AMPLIFIER KLYSTRONS

EEV Product Data

QUICK REFERENCE DATA

AMPLIFIER KLYSTRONS

C.W. AMPLIFIER KLYSTRONS For Television Service

EEV type	Tuning range (MHz)	Sat. output power‡ (kW)	Beam voltage (kV)	Beam current (A)	Cooling (see below)	Circuit assembly
K365	400–610	11	17	1.8	1,2	K4019A
K370	470–606	11.5	12.5	2.8	1,3	K4145
K371	606–742	11.5	12.5	2.8	1,3	K4146
K372	742–854	11.5	12.5	2.8	1,3	K4147
K376L	470–610	28	18	4.6	1,2	K4204
K377L	590–720	28	18	4.6	1,2	K4205
K3217HBCD	470–590	45	21.5	5.25	1,2,3	K4170
K3218HBCD	590–702	45	21.5	5.25	1,2,3	K4171
K3219HBCD	702–860	45	21.5	5.25	1,2,3	K4172
K3230BCD	470–596	32	19	4.2	1,2	K4204
K3231BCD	590–704	32	19	4.2	1,2	K4205

Continued on page 2

‡ At klystron output flange; bandwidth 8 MHz.

Cooling 1. Forced-air cooled. 2. Water cooled. 3. Vapour cooled.

TELEVISION AMPLIFIERS – continued

EEV type	Tuning range (MHz)	Sat. output power‡ (kW)	Beam voltage (kV)	Beam current (A)	Cooling (see page 3)	Circuit assembly
					1,3	K4275
K3270BCD	470–860	15	19	1.95	1,2	K4275W
					1,3	K4276
K3271BCD	470–860	25	24	2.6	1,2	K4276W
		40	22.5	5.7		
K3272WBCD	470–860	58	25.5	6.5	1,2	K4251W
K3276HBCD	470–596	58	24	6.0	1,2	K4204
K3277HBCD	590–710	58	24	6.0	1,2	K4205
K3278HBCD	702–860	58	24	6.0	1,2	K4206
K3282BCD	470–610	45	22	6.2	1,2,3	K4170
K3283BCD	590–720	45	22	6.2	1,2,3	K4171
K3284BCD	700–860	45	22	6.2	1,2,3	K4172
K3382BCD	470–590	58	23.5	6.15	1,2,3	K4170
K3383BCD	590–702	58	23.5	6.15	1,2,3	K4171
K3384BCD	702–860	58	24	6.0	1,2,3	K4172
		40	23.5	5.0	1,3	K4651
K3572BCD	470–810	58	25.5	6.0	1,2	K4651W
		40	23.5	5.0	1,3	K4653
K3573BCD	470–860	58	25.5	6.0	1,2	K4653W
		40	21	4.0	1,3	K4651
K3672BCD	470–810	64	27	6.0	1,2	K4651W
		40	21	4.0	1,3	K4653
K3673BCD	470–860	64	27	6.0	1,2	K4653W
		40	24.5	5.6	1,3	K4653
K3773BCD	470–860	74	27.5	7.0	1,2	K4653W

C.W. AMPLIFIER KLYSTRONS For Tropospheric Scatter Service

EEV type*	Tuning range (MHz)	Output power† (kW)	Beam voltage (kV)	Beam current (A)	Cooling (see below)
3K3000LQ	610–985	2.8	9.0	0.6	1
4KM50,000LQ	610–985	10.5	17	1.8	1,2
4KM50,000LR	755–985	12	17	1.8	1,2
K386	755–985	11.5	12	2.7	1,3

C.W. AMPLIFIER KLYSTRONS For Satellite Communications

Five-cavity amplifier klystrons for use in earth-to-satellite communication systems. Mechanically tunable over the range 5925 to 6425 MHz, they include channel tuners for rapid channel selection. Focusing is by integral permanent magnet and the klystron is forced-air cooled.

EEV type	Tuning range (MHz)	Output power (kW)	Channel tuners	Beam voltage (kV)	Beam current (A)
K3936G6	5925–6425	3.0	6	8.0	1.05
K3936G12	5925–6425	3.0	12	8.0	1.05
K3936L6	5925–6425	3.35	6	8.2	1.08
K3936L12	5925–6425	3.35	12	8.2	1.08
K3936L24	5925–6425	3.35	24	8.2	1.08

‡ At klystron output flange; bandwidth 8 MHz.

† Narrow band operation.

Cooling

1 Forced-air cooled.

2 Water cooled.

3 Vapour cooled.

PULSE AMPLIFIER KLYSTRON

EEV type •	Tuning range (MHz)	Output power (peak) (kW)	Gain (dB)	Beam voltage (kV)	Cooling (see below)
K347A	580–615	600	33	75	1

Cooling 1 Forced-air cooled.

Chelmsford, Essex, England

Subsidiary of The General Electric Company, p.l.c. of England Printed in England

K365

AMPLIFIER KLYSTRON

ABRIDGED DATA

Four cavity, electro-magnetically focused amplifier klystron, with separate tuning cavities, for u.h.f. television service. The collector is water cooled in an integral water jacket. A modulating anode is fitted which may be used for beam current control or as a protective device.

The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

Frequency range	400 to 610	MHz
Output power (peak sync.)	11	kW
Power gain (typical, 6.0MHz bandwidth)	30	dB
Beam voltage	17	kV
Circuit assembly		K4019A
Output	$3^1/_8$ inch 50Ω coaxial line	
Cooling (see page 2)	water and forced-air	

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	7.5	V
Heater current range	38 to 42	A
Heater starting current (peak)	80	A max

Mechanical

Overall length	62.5 inches (159cm) nom
Overall diameter	5.125 inches (13cm) nom
Mounting position	vertical, cathode end up
Net weight of klystron	64 pounds (29kg) approx

November 1980

Supersedes July 1977 Issue

Circuit Assembly

Prefocus coil voltage	0 to 50	V
Prefocus coil current:		
maximum	1.5	A
typical	1.0	A
Body and collector coils voltage:		
range	0 to 600	V
typical	500	V
Body and collector coils current (typical)	2.6	A
R.F. input connector		UG-58/U
R.F. output	$3^1/_8$ inch 50Ω coaxial line	
Load couplers	$1^5/_8$ inch coaxial terminals	
Net weight with K365 klystron	831 pounds (378kg) approx	
Cavity tuning controls:		
total turns	55	
torque	1.67 lb-ft (0.231kg-m) max	
Output coupler control:		
total turns	25	
torque	0.83 lb-ft (0.115kg-m) max	

Cooling

At sea level and with an inlet air temperature of 20°C the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Air flow to cathode	25	ft^3/min
	0.71	m^3/min
Air flow to output cavity	50	ft^3/min
	1.42	m^3/min
Water flow to klystron body	1.0	imp.gal/min
	4.5	l./min
Water flow to collector	25	imp.gal/min
	114	l./min
Outlet water temperature	70	°C max
The temperature of any external part of the klystron must not exceed	175	°C

MAXIMUM RATINGS (Absolute values)

No individual rating should be exceeded (see note 4)

Beam voltage	20	kV max
Beam current (mean)	2.5	A max
Body current (mean):		
for continuous operation	0.15	A max
for tuning	0.25	A max
Focus electrode voltage (negative)	500	V max
Collector dissipation	50	kW max

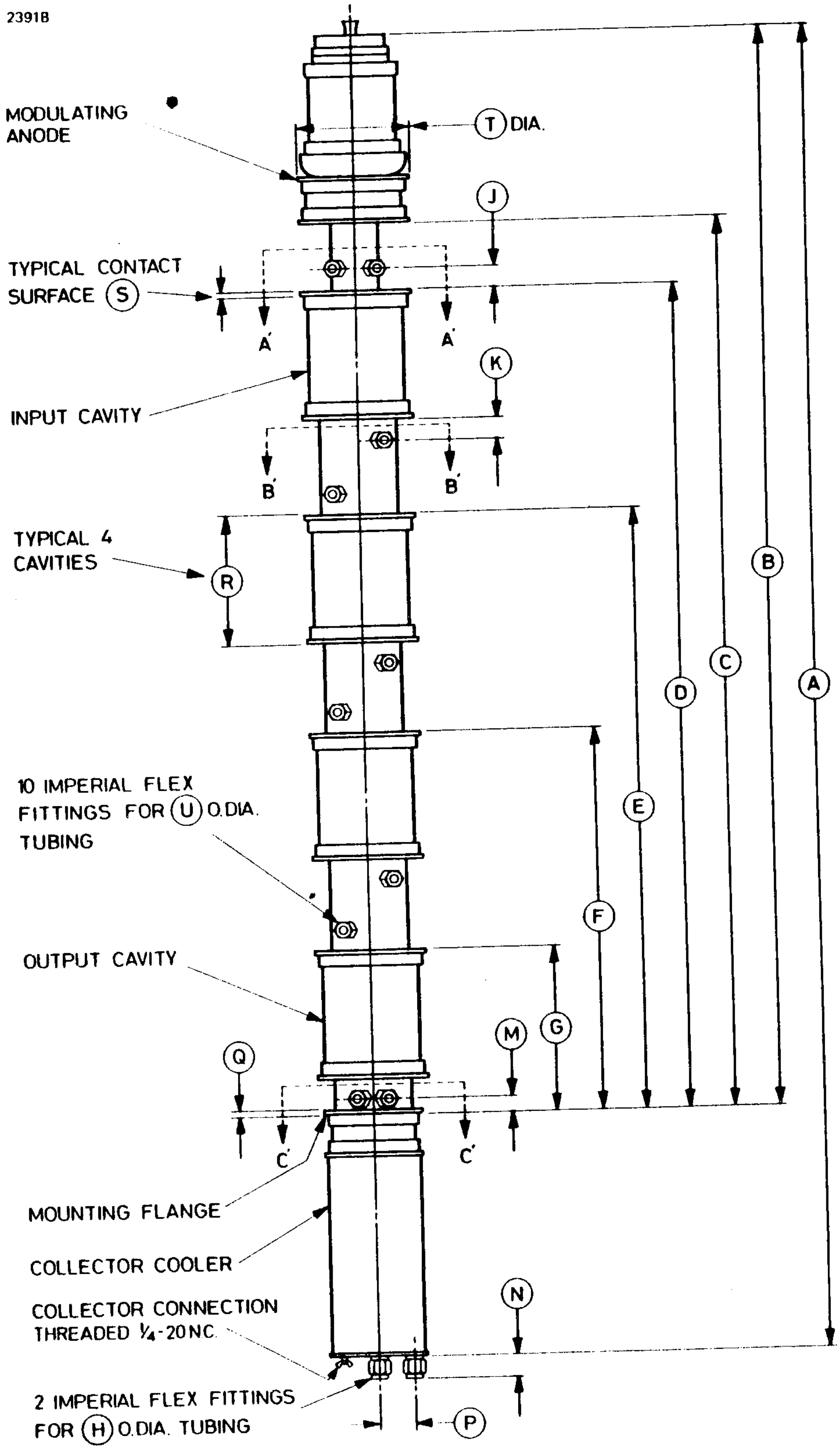
TYPICAL OPERATION (Vision amplifier)

Frequency	500	MHz
Beam voltage	17	kV
Beam current	1.8	A
Bandwidth	6.0	MHz
Focus electrode voltage	−200	V
Body current (mean)	70	mA
Drive power (see note 1)	10	W
Second cavity power (see note 2)	25	W
Third cavity power (see note 2)	100	W
Output power (peak sync.)	11	kW

NOTES

1. The drive power specified should be available if required.
2. For broad-band operation the cavities are loaded externally; the power specified is that dissipated in the external load.
3. The modulating anode is connected to the body of the klystron by a 10 kΩ resistor.
4. If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

OUTLINE


23918
MODULATING ANODE
T DIA.
J
TYPICAL CONTACT SURFACE S
A'
A'
K
INPUT CAVITY
B'
B'
TYPICAL 4 CAVITIES
R
B
C
D
A
10 IMPERIAL FLEX FITTINGS FOR U O.DIA. TUBING
E
F
OUTPUT CAVITY
G
M
Q
C'
C'
MOUNTING FLANGE
COLLECTOR COOLER
COLLECTOR CONNECTION THREADED ¼-20NC.
N
2 IMPERIAL FLEX FITTINGS FOR H O.DIA. TUBING
P

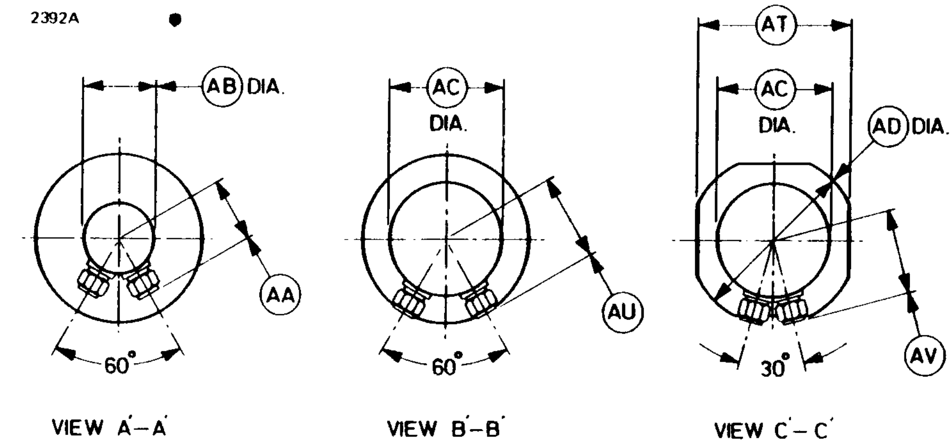
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres
A	61.410 ± 0.255	1559.8 ± 6.5
B •	49.900	1267.5
C	41.160	1045.5
D	38.100	967.7
E	27.900	708.7
F	17.700	449.6
G	7.500	190.5
H	0.750	19.05
J	1.000	25.40
K	0.875	22.23
M	0.675	17.15
N	1.125	28.58
P	1.625	41.28
Q	0.250	6.35
R	6.010	152.65
S	0.250	6.35
T	5.125	130.18
U	0.313	7.95

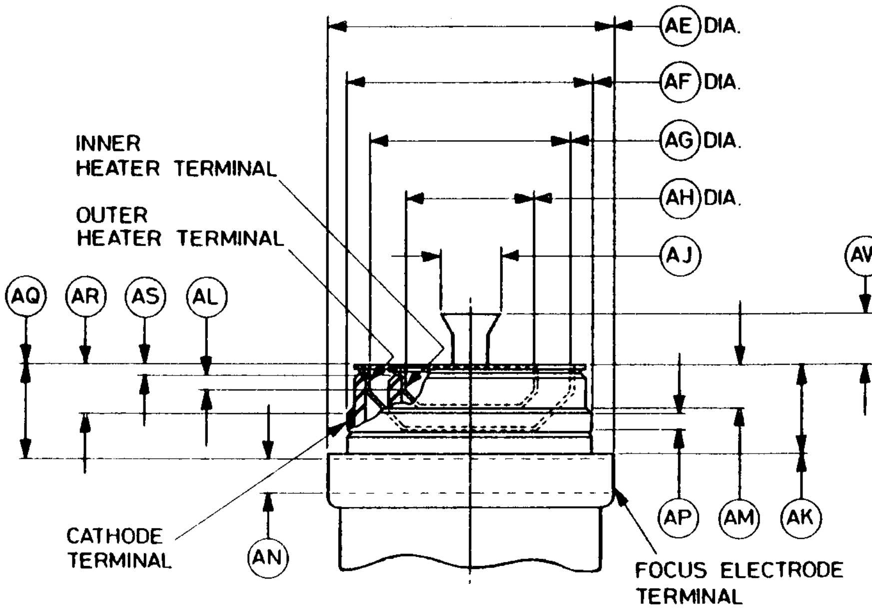
Millimetre dimensions have been derived from inches.

OUTLINE DETAILS

Detail of Body Sections



Detail of Cathode Terminals

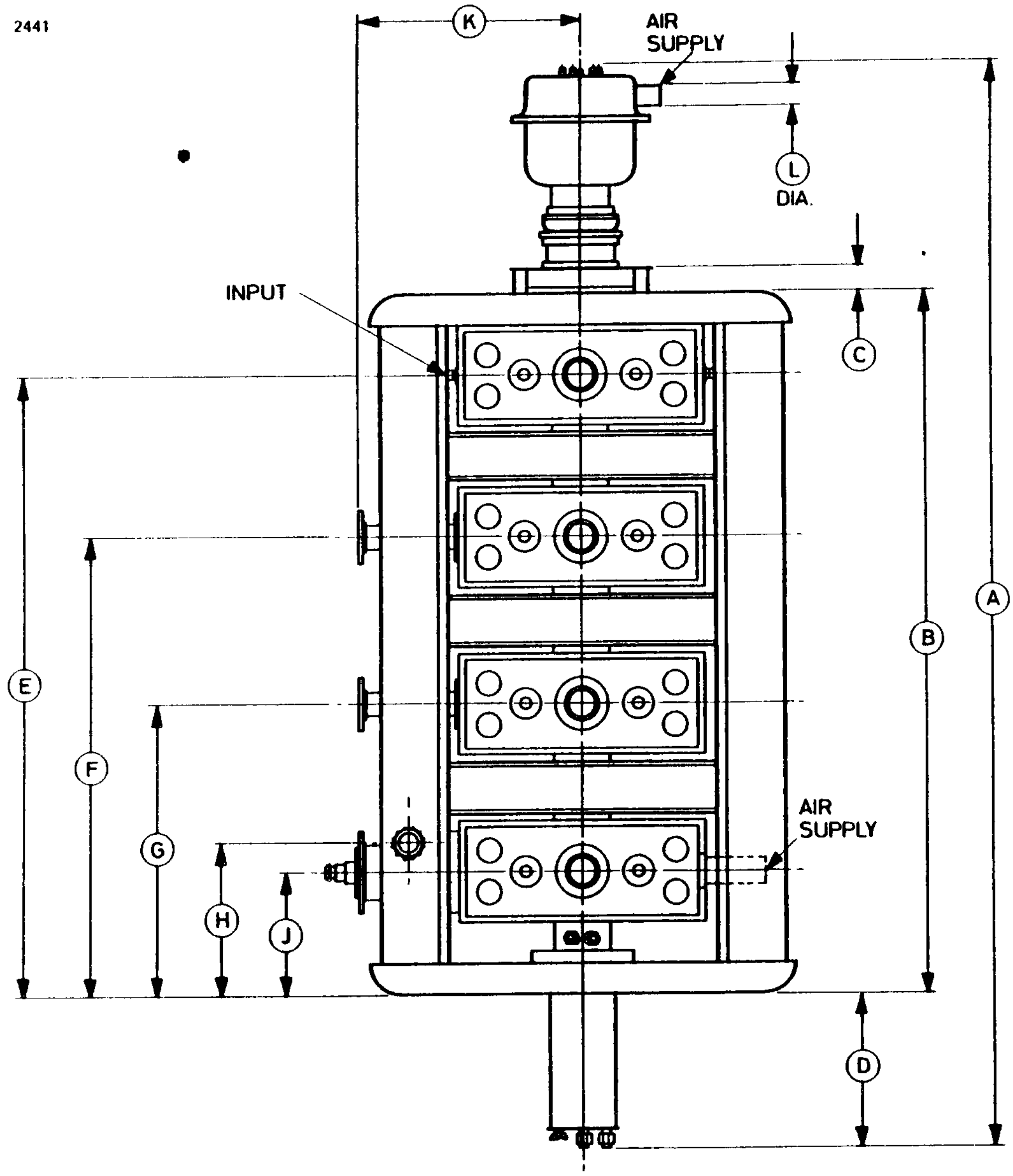


Outline Detail Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres
AA •	1.875	47.63
AB	2.120	53.85
AC	3.500	88.90
AD	5.125	130.18
AE	4.375	111.13
AF	3.783	96.09
AG	3.188	80.98
AH	1.938	49.23
AJ	1.261 max	32.03 max
AK	1.312	33.32
AL	0.250 min	6.35 min
AM	0.656	16.66
AN	0.500 min	12.70 min
AP	0.125 min	3.18 min
AQ	1.344	34.14
AR	0.750	19.05
AS	0.156 min	3.96 min
AT	4.625	117.48
AU	2.562	65.07
AV	2.562	65.07
AW	1.750 max	44.45 max

Millimetre dimensions have been derived from inches.

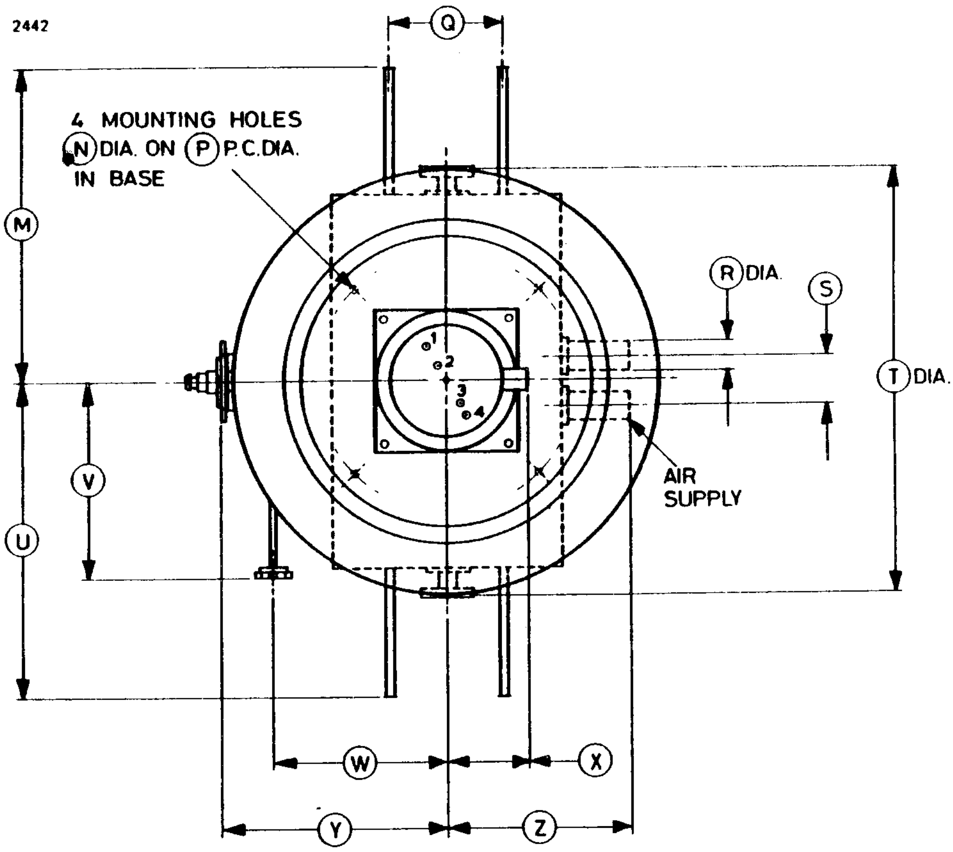
OUTLINE OF K4019A (All dimensions nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	66.500	1689	G	17.719	450.1
B	43.062	1094	H	9.312	236.5
C	1.625	41.27	J	7.500	190.5
D	9.625	244.5	K	13.688	347.7
E	38.125	968.4	L	1.500	38.10
F	27.906	708.8			

Millimetre dimensions have been derived from inches.

Top View of K4019A (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
M	19.250 max	489.0 max	U	19.250 max	489.0 max
N	0.438	11.12	V	12.000	304.8
P	16.250	412.8	W	10.625	269.9
Q	6.940	176.3	X	5.062	128.6
R	1.875	47.62	Y	13.656	346.9
S	3.000	76.20	Z	11.312	287.3
T	26.250	666.8			

Millimetre dimensions have been derived from inches.

Connections

1. Focus electrode, threaded 6–32 U.N.C.
2. Heater, threaded ¼–20 U.N.C.
3. Heater, threaded ¼–20 U.N.C.
4. Cathode, threaded 6–32 U.N.C.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. English Electric Valve Company cannot accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K370 K371 K372

HIGH POWER AMPLIFIER KLYSTRONS for U.H.F. TELEVISION SERVICE

FEATURING

- **Output Power** 12.5 kW output, combined with long life and reliable performance.
- **High Gain** Fully compatible with solid state drive.
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Air blown cavities ensure high operational stability.
- **Arc Detector in Output Cavity.** ☆
- **Simple Installation** Pre-adjusted cavities are an integral part of the transmitter. Vacuum tube changes can be carried out by unskilled staff in less than 30 minutes.
- **Simple Vapour Cooling** Collector down configuration with vapour cooling – silent, self-circulating system; no pump.
- **Adjustable Cavity Loading** Adjustable loops to give optimum overall system performance on any channel.

DESCRIPTION

K370, K371 and K372 are four-cavity amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The three tubes operate in the frequency bands 470–606 MHz, 606–742 MHz and 742–854 MHz respectively. A modulating anode is fitted, enabling the tubes to operate at lower power levels in sound transmitters but using the same beam voltage supply as the vision amplifier.

The tubes are electro-magnetically focused and their associated circuit assemblies are designed to reduce tube replacement time to a minimum. With this design, full use is made of the advantages of the external cavity klystron. On initial installation the cavities can be tuned to a specific channel and the loading loops adjusted for optimum television performance. The cavities can be detached from the vacuum tube and refitted on a replacement tube without disturbing the tuning or the loading loop settings. At switch-on, the replacement klystron will be coarse-tuned, requiring only a trimming adjustment to meet the full specification.

☆ Indicates a change.

December 1980

Supersedes November 1978 Issue

APPROVED CIRCUIT ASSEMBLIES

Klystron	Frequency in the range	Channels	Circuit Assembly
K370	470 to 606MHz	21–37	K4145
K371	606 to 742MHz	38–54	K4146
K372	742 to 854MHz	55–68	K4147

Note For operation of these tubes in circuit assemblies of the K4105, K4106, K4107 series, see data sheet K370, K371, K372 dated May 1969.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see note 1)	in the range 5.0 to 5.5	V
Heater current	38 to 44	A
Heater starting current (peak)	84	A max
Cathode heating time (minimum)	5	min

Mechanical

Overall length (see note 11):	
K370	44.187 inches (112.2cm) max
K371, K372	40.162 inches (102.0cm) max
Overall diameter	8 inches (20.3cm) max
Mounting position	vertical, cathode end up
Net weight of klystron:	
K370	60 pounds (27kg) approx
K371, K372	55 pounds (25kg) approx

Circuit Assembly

Electro-magnet current, stabilized to ±2% (see note 2)	11 to 13	A
Electro-magnet resistance:		
cold (20°C)	5.7	Ω
hot (20°C ambient)	7.3	Ω max
R.F. input connector	type N coaxial	
R.F. output	quick release 1⁵/₈ inch 50Ω coaxial line	
Net weight of tuning cavities:		
for K370	102 pounds (46kg) approx	
for K371	83 pounds (38kg) approx	
for K372	64 pounds (29kg) approx	
Net weight of magnet assembly	784 pounds (356kg) approx	

Arc Detector

Arc detector type MA257A is fitted to the output cavity.

Photo-resistor type		NSL462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A

Cooling

The klystron collector is vapour cooled. The boiler, which is part of the circuit assembly, is of the upward steam exit type and intended for use with a separate condenser.

The final drift tube and the four cavities are forced-air cooled. This is achieved by means of a single air inlet pipe on the circuit assembly, the air being directed to the required parts of the klystron by channeling within the circuit. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust.

Air flow for cavity cooling (minimum) . . .	100	ft^3/min
	2.8	m^3/min
Air flow to cathode terminal	5.0	ft^3/min
	0.14	m^3/min
Static pressure head at 100 ft^3/min (see note 3)	2.0	inches (51 mm) w.g.
Inlet air temperature	45	°C max
Temperature of any external parts of the klystron must not exceed	175	°C max
Volume of steam produced by collector dissipation	1.5	ft^3/min/kW
	0.043	m^3/min/kW
Volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	litre/min/kW

MAXIMUM AND MINIMUM RATINGS (Absolute values)

Beam voltage	14	kV max
Beam current (mean)	3.5	A max
Body current:		
with no input power	50	mA max
at saturated output power	150	mA max
Output power (saturated)	14	kW max
Collector dissipation	45	kW max
Load v.s.w.r. (see note 4)	1.5:1	max

Warning It is common practice when operating a klystron in a sound socket at reduced beam current (see page 5), to reduce the focus current. If the following minimum values are not observed, the klystron may be damaged even though the body current is not excessive.

