

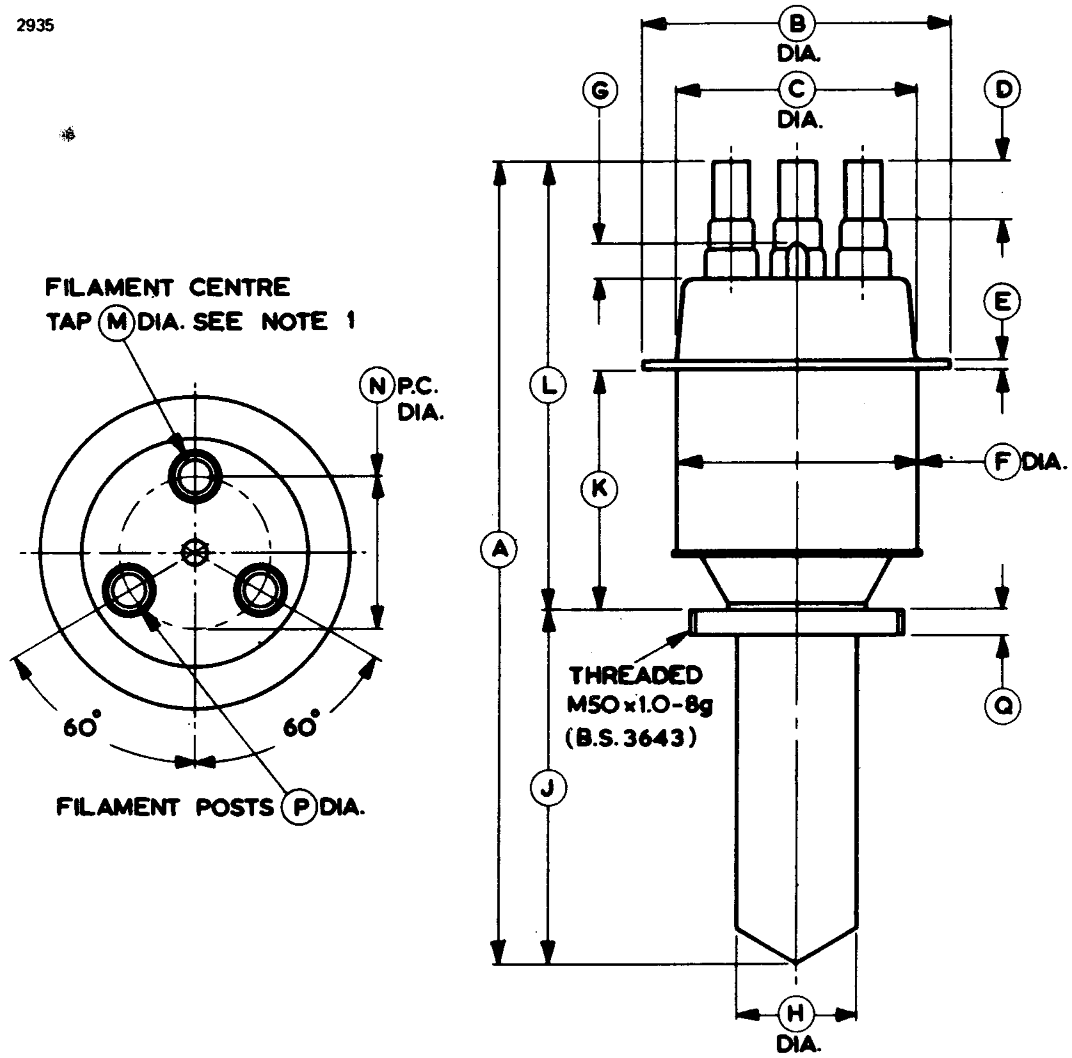


Ref	Millimetres	Inches
A	195.0 max	7.677 max
B	70.00 ± 0.50	2.756 ± 0.020
C	59.00 max	2.323 max
D	12.00 min	0.472 min
E	2.50	0.098
F	64.00 max	2.520 max
G	20.00 max	0.787 max
H	122.3 ± 0.5	4.815 ± 0.020
J	94.00	3.701
K	54.00 ± 0.50	2.126 ± 0.020
M	10.50	0.413
N	35.00 ± 1.00	1.378 ± 0.040
P	9.10	0.358

Inch dimensions have been derived from millimetres.

Note The filament centre tap pin is marked O.

OUTLINE FOR BW1162 (All dimensions without limits are nominal)

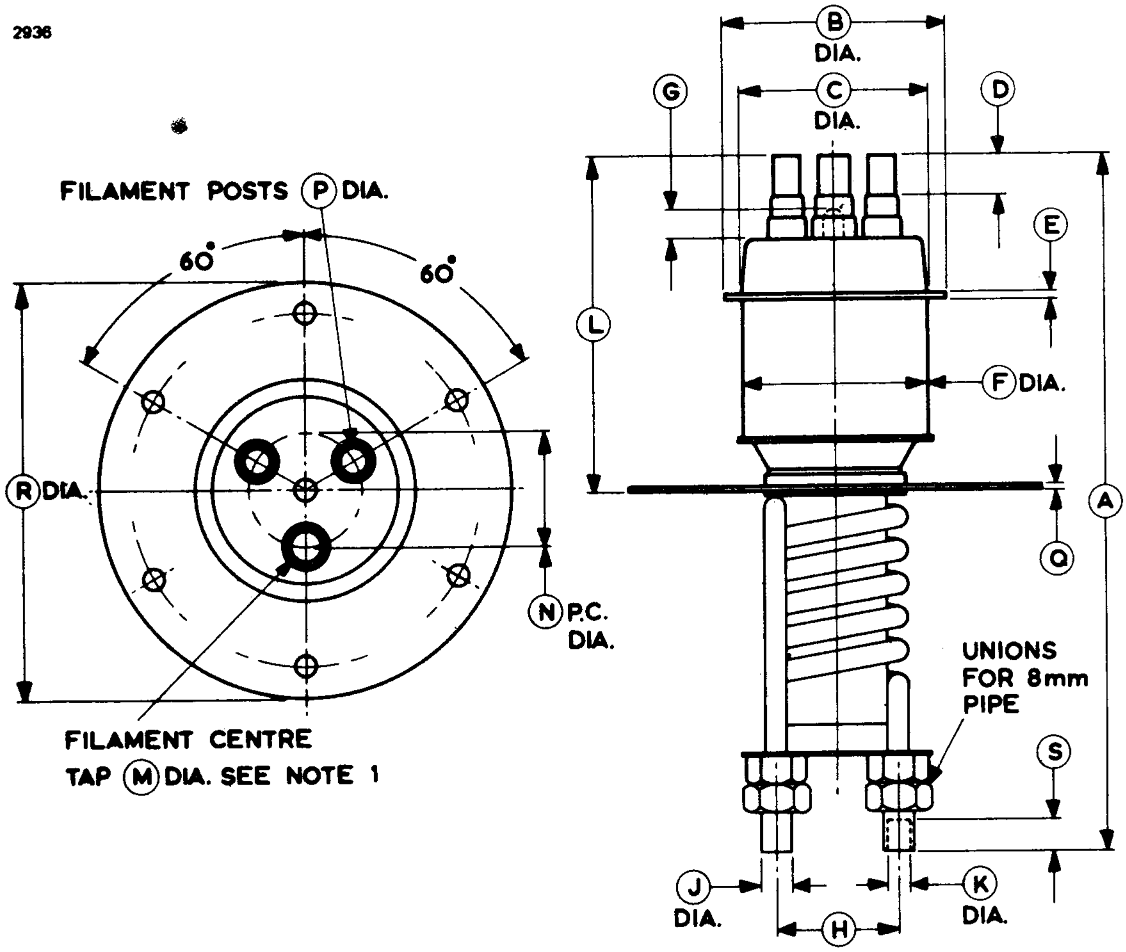


Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	190.0 max	7.480 max	J	83.00 max	3.268 max
B	70.00 ± 0.50	2.756 ± 0.020	K	56.00	2.205
C	59.00 max	2.323 max	L	106.0	4.173
D	12.00 min	0.472 min	M	10.50	0.413
E	2.50	0.098	N	35.00 ± 1.00	1.378 ± 0.040
F	64.00 max	2.520 max	P	9.10	0.358
G	20.00 max	0.787 max	Q	6.25	0.246
H	30.00 max	1.181 max			

Inch dimensions have been derived from millimetres.

Note The filament centre tap pin is marked O.

OUTLINE FOR BW1162J3 (All dimensions without limits are nominal)

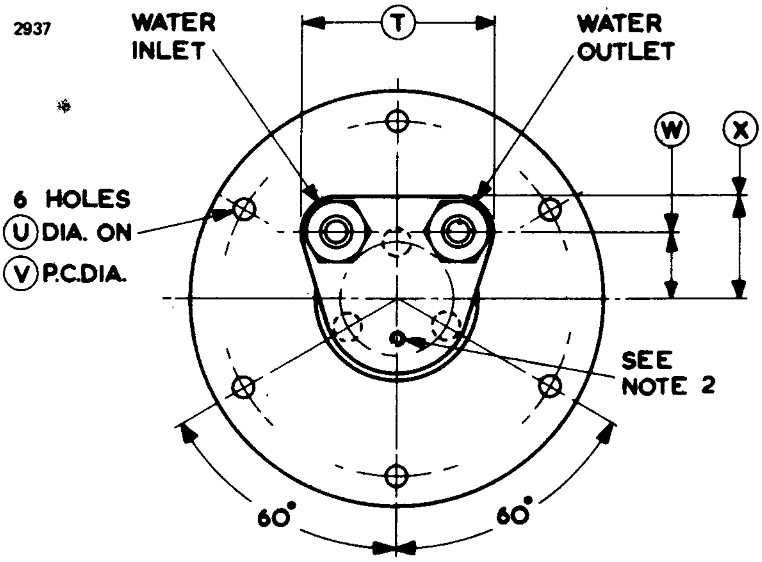


Ref	Millimetres	Inches
A	218.0 max	8.583 max
B	70.00 ± 0.50	2.756 ± 0.020
C	59.00 max	2.323 max
D	12.00 min	0.472 min
E	2.50	0.098
F	64.00 max	2.520 max
G	20.00 max	0.787 max
H	39.00	1.535
J	10.00	0.394

Ref	Millimetres	Inches
K	8.20	0.323
L	105.0	4.134
M	10.50	0.413
N	35.00 ± 1.00	1.378 ± 0.040
P	9.10	0.358
Q	2.00	0.079
R	130.0 ± 0.5	5.118 ± 0.020
S	10.0	0.394

Inch dimensions have been derived from millimetres.

View of BW1162J3 from below



Ref	Millimetres	Inches
T	61.00 max	2.402 max
U	6.50	0.256
V	110.0 ± 1.00	4.331 ± 0.040
W	21.00	0.827
X	32.00	1.260

Inch dimensions have been derived from millimetres.

Outline Notes for BW1162J3

1. The filament centre tap pin is marked O.
2. Hole threaded 4B.A. to accept thermal fuse.

BR/BW1165 Series

R.F. POWER TRIODES

Service Type (BR1165) CV3926

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Three r.f. power triodes intended for a.m., f.m. or television transmitters and for industrial applications. They differ only in anode dissipation and in the method of anode cooling.

Anode cooling:		
BR1165	forced-air	
BW1165	water; separate jacket	
BW1165J3	water; integral jacket	
Anode dissipation:		
BR1165	5.0	kW max
BW1165, BW1165J3	6.0	kW max
Anode voltage	6.0	kV max
Operating frequency	220	MHz max
Output power:		
class B audio, per valve	6.65	kW
class C telegraphy, f.m. telephony	6.9	kW
class C television, per valve	4.5	kW
class C industrial oscillator	6.5	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	12.6	V
Filament current	33	A
Peak usable cathode current	8.5	A
Amplification factor (V_a = 4.0kV, I_a = 1.0A)	32	
Mutual conductance (V_a = 4.0kV, I_a = 1.0A)	17	mA/V
Inter-electrode capacitances:		
grid to anode	11	pF
grid to filament	16	pF
anode to filament	0.3	pF

Mechanical

Overall dimensions . . . . see outline drawings
Net weight:
BR1165 . . . . 10.1 pounds (4.6kg) approx
BW1165 . . . . 1 pound (0.45kg) approx
BW1165J3* . . . . 1.8 pounds (0.7kg) approx
Mounting position:
BR1165, BW1165J3 . . . . vertical, either way up
BW1165 . . . . vertical, filament pins up

Accessories

Filament connectors MA146A
Centre-tap dissipating connector MA146A
Grid connector (above 30MHz) MA147A
Grid connector (below 30MHz) MA148A
Insulating pedestal for BR1165 . . . . MA149A
Water jacket for BW1165 . . . . BW4088A
Sealing ring (supplied with BW1165) MA314

COOLING

Anode

The air cooling requirements for BR1165 are given in the following table. The air flow should be delivered immediately before and during the application of any voltages.

Anode dissipation (kW)	Height above sea level (m)	Inlet temperature (max) (°C)	Rate of flow of air (min) (m^3/min)	Pressure drop (mm water)
1.0	0	35	3.0	8.0
1.0	0	45	3.1	8.0
1.0	1500	35	3.7	9.0
1.0	3000	25	4.1	10
3.0	0	35	5.2	23
3.0	0	45	6.1	29
3.0	1500	35	6.2	26
3.0	3000	25	6.6	26
5.0	0	35	9.2	68
5.0	0	45	10.7	90
5.0	1500	35	11.2	81
5.0	3000	25	11.6	79

The BW1165 anode must be fitted into a water jacket for cooling, the recommended jacket being type BW4088A. The water cooling requirements are given in the following table.

Anode dissipation (kW)	Inlet temperature (°C)	Rate of flow of water l./min	Rate of flow of water gal/min	Pressure drop across jacket (atm)
1.0	20	2.5	0.55	0.08
1.0	50	3.0	0.66	0.10
2.0	20	2.5	0.55	0.08
2.0	50	5.0	1.10	0.30
4.0	20	4.0	0.88	0.18
4.0	50	9.0	1.98	0.90
6.0	20	6.0	1.32	0.4
6.0	50	14	3.08	2.5

The BW1165J3 has an integral water jacket. Minimum water cooling requirements are shown on page 16, higher rates of flow should be used where possible. A thermal fuse may be fitted (see page 20).

Filament, Grid and Anode Seals

It may be necessary to direct a flow of air on to the filament and grid seals in order to maintain their temperatures within the following limits.

Temperature of filament seals . . . . 210 °C max
Temperature of grid and anode seals . . . . 180 °C max

Filament Centre-tap Pin

A heat dissipating connector such as MA146A must be used on the filament centre-tap pin.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR (Class B)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.5	A max
Anode input power	9.0	kW max
Anode dissipation	6.0	kW max
Grid dissipation	120	W max
Grid circuit resistance	15	kΩ max
Cathode current (peak)	5.7	A max

TYPICAL OPERATING CONDITIONS (Class B, 2 valves)

Anode voltage	3.0	3.5	4.0	kV
Grid voltage	–90	–100	–112	V
Peak a.f. grid drive voltage (per valve)	285	310	318	V
Anode current (zero signal)	2 x 65	2 x 75	2 x 100	mA
Anode current (maximum signal)	2 x 0.80	2 x 0.95	2 x 0.94	A
Grid current (maximum signal)	2 x 0.20	2 x 0.18	2 x 0.19	A
Effective load (anode to anode)	4.4	4.2	4.9	kΩ
Nominal driving power (maximum signal)	2 x 52	2 x 50	2 x 54	W
Anode dissipation	2 x 0.75	2 x 1.0	2 x 1.1	kW
Output power (maximum signal)	3.3	4.6	5.3	kW
Efficiency	69	70	71	%
Total distortion	3.3	2.9	2.6	%

Anode voltage	4.5	5.0	6.0	kV
Grid voltage	–125	–138	–165	V
Peak a.f. grid drive voltage (per valve)	327	330	455	V
Anode current (zero signal)	2 x 100	2 x 110	2 x 125	mA
Anode current (maximum signal)	2 x 0.92	2 x 0.91	2 x 1.50	A
Grid current (maximum signal)	2 x 0.19	2 x 0.14	2 x 0.28	A
Effective load (anode to anode)	6.1	6.4	4.9	kΩ
Nominal driving power (maximum signal)	2 x 27	2 x 42	2 x 115	W
Anode dissipation	2 x 1.15	2 x 1.25	2 x 2.35	kW
Output power (maximum signal)	6.0	6.6	13.3	kW
Efficiency	72	73	74	%
Total distortion	3.7	3.3	4.3	%

RADIO FREQUENCY POWER AMPLIFIER

(Class B Telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.1	A max
Anode input power	6.6	kW max
Anode dissipation	5.0	kW max
Grid dissipation	120	W max
Cathode current (peak)	4.6	A max

TYPICAL OPERATING CONDITIONS (frequency 75MHz)

Anode voltage	5.0	6.0	kV
Grid voltage	−145	−180	V
Peak r.f. grid drive voltage	225	250	V
Anode current	900	990	mA
Grid current (100% modulation)	320	300	mA
Driving power (100% modulation)	160	170	W
Anode dissipation	3.0	4.0	kW
Output power	1.45	1.90	kW
Efficiency	32	32	%

RADIO FREQUENCY POWER AMPLIFIER

(Class C Telegraphy, key down conditions, or F.M. Telephony, per valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode current	1.5	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	1.0	kV max
Grid current	0.35	A max
Grid dissipation	120	W max
Cathode current (peak)	8.5	A max

TYPICAL OPERATING CONDITIONS
(Grounded Cathode)

Frequency	75	75	75	110	MHz
Anode voltage	4.0	5.0	6.0	5.0	kV
Grid voltage	−200	−300	−400	−300	V
Peak r.f. grid drive voltage	500	640	740	640	V
Anode current	1.37	1.50	1.50	1.25	A
Grid current	350	330	310	300	mA
Nominal driving power .	190	240	275	250	W
Anode dissipation . . .	1.5	1.9	2.1	1.45	kW
Output power	4.0	5.6	6.9	4.8	kW
Efficiency	73	75	76.5	70	%

TYPICAL OPERATING CONDITIONS
(Grounded Grid, 2 valves)

Frequency	75	110	110	220	MHz
Anode voltage	6.0	4.0	5.0	4.0	kV
Filament-grid voltage .	400	200	300	200	V
Peak r.f. drive voltage, filament to filament .	1480	1000	1280	900	V
Anode current	2 x 1.5	2 x 1.37	2 x 1.5	2 x 1.25	A
Grid current	2 x 310	2 x 350	2 x 330	2 x 220	mA
Nominal driving power	2 x 1190	2 x 705	2 x 965	2 x 395	W
Anode dissipation .	2 x 2.1	2 x 1.7	2 x 2.2	2 x 2.5	kW
Output power (see note 2)	15.6	8.6	12	5.6	kW
Efficiency	77	69	71	50	%

ANODE MODULATED R.F. POWER AMPLIFIER

(Class C Telephony, carrier conditions per valve for use with a maximum modulation factor of 1.0)

MAXIMUM RATINGS (Absolute values)

Anode voltage	5.0	kV max
Anode current	1.3	A max
Anode input power	6.5	kW max
Anode dissipation	3.4	kW max
Grid voltage (negative value)	1.0	kV max
Grid current	0.35	A max
Grid dissipation	120	W max
Cathode current (peak)	5.7	A max

TYPICAL OPERATING CONDITIONS

Frequency	75	75	75	MHz
Anode voltage	3.0	3.5	4.0	kV
Grid voltage	−250	−300	−300	V
Peak r.f. grid drive voltage	510	600	600	V
Anode current	1.0	1.2	1.2	A
Grid current	0.3	0.3	0.3	A
Nominal driving power	170	205	205	W
Anode dissipation	0.8	1.2	1.3	kW
Output power	2.2	3.0	3.5	kW
Efficiency	73	71.5	73	%

Frequency	75	75	110	MHz
Anode voltage	4.5	5.0	4.0	kV
Grid voltage	−350	−400	−350	V
Peak r.f. grid drive voltage	650	690	600	V
Anode current	1.2	1.2	0.93	A
Grid current	0.3	0.3	0.24	A
Nominal driving power	230	205	130	W
Anode dissipation	1.3	1.3	0.92	kW
Output power	4.1	4.7	2.8	kW
Efficiency	76	78	75	%

CLASS C TELEVISION SERVICE, GRID-MODULATED

MAXIMUM RATINGS (Absolute values)

	Up to 75MHz	Up to 220MHz	
Anode voltage	5.0	4.0	kV max
Anode current	1.9	1.6	A max
Anode input power	9.5	6.5	kW max
Anode dissipation (sync. level)	5.0	4.0	kW max
Grid voltage (negative value) (sync. level)	1.0	1.0	kV max
Grid current	0.25	0.25	A max
Grid dissipation (sync. level)	120	120	W max
Cathode current (peak)	10	10	A max

TYPICAL OPERATING CONDITIONS

(Negative modulation, positive synchronisation) (2 valves)

Frequency	48 to 75	170 to 220	MHz
Anode voltage	5.0	4.0	kV
Grid voltage:			
peak sync.	−200	−150	V
black level	−300	−225	V
white level	−550	−500	V
Peak r.f. grid to grid voltage (sync. level)	1.0	1.0	kV
Anode current:			
peak sync.	2 x 1.9	2 x 1.6	A
black level	2 x 1.3	2 x 1.3	A
Grid current:			
peak sync.	2 x 0.250	2 x 0.20	A
black level	2 x 0.175	2 x 0.11	A
Nominal driving power (sync. level)	2 x 250	2 x 400	W
Output power (sync. level)	9.0	6.0	kW
Power into load (sync. level) (see note 3)	6.3	4.2	kW
Bandwidth (see note 4):			
to −3db points	8.00	10	MHz
to −1.5db points	5.25	6.5	MHz

TYPICAL OPERATING CONDITIONS

(Positive modulation, negative synchronisation) (2 valves)

Frequency	48 to 75	MHz
Anode voltage	5.0	kV
Grid voltage:		
white level	−200	V
black level	−460	V
peak sync.	−580	V
Peak r.f. grid to grid voltage (white level)	1.0	kV
Anode current:		
white level	2 x 1.9	A
black level	2 x 0.4	A
Grid current:		
white level	2 x 250	mA
black level	0	mA
Nominal driving power (white level)	2 x 250	W
Output power (white level)	9.0	kW
Power into load (white level) (see note 3)	6.3	kW
Bandwidth (see note 4):		
to −3db points	8.0	MHz
to −1.5db points	5.25	MHz

RADIO FREQUENCY OSCILLATOR FOR INDUSTRIAL SERVICE

(Class C, anode supply from unfiltered two-phase half-wave rectifier)

MAXIMUM RATINGS (Absolute values)

Anode voltage	5.4	kV max
Anode current	1.35	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	900	V max
Grid current	0.31	A max
Grid dissipation	120	W max

TYPICAL OPERATING CONDITIONS

Output voltage (r.m.s.) from transformer	5.1	6.0	kV
Anode voltage	4.6	5.4	kV
Anode current	1.15	1.35	A
Grid current	0.27	0.31	A
Anode dissipation	1.84	2.3	kW
Grid resistor	1.1	1.3	kΩ
Nominal driving power	160	210	W
Output power	4.5	6.5	kW
Efficiency	70	72	%

RADIO FREQUENCY OSCILLATOR FOR INDUSTRIAL SERVICE

(Class C, anode supply unrectified a.c.)

MAXIMUM RATINGS (Absolute values)

Output voltage (r.m.s.) from transformer	6.8	kV max
Anode current	0.8	A max
Anode input power	9.0	kW max
Anode dissipation	5.0	kW max
Grid voltage (negative value)	640	V max
Grid current	190	mA max
Grid dissipation	120	W max
Operating frequency	75	MHz max

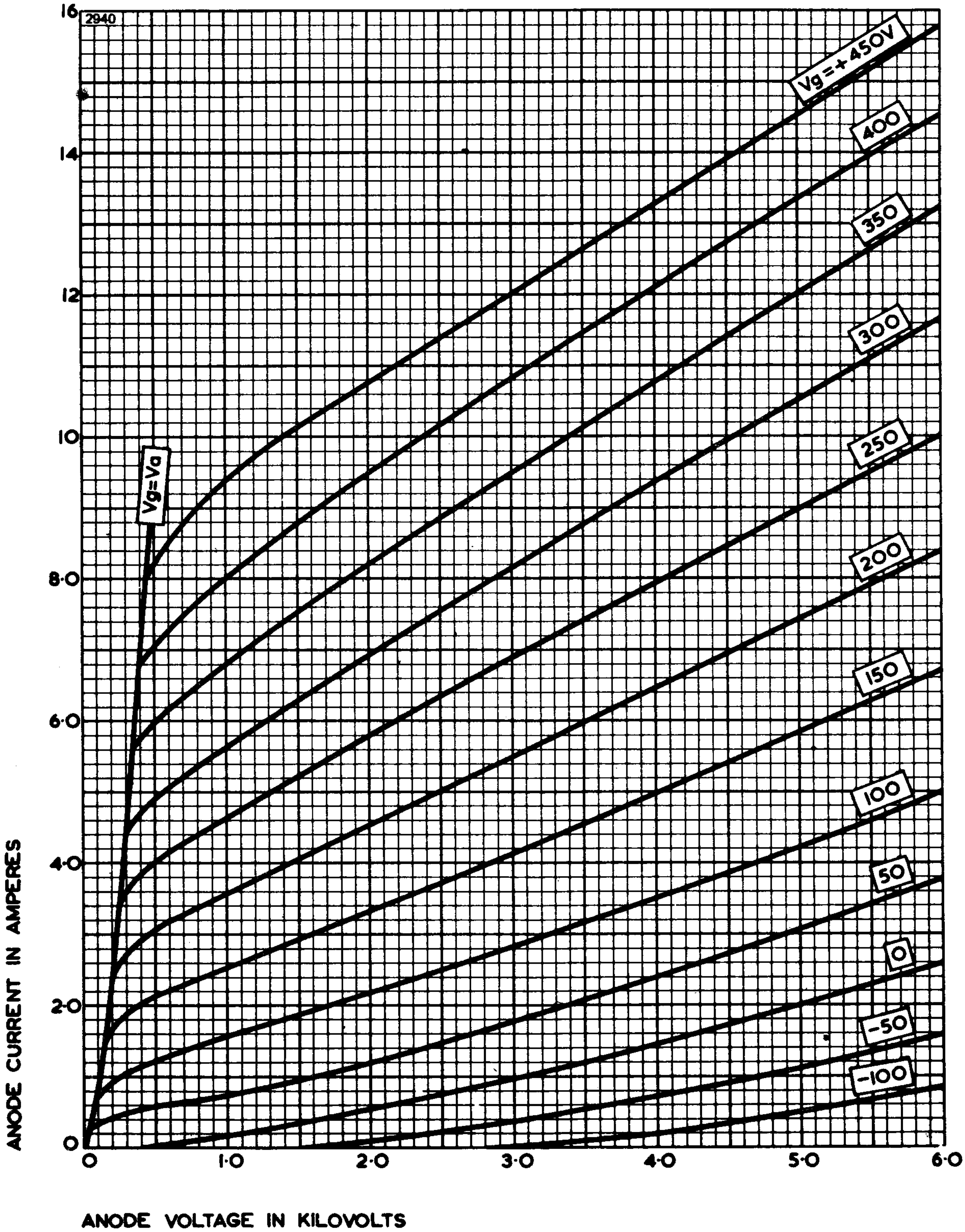
TYPICAL OPERATING CONDITIONS

Output voltage (r.m.s.) from transformer	5.9	6.8	kV
Grid voltage	−173	−200	V
from grid resistor	1050	1050	Ω
Anode current	0.7	0.8	A
Grid current (approx)	165	190	mA
Anode dissipation	1.24	1.5	kW
Output power	3.36	4.55	kW
Efficiency	73	75	%

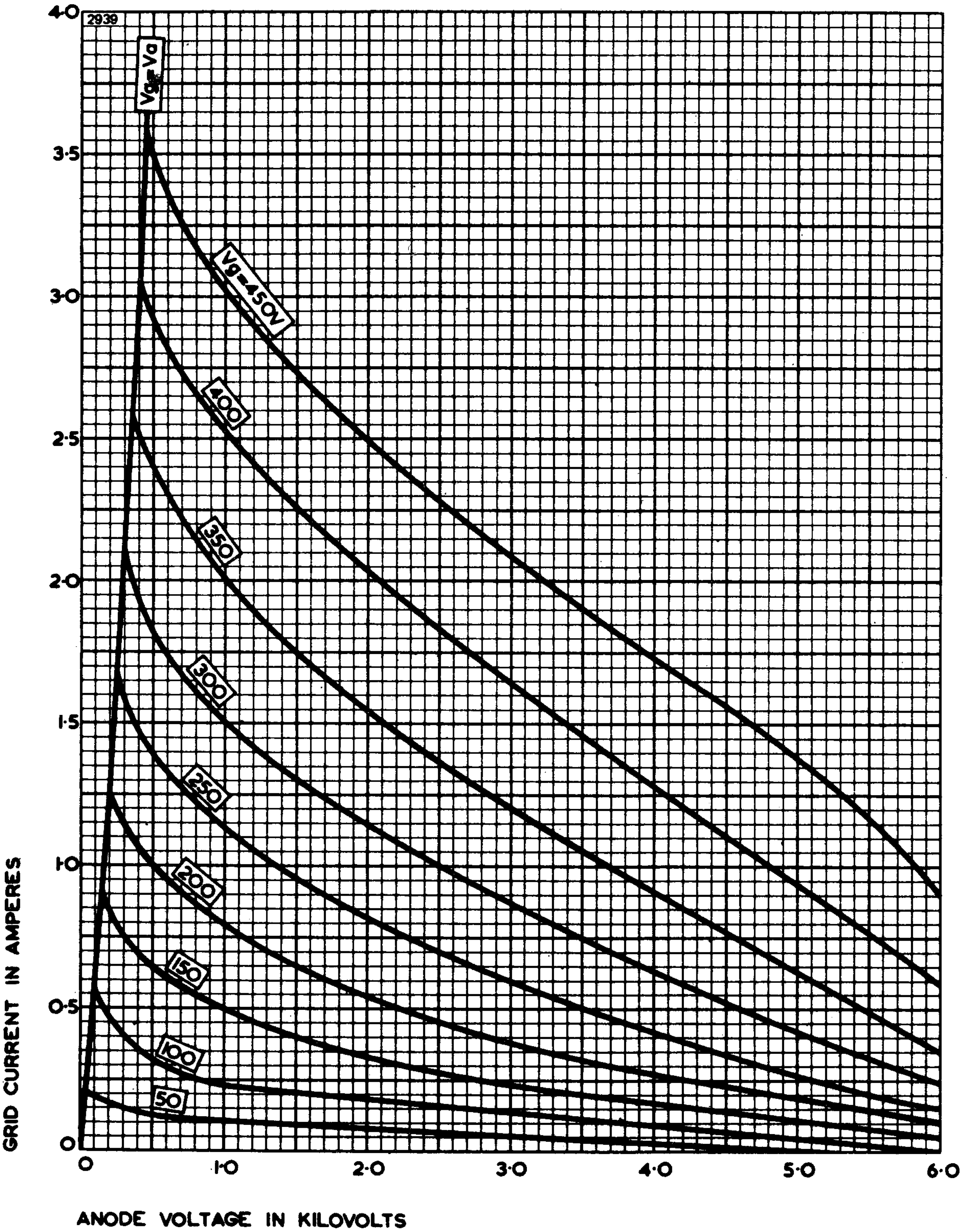
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed +5% or −10%. The centre-tap pin may be used for the anode current return but must not be used for the filament current supply. At frequencies above 30MHz, all three filament pins should be interconnected with suitable capacitors.
2. This includes the power transferred from the drive circuit.
3. Assuming circuit transfer efficiency of 70%.
4. For a bandwidth based on one inductor-capacitor circuit.

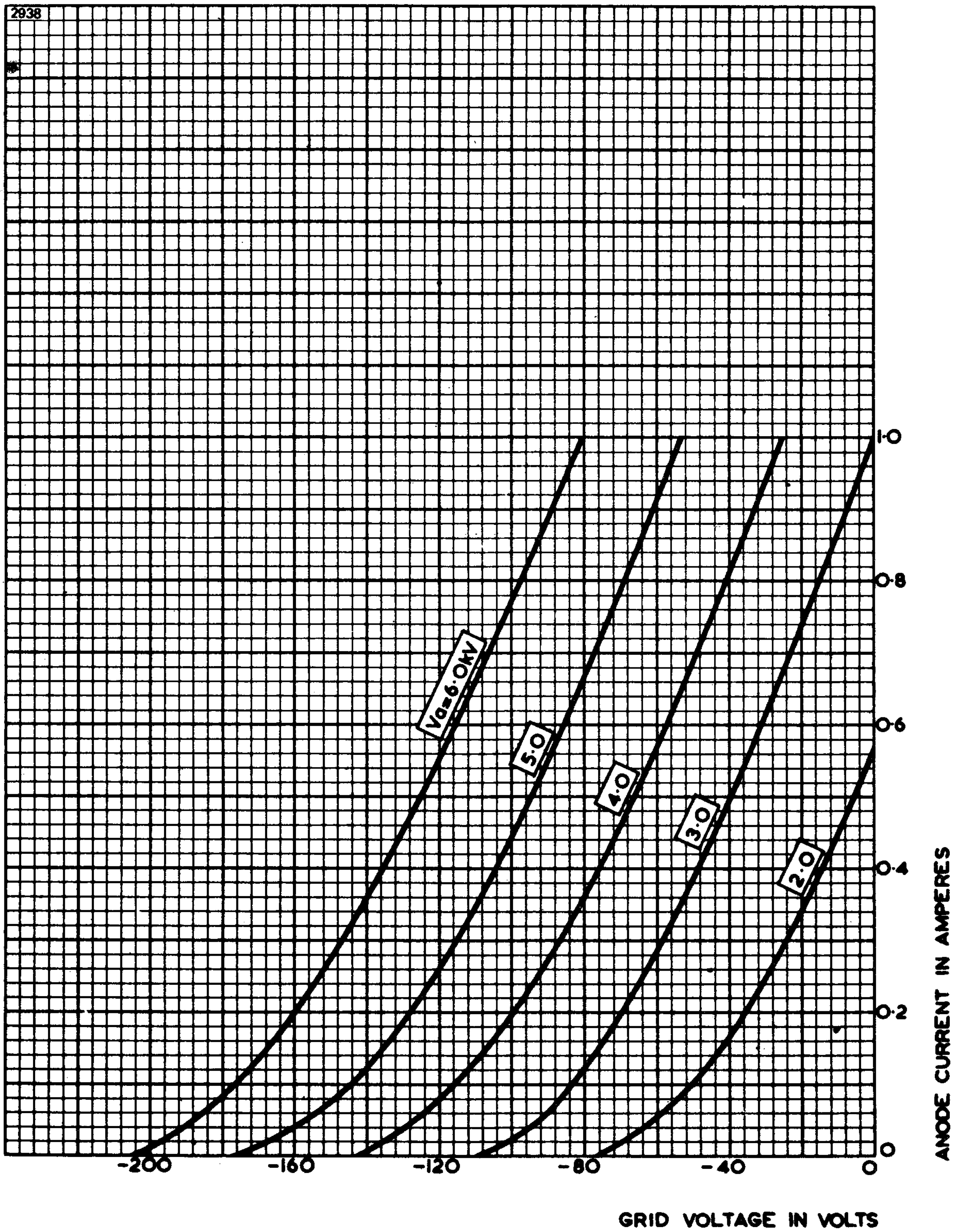
TYPICAL ANODE CHARACTERISTICS



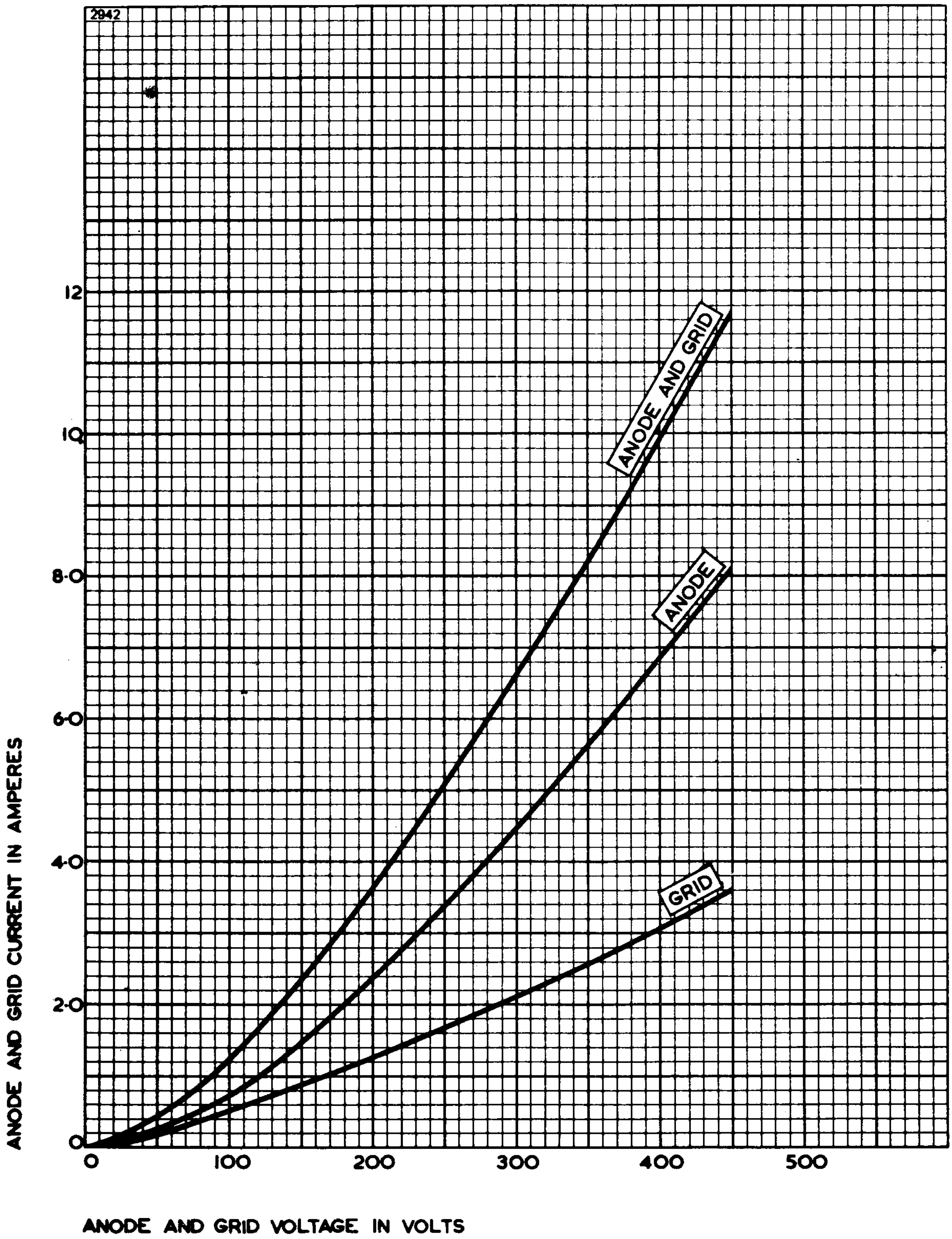
TYPICAL GRID CHARACTERISTICS



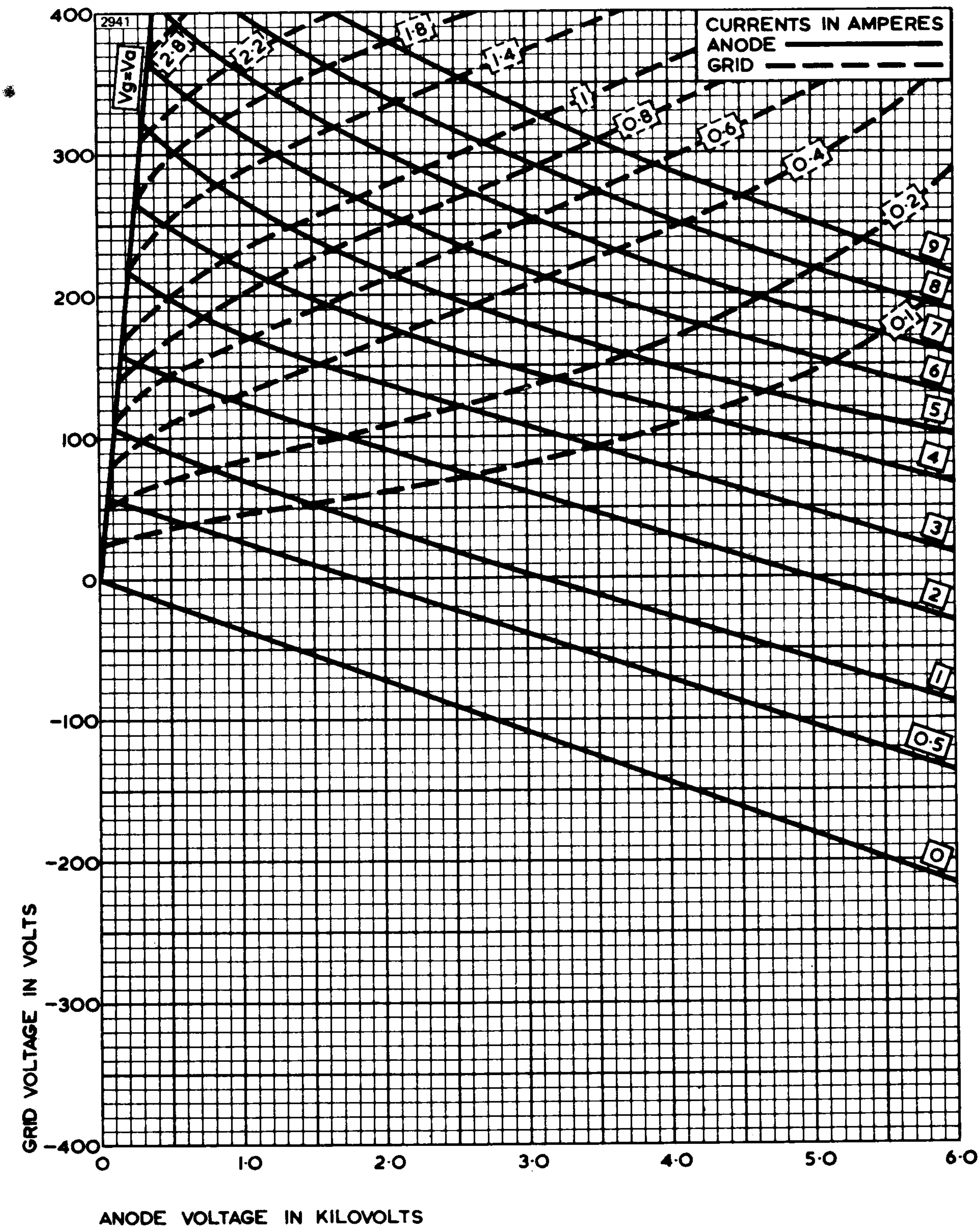
TYPICAL ANODE CURRENT – GRID VOLTAGE CHARACTERISTICS



TYPICAL STRAPPED CHARACTERISTICS

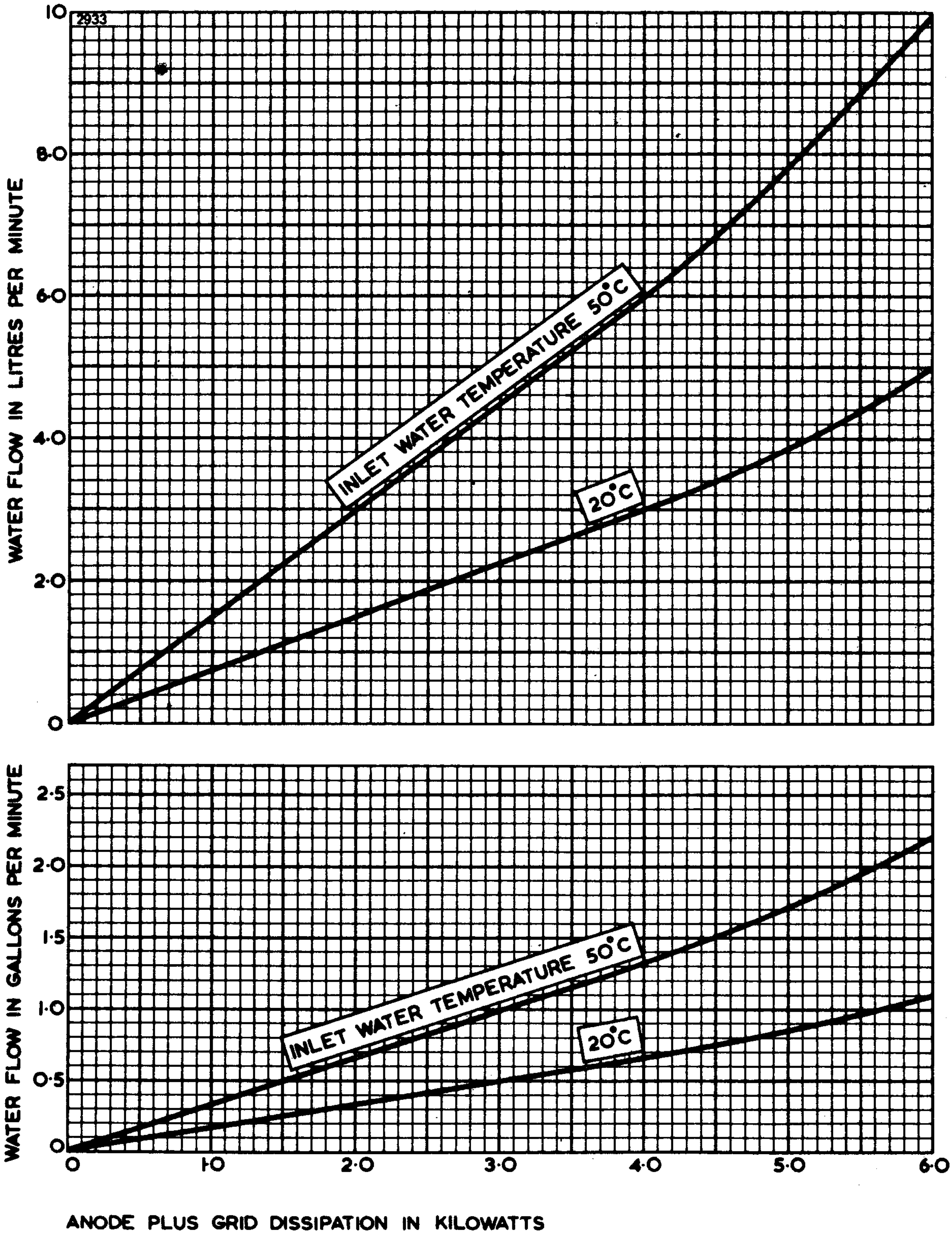


TYPICAL CONSTANT CURRENT CHARACTERISTICS

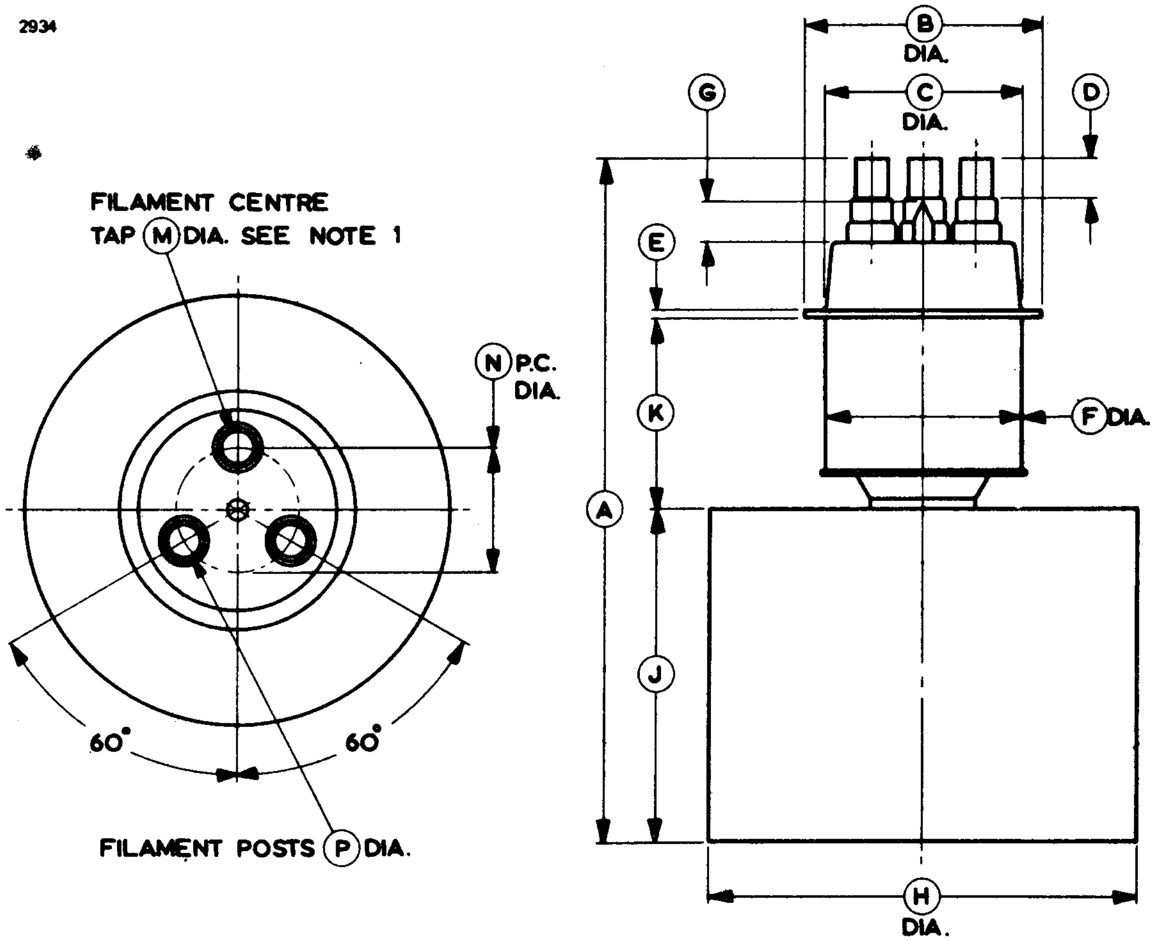


MINIMUM WATER COOLING REQUIREMENTS FOR BW1165J3

Higher rates of flow should be used where possible.