K370, K371	8.0	A min
K372	9.0	A min

TYPICAL OPERATION

The operating conditions and performance figures given are for operation in a television transmitter giving a peak synchronous output power of 10 kW. The klystrons are also suitable for transposer service.

Operating Conditions

Beam voltage	12.5	kV
Beam current	2.8	A
Electro-magnet current	12	A
Bandwidth (to 1 dB points)	8.0	MHz

K370 in K4145 Circuit

Frequency	**470 to 478 (channel 21)**	**526 to 534 (channel 28)**	**598 to 606 (channel 37)**	**MHz**
Body current:				
with no input power	15	15	15	mA
black level + sync. (10 kW)	30	35	40	mA
at 11.25 kW c.w. output, vision frequency	50	55	65	mA
Drive power:				
at 10 kW output	1.2	0.8	0.65	W
at 11.25 kW output	1.5	1.0	0.8	W
Saturated output power	11.5	12.0	12.0	kW

K371 in K4146 Circuit

Frequency	**606 to 614 (channel 38)**	**670 to 678 (channel 46)**	**734 to 742 (channel 54)**	**MHz**
Body current:				
with no input power . . .	17	17	17	mA
black level + sync. (10 kW) .	21	25	35	mA
at 11.25 kW c.w. output, vision frequency	25	35	55	mA
Drive power:				
at 10 kW output	1.0	0.4	0.4	W
at 11.25 kW output . . .	1.3	0.6	0.6	W
Saturated output power . . .	12.3	12.5	12.0	kW

K372 in K4147 Circuit

Frequency	**742 to 750 (channel 55)**	**790 to 798 (channel 61)**	**846 to 854 (channel 68)**	**MHz**
Body current:				
with no input power . . .	17	17	17	mA
black level + sync. (10 kW) .	25	28	26	mA
at 11.25 kW c.w. output, vision frequency	40	55	40	mA
Drive power:				
at 10 kW output	0.8	0.5	0.3	W
at 11.25 kW output . . .	1.0	0.7	0.5	W
Saturated output power . . .	11.8	12.4	12.3	kW

Sound Amplifier Service

For operation at the same beam voltage as the vision amplifier and one fifth of the output power, the beam current is reduced to one fifth that of the vision amplifier klystron by means of the modulating anode. The graph on page 10 shows approximately the modulating anode voltage required for a given beam current (the voltage is expressed relative to cathode potential). Under these conditions the modulating anode current may vary between 0 and 1.5 mA. If a potential divider network is used to supply the modulating anode it must allow for this variation.

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN
K370 IN K4145 CIRCUIT, VISION AMPLIFIER SERVICE

Test Conditions

Heater voltage	5.0 to 5.5	V
Electro-magnet current	11 to 13	A
Frequency range	470 to 606	MHz
Bandwidth (see note 5)	8.0	MHz
Output power (see note 6)	11.25	kW

Range of Characteristics

	Min	Max	
Heater current	38	44	A
Beam voltage (see note 7):			
frequency range 470 to 490 MHz	–	13.5	kV
frequency range 490 to 606 MHz	–	13.0	kV
Body current (see note 8)	–	150	mA
Modulating anode current	–	5.0	mA
R.F. drive power (see note 9)	–	1.5	W
Efficiency (see note 10):			
frequency range 470 to 490 MHz	29	–	%
frequency range 490 to 606 MHz	32	–	%

K371 IN K4146 CIRCUIT, VISION AMPLIFIER SERVICE

Test Conditions

Heater voltage	5.0 to 5.5	V
Electro-magnet current	11 to 13	A
Frequency range	606 to 742	MHz
Bandwidth (see note 5)	8.0	MHz
Output power (see note 6)	11.25	kW

Range of Characteristics

	Min	Max	
Heater current	38	44	A
Beam voltage (see note 7)	–	13	kV
Body current (see note 8)	–	150	mA
Modulating anode current	–	5.0	mA
R.F. drive power (see note 9)	–	1.5	W
Efficiency (see note 10)	32	–	%

K372 IN K4147 CIRCUIT, VISION AMPLIFIER SERVICE

Test Conditions

Heater voltage	5.0 to 5.5	V
Electro-magnet current	11 to 13	A
Frequency range	742 to 854	MHz
Bandwidth (see note 5)	8.0	MHz
Output power (see note 6)	11.25	kW

Range of Characteristics

	Min	Max	
Heater current	38	44	A
Beam voltage (see note 7)	–	13	kV
Body current (see note 8)	–	150	mA
Modulating anode current	–	5.0	mA
R.F. drive power (see note 9)	–	1.5	W
Efficiency (see note 10)	32	–	%

NOTES

1. When a klystron is first installed it must be operated at 5.0 V heater voltage. If, after some thousands of hours operation, the beam current drops slightly or takes longer than normal to reach full value after switch-on it is permissible to increase the heater voltage to a maximum of 5.5 V. The heater supply must be able to deliver 5.5 V under load at the heater terminals.
2. Under T.V. picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within the specified range of electro-magnet current. Maximum stability is obtained by adjusting the magnet current within this range and stabilizing to $\pm$ 2% about this optimum value.
3. Measured at the input to the circuit assembly.
4. This value applies to television service. English Electric Valve Company Ltd. should be consulted regarding other conditions of service.
5. The klystron is tuned so that, for constant input power, the variation in output power is less than 1 dB over the specified bandwidth at all power levels between −2 dB and −14 dB with respect to the specified output power.
6. Input frequency set 2.75 MHz below the centre of the 8 MHz channel, and the input power and beam power adjusted to give the specified output.

7. With the modulating anode connected to the body via a 10 kΩ resistor the beam current will be within ± 5% of the value given by the graph on page 10.
8. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
9. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.
10. The efficiency will not fall below the specified limit for any beam power in the range 30 to 40 kW.
11. Using lifting yoke MA365 (available to order), the clearance required above the circuit assembly for tube removal is 54 inches (1.37 m).

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a tube is damaged. English Electric Valve Company cannot accept responsibility for damage or injury resulting from the use of EEV tubes. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities and airpipes fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities, airpipes and electron gun enclosure fitted.

Beryllium Oxide Ceramics

The **output** cavity ceramic of these klystrons is made of beryllium oxide (coloured blue, or marked with a black line). **Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramic;** if it is touched, the hands must be washed before smoking or eating.

Do not do anything to the beryllium oxide ceramic which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

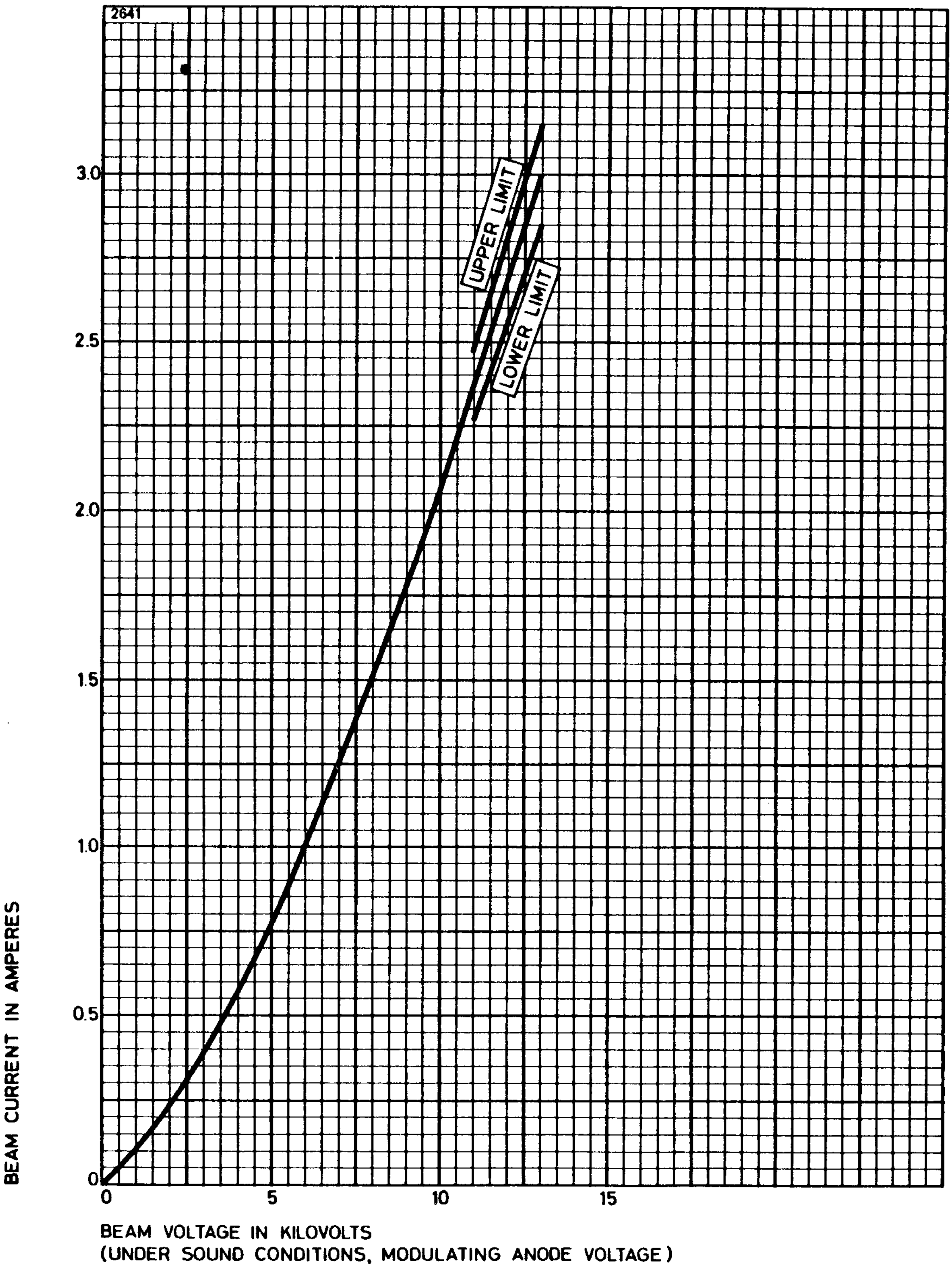
a) Wear impervious rubber gloves and use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths and discarded rubber gloves wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

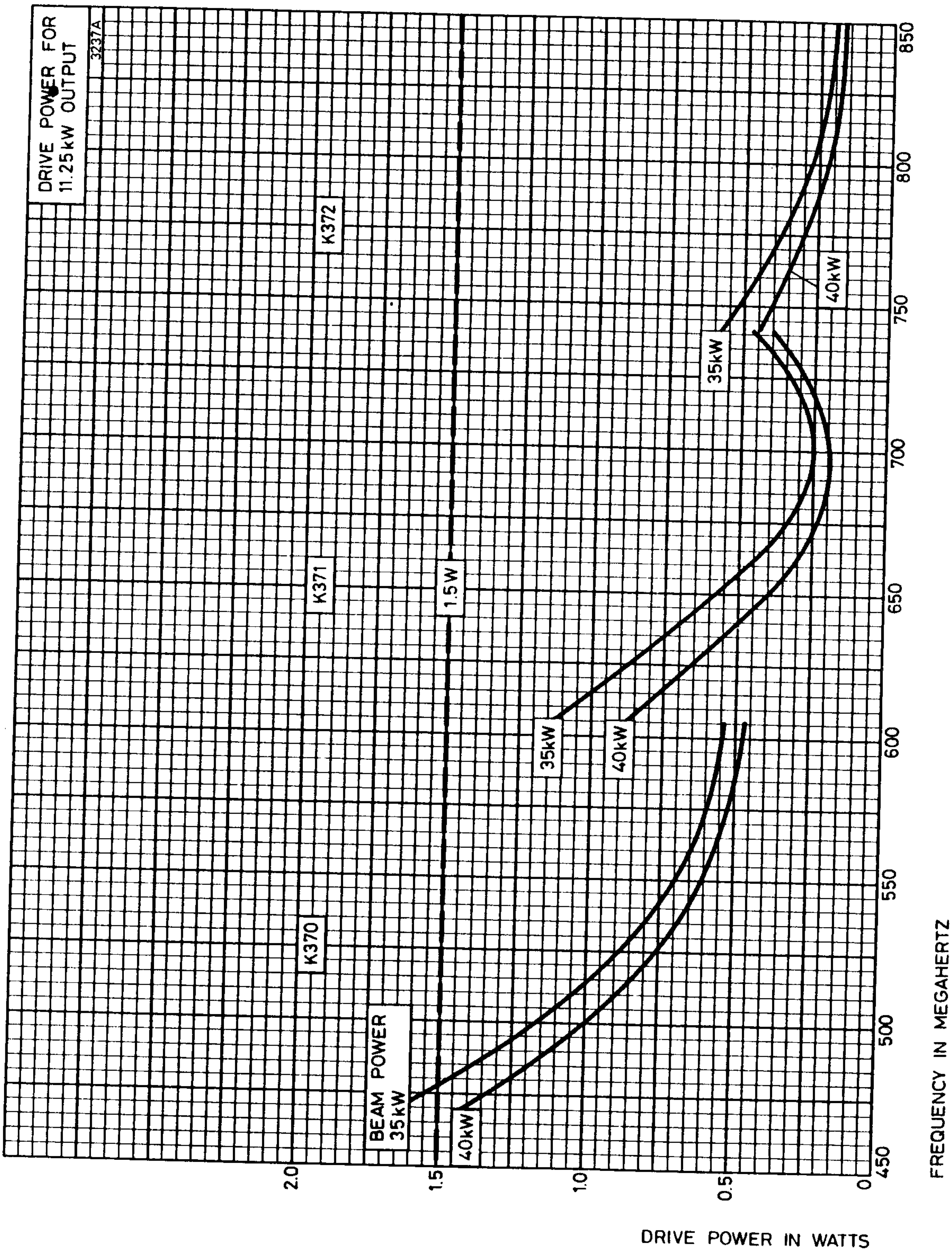
c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

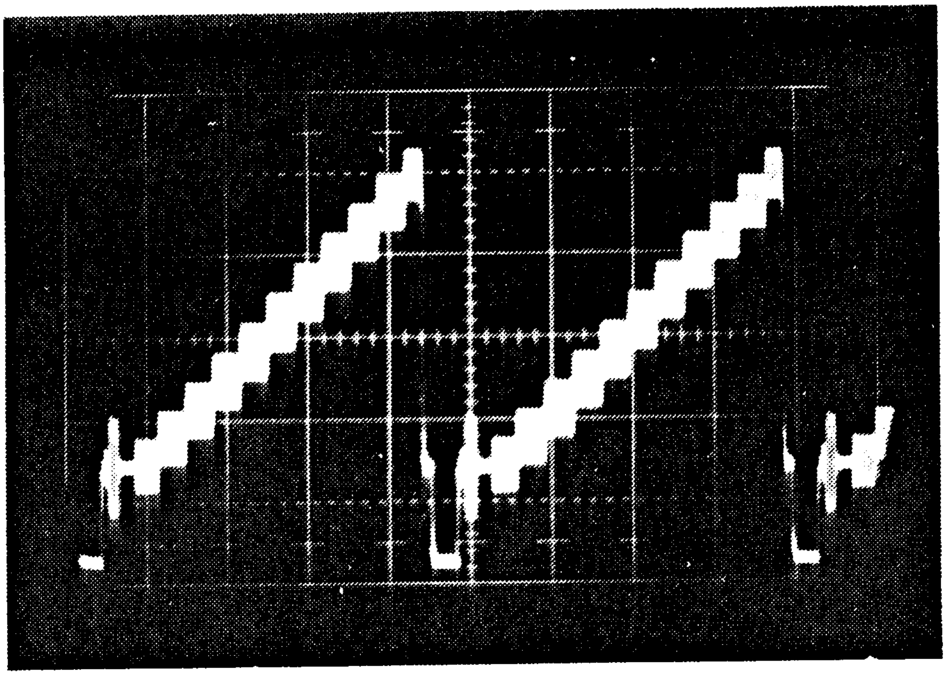
TYPICAL BEAM CHARACTERISTIC



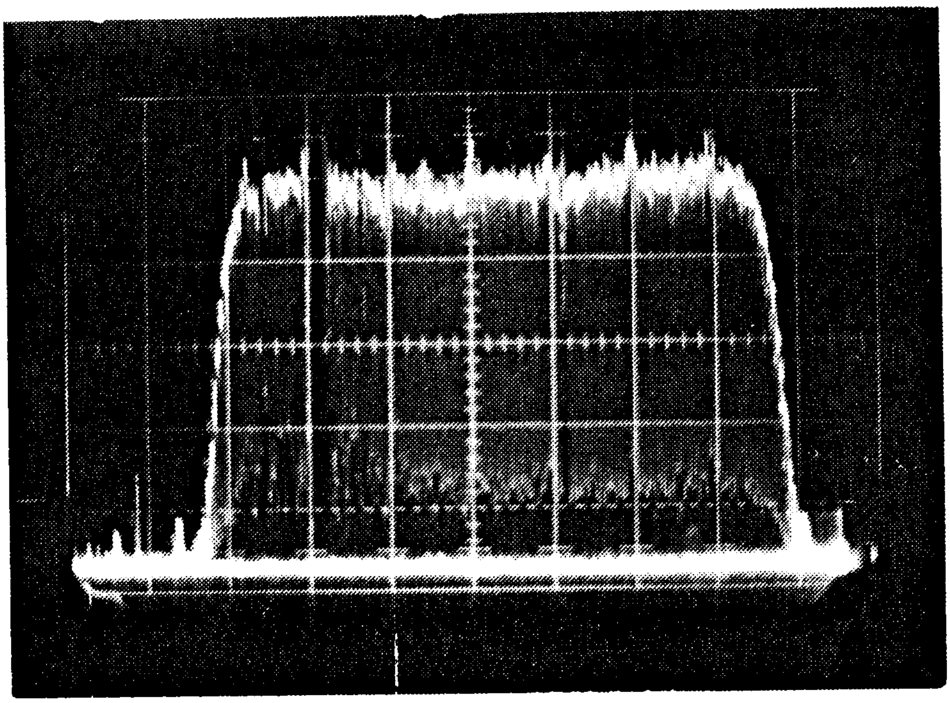
TYPICAL DRIVE REQUIREMENTS



TYPICAL TELEVISION PERFORMANCE

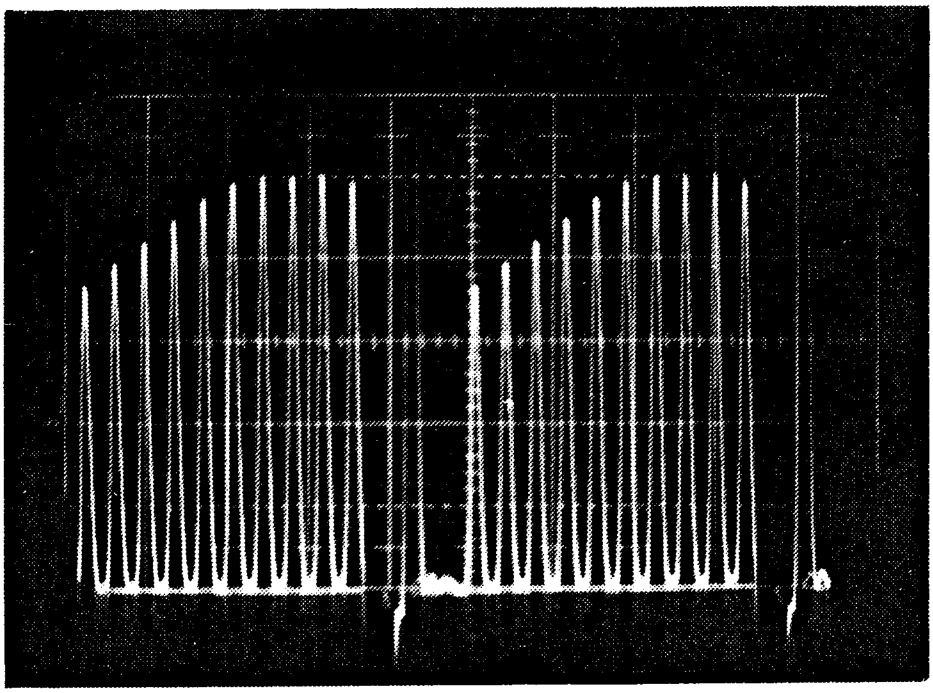


Test Waveform

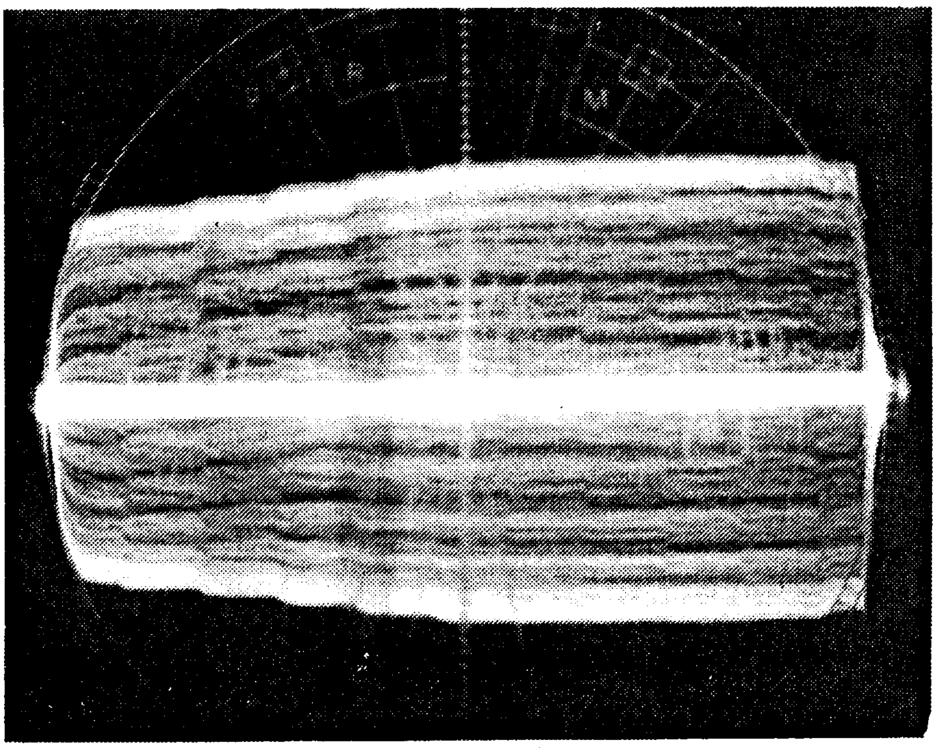


Output Frequency Response at Mid Grey

TYPICAL TELEVISION PERFORMANCE

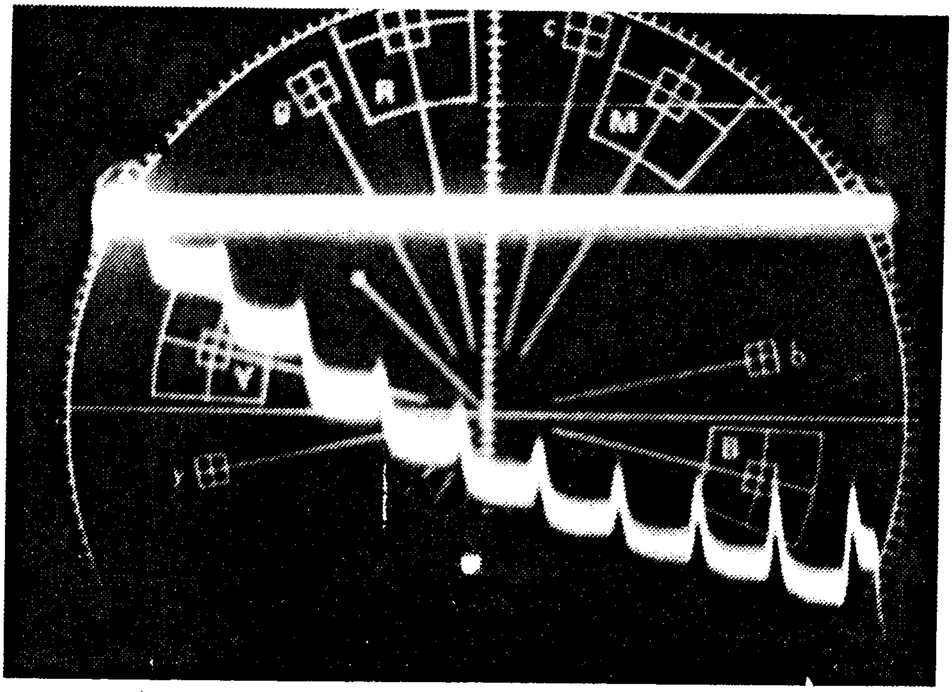


Linearity 70%



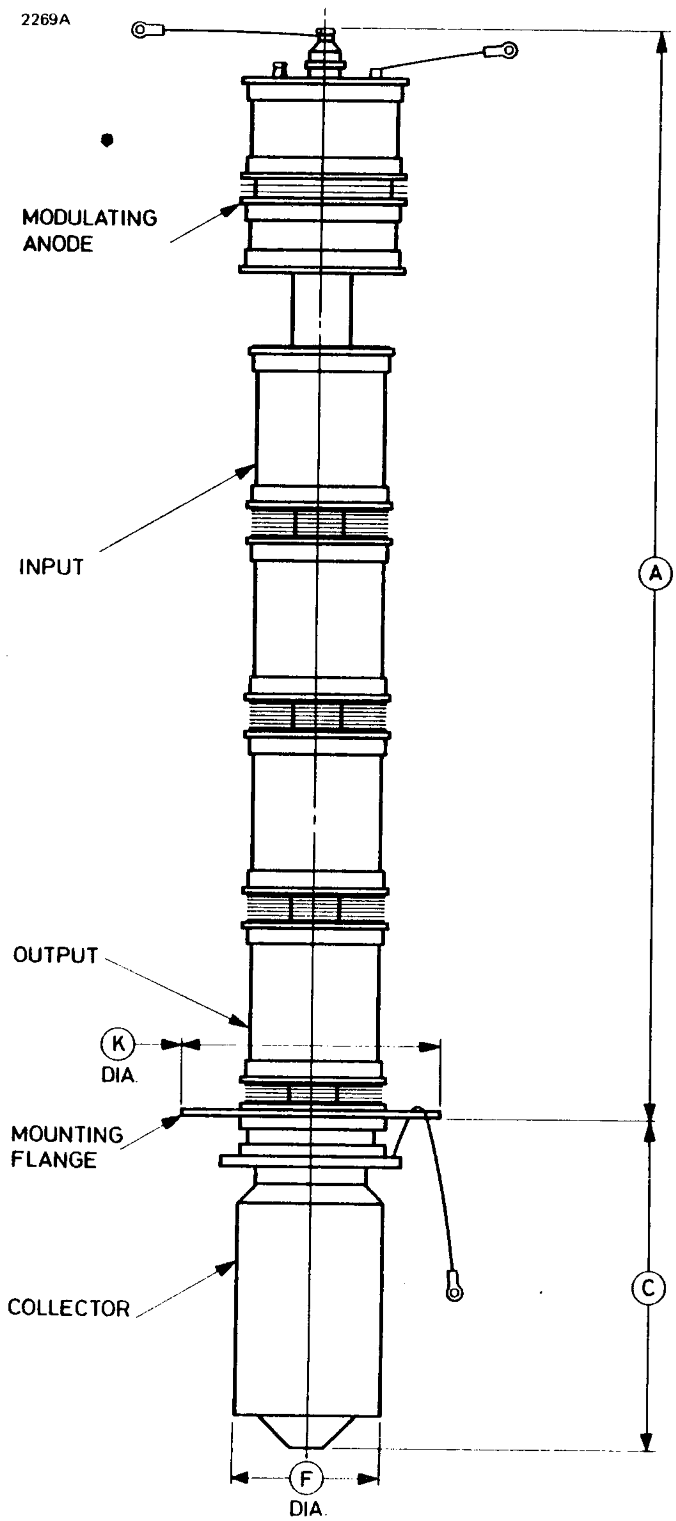
Differential Gain 78%

TYPICAL TELEVISION PERFORMANCE



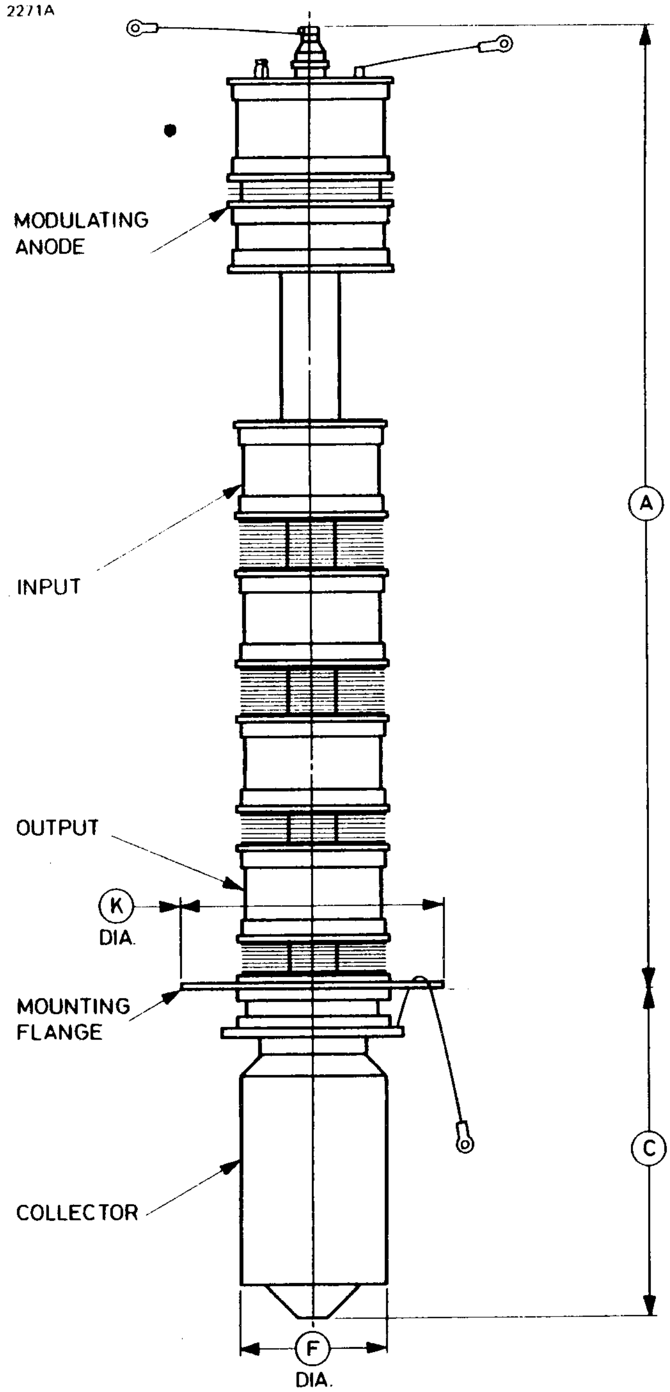
Differential Phase 8°

OUTLINE FOR K370



See page 17 for outline details and dimensions

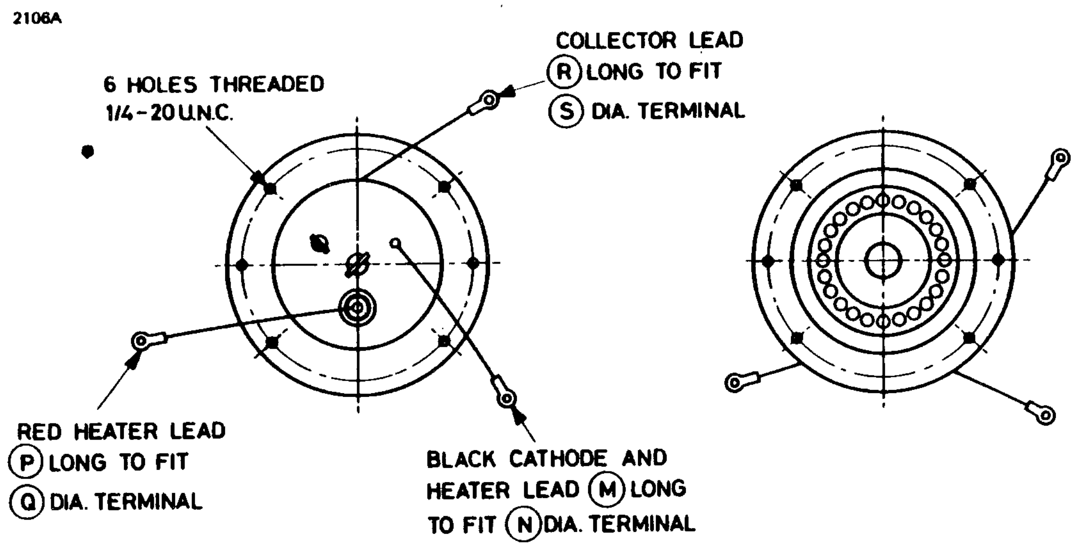
OUTLINE FOR K371 AND K372



This drawing is not to scale for the K371.

See page 17 for outline details and dimensions

Outline Details for K370, K371 and K372



View on gun end

View on collector end

Outline Dimensions for K370 (All dimensions without limits are nominal)

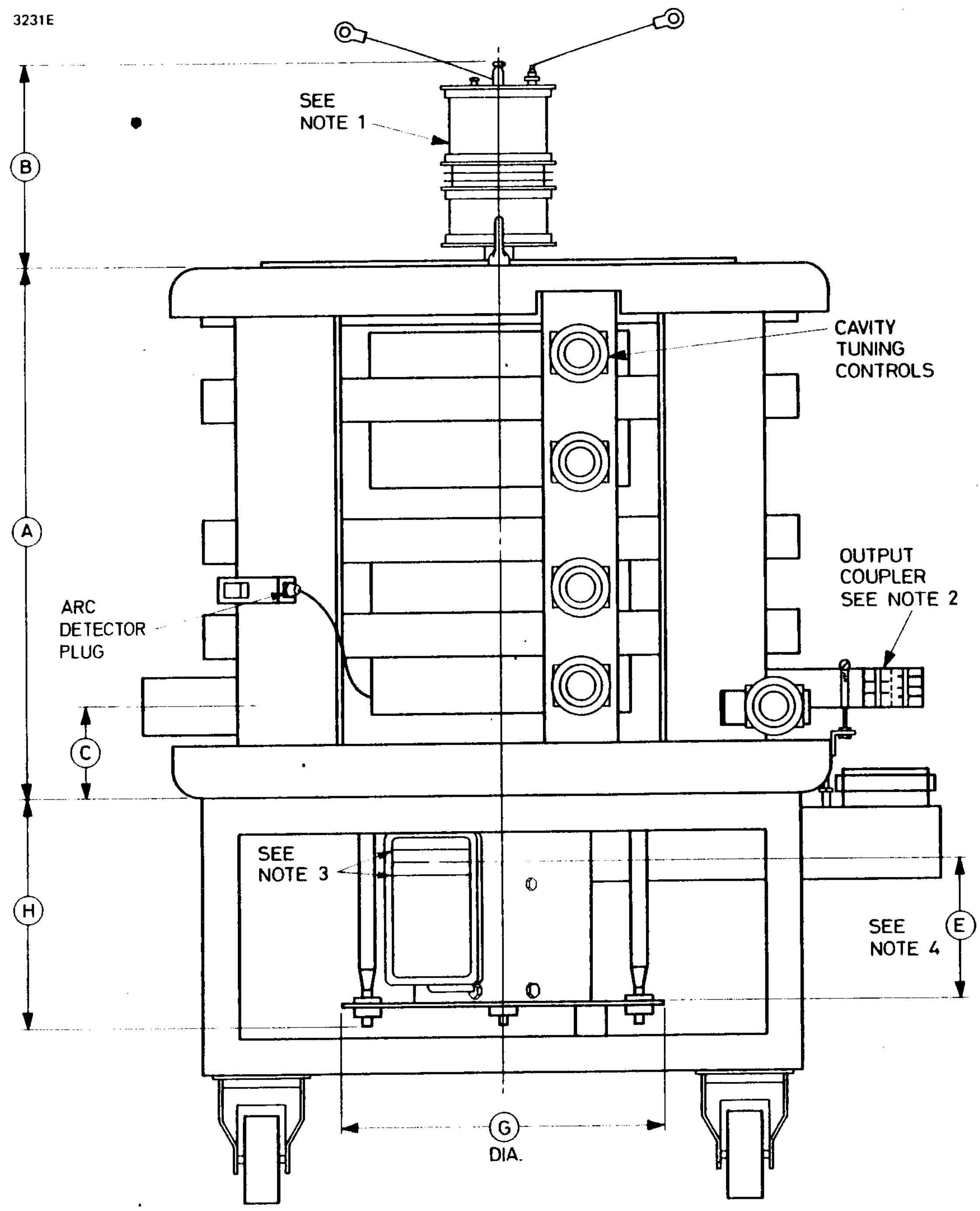
Ref	Inches	Millimetres
A*	34.125 max	866.8 max
C	10.062 max	255.6 max
F	4.375	111.1
K	8.000 max	203.2 max
M	19.000 min	482.6 min
N	0.312	7.92
P	19.000 min	482.6 min
Q	0.250	6.35
R	36.000 min	914.4 min
S	0.196	4.98

Millimetre dimensions have been derived from inches.

* For K371 and K372, dimension A is 30.100 inches (764.5mm) max; the other dimensions are as for K370.

Note The output cavity ceramic is beryllium oxide.

☆ OUTLINE FOR K4145, K4146 AND K4147

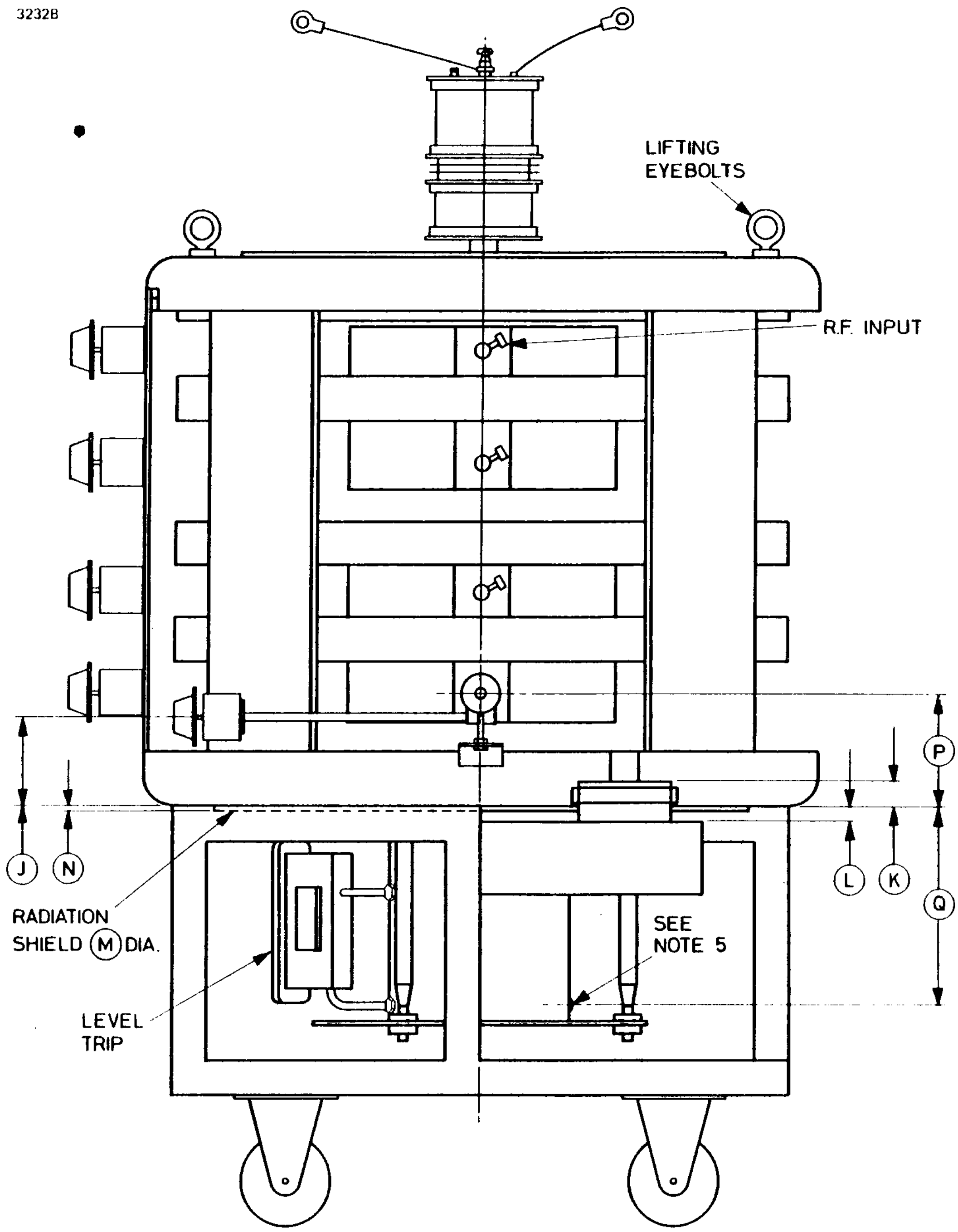


Note The circuit assembly is shown mounted on a trolley. This trolley is not part of the circuit assembly; it can be supplied to order.

See page 21 for Outline Dimensions

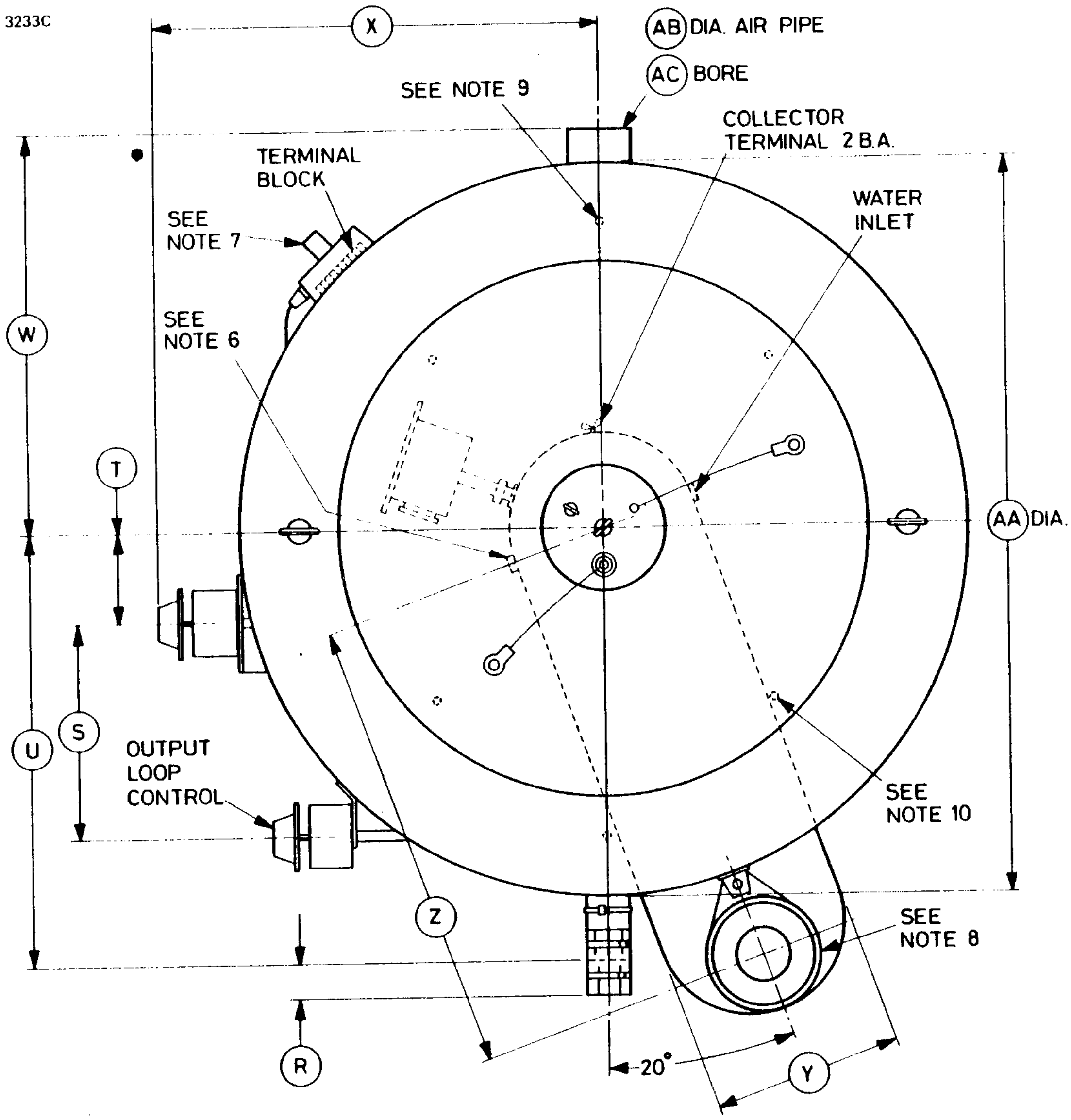
☆ Indicates a change.

OUTLINE FOR K4145, K4146 AND K4147



See page 21 for Outline Dimensions

OUTLINE FOR K4145, K4146 AND K4147



Outline Notes

1. The klystron is shown installed for clarity.
2. $1^5/_8$ inch 50Ω coaxial line with quick release coupler.
3. Maximum and minimum operating water levels. The level trip is set up to the minimum operating level.
4. Minimum cold switch-on level. It is recommended that the cold switch-on level should be as near as possible to the maximum operating level.
5. Water inlet $^3/_4$ inch B.S.P.F. thread.

☆ Indicates a change.

6. Pipe fittings for a water level control unit are provided. They are 15 mm 'Kontite' couplings at 6.250 inch (158.8 mm) centres. The water level control unit is not supplied as part of the circuit assembly.
7. Input connector, see page 23.
8. •Steam outlet 4½ inch diameter, 4 U.N. class 2A thread.
9. Four mounting holes in base threaded M10, equally spaced on 24 inch (609.6 mm) P.C.D.
10. Four mounting holes in base, threaded M10 equally spaced on 18.500 inch (470 mm) P.C.D.

Outline Dimensions for K4145 (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A*	27.000 max	685.8 max	Q	8.125	206.4
B	8.750 max	222.3 max	R	1.094	27.79
C	4.000	101.6	S	8.500	215.9
E	5.900	149.9	T	3.500	88.90
G	14.000	355.6	U	17.000 ± 0.100	431.8 ± 2.5
H	10.750 max	273.1 max	W	15.625 ± 0.250	396.9 ± 6.4
J	3.700	93.98	X	17.500 max	444.5 max
K	1.000 ± 0.125	25.40 ± 3.18	Y	7.500	190.5
L	0.625 min	15.88 min	Z	18.000	457.2
M	22.750	577.9	AA	29.250 max	743.0 max
N	0.207	5.26	AB	2.625	66.68
P	4.625 ± 0.062	117.5 ± 1.6	AC	2.500	63.50

Millimetre dimensions have been derived from inches.

* For K4146 and K4147, dimension A is 23.000 inches (584.2 mm) max; the other dimensions are as for K4145.

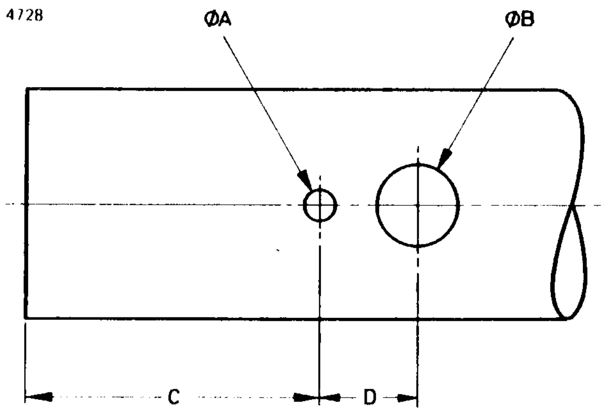
K4145P, K4146P and K4147P

Alternative circuit assemblies are available to order under the type numbers K4145P, K4146P and K4147P. These are fitted with moving flux plates and a flanged output coupler to mate with E.I.A. standard $1^5/_8$ inch 50 Ω coaxial line fittings. The steam outlet coupling is repositioned 25° clockwise from the r.f. output coupler viewed from above.

A shorter inlet pipe is provided, with two holes as detailed below for the fitting of an air supply trip switch (not supplied).

Dimension W is reduced to 13.875 inches (352.4 mm).

Detail of Air Pipe (View from control side of circuit assembly)



Ref	Inches	Millimetres
A*	0.217	5.50
B*	0.630	16.0
C	2.250	57.15
D	0.750	19.05

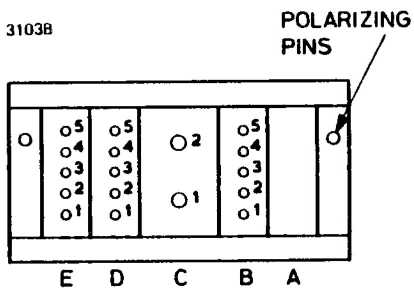
Millimetre dimensions have been derived from inches except where indicated thus*.

ELECTRICAL CONNECTIONS

All connections to the circuit assembly are made through a Smiths Hypertac connector. The mating socket is connected to a 10-way terminal block. The focus coils are wired through to the input connector; all other connections are to be made by the customer after assembling the circuit assembly and boiler. The body of the klystron is earthed through the circuit assembly and the heater, cathode, modulating anode and collector connections are made by flying leads.

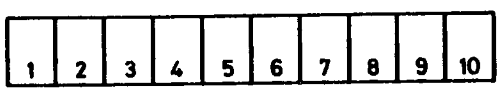
Input Connector
(to be wired by customer)

View on solder connections with cover removed



Water level trip	B1, B2
Collector	B3
Link	B4, B5
Focus coils:	
negative	C1
positive	C2
Water level control (see note 6 on page 21)	D1, D2
Earth	E3
Arc Detector Circuit: ☆	
photo resistor	E4, E5
bulb	E1, E2

Terminal Block
(to be wired by customer)



Water level trip	1, 2
Collector	3
Focus coils (wired by EEV):	
negative	4
positive	5
Water level control (see note 6 on page 21)	6, 7
Earth	10

☆ Indicates a change.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K376L

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

The K376L is a direct, plug-in replacement for the 4KM100LA. ★

ABRIDGED DATA

Four cavity, electro-magnetically focused amplifier klystron with separate tuning cavities, for u.h.f. television service. The collector is water cooled in an integral water jacket. A modulating anode is fitted which may be used for beam current control or as a protective device.

Frequency range		470 to 610	MHz	
European channel numbers		21 to 37		
U.S. channel numbers		14 to 36		
Power gain (typical)		42	dB	
Output power (saturated) at klystron flange	28	35	kW	★
Beam voltage	18	19	kV	★
Circuit assembly			K4204	★
Output		3⅛ inch 50 Ω coaxial line		
Cooling (see page 3)		water and forced-air		

The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

The ceramic insulators on this tube are typically made of aluminium oxide. ★ A few tubes may have beryllium oxide ceramics on the third and output cavities. Please see safety notes for beryllium oxide on page 13.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	26	V
Heater current	11 to 13	A
Heater starting current (peak)	23	A max
Cathode pre-heating time	15	minutes

★ Indicates a change.

September 1985

Supersedes January 1980 Issue

Mechanical

Overall length (see note 1)	60.875 inches (154.6 cm) nom
Overall diameter	10.00 inches (254 mm) nom
Mounting position	vertical, cathode end up
Net weight of klystron	120 pounds (55 kg) approx

Circuit Assembly

For front loading transmitters		K4204
Electro-magnet current (see note 2)	8.0	A min
	12.0	A max ★
Electro-magnet resistance:		
cold (20 °C)	9.5 ± 1	Ω
hot (20 °C ambient)	13	Ω max
hot (45 °C ambient)	14	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		90 pounds (41 kg) approx
Total lifting weight of klystron and cavities		240 pounds (109 kg) approx
Net weight of magnet assembly		1150 pounds (523 kg) approx

Arc Detectors

The third and output cavities of circuit assembly K4204 are fitted with an arc detector module type MA693A.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candle	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test bulb	28	V
	0.04	A
Photo-resistor connection		coaxial cable 900 mm long fitted with BNC 50 Ω coaxial plug
Test lamp connection		twin flexible insulated cable, 900 mm long. No plug provided

★ Indicates a change.

COOLING

At sea level, the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Inlet air temperature	40		50	°C ★
Air flow to electron gun	5.0		6.0	ft^3/min
	0.14		0.17	m^3/min
Air flow to output and penultimate cavities	50		55	ft^3/min each
	1.42		1.6	m^3/min each
Static pressure head (see note 3)	2.0		2.4	inch w.g.
	51		61	mm
Water flow to body and electro-magnet in series (see notes 4 and 5)		2.0		imp. gal/min
		9.0		l./min
Pressure drop, body and electro-magnet in series (see note 5)		35		lb/in^2 max
		2.5		kg/cm^2 max
Saturated output power	28		35	kW ★
Collector water flow (see note 4)	25		32	imp. gal/min
	30		38	US gal/min
	114		144	l./min
Collector pressure drop	7.5		12.5	lb/in^2 max
	0.53		0.88	kg/cm^2 max
Outlet water temperature		70		°C max
Inlet water pressure to collector		100		lb/in^2 max
		7.0		kg/cm^2 max
Inlet water pressure to body		50		lb/in^2 max
		3.5		kg/cm^2 max

Recommended Coolants ★

Good quality demineralized water should be used for cooling when there is no danger from freezing. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use.

★ Indicates a change.

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:			
continuous	20	kV max	
switch-on surge (up to 8500 ft altitude)	24	kV max	★
Beam current (mean)	6.0	A max	
Body current	150	mA max	
Output power	38	kW max	★
Collector dissipation	105	kW max	★
Load v.s.w.r. (see note 6)	1.5:1	max	
Temperature of any external part of the klystron	175	°C max	

TYPICAL OPERATION (Vision amplifier) ★

Saturated output power	28	35	kW	
Beam voltage	18.0	19.0	kV	
Beam current	4.6	5.0	A	
Electro-magnet current	9.0	11.2	A	
Bandwidth (to 1 dB points)	8.0	8.0	MHz	
Drive power	2.0	2.0	W	
Efficiency	34	37	%	★

★ Indicates a change.

Sound Amplifier Service

For operation at the same beam voltage as the vision amplifier and one fifth of the output power, the beam current is reduced to one fifth that of the vision amplifier klystron by means of the modulating anode. The graph on page 7 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the modulating anode current may vary between 0 and 1.5 mA. The potential divider network must be designed accordingly.

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN
K376L IN K4204 CIRCUIT, VISION AMPLIFIER

Test Conditions

Heater voltage	26		V	
Electro-magnet current	8 to 12		A	★
Frequency range	470 to 610		MHz	
Bandwidth (see note 7)	8.0		MHz	
Output power (see note 8)	28	35	kW	★

Range of Characteristics

	Min	Max	Min	Max		
Heater current	11	13	11	13	A	
Beam voltage	–	18.5	–	19.5	kV	★
Body current (see note 9)	–	150	–	150	mA	
R.F. drive power (see note 10)	–	4.0	–	4.0	W	★

NOTES

1. To lift the klystron clear of the circuit assembly, using the lifting harness provided with the circuit assembly, a total height of 126 inches (3.2 m) is required. This is measured to the top of the lifting harness and does not include the hoist.
2. Under T.V. picture conditions (black level + sync. pulses) the klystron will focus satisfactorily over the current range stated, with the electro-magnet coils connected in series.
3. Measured at the input pipes to the circuit assembly.
4. These values apply when the coolant used is distilled water with the dissolved oxygen removed.