OUTLINE FOR BR1165 (All dimensions without limits are nominal)

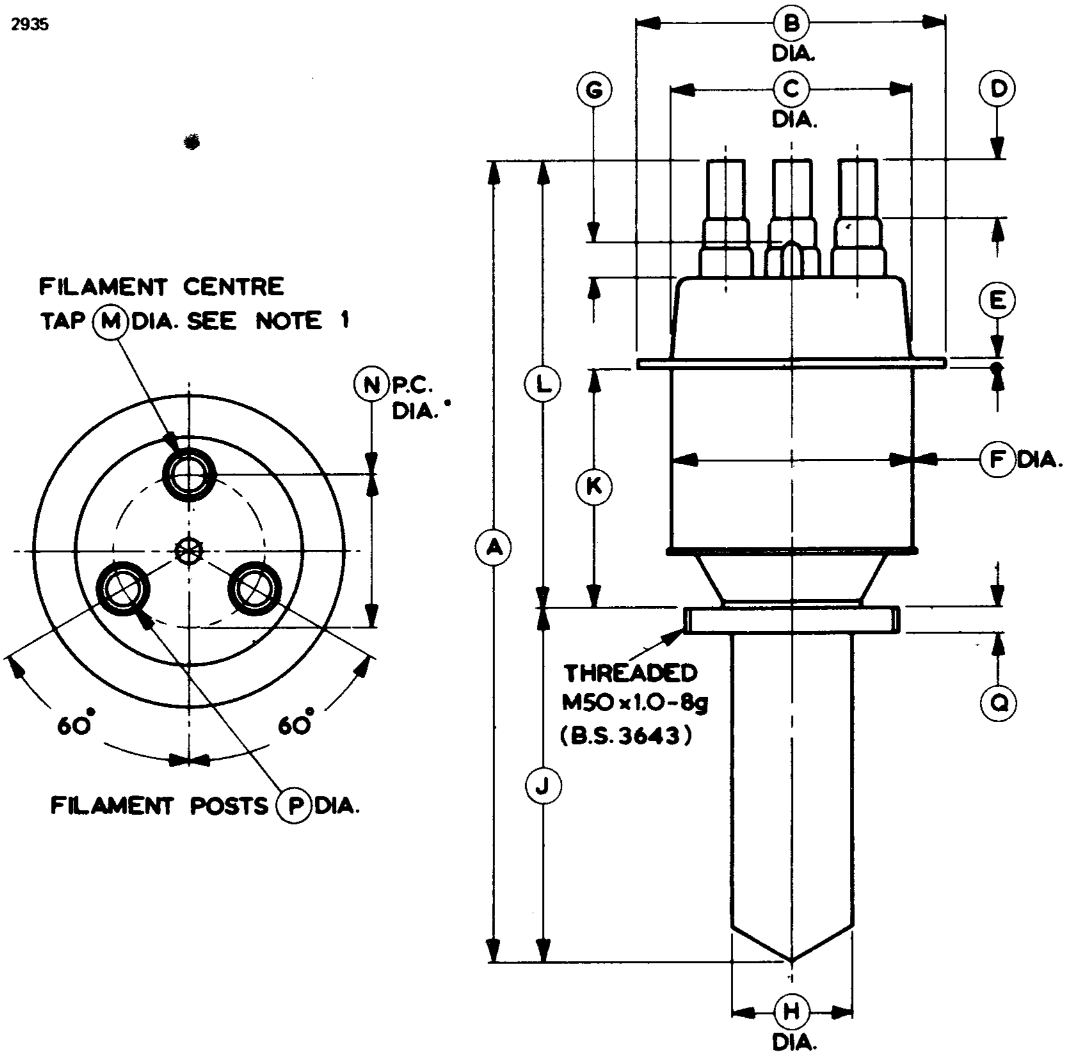


Ref	Millimetres	Inches
A	195.0 max	7.677 max
B	70.00 ± 0.50	2.756 ± 0.020
C	59.00 max	2.323 max
D	12.00 min	0.472 min
E	2.50	0.098
F	64.00 max	2.520 max
G	20.00 max	0.787 max
H	122.3 ± 0.5	4.815 ± 0.020
J	94.00	3.701
K	54.00 ± 0.50	2.126 ± 0.020
M	9.10	0.358
N	35.00 ± 1.00	1.378 ± 0.040
P	9.10	0.358

Inch dimensions have been derived from millimetres.

Note The filament centre tap pin is marked O.

OUTLINE FOR BW1165 (All dimensions without limits are nominal)

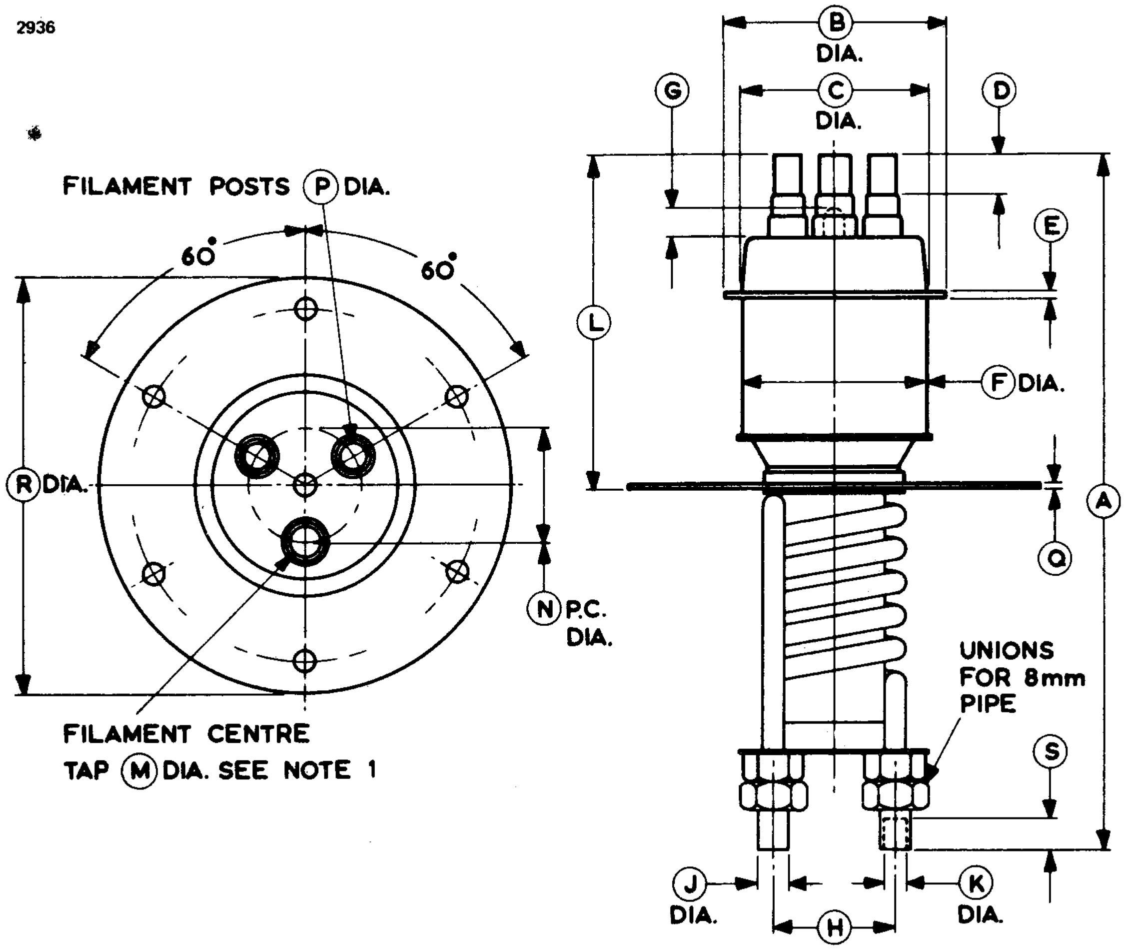


Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	190.0 max	7.480 max	J	83.00 max	3.268 max
B	70.00 ± 0.50	2.756 ± 0.020	K	56.00	2.205
C	59.00 max	2.323 max	L	106.0	4.173
D	12.00 min	0.472 min	M	9.10	0.358
E	2.50	0.098	N	35.00 ± 1.00	1.378 ± 0.040
F	64.00 max	2.520 max	P	9.10	0.358
G	20.00 max	0.787 max	Q	6.25	0.246
H	30.00 max	1.181 max			

Inch dimensions have been derived from millimetres.

Note The filament centre tap pin is marked O.

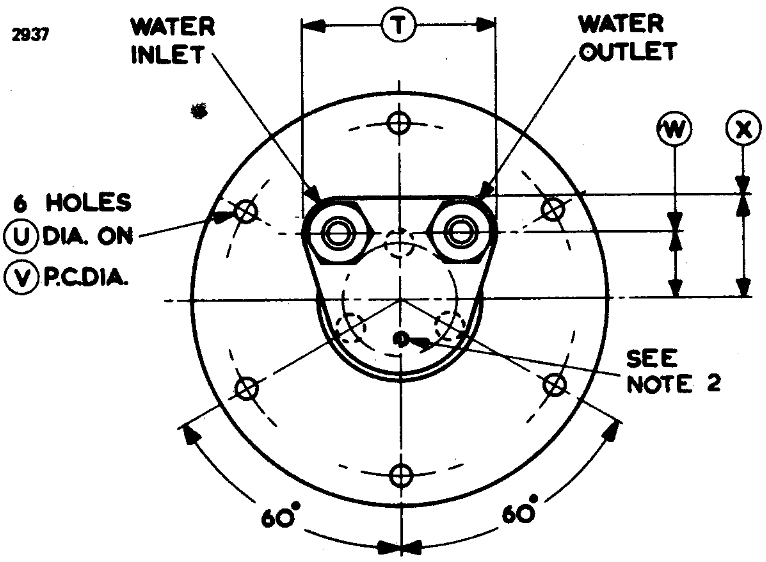
OUTLINE FOR BW1165J3 (All dimensions without limits are nominal)



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	218.0 max	8.583 max	K	8.20	0.323
B	70.00 ± 0.50	2.756 ± 0.020	L	105.0	4.134
C	59.00 max	2.323 max	M	9.10	0.358
D	12.00 min	0.472 min	N	35.00 ± 1.00	1.378 ± 0.040
E	2.50	0.098	P	9.10	0.358
F	64.00 max	2.520 max	Q	2.00	0.079
G	20.00 max	0.787 max	R	130.0 ± 0.5	5.118 ± 0.020
H	39.00	1.535	S	10.0	0.394
J	10.00	0.394			

Inch dimensions have been derived from millimetres.

View of BW1165J3 from below



Ref	Millimetres	Inches
T	61.00 max	2.402 max
U	6.50	0.256
V	110.0 ± 1.00	4.331 ± 0.040
W	21.00	0.827
X	32.00	1.260

Inch dimensions have been derived from millimetres.

Outline Notes for BW1165J3

1. The filament centre tap pin is marked O.
2. Hole threaded 4B.A. to accept thermal fuse.

BW1176J1
BW1176J2

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Water cooled triodes with integral water jackets, intended primarily for industrial service and differing only in the location of the water jacket inlet and outlet connectors.

Anode dissipation	20	kW max
Anode voltage	10	kV max
Frequency for full ratings	20	MHz max
Output power (class C unmodulated)	70	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	8.2	V
Filament current	230	A
Surge filament current (peak) (see note 2)	600	A max
Filament cold resistance	4.0	mΩ
Peak usable cathode current	60	A
Perveance	3.0	$mA/V^{3/2}$
Amplification factor (V_a = 6.0kV, I_a = 4.0A)	38	
Mutual conductance (V_a = 7.0kV, I_a = 4.0A)	60	mA/V
Inter-electrode capacitances:		
grid to anode	57	pF
grid to filament	105	pF
anode to filament	1.1	pF

Mechanical

Overall length	17.785 inches (451.7mm) max
Overall width	6.500 inches (165.1mm) nom
Net weight	14 pounds (6.4kg) approx
Mounting position	vertical, filament pins up

Accessories

Filament leads	MA131
Grid connector	MA66

COOLING

Anode

Types BW1176J1 and BW1176J2 have integral water jackets and differ only in the location of the water inlet and outlet connectors (see outline drawings). Minimum water cooling requirements are shown on page 8; higher rates of flow should be used where possible.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed into the filament header via a 1-inch (25mm) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of the seals.

Bulb

The bulb temperature must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR
(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	10	kV max
Anode current	8.6	A max
Anode dissipation (see note 4)	20	kW max
Grid dissipation	1.0	kW max
Operating frequency (for full ratings)	20	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	8.0	10	kV
Grid voltage	−420	−520	V
from grid resistor	380	475	Ω
Peak r.f. grid drive voltage	845	955	V
Anode current	8.5	8.6	A
Grid current (approx)	1.1	1.1	A
Anode dissipation	12.8	15	kW
Grid dissipation	470	480	W
Driving power	940	1050	W
Output power	54	70	kW
Efficiency	79	81	%
Load resistance	500	625	Ω

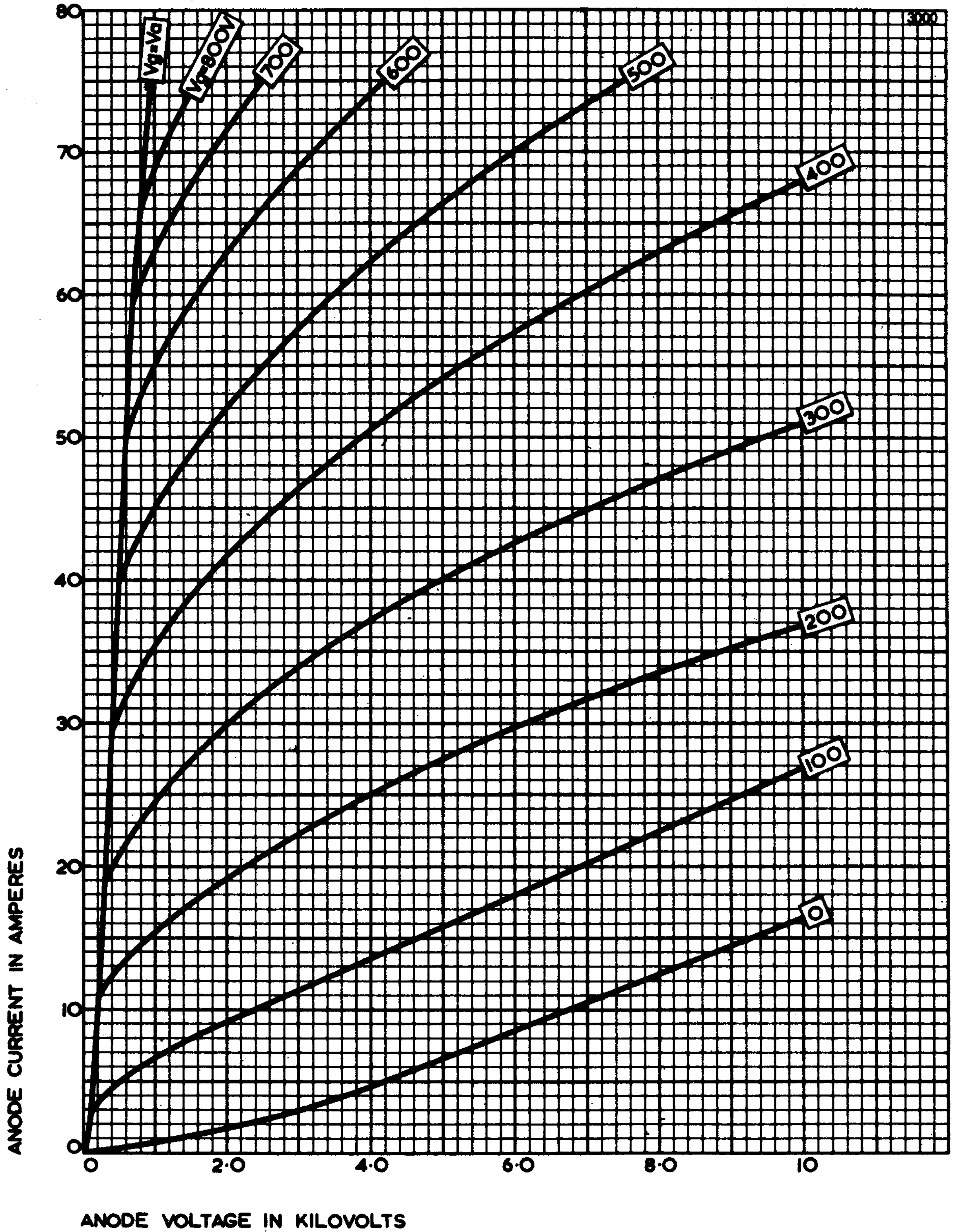
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 8.2V . . .	207	253	A
Amplification factor (V_a = 6.0kV, I_a = 4.0A) .	32	44	
Mutual conductance (V_a = 7.0kV, I_a = 4.0A) .	54	66	mA/V
Anode current (V_a = 1.5kV, V_g = +600V) . .	53	65	A
Grid current (V_a = 1.5kV, V_g = +600V) . . .	8.0	12	A

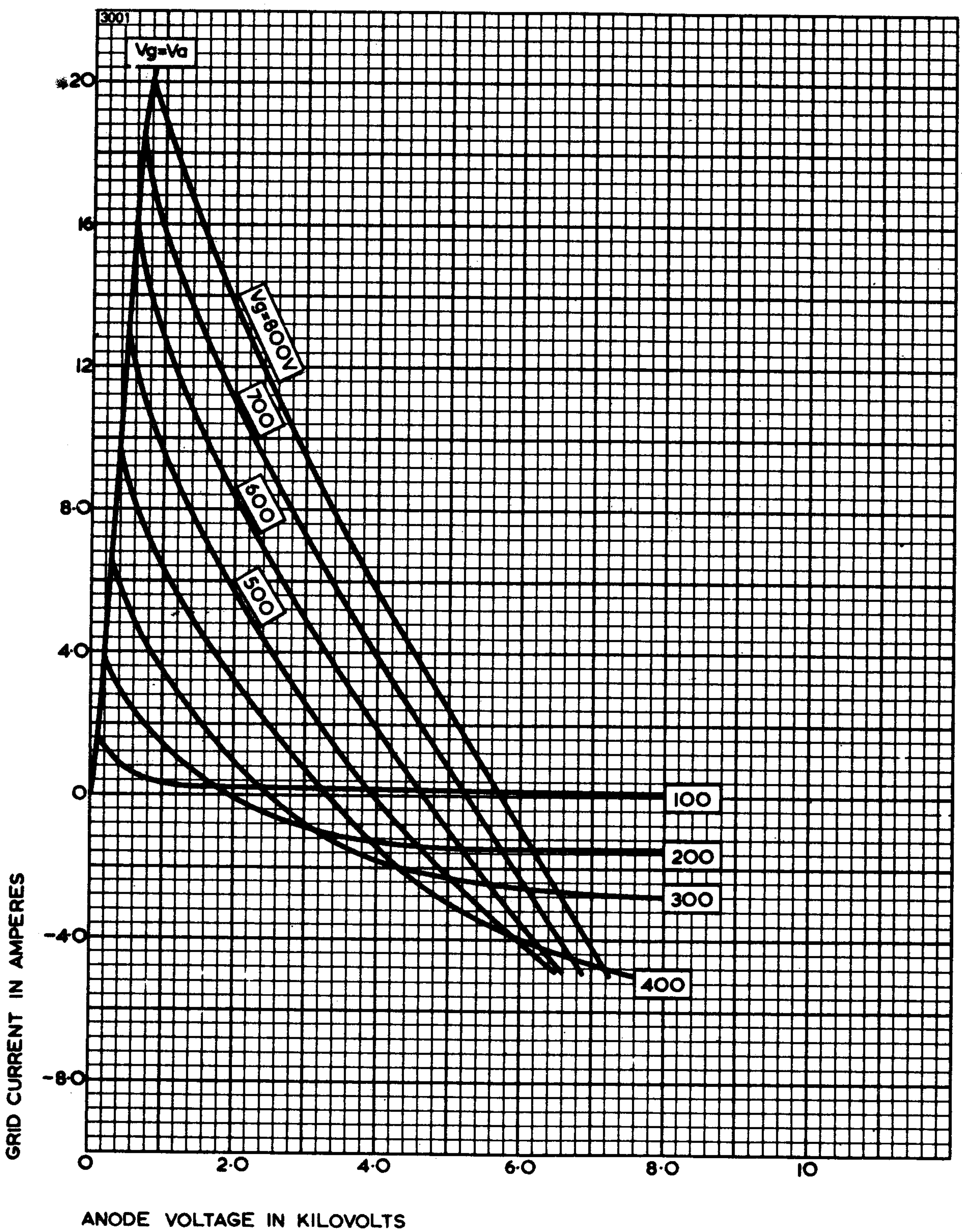
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.

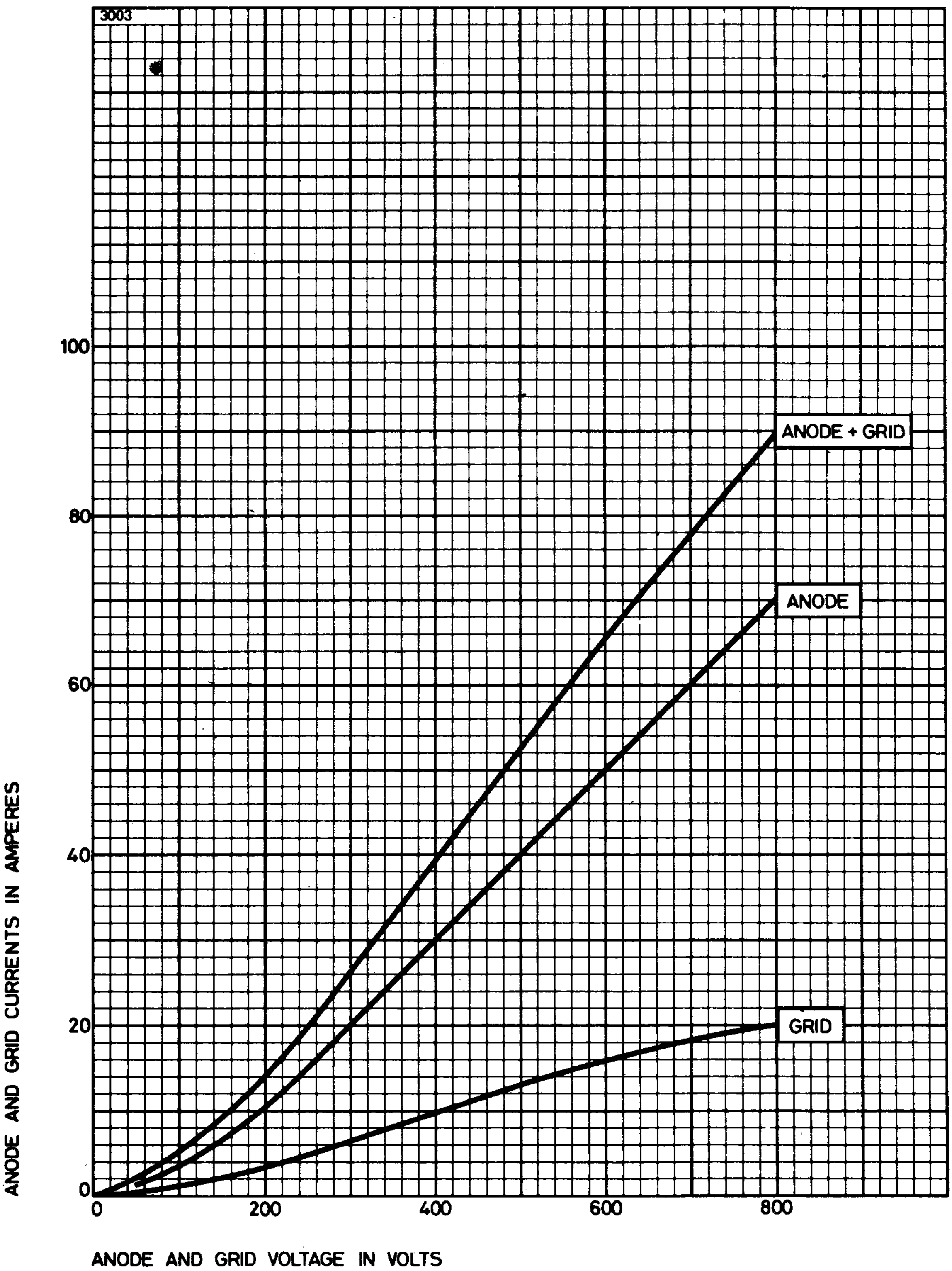
TYPICAL ANODE CHARACTERISTICS



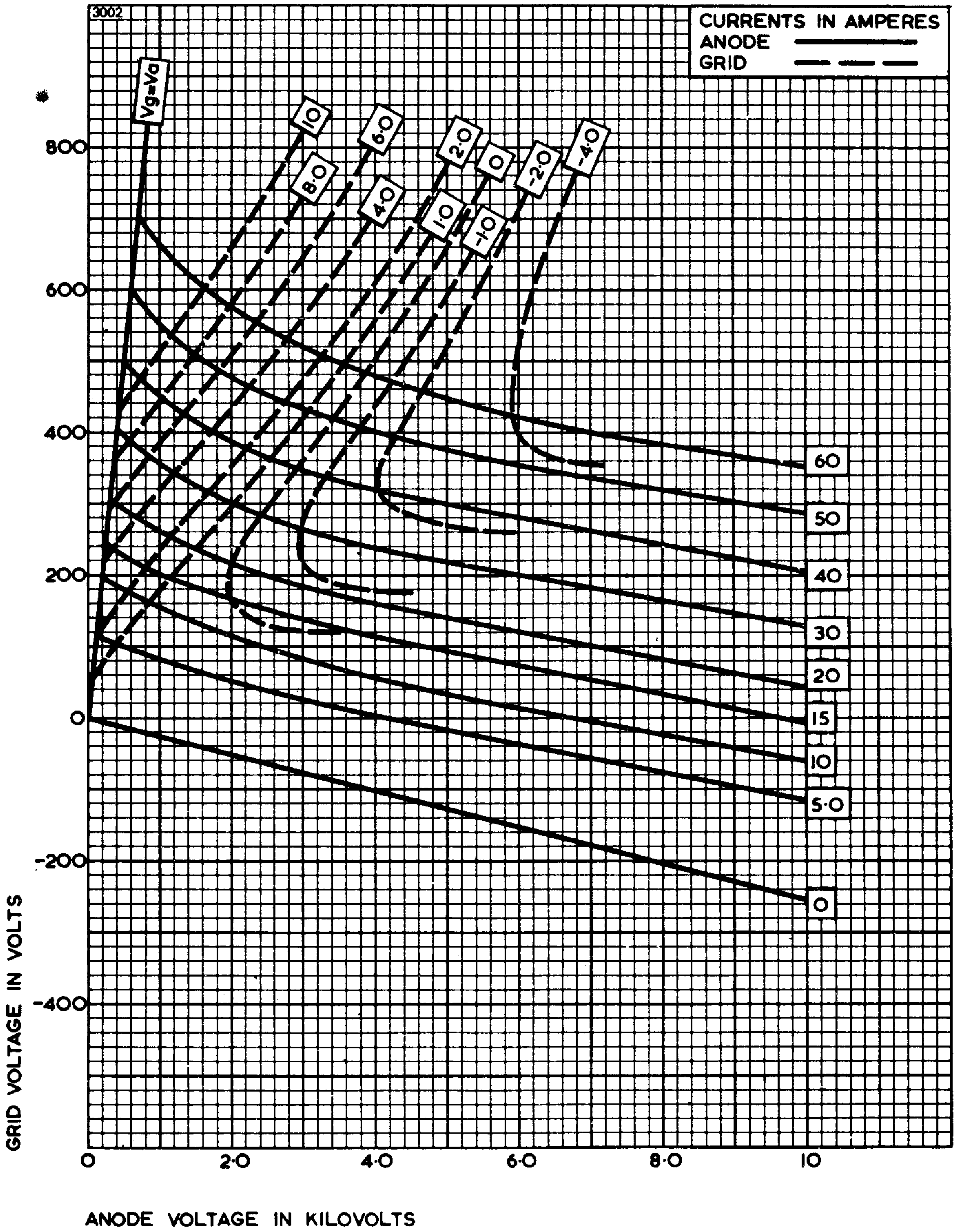
TYPICAL GRID CHARACTERISTICS



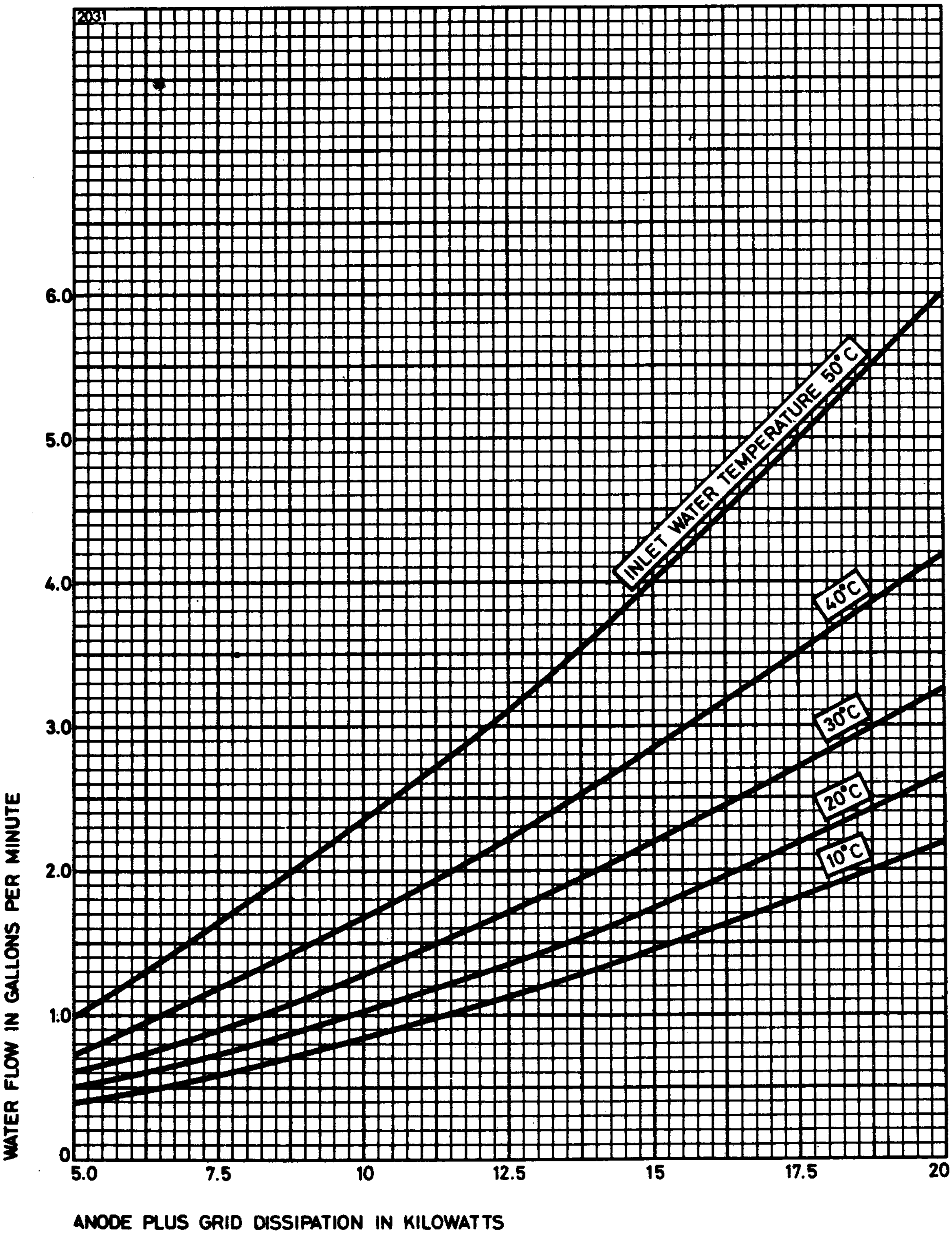
TYPICAL STRAPPED CHARACTERISTICS



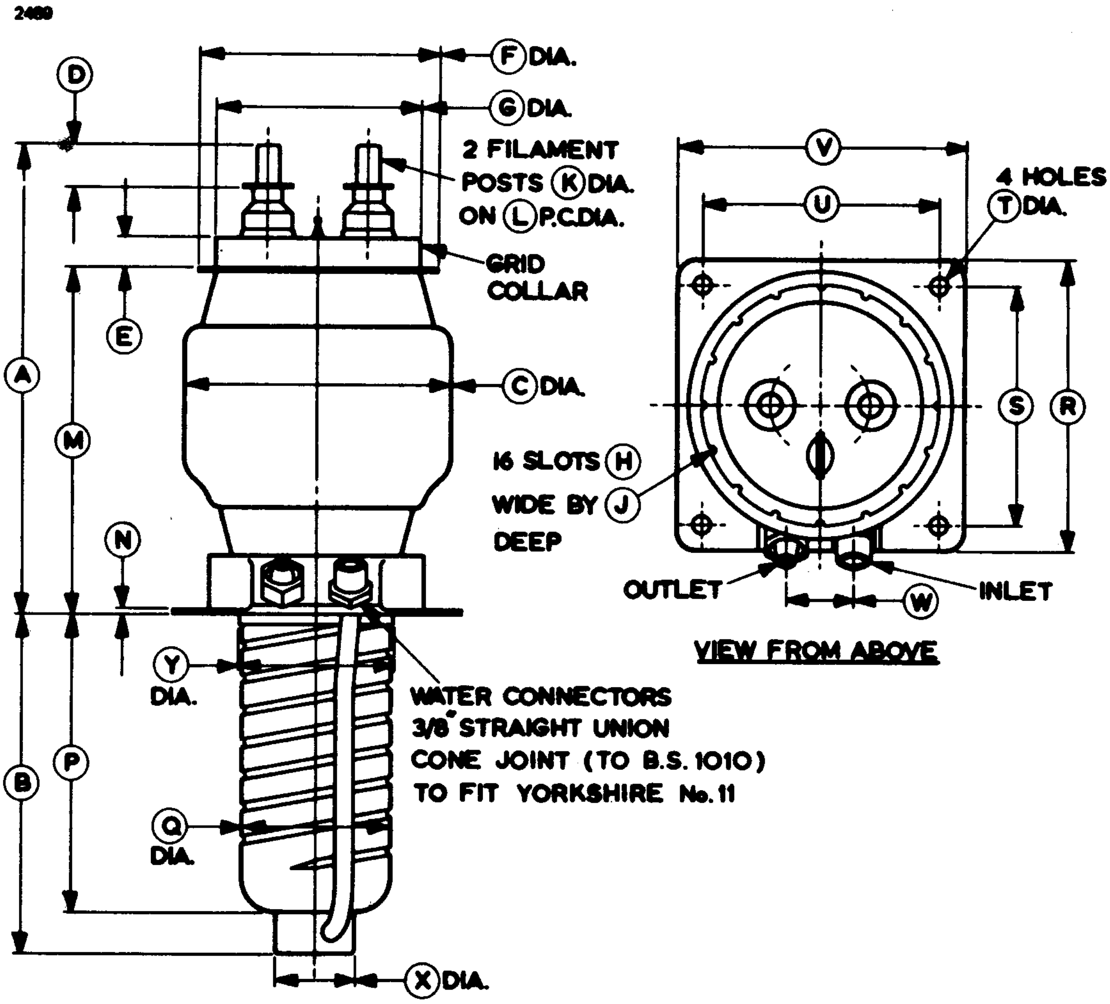
TYPICAL CONSTANT CURRENT CHARACTERISTICS



MINIMUM WATER COOLING REQUIREMENTS



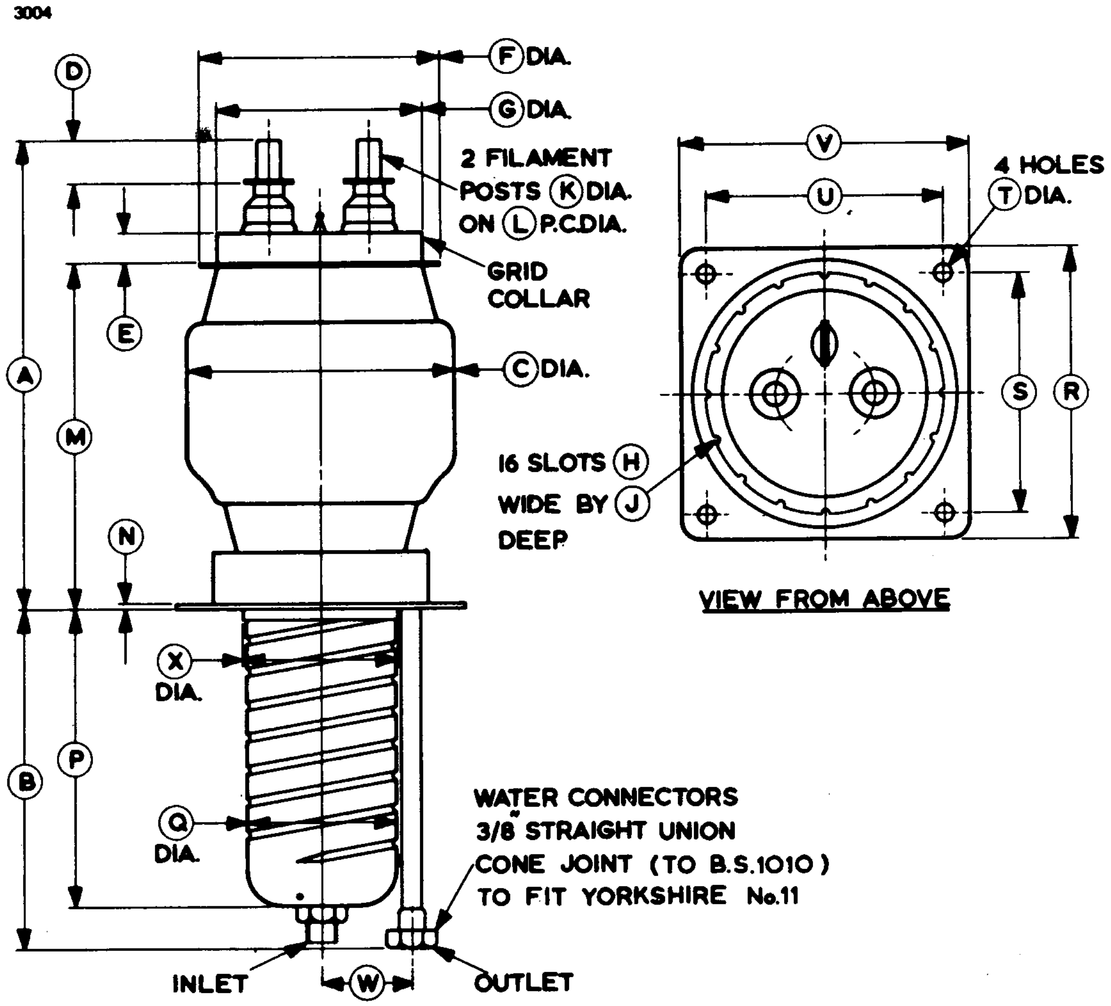
OUTLINE FOR BW1176J1 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250 max	260.4 max	N	0.125	3.18
B	7.535 max	191.4 max	P	6.555	166.5
C	6.000 max	152.4 max	Q	3.562	90.47
D	1.000	25.40	R	6.500	165.1
E	0.734	18.64	S	5.000	127.0
F	5.630	143.0	T	0.375	9.53
G	4.703	119.5	U	5.000	127.0
H	0.153	3.89	V	6.500	165.1
J	0.205	5.21	W	1.250	31.75
K	0.625	15.88	X	2.000	50.80
L	2.250	57.15	Y	3.875	98.43
M	7.750 max	196.9 max			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW1176J2 (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250 max	260.4 max	M	7.750 max	196.9 max
B	7.535 max	191.4 max	N	0.125	3.18
C	6.000 max	152.4 max	P	6.555	166.5
D	1.000	25.40	Q	3.562	90.47
E	0.734	18.64	R	6.500	165.1
F	5.630	143.0	S	5.000	127.0
G	4.703	119.5	T	0.375	9.53
H	0.153	3.89	U	5.000	127.0
J	0.205	5.21	V	6.500	165.1
K	0.625	15.88	W	2.170	55.12
L	2.250	57.15	X	3.875	98.43

Millimetre dimensions have been derived from inches.

BR1181
BW1181J3

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes of coaxial ceramic/metal construction, intended primarily for industrial service. They differ only in the method of anode cooling and in anode dissipation. BR1181 and BW1181J3 have higher ratings for anode dissipation and current than BR1169 and BW1169J3 respectively but are otherwise electrically identical with, and may be used as replacements for, the latter tubes.

Anode cooling:		
BR1181	forced-air	
BW1181J3	water; integral jacket	
Anode dissipation:		
BR1181	10	kW max
BW1181J3	12	kW max
Anode voltage	8.0	kV max
Frequency for full ratings	100	MHz max
Output power (class C unmodulated)	26	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage (see note 1)	6.6	V
Filament current	103	A
Filament cold resistance	7.5	mΩ
Peak usable cathode current	25	A
Perveance	3.6	$mA/V^{3/2}$
Amplification factor (V_a = 2.0kV, I_a = 1.0A)	11	
Mutual conductance (V_a = 2.0kV, I_a = 2.75A)	43.5	mA/V
Inter-electrode capacitances:		
grid to anode	36.5	pF
grid to filament	47.5	pF
anode to filament	2.35	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1181	9½ pounds (4.3kg) approx
BW1181J3*	5½ pounds (2.5kg) approx
Mounting position	vertical, either way up

Accessories

Outer filament connector	MA208A
Inner filament connector	MA208B
Grid connector	MA208
Thermal fuse, available for BW1181J3	MA85E

COOLING

Anode

The BR1181 air cooling requirements are shown on pages 7 and 8. The required air flow should be delivered through the radiator immediately before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

BW1181J3 has an integral water jacket. Minimum water cooling requirements are shown on page 9; higher rates of flow should be used where possible.