★ Indicates a change.

5. When the K376L is used in a circuit assembly other than K4204, the electro-magnet is usually water cooled in series with the klystron body. EEV circuit assembly K4204 requires no water cooling but transmitter cubicle air cooling must be increased if necessary to ensure that the heat dissipated in the magnet (about 1 kW) is extracted from the cubicle without producing excessive circuit assembly temperatures. ★

6. This applies to television service. The load v.s.w.r. must not exceed 1.3:1 when output powers of 30 kW or more are required. EEV should be consulted regarding other conditions of service. ★

7. The klystron cavities shall be tuned so that, for constant input power, the variation in output power at the klystron flange will be less than 1 dB over the specified bandwidth.

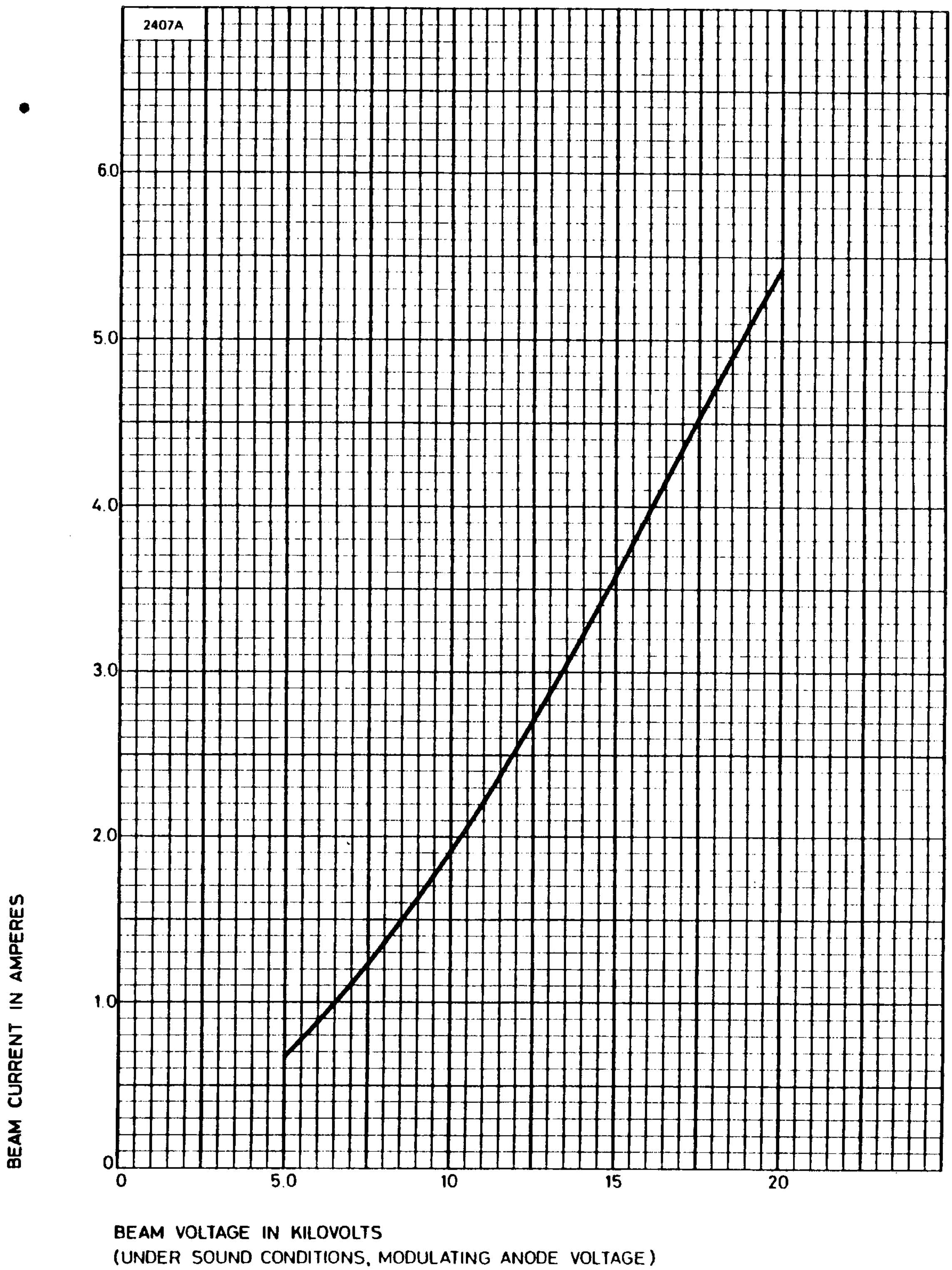
8. Input frequency set 2.75 MHz below the centre of the 8 MHz channel, and the input power and beam power adjusted to give the specified output.

9. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.

10. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

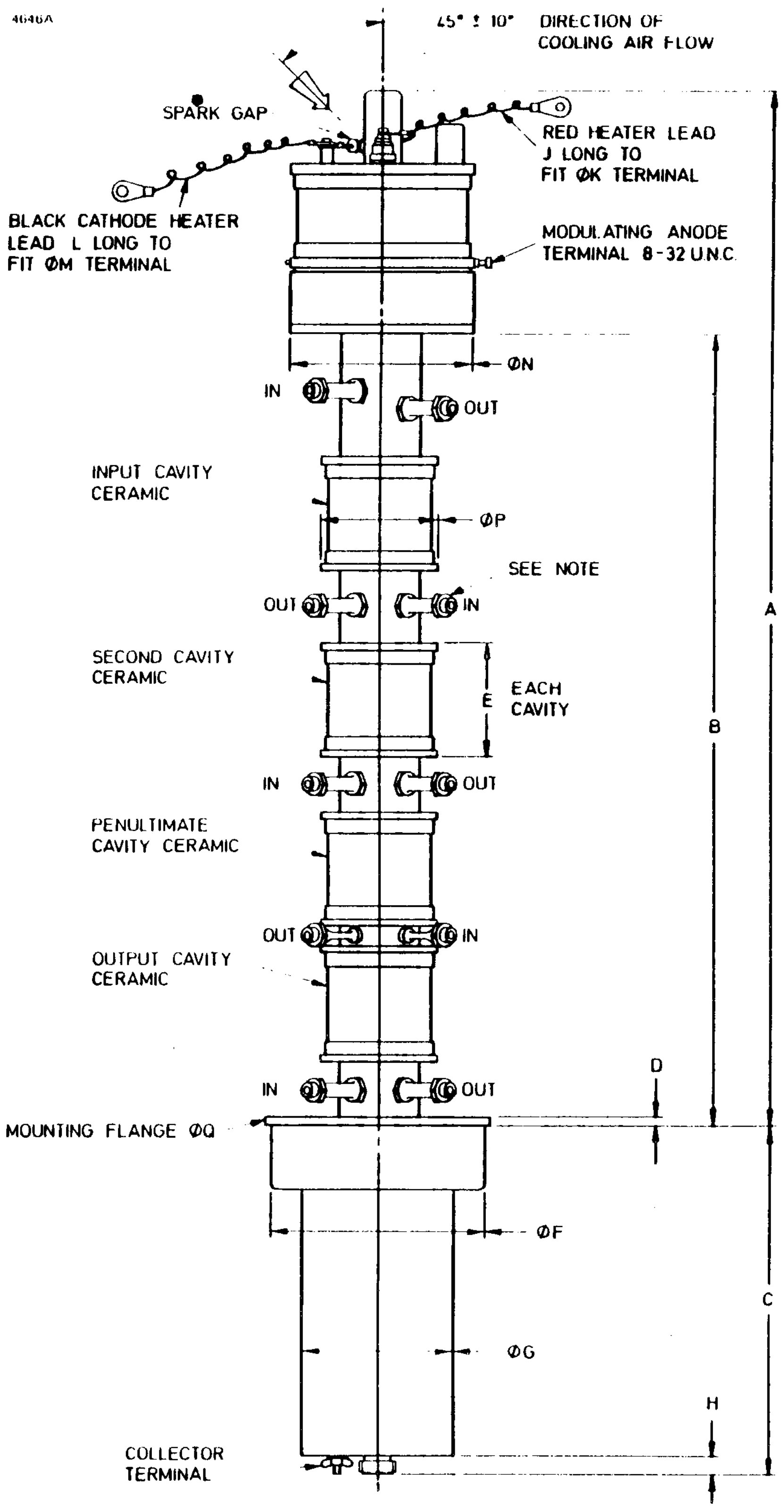
★ Indicates a change.

TYPICAL BEAM CHARACTERISTIC ★

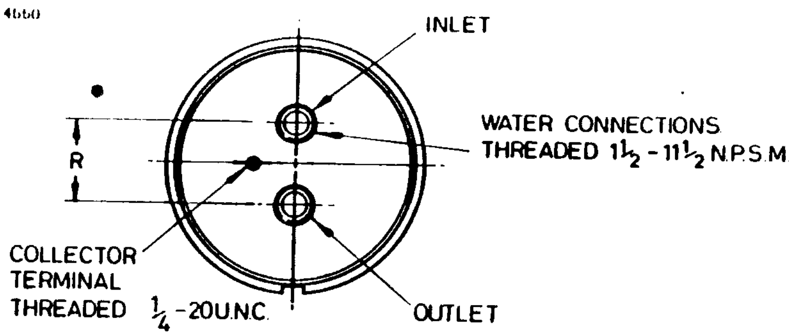


★ Indicates a change.

OUTLINE FOR K376L



OUTLINE FOR K376L



Outline Dimensions (All dimensions without limits are nominal) ★

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	45.300 max	1150.6 max	J	15.000	381.0
B	34.250 min	870.0 min	K	0.250	6.35
C	15.707	399.0	L	15.000	381.0
D	0.375	9.53	M	0.312	7.92
E	6.000	152.4	N	8.100	205.7
F	9.244 max	234.8 max	P	5.125	130.2
G	6.750	171.5	Q	10.000	254.0
H	0.812	20.62	R	3.125	79.38

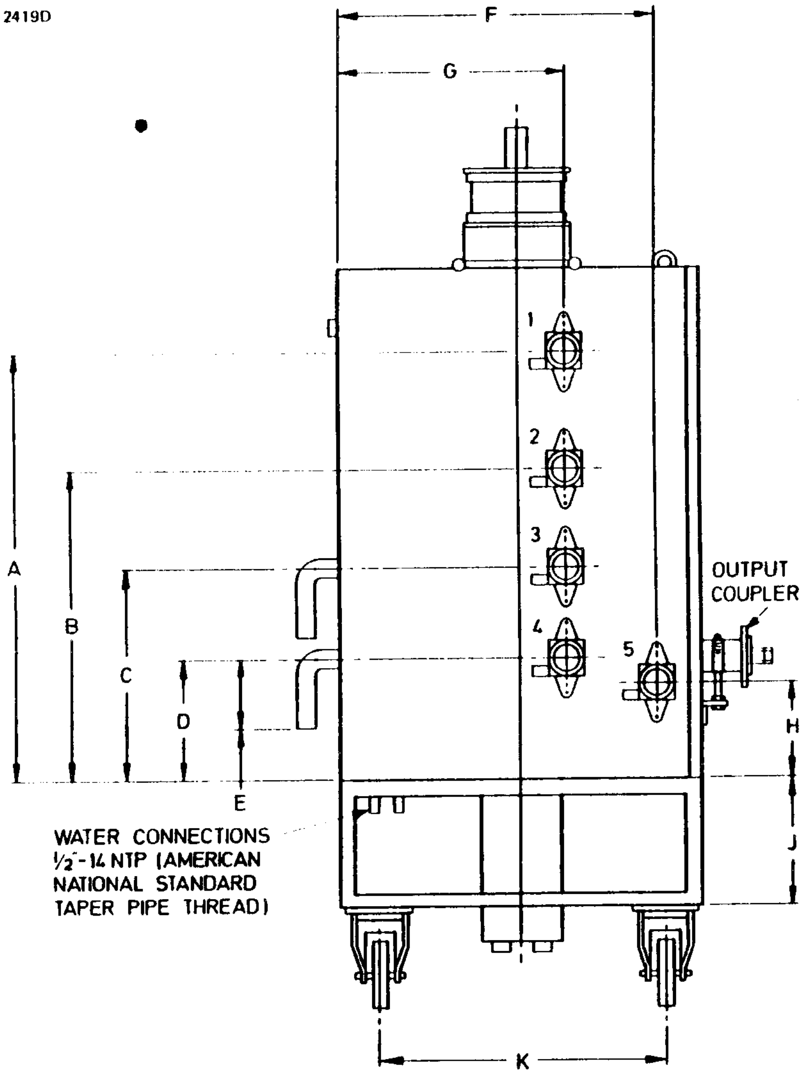
Millimetre dimensions have been derived from inches.

Outline Note ★

The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.

★ Indicates a change.

OUTLINE FOR K4204 (All dimensions nominal) ★

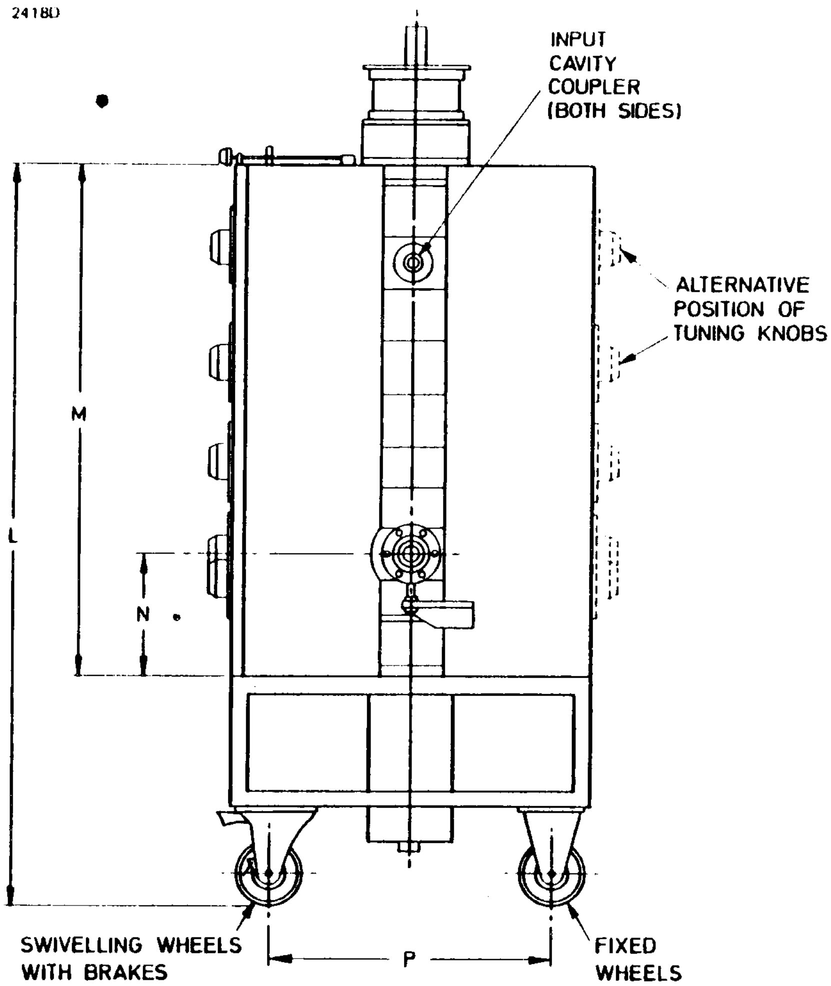


Controls

1 Input cavity tuning
2 Second cavity tuning
3 Penultimate cavity tuning
4 Output cavity tuning
5 Output coupling

★ Indicates a change.

OUTLINE FOR K4204 (All dimensions nominal) ★

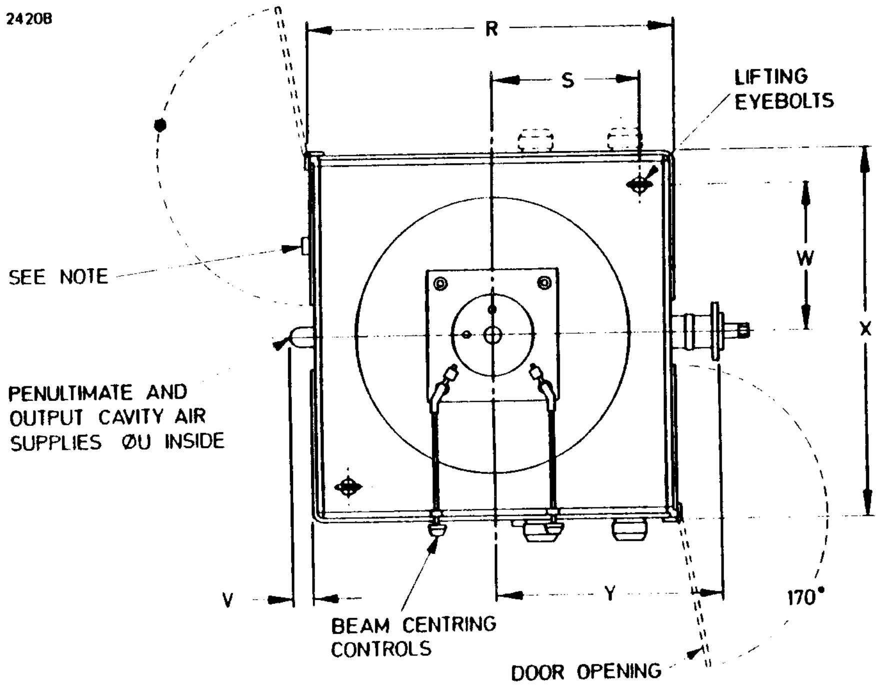


Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	32.312	820.7	H	7.250	184.2
B	23.500	596.9	J	9.875	250.8
C	16.000	406.4	K	21.875	555.6
D	9.125	231.8	L	56.375	1432
E	5.375	136.5	M	38.875	987.5
F	24.531	623.1	N	9.125	231.8
G	17.500	444.5	P	22.25	565.2

Millimetre dimensions have been derived from inches.

★ Indicates a change.

OUTLINE FOR K4204 (All dimensions without limits are nominal) ★



Ref	Inches	Millimetres
R	28.000 ± 0.125	711.2 ± 3.2
S	11.250	285.8
U	1.500	38.1
V	2.250	57.15
W	11.250	285.8
X	28.000 ± 0.125	711.2 ± 3.2
Y	15.550	395

Millimetre dimensions have been derived from inches.

Outline Note

Coil connections, box receptacle 3102A-24-19P.

Pin	Connection
A	Coil 1 (top) positive
B	Coil 1 negative
C	Coil 2 positive
D	Coil 2 negative
E	Coil 3 positive
F	Coil 3 negative
H	Coil 4 positive
J	Coil 4 negative
K	Coil 5 (collector) positive
L	Coil 5 negative

★ Indicates a change.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV tubes. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities, airpipes and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K376L klystrons have white, unmarked, aluminium oxide ceramics in all cavities. ★ However, on a few tubes the **third** and **output** cavity ceramics may be made of beryllium oxide; these ceramics are coloured blue, or marked with a black line. **Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics;** if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Wear impervious rubber gloves and use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths and discarded rubber gloves wet and store wet in a plastic bucket with lid.
b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.
c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.
d) Wash hands before smoking or eating.

★ Indicates a change.

Chelmsford, Essex, England

Printed in England

K377L

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

The K377L is a direct, plug-in replacement for the 4KM100LF. ★

ABRIDGED DATA

Four cavity, electro-magnetically focused amplifier klystron with separate tuning cavities, for u.h.f. television service. The collector is water cooled in an integral water jacket. A modulating anode is fitted which may be used for beam current control or as a protective device.

Frequency range		590 to 720	MHz
European channel numbers		36 to 51	
U.S. channel numbers		34 to 54	
Power gain (typical)		42	dB ★
Output power (saturated) at klystron flange .	28	35	kW ★
Beam voltage	18	19	kV ★
Circuit assembly			K4205 ★
Output		3⅛ inch 50 Ω coaxial line	
Cooling (see page 3)		water and forced-air	

The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

The ceramic insulators on this tube are typically made of aluminium oxide. ★ A few tubes may have beryllium oxide ceramics on the third and output cavities. Please see safety notes for beryllium oxide on page 13.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	26	V
Heater current	11 to 13	A
Heater starting current (peak)	23	A max
Cathode pre-heating time	15	minutes

★ Indicates a change.

September 1985

Supersedes January 1980 Issue

Mechanical

Overall length (see note 1)	60.875 inches (154.6 cm) nom
Overall diameter	10.00 inches (254 mm) nom
Mounting position	vertical, cathode end up
Net weight of klystron	120 pounds (55 kg) approx

Circuit Assembly

For front loading transmitters		K4205
Electro-magnet current (see note 2)	8.0	A min
	12.0	A max ★
Electro-magnet resistance:		
cold (20 °C)	9.5 ± 1	Ω
hot (20 °C ambient)	13	Ω max
hot (45 °C ambient)	14	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		90 pounds (41 kg) approx
Total lifting weight of klystron and cavities		240 pounds (109 kg) approx
Net weight of magnet assembly		1150 pounds (523 kg) approx

Arc Detectors

The third and output cavities of circuit assembly K4205 are fitted with an arc detector module type MA693A.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candle	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test bulb	28	V
	0.04	A
Photo-resistor connection		coaxial cable 900 mm long fitted with BNC 50 Ω coaxial plug
Test lamp connection		twin flexible insulated cable, 900 mm long. No plug provided

★ Indicates a change.

COOLING

At sea level, the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Inlet air temperature	40		50	°C	★
Air flow to electron gun	5.0		6.0	ft^3/min	
	0.14		0.17	m^3/min	
Air flow to output and penultimate cavities	50		55	ft^3/min each	
	1.42		1.6	m^3/min each	
Static pressure head (see note 3)	2.0		2.4	inch w.g.	
	51		61	mm	
Water flow to body and electro-magnet in series (see notes 4 and 5)		2.0		imp. gal/min	
		9.0		l./min	
Pressure drop, body and electro-magnet in series (see note 5)		35		lb/in^2 max	
		2.5		kg/cm^2 max	
Saturated output power	28		35	kW	★
Collector water flow (see note 4)	25		32	imp. gal/min	
	30		38	US gal/min	
	114		144	l./min	
Collector pressure drop	7.5		12.5	lb/in^2 max	
	0.53		0.88	kg/cm^2 max	
Outlet water temperature		70		°C max	
Inlet water pressure to collector		100		lb/in^2 max	
		7.0		kg/cm^2 max	
Inlet water pressure to body		50		lb/in^2 max	
		3.5		kg/cm^2 max	

Recommended Coolants ★

Good quality demineralized water should be used for cooling when there is no danger from freezing. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use.

★ Indicates a change.

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:			
continuous	20	kV max	
switch-on surge (up to 8500 ft altitude)	24	kV max	★
Beam current (mean)	6.0	A max	
Body current	150	mA max	
Output power	38	kW max	★
Collector dissipation	105	kW max	★
Load v.s.w.r. (see note 6)	1.5:1	max	
Temperature of any external part of the klystron	175	°C max	

TYPICAL OPERATION (Vision amplifier) ★

Saturated output power	28	35	kW	
Beam voltage	18.0	19.0	kV	
Beam current	4.6	5.0	A	
Electro-magnet current	9.0	10.7	A	
Bandwidth (to 1 dB points)	8.0	8.0	MHz	
Drive power	1.0	3.0	W	
Efficiency	34	37	%	★

★ Indicates a change.

Sound Amplifier Service

For operation at the same beam voltage as the vision amplifier and one fifth of the output power, the beam current is reduced to one fifth that of the vision amplifier klystron by means of the modulating anode. The graph on page 7 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the modulating anode current may vary between 0 and 1.5 mA. The potential divider network must be designed accordingly.

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN
K377L IN K4205 CIRCUIT, VISION AMPLIFIER

Test Conditions

Heater voltage		26		V
Electro-magnet current		8 to 12		A ★
Frequency range		590 to 720		MHz
Bandwidth (see note 7)		8.0		MHz
Output power (see note 8)	28		35	kW ★

Range of Characteristics

	Min	Max	Min	Max	
Heater current	11	13	11	13	A
Beam voltage	–	18.5	–	19.5	kV ★
Body current (see note 9)	–	150	–	150	mA
R.F. drive power (see note 10)	–	4.0	–	4.0	W ★

NOTES

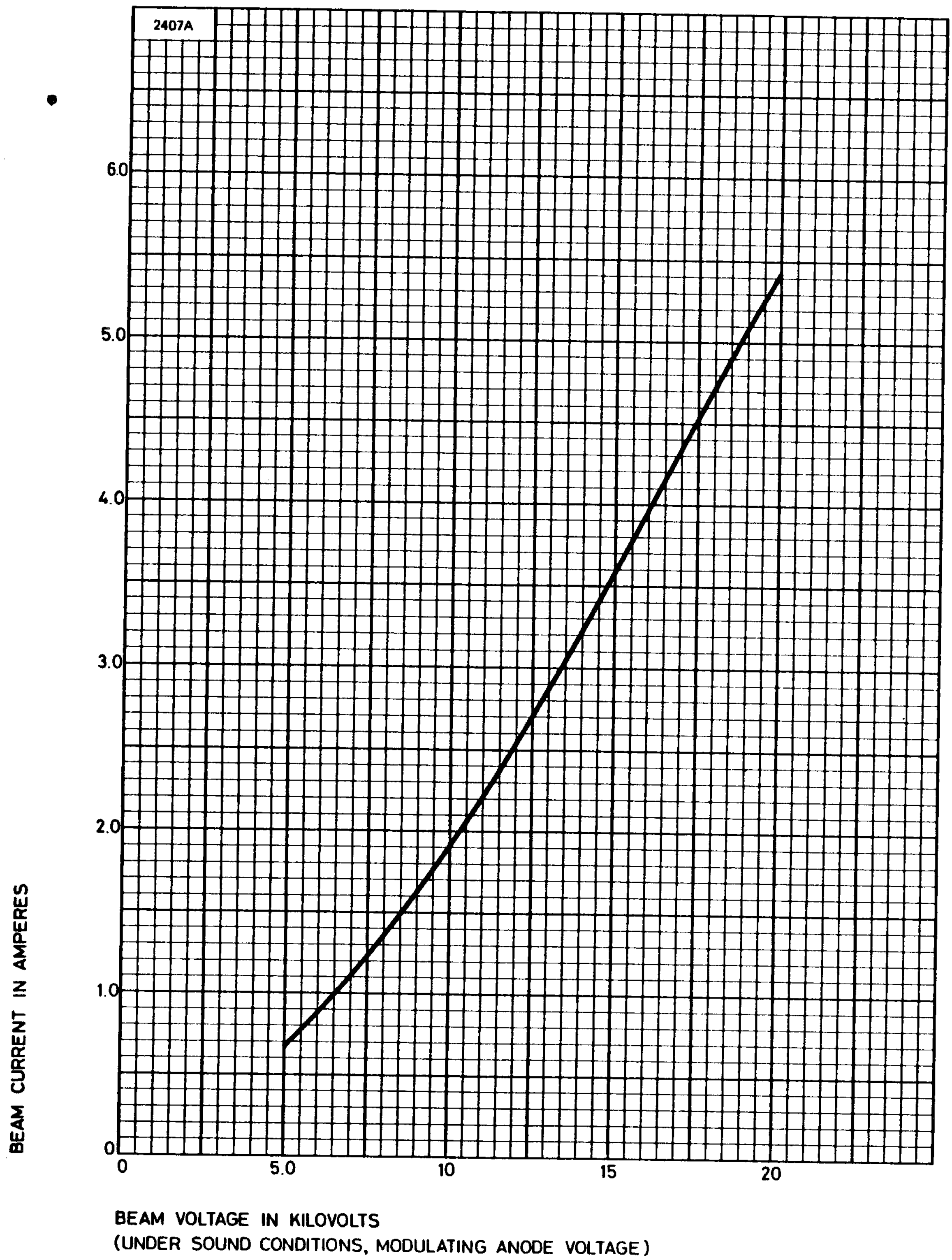
1. To lift the klystron clear of the circuit assembly, using the lifting harness provided with the circuit assembly, a total height of 126 inches (3.2 m) is required. This is measured to the top of the lifting harness and does not include the hoist.
2. Under T.V. picture conditions (black level + sync. pulses) the klystron will focus satisfactorily over the current range stated, with the electro-magnet coils connected in series.
3. Measured at the input pipes to the circuit assembly.
4. These values apply when the coolant used is distilled water with the dissolved oxygen removed.

★ Indicates a change.

5. When the K377L is used in a circuit assembly other than K4205, the electro-magnet is usually water cooled in series with the klystron body. EEV circuit assembly K4205 requires no water cooling but transmitter cubicle air cooling must be increased if necessary to ensure that the heat dissipated in the magnet (about 1 kW) is extracted from the cubicle without producing excessive circuit assembly temperatures. ★
6. This applies to television service. The load v.s.w.r. must not exceed 1.3:1 when output powers of 30 kW or more are required. EEV should be consulted regarding other conditions of service. ★
7. The klystron cavities shall be tuned so that, for constant input power, the variation in output power at the klystron flange will be less than 1 dB over the specified bandwidth.
8. Input frequency set 2.75 MHz below the centre of the 8 MHz channel, and the input power and beam power adjusted to give the specified output.
9. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
10. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

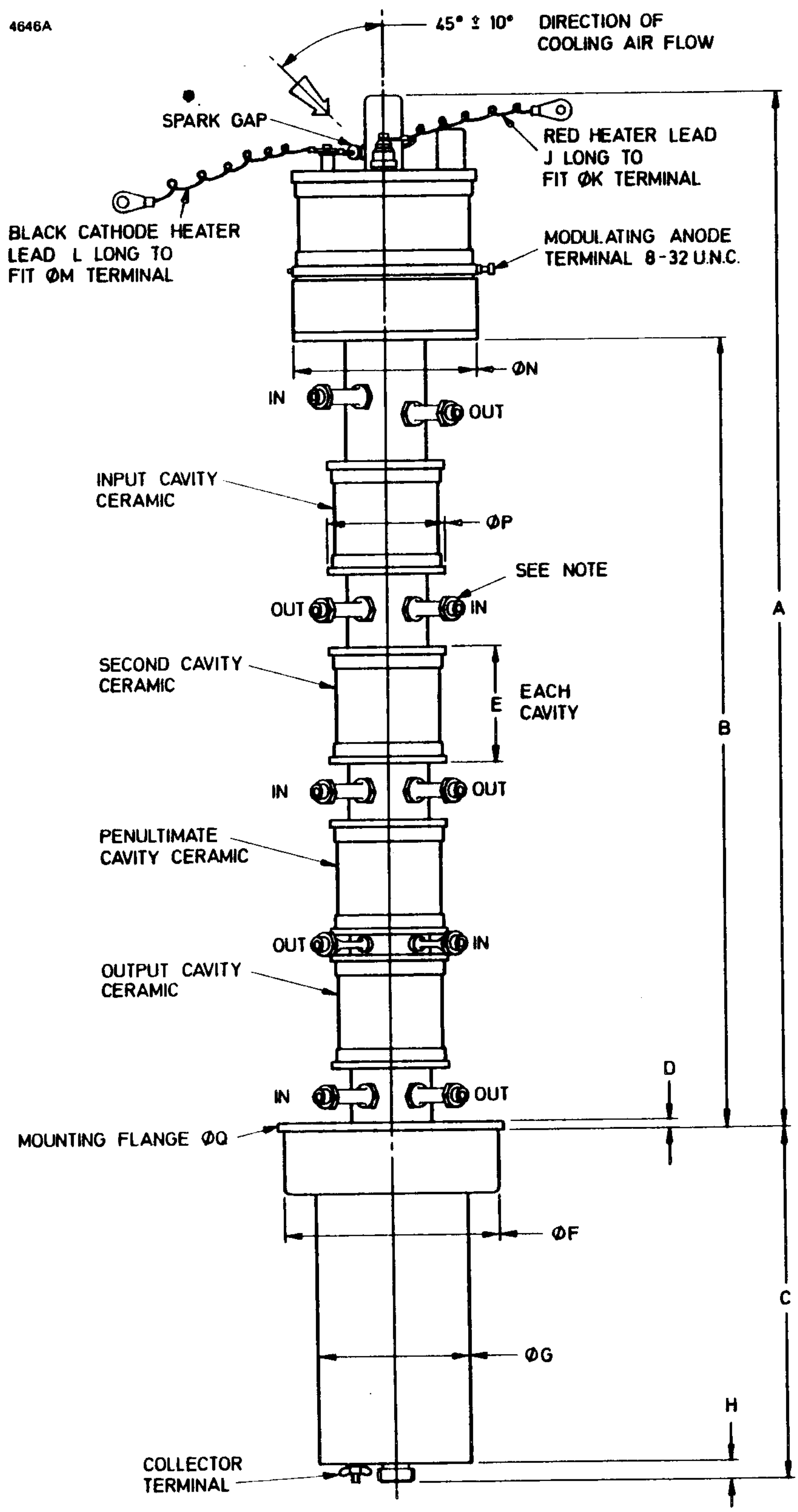
★ Indicates a change.

TYPICAL BEAM CHARACTERISTIC ★

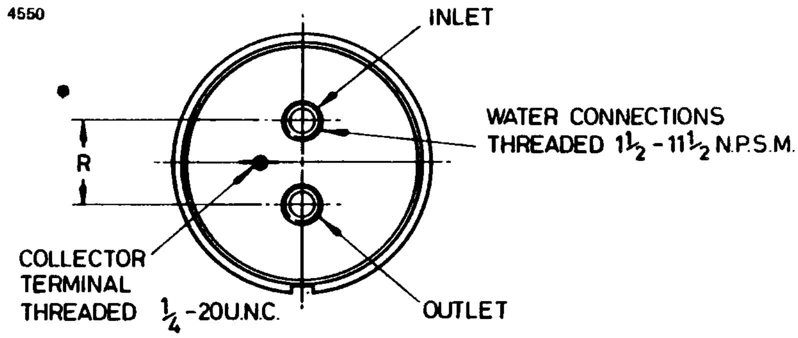


★ Indicates a change.

OUTLINE FOR K377L



OUTLINE FOR K377L



Outline Dimensions (All dimensions without limits are nominal) ★

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	45.300 max	1150.6 max	J	15.000	381.0
B	34.250 min	870.0 min	K	0.250	6.35
C	15.707	399.0	L	15.000	381.0
D	0.375	9.53	M	0.312	7.92
E	5.000	127.0	N	8.100	205.7
F	9.244 max	234.8 max	P	5.125	130.2
G	6.750	171.5	Q	10.000	254.0
H	0.812	20.62	R	3.125	79.38

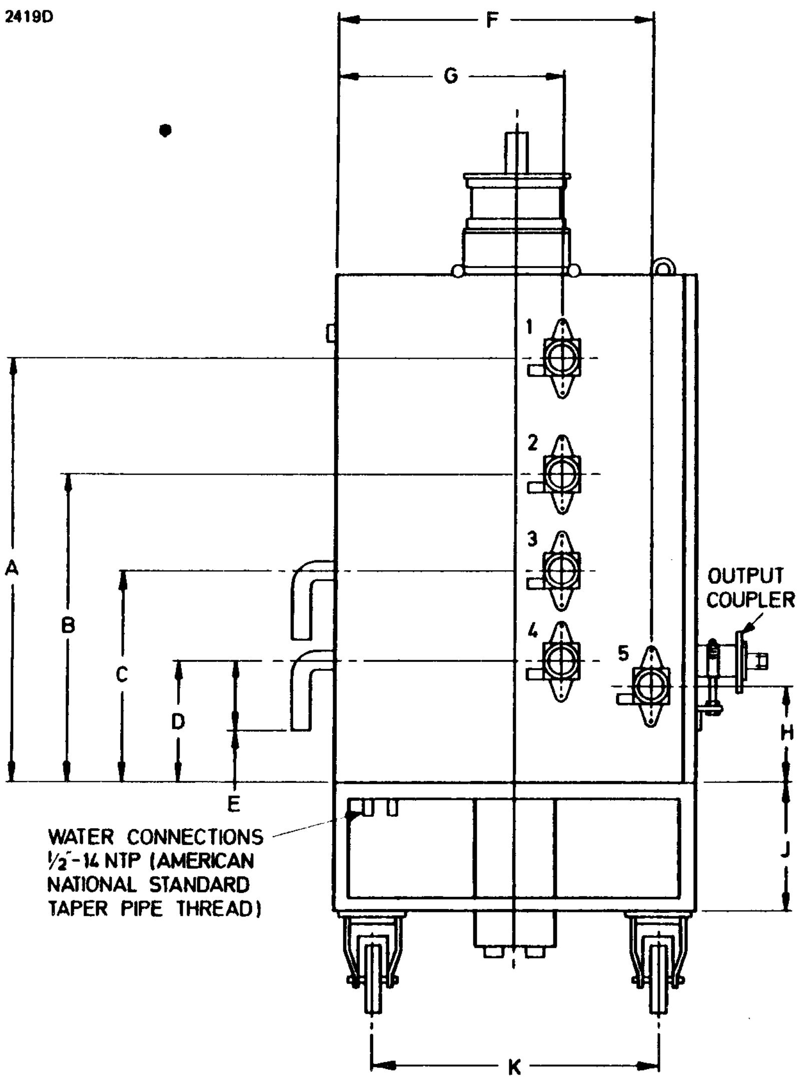
Millimetre dimensions have been derived from inches.

Outline Note ★

The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.

★ Indicates a change.

OUTLINE FOR K4205 (All dimensions nominal) ★

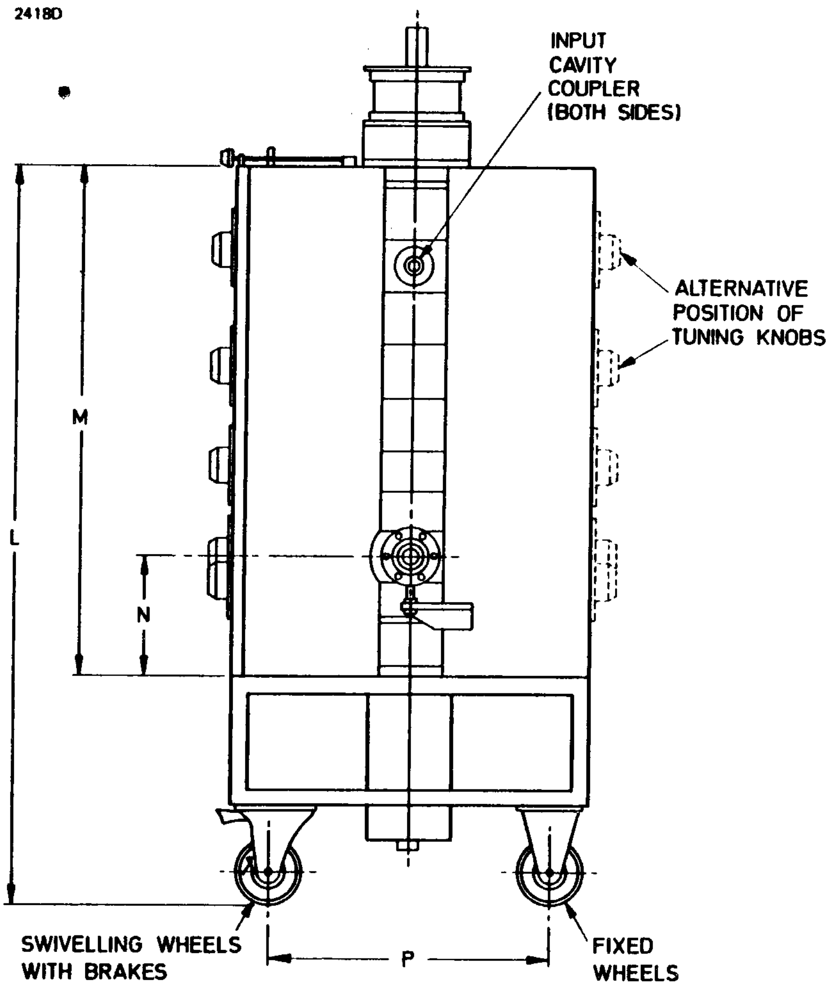


Controls

1 Input cavity tuning
2 Second cavity tuning
3 Penultimate cavity tuning
4 Output cavity tuning
5 Output coupling

★ Indicates a change.

OUTLINE FOR K4205 (All dimensions nominal) ★

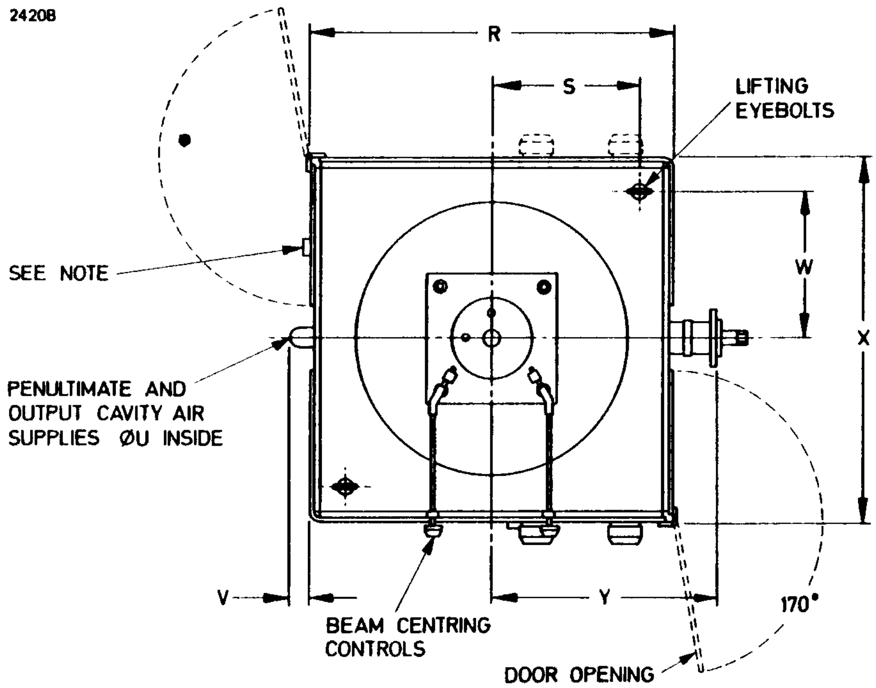


Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	32.312	820.7	H	7.250	184.2
B	23.500	596.9	J	9.875	250.8
C	16.000	406.4	K	21.875	555.6
D	9.125	231.8	L	56.375	1432
E	5.375	136.5	M	38.875	987.5
F	24.531	623.1	N	9.125	231.8
G	17.500	444.5	P	22.250	565.2

Millimetre dimensions have been derived from inches.

★ Indicates a change.

OUTLINE FOR K4205 (All dimensions without limits are nominal) ★



Ref	Inches	Millimetres	Ref	Inches	Millimetres
R	28.000 ± 0.125	711.2 ± 3.2	W	11.250	285.8
S	11.250	285.8	X	28.000 ± 0.125	711.2 ± 3.2
U	1.500	38.1	Y	15.550	395
V	2.250	57.15			

Millimetre dimensions have been derived from inches.

Outline Note

Coil connections, box receptacle 3102A-24-19P.

Pin	Connection	Pin	Connection
A	Coil 1 (top) positive	F	Coil 3 negative
B	Coil 1 negative	H	Coil 4 positive
C	Coil 2 positive	J	Coil 4 negative
D	Coil 2 negative	K	Coil 5 (collector) positive
E	Coil 3 positive	L	Coil 5 negative

★ Indicates a change.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV tubes. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities, airpipes and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K377L klystrons have white, unmarked, aluminium oxide ceramics in all cavities. ★ However, on a few tubes the **third** and **output** cavity ceramics may be made of beryllium oxide; these ceramics are coloured blue, or marked with a black line. **Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics;** if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Wear impervious rubber gloves and use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths and discarded rubber gloves wet and store wet in a plastic bucket with lid.
b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.
c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.
d) Wash hands before smoking or eating.

★ Indicates a change.

Chelmsford, Essex, England

Printed in England

K3153BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacement for YK1270 in circuit assembly type TE1188 (modified).

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing. 40% minimum sync. efficiency at 15 kW output in standard operational mode.
- **Output Power** Rated up to 15 kW in vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Collector Cooling** The collector is forced-air cooled.
- **Simple Tube Exchange** Pre-adjusted, external cavities mean that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3153BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 15 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators. The klystron collector is also forced-air cooled by filtered air, with an upward air exit.

ABRIDGED DATA

Frequency range	470 to 860	MHz
European channel numbers	21 to 68	
Output power at klystron flange	16.5	kW
Power gain	30	dB
Beam voltage	13 to 19	kV
Modulating anode to cathode voltage (see note 1)	10 to 15	kV

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see page 10)	4.5 to 5.5	Vd.c.
Heater current range	19 to 26	A
Cathode pre-heating time	5	minutes

Mechanical

Overall length	55.90 inches (142 cm) max
Overall diameter	8.900 inches (22.6 cm) max
Mounting position	vertical, collector end up
Net weight of klystron	148 pounds (67 kg) approx

Circuit Assembly K4153

Electro-magnet current, stabilized to ± 2% (see note 2)	9.5 to 11.5	A
Electro-magnet resistance:		
cold	8.3 ± 1.2	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		100 pounds (45 kg) approx
Net weight of magnet assembly		485 pounds (220 kg) approx

Cooling

Air flow to cavities and body	50	ft^3/min
	1.4	m^3/min
Air flow to cathode terminal, during heater-only (black heat) operation	5.0	ft^3/min
	0.14	m^3/min
Air flow to collector (see note 3)	1250	ft^3/min
	35	m^3/min
Static pressure head (see note 4)		10 inches (254 mm) w.g.

Arc Detector

Arc detector type MA257E is fitted to the output cavity.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test lamp	28	V
	0.04	A
Connections		1.5 m cable (see page 20)

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater starting current (peak)	60	A max
Beam voltage	21	kV max
Modulating anode to cathode voltage (see note 1)	21	kV max
Beam current (mean)	3.0	A max
Modulating anode current	5.0	mA max
Mean output power	11	kW max
Collector dissipation	42	kW max
Load v.s.w.r. (see note 5)	1.5:1	max
Temperature of any part of tube envelope (except collector)	175	°C max
Temperature of collector	200	°C max
B.C.D. electrode voltage (see note 6)	−1250	V max
B.C.D. current (see note 7)	2.0	mA max

TYPICAL OPERATION

10 kW vision amplifier (B.C.D. electrode at cathode potential)

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*
Beam voltage (see page 12)	13.2	15	16.4	kV
Modulating anode to cathode voltage (approx) (see page 12)	12.3	10.5	10.3	kV
Beam current	2.03	1.63	1.56	A
Output power	11	11	11	kW
Electro-magnet current	10	9.8	9.8	A
Drive power for 11 kW output (see note 8)	15	10	8.0	W
Efficiency:				
typical	43	47	45	%
minimum	40	44	43	%

Sound amplifier (B.C.D. electrode at cathode potential)

	1.0 kW		**2.0 kW**		
Beam voltage	13.2	16.4	13.2	16.4	kV
Modulating anode to cathode voltage (approx)	4.0	3.5	4.7	4.1	kV
Beam current	0.38	0.31	0.49	0.39	A
Focus current (approx)	10		10		A
Output power	1.1		2.2		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	22		34		%

15 kW vision amplifier (B.C.D. electrode at cathode potential)

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*
Beam voltage (see page 12)	15.5	17.5	19	kV
Modulating anode to cathode voltage (approx) (see page 12)	14.5	12.5	12	kV
Beam current	2.6	2.05	1.95	A
Output power	16	16	16	kW
Electro-magnet current	10	9.8	9.8	A
Drive power for 16 kW output (see note 8)	15	10	8.0	W
Efficiency:				
typical	43	47	45	%
minimum	41	45	43	%

Sound amplifier (B.C.D. electrode at cathode potential)

	1.5 kW		**3.0 kW**		
Beam voltage	15.5	19	15.5	19	kV
Modulating anode to cathode voltage (approx)	3.9	3.4	5.6	4.9	kV
Beam current	0.37	0.30	0.63	0.51	A
Focus current (approx)	10		10		A
Output power	1.65		3.3		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	29		34		%

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a modulating anode current of 1.5 mA.
2. Under TV picture conditions the klystron will focus satisfactorily within the specified range. Adjust the magnet current for maximum stability within this range and stabilize to ± 2% about the optimum value.
3. Cooling air must be filtered to remove 99% of particles exceeding 1 µm diameter.
4. Measured by a manometer at the input pipe to the circuit assembly.
5. This value applies to television service. EEV should be consulted regarding other conditions of service.
5. The K3153BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 15 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to the cathode.

   (b) The B.C.D. voltage must **not** exceed −1250 V with respect to the cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.
7. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	13.5	kV
Beam current	2.3	A
Heater voltage	5.5	V
B.C.D. voltage	zero with respect to cathode	

   The B.C.D. voltage must then be increased to −500 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 1 mA and typically will be less than 0.5 mA. At end-of-life, the B.C.D. current will not exceed 2 mA.

With a B.C.D.-to-cathode voltage of −500 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 60% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	65	pF
Cathode to modulating anode (B.C.D. connected to cathode)	30	pF
Modulating anode to klystron body	20	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

8. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

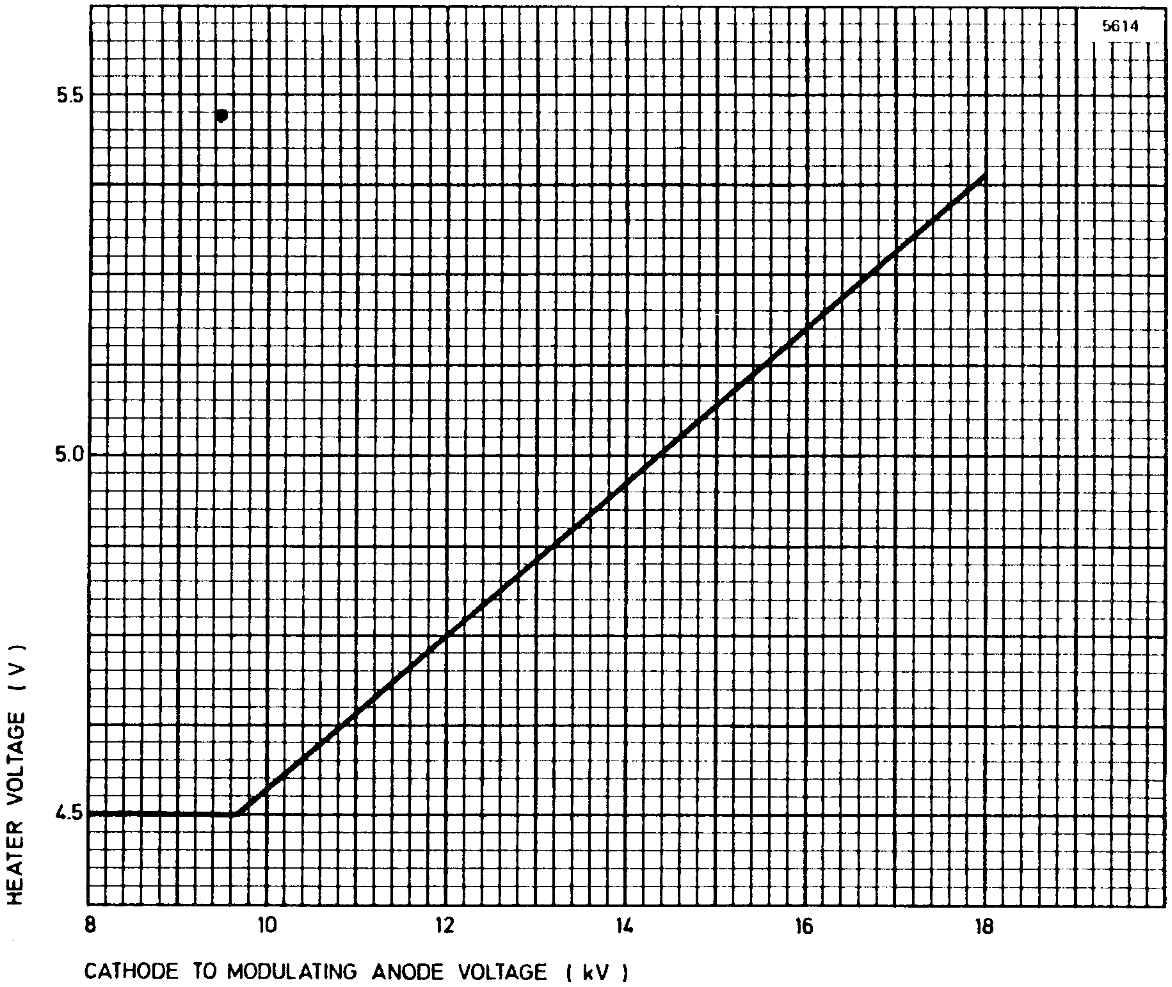
R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

RECOMMENDED HEATER VOLTAGE



Notes

1. For extended periods of heater-only operation, a black heat voltage of 4.5 V is recommended.
2. The klystron must not be operated, even under sound conditions, with a heater voltage less than 4.5 V.
3. If a continuously variable supply is not available the following values should be used:

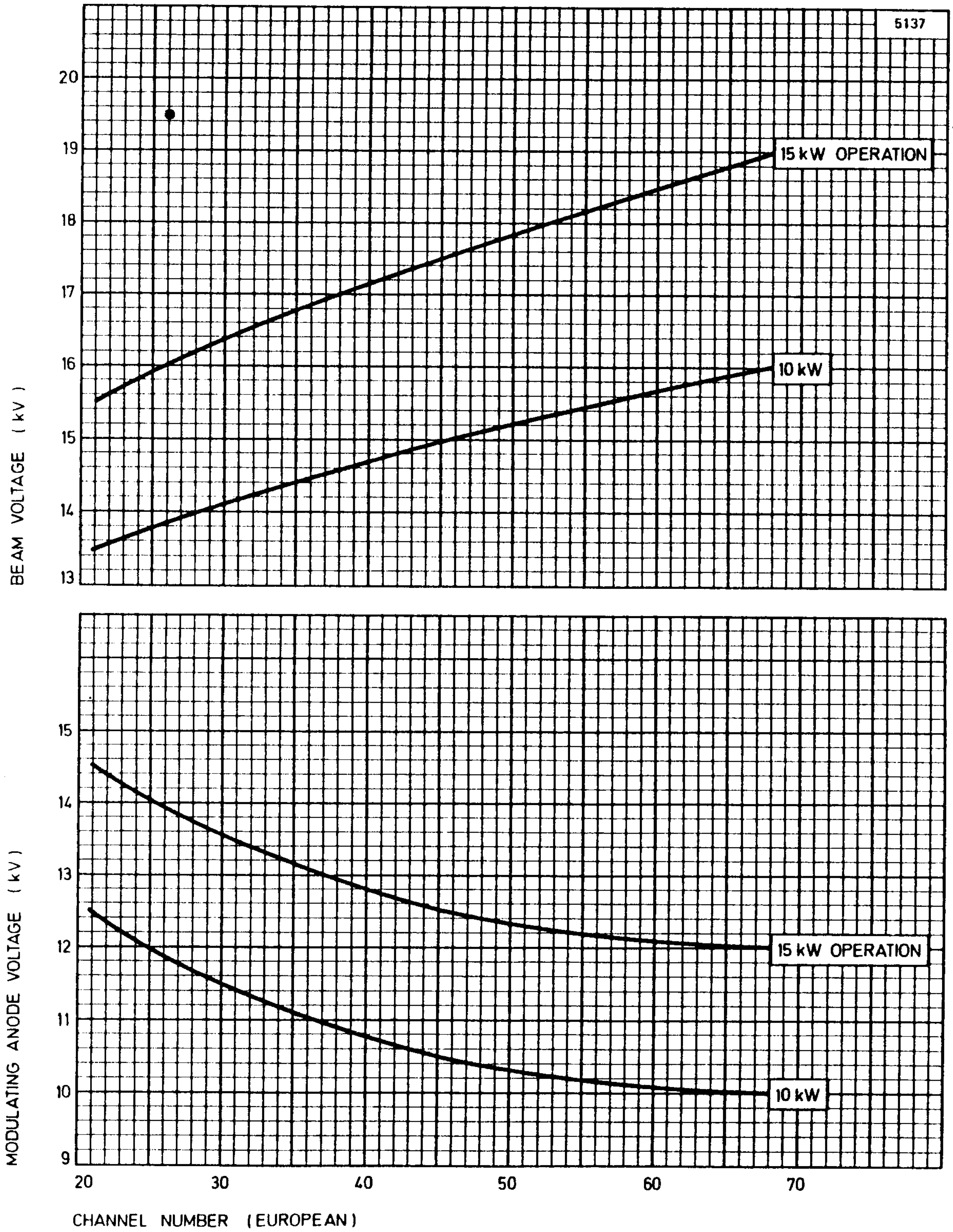
	below 670 MHz	above 670 MHz	
15 kW operation	5.0	4.8	V
10 kW operation	4.8	4.6	V