A thermal fuse, part number MA85E, is available for BW1181J3, to give protection against anode overheating. The fuse should be screwed into one of the two threaded holes in the end of the anode (see page 12). The fuse should be connected by a non-conducting cord to a suitable switching device; a tension of about 1 pound (450g) should be applied to the fuse via the cord. If the temperature exceeds the safe limit, the fuse core is pulled outwards; this should actuate the switching device and remove all electrical supplies to the valve. Replacement fuses can be supplied to order.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 180°C. A flow of air of 15 to 20ft^3/min (0.43 to 0.57m^3/min) directed onto the terminals via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperature of the seals.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage	8.0	kV max
Anode current	4.5	A max
Anode dissipation:		
BR1181	10	kW max
BW1181J3	12	kW max
Grid dissipation	250	W max
Frequency	100	MHz max

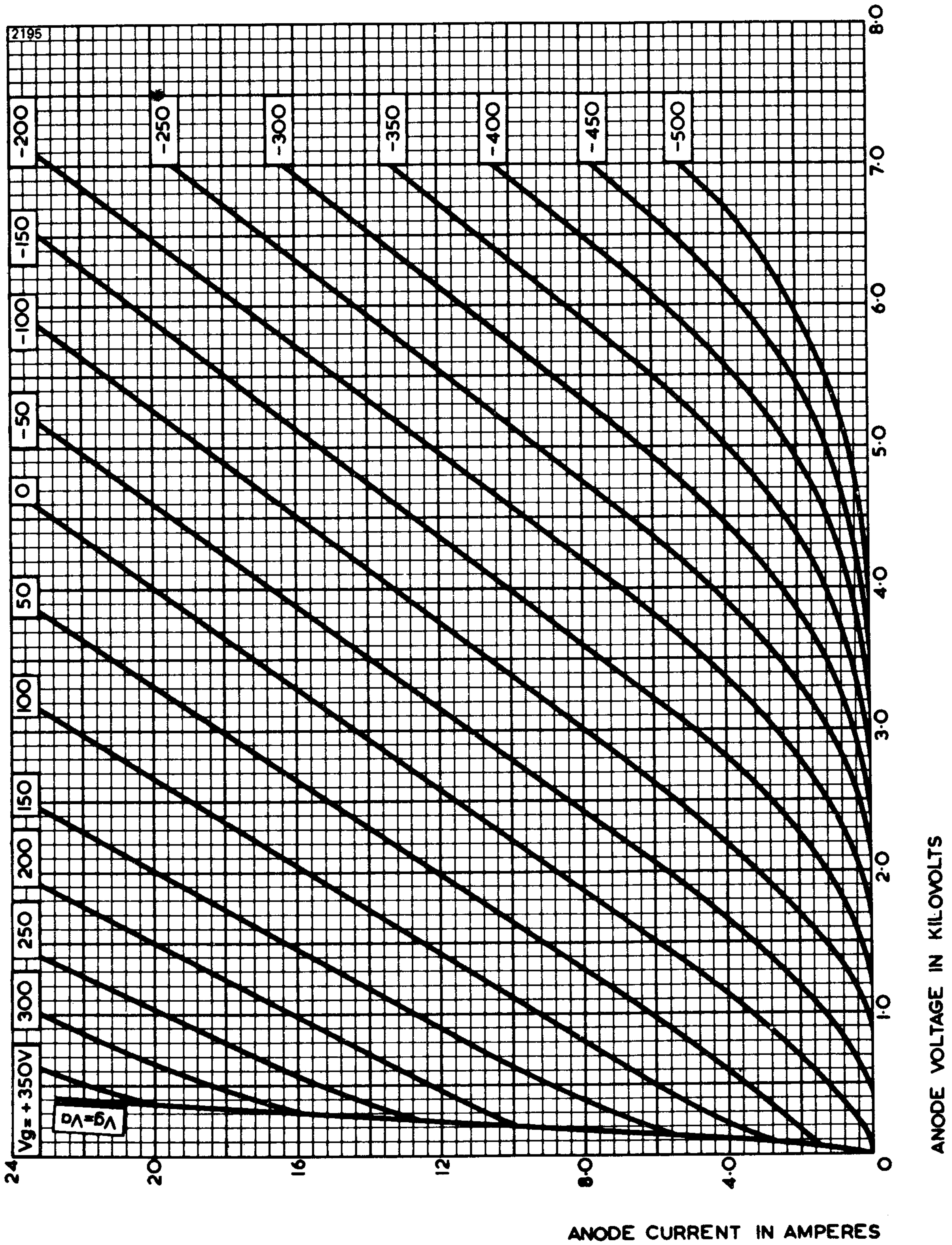
TYPICAL OPERATING CONDITIONS

Anode voltage	8.0	kV
Grid voltage	−1000	V
from grid resistor	2050	Ω
Peak r.f. grid drive voltage	1290	V
Anode current	4.0	A
Grid current	485	mA
Anode dissipation	5.5	kW
Grid dissipation	145	W
Driving power	630	W
Output power (see note 2)	26	kW
Efficiency	81	%
Load resistance	1000	Ω

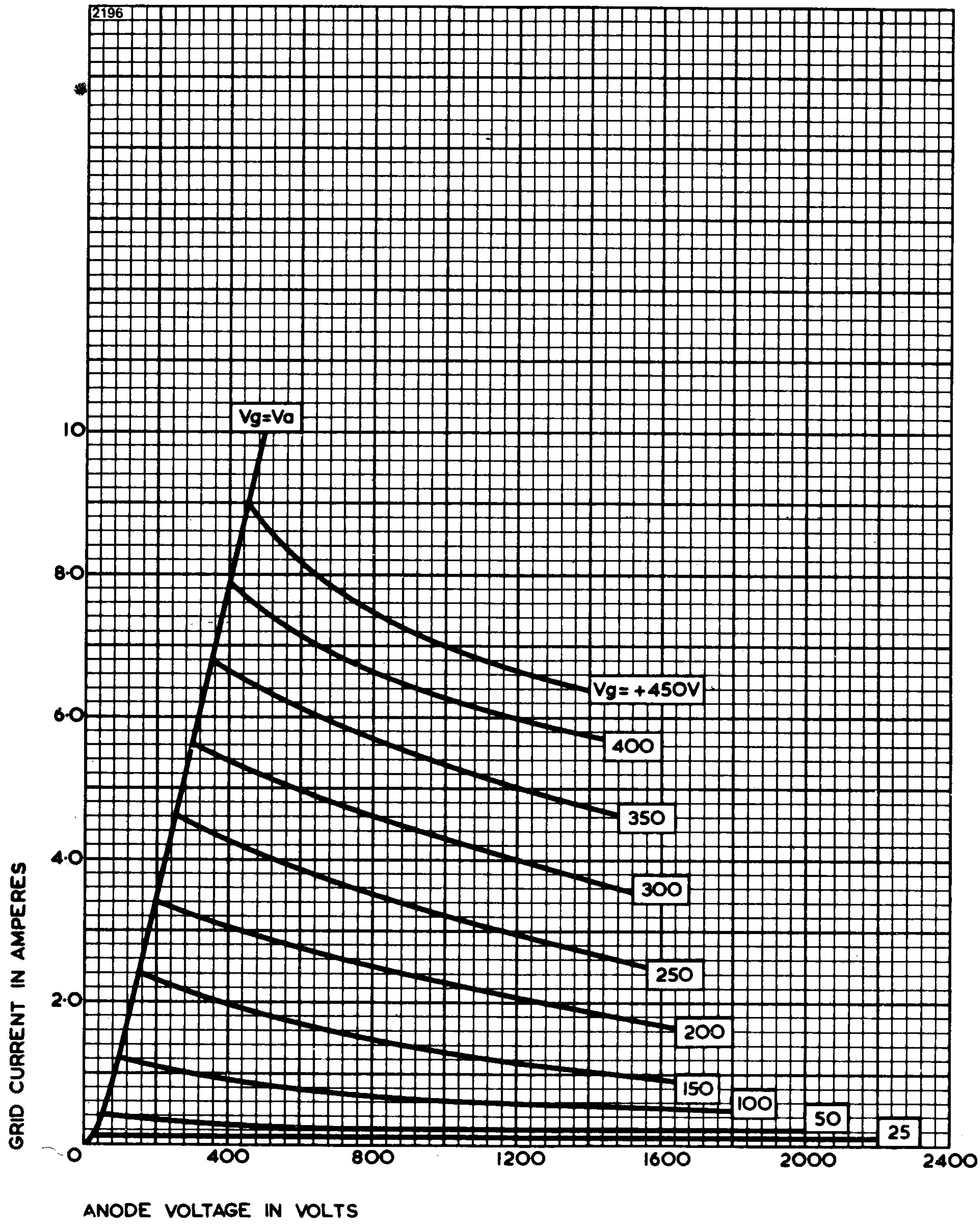
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%. The filament may be switched on at its operating voltage and no surge limiting devices need be incorporated in the filament circuit.
2. This is the output power from the valve after the grid drive power has been deducted. With 85% circuit efficiency the power to the load is 22kW.

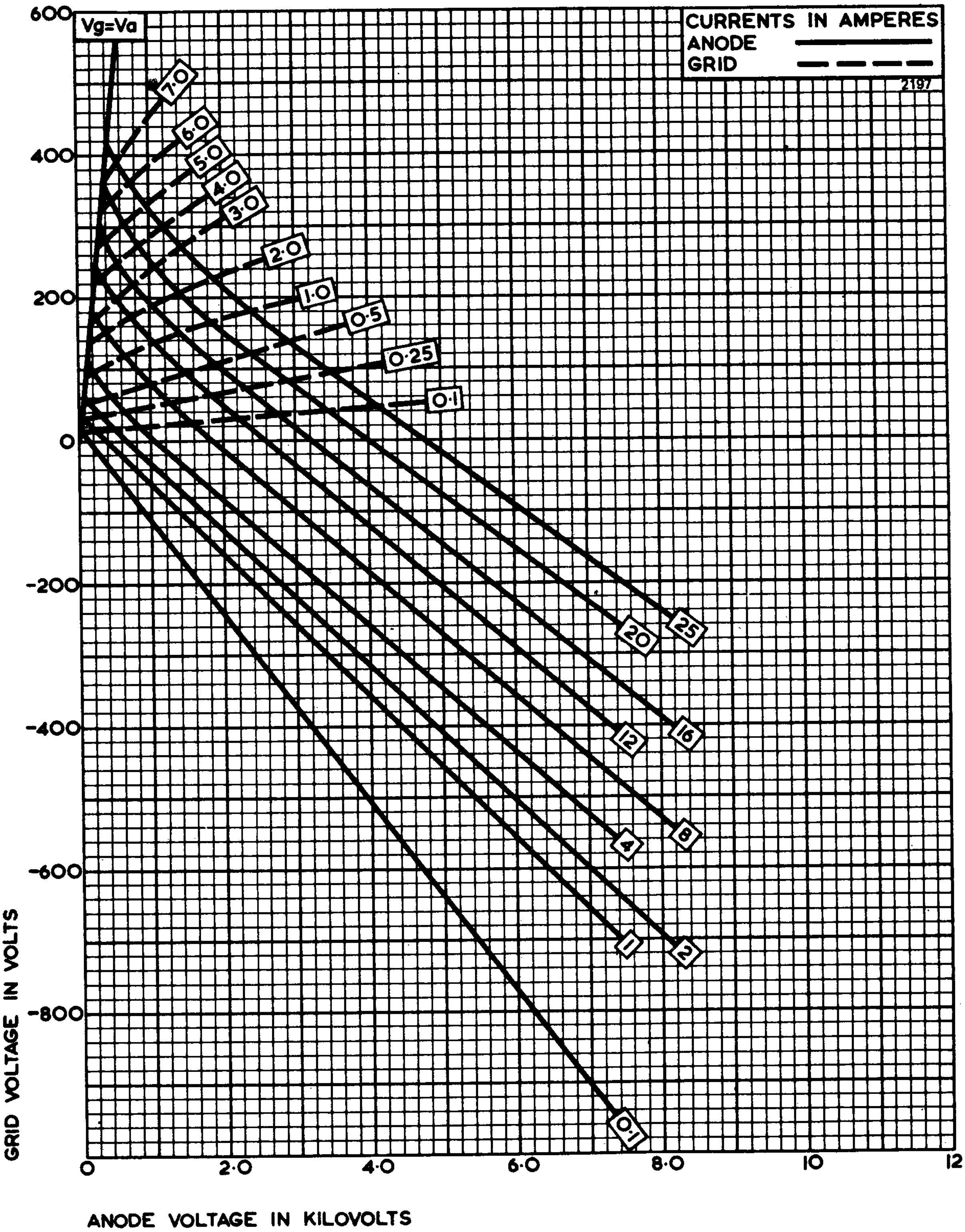
TYPICAL ANODE CHARACTERISTICS



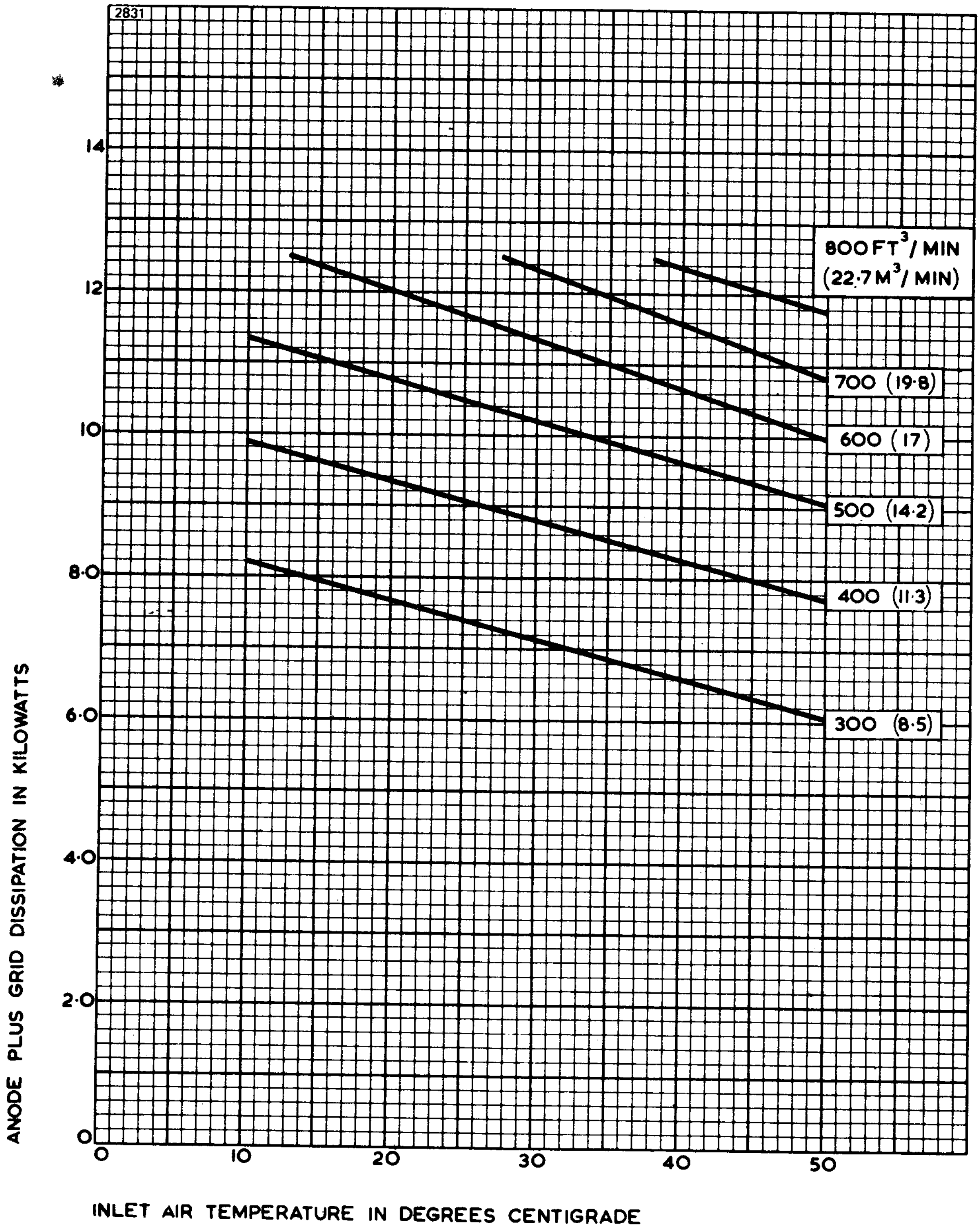
TYPICAL GRID CHARACTERISTICS



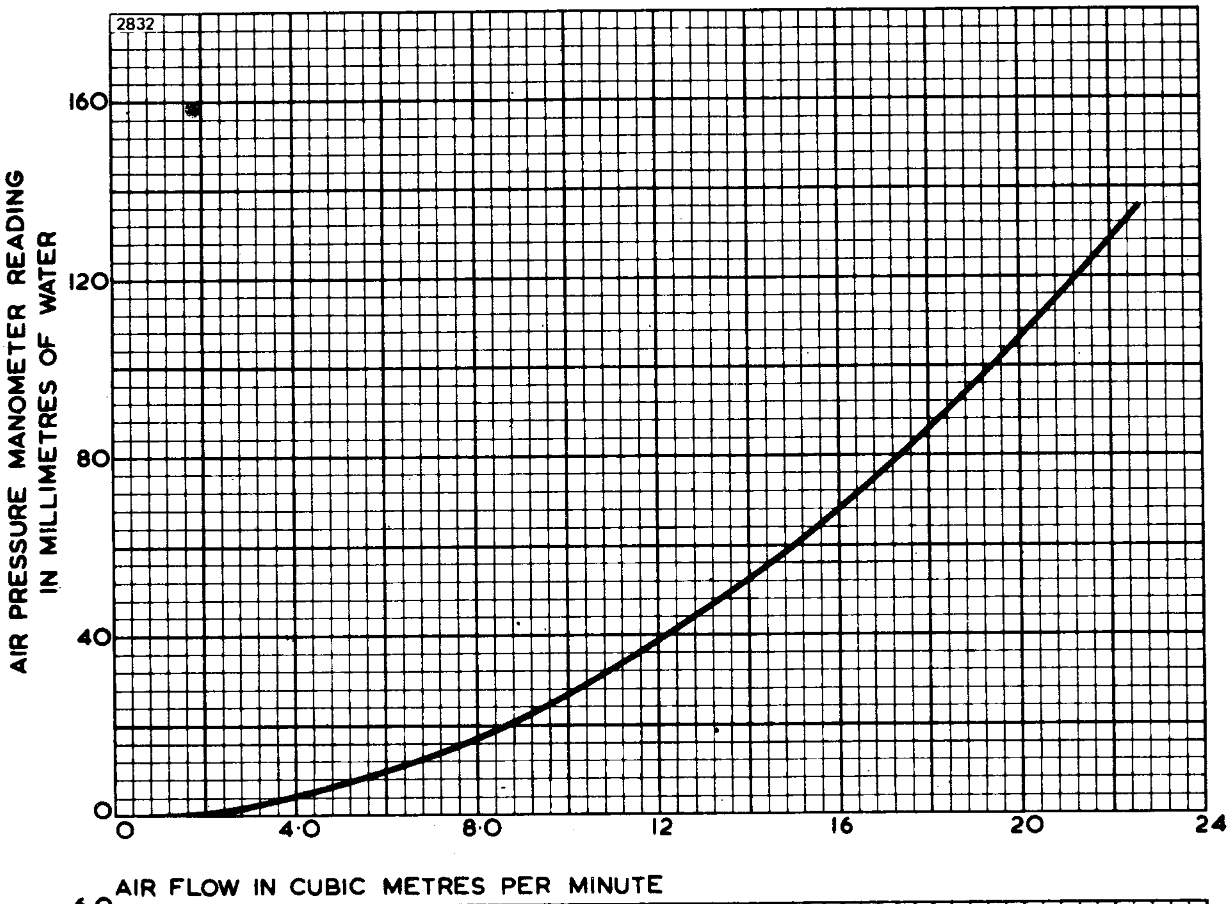
TYPICAL CONSTANT CURRENT CHARACTERISTICS

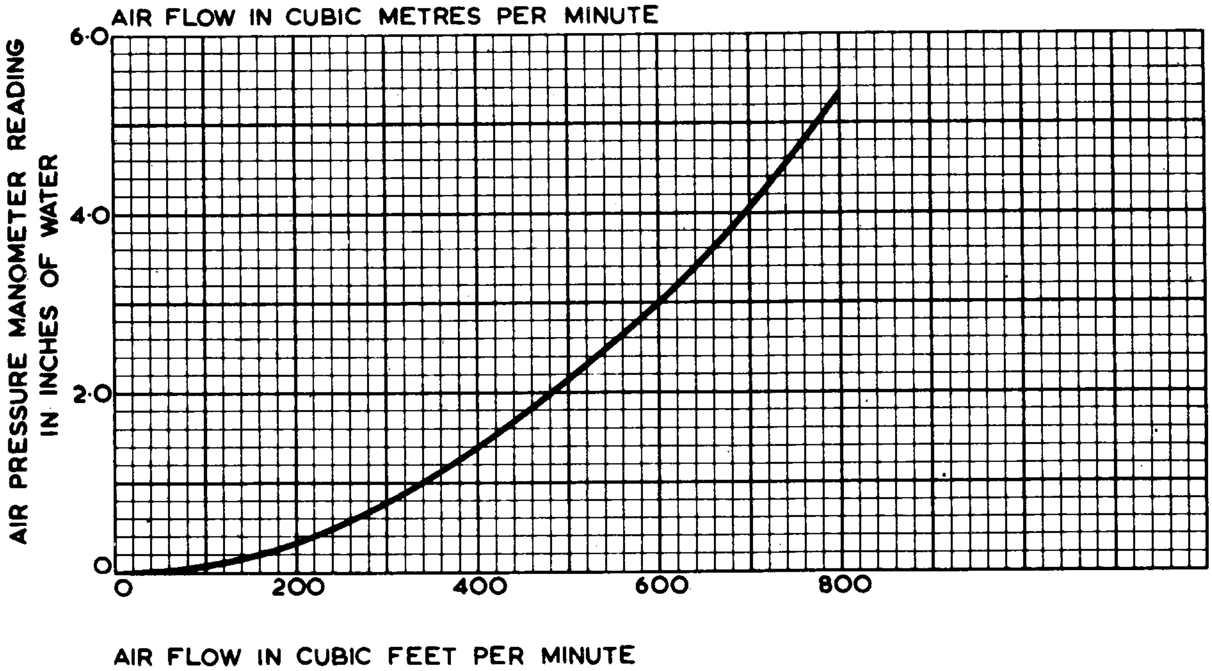


AIR COOLING REQUIREMENTS FOR BR1181

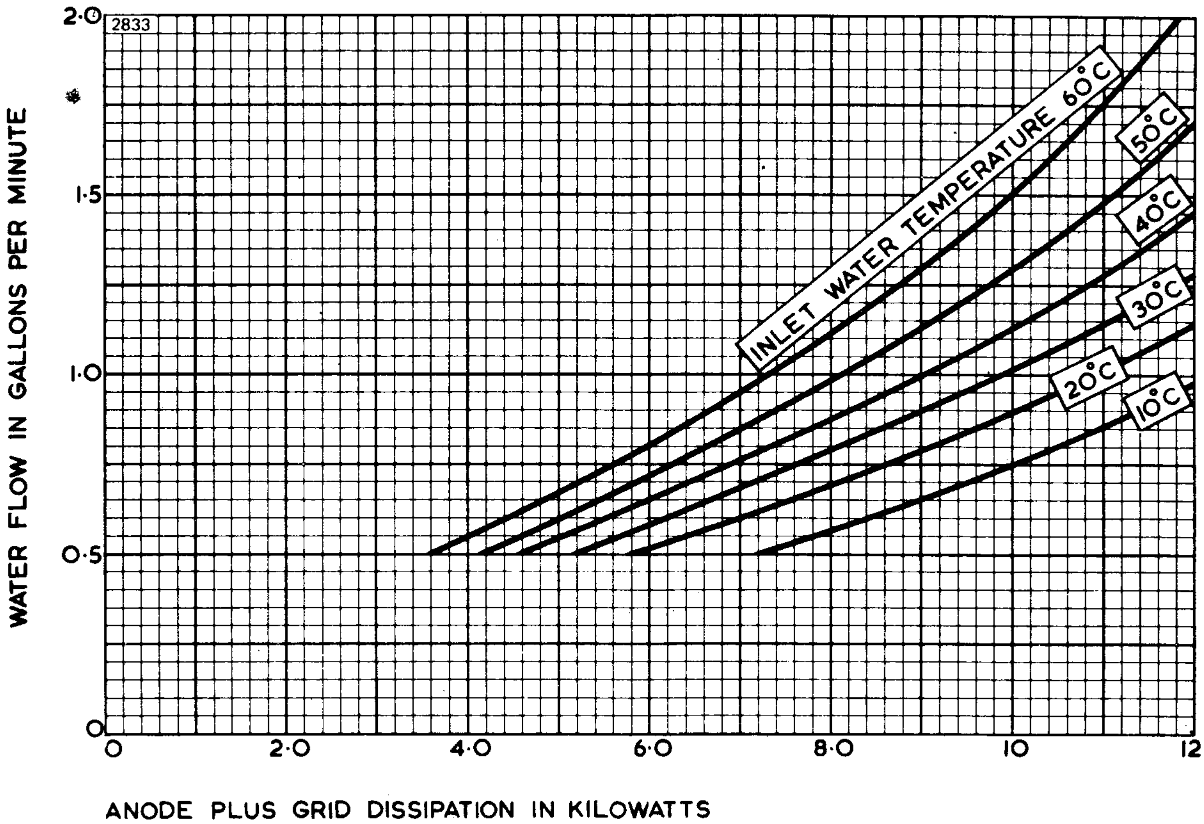


TYPICAL AIR FLOW CHARACTERISTIC FOR BR1181

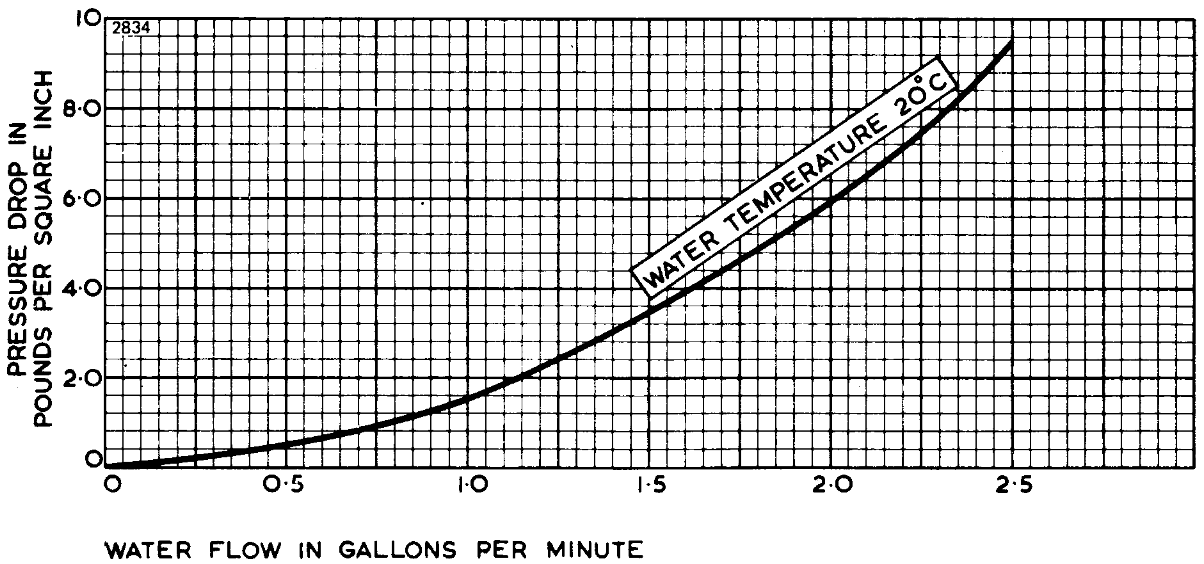




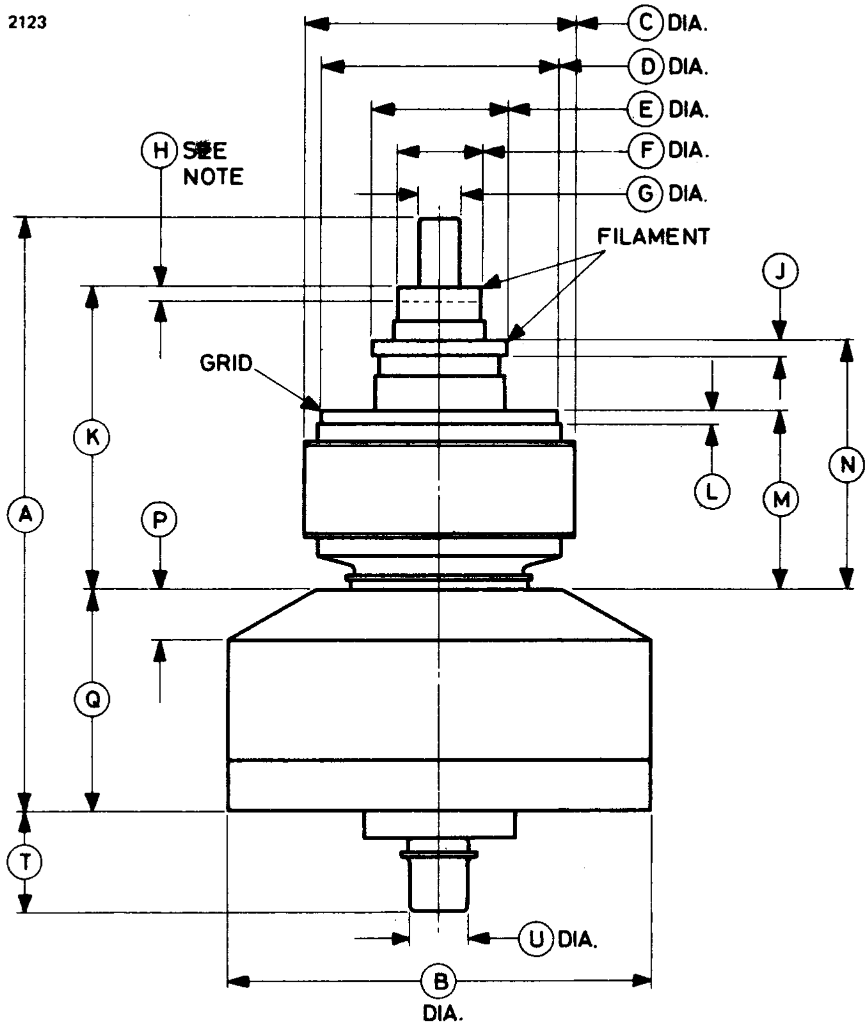
MINIMUM WATER COOLING REQUIREMENTS FOR BW1181J3
(Higher rates of flow should be used where possible)



TYPICAL WATER FLOW CHARACTERISTIC FOR BW1181J3



OUTLINE FOR BR1181 (All dimensions without limits are nominal)



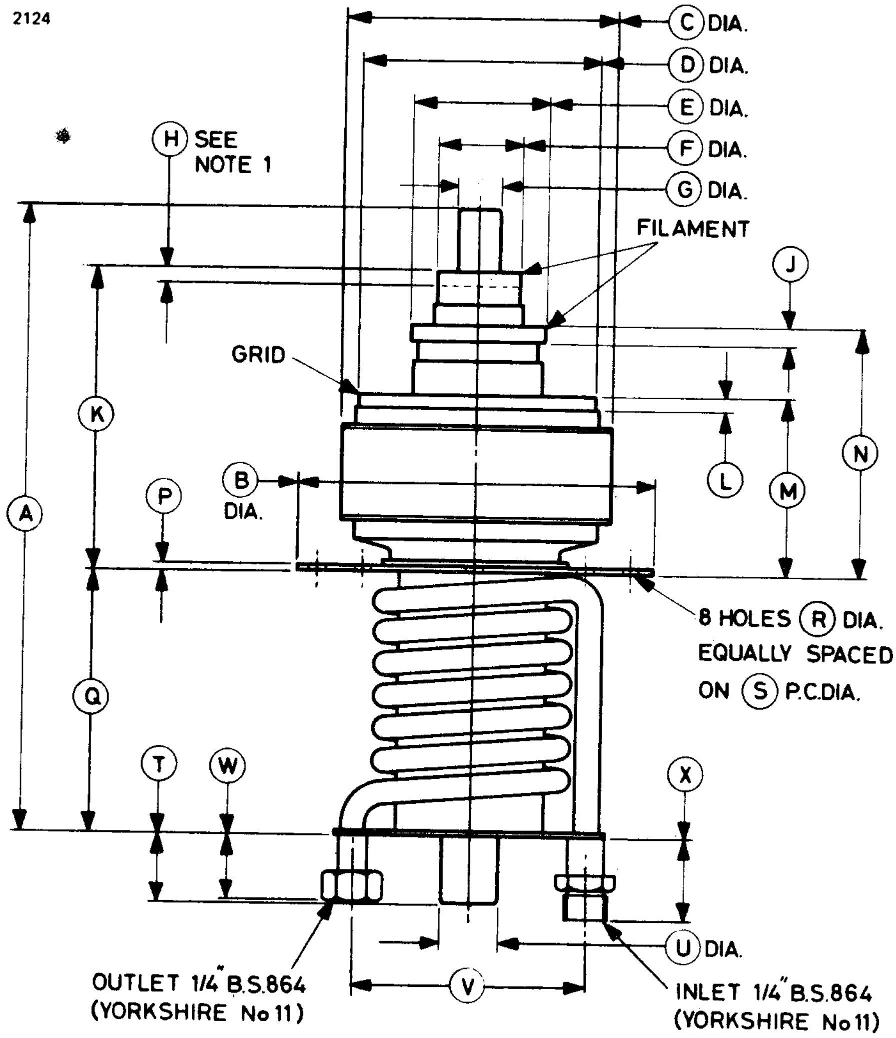
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	8.782	223.1	K	4.470	113.5
B	6.250	158.8	L	0.218	5.54
C	4.000	101.6	M	2.656	67.46
D	3.500	88.90	N	3.687	93.65
E	2.000	50.80	P	0.750	19.05
F	1.250	31.75	Q	3.312	84.12
G	0.625	15.88	T	1.501	38.13
H	0.219 ± 0.031	5.56 ± 0.79	U	0.875 ± 0.005	22.23 ± 0.13
J	0.250	6.35			

Millimetre dimensions have been derived from inches.

Outline Note for BR1181

The filament contact surface may be clamped only within this area.

OUTLINE FOR BW1181J3 (All dimensions without limits are nominal)

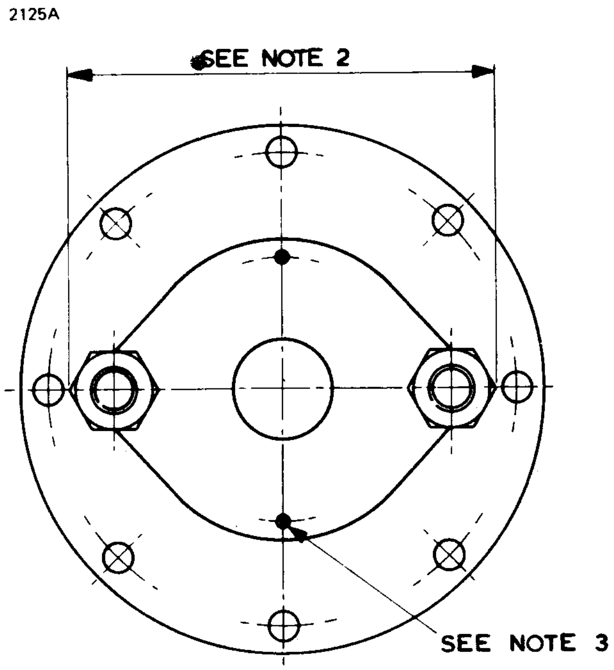


Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.300	236.2	M	2.656	67.46
B	5.250	133.4	N	3.687	93.65
C	4.000	101.6	P	0.128	3.25
D	3.500	88.90	Q	3.830	97.28
E	2.000	50.80	R	0.257	6.53
F	1.250	31.75	S	4.687	119.0
G	1.000 max	25.40 max	T	1.000	25.40
H	0.187 min	4.75 min	U	1.000 max	25.40 max
J	0.187 min	4.75 min	V	3.375	85.73
K	4.470	113.5	W	0.985	25.02
L	0.187 min	4.75 min	X	1.250	31.75

Millimetre dimensions have been derived from inches.

Outline Detail of BW1181J3

(Enlarged view from below)



Outline Notes for BW1181J3

1. The filament contact surface may be clamped only within this area.
2. This dimension will pass through a hole of 4.250 inches (108.0mm) minimum diameter.
3. Two holes threaded 4B.A., for thermal fuses MA85E (see page 2).

BR1182
BW1182J1

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes with ceramic/metal envelopes, intended primarily for industrial service. They differ only in the method of anode cooling.

Anode cooling:		
BR1182		forced-air
BW1182J1		water; integral jacket
Anode dissipation	15	kW max
Anode voltage	10	kV max
Frequency for full ratings	50	MHz max
Output power (class C unmodulated conditions)	50	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	6.6	V
Filament current	230	A
Filament starting current (peak) (see note 2)	600	A max
Filament cold resistance	3.5	mΩ
Peak usable cathode current	45	A
Perveance	2.3	$mA/V^{3/2}$
Amplification factor (V_a = 6.0kV, I_a = 3.0A)	38	
Mutual conductance (V_a = 7.0kV, I_a = 3.0A)	45	mA/V
Inter-electrode capacitances:		
grid to anode	50	pF
grid to filament	82	pF
anode to filament	1.5	pF

Mechanical

Overall dimensions	see outline drawings
Net weight:	
BR1182	16kg (35 pounds) approx
BW1182J1	4.5kg (10 pounds) approx
Mounting position	vertical, either way up

Accessories

Smaller filament terminal connector	MA291C
Larger filament terminal connector	MA291D

COOLING

Anode

The BR1182 air cooling requirements are shown on pages 7 and 8. The required air flow should be delivered by a blower through the radiator immediately* before and during the application of any voltages. Filament power, anode power and air flow may be removed simultaneously.

Type BW1182J1 has an integral water jacket (see outline drawing). Minimum water cooling requirements are shown on page 9; higher rates of flow should be used where possible.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed onto the filament terminals via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperatures of the seals.

Anode Seal and Envelope

The anode seal and envelope temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	10	kV max
Anode current	7.0	A max
Anode dissipation (see note 4)	15	kW max
Grid dissipation	1.0	kW max
Operating frequency (for full ratings)	50	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	8.0	10	kV
Grid voltage	−420	−470	V
from grid resistor	350	410	Ω
Peak r.f. grid drive voltage	870	920	V
Anode current	6.6	6.6	A
Grid current (approx)	1.2	1.14	A
Anode dissipation	11	12.8	kW
Grid dissipation	540	510	W
Driving power	1040	1050	W
Output power	40	52	kW
Efficiency	77	79	%
Load resistance	640	810	Ω

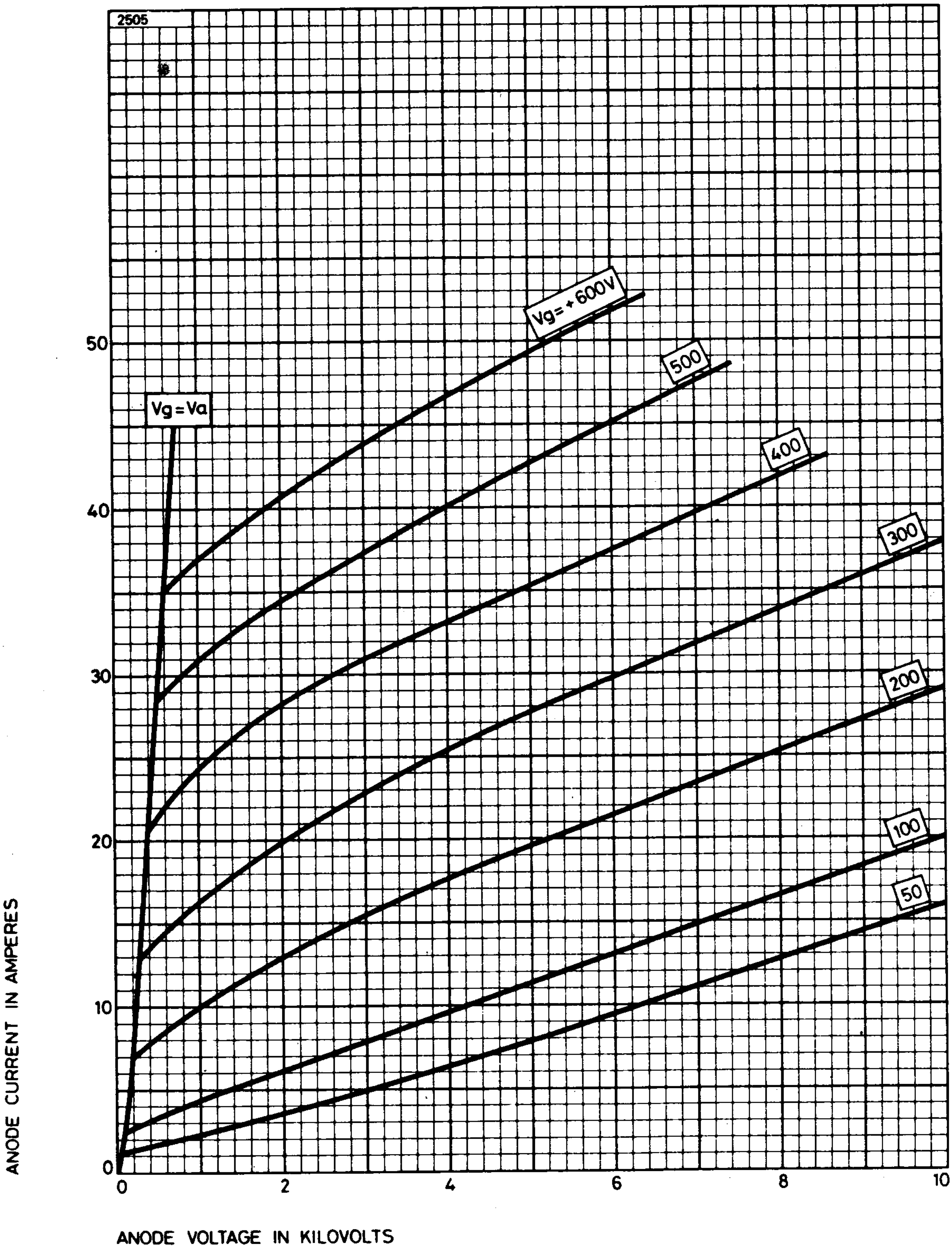
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 6.6V . . .	216	244	A
Amplification factor (V_a = 6.0kV, I_a = 3.0A) .	33	45	
Mutual conductance (V_a = 7.0kV, I_a = 3.0A) .	40	50	mA/V
Anode current (V_a = 1.5kV, V_g = +600V) . .	33	42	A
Grid current (V_a = 1.5kV, V_g = +600V) . . .	8.0	11	A
Grid voltage (negative) (V_a = 6.0kV, I_a = 0.1A)	–	200	V

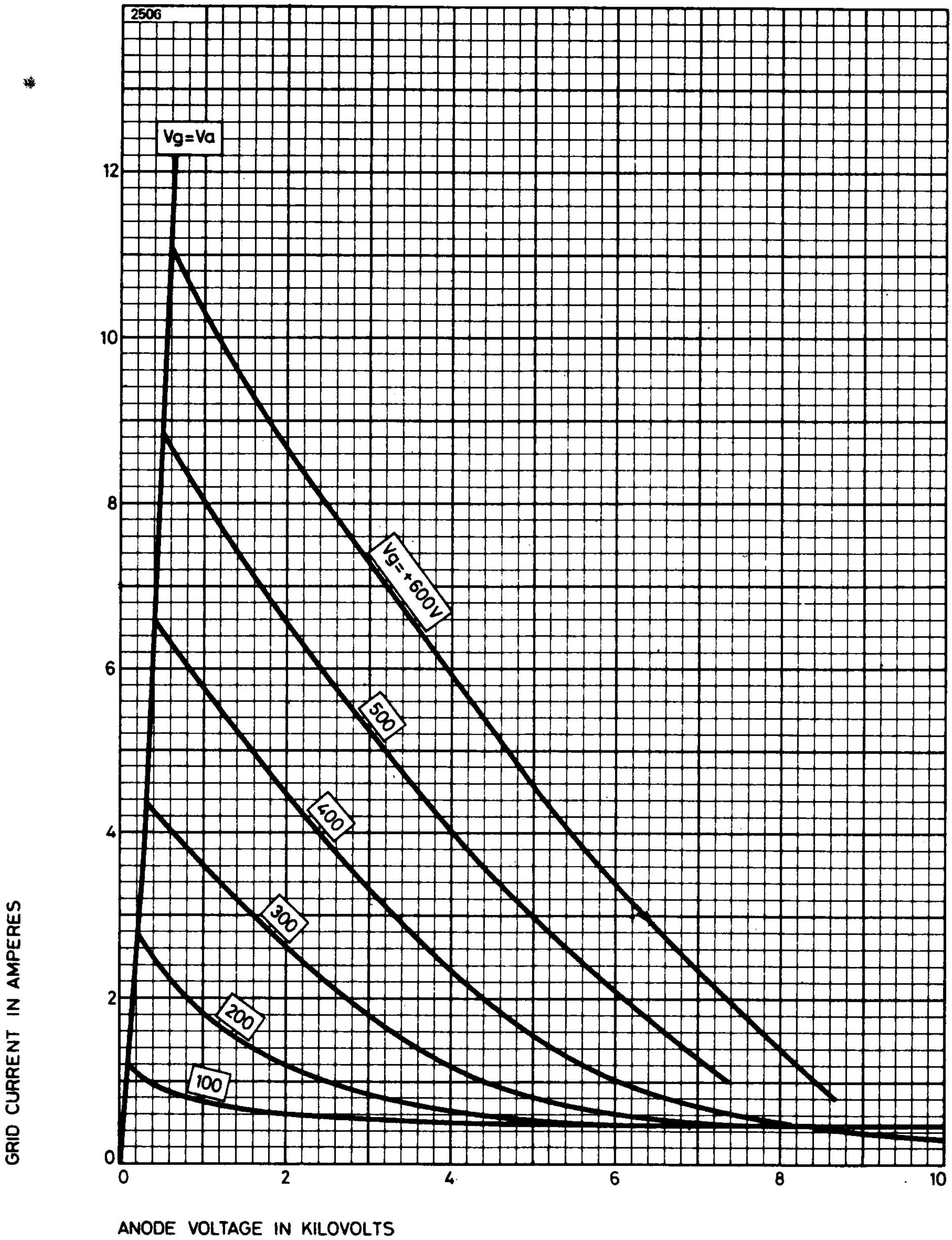
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.

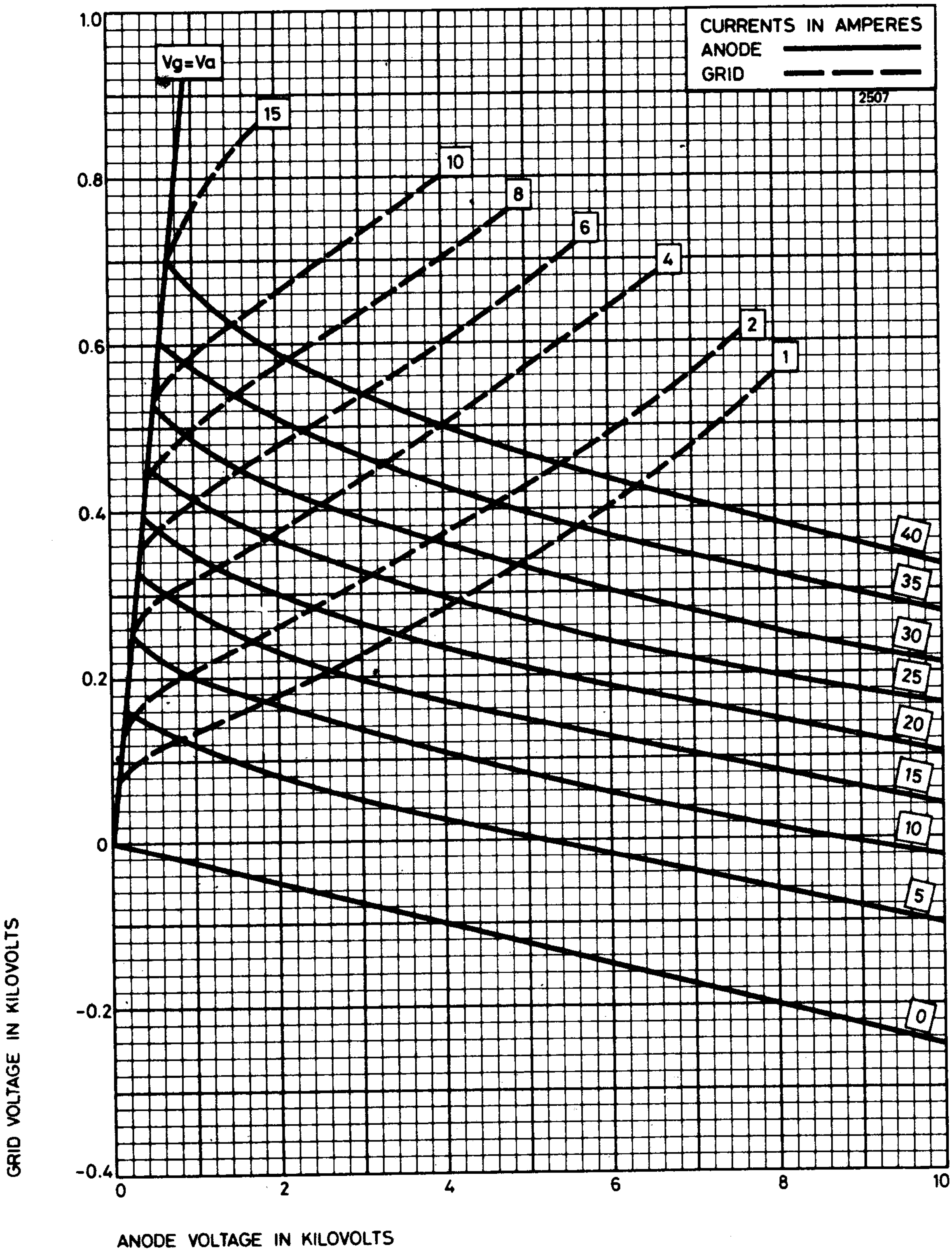
TYPICAL ANODE CHARACTERISTICS



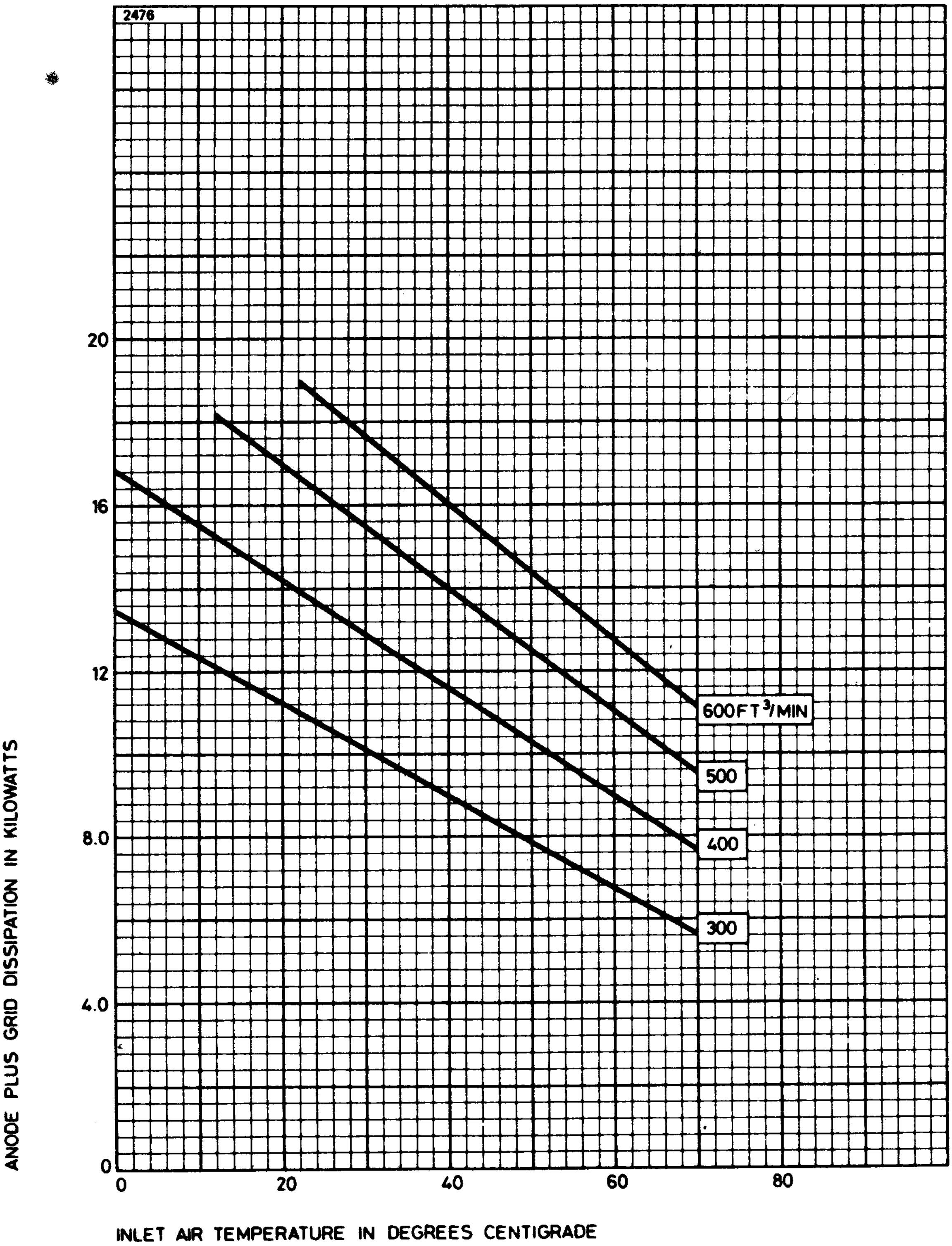
TYPICAL GRID CHARACTERISTICS



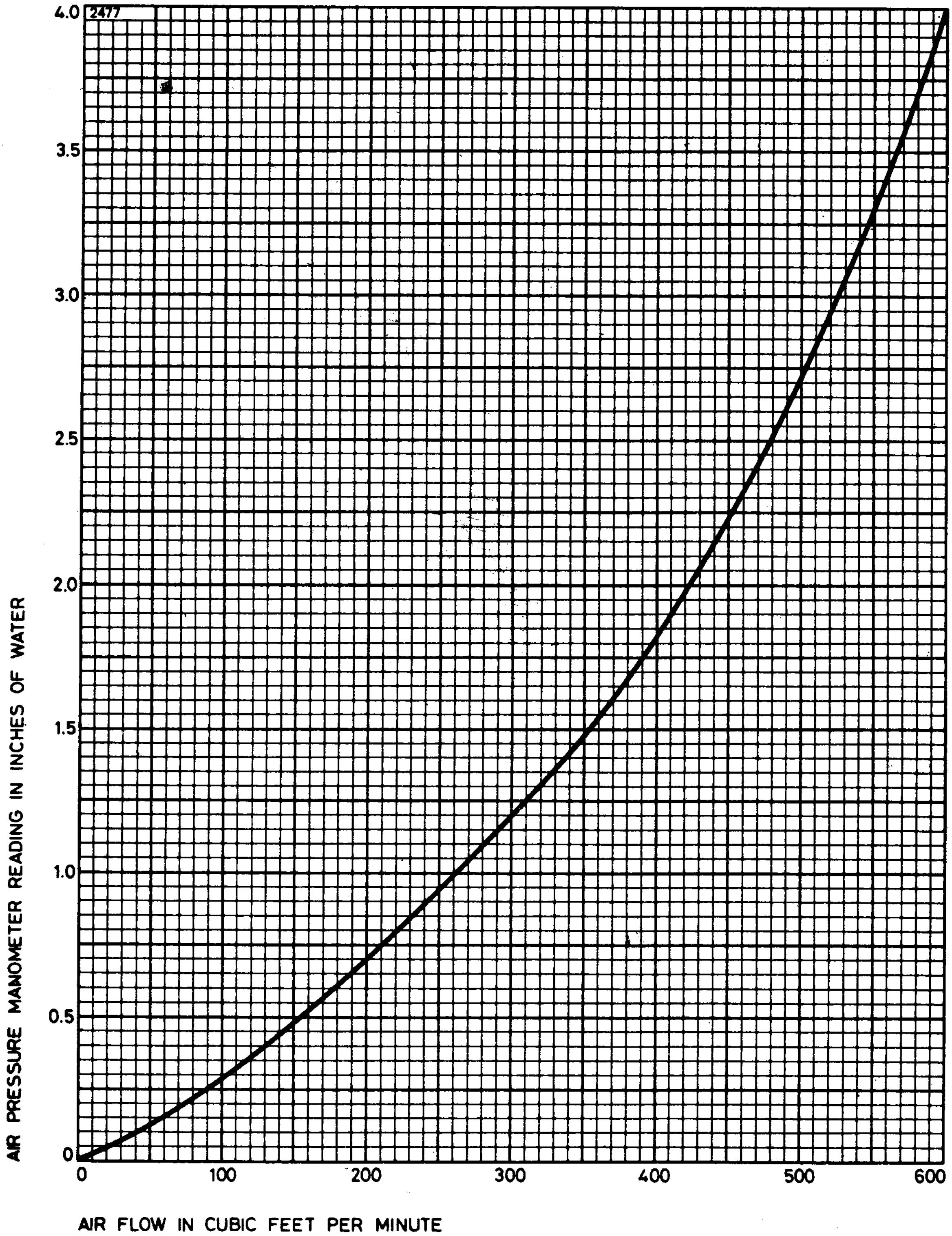
TYPICAL CONSTANT CURRENT CHARACTERISTICS



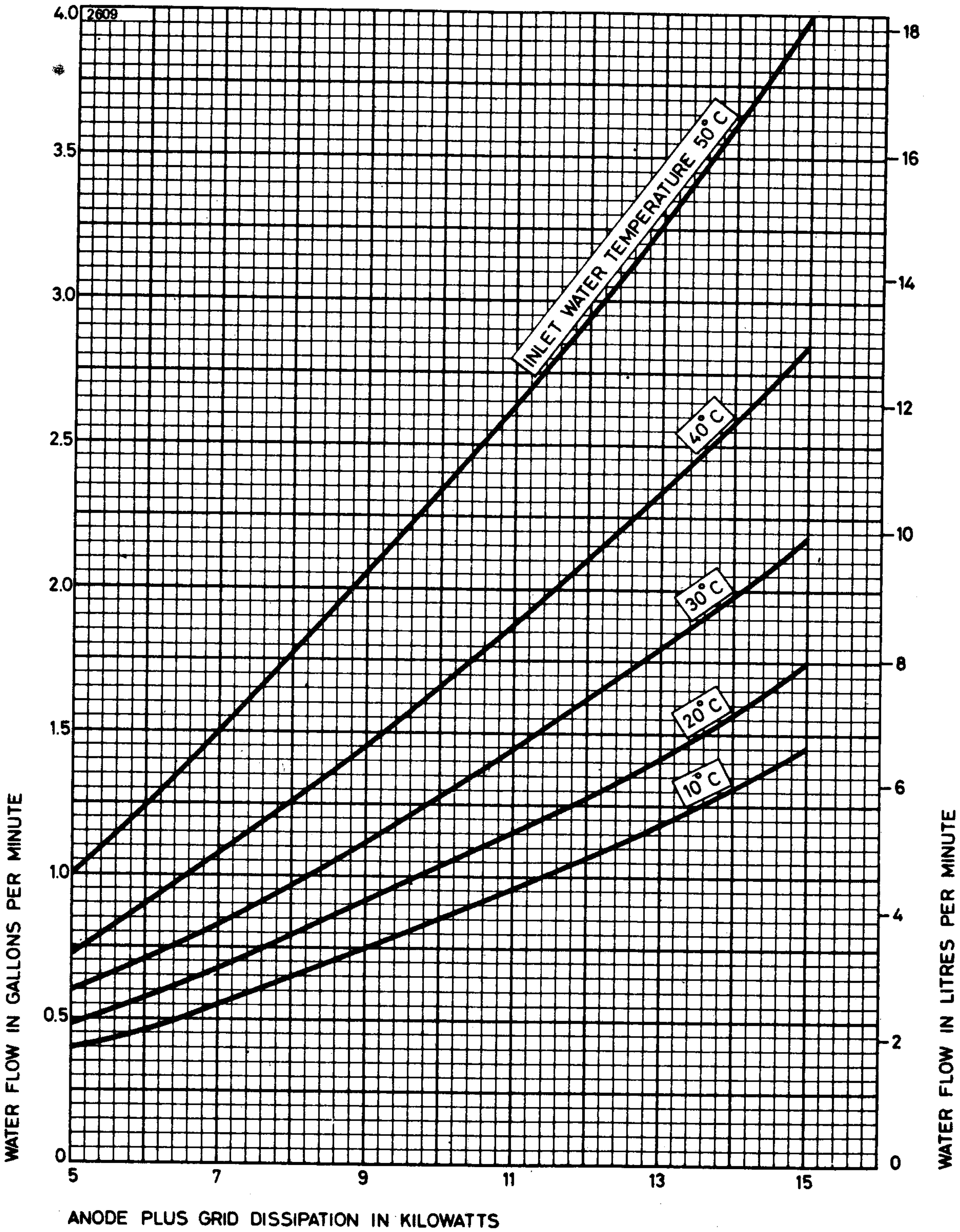
AIR COOLING REQUIREMENTS FOR BR1182



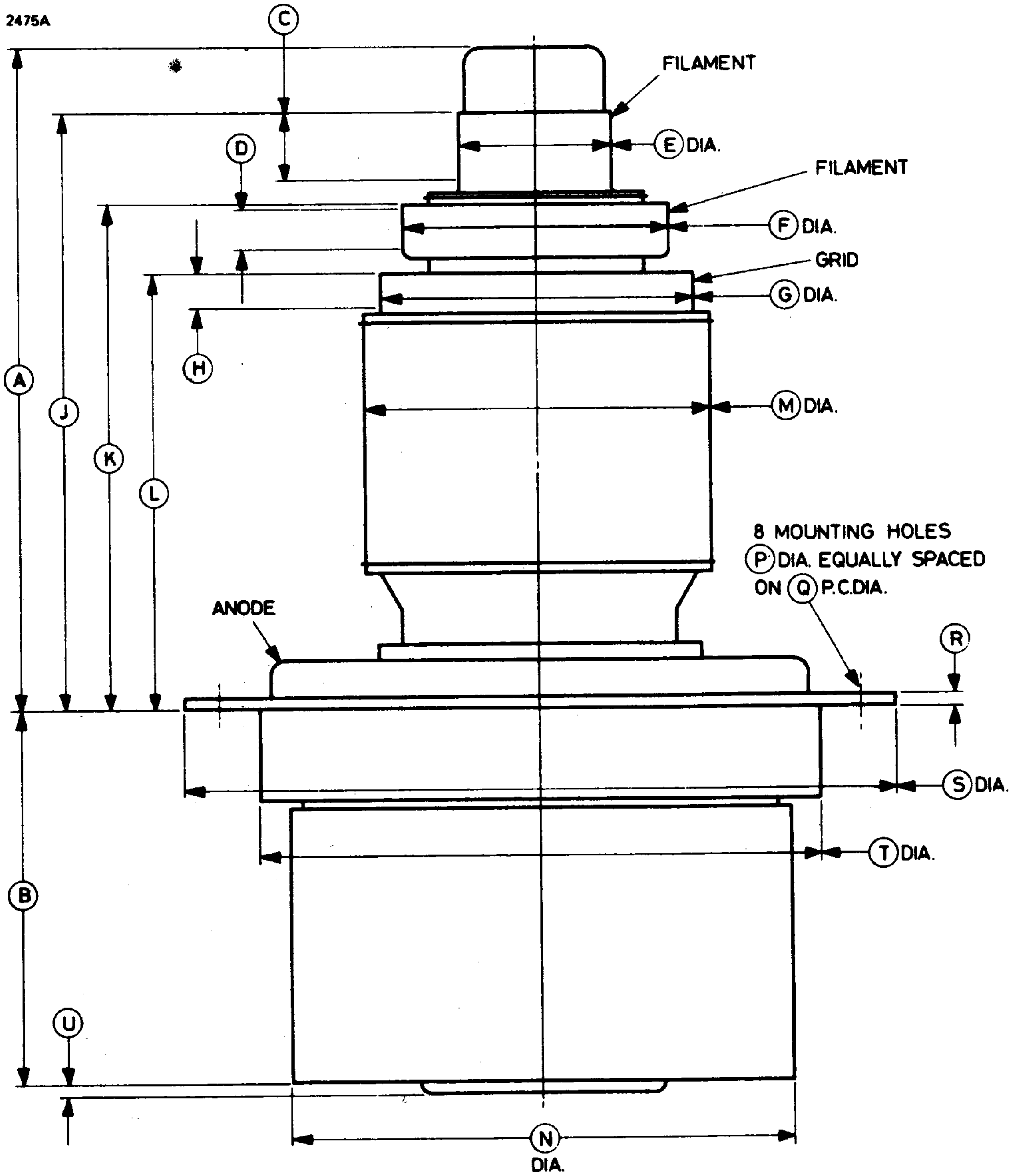
TYPICAL AIR FLOW CHARACTERISTIC FOR BR1182



MINIMUM WATER COOLING REQUIREMENTS FOR BW1182J1



OUTLINE FOR BR1182

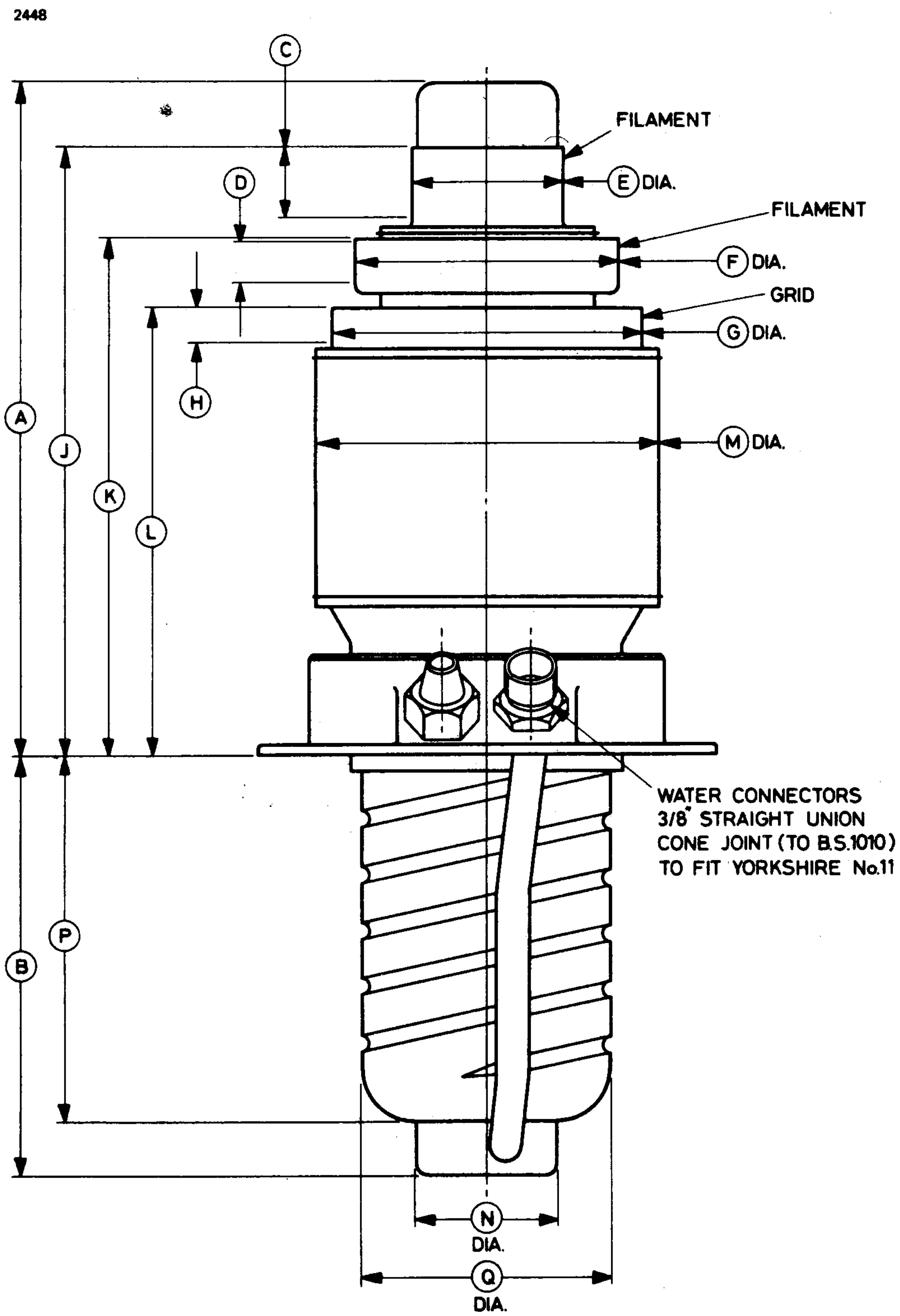


Outline Dimensions for BR1182 (All dimensions without limits are nominal)

Ref	Millimetres	Inches
A *	232.0 max	9.134 max
B	132.0	5.197
C	25.0	0.984
D	15.0	0.591
E	54.0 ± 0.2	2.126 ± 0.079
F	96.0 ± 0.3	3.780 ± 0.118
G	112.0 ± 0.3	4.409 ± 0.118
H	14.0	0.551
J	212.0	8.346
K	179.0	7.047
L	155.0	6.102
M	127.0 max	5.000 max
N	179.5 max	7.067 max
P*	9.53	0.375
Q*	228.6	9.000
R	4.76	0.187
S	256.0 max	10.079 max
T	202.0 max	7.953 max
U	4.0	0.157

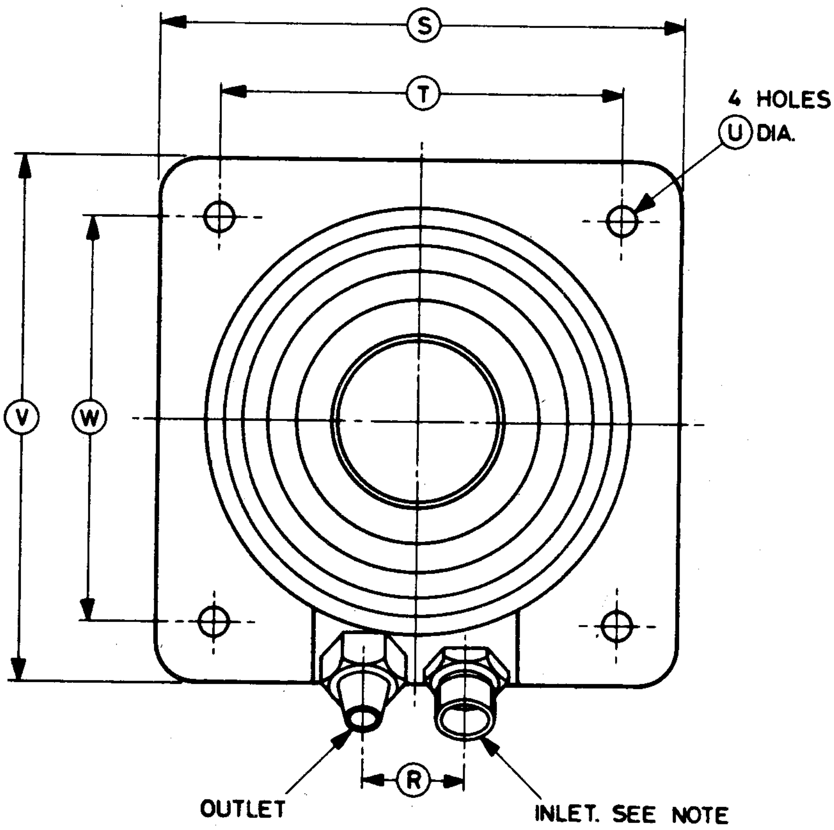
Inch dimensions have been derived from millimetres except where marked *.

OUTLINE FOR BW1182J1 (All dimensions without limits are nominal)



Outline Detail for BW1182J1

2449



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	237.0 max	9.331 max	M	127.0 max	5.000 max
B	150.0	5.906	N	51.0 ± 1.5	2.008 ± 0.059
C	25.0	0.984	P	131.0	5.157
D	15.0	0.591	Q	90.0 ± 1.5	3.543 ± 0.059
E	54.0 ± 0.2	2.126 ± 0.079	R	31.75	1.250
F	96.0 ± 0.3	3.780 ± 0.118	S	165.0 ± 3.0	6.496 ± 0.118
G	112.0 ± 0.3	4.409 ± 0.118	T	127.0 ± 1.5	5.000 ± 0.059
H	14.0	0.551	U	9.5	0.374
J	217.0	8.543	V	165.0 ± 3.0	6.496 ± 0.118
K	184.0	7.244	W	127.0 ± 1.5	5.000 ± 0.059
L	160.0	6.299			

Inch dimensions have been derived from millimetres.

Note If the valve is mounted filament terminals down, the water flow must be opposite to the direction shown.

BR1183
BW1183J1

R.F. POWER TRIODES

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Two r.f. power triodes with ceramic/metal envelopes, intended primarily for industrial service. They differ only in the method of anode cooling.

Anode cooling:		
BR1183		forced-air
BW1183J1		water; integral jacket
Anode dissipation	20	kW max
Anode voltage	10	kV max
Frequency for full ratings	50	MHz max
Output power (class C unmodulated conditions)	70	kW

GENERAL

Electrical

Filament		thoriated tungsten
Filament voltage (see note 1)	8.2	V
Filament current	230	A
Filament starting current (peak) (see note 2)	600	A max
Filament cold resistance	4.0	mΩ
Peak usable cathode current	60	A
Perveance	3.0	$mA/V^{3/2}$
Amplification factor (V_a = 6.0kV, I_a = 4.0A)	38	
Mutual conductance (V_a = 7.0kV, I_a = 4.0A)	60	mA/V
Inter-electrode capacitances:		
grid to anode	57	pF
grid to filament	100	pF
anode to filament	1.7	pF

Mechanical

Overall dimensions	see outline drawings
Net weights:	
BR1183	18kg (40 pounds) approx
BW1183J1	5.5kg (12 pounds) approx
Mounting position	vertical, either end up

COOLING

Anode

The BR1183 air cooling requirements are shown on pages 7 and 8. The required air flow should be delivered by a blower through the radiator before and during the application of any voltages. Filament power, anode power and air may be removed simultaneously.

Type BW1183J1 has an integral water jacket (see outline drawing). Minimum water cooling requirements are shown on page 9; higher rates of flow should be used where possible.

Filament and Grid Seals

The temperature of the filament and grid seals must not exceed 140°C. A flow of air of 20 to 30ft^3/min (0.57 to 0.85m^3/min) directed onto the filament terminals via a 1-inch (25mm approx) diameter nozzle before and during the application of any voltages is usually adequate for limiting the temperatures of the seals.

Anode Seal and Envelope

The anode seal and envelope temperatures must not exceed 180°C.

R.F. POWER AMPLIFIER AND OSCILLATOR

(Class C unmodulated conditions, one valve)

MAXIMUM RATINGS (Absolute values)

Anode voltage (see note 3)	10	kV max
Anode current	9.0	A max
Anode dissipation (see note 4)	20	kW max
Grid dissipation	1.0	kW max
Operating frequency (for full ratings)	50	MHz max

TYPICAL OPERATING CONDITIONS

Anode voltage	8.0	10	kV
Grid voltage	−420	−520	V
from grid resistor	250	330	Ω
Peak r.f. grid drive voltage	860	980	V
Anode current	8.7	8.75	A
Grid current (approx)	1.6	1.6	A
Anode dissipation	14.3	16.2	kW
Grid dissipation	720	730	W
Driving power	1400	1560	W
Output power	54	70	kW
Efficiency	78	80	%
Load resistance	475	600	Ω

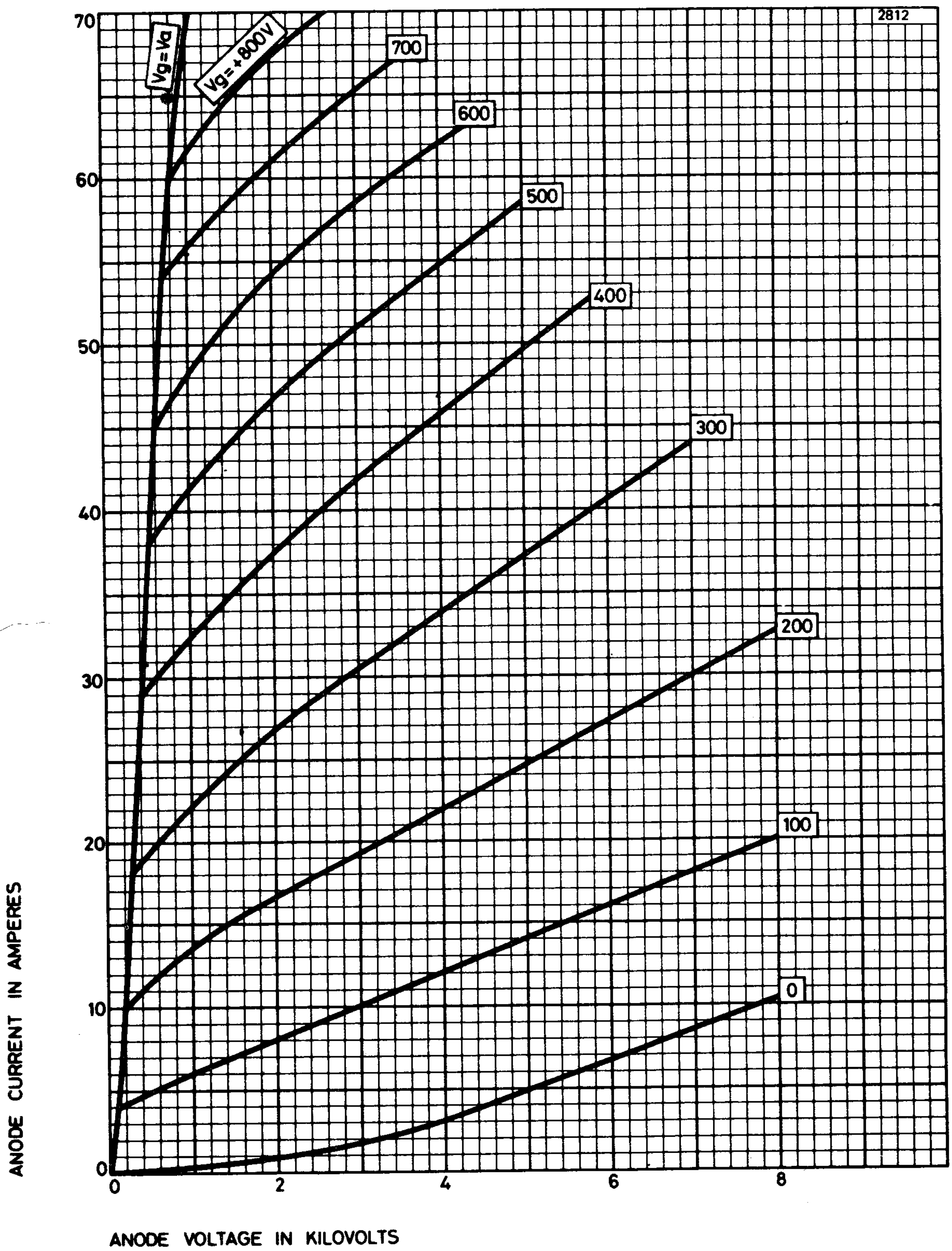
RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

	Min	Max	
Filament current at filament voltage 8.2V .	207	253	A
Amplification factor (V_a = 6.0kV, I_a = 4.0A) .	32	44	
Mutual conductance (V_a = 7.0kV, I_a = 4.0A) .	56	68	mA/V
Anode current (V_a = 1.5kV, V_g = +600V) . .	47	57	A
Grid current (V_a = 1.5kV, V_g = +600V)	11	15	A

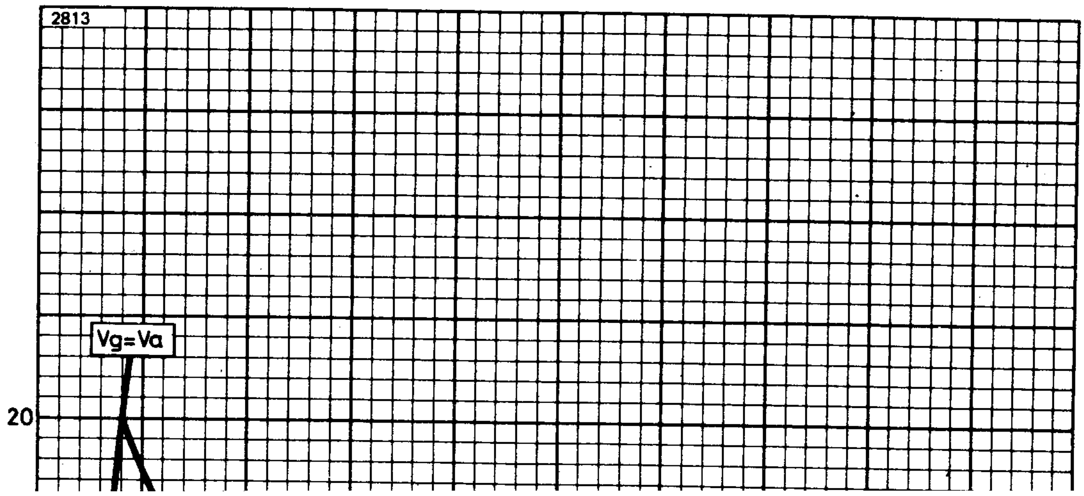
NOTES

1. The valve must be operated at the stated filament voltage. Fluctuation in filament voltage must not exceed ±5%.
2. The filament current must not exceed 600A, even momentarily, at any time.
3. This is the highest nominal operating voltage to be used. It makes allowance for the normal mains voltage fluctuations as well as tolerances in the equipment.
4. The valve can dissipate higher powers for periods up to 15 seconds provided that the average over a long period does not exceed the maximum stated.

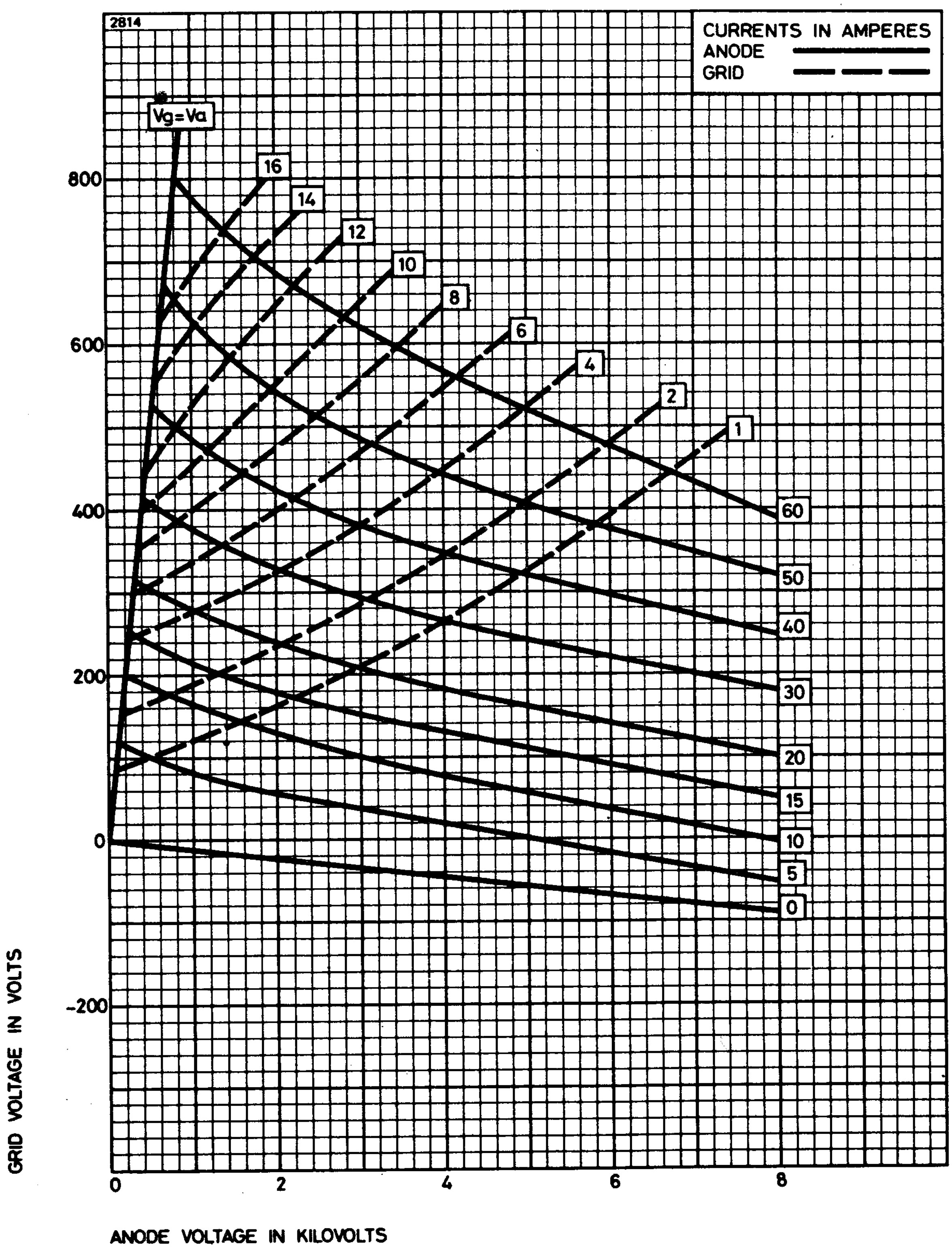
TYPICAL ANODE CHARACTERISTICS



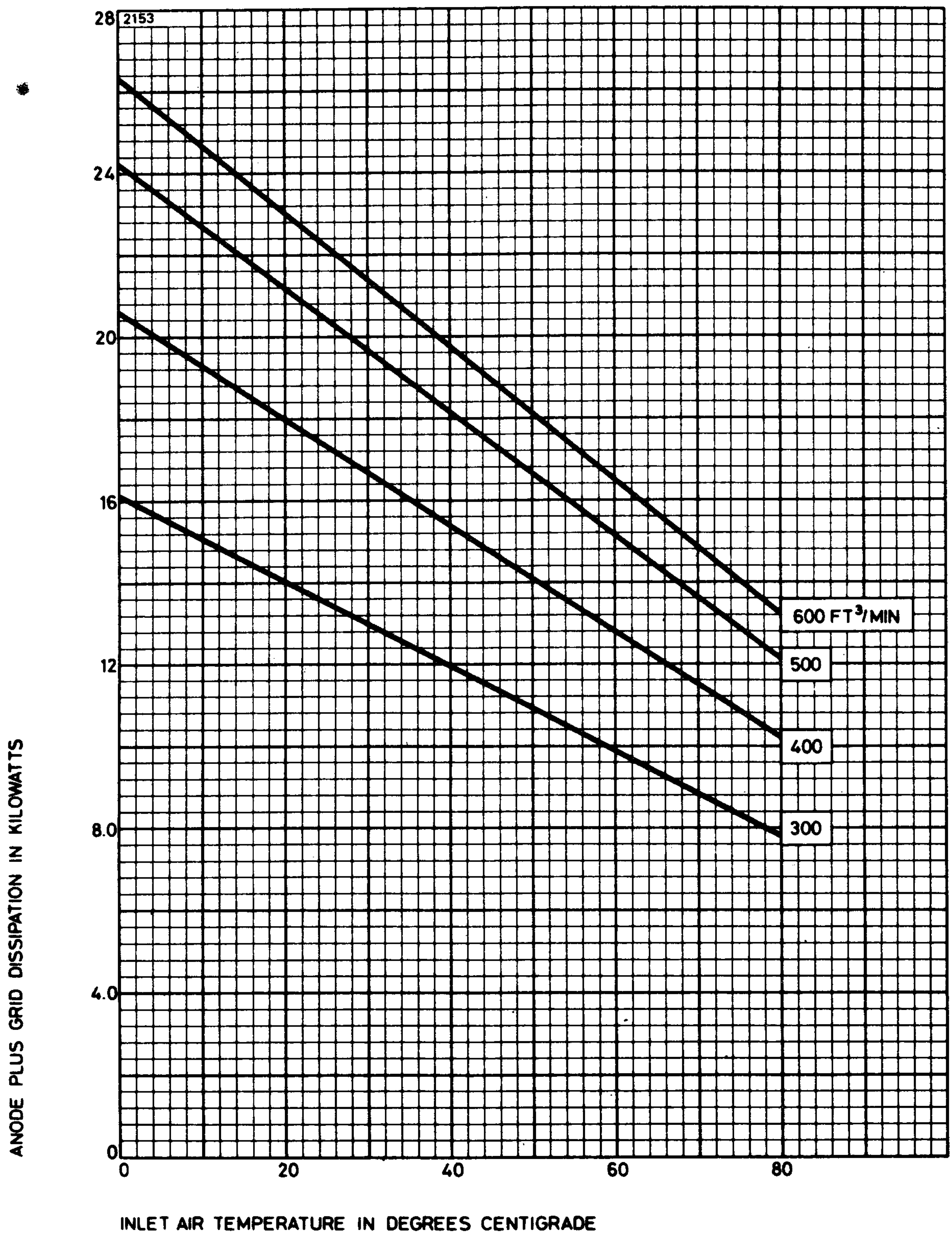
TYPICAL GRID CHARACTERISTICS



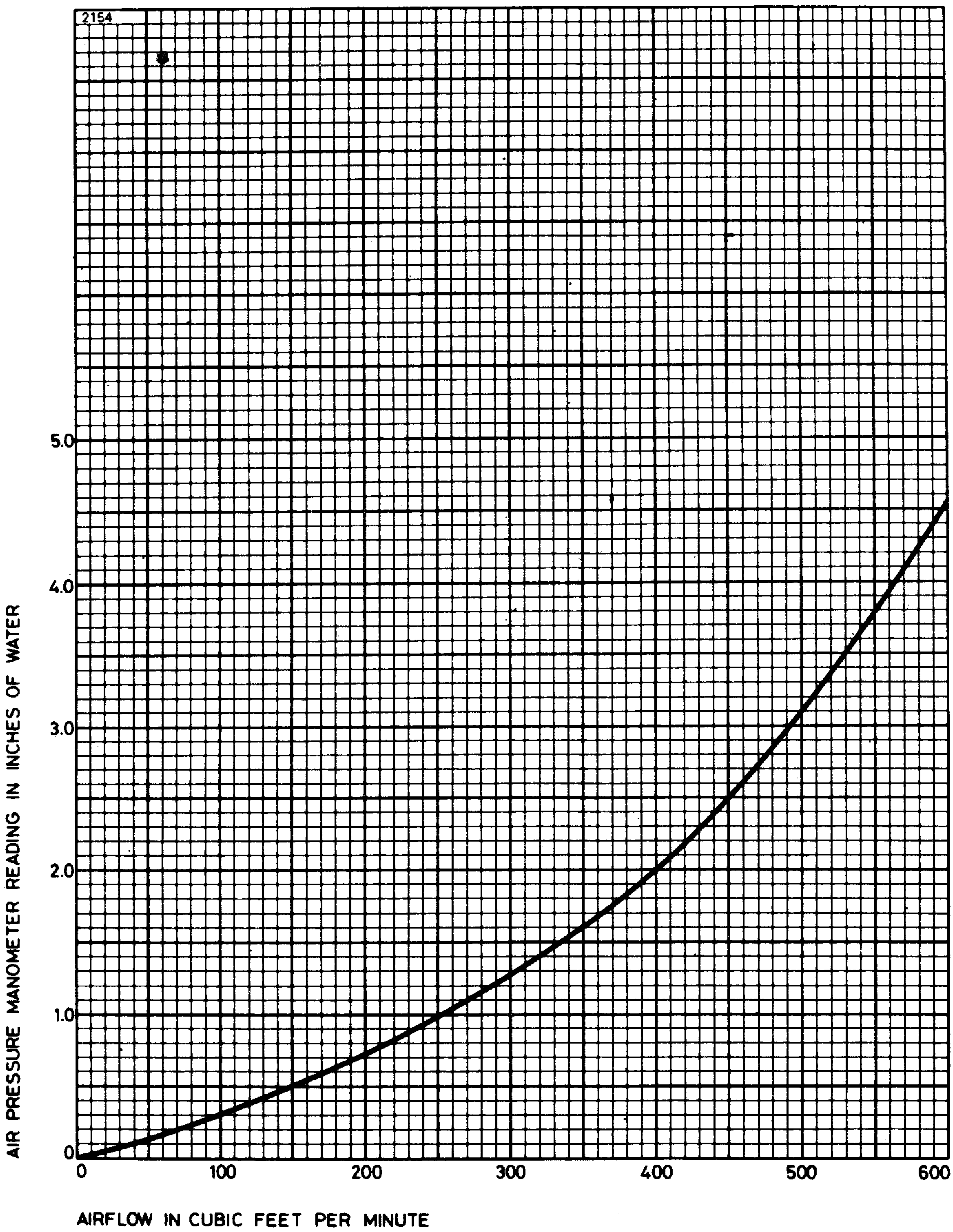
TYPICAL CONSTANT CURRENT CHARACTERISTICS



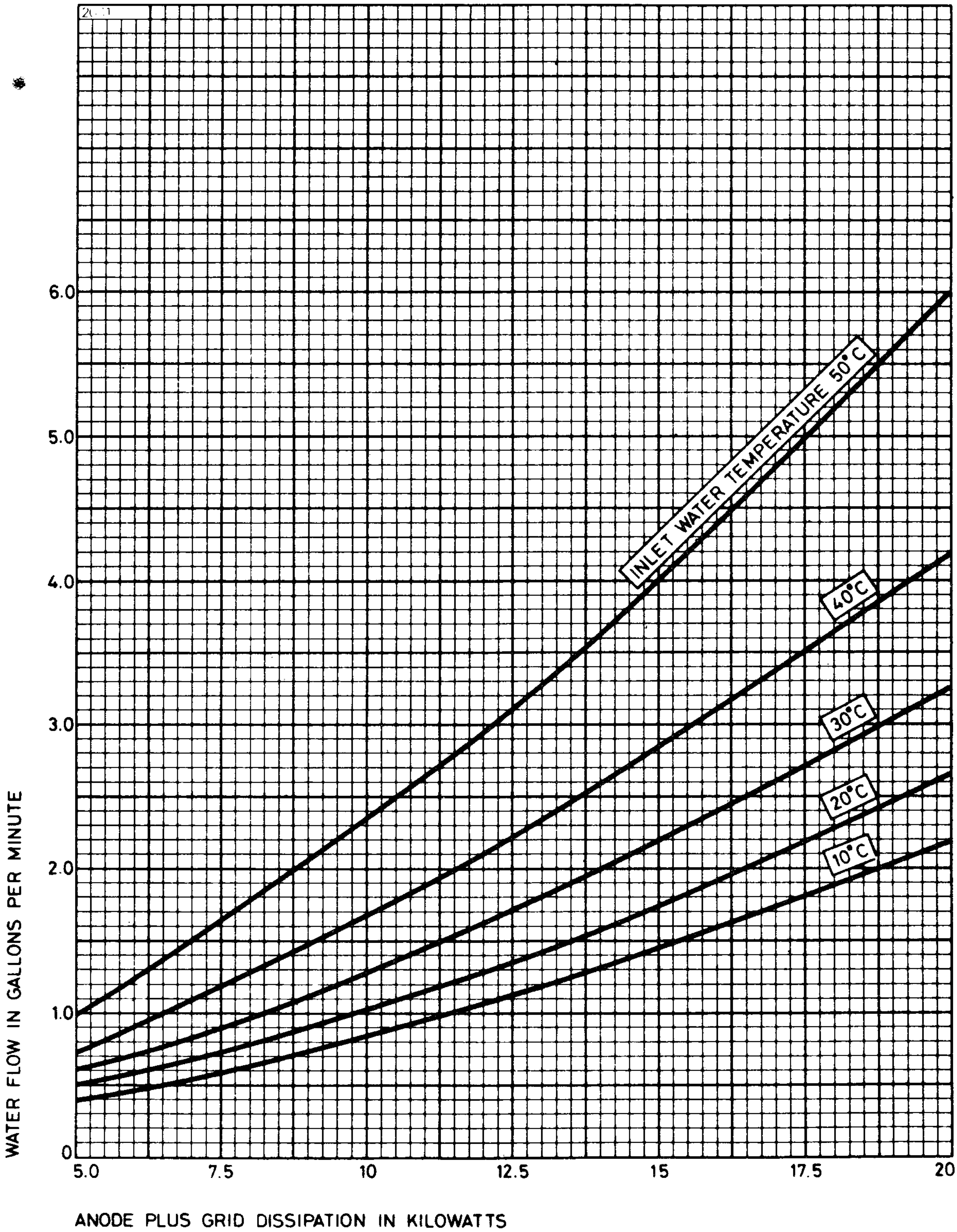
AIR COOLING REQUIREMENTS FOR BR1183



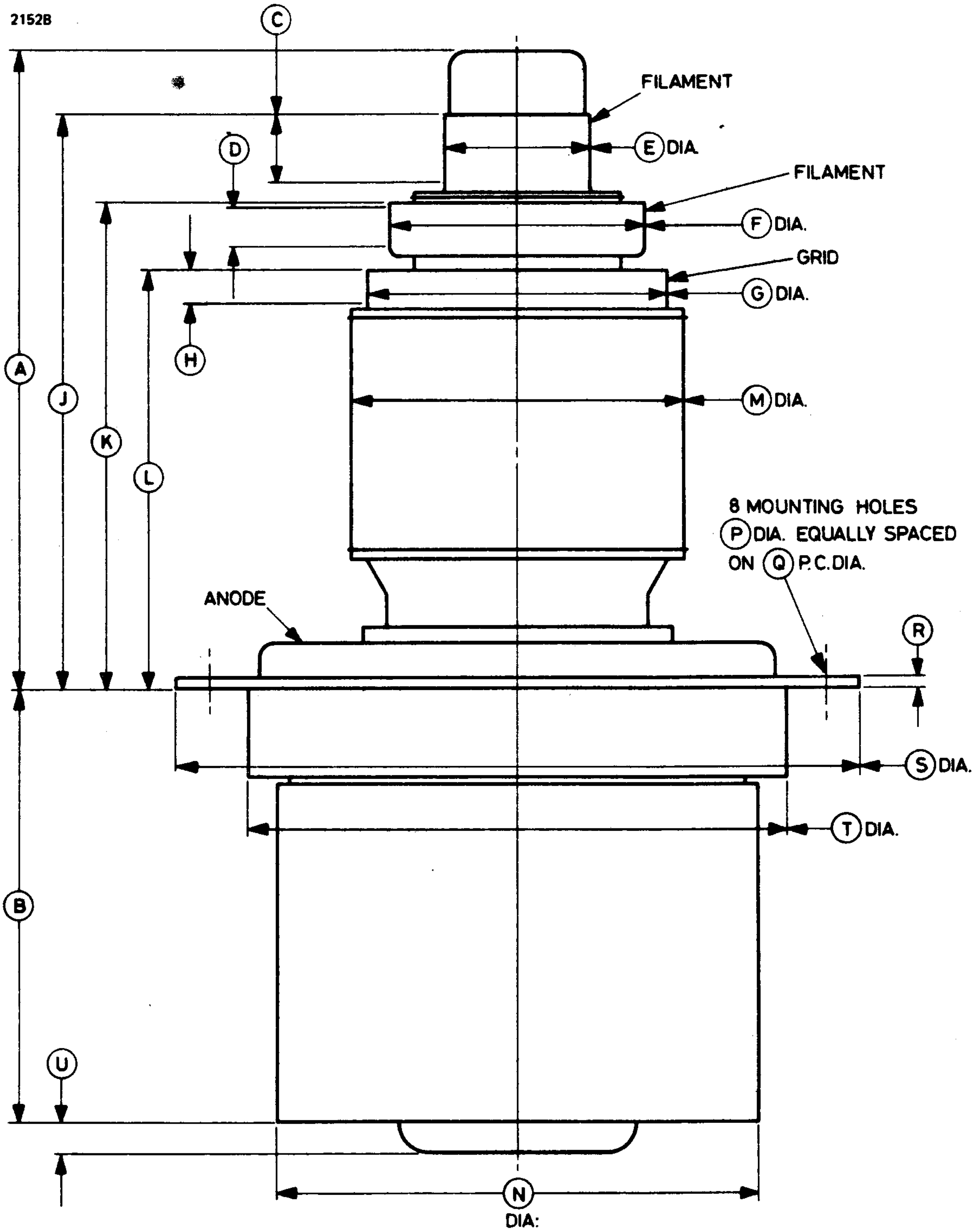
TYPICAL AIR FLOW CHARACTERISTIC FOR BR1183