4. The klystron must be operated with a heater voltage of 5.5 V for the first 1000 hours.

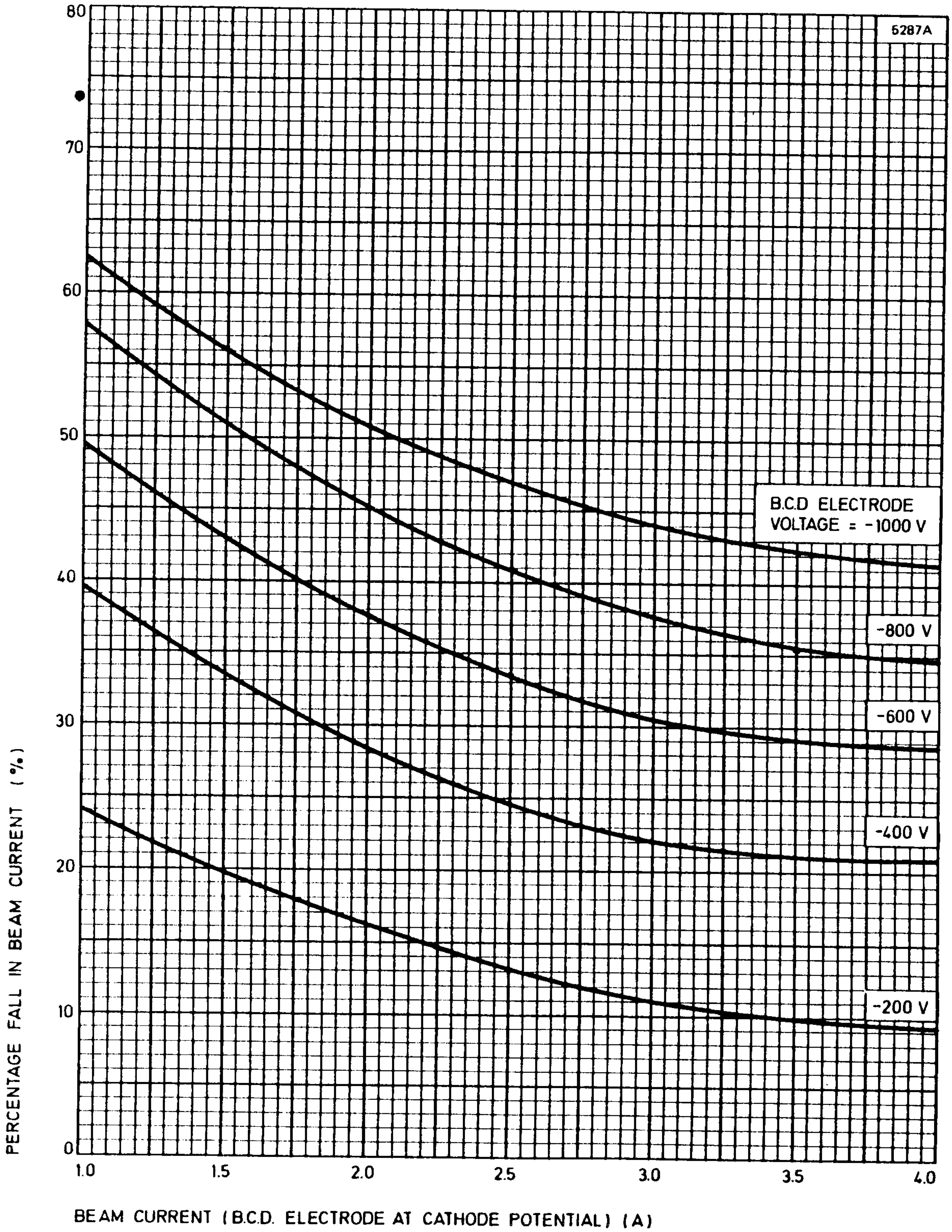
BEAM CURRENT CHARACTERISTIC

(B.C.D. electrode at cathode potential)

TYPICAL VARIATION OF OPTIMUM VOLTAGES WITH FREQUENCY

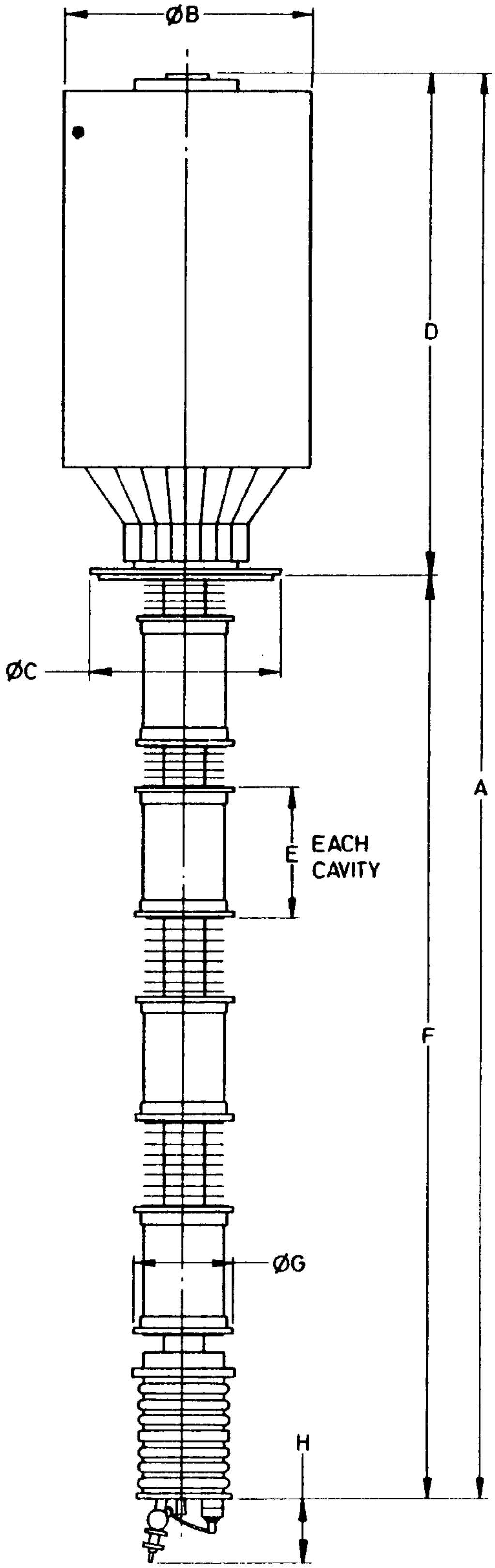


B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3153BCD

6254

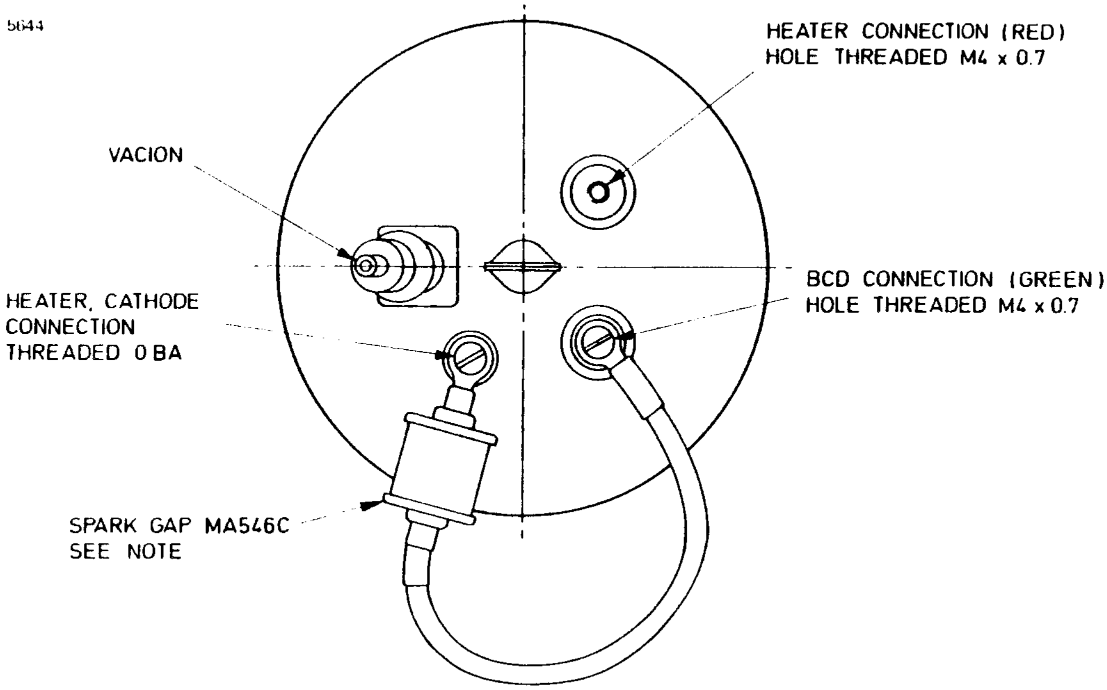


Outline Dimensions (All dimensions without limits are nominal)

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	1421 max	55.945 max	F	$840.0^{+4.0}_{-1.0}$	$33.071^{+0.157}_{-0.039}$
B	226.0 max	8.898 max			
C	176.0	6.929	G	93.0	3.661
D	462.0	18.189	H	115 max	4.528 max
E	117.0	4.606			

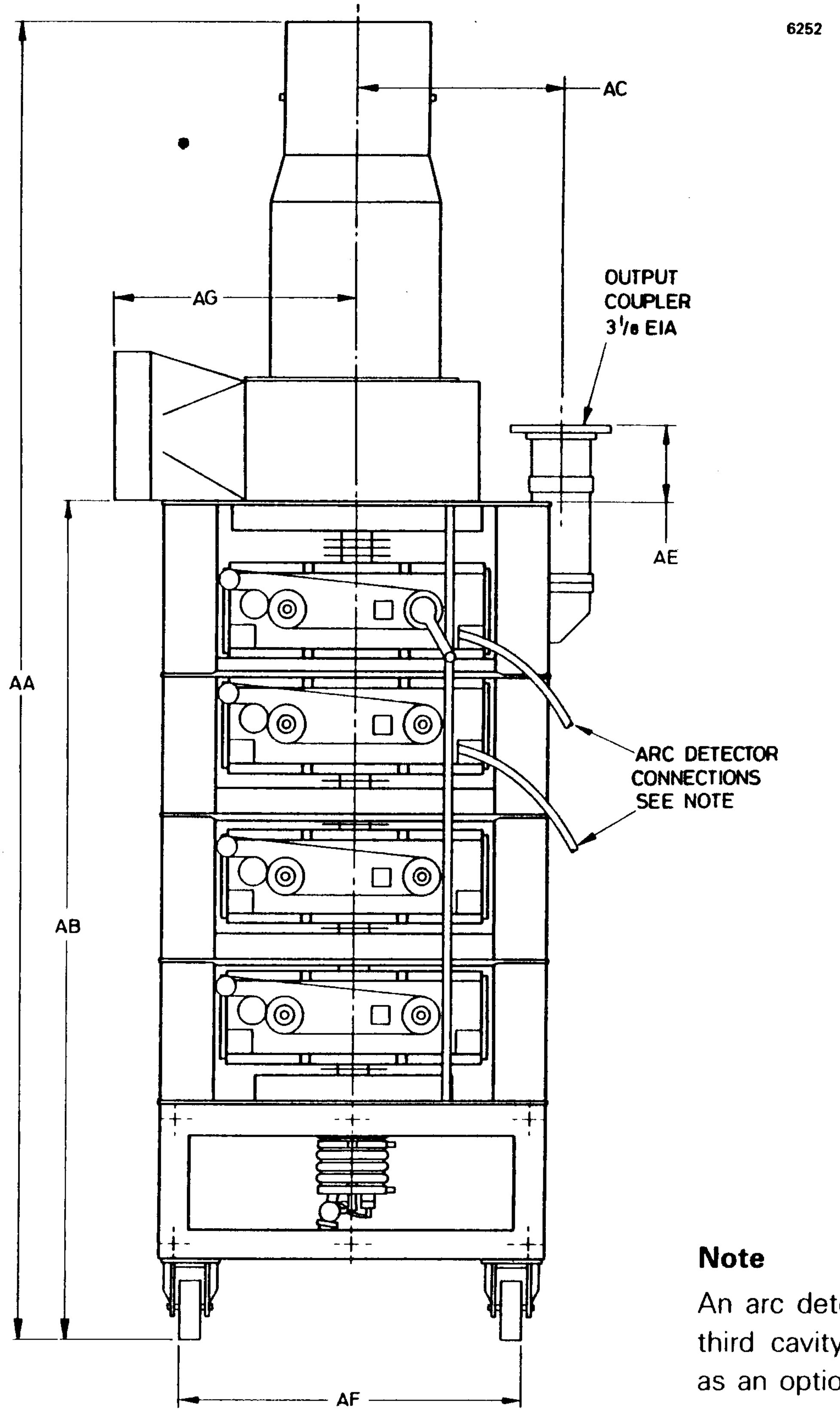
Inch dimensions have been derived from millimetres.

Enlarged View on Gun End of Klystron



Note The spark gap shown connected between the B.C.D. and cathode terminals is replaced by a shorting link for shipping. ***If the B.C.D. electrode is to be used, this link must be replaced by the spark gap as shown.*** Failure to fit the spark gap will result in failure of the B.C.D. insulation in the event of an internal flashover.

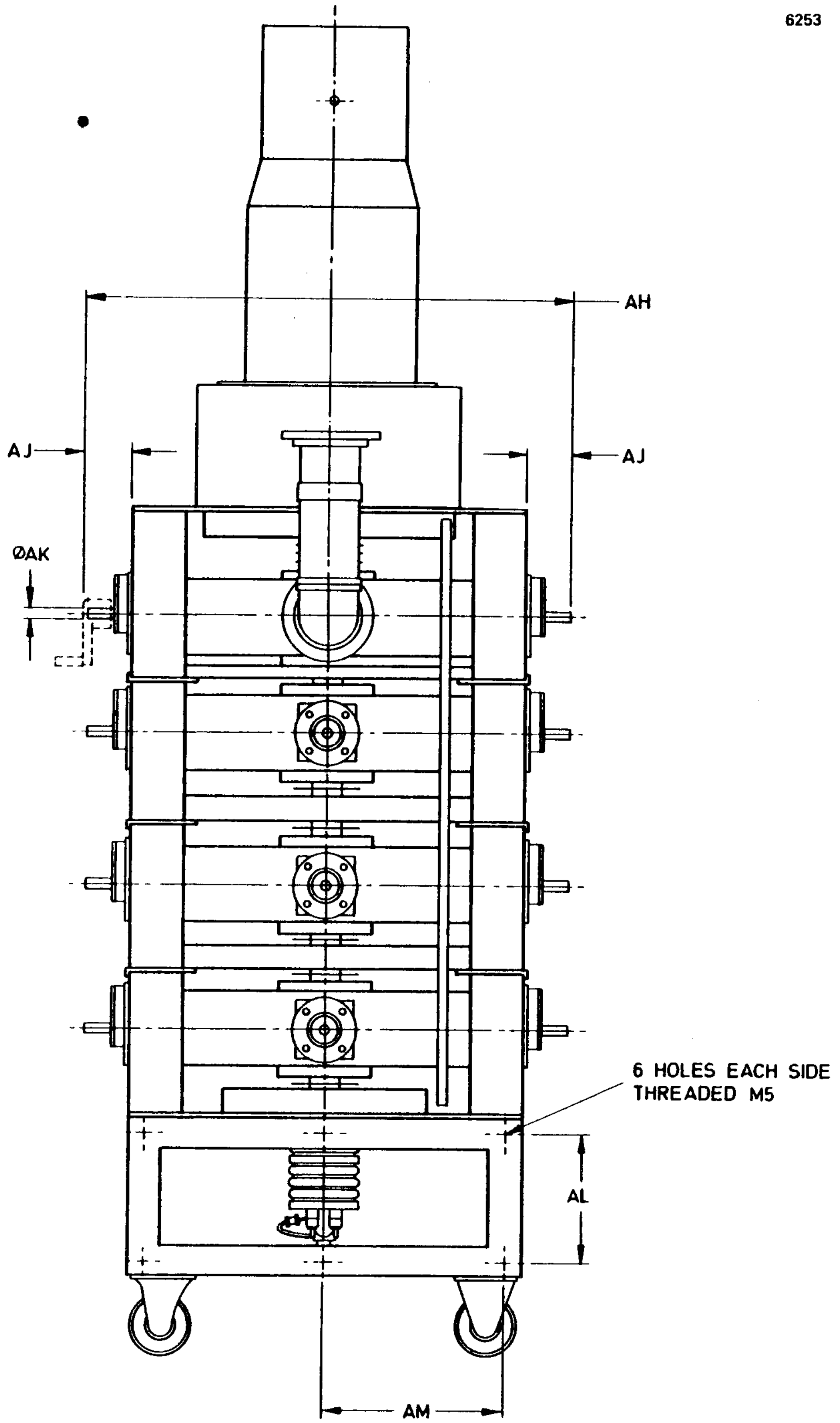
OUTLINE OF CIRCUIT ASSEMBLY K4153



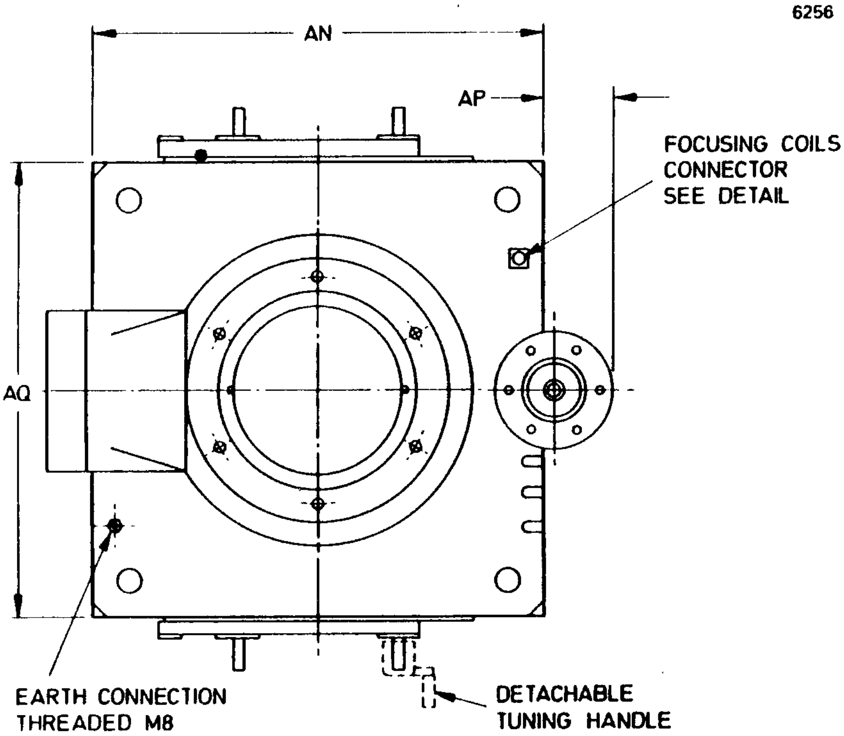
Note

An arc detector for the third cavity is available as an optional extra.

OUTLINE OF CIRCUIT ASSEMBLY K4153



Top View of K4153 (All dimensions without limits are nominal)

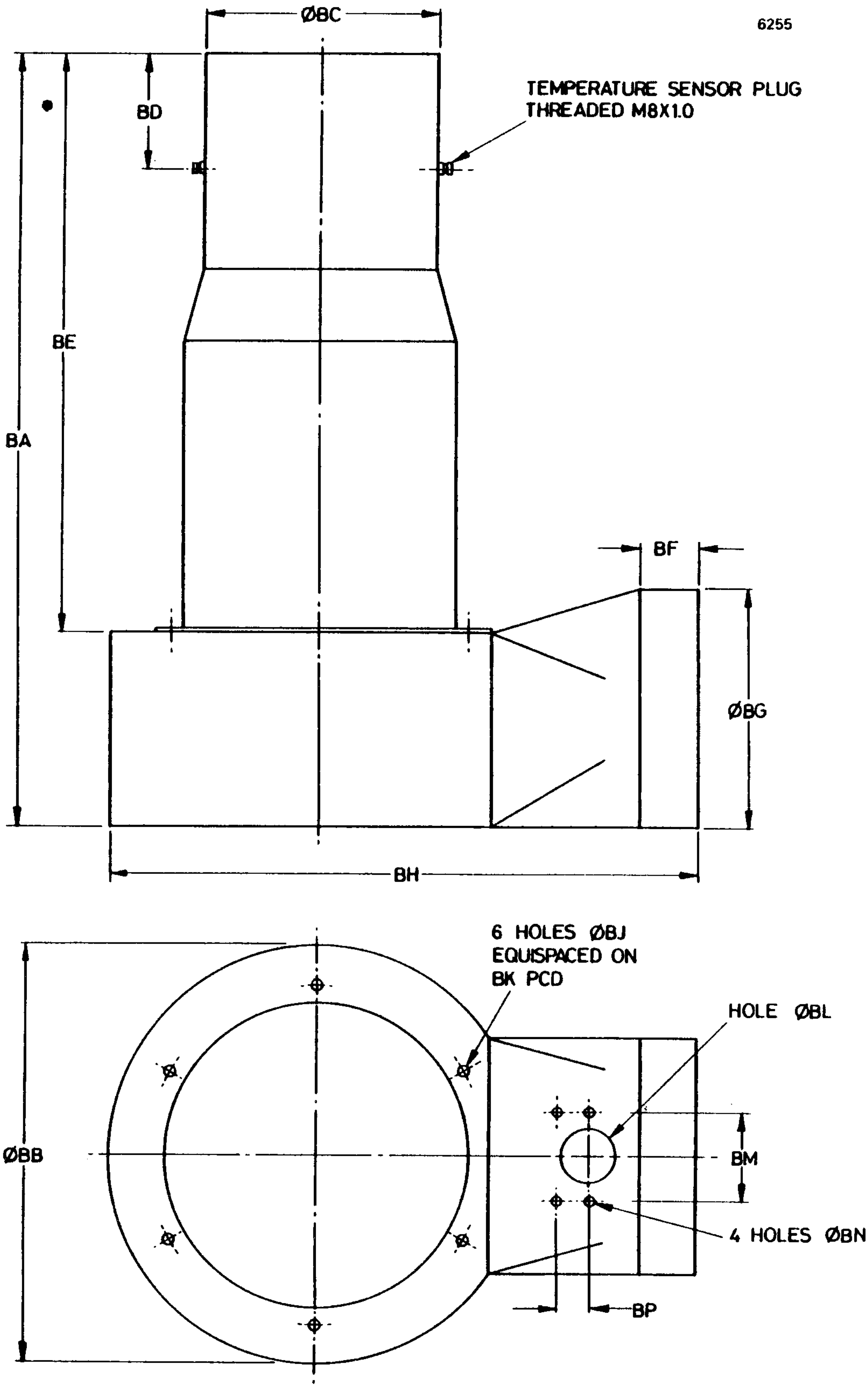


Ref	Millimetres	Inches
AA	1733.6 ± 3.0	68.252 ± 0.118
AB	1086.0 ± 3.0	42.756 ± 0.118
AC	264.0	10.394
AE	100.0	3.937
AF	453.0 ± 2.0	17.835 ± 0.079
AG	323.6	12.740
AH	630.0 max	24.803 max
AJ	61.0 max	2.402 max
AK	14.3	0.563
AL	162.0	6.378
AM	234.0	9.213
AN	508.0	20.000
AP	75.0	2.953
AQ	508.0	20.000

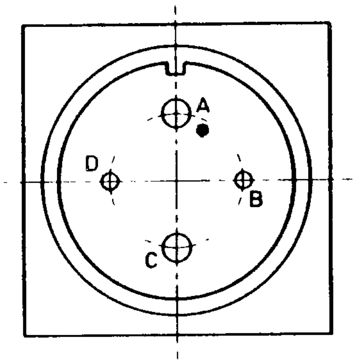
Ref	Millimetres	Inches
BA	647.55	25.494
BB	350.0	13.780
BC	198.0	7.795
BD	100.0	3.937
BE	487.55	19.195
BF	50.0	1.969
BG	198.0	7.795
BH	498.61	19.630
BJ	8.5	0.335
BK	288.0	11.339
BL	44.0	1.732
BM	70.0	2.756
BN	5.5	0.217
BP	25.0	0.984

Inch dimensions have been derived from millimetres.

OUTLINE OF COLLECTOR AIR DUCT



View on Focus Coil Connector



Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

Arc Detector Connections

Connection	Colour
Test lamp	Blue
Test lamp	Red
Photo resistor	Yellow
Photo resistor	Green
Screen	–

English Electric Valve Company Limited

Chelmsford, Essex, England

Printed in England

Subsidiary of The General Electric Company, p.l.c. of England

K3217HBCD K3218HBCD K3219HBCD

HIGH POWER AMPLIFIER KLYSTRONS FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacements for K3217H Series klystrons featuring:

- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam current reduction during picture information.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing at 45 kW output. 40% minimum sync. efficiency at 45 kW output in standard operational mode.
- **Output Power** Rated up to 45 kW output in vision amplifier service.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Simple, Efficient Vapour Cooling** A single water supply of 9 litres/minute cools both body and collector. Cold-weir type boiler.
- **Simple Tube Exchange** Pre-adjusted cavities and loops in K4170 and K4158 series circuit assemblies. Settings not upset by tube exchange.

DESCRIPTION

The K3217HBCD, K3218HBCD and K3219HBCD are four-cavity high efficiency amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The three tubes operate in the frequency bands 470–590 MHz, 590–702 MHz and 702–860 MHz respectively at sync. power levels of 22.5, 28 or 45 kW.

A rugged beam current control electrode allows the beam current to be reduced during the picture region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to set the sync. level perveance and by pulsing the B.C.D. electrode voltage (see note 1).

The klystrons can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

January 1985

Supersedes December 1982 Issue

The modulating anode enables the klystrons to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The tubes are electro-magnetically focused and their associated circuit assemblies are designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing either the tuning or the loading loop settings, so that the replacement klystron is coarse-tuned at switch-on and requires only a trimming adjustment to meet the full transmission specification.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is vapour cooled in a cold-weir type boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied). The boiler is fitted with a visual water level indicator and a fail-safe electric low water level alarm sensor.