MINIMUM WATER COOLING REQUIREMENTS FOR BW1183J1



OUTLINE FOR BR1183

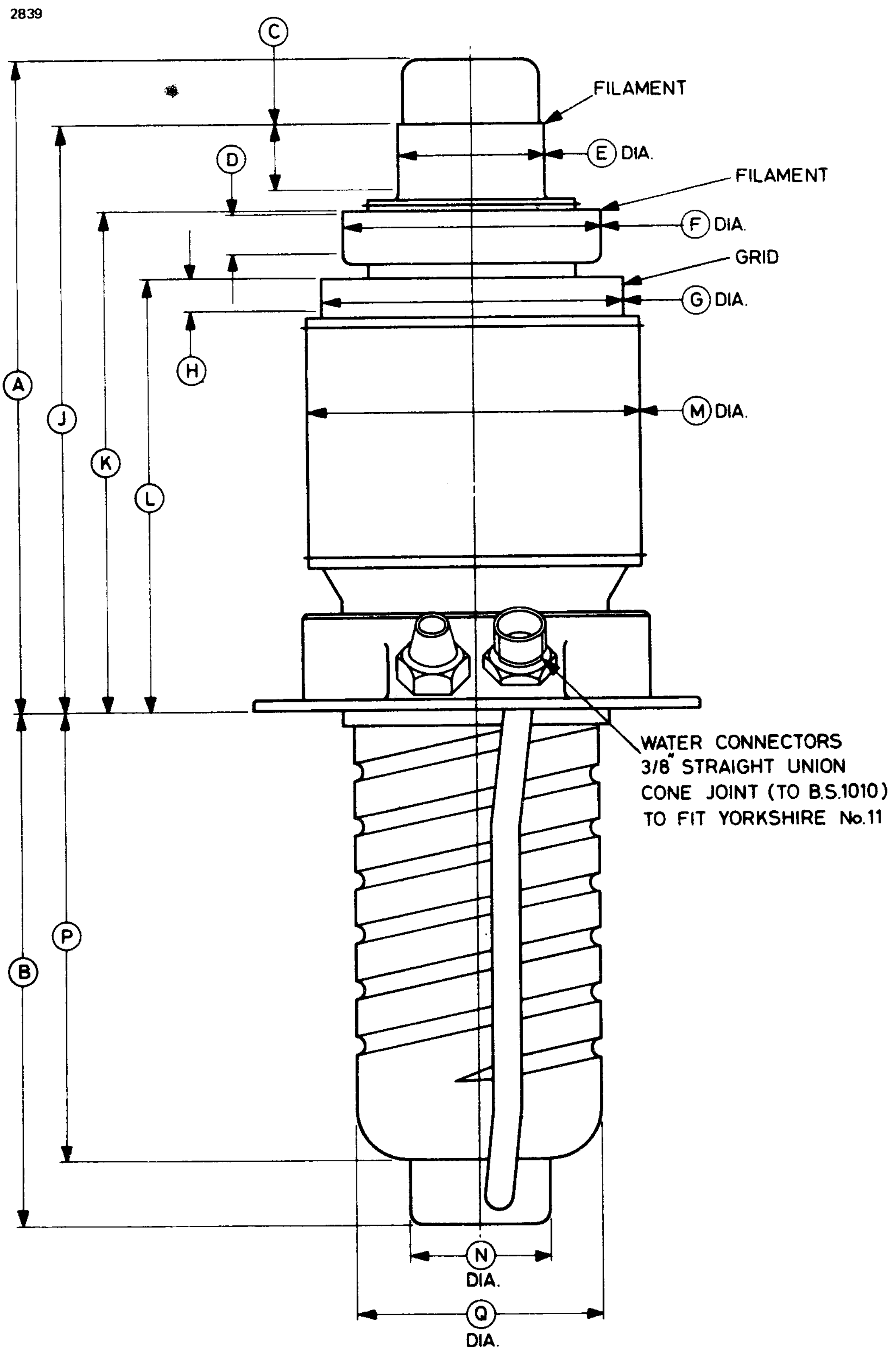


Outline Dimensions for BR1183 (All dimensions without limits are nominal)

Ref	Millimetres	Inches
A*	235.0	9.252
B	160.0	6.299
C	25.0	0.984
D	15.0	0.591
E	54.0	2.126
F	96.0	3.780
G	112.0	4.409
H	14.0	0.551
J	212.0	8.347
K	179.0	7.047
L	155.0	6.102
M	124.0	4.882
N	179.5 max	7.067 max
P*	9.53	0.375
Q*	228.6	9.000
R	4.76	0.187
S	254.0 ± 1.5	10.000 ± 0.059
T	200.0 ± 1.5	7.874 ± 0.059
U	11.2	0.441

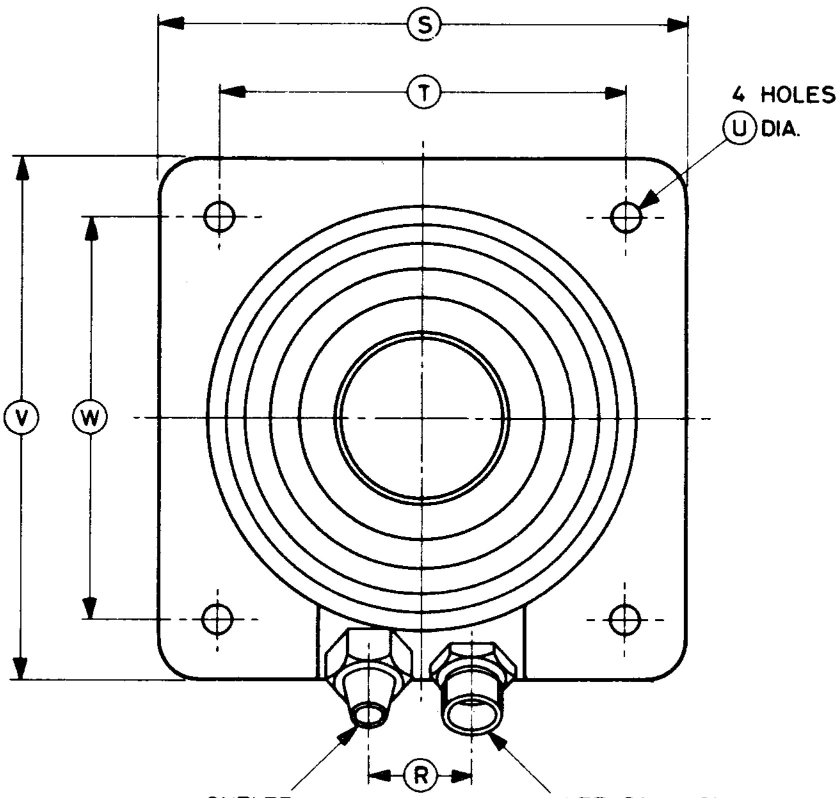
Inch dimensions have been derived from millimetres except where marked *.

OUTLINE FOR BW1183J1 (All dimensions without limits are nominal)



Outline Detail for BW1183J1

2449



Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	240.0 max	9.449 max	M	124.0	4.882
B	191.5 max	7.539 max	N	51.0 ± 1.5	2.008 ± 0.059
C	25.0	0.984	P	166.5	6.555
D	15.0	0.591	Q	90.0 ± 1.5	3.543 ± 0.059
E	54.0	2.126	R	31.75	1.25
F	96.0	3.780	S	165.0 ± 3.0	6.496 ± 0.118
G	112.0	4.409	T	127.0 ± 1.5	5.000 ± 0.059
H	14.0	0.551	U	9.5	0.374
J	216.0	8.504	V	165.0 ± 3.0	6.496 ± 0.118
K	183.0	7.205	W	127.0 ± 1.5	5.000 ± 0.059
L	160.0	6.299			

Inch dimensions have been derived from millimetres.

Note If the valve is mounted filament terminals down, the water flow must be opposite to the direction shown.

BW1190J4

R.F. POWER TRIODE

The data should be read in conjunction with the Power Triode Preamble.

ABRIDGED DATA

Water cooled power triode intended primarily for use as a self-excited oscillator in industrial heating service.

Anode dissipation	3.5	kW max
Anode voltage	6.0	kV max
Frequency for full ratings	20	MHz max
Output power (class C, self-excited oscillator)	9.1	kW

GENERAL

Electrical

Filament	thoriated tungsten	
Filament voltage	20.5	V
Filament current	26	A
Amplification factor (Va = 5.0kV, Ia = 0.8A)	32	
Mutual conductance (Va = 5.0kV, Ia = 0.8A)	15	mA/V
Inter-electrode capacitances:		
grid to anode	35	pF
grid to filament	25	pF
anode to filament	3.5	pF

Mechanical

Overall length (excluding leads)	530mm (20.866 inches) max
Overall diameter (excluding water connections)	106mm (4.173 inches) max
Net weight	3.75kg (8.25 pounds) approx
Mounting position	vertical with filament leads down
Mounting clamp	MA330

COOLING

The water cooling requirements for BW1190J4 as a function of anode dissipation at various water inlet temperatures are shown on page 6.

R.F. POWER AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Absolute values)

Anode voltage	6.0	kV max
Anode dissipation	3.5	kW max
Grid current*(at maximum anode dissipation)	400	mA max
Cathode current	2.8	A max
Frequency for above ratings	20	MHz max

TYPICAL OPERATING CONDITIONS

Class C Unmodulated Amplifier

Frequency	3.0	MHz
Anode voltage	6.0	kV
Grid voltage	−550	V
Peak r.f. grid drive voltage	1100	V
Anode current	2.33	A
Grid current	350	mA
Anode dissipation	3.5	kW
Output power	10.5	kW
Efficiency	75	%

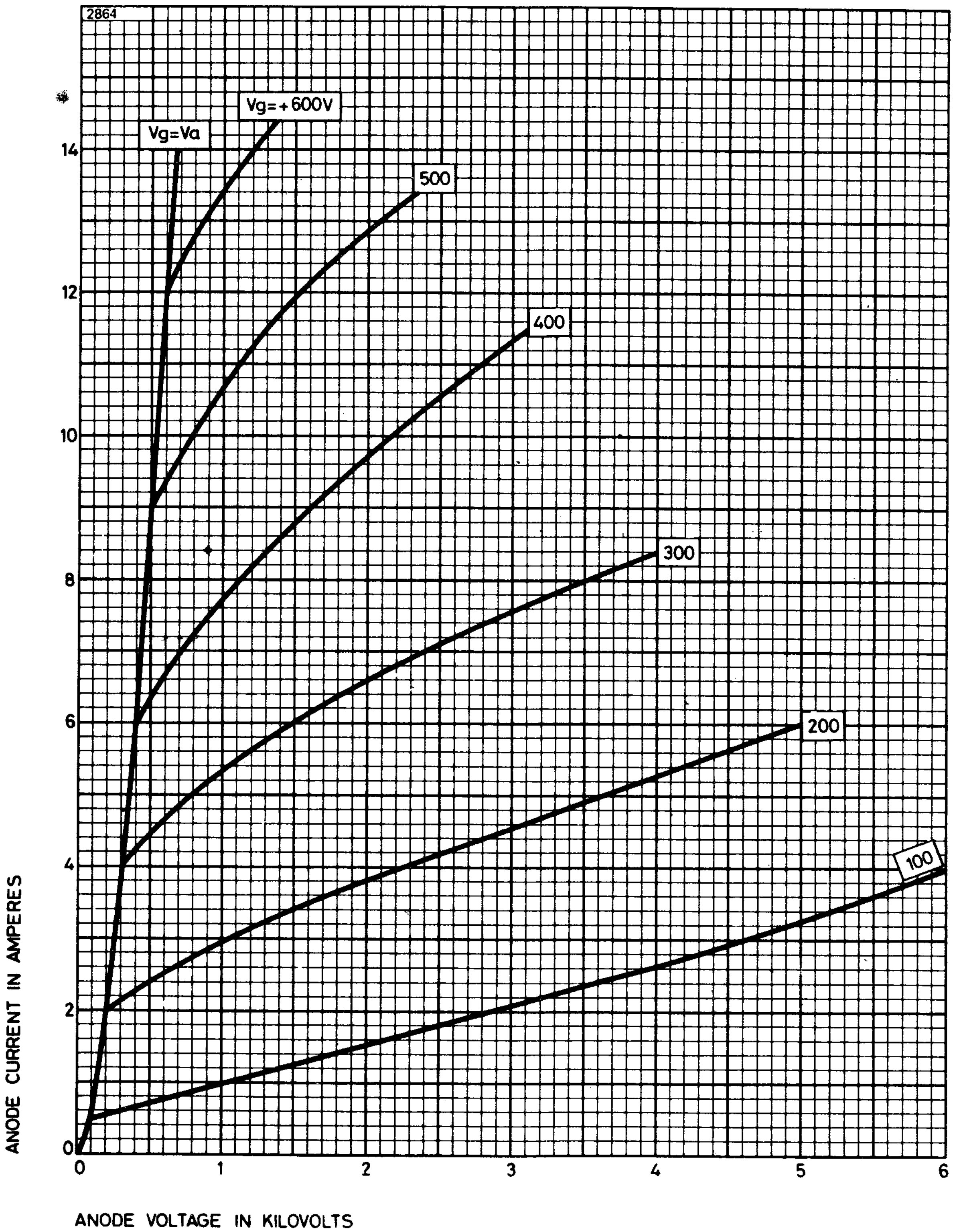
Class C Self-Excited Oscillator, Dielectric Heater Service

Frequency	20	MHz
Anode voltage (non-regulated supply)	6.0	kV
Grid voltage	−550	V
from grid-filament resistor	2.2	kΩ
Peak r.f. grid drive voltage	950	V
Anode current	1.5	A
Grid current	250	mA
Anode dissipation	2.7	kW
Output power	6.3	kW
Efficiency	70	%

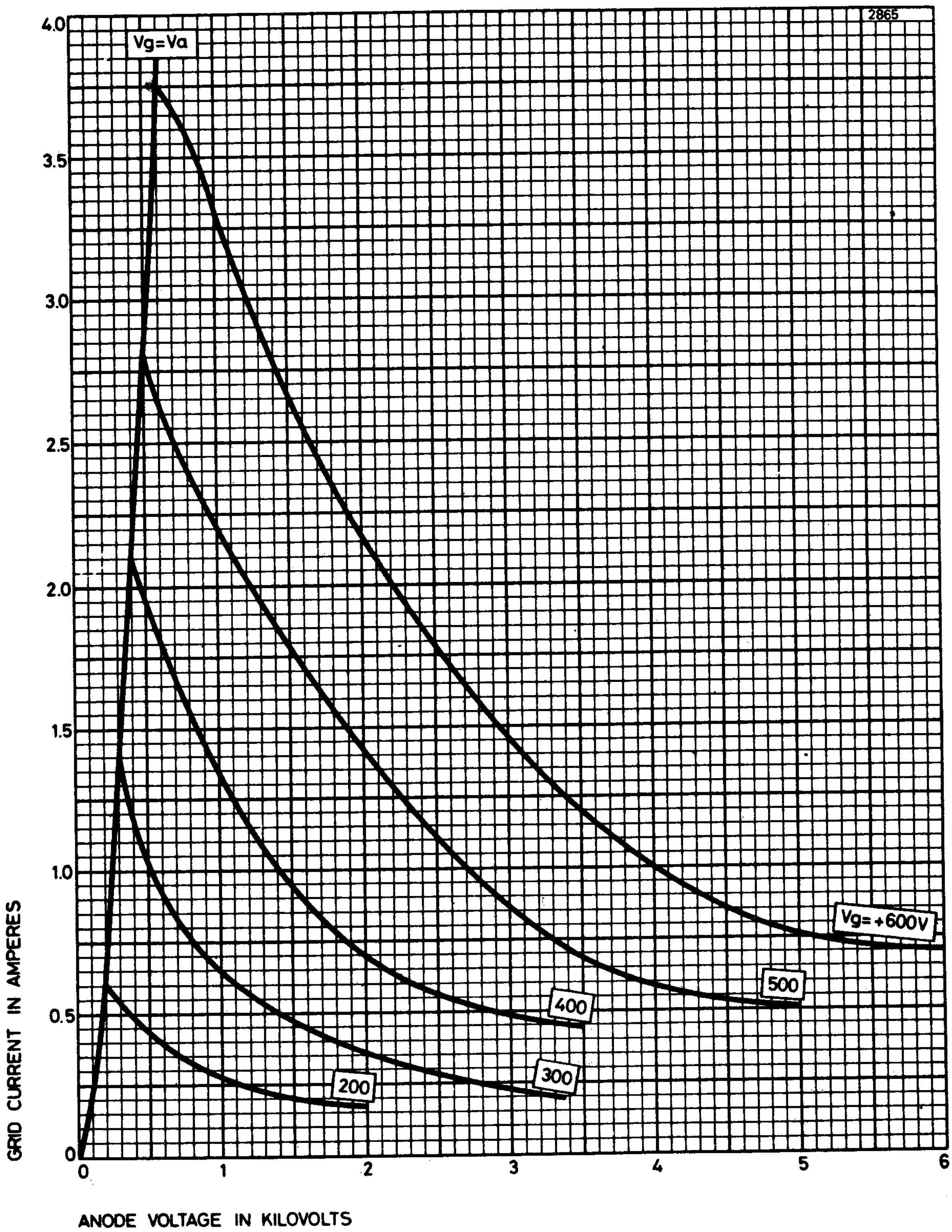
Class C Self-Excited Oscillator, Induction Heater Service (Repetition work with a short duty cycle)

Frequency	450	kHz
Anode voltage (non-regulated supply)	6.0	kV
Grid voltage	−545	V
from grid-filament resistor	1.7	kΩ
Peak r.f. grid drive voltage	1000	V
Anode current	2.0	A
Grid current	320	mA
Anode dissipation	2.9	kW
Output power	9.1	kW
Efficiency	76	%

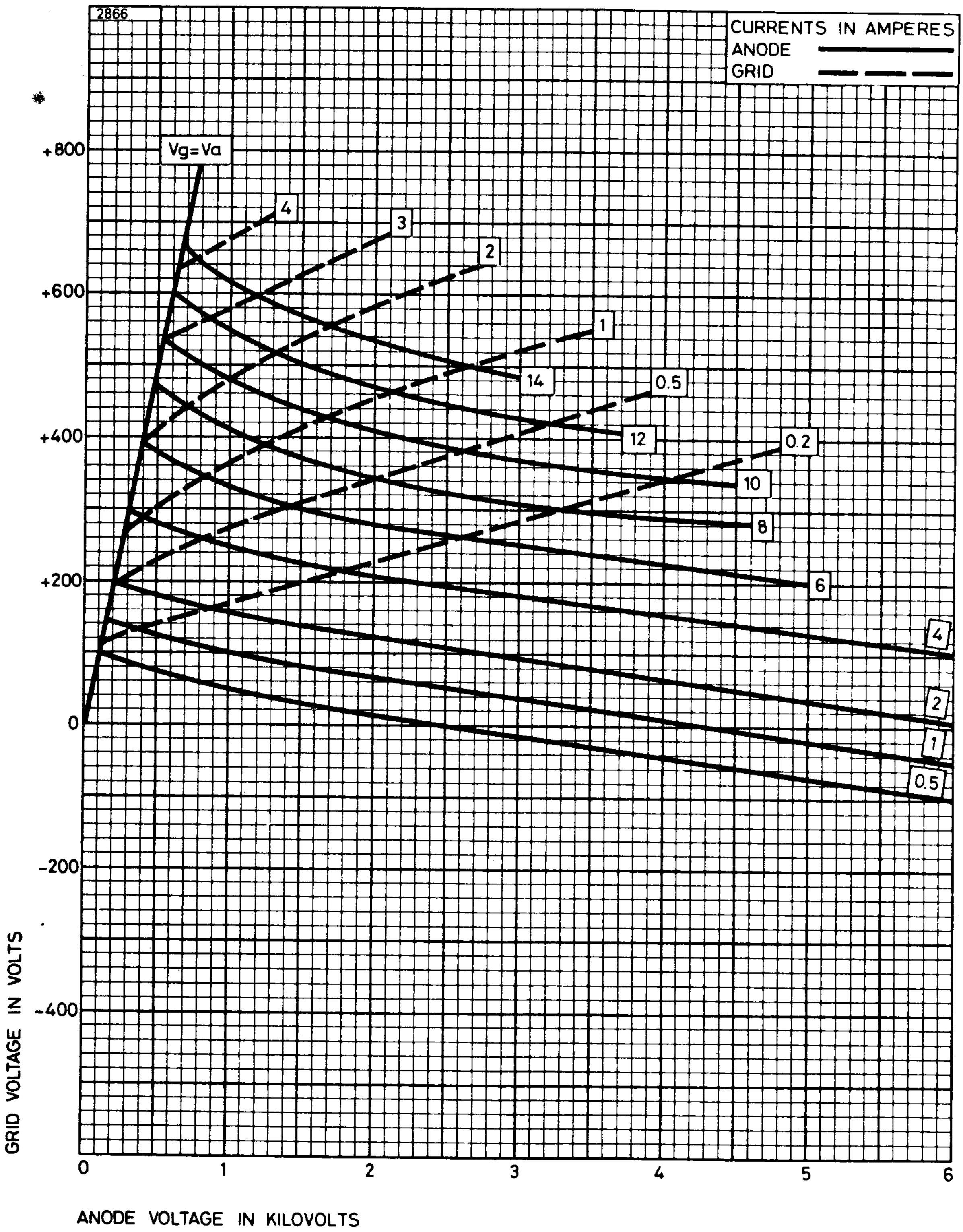
TYPICAL ANODE CHARACTERISTICS



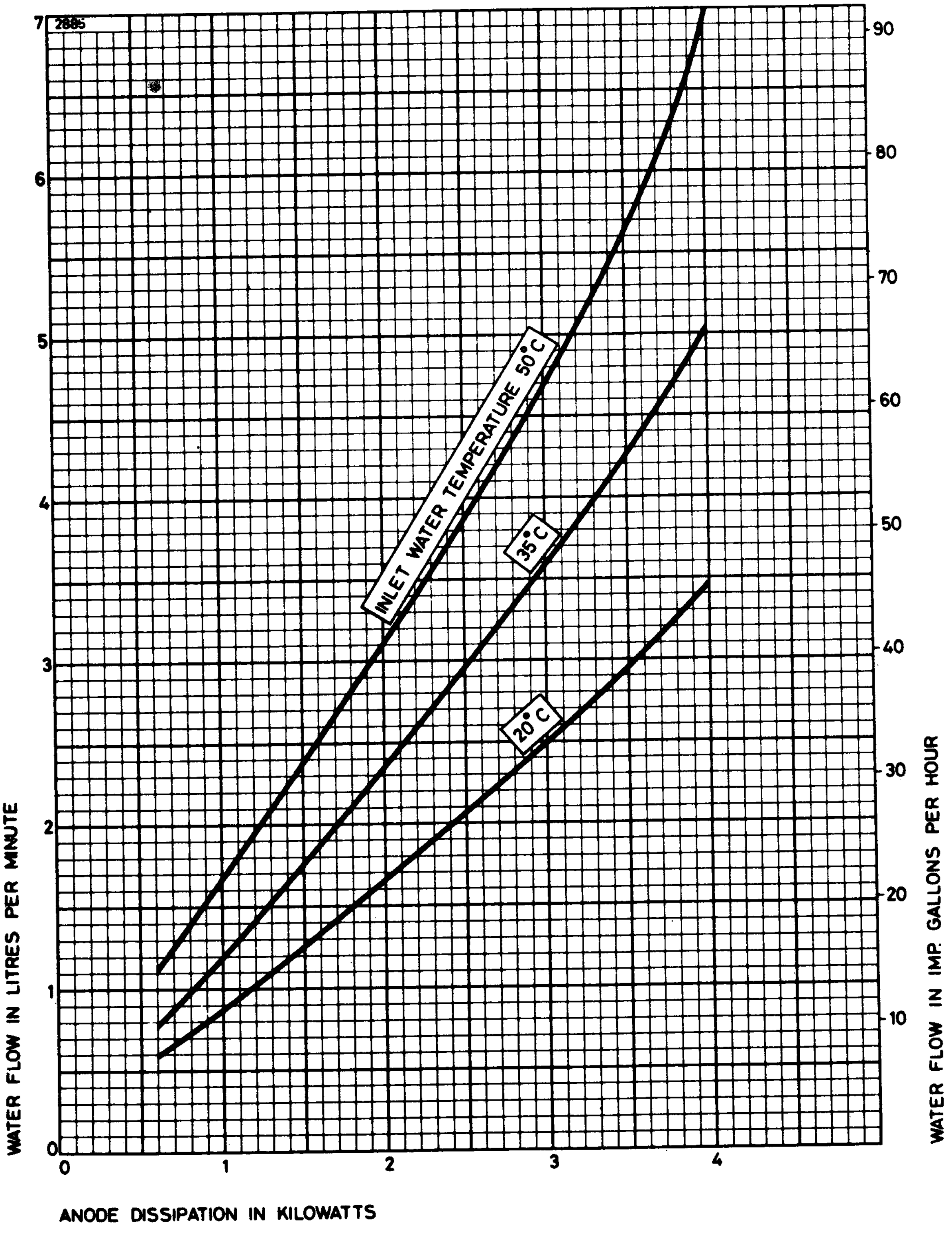
TYPICAL GRID CHARACTERISTICS



TYPICAL CONSTANT CURRENT CHARACTERISTICS

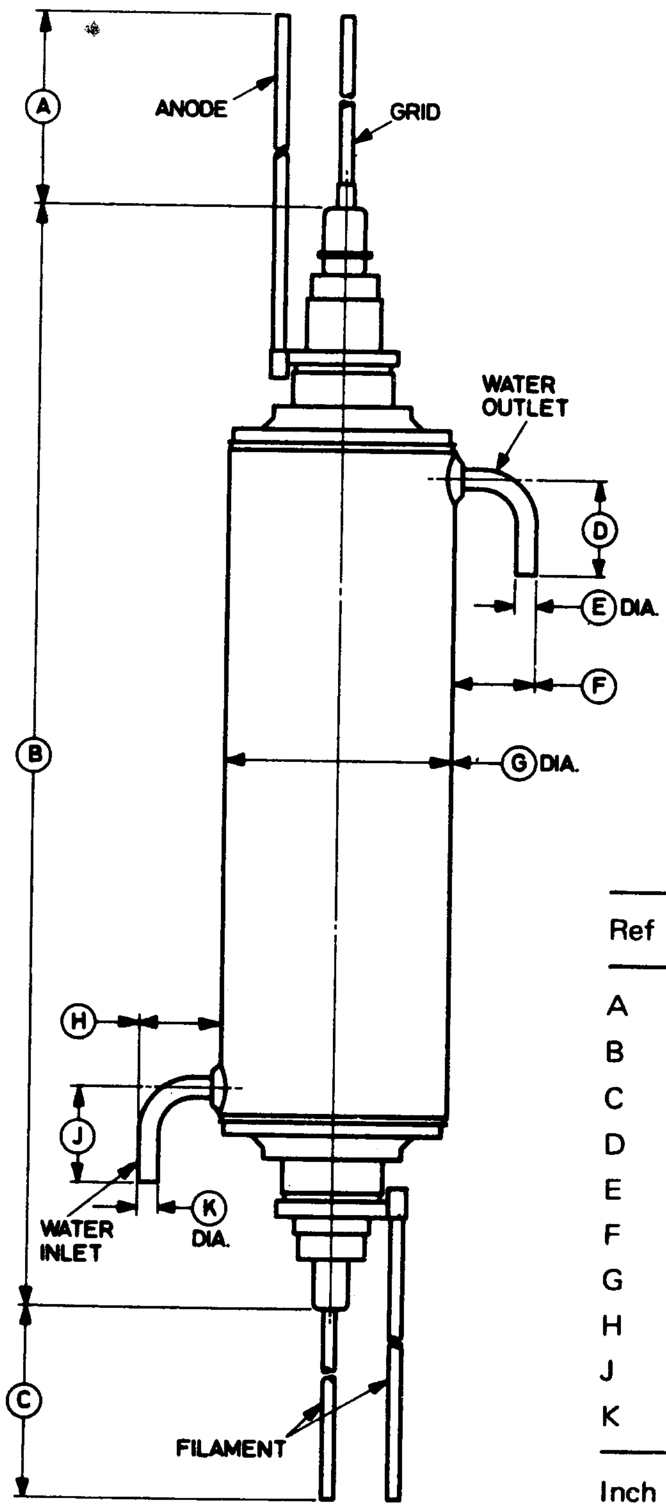


WATER COOLING REQUIREMENTS



OUTLINE (All dimensions without limits are nominal)

2842



Ref	Millimetres	Inches
A	250.0	9.843
B	530.0 max	20.866 max
C	250.0	9.843
D	50.0 max	1.969 max
E	10.25	0.404
F	40.0 max	1.575 max
G	106.0	4.173
H	40.0 max	1.575 max
J	50.0 max	1.969 max
K	10.25	0.404

Inch dimensions have been derived from millimetres.

Filament, grid and anode leads 162/0076 stranded wire.

Power Triode Accessories

TABULATED DATA

POWER TRIODE ACCESSORIES

MA SERIES OF ACCESSORIES

Type	Description
MA66	Grid connector for 4.703 inches diameter terminal
MA66A	Grid connector for 3.750 inches diameter terminal
MA66B	Grid connector for 8.086 inches diameter terminal
MA85C	Thermal fuse; large head, 177°C fusing temperature
MA85D	Thermal fuse; small head, 177°C fusing temperature
MA85E	Thermal fuse; small head, 103°C fusing temperature
MA130 MA130A	Left and right hand filament lead assembly for 0.875 inch terminal
MA131 MA131A	Left and right hand filament lead assembly for 0.625 inch terminal
MA135	Filament lead assembly, 17$^3/_8$ inches long, for 0.437 inch terminal
MA135A	Filament lead assembly, 6 inches long, for 0.437 inch terminal
MA135B	Filament lead assembly, 12 inches long, for 0.437 inch terminal
MA146A	Filament clamp connector for BR/BW1162,65 series, centre tap connector for BR/BW1165 series
MA146B	Filament centre-tap terminal clamp for BR/BW1162 series
MA147A	Grid terminal connector, for use above 30MHz, for BR/BW1162, BR/BW1165 series
MA148A	Grid terminal connector, for use below 30MHz, for BR/BW1162, BR/BW1165 series
MA149A	Insulating pedestal for BR1162, BR1165
MA150A	Expansion coil assembly for BY4031
MA150B	Expansion coil assembly for BY4037, BY4038
MA202	Sealing ring, rectangular section, for BW1162/65 series

Type	Description
MA208	Grid terminal connector for BR/BW1181J3
MA208A	* Outer filament terminal connector for BR/BW1181J3
MA208B	Inner filament terminal connector for BR/BW1181J3
MA239	Complete water pipe assembly for BY4060
MA243	Sealing ring, round section, for BW1156; B.S. no. 446
MA245	Sealing ring, round section, for BY1161; B.S. no. 445
MA246	Sealing ring, rectangular section, for BY1102 etc.
MA248	Sealing ring, triangular section, for BW140
MA249	Sealing ring, rectangular section, for BW153 etc.
MA250	Sealing ring, round section, for BW1121J; B.S. no. 346
MA251	Sealing ring, round section, for BW1121
MA252	Sealing ring, rectangular section, for BW179 etc.
MA253	Sealing ring, round section, for BY1122 etc. B.S. no. 349
MA254	Sealing ring, round section, for BW189 etc. B.S. no 431
MA255	Sealing ring, round section, for BY189A etc. B.S. no. 441
MA256	Sealing ring, round section, for BW1124J1,J2
MA260	Sealing ring, round section, for BY1144, BY1144L
MA291C	Smaller filament terminal connector for BR/BW1182/3
MA291D	Larger filament terminal connector for BR/BW1182/3
MA314	Sealing ring, round section, for BW1162/65 series. B.S. no. 122
MA315	Sealing ring, round section, for BW1115, B.S. no. 329
MA319	Left and right hand filament terminals only, for BR1121 etc.
MA323	Pair of water union couplings for BW1121 etc. water jacket
MA324	Pair of water jacket conn. tubes for BW1121 etc. water jacket
MA326	Sealing ring, round section, for BY1121 in BY4063 only. B.S. no. 435
MA328	Filament connectors only (MA135), one pair
MA329	Filament connectors only (MA130), one pair

4000 SERIES OF ACCESSORIES

Type	Description	Valve	Sealing Ring
BR4044	Air ducting	BR194	–
BR4045	Air ducting	BR1121	–
BR4080	Air ducting	BR1124	–
BW4027	Water jacket	BW194	MA254
BW4028	Water jacket	BW161, BW1102	MA251
BW4029	Water jacket	BW179, BW1124	MA252
BW4034	Water jacket	BW1121	MA251
BW4035	Water jacket	BW1144, BW1156	MA243
BW4050	Water jacket	BW189, BW1143	MA254
BW4070	Water jacket	BW1122	MA252
BW4088A	Water jacket	BW1162, BW1165	MA314
BW4123	Water jacket	BW1115, BW1126	MA315
BY4030	Double boiler condenser unit	BY1102	MA246
BY4031	Single boiler condenser unit	BY1102	MA246
BY4032	Double boiler condenser unit	BY1121	MA246
BY4033	Single boiler condenser unit	BY1121	MA246

Type	Description	Valve	Sealing Ring
BY4036	* Single boiler condenser unit	BY1144	MA260
BY4037A	Single boiler unit	BY189A, BY1143	MA255
BY4038	Single boiler condenser unit	BY189A, BY1143	MA255
BY4038A	Double boiler condenser unit	BY189A, BY1143	MA255
BY4039	Single boiler condenser unit	BY194	MA255
BY4048A	Single boiler unit	BY1124	MA253
BY4049	Single boiler unit	BY194	MA255
BY4059	Single boiler unit	BY1161	MA245
BY4060	Single boiler unit	BY1144	MA260
BY4063	Single boiler unit	BY1121	MA326
BY4064	Single boiler condenser unit	BY1122	MA253
BY4093	Single boiler condenser unit	BY1161	MA245

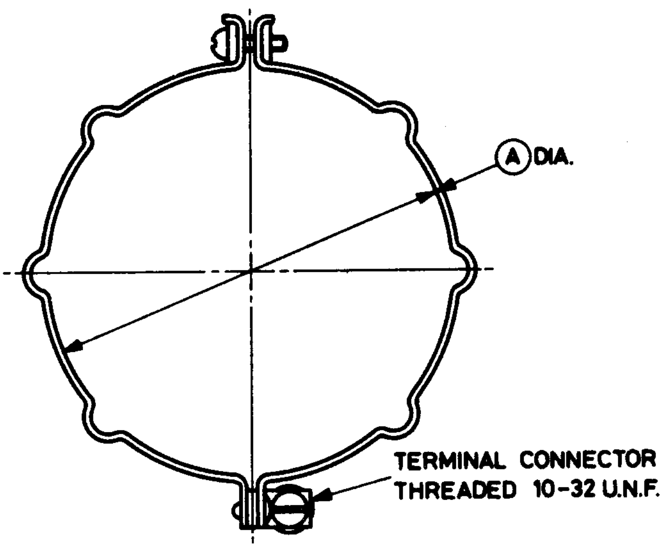
MA SERIES
of ACCESSORIES

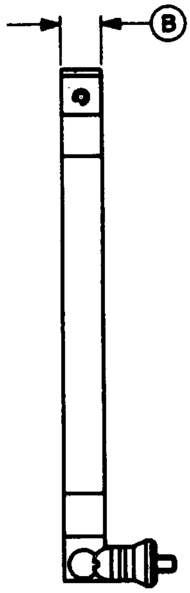
MA66, MA66A and MA66B

Grid connectors for use on power triodes with terminal diameters as listed below.

Type	Grid Terminal Diameter
MA66	4.703 inches (119.5mm)
MA66A	3.750 inches (95.25mm)
MA66B	8.086 inches (205.4mm)

3040



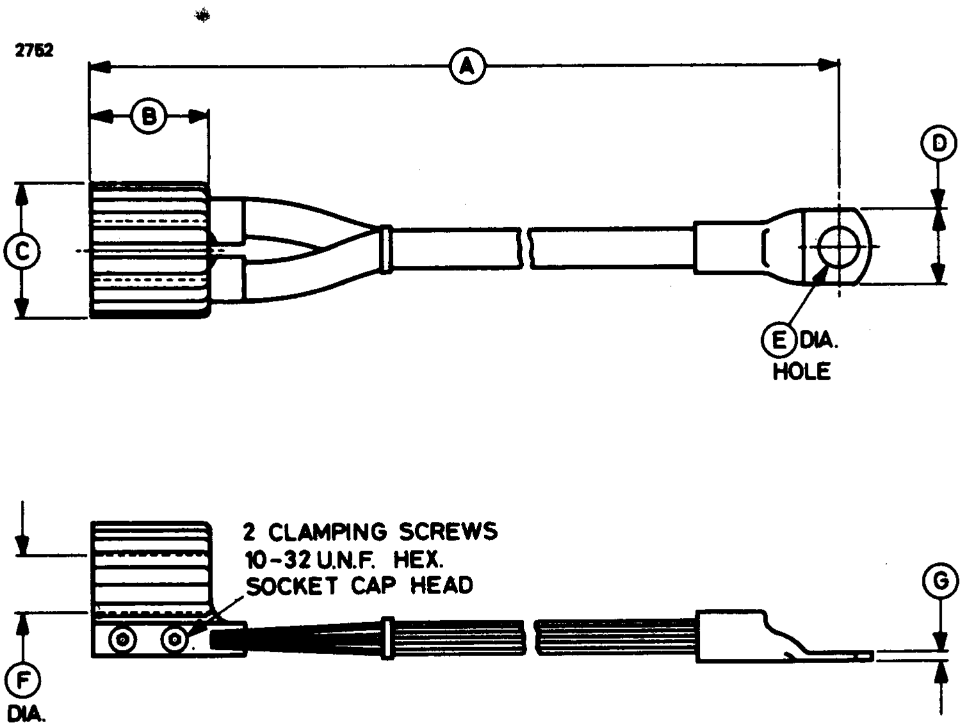


	Reference A		Reference B	
Type	Inches	Millimetres	Inches	Millimetres
MA66	4.703	119.5	0.375 $\pm$ 0.020	9.53 $\pm$ 0.51
MA66A	3.750	95.25	0.375 $\pm$ 0.020	9.53 $\pm$ 0.51
MA66B	8.086	205.4	0.375 $\pm$ 0.020	9.53 $\pm$ 0.51

Millimetre dimensions have been derived from inches.

MA130 and MA130A

MA130 and MA130A are left and right hand filament lead assemblies for use on power triodes with 0.875 inch (22.23mm) diameter filament terminals.

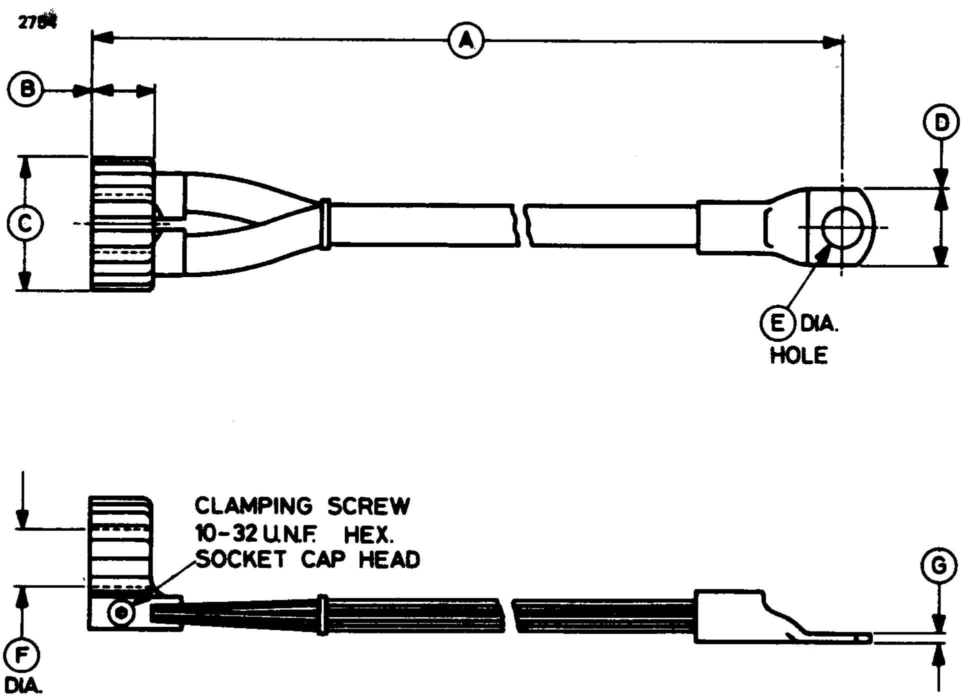


Ref	Inches	Millimetres
A	24	610
B	1.750	44.45
C	2.000	50.80
D*	1.181	30.00
E*	0.512	13.00
F	0.875 $^{+0.002}_{-0.000}$	22.225 $^{+0.051}_{-0.000}$
G*	0.118	3.00

Millimetre dimensions have been derived from inches except where marked *.

MA131 and MA131A

MA131 and MA131A are left and right hand filament lead assemblies for use on power triodes with 0.625 inch (15.88mm) diameter filament terminals.

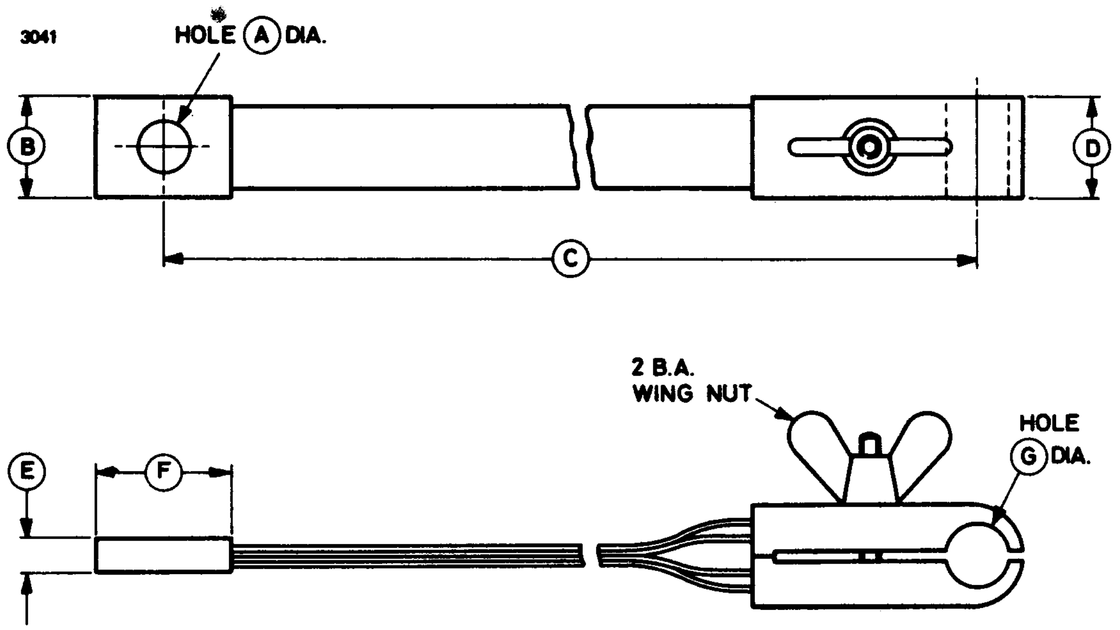


Ref	Millimetres	Inches
A*	610	24.000
B	25.00	0.984
C	52.00	2.047
D	30.00	1.181
E	13.00	0.512
F*	$15.875^{+0.051}_{-0.000}$	$0.625^{+0.002}_{-0.000}$
G	3.00	0.118

Inch dimensions have been derived from millimetres except where marked *

MA135

MA135 is a filament lead assembly for use on power triodes with 0.437 inch (11.10mm) diameter filament terminals.



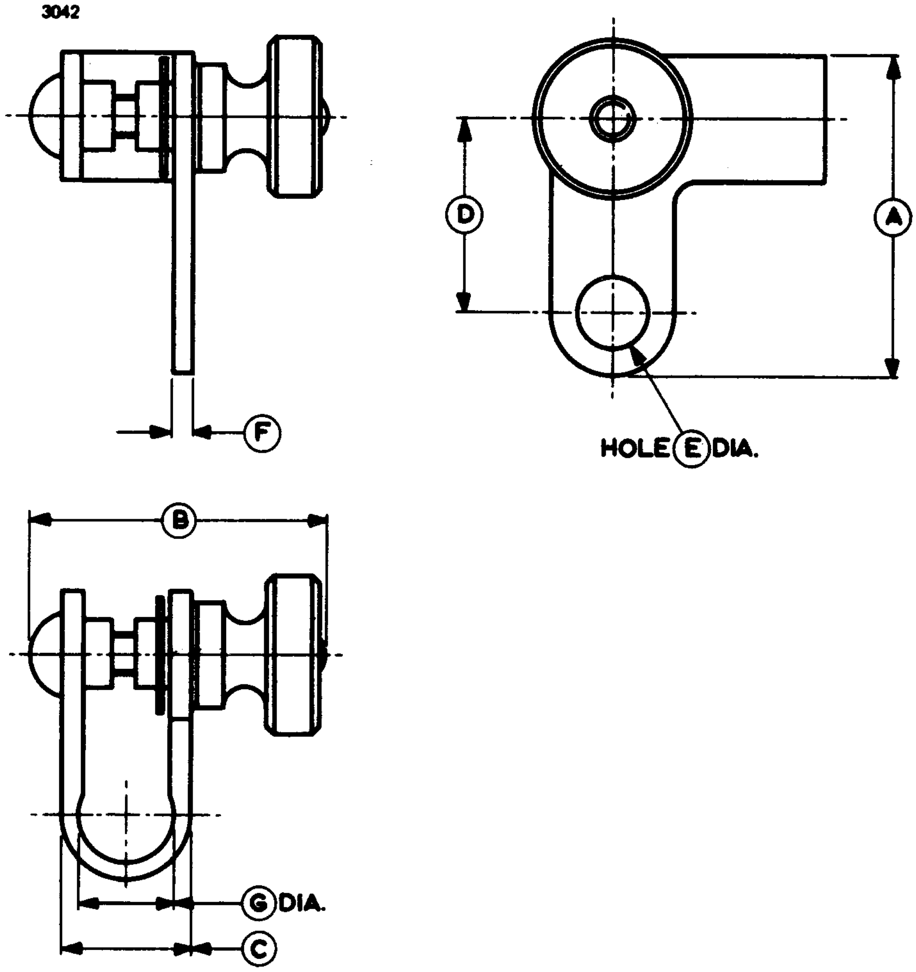
Ref	Inches	Millimetres
A	0.386	9.80
B	0.750	19.05
C*	18.00	457
D	0.750	19.05
E	0.250	6.35
F	1.000	25.40
G	0.437	11.10
H	2.000	50.80

Millimetre dimensions have been derived from inches.

* Also available as MA135A with dimension C 6 inches (152mm) and MA135B with dimension C 12 inches (305mm).

MA146A and MA146B

MA146A is a filament clamp connector for the BR/BW1162 and BR/BW1165 series; it is also used as a heat dissipating connector for the filament centre-tap terminal of BR/BW1165 tubes. MA146B is used on the filament centre-tap terminal of BR/BW1162 tubes.

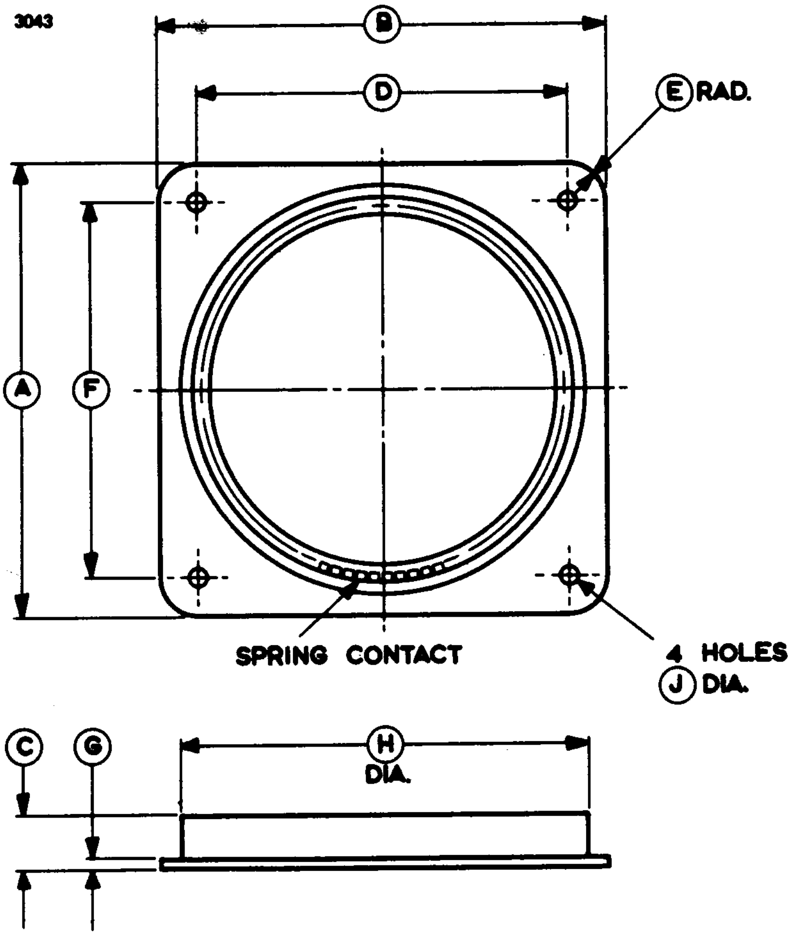


	MA146A		MA146B	
Ref	Millimetres	Inches	Millimetres	Inches
A	30.0 ± 1.0	1.181 ± 0.039	30.0 ± 1.0	1.181 ± 0.039
B	30.0 ± 1.0	1.181 ± 0.039	30.0 ± 1.0	1.181 ± 0.039
C	12.3 ± 0.5	0.484 ± 0.020	13.7 ± 0.5	0.539 ± 0.020
D	18.0 ± 1.0	0.709 ± 0.039	18.0 ± 1.0	0.709 ± 0.039
E	6.5 ± 0.2	0.256 ± 0.008	6.5 ± 0.2	0.256 ± 0.008
F	2.0 ± 0.2	0.080 ± 0.008	2.0 ± 0.2	0.080 ± 0.008
G	9.0 ± 0.2	0.354 ± 0.008	10.5 ± 0.2	0.413 ± 0.008

Inch dimensions have been derived from millimetres.

MA147A

MA147A is a grid terminal connector designed for use with the BR/BW1162 and BR/BW1165 series. It is suitable for use at frequencies above 30MHz.

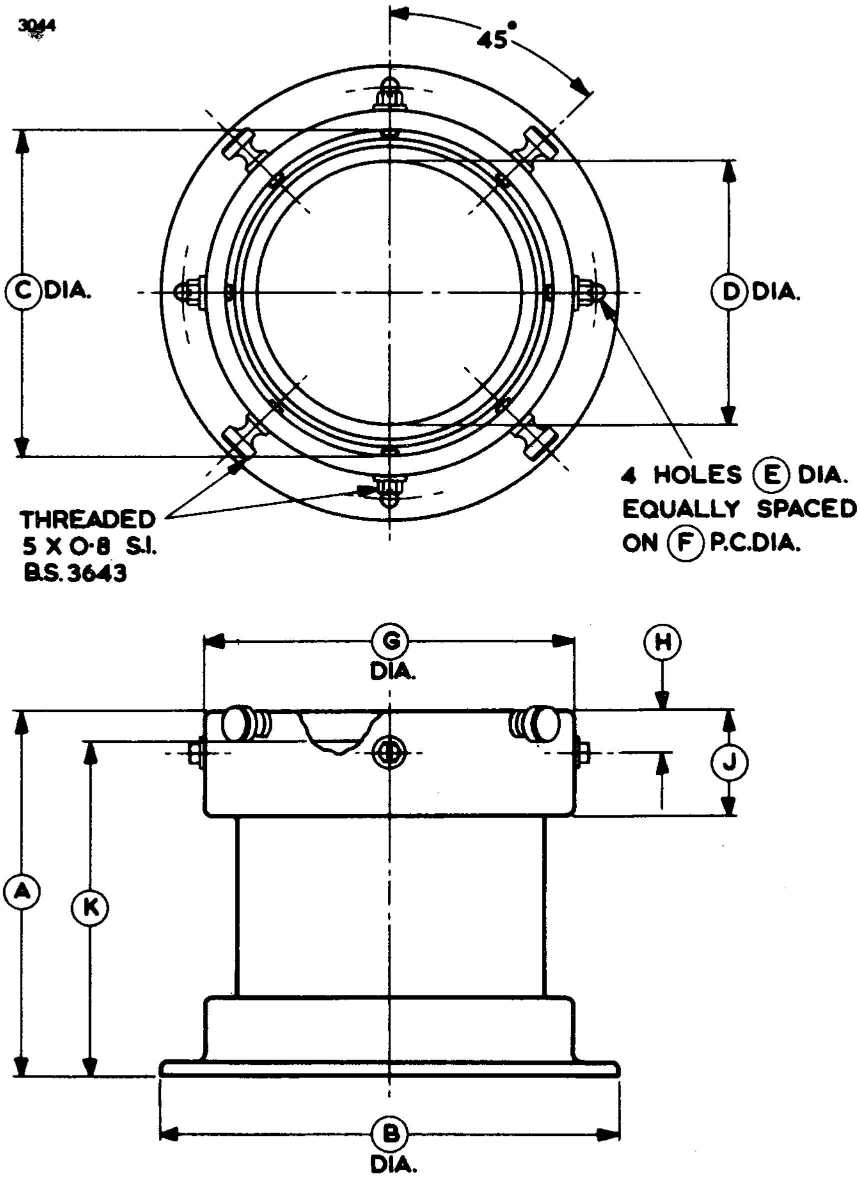


Ref	Millimetres	Inches
A	85.0 ± 0.5	3.346 ± 0.020
B	85.0 ± 0.5	3.346 ± 0.020
C	10.0 ± 0.25	0.394 ± 0.010
D	70.0 ± 0.5	2.756 ± 0.020
E	8.0	0.315
F	70.0 ± 0.5	2.756 ± 0.020
G	2.0 ± 0.2	0.080 ± 0.008
H	77.4 ± 0.5	3.047 ± 0.020
J	3.5 ± 0.1	0.138 ± 0.004

Inch dimensions have been derived from millimetres.

MA149A

MA149A is an insulating pedestal designed for use with the forced-air cooled triodes BR1162 and BR1165.

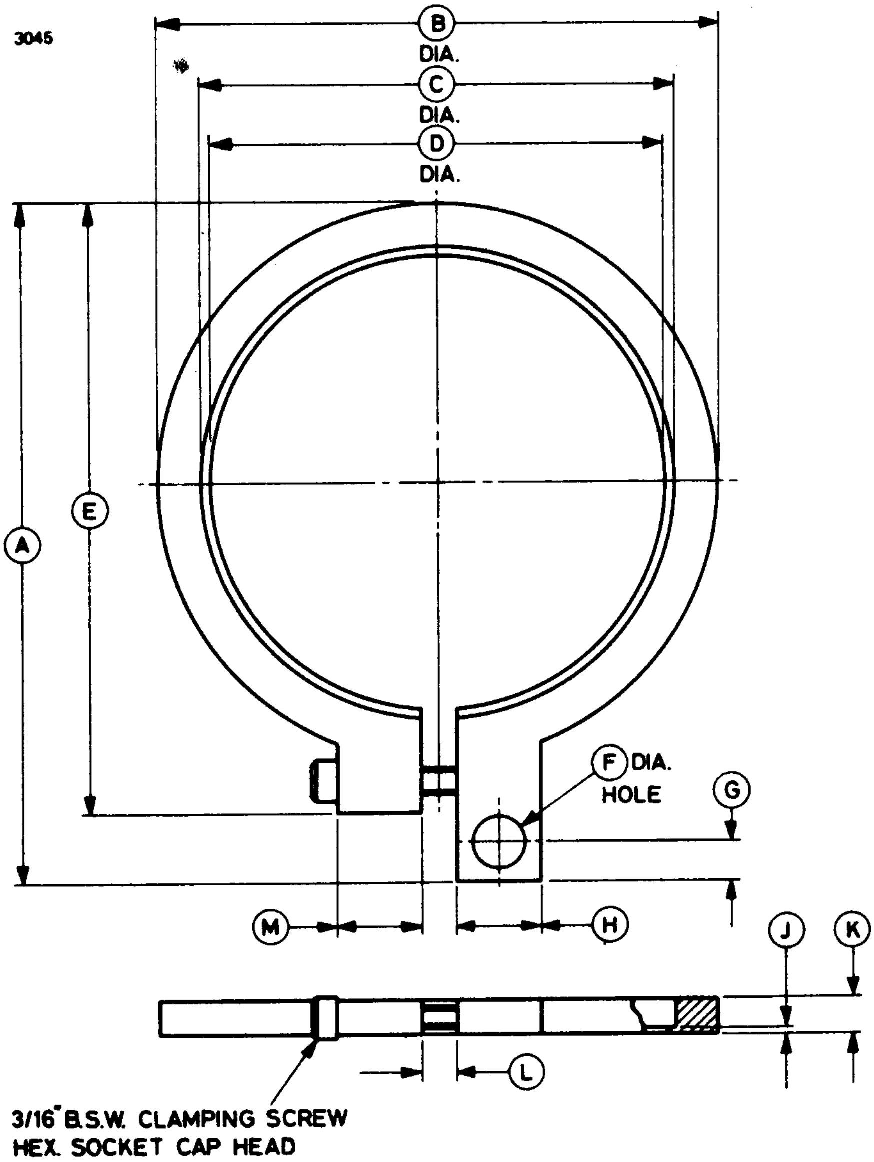


Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	138.0 ± 3.0	5.433 ± 0.118	F	155.0	6.102
B	172.0 max	6.772 max	G	139.0 max	5.472 max
C	123.0	4.843	H	14.5	0.571
D	113.0 max	4.449 max	J	40.0	1.575
E	7.0	0.276	K	128.0	5.039

Inch dimensions have been derived from millimetres.

MA208

MA208 is a grid terminal connector for use on the BR/BW1181 series.

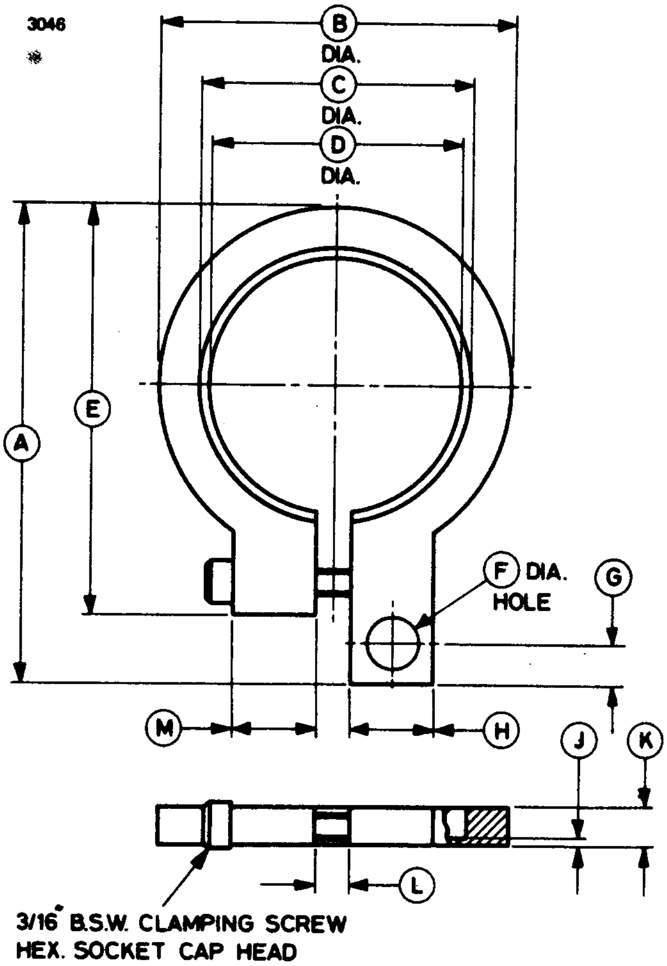


Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	5.000	127.0	G	0.313	7.95
B	4.125	104.8	H	0.625	15.88
C	3.500 ± 0.002	88.900 ± 0.051	J	0.062	1.57
D	3.375	85.73	K	0.276	7.01
E	4.500	114.3	L	0.250	6.35
F	0.374	9.50	M	0.625	15.88

Millimetre dimensions have been derived from inches except dimension F.

MA208A and MA208B

MA208A and MA208B are connectors designed for use on the large and small filament terminals respectively of the BR/BW1181 series.

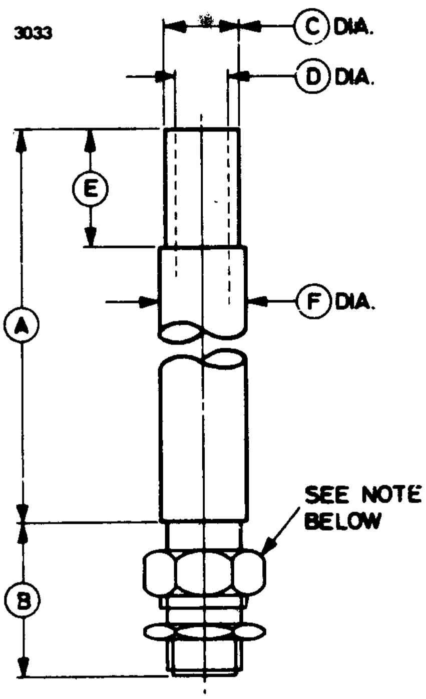


	MA208A		MA208B	
Ref.	Inches	Millimetres	Inches	Millimetres
A	3.500	88.90	2.750	69.85
B	2.625	66.68	1.875	47.63
C	2.000 ± 0.002	50.800 ± 0.051	1.250 ± 0.002	31.750 ± 0.051
D	1.875	47.63	1.125	28.58
E	3.000	76.20	2.250	57.15
F	0.374	9.50	0.374	9.50
G	0.313	7.95	0.313	7.95
H	0.625	15.88	0.625	15.88
J	0.062	1.57	0.062	1.57
K	0.276	7.01	0.276	7.01
L	0.250	6.35	0.250	6.35
M	0.625	15.88	0.625	15.88

Millimetre dimensions have been derived from inches except dimension F.

MA239

MA239 is an inlet water tube designed for use with boiler unit BY4060.



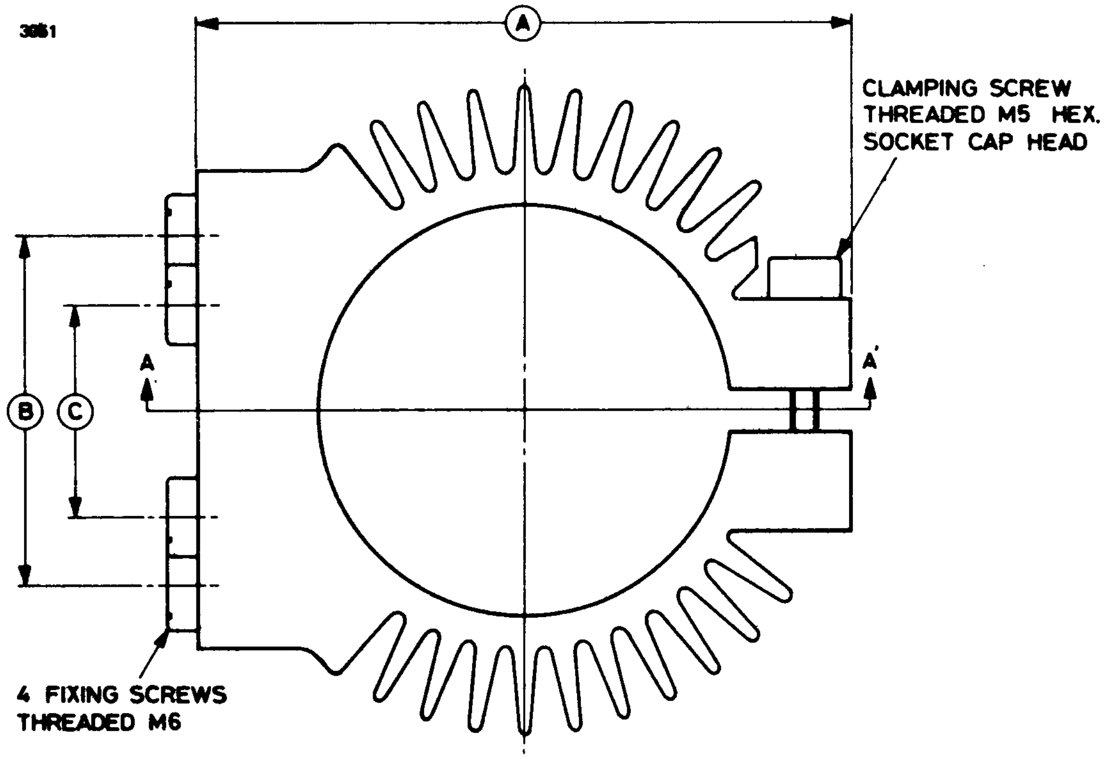
Ref	Inches	Millimetres
A	34.250	870.0
B	2.250	57.15
C	$1.125^{+0.000}_{-0.005}$	$28.58^{+0.00}_{-0.13}$
D	0.750	19.05
E	1.750	44.45
F	1.250	31.75

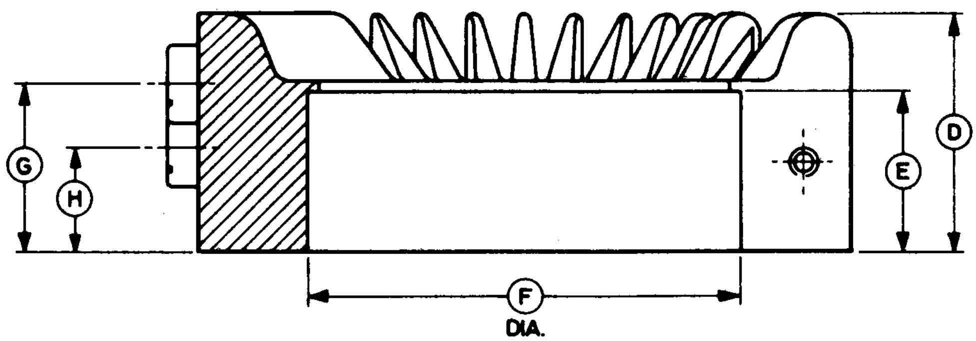
Millimetre dimensions have been derived from inches.

Note Kontite no. 3 1.000 inch coupling, 1.250 inch external diameter, fitting Kontite no. 78 liner, 0.699 inch external diameter fitting.

MA291C

MA291C is a connector designed for use on the smaller filament terminal of the BR/BW1182 and BR/BW1183 series.





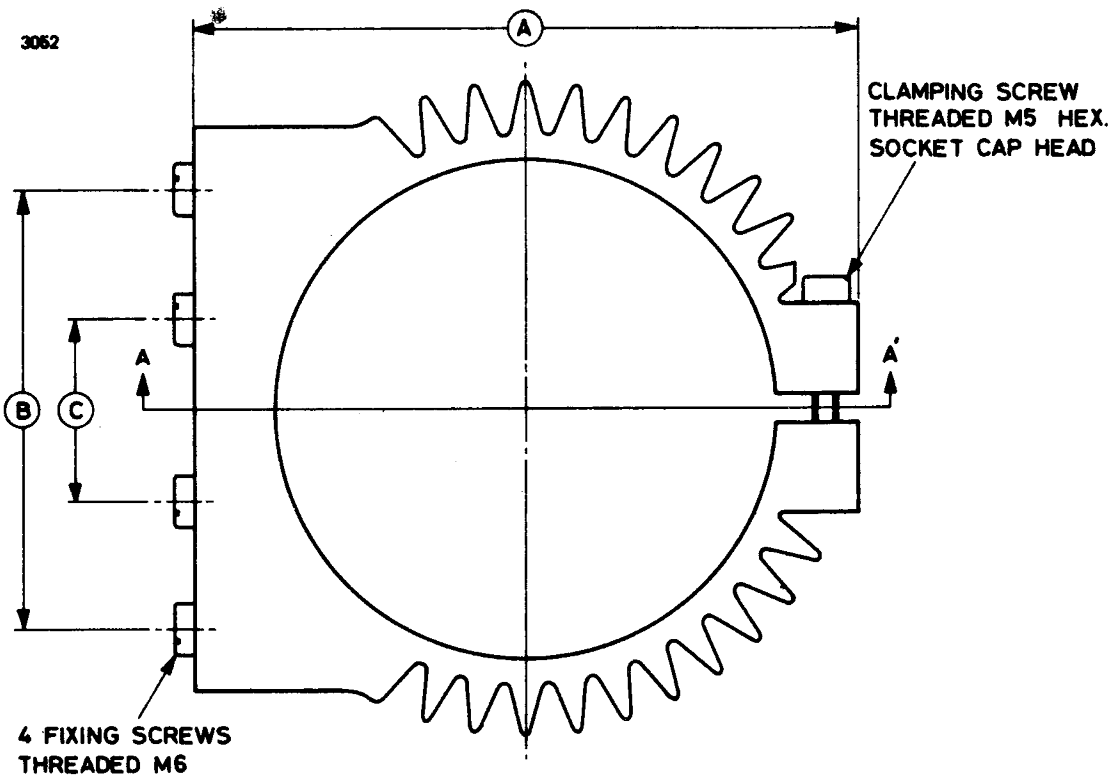
SECTION A—A'

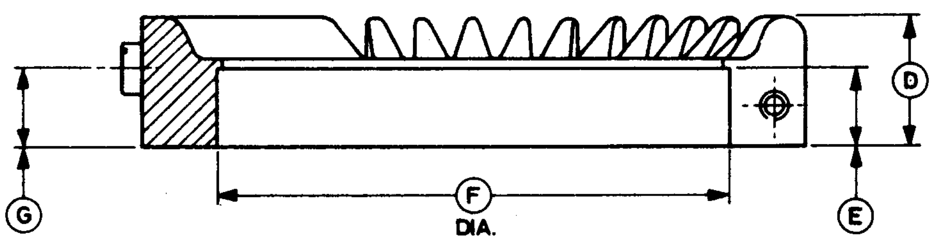
Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	82.0	3.228	E	20.0	0.787
B	44.0	1.732	F	54.35 ± 0.05	2.140 ± 0.002
C	26.0	1.024	G	21.0	0.827
D	30.0	1.181	H	13.0	0.512

Inch dimensions have been derived from millimetres.

MA291D

MA291D is a connector designed for use on the larger filament terminal of the BR/BW1182 and BR/BW1183 series.





SECTION A—A'

Ref	Millimetres	Inches
A	124.0	4.882
B	82.0	3.228
C	34.0	1.339
D	25.0	0.984

Ref	Millimetres	Inches
E	15.0	0.591
F	96.35 ± 0.05	3.793 ± 0.002
G	15.0	0.591

Inch dimensions have been derived from millimetres

SEALING RINGS

The sealing rings listed are intended for use with EEV water or vapour cooled triodes. A sealing ring is supplied with each valve and also with the associated cooling unit; should replacements be required they may be ordered under the EEV number given below.

EEV number	Used with	Cross-section (see next page)	Nominal internal diameter
MA243	BW1144, BW1156 BW4035	Fig. 1	8½ inches (216mm)
MA245	BY1161 BY4059, BY4093	Fig. 1	8 inches (203mm)
MA246	BY1102, BY1121 BY4030, BY4031 BY4032, BY4033	Fig. 2	5¾ inches (146mm)
MA248	BW140	Fig. 3	$1\frac{29}{32}$ inches (48.5mm)
MA249	BW153, BW1139	Fig. 2	3 inches (76mm)
MA251	BW161, BW1102, BW1121 BW4028, BW4034	Fig. 2	4 inches (102mm)
MA252	BW179, BW1103, BW1122, BW1124 BW4029, BW4070	Fig. 2	2¾ inches (70mm)

Continued on next page

EEV number	Used with	Cross-section (see below)	Nominal internal diameter
MA253	BY1122, BY1124 BY4048A, BY4064	Fig. 1	4½ inches (114mm)
MA254	BW189, BW194, BW1143 BW4027, BW4050	Fig. 1	5¼ inches (133mm)
MA255	BY189A, BY194, BY1143 BY4037, BY4038, BY4038A, BY4039, BY4049	Fig. 1	6¾ inches (172mm)
MA260	BY1144, BY1156 BY4036, BY4060	Fig. 1	9¾ inches (248mm)
MA314	BW1162, BW1165 BW4088A	Fig. 1	$1^1/_8$ inches (29mm)
MA315	BW1115, BW1126 BW4123	Fig. 1	2 inches (51mm)

Cross-sections of Sealing Rings

3060

Fig. 1

Fig. 2

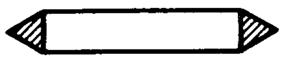


Fig. 3

WATER JACKETS

The following table lists the water jackets available for use with EEV water cooled triodes.

Water jacket	Used on valve	Net weight approx	Sealing ring (see note 3)
BW4027	BW194	40 pounds (18kg)	MA254
BW4028	BW161 BW1102	20 pounds (9.1kg)	MA251
BW4029	BW179 BW1103 BW1124	10 pounds (4.6kg)	MA252
BW4034	BW1121	18 pounds (8.2kg)	MA251
BW4035	BW1144 BW1156	60 pounds (27kg)	MA243
BW4050	BW189 BW1143	36 pounds (16.4kg)	MA254
BW4070	BW1122	10 pounds (4.6kg)	MA252
BW4088A*	BW1162 BW1165	1.1 pounds (0.5kg)	MA314
BW4123	BW1115 BW1126	2 pounds (0.9kg)	MA315

* BW4088A supersedes BW4088; the latter can be supplied to special order if required.

See page 2 for Notes

NOTES

1. All the above water jackets except BW4035, BW4088 and its variants have two alternative inlet water connections at the lower end and two alternative outlet connections at the top of the assembly. Any pair of connections may be used and two blanking plugs with sealing washers are supplied with the jacket for sealing the water connections not required.

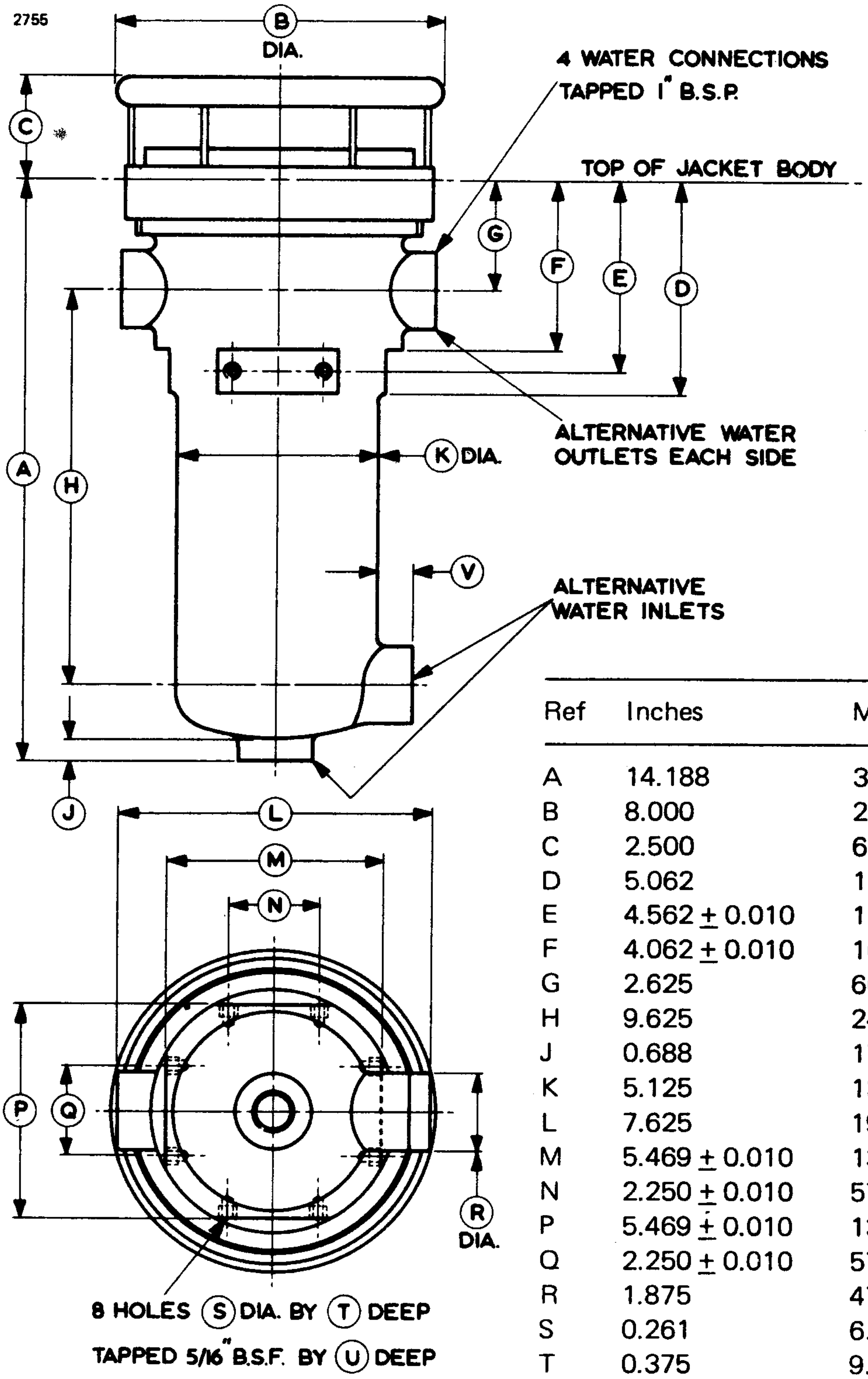
   The BW4035 has three inlet water connections at the lower end and two outlet connections at the top of the assembly. Both outlet connections must be used. The inlet connection can be made to the 2-inch tapped hole only, or alternatively to the two side inlet holes used together. Blanking plugs with sealing washers are supplied with the jacket for sealing the water connections not required.

   Any flow reducing or measuring devices should be incorporated in the system on the outlet side of the water jacket as it is desirable to operate the jacket at the highest possible pressure.

2. All the above water jackets except BW4088, BW4088A and BW4123 may be mounted by means of the tapped holes in any two of the four flat surfaces round the circumference.

3. One sealing ring is supplied with each water jacket.

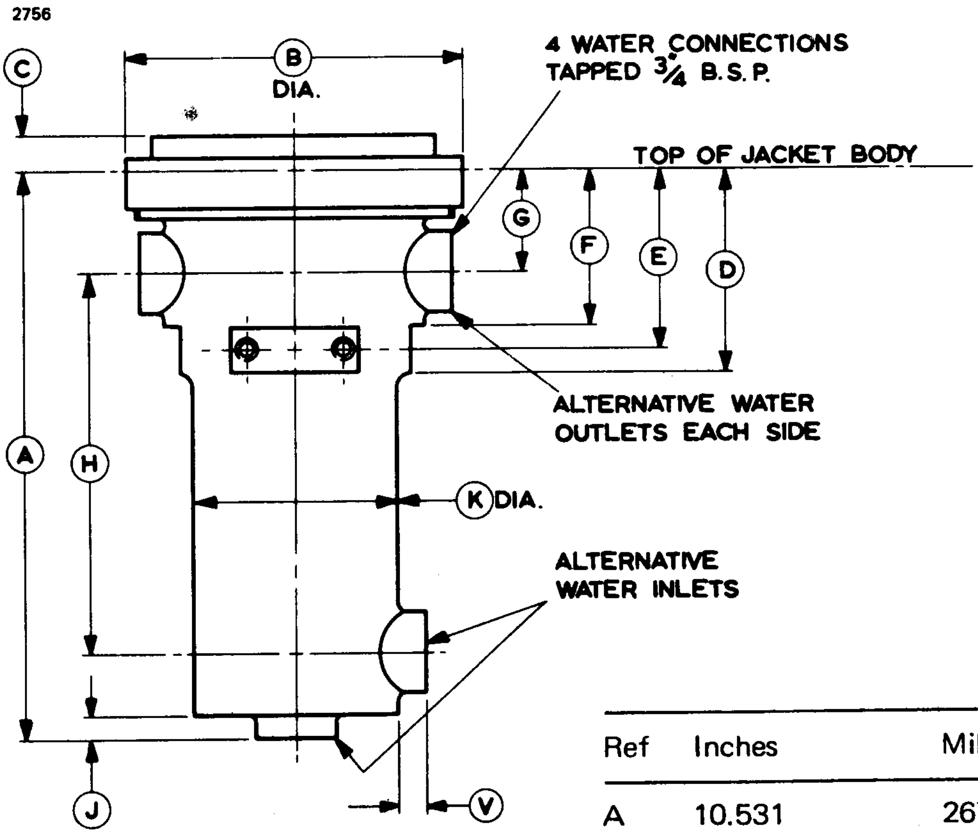
OUTLINE FOR BW4027 (All dimensions without limits are nominal)

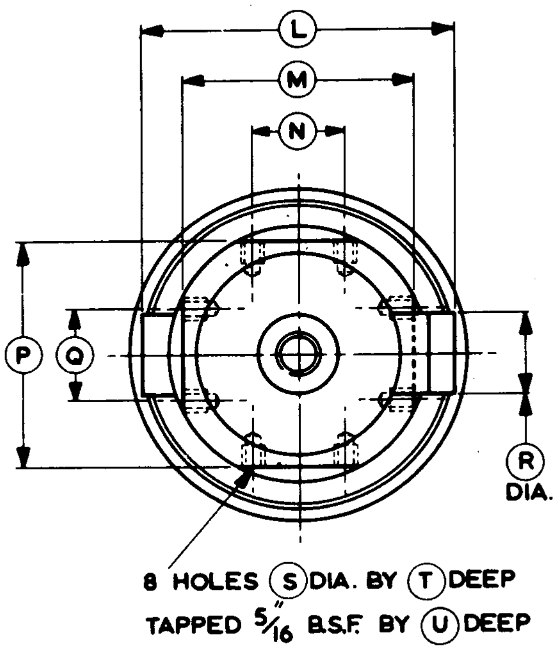


Ref	Inches	Millimetres
A	14.188	360.4
B	8.000	203.2
C	2.500	63.50
D	5.062	128.6
E	4.562 ± 0.010	115.88 ± 0.25
F	4.062 ± 0.010	103.17 ± 0.25
G	2.625	66.68
H	9.625	244.5
J	0.688	17.48
K	5.125	130.2
L	7.625	193.7
M	5.469 ± 0.010	138.91 ± 0.25
N	2.250 ± 0.010	57.15 ± 0.25
P	5.469 ± 0.010	138.91 ± 0.25
Q	2.250 ± 0.010	57.15 ± 0.25
R	1.875	47.63
S	0.261	6.63
T	0.375	9.53
U	0.343	8.71
V	0.875	22.23

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4028 (All dimensions without limits are nominal)



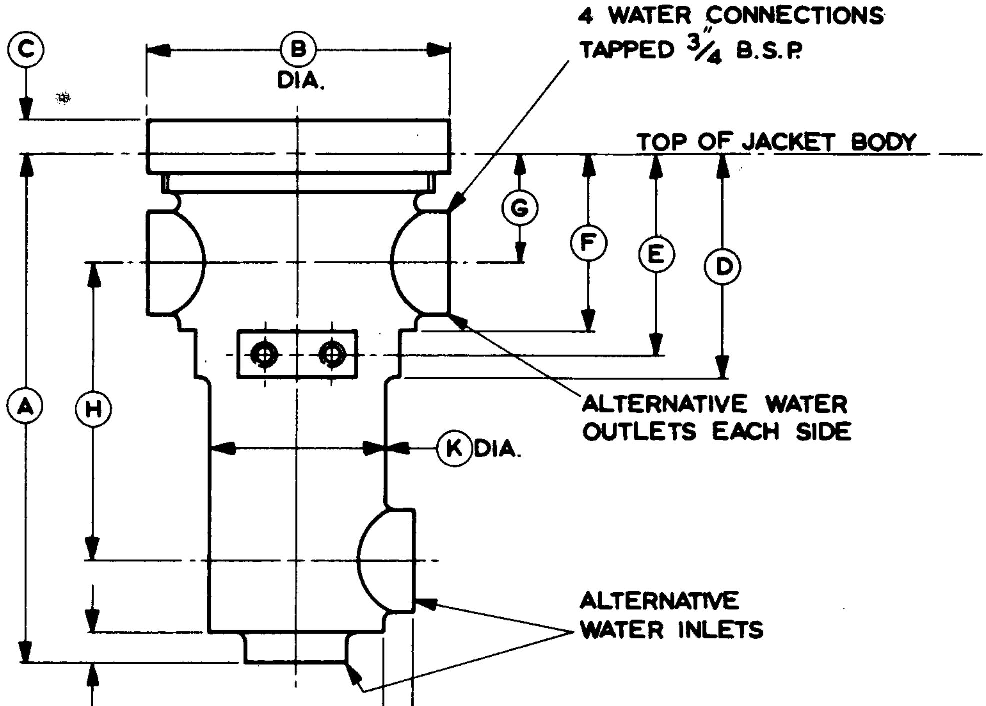


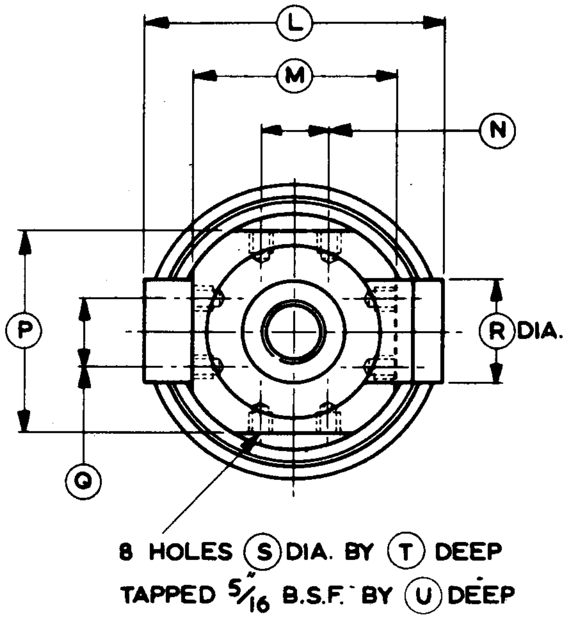
Ref	Inches	Millimetres
A	10.531	267.5
B	6.250	158.8
C	0.625	15.88
D	3.812	96.82
E	3.281 ± 0.010	83.34 ± 0.25
F	2.937 ± 0.010	74.60 ± 0.25
G	1.937	49.20
H	7.062	179.4
J	0.468	11.89
K	3.875	98.43
L	5.812	147.6
M	4.593 ± 0.010	116.7 ± 0.25
N	1.750 ± 0.010	44.45 ± 0.25
P	4.593 ± 0.010	116.7 ± 0.25
Q	1.750 ± 0.010	44.45 ± 0.25
R	1.500	38.10
S	0.261	6.63
T	0.343	8.71
U	0.312	7.92
V	0.531	13.49

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4029 (All dimensions without limits are nominal)

2761

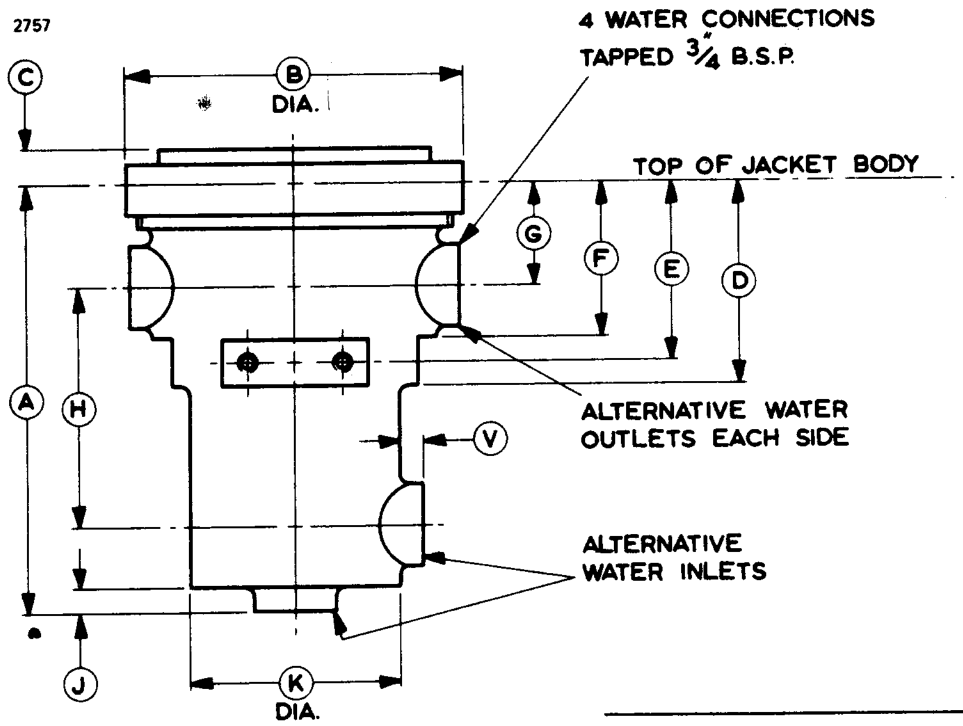


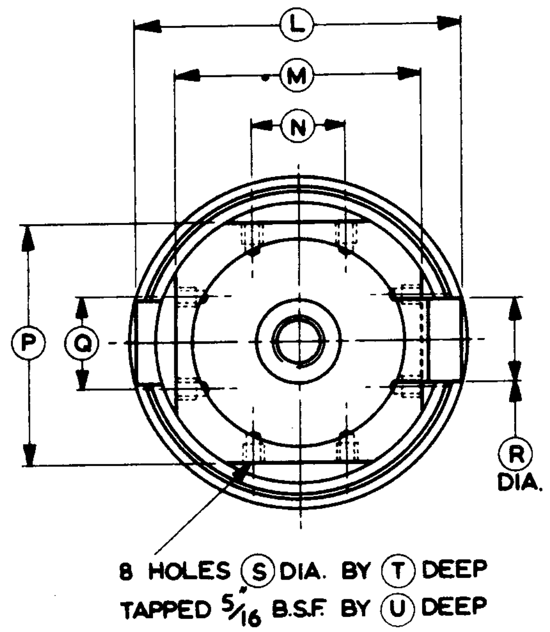


Ref	Inches	Millimetres
A	7.531	191.3
B	4.562	115.9
C	0.437	11.10
D	3.343	84.91
E	2.968 ± 0.010	75.39 ± 0.25
F	2.625 ± 0.010	66.68 ± 0.25
G	1.625	41.28
H	4.375	111.1
J	0.468	11.89
K	2.625	66.68
L	4.562	115.9
M	3.000 ± 0.010	76.20 ± 0.25
N	1.000 ± 0.010	25.40 ± 0.25
P	3.000 ± 0.010	76.20 ± 0.25
Q	1.000 ± 0.010	25.40 ± 0.25
R	1.500	38.10
S	0.261	6.63
T	0.343	8.71
U	0.312	7.92
V	0.468	11.89

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4034 (All dimensions without limits are nominal)

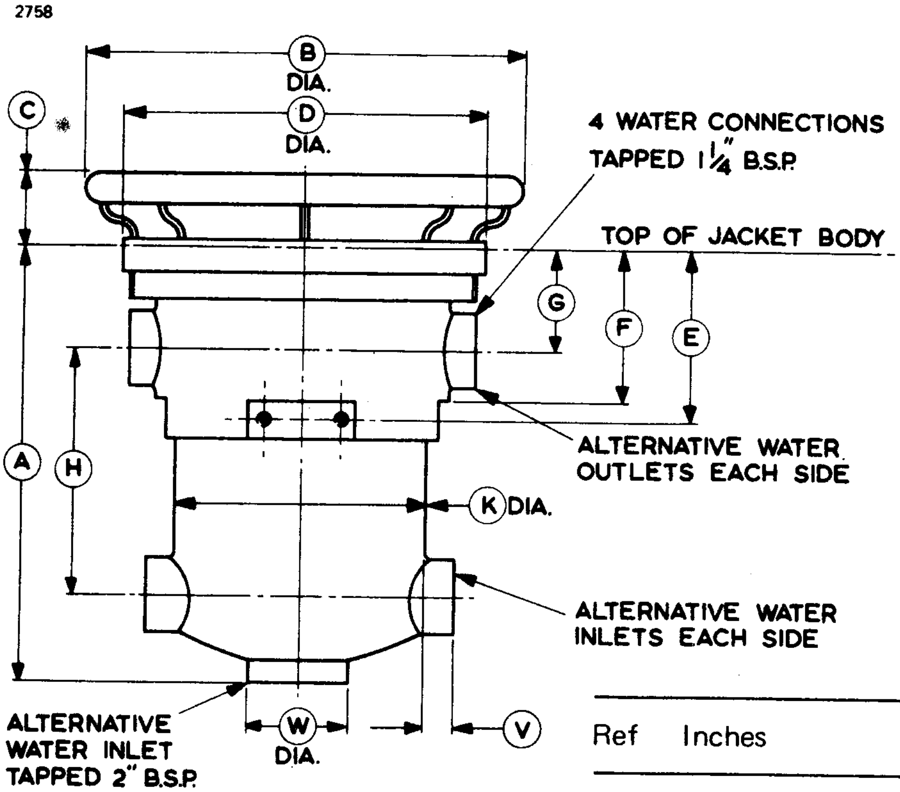


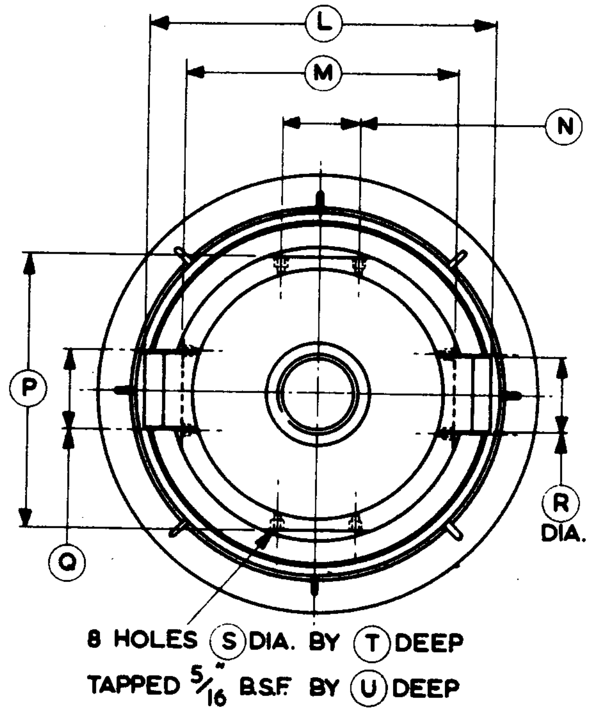


Ref	Inches	Millimetres
A	8.125	206.4
B	6.250	158.8
C	0.625	15.88
D	3.812	96.82
E	3.281 $\pm$ 0.010	83.34 $\pm$ 0.25
F	2.937 $\pm$ 0.010	74.60 $\pm$ 0.25
G	1.937	49.20
H	4.437	112.7
J	0.468	11.89
K	3.875	98.43
L	6.187	157.2
M	4.593 $\pm$ 0.010	116.66 $\pm$ 0.25
N	1.750 $\pm$ 0.010	44.45 $\pm$ 0.25
P	4.593 $\pm$ 0.010	116.66 $\pm$ 0.25
Q	1.750 $\pm$ 0.010	44.45 $\pm$ 0.25
R	1.500	38.10
S	0.261	6.63
T	0.375	9.53
U	0.312	7.92
V	0.468	11.89

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4035 (All dimensions without limits are nominal)