The electron gun and the output and penultimate cavities require forced-air cooling; suitable air ducts are provided for the cavities. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

ABRIDGED DATA

Klystron	Frequency Range	European Channel Numbers	Circuit Assembly
K3217HBCD	470 to 590 MHz	21 to 35	K4170
K3218HBCD	590 to 702 MHz	36 to 49	K4171
K3219HBCD	702 to 860 MHz	50 to 68	K4172

Note These klystrons may be used as direct replacements for K3017, K3018 and K3019 respectively in earlier circuit assemblies of the K4102BDS and K4158 series, but it should be noted that there are some differences in the frequency ranges.

Output power (saturated) at klystron flange	45	kW
Power gain (typical)	41	dB
Beam voltage	21.5	kV

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	8.5 ± 3%	V
Heater current range	37 to 46	A
Heater starting current (peak)	200	A max
Cathode pre-heating time	5	minutes

Mechanical

Overall length (see note 2):	
K3217HBCD, K3218HBCD	63.75 inches (161.9 cm) max
K3219HBCD	59.5 inches (151.1 cm) max
Overall diameter	11.125 inches (283 mm) nom
Mounting position	vertical, collector end up
Net weight of klystron:	
K3217HBCD, K3218HBCD	210 pounds (95 kg) approx
K3219HBCD	155 pounds (70 kg) approx

Circuit Assembly

Electro-magnet current, stabilized to ± 2% (see note 3)			10.8	A min
			12.5	A max
Electro-magnet resistance:	**K4170**	**K4171**	**K4172**	
cold (20 °C)	9.5 ± 1	9.0 ± 1	8.5 ± 1	Ω
hot (20 °C ambient)	13	13	12	Ω max
hot (45 °C ambient)	14	14	13	Ω max

R.F. input connector	type N coaxial
R.F. output	3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities:	
K4170 (for K3217HBCD)	120 pounds (54 kg) approx
K4171 (for K3218HBCD)	90 pounds (41 kg) approx
K4172 (for K3219HBCD)	70 pounds (32 kg) approx
Total lifting weight of klystron, cavities, boiler and mounting collar:	
K3217HBCD	440 pounds (200 kg) approx
K3218HBCD	410 pounds (186 kg) approx
K3219HBCD	335 pounds (152 kg) approx
Net weight of magnet assembly	1150 pounds (523 kg) approx

EEV arc detector type MA257 is fitted to the output cavity. See pages 26 and 27 for connection details.

Cooling

Volume of steam produced by collector dissipation	1.5	ft³/min/kW
	0.043	m³/min/kW
Volume of water converted to steam	0.006	imp. gal/min/kW
	0.027	litre/min/kW
Inlet water flow to body and collector in series (see note 4)	2.0	imp. gal/min
	9.0	litre/min
Body pressure drop at 2.0 imp. gal/min	28	lb/in²
	2.0	kg/cm²
Inlet water temperature	80	°C max
Air flow to penultimate and output cavities	50	ft³/min each
	1.42	m³/min each
Static pressure head (see note 5)	2.0	inch water gauge
	51	mm water gauge
Air flow to electron gun	5.0	ft³/min
	0.142	m³/min
Inlet air temperature	40	°C max

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:			
continuous	23	kV max	
switch-on surge	27	kV max	
Beam current (mean)	7.0	A max	
B.C.D. voltage (relative to cathode) (see note 1)	−2.0	kV max	
B.C.D. current (see note 6)	2.0	mA max	★
Body current	150	mA max	
Output power	50	kW max	
Collector dissipation	150	kW max	
Load v.s.w.r. (see note 7)	1.5:1	max	
Temperature of any external part of the klystron must not exceed	175	°C max	

★ Indicates a change.

TYPICAL OPERATION (Vision amplifier without beam current pulsing)

Operating Conditions (B.C.D. Electrode connected to cathode)

Beam voltage	21.5	kV
Beam current	5.25	A
Electro-magnet current	12.0	A
Bandwidth (to 1 dB points) (see note 8)	8.0	MHz

K3217HBCD in K4170 Circuit

Frequency	470–478	526–534	582–590	MHz
European channel	21	28	35	
Saturated output power	50	50	50	kW
Sync. output power	45	45	45	kW
Body current:				
with no r.f. input power	15	15	15	mA
black level + sync. (45 kW)	55	50	50	mA
Drive power (sync.)	2.5	3.0	3.5	W
Linearity (see note 9)	60	60	60	%
Differential gain (see note 10)	70	70	70	%
Differential phase (see note 11)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	44	44	44	%

K3218HBCD in K4171 Circuit

Frequency	590–598	646–654	694–702	MHz
European channel	36	43	49	
Saturated output power	50	50	50	kW
Sync. output power	45	45	45	kW
Body current:				
with no r.f. input power	15	15	15	mA
black level + sync. (45 kW)	50	50	55	mA
Drive power (sync.)	2.5	2.5	3.0	W
Linearity (see note 9)	60	60	60	%
Differential gain (see note 10)	70	70	70	%
Differential phase (see note 11)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	44	44	44	%

K3219HBCD in K4172 Circuit

Frequency	702–710	774–782	846–854	MHz
European channel	50	59	68	
Saturated output power	50	50	50	kW
Sync. output power	45	45	45	kW
Body current:				
with no r.f. input power	15	15	15	mA
black level + sync. (45 kW)	55	50	50	mA
Drive power (sync.)	2.0	3.0	4.0	W
Linearity (see note 9)	60	60	60	%
Differential gain (see note 10)	70	70	70	%
Differential phase (see note 11)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	44	44	44	%

PERFORMANCE SPECIFICATION

This specification covers use of the klystron with peak sync. vision output powers at the klystron flange in the range 22.5 kW to 45 kW and sound powers in the range 2.25 kW to 4.5 kW. In all cases the B.C.D. electrode is assumed to be connected to cathode.

GENERAL SPECIFICATION

The following are the test conditions common to vision or sound operation.

Heater voltage	8.5 ± 3%	V
Heater current	37 to 46	A

VISION SERVICE

Test Conditions

Peak sync. power at klystron flange	22.5	28	45	kW
Bandwidth	see note 8	see note 8	see note 8	

Continued on page 7

Range of Characteristics

	Min	Max	Min	Max	Min	Max	
Efficiency	35	–	37	–	40	–	%
Beam power	–	64	–	76	–	113	kW
H.T. voltage taps . . .	16.0	17.0	17.0	18.2	19.8	21.5	kV
Beam current	–	4.0	–	4.5	–	5.7	A
Modulating anode current .	–	6.0	–	6.0	–	6.0	mA
Body current (see note 12) .	–	150	–	150	–	150	mA
Body current (see note 13) .	–	50	–	50	–	50	mA
R.F. drive power (see note 14)	–	5	–	5	–	5	W
Linearity (see note 9) .	50	–	50	–	50	–	%
Differential gain (see note 10)	65	–	65	–	65	–	%
Differential phase (see note 11)	–	10	–	10	–	10	degrees
A.M. noise (see note 15) .	–	−60	–	−60	–	−60	dB
R.F. radiation (see note 16) .	–	10	–	10	–	10	mW/cm^2
X-radiation (see note 17) .	–	5	–	5	–	5	mR/hr

SOUND SERVICE

Test Conditions

Output power	2.25	2.8	4.5	kW
Modulating anode voltage (nominal) relative to cathode potential (see note 18) . .	5.0	5.0	5.5	kV

Range of Characteristics

	Min	Max	Min	Max	Min	Max	
Beam voltage	–	17.0	–	18.2	–	21.5	kV
Beam current (see note 18)	–	0.75	–	0.75	–	0.75	A
Body current (see note 19)	–	50	–	50	–	50	mA
Efficiency (see note 20) .	20	–	22	–	25	–	%
R.F. drive power (see note 14)	–	2.0	–	2.0	–	2.0	W

NOTES

1. The K3217HBCD series klystrons may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 45 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to cathode.

   (b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.

2. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 135 inches (3.43 m) is required. This is measured to the top of the lifting harness and does not include the hoist.

3. Under TV picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within an electro-magnet current range of 10.8 to 12.5 A. Maximum stability is obtained by adjusting the magnet current within the above range and stabilizing it to ± 2% about this optimum value.

4. Alternative cooling arrangements can be used.

5. Measured by a manometer at the input pipes to the circuit assembly.

6. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions. ★

Beam voltage	21.5	kV
Beam current	5.25	A
Heater voltage	8.5	V
B.C.D. voltage	zero with respect to cathode	

   The B.C.D. voltage must then be increased to −700 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 2 mA and typically will be less than 1 mA. At end-of-life, the B.C.D. current will not exceed 3 mA.

★ Indicates a change.

With a B.C.D.-to-cathode voltage of −700 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow better than 60% efficiency to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Designers of B.C.D. pulsing equipment for these klystrons are advised to allow for a B.C.D. current value of about 10 mA. Typical values of inter-electrode capacitance are:–

B.C.D. to cathode	75	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

7. This applies to television service. EEV should be consulted regarding other conditions of service.

8. **Bandwidth** The klystron can be tuned to any vision carrier frequency within the stated frequency range.

   Then at a power output corresponding to black level it will produce an output having a −1 dB bandwidth from $(f_0 - 2)$ MHz to $(f_0 + 6)$ MHz. Over this bandwidth and when driven by a u.h.f. swept frequency signal, the output power will remain within the limits ± 1 dB as the swept input level is varied from white to peak sync. In the frequency range $(f_0 - 1)$ MHz to $(f_0 + 5)$ MHz the output power will remain within the limits ± 0.5 dB as the swept input level is varied from white to black levels.

   The amplitude/frequency response, as measured using a Marconi Instruments Ltd. UHF Sideband Analyser (or other approved instrument) will be that shown on page 12. The following conditions apply:

   (a) There will be no vestigial sideband filter in circuit.

   (b) The depth of modulation is 10% (single amplitude peak).

   (c) The specification set-up levels are 30%, 48% and 66% on the output waveform.

The frequency response 'step' shown on page 12 occurs over the frequency region where both upper and lower sidebands are present (see EEV Technical Publication 'Klystron Amplifiers for Television Applications').

9. **Linearity** The klystron, when operating at the appropriate peak sync. output level, will be driven with a video test waveform consisting of a 10-step staircase from black level to peak white occurring on each line. The ratio of the minimum step amplitude to the maximum step amplitude measured at the output of the klystron is the definition of linearity. For this test the klystron will deliver into its output transmission line, correctly terminated, an envelope waveform with amplitudes as follows:

Black level signal	76% amplitude of rated carrier at sync.
Peak white signal	20% amplitude of rated carrier at sync.

10. **Differential Gain** With a test waveform as that described in note 9 but with sine waves of 4.43 MHz and 10% (peak-to-peak of the maximum carrier) amplitude superimposed on each step of the staircase from black level to peak white, the ratio of the minimum to maximum amplitude of the sine wave, after passing the demodulated waveform at the output of the klystron through a suitable bandpass filter is the definition of differential gain.

11. **Differential Phase** With a test waveform as that described in note 9 but with sine waves of 4.43 MHz and 10% (peak-to-peak of the maximum carrier) amplitude superimposed on each step of the staircase from black level to white level, the phase difference between the phase of the 4.43 MHz signal on the white level step and that on the black level step is the definition of differential phase.

12. The combined body current of one sound and one vision klystron will not exceed this value.

13. The body current of one sound and one vision klystron in the absence of r.f. drive.

14. Defined as the power measured into a matched load substituted for the input cavity of the klystron.

15. There shall be no random or periodic noise generated within the klystron having a level greater than that stated, measured as a peak-to-peak voltage referred to the rectified level of the peak sync. signal. The focus current shall be adjusted for minimum noise. The level stated shall be maintained over a range of ±2% of this optimum focus current value.

16. The radiation will not exceed the stated level at a distance of 300 mm (11.8 inches) from the klystron or circuit assembly. The measurement is to be performed with an isotropic r.f. radiation monitor such as the Narda Model 8300 with a hand-held isotropic probe such as the model 8321.

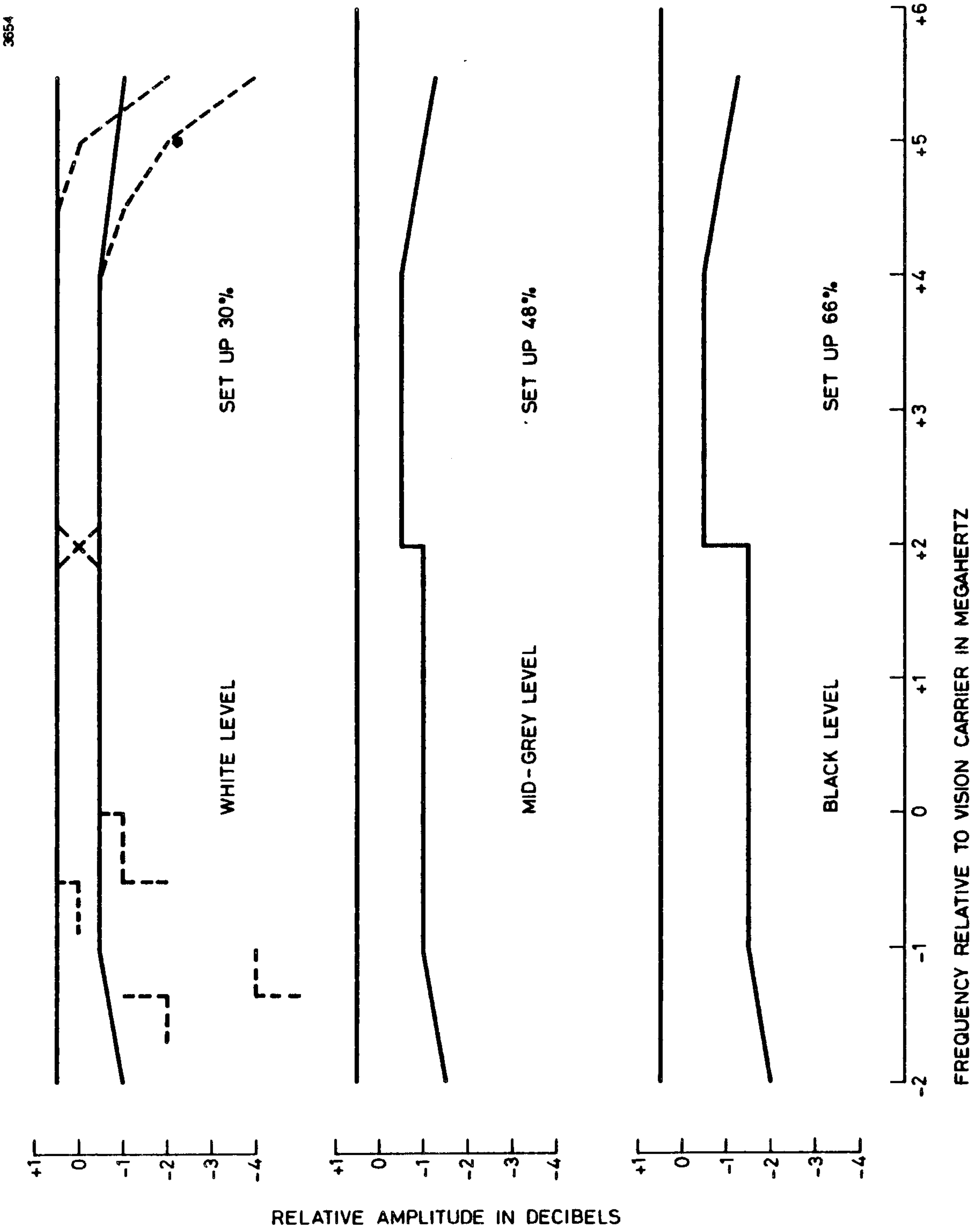
17. With the klystron operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission will not exceed the stated level at a distance of 300 mm (11.8 inches) from the klystron or circuit assembly.

18. For operation at the same beam voltage as the vision amplifier and one tenth of the vision output power, the beam current is reduced by means of the modulating anode. The graph on page 13 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the maximum value of the modulating anode current is 1.5 mA. The potential divider network must be designed accordingly.

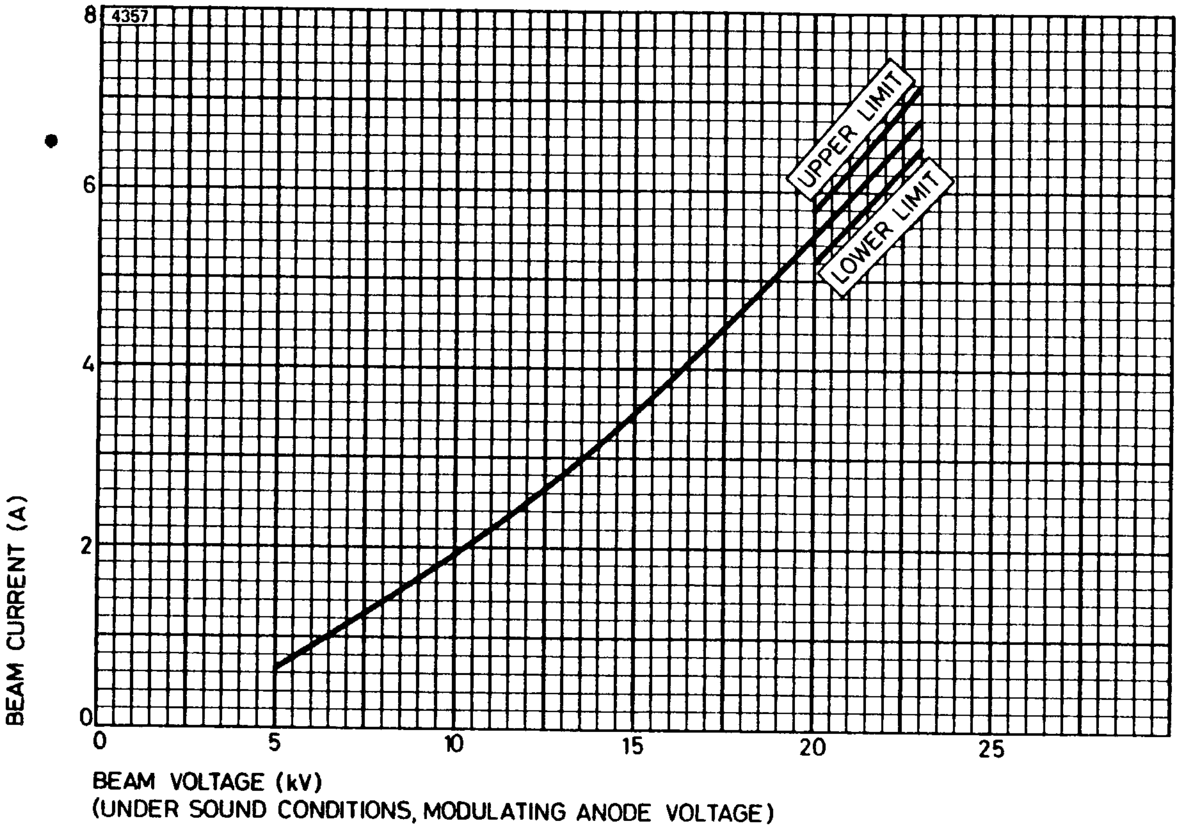
19. The current stated applies to a single sound klystron only.

20. Minimum efficiency for the output power stated.

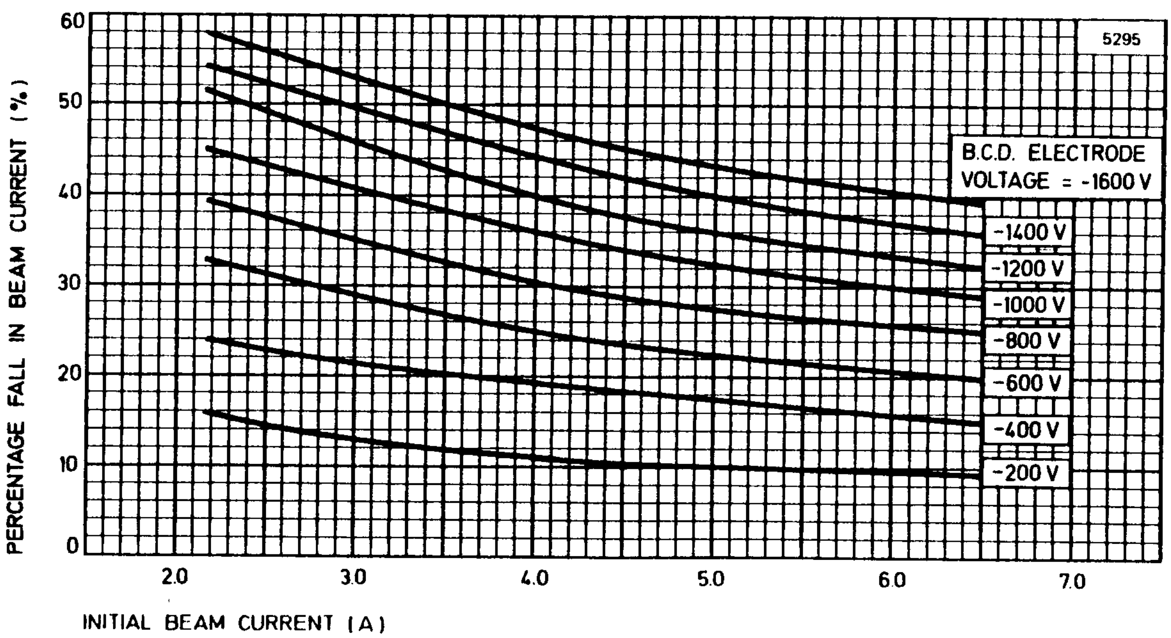
VISION AMPLIFIER KLYSTRON FREQUENCY RESPONSE



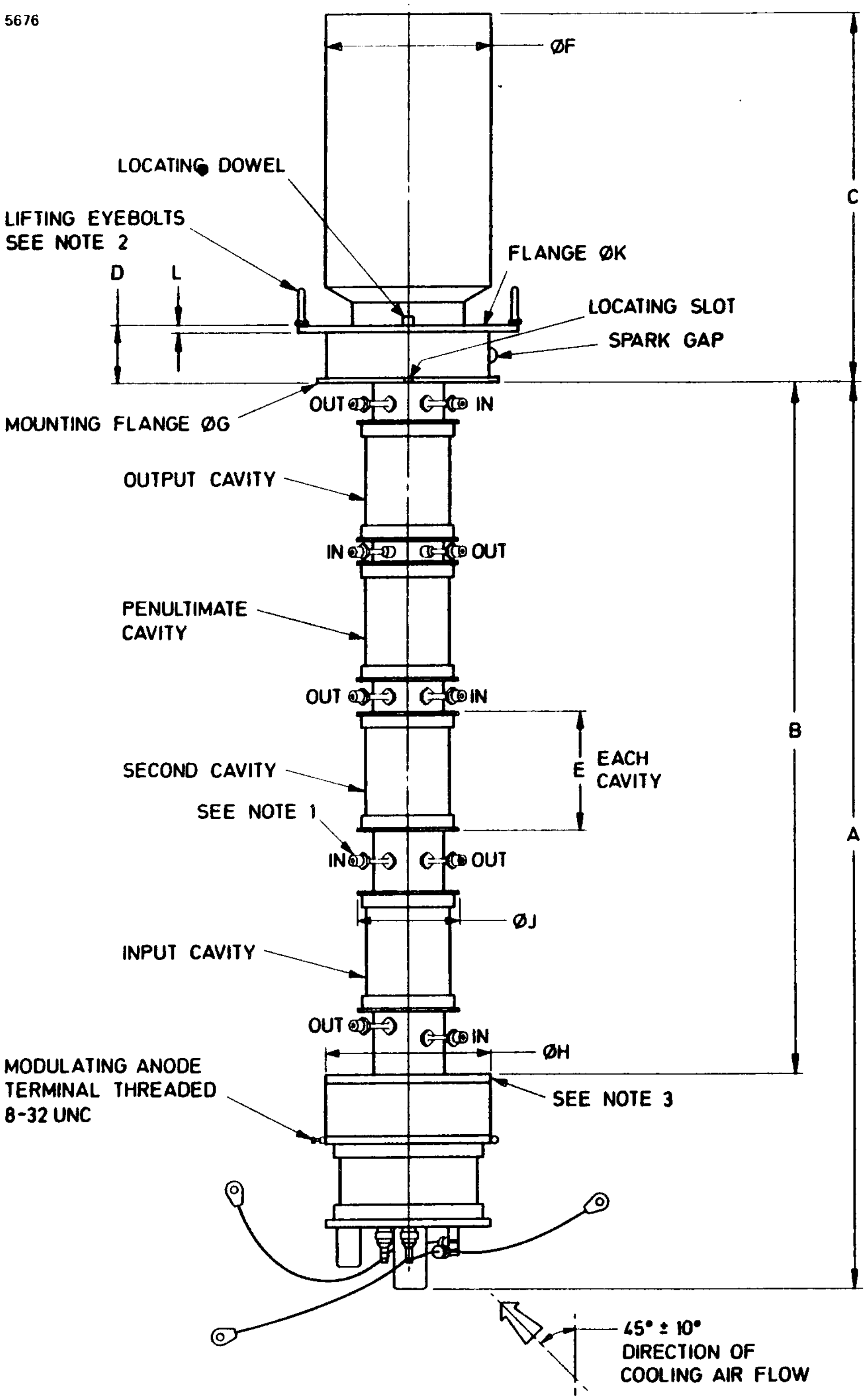
TYPICAL BEAM CHARACTERISTIC



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS

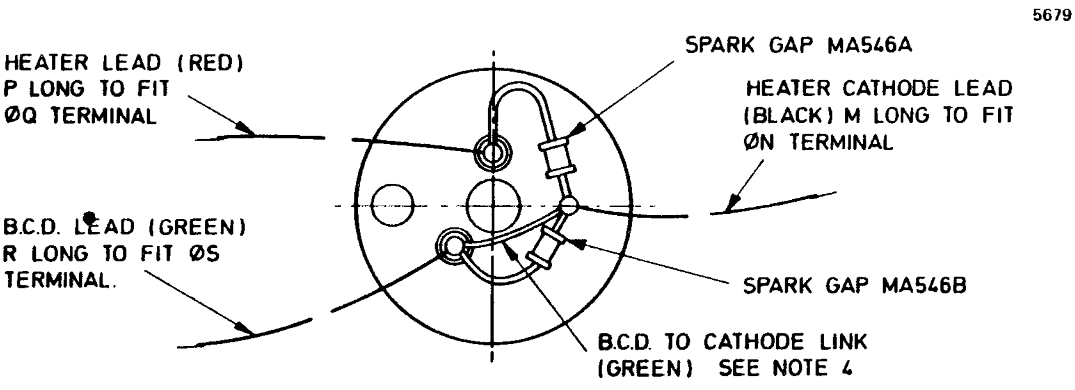


OUTLINE FOR K3217HBCD ★



★ Indicates a change.

View on Gun End of Klystron ★



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	44.812	1138.2	K	11.125	282.6
B	34.090	865.9	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	5.990	152.1	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	5.125	130.2			

Millimetre dimensions have been derived from inches.