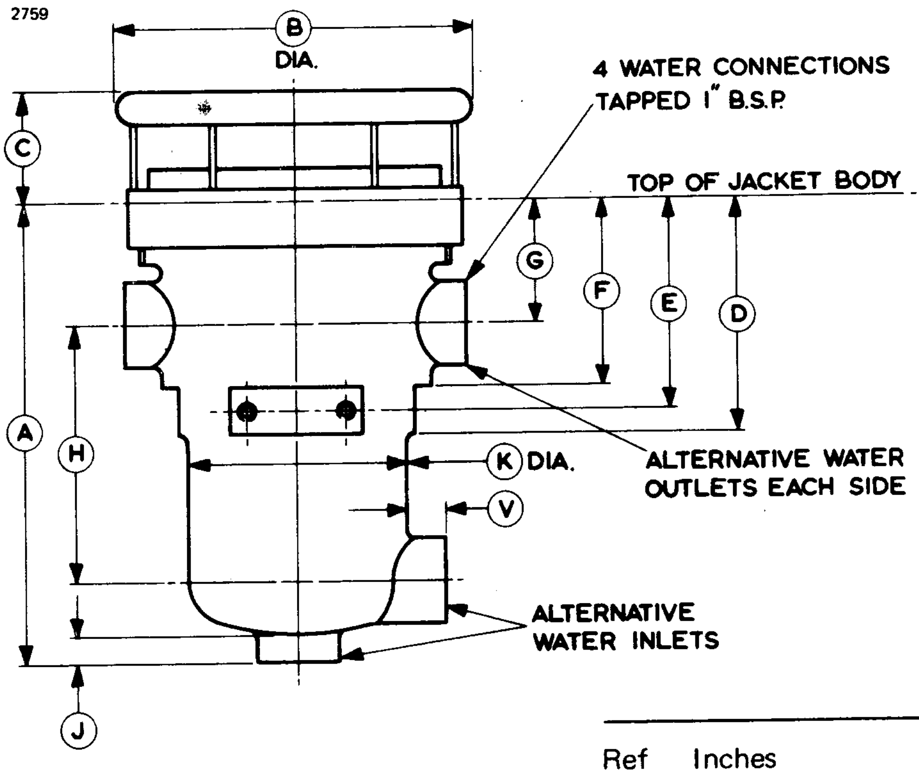


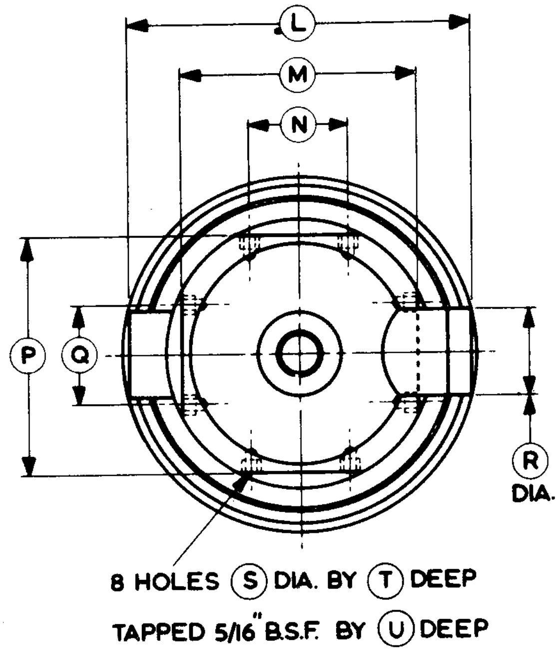


Ref	Inches	Millimetres
A	12.875	327.0
B	13.000	330.2
C	2.250	57.15
D	11.000	279.4
E	5.093 $\pm$ 0.010	129.4 $\pm$ 0.25
F	4.593 $\pm$ 0.010	116.7 $\pm$ 0.25
G	2.984	75.79
H	7.250	184.2
K	7.500	190.5
L	10.250	260.4
M	8.125 $\pm$ 0.010	206.38 $\pm$ 0.25
N	2.250 $\pm$ 0.010	57.15 $\pm$ 0.25
P	8.125 $\pm$ 0.010	206.38 $\pm$ 0.25
Q	2.250 $\pm$ 0.010	57.15 $\pm$ 0.25
R	2.218	56.34
S	0.261	6.63
T	0.375	9.53
U	0.344	8.74
V	0.812	20.63
W	2.913	73.99

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4050 (All dimensions without limits are nominal)

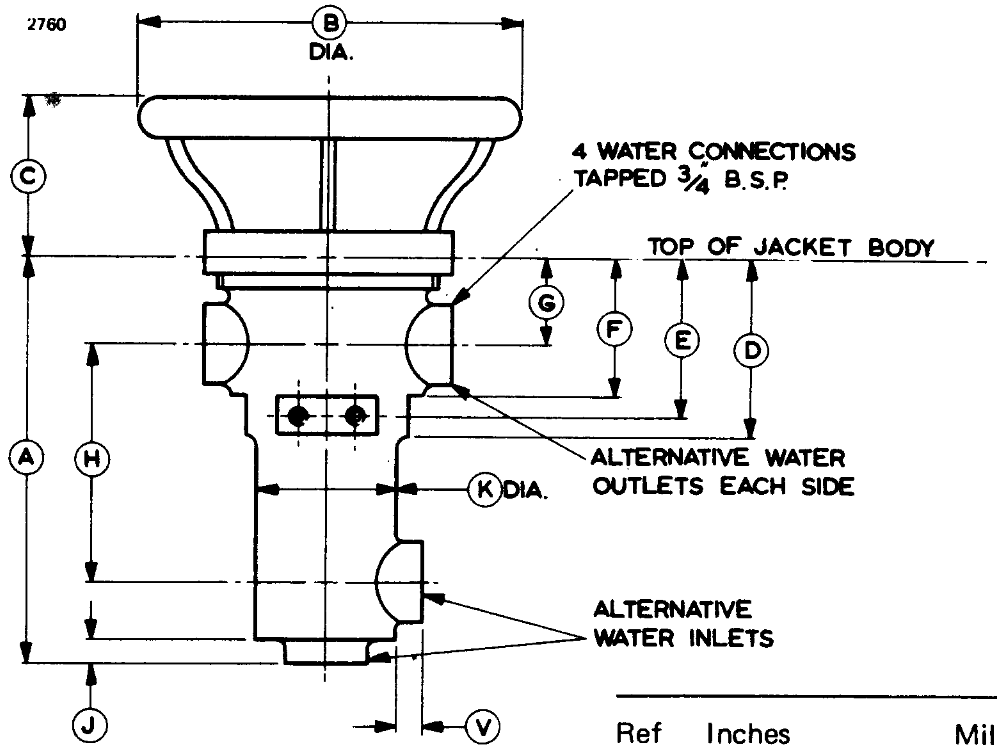


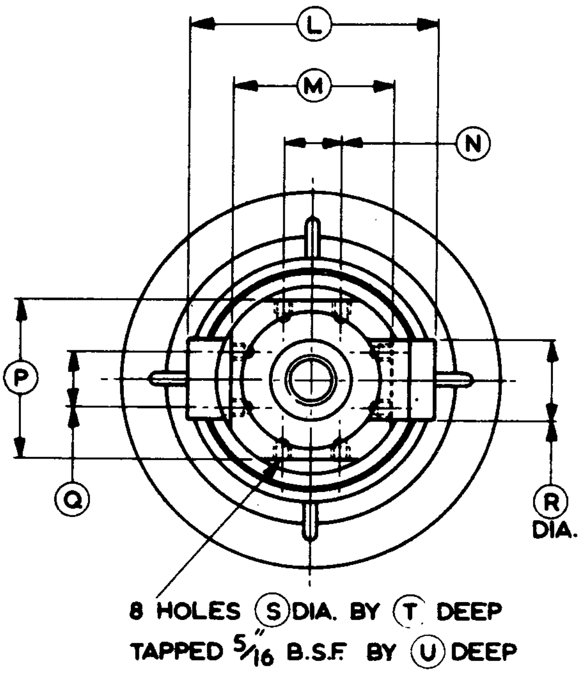


Ref	Inches	Millimetres
A	10.187	258.8
B	8.000	203.2
C	2.500	63.50
D	5.062	128.6
E	4.562 ± 0.010	115.88 ± 0.25
F	4.062 ± 0.010	103.18 ± 0.25
G	2.625	66.68
H	5.625	142.9
J	0.688	17.46
K	5.125	130.2
L	7.625	193.7
M	5.469 ± 0.010	138.91 ± 0.25
N	2.250 ± 0.010	57.15 ± 0.25
P	5.469 ± 0.010	138.91 ± 0.25
Q	2.250 ± 0.010	57.15 ± 0.25
R	1.875	47.63
S	0.261	6.63
T	0.375	9.53
U	0.343	8.71
V	0.875	22.23

Millimetre dimensions have been derived from inches.

OUTLINE FOR BW4070 (All dimensions without limits are nominal)

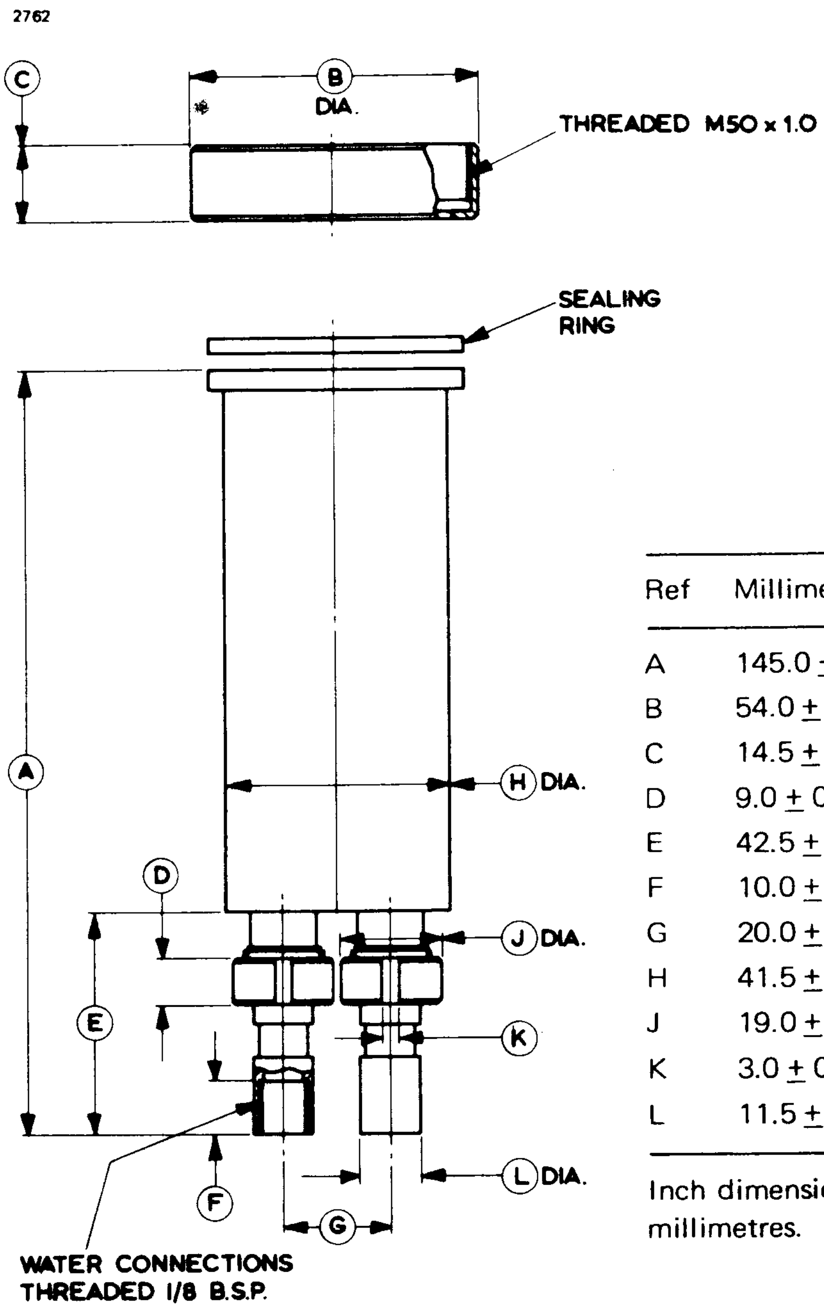




Ref	Inches	Millimetres
A	7.531	191.3
B	7.125	182.0
C	2.500	63.50
D	3.343	84.91
E	2.968 ± 0.010	75.39 ± 0.25
F	2.625 ± 0.010	66.68 ± 0.25
G	1.625	41.28
H	4.375	111.1
J	0.468	11.89
K	2.625	66.68
L	4.562	115.9
M	3.000 ± 0.010	76.20 ± 0.25
N	1.000 ± 0.010	25.40 ± 0.25
P	3.000 ± 0.010	76.20 ± 0.25
Q	1.000 ± 0.010	25.40 ± 0.25
R	1.500	38.10
S	0.261	6.63
T	0.343	8.71
U	0.312	7.92
V	0.468	11.89

Millimetre dimensions have been derived from inches.

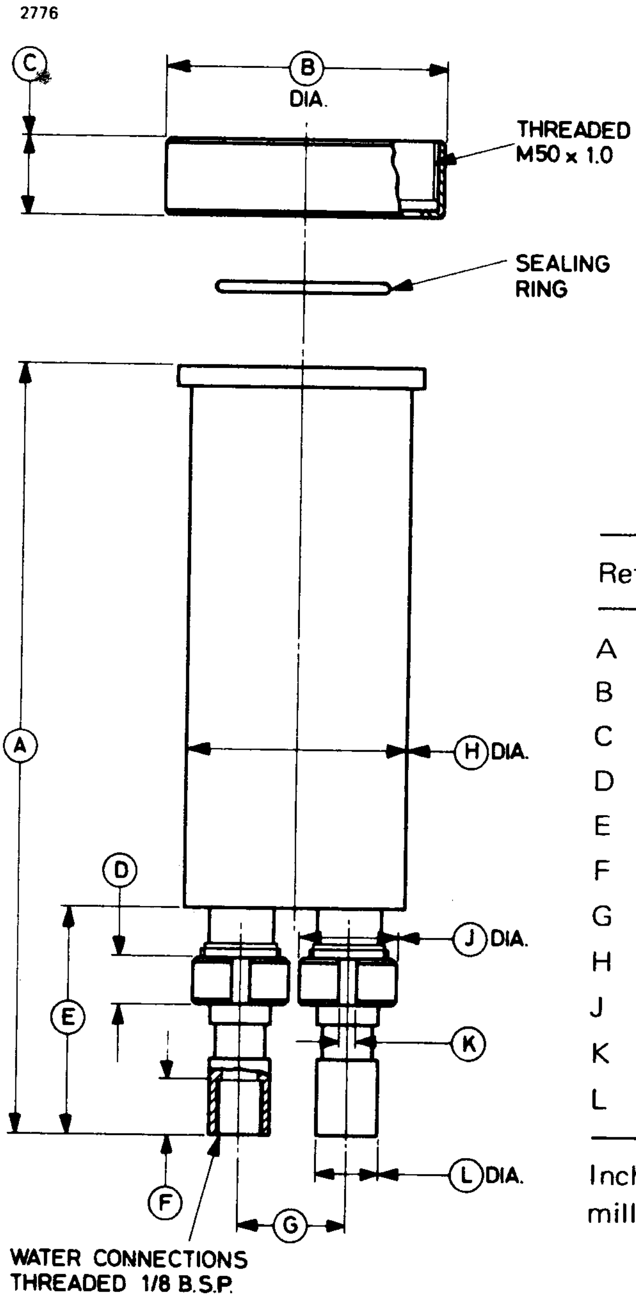
OUTLINE FOR BW4088 (Superseded by BW4088A)



Ref	Millimetres	Inches
A	145.0 ± 5.0	5.709 ± 0.197
B	54.0 ± 1.0	2.126 ± 0.039
C	14.5 ± 0.5	0.571 ± 0.020
D	9.0 ± 0.4	0.354 ± 0.016
E	42.5 ± 2.0	1.673 ± 0.079
F	10.0 ± 1.0	0.394 ± 0.039
G	20.0 ± 1.0	0.787 ± 0.039
H	41.5 ± 0.5	1.634 ± 0.020
J	19.0 ± 0.2	0.748 ± 0.008
K	3.0 ± 0.3	0.118 ± 0.012
L	11.5 ± 0.5	0.453 ± 0.020

Inch dimensions have been derived from millimetres.

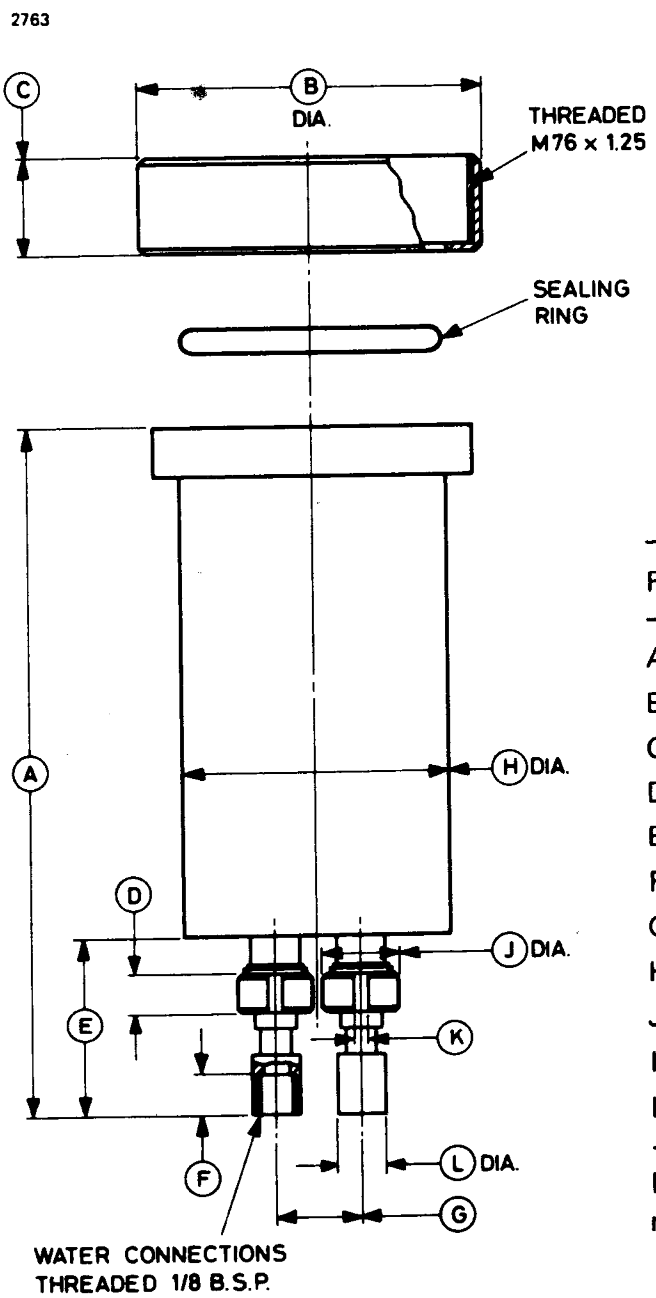
OUTLINE FOR BW4088A



Ref	Millimetres	Inches
A	145.0 ± 5.0	5.709 ± 0.197
B	54.0 ± 1.0	2.126 ± 0.039
C	14.5 ± 0.5	0.571 ± 0.020
D	9.0 ± 0.4	0.354 ± 0.016
E	42.5 ± 2.0	1.673 ± 0.079
F	10.0 ± 1.0	0.394 ± 0.039
G	20.0 ± 1.0	0.787 ± 0.039
H	41.5 ± 0.5	1.634 ± 0.020
J	19.0 ± 0.2	0.748 ± 0.008
K	3.0 ± 0.3	0.118 ± 0.012
L	11.5 ± 0.5	0.453 ± 0.020

Inch dimensions have been derived from millimetres.

OUTLINE FOR BW4123



Ref	Millimetres	Inches
A	162.5 ± 5.0	6.398 ± 0.197
B	80.0 ± 1.0	3.150 ± 0.039
C	23.0 ± 0.5	0.906 ± 0.020
D	9.0 ± 0.4	0.354 ± 0.016
E	42.5 ± 2.0	1.673 ± 0.079
F	10.0 ± 1.0	0.394 ± 0.039
G	20.0 ± 1.0	0.787 ± 0.039
H	62.5 ± 0.5	2.461 ± 0.020
J	19.0 ± 0.2	0.748 ± 0.008
K	3.0 ± 0.3	0.118 ± 0.012
L	11.5 ± 0.5	0.453 ± 0.020

Inch dimensions have been derived from millimetres.

BOILER UNITS

The following table lists the boiler units available for use with EEV vapour cooled triodes. Further information is given in the following pages.

Boiler unit	Description	Used with valve
BY4030	Double unit, integral condenser	BY1102
BY4031	Single unit, integral condenser	BY1102
BY4032	Double unit, integral condenser	BY1121
BY4033	Single unit, integral condenser	BY1121
BY4036	Single unit, integral condenser	BY1144, BY1156
BY4037A	Single unit, separate condenser	BY189A, BY1143
BY4038	Single unit, integral condenser	BY189A, BY1143
BY4038A	Double unit, integral condenser	BY189A, BY1143
BY4039	Single unit, integral condenser	BY194
BY4048A	Single unit, separate condenser	BY1122, BY1124
BY4049	Single unit, separate condenser	BY194
BY4060	Single unit, separate condenser	BY1144
BY4063	Single unit, separate condenser	BY1121
BY4064	Single unit, integral condenser	BY1122, BY1124
BY4093	Single unit, integral condenser	BY1161

GENERAL DATA FOR BY4030

Double boiler unit with integral condenser system for use with a pair of BY1102. The valves are held in the boiler unit by clamping rings, each with six bolts.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valves should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit, any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

Net weight (empty)	95 pounds (43kg) approx
Water capacity of boiler to maximum water level	3½imp.gal (16 l.) approx
Condenser water flow	5½imp.gal/min approx 25 l./min approx
Sealing ring (supplied with boiler)	MA246

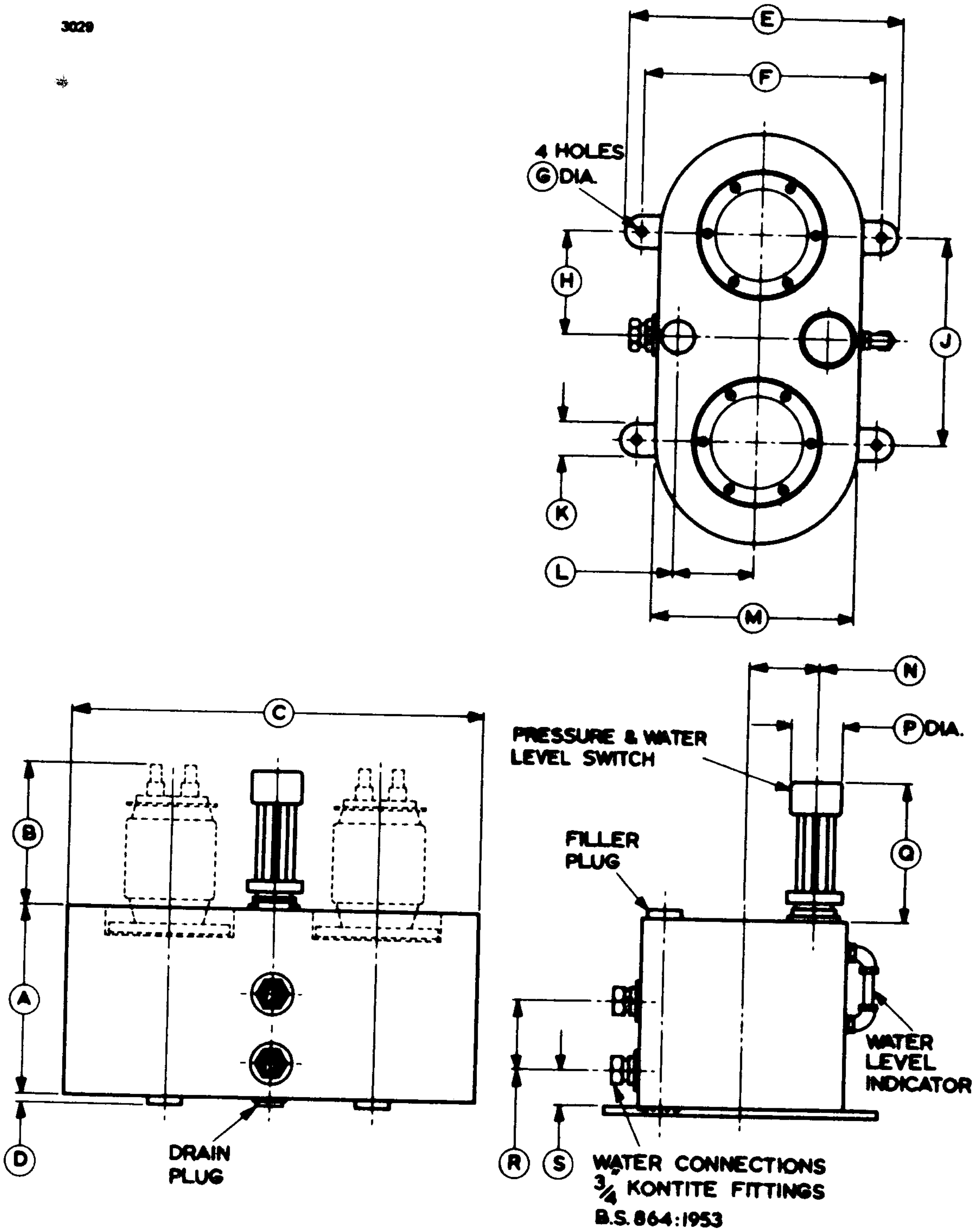
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.000	279.4	K	2.000	50.80
B	9.125 max	231.8 max	L	4.750	120.7
C	24.000	609.6	M	12.000	304.8
D	0.500	12.70	N	4.250	108.0
E	16.000	406.4	P	3.000	76.20
F	14.000	355.6	Q	8.000 max	203.2 max
G	0.500	12.70	R	4.000	101.6
H	6.000	152.4	S	2.000	50.80
J	12.000	304.8			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4030

3029



GENERAL DATA FOR BY4031

Single boiler unit with integral condenser system for use with BY1102. The valve is held in the boiler unit by a clamping ring with six bolts.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

Net weight (empty)	84 pounds (38kg) approx
Water capacity of boiler to maximum water level	1¼imp.gal (5.7 l.) approx
Condenser water flow	3½imp.gal/min approx 16 l./min approx
Sealing ring (supplied with boiler)	MA246

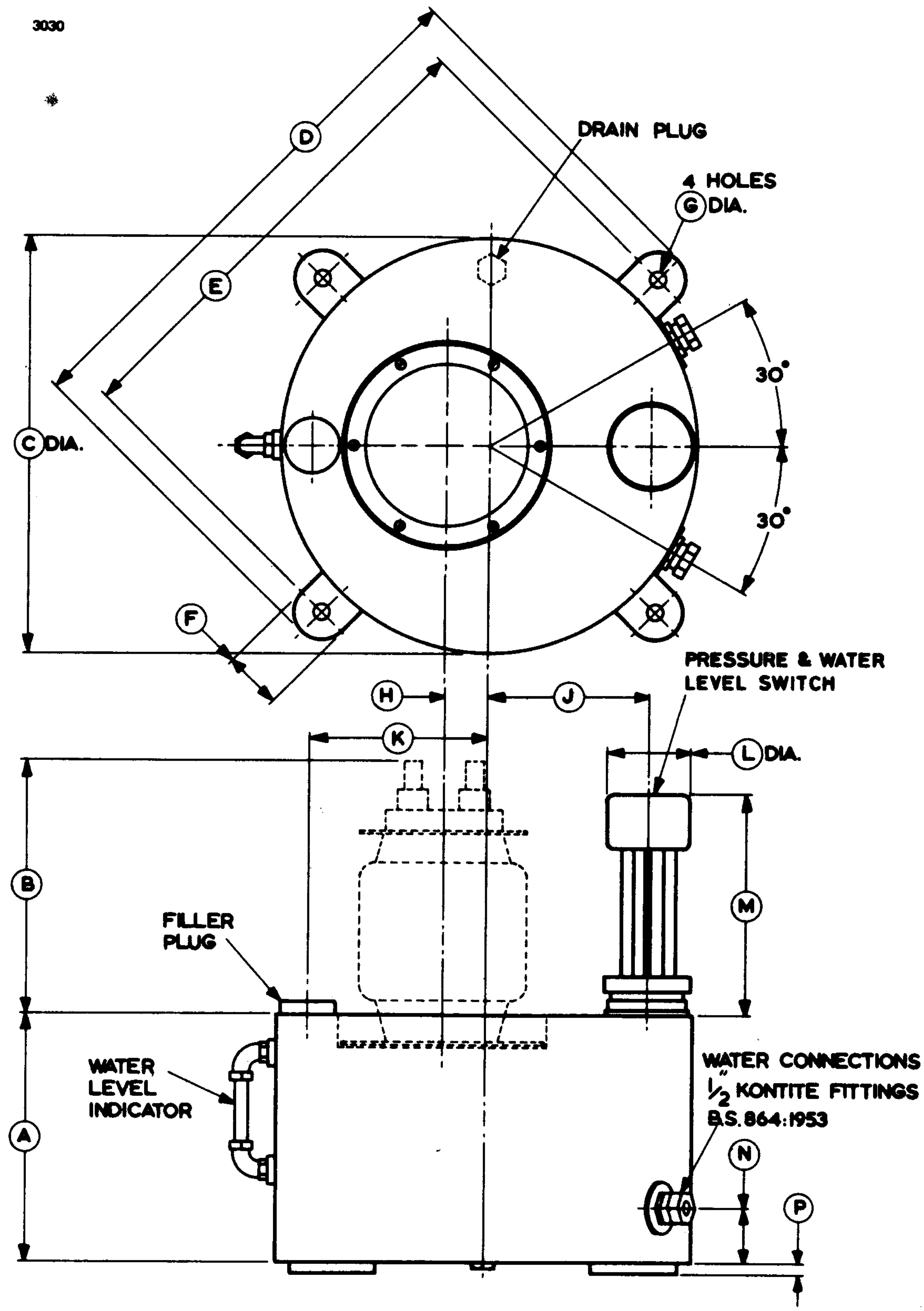
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	11.000	279.4	H	1.500	38.10
B	9.125 max	231.8 max	J	5.875	149.2
C	15.000	381.0	K	6.375	161.9
D	19.000	482.6	L	3.000	76.20
E	17.000	431.8	M	8.000 max	203.2 max
F	2.000	50.80	N	2.000	50.80
G	0.500	12.70	P	0.375	9.53

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4031

3030



GENERAL DATA FOR BY4032

Double boiler unit with integral condenser system for use with a pair of BY.1121. The valves are held in the boiler unit by clamping rings, each with six bolts.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valves should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

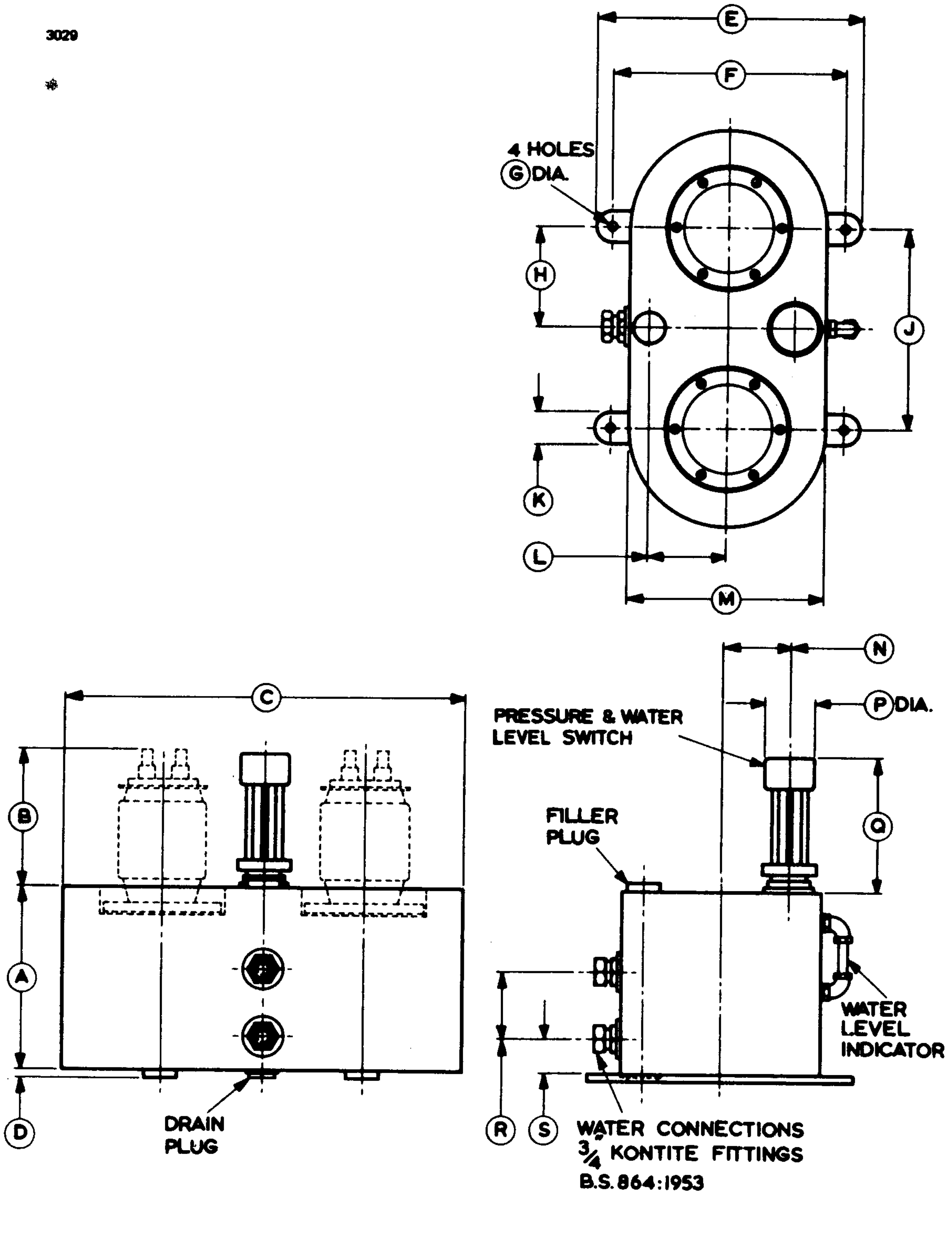
Net weight (empty)	90 pounds (41 kg) approx
Water capacity of boiler to maximum water level	3imp.gal (13.5 l.) approx
Condenser water flow	5imp.gal/min approx 23 l./min approx
Sealing ring (supplied with boiler)	MA246

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.000	228.6	K	2.000	50.80
B	8.125 max	206.4 max	L	4.750	120.7
C	24.000	609.6	M	12.000	304.8
D	0.500	12.70	N	4.250	108.0
E	16.000	406.4	P	3.000	76.20
F	14.000	355.6	Q	8.000 max	203.2 max
G	0.500	12.70	R	4.000	101.6
H	6.000	152.4	S	2.000	50.80
J	12.000	304.8			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4032



GENERAL DATA FOR BY4033

Single boiler unit with integral condenser system for use with BY1121. The valve is held in the boiler unit by a clamping ring with six bolts.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

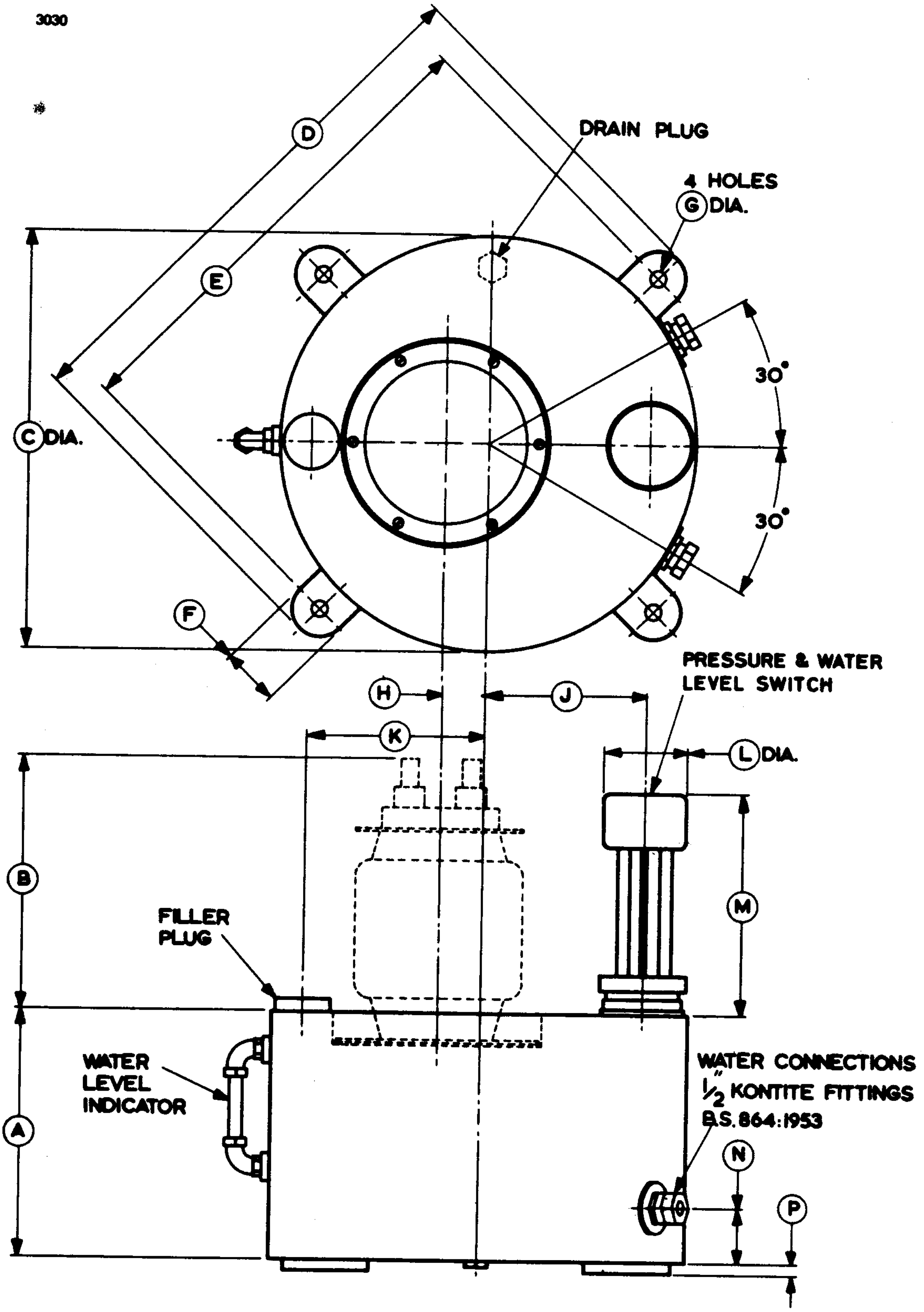
Net weight (empty)	80 pounds (36kg) approx
Water capacity of boiler to maximum water level	1¼imp.gal (5.7 l.) approx
Condenser water flow	3imp.gal/min approx 13.5 l./min approx
Sealing ring (supplied with boiler)	MA246

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	9.500 max	241.3 max	H	1.500	38.10
B	8.125 max	206.4 max	J	5.875	149.2
C	15.000	381.0	K	6.375	161.9
D	19.000	482.6	L	3.000	76.20
E	17.000	431.8	M	8.500 max	215.9 max
F	2.000	50.80	N	2.500 max	63.50 max
G	0.500	12.70	P	0.375	9.53

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4033



GENERAL DATA FOR BY4036

Single boiler unit with integral condenser system for use with BY1144 or BY1156. The valve is held in the boiler unit by its own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

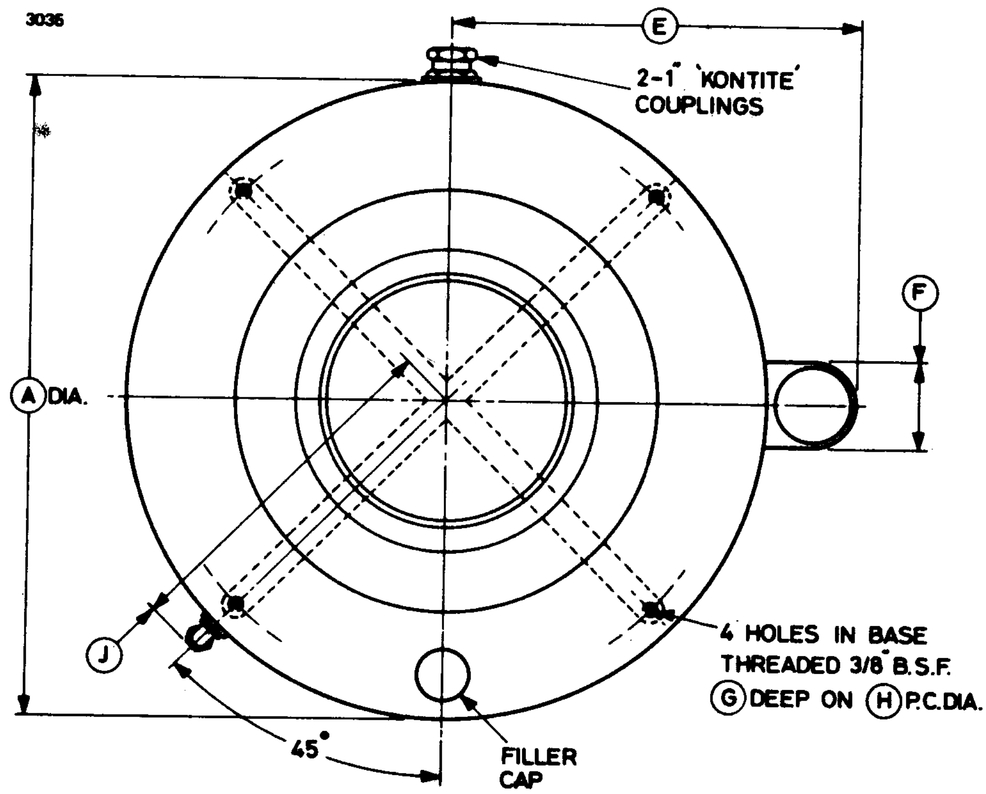
Net weight (empty)	100 pounds (45.5kg) approx
Water capacity of boiler to maximum water level	13imp.gal (59 l.) approx
Condenser water flow	7imp.gal/min (32 l./min) approx
Sealing ring (supplied with boiler)	MA260

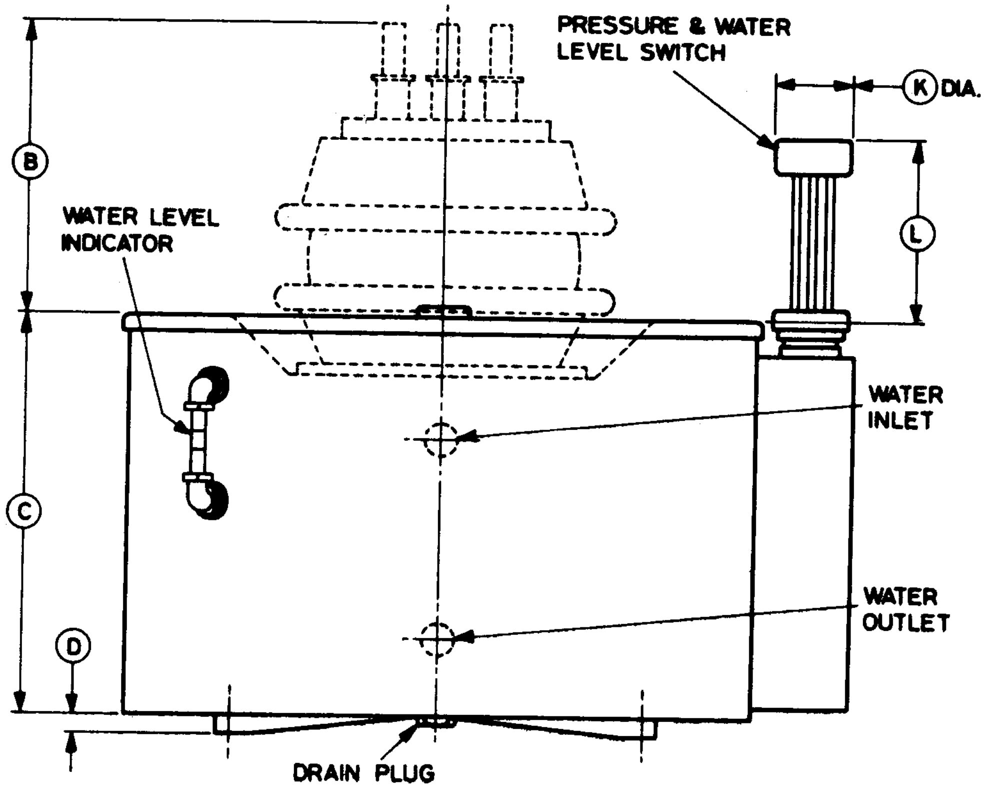
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	24.375 max	619.1 max	G	0.625	15.88
B	11.500 max	292.1 max	H	22.000	558.8
C	14.000 max	355.6 max	J	13.625 max	346.1 max
D	0.750	19.05	K	3.000	76.20
E	15.406 max	391.3 max	L	6.875 max	174.6 max
F	3.250	82.55			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4036





GENERAL DATA FOR BY4037A

Single boiler unit for use with BY189A or BY1143. A separate condenser is required, with insulating pipes for the steam outlet and water return to the boiler. The valve is held in the boiler unit by its own weight.

The boiler unit may be mounted by means of the four lugs on the base, and these may also be used for h.t. supply connections. The unit can be modified in some respects to meet the requirements of particular applications.

Distilled or de-mineralized water should be used in the boiler unit.

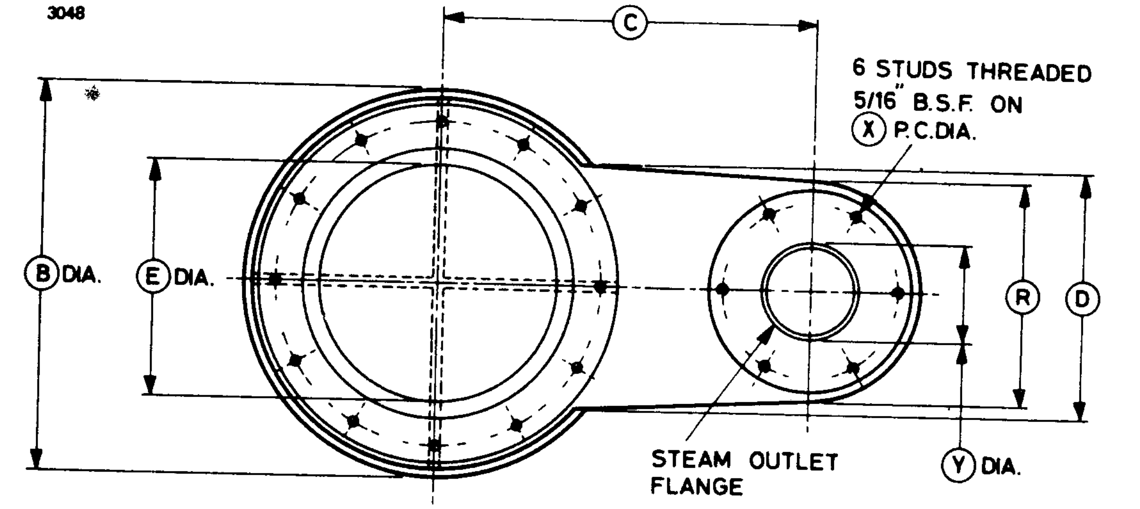
Net weight (empty)	46 pounds (21kg) approx
Water capacity of boiler to maximum water level	2imp.gal (9 l.) approx
Sealing ring (supplied with boiler)	MA255

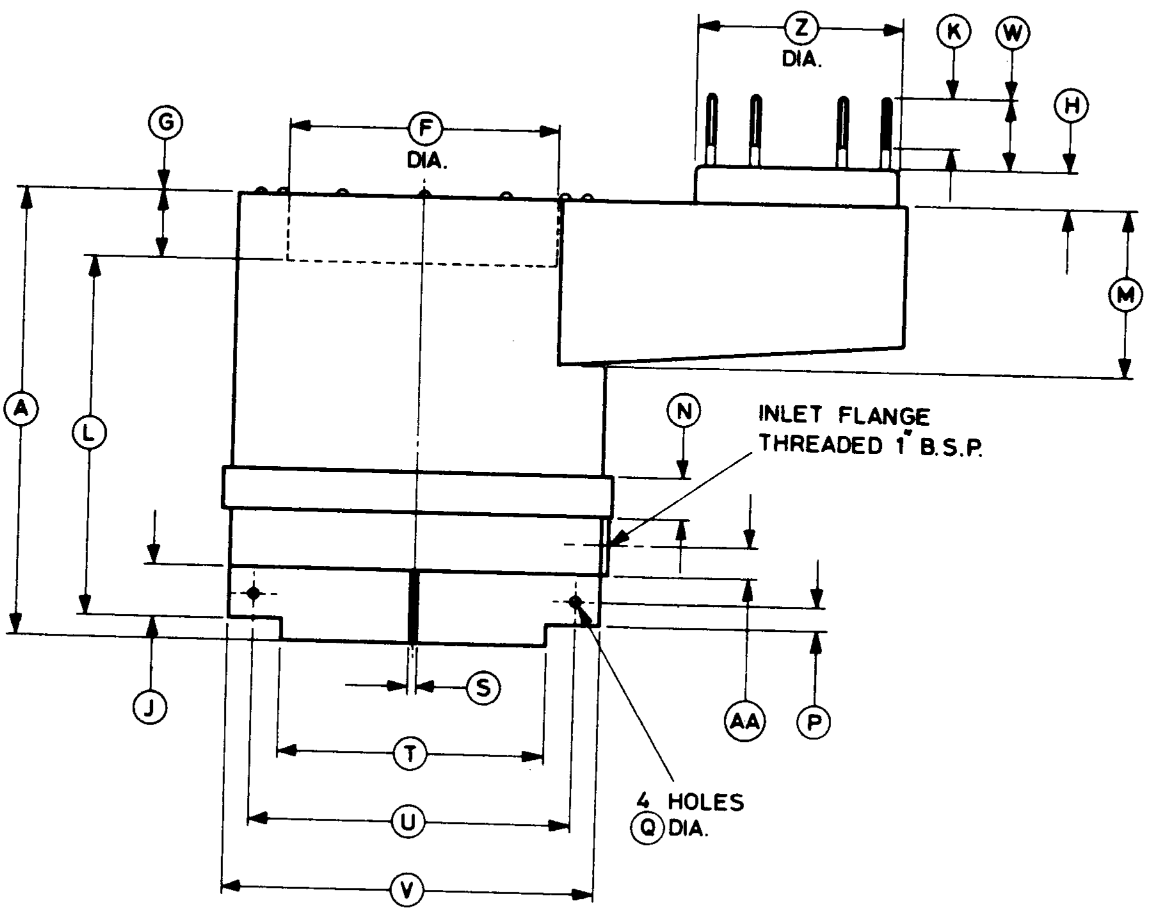
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	13.250 max	336.6 max	P	0.750	19.05
B	11.500 ± 0.020	292.1 ± 0.51	Q	0.344	8.75
C	11.000	279.4	R	6.625 max	168.3 max
D	7.250 max	184.2 max	S	0.250 ± 0.010	6.35 ± 0.25
E	7.000 ± 0.010	177.8 ± 0.25	T	7.875 ± 0.020	200.0 ± 0.51
F	8.000 ± 0.010	203.2 ± 0.25	U	9.500 ± 0.010	241.3 ± 0.25
G	2.000	50.80	V	11.000 ± 0.020	279.4 ± 0.51
H	1.156 ± 0.010	29.36 ± 0.25	W	2.125	53.98
J	1.500	38.10	X	5.250	133.4
K	1.500	38.10	Y	2.750	69.85
L	10.625 ± 0.062	269.9 ± 1.57	Z	6.000 ± 0.010	152.4 ± 0.25
M	4.875 max	123.8 max	AA	0.937	23.80
N	1.250 ± 0.020	31.75 ± 0.51			

Millimetre dimensions have been derived from inches, except dimension Q.

OUTLINE FOR BY4037A





GENERAL DATA FOR BY4038

Single boiler unit with integral condenser system for use with BY189A and BY1143. The valve is held in the boiler unit by its own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

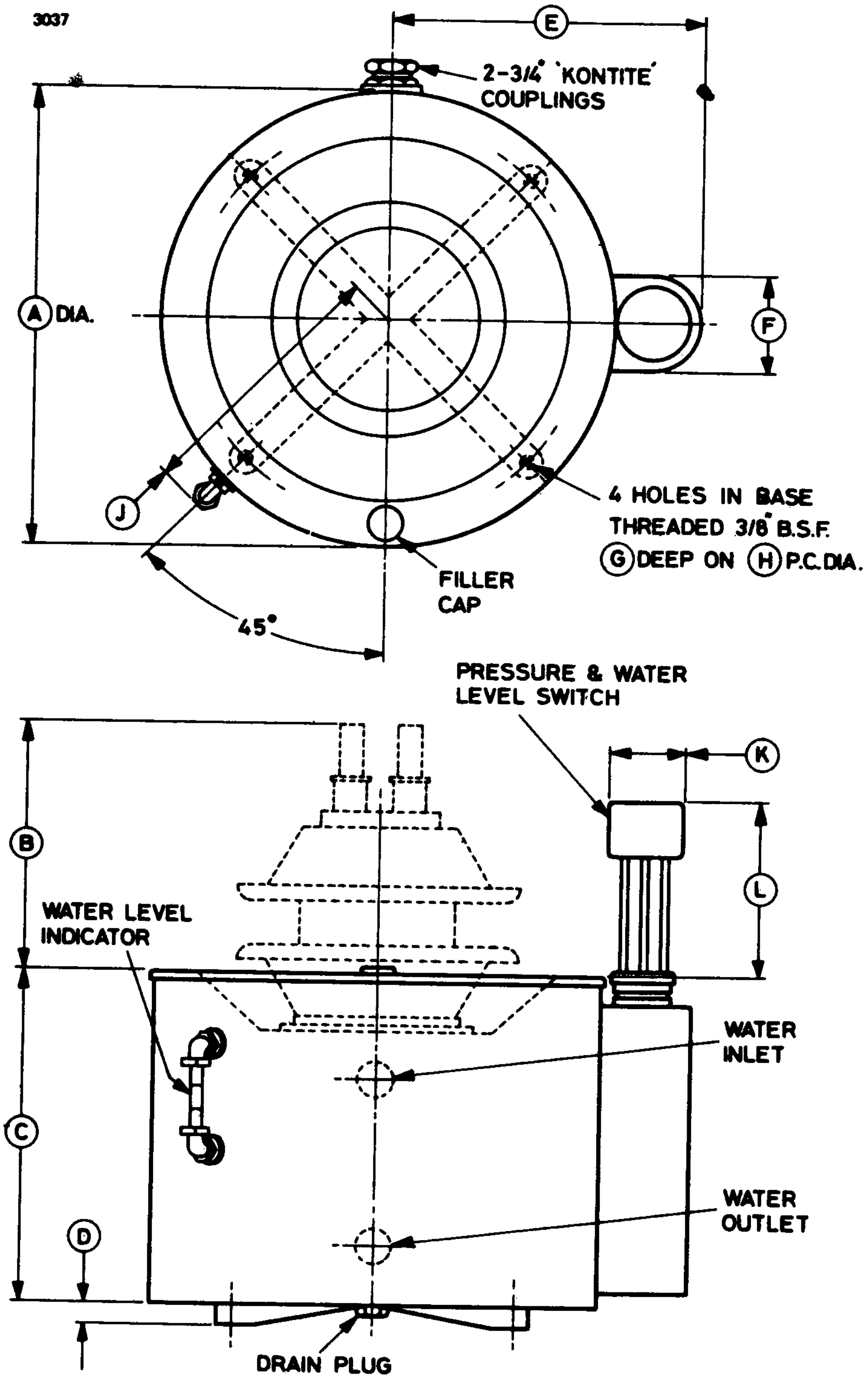
Net weight (empty)	85 pounds (39kg) approx
Water capacity of boiler to maximum water level	1½imp.gal (6.8 l.) approx
Condenser water flow	3½imp.gal/min (16 l./min) approx
Sealing ring (supplied with boiler)	MA255

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	17.875 max	454.0 max	G	0.625	15.88
B	9.750 max	247.7 max	H	15.500	393.7
C	12.875 max	327.0 max	J	10.375 max	263.5 max
D	0.750	19.05	K	3.000	76.20
E	12.156 max	308.8 max	L	6.875 max	174.6 max
F	3.250	82.55			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4038



GENERAL DATA FOR BY4038A

Double boiler unit with integral condenser system for use with a pair of BY189A or BY1143. The valves are held in the boiler unit by their own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valves should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

Net weight (empty) . . . . 155 pounds (70kg) approx

Water capacity of boiler to maximum water level . . . . 3½imp.gal (16 l.) approx

Condenser water flow . . . . 3½imp.gal/min approx
16 l./min approx

Sealing ring (supplied with boiler) MA255

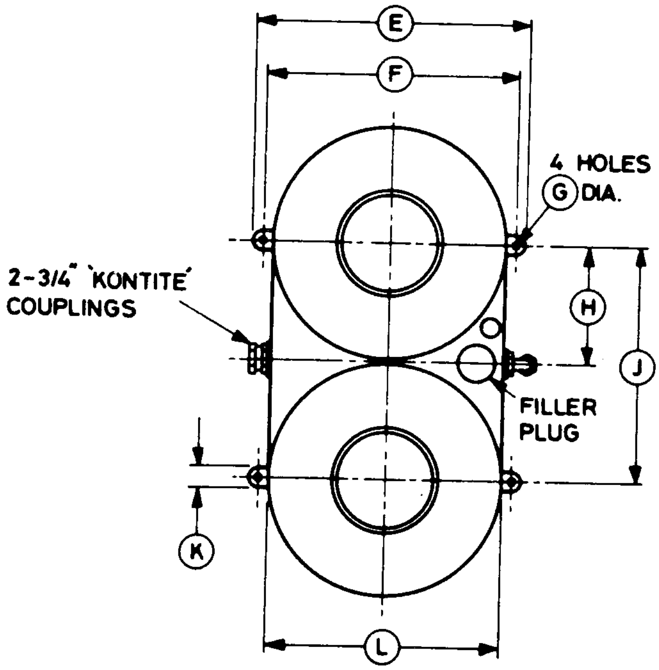
Outline Dimensions (All dimensions without limits are nominal)

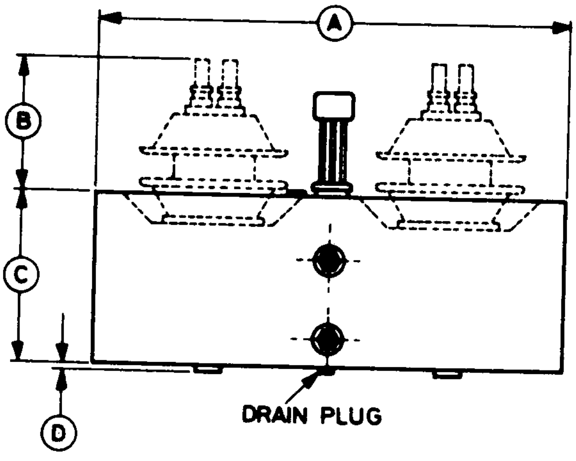
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	35.000	889.0	J	17.750	450.9
B	9.827 max	249.6 max	K	2.000	50.80
C	12.750	323.9	L	17.250	438.2
D	0.500	12.70	M	6.500	165.1
E	20.750	527.1	N	3.000	76.20
F	18.750	476.3	P	7.656 max	194.5 max
G	0.500	12.70	Q	5.750	146.1
H	8.875	225.4	R	2.156	54.76

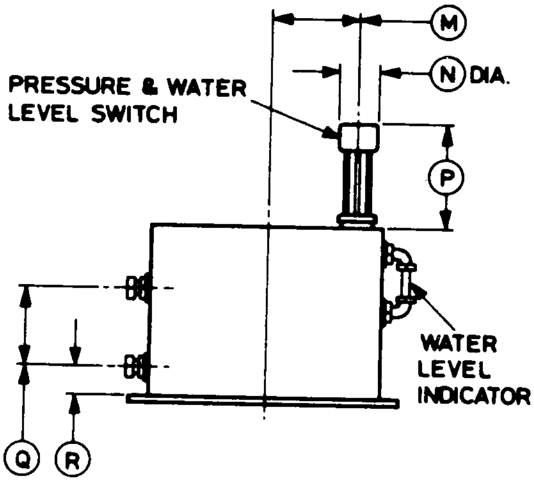
Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4038A

3047







GENERAL DATA FOR BY4039

Single boiler unit with integral condenser system for use with BY194. The valve is held in the boiler unit by its own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

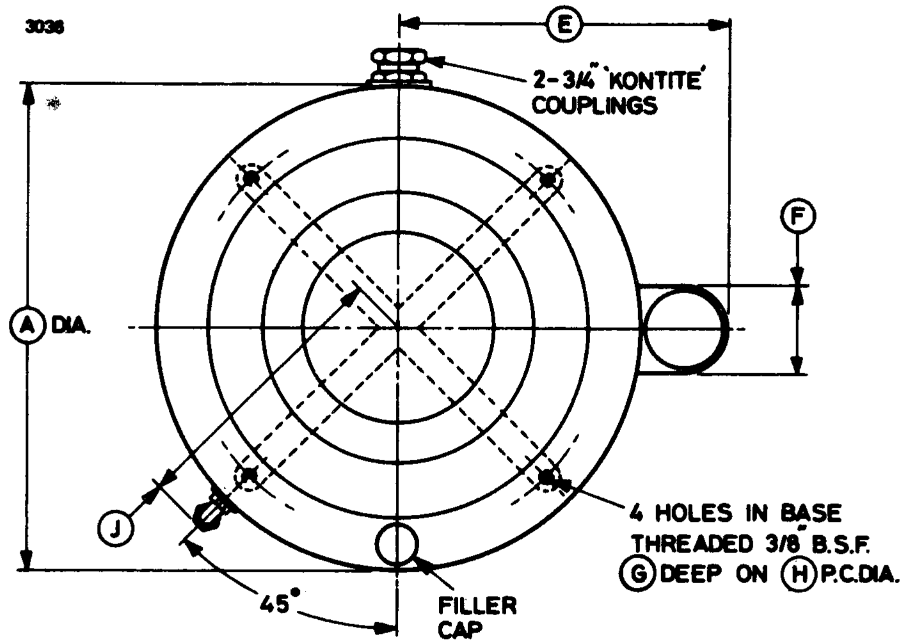
Net weight (empty)	88 pounds (40kg) approx
Water capacity of boiler to maximum water level	1½imp.gal (6.8 l.) approx
Condenser water flow	4imp.gal/min (18.2 l./min) approx
Sealing ring (supplied with boiler)	MA255

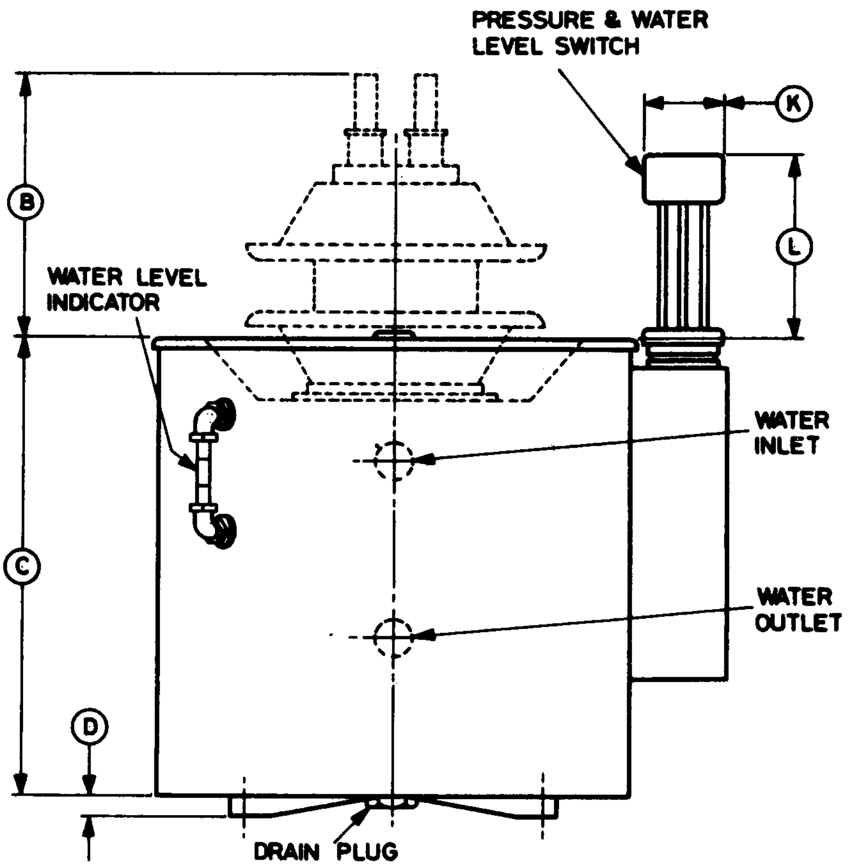
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	17.875 max	454.0 max	G	0.625	15.88
B	9.750 max	247.7 max	H	15.500	393.7
C	16.875 max	428.6 max	J	10.375 max	263.5 max
D	0.750	19.05	K	3.000	76.20
E	12.156 max	308.8 max	L	6.875 max	174.6 max
F	3.250	82.55			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4039





439.

GENERAL DATA FOR BY4048A

Single boiler unit for use with BY1122 or BY1124. A separate condenser is required, with insulating pipes for the steam outlet and water return to the boiler. The valve is held in the boiler unit by its own weight.

The boiler unit may be mounted by means of the four lugs provided, and these may also be used for h.t. supply connections. The unit can be modified in some respects to meet the requirements of particular applications.

Distilled or de-mineralized water should be used in the boiler unit.

Net weight (empty) . . . . 22 pounds (10kg) approx

Water capacity of boiler to maximum water level . . . . 0.9imp.gal (4 l.) approx

Sealing ring (supplied with boiler) MA253

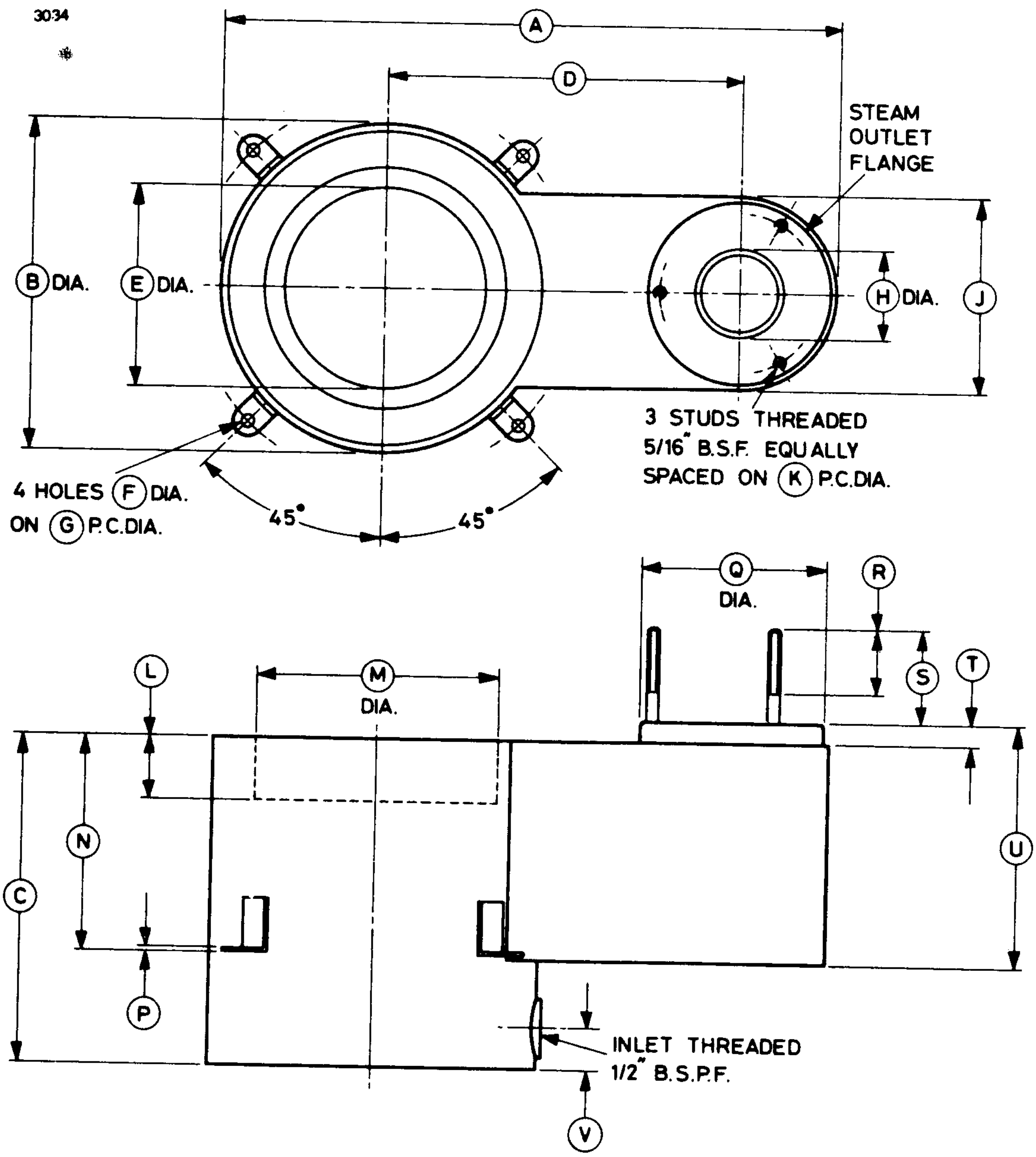
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	14.000 ± 0.031	355.6 ± 0.8	L	1.500	38.10
B	7.500	190.5	M	5.500	139.7
C	7.500	190.5	N	4.968	126.2
D*	8.000	203.2	P	0.187	4.78
E	4.562	115.9	Q	4.375	111.1
F	0.343	8.71	R	1.500	38.10
G	8.750	222.3	S	2.125	53.98
H	2.062	52.37	T	0.500	12.70
J	4.500	114.3	U	5.500	139.7
K	3.875	98.43	V	1.000	25.40

Millimetre dimensions have been derived from inches.

* Boiler units can be supplied with this dimension to customer's requirement within ± 3.000 inches (76.2mm) of the value shown (dimension A will vary accordingly).

OUTLINE FOR BY4048A



GENERAL DATA FOR BY4049

Single boiler unit for use with BY194. A separate condenser is required, with insulating pipes for the steam outlet and water return to the boiler. The valve is held in the boiler unit by its own weight.

The boiler unit may be mounted by means of the four lugs on the base, and these may also be used for h.t. supply connections. The unit can be modified in some respects to meet the requirements of particular applications.

Distilled or de-mineralized water should be used in the boiler unit.

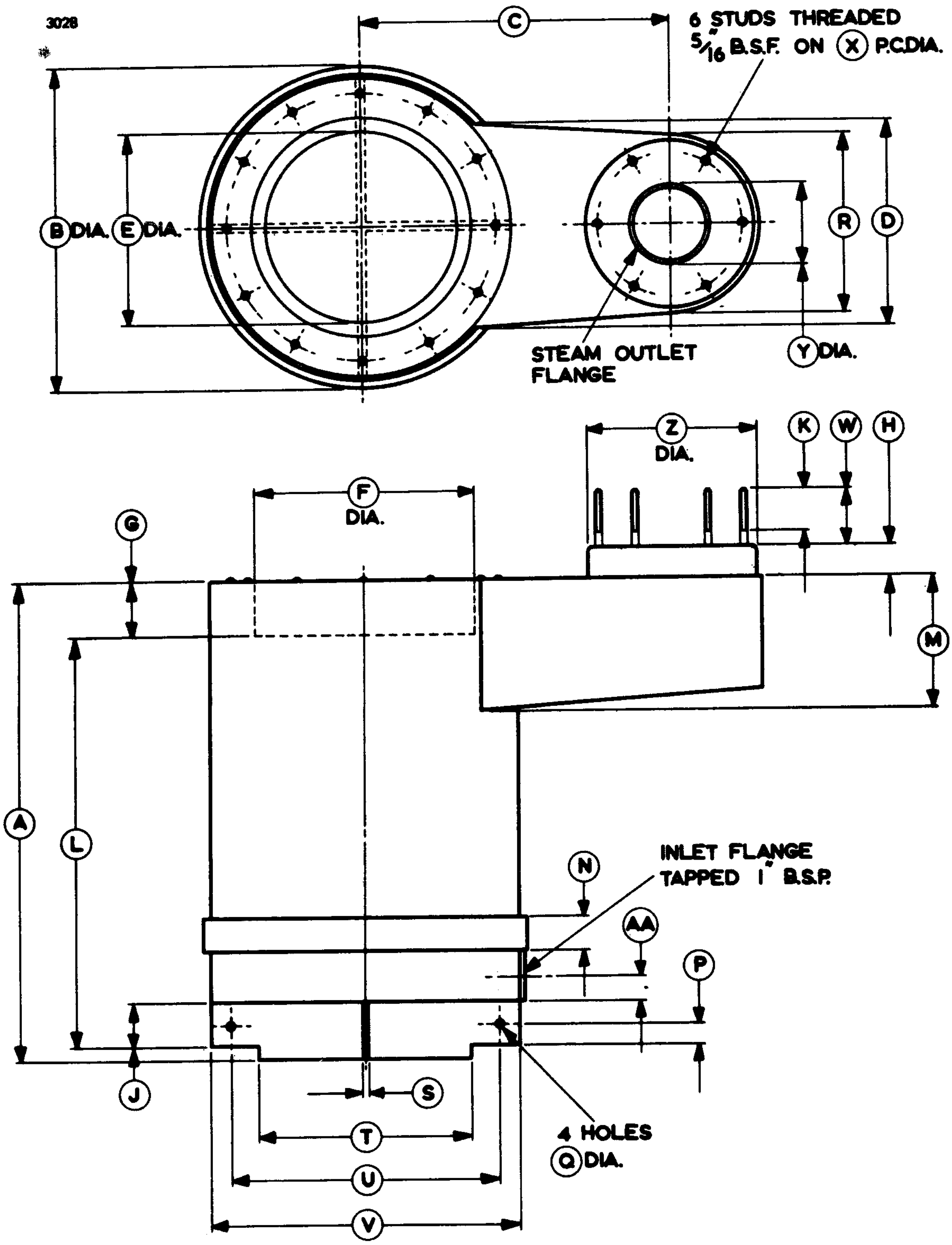
Net weight (empty)	60 pounds (27kg) approx
Water capacity of boiler to maximum water level	3imp.gal (13.6 l.) approx
Sealing ring (supplied with boiler)	MA255

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	17.750 max	450.9 max	P	0.750	19.05
B	11.500 ± 0.020	292.1 ± 0.51	Q	0.344	8.75
C	11.000	279.4	R	6.625 max	168.3 max
D	7.250 max	184.2 max	S	0.250 ± 0.010	6.35 ± 0.25
E	7.000 ± 0.010	177.8 ± 0.25	T	7.875 ± 0.020	200.0 ± 0.51
F	8.000 ± 0.010	203.2 ± 0.25	U	9.500 ± 0.010	241.3 ± 0.25
G	2.000	50.80	V	11.000 ± 0.020	279.4 ± 0.51
H	1.156 ± 0.010	29.36 ± 0.25	W	2.125	53.98
J	1.500	38.10	X	5.250	133.4
K	1.500	38.10	Y	2.750	69.85
L	15.125 ± 0.062	384.2 ± 1.57	Z	6.000 ± 0.010	152.4 ± 0.25
M	4.875 max	123.8 max	AA	0.937	23.80
N	1.250 ± 0.020	31.75 ± 0.51			

Millimetre dimensions have been derived from inches, except dimension Q.

OUTLINE FOR BY4049



GENERAL DATA FOR BY4060

Single boiler unit for use with BY1144 or BY1156. A separate condenser is required, with insulating pipes for the steam outlet and water return to the boiler. The valve is held in the boiler unit by its own weight.

The boiler unit may be mounted by means of the four bosses on the base, and these may also be used for h.t. supply connections. The unit can be modified in some respects to meet the requirements of particular applications.

Distilled or de-mineralized water should be used in the boiler unit.

Net weight (empty) . . . . 100 pounds (45kg) approx
Water capacity of boiler to
maximum water level . . . . 8imp.gal (37 l.) approx
Sealing ring (supplied with boiler) MA260

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	15.000	381.0	J	0.750	19.05
B	18.000 max	457.2 max	K	2.406	61.11
C	13.500	342.9	L	4.000	101.6
D	4.000	101.6	M	0.250	6.35
E	1.500	38.10	N	0.625	15.88
F	7.000	177.8	P	16.000	406.4
G	2.125	53.98	Q	4.500	114.3
H	7.750	196.9	R	6.500	165.1

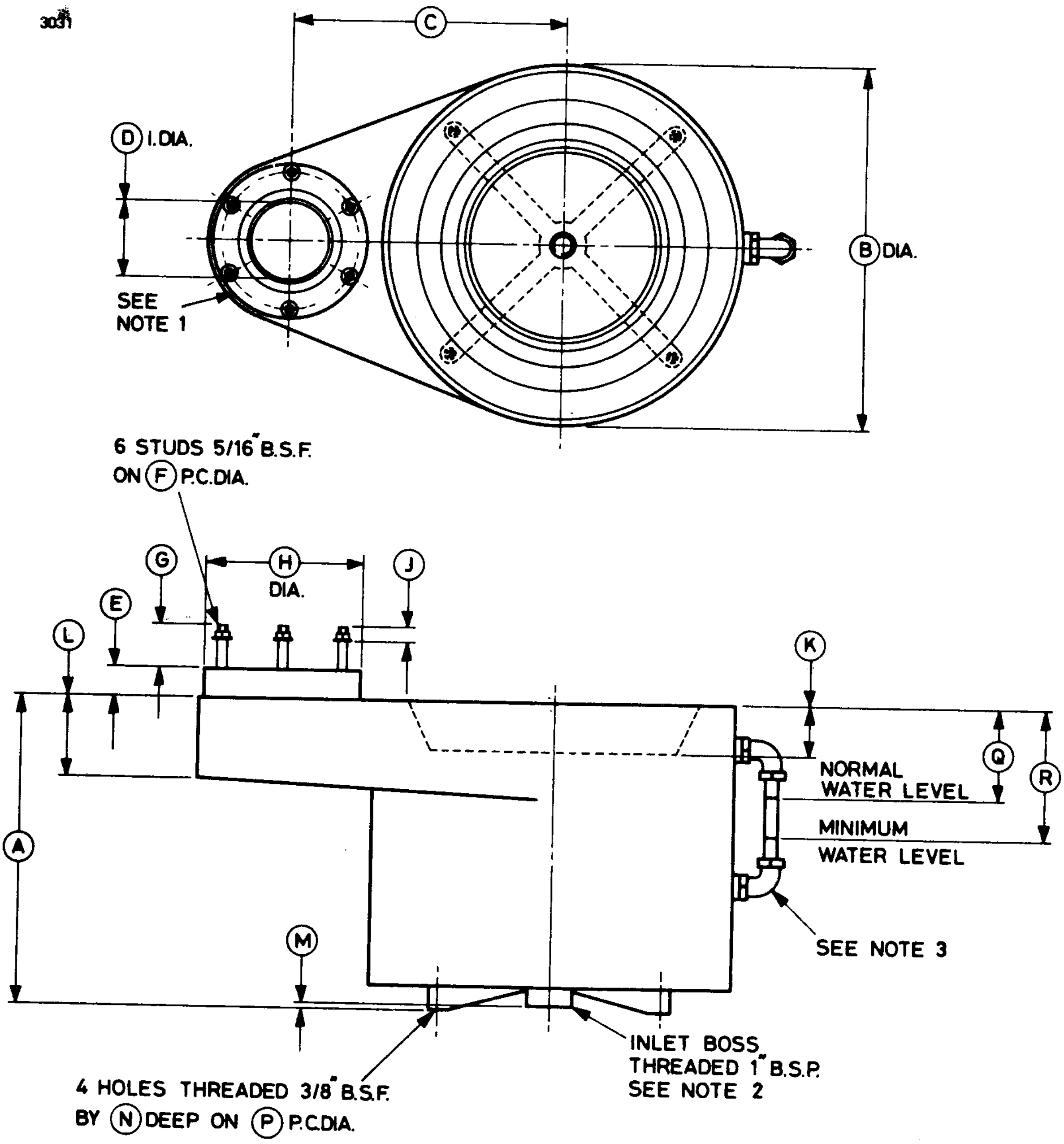
Millimetre dimensions have been derived from inches.

Outline Notes

1. It is recommended that the following QVF fittings* should be used for the steam outlet section; they are not supplied with the unit:
   (a) One glass section PS4/24, 24 inches (610mm) long.
   (b) Two backing flanges CF4.
   (c) One PTFE bellows FB4 (these are supplied with flanges).
   (d) Two rubber inserts CNR4.
   (e) One gasket CGB/4 (only required if bellows FB4 are not used).
   (f) Twelve bolts NB4 (if bellows FB4 are used).
   (g) Six bolts NB4 (if bellows FB4 are not used).
2. An inlet water tube, EEV part MA239, can be supplied.
3. The BY4060 can be supplied with a water level indicator fitted (as shown) if this is specified on the customer's order.

* Available from Q.V.F. Limited, Duke Street, Fenton, Stoke-on-Trent, Staffordshire.

OUTLINE FOR BY4060



GENERAL DATA FOR BY4063

Single boiler unit for use with BY1121. A separate condenser is required, with insulating pipes for the steam outlet and water return to the boiler. The valve is held in the boiler unit by its own weight.

The boiler unit may be mounted by means of the four lugs on the base, and these may also be used for h.t. supply connections. The unit can be modified in some respects to meet the requirements of particular applications.

Distilled or de-mineralized water should be used in the boiler unit.

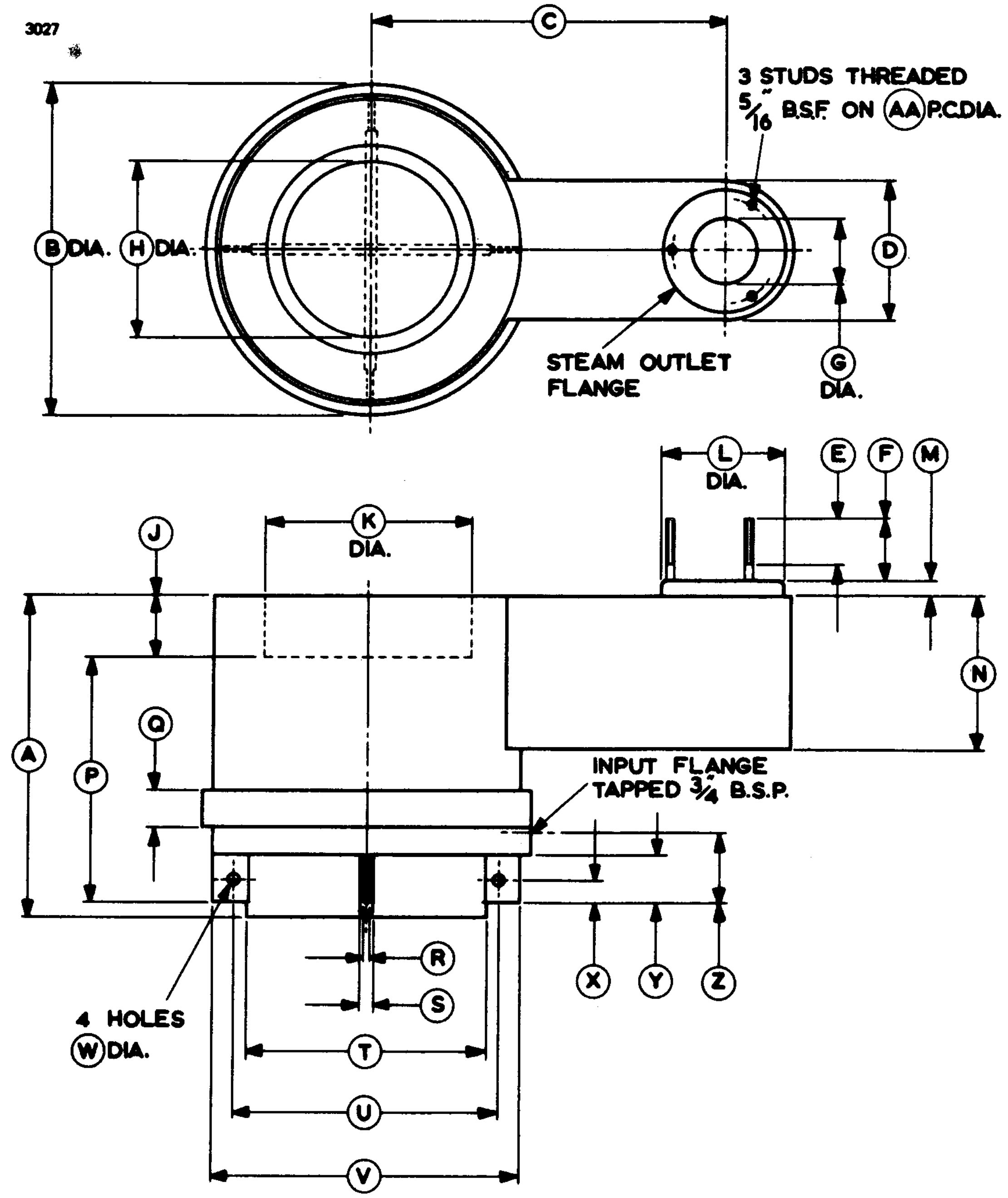
Net weight (empty)	42 pounds (19kg) approx
Water capacity of boiler to maximum water level	1½imp.gal (6.8 l.) approx
Sealing ring (supplied with boiler)	MA326

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.500	266.7	P	8.000	203.2
B	10.750	273.1	Q	1.250	31.75
C	11.500	292.1	R	0.250	6.35
D	4.500	114.3	S	0.313	7.95
E	1.500	38.10	T	7.125	181.0
F	2.125	53.98	U	8.750 ± 0.010	222.3 ± 0.25
G	2.062	52.37	V	10.250	260.4
H	5.812	147.6	W	0.344	8.74
J	2.000	50.80	X	0.750	19.05
K	6.875	174.6	Y	1.500	38.10
L	4.375	111.1	Z	2.250	57.15
M	0.500	12.70	AA	3.875	98.43
N	5.500	139.7			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4063



GENERAL DATA FOR BY4064

Single boiler unit with integral condenser system for use with BY1122 or BY1124. The valve is held in the boiler unit by its own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

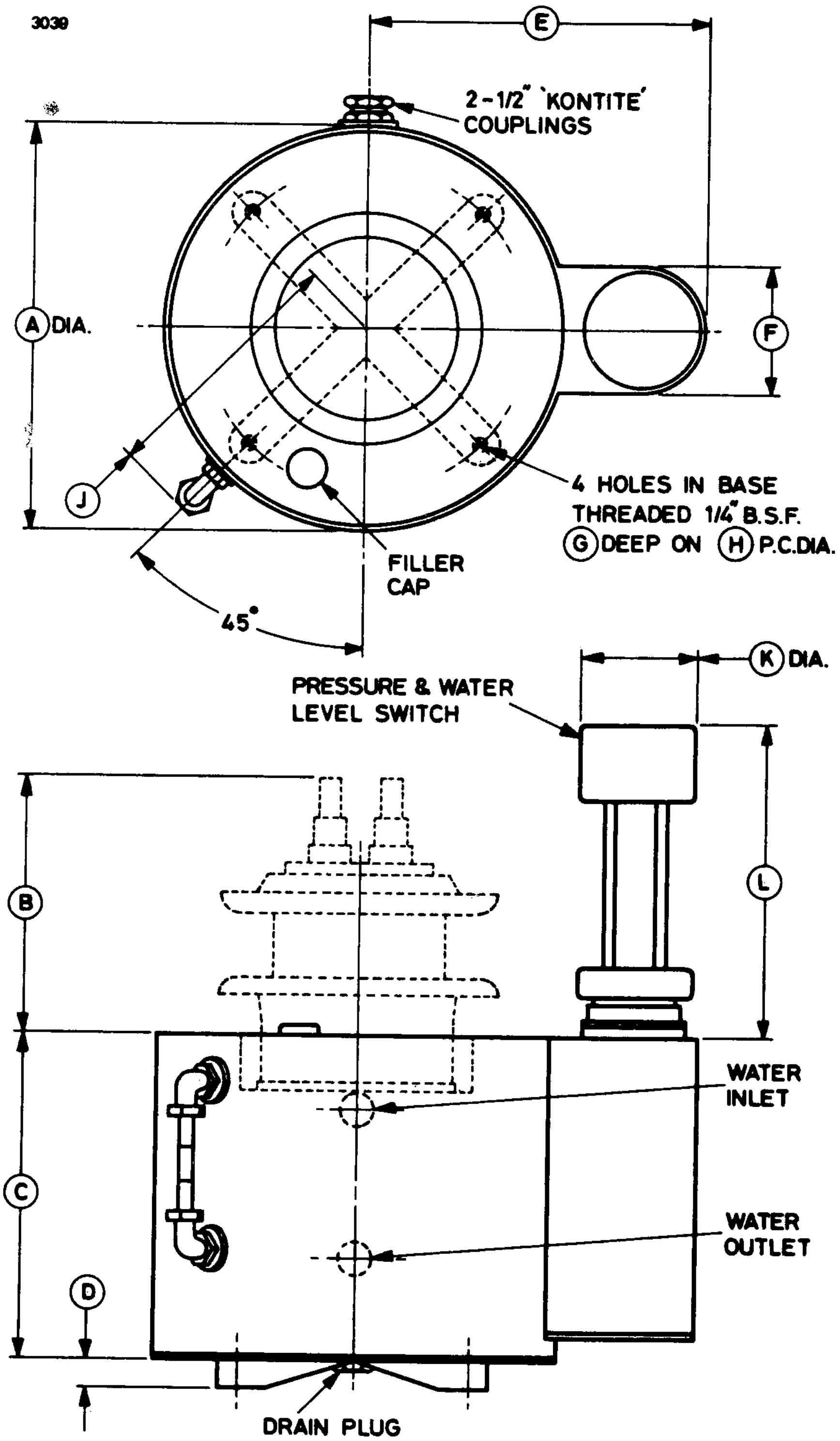
Net weight (empty)	26 pounds (12kg) approx
Water capacity of boiler to maximum water level	1½imp.gal (6.8 l.) approx
Condenser water flow	1imp.gal/min (4.5 l./min) approx
Sealing ring (supplied with boiler)	MA253

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	10.250	260.4	G	0.375	9.53
B	6.500 max	165.1 max	H	8.312	211.1
C	8.250	209.6	J	6.562 max	166.7 max
D	0.750	19.05	K	3.000	76.20
E	8.656 max	219.9 max	L	8.031	204.0
F	3.250	82.55			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4064



GENERAL DATA FOR BY4093

Single boiler unit with integral condenser system for use with BY1161. The valve is held in the boiler unit by its own weight.

A visual water-level indicator is incorporated. The water in the boiler unit must not fall below the minimum level; the cut-out switch mounted above the boiler can be used to switch off power to the valve should the water level fall. A part of the cut-out assembly also acts as a steam pressure relief valve and switches off power if excessive pressure builds up inside the unit.

Distilled or de-mineralized water should be used in the boiler unit; any suitable supply of clean water may be used for the condenser system.

The unit can be supplied with alternative water connections and can be readily adapted to suit particular applications.

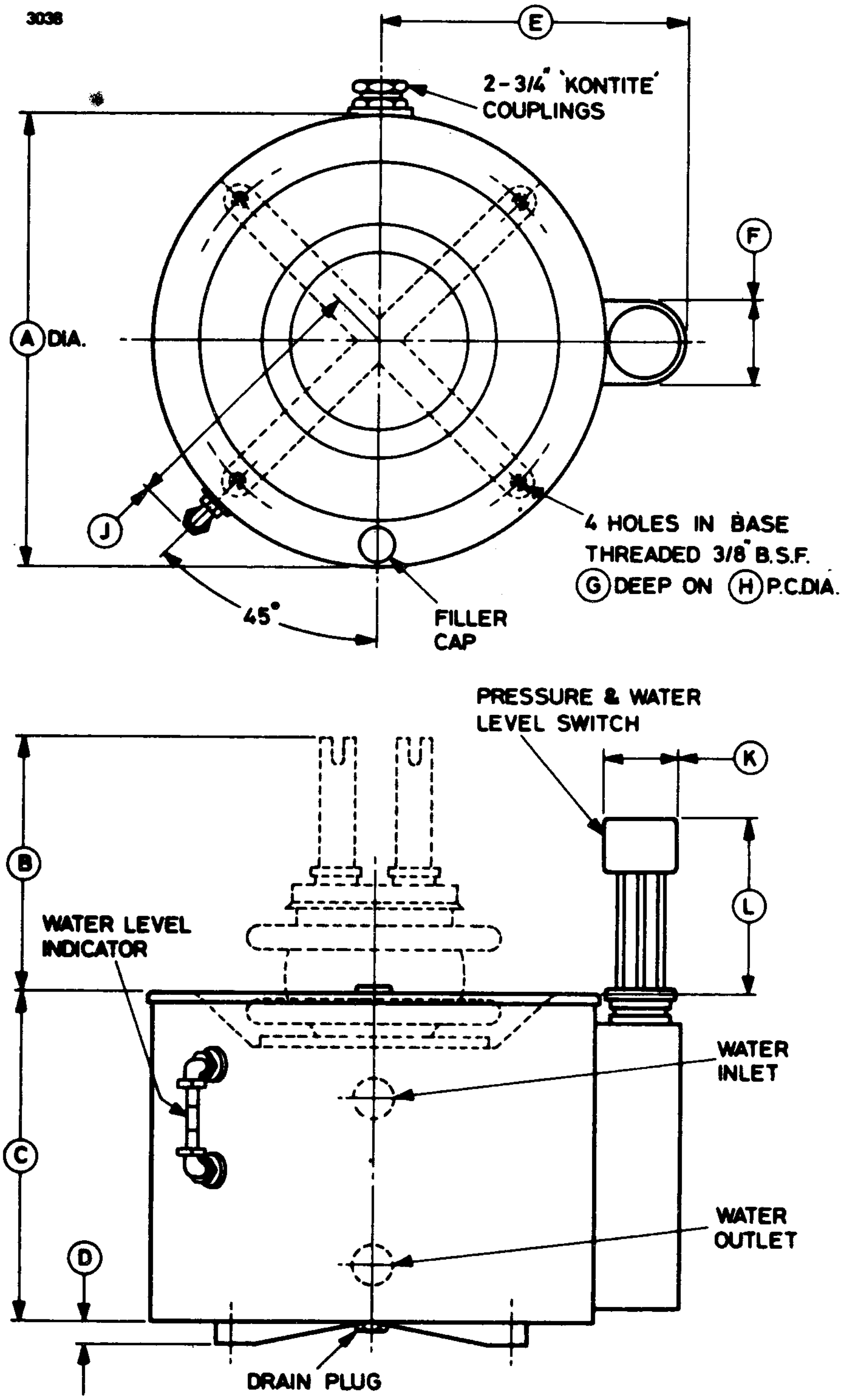
Net weight (empty)	85 pounds (39kg) approx
Water capacity of boiler to maximum water level	6imp.gal (27 l.) approx
Condenser water flow	5imp.gal/min (23 l./min) approx
Sealing ring (supplied with boiler)	MA245

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	17.875 max	454.0 max	G	0.625	15.88
B	9.900	251.5	H	15.500	393.7
C	12.875 max	327.0 max	J	10.375 max	263.5 max
D	0.750	19.05	K	3.000	76.20
E	12.156 max	308.8 max	L	6.875 max	174.6 max
F	3.250	82.55			

Millimetre dimensions have been derived from inches.

OUTLINE FOR BY4093



POWER TRIODES

GENERAL SECTION

MEDIUM POWER TRIODES

HIGH POWER TRIODES

POWER TRIODE ACCESSORIES