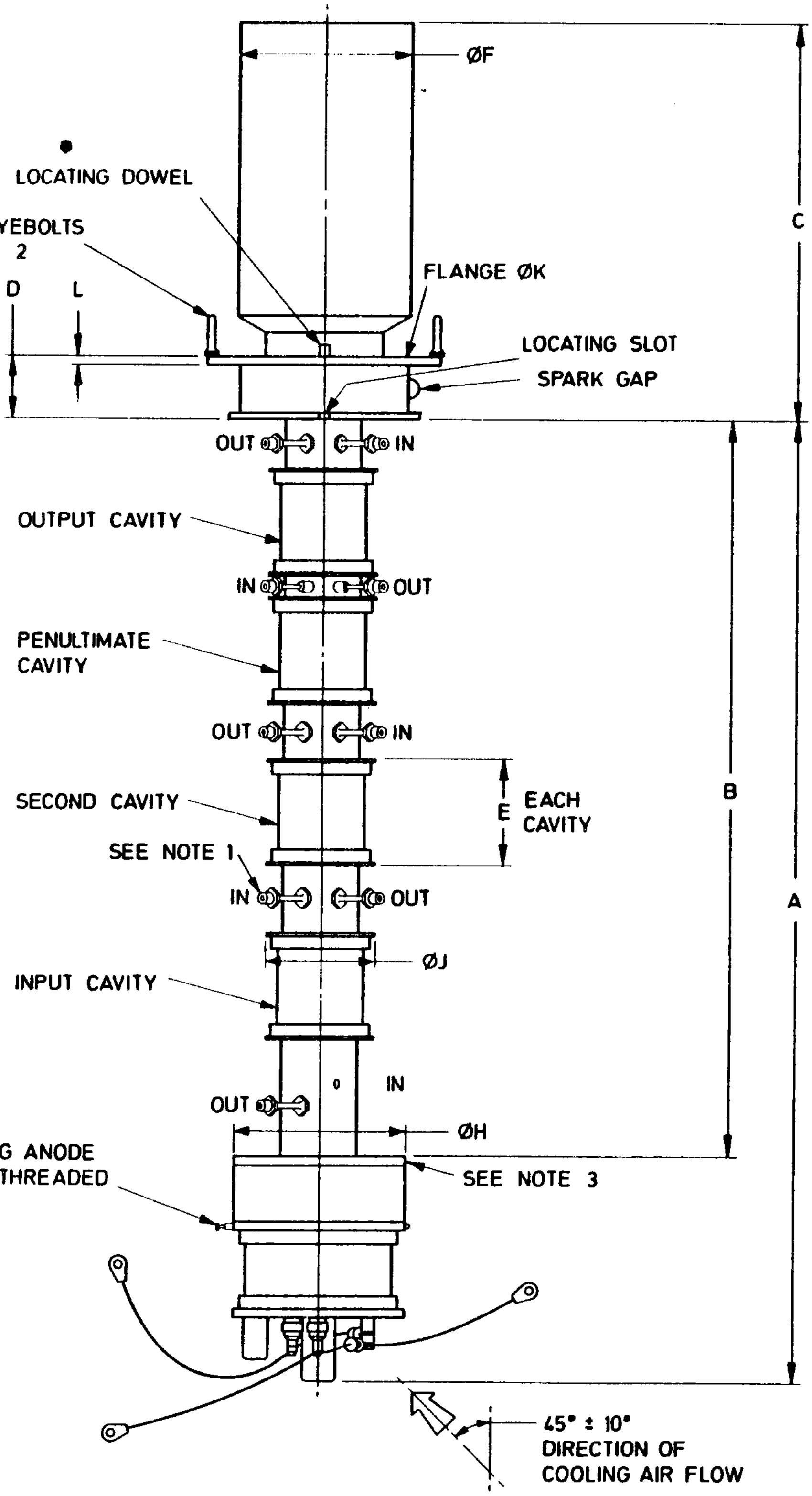
Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life. The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times. ★

★ Indicates a change.

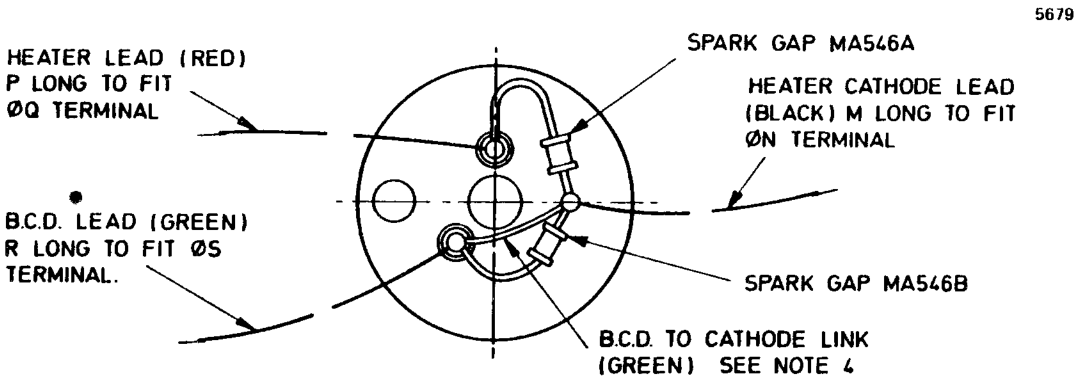
OUTLINE FOR K3218HBCD ★

5677



★ Indicates a change.

View on Gun End of Klystron ★



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	44.812	1138.2	K	11.125	282.6
B	34.090	865.9	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	4.990	126.7	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	5.125	130.2			

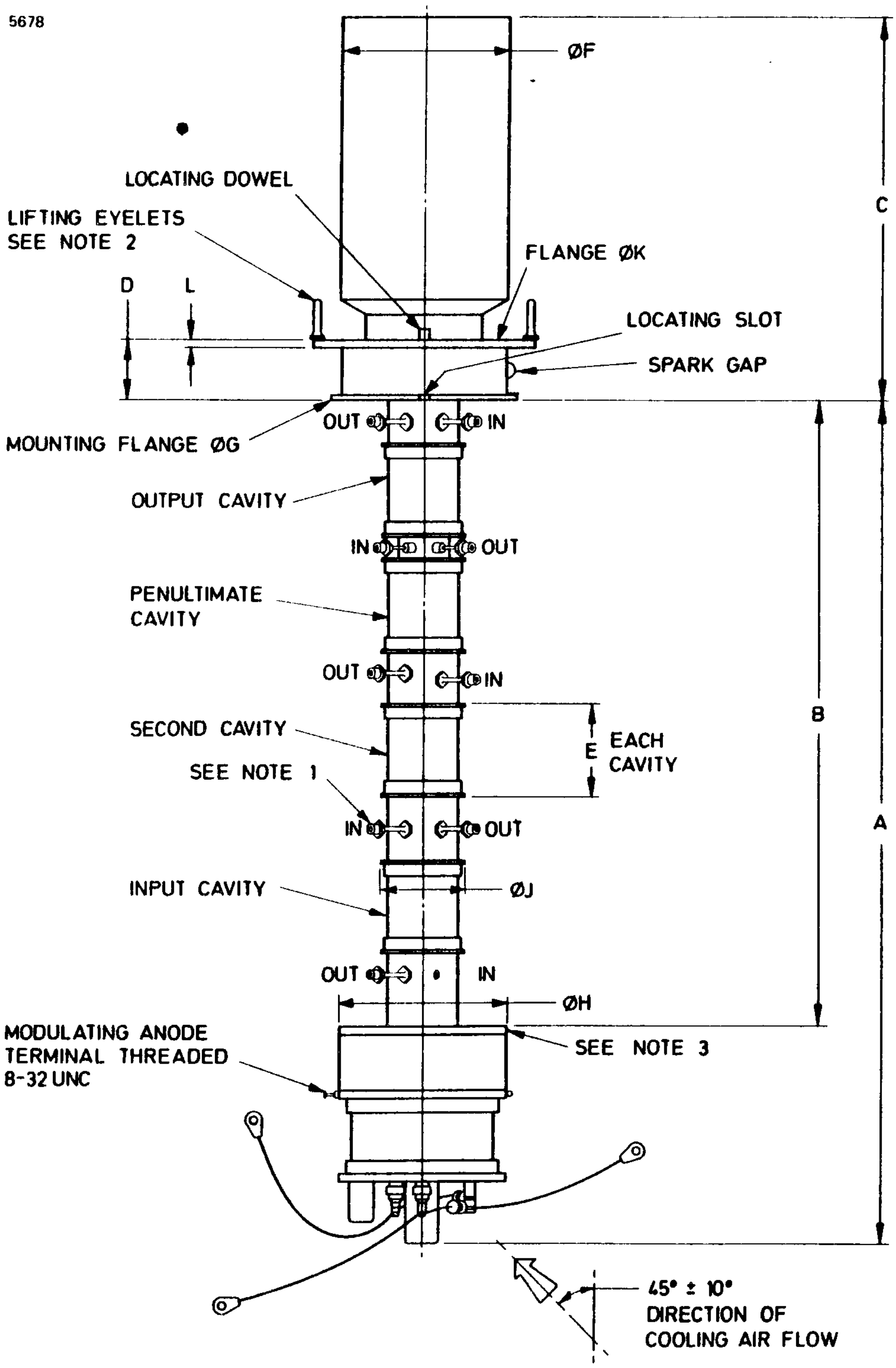
Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life. The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times. ★

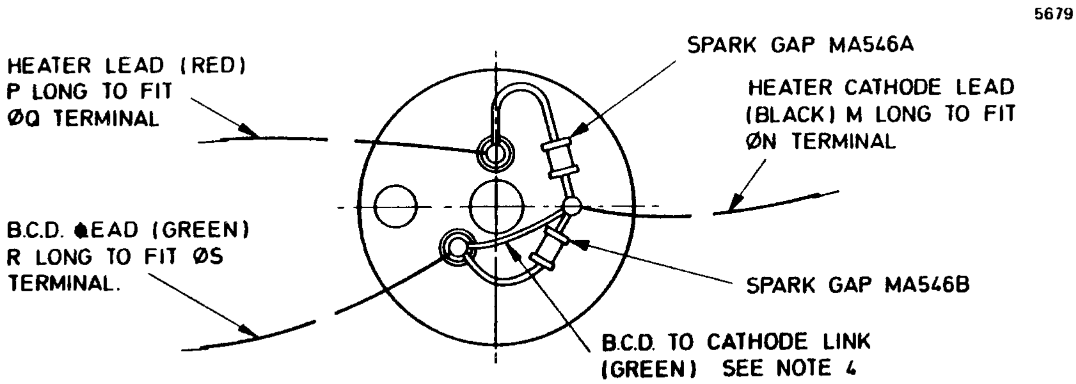
★ Indicates a change.

OUTLINE FOR K3219HBCD ★



★ Indicates a change.

View on Gun End of Klystron ★



Ref	Inches	Millimetres
A	40.600	1031.2
B	29.875	758.8
C	18.500	469.9
D	3.000	76.20
E	4.490	114.0
F	8.100 max	205.7 max
G	9.125	231.8
H	8.100	205.7
J	4.125	104.8

Ref	Inches	Millimetres
K	11.125	282.6
L	0.500	12.70
M	23.000	584.2
N	0.313	7.95
P	23.000	584.2
Q	0.250	6.35
R	23.000	584.2
S	0.250	6.35

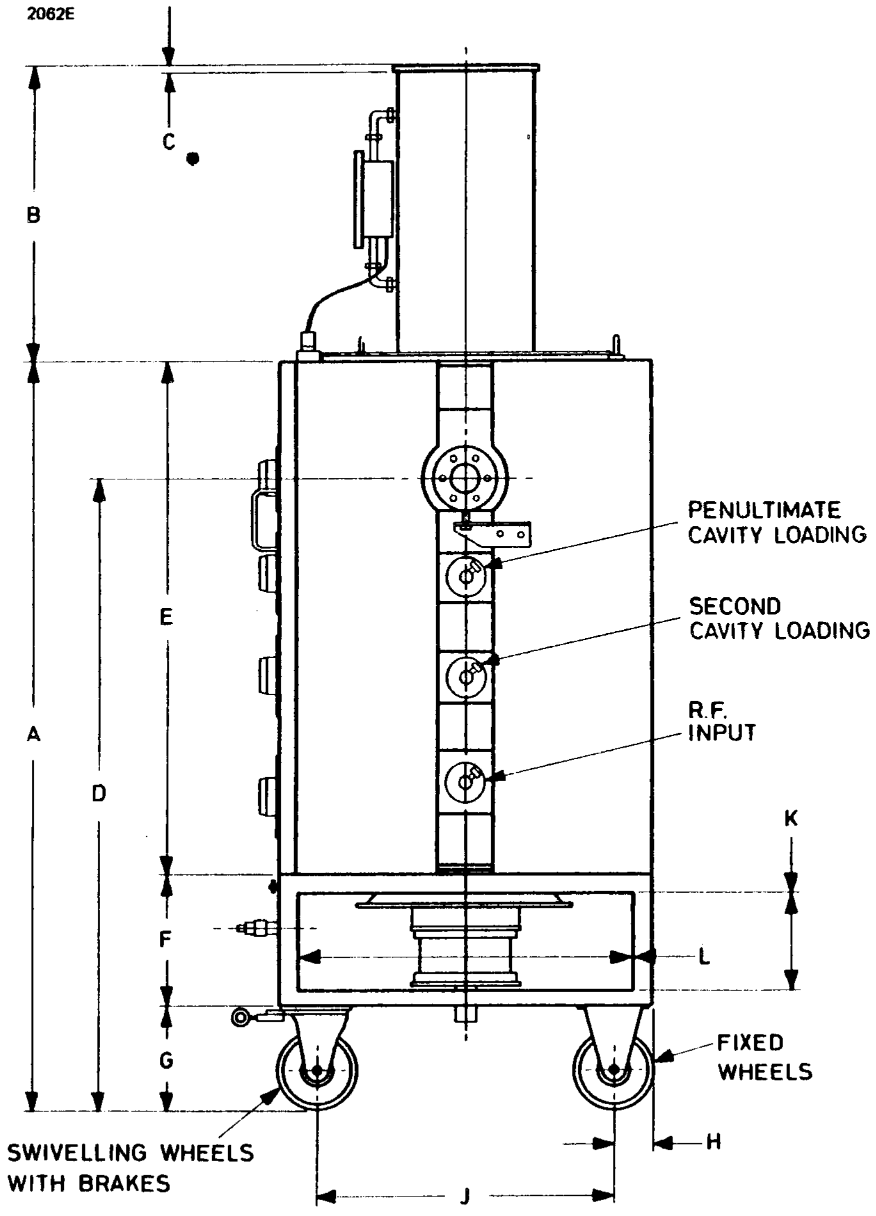
Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life. The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times. ★

★ Indicates a change.

OUTLINE FOR CIRCUIT ASSEMBLIES

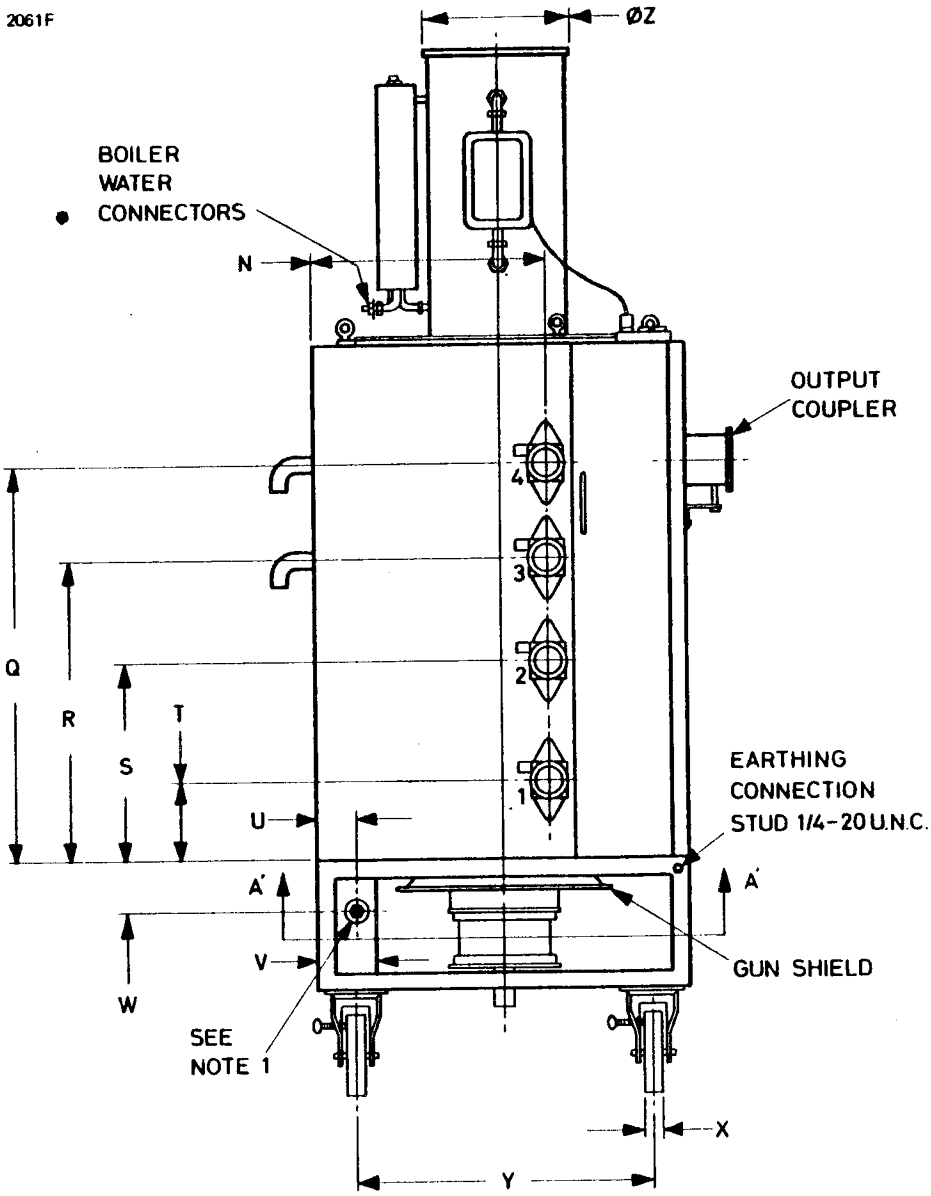


Note This drawing is not to scale for the K4172

See page 23 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES

2061F



Controls

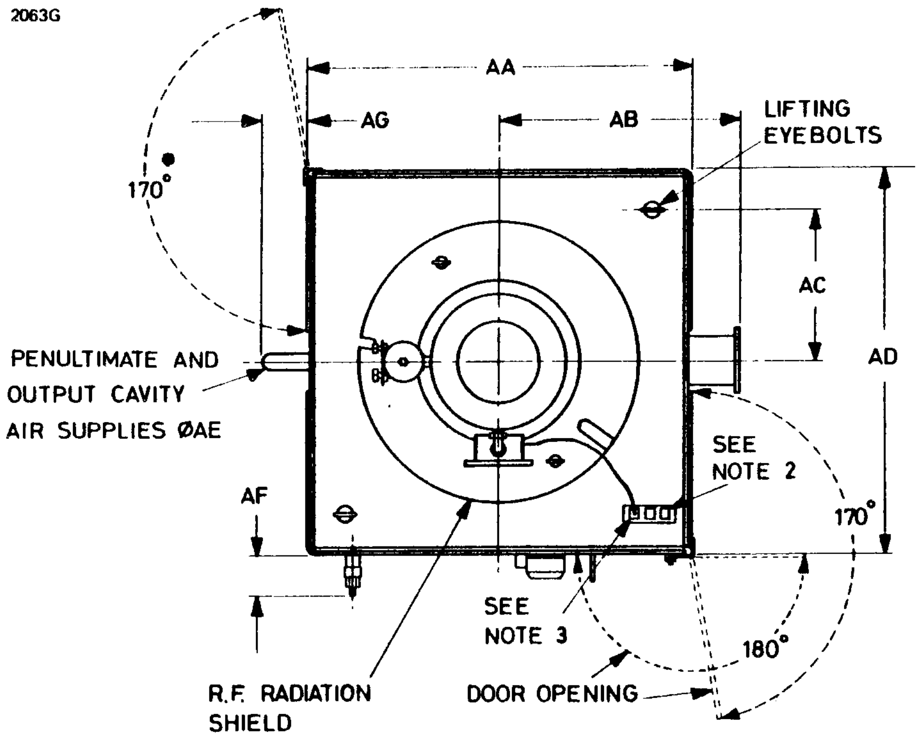
1 Input cavity tuning
2 Second cavity tuning
3 Penultimate cavity tuning
4 Output cavity tuning

Note This drawing is not to scale for the K4172.

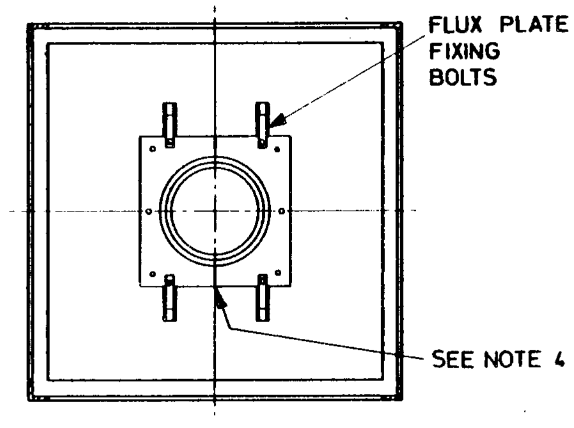
See page 23 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES

2063G



View from above



Section A'-A' with gun shield omitted showing flux plate

Outline Notes

1. Water inlet connection Hitemp Minilock Self Sealing Coupling, threaded ½-inch B.S.P.
2. Connections to external circuits; see page 26.
3. Collector and level trip socket, accepts plug wired to boiler.
4. Position of colour code band to match that of klystron.

Ref	Inches	Millimetres
A	55.125 ± 0.125	1400.2 ± 3.2
B	21.437 ± 0.125	554.5 ± 3.2
C	0.500	12.70
D	46.250 ± 0.250	1174.8 ± 6.4
E	37.813 ± 0.062	960.5 ± 1.6
F	9.688 ± 0.062	246.1 ± 1.6
G	7.625 ± 0.062	193.7 ± 1.6
H	• 3.500 ± 0.187	88.90 ± 4.75
J	22.250 ± 0.062	565.2 ± 1.6
K	5.688 ± 0.187	144.48 ± 4.75
L	25.000 ± 0.187	635.0 ± 4.75
N	17.500	444.5
Q	28.937	735.0
R	22.062	560.4
S	14.562	369.9
T	5.750	146.1
U	3.000 ± 0.062	76.20 ± 1.57
V	4.500 ± 0.062	114.3 ± 1.57
W	3.500	88.90
X	1.750 ± 0.016	44.45 ± 0.41
Y	21.875 ± 0.125	555.6 ± 3.2
Z	11.125	282.6
AA	28.750 ± 0.125	730.3 ± 3.2
AB	15.750 max	400.1 max
AC	11.250	285.8
AD	28.750 ± 0.125	730.3 ± 3.2
AE	1.687	42.85
AF	4.250	108.0
AG	2.500	63.50

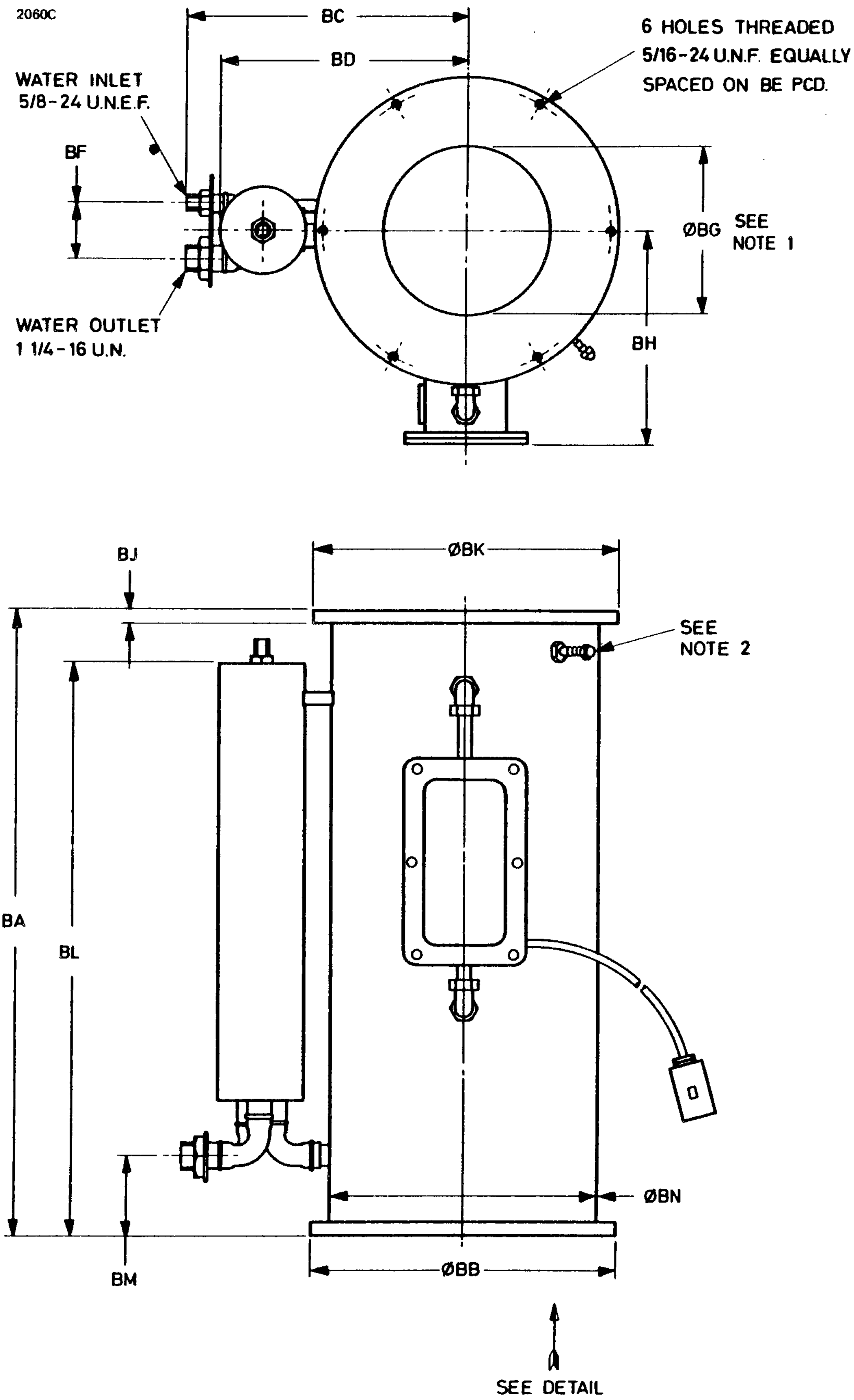
Millimetre dimensions have been derived from inches.

Outline Dimensions for K4172
(All dimensions without limits are nominal)

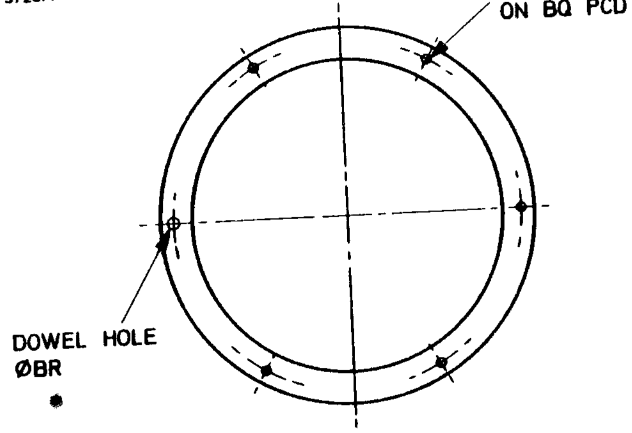
Ref	Inches	Millimetres
A	54.562 ± 0.125	1385.9 ± 3.2
B	21.437 ± 0.125	554.5 ± 3.2
C	0.500	12.70
D	46.250 ± 0.250	1174.8 ± 6.4
E	33.375 ± 0.062	847.7 ± 1.6
F	13.562 ± 0.062	344.5 ± 1.6
G	7.625 ± 0.062	193.7 ± 1.6
H	3.500 ± 0.187	88.90 ± 4.75
J	22.250 ± 0.062	565.2 ± 1.6
K	5.688 ± 0.187	144.48 ± 4.75
L	25.000 ± 0.187	635.0 ± 4.75
N	17.500	444.5
Q	25.062	636.6
R	19.562	496.9
S	12.625	320.7
T	5.125	130.2
U	3.000 ± 0.062	76.20 ± 1.57
V	4.500 ± 0.062	114.3 ± 1.57
W	3.500	88.90
X	1.750 ± 0.016	44.45 ± 0.41
Y	21.875 ± 0.125	555.6 ± 3.2
Z	11.125	282.6
AA	28.750 ± 0.125	730.3 ± 3.2
AB	15.5 max	393.7 max
AC	11.250	285.8
AD	28.750 ± 0.125	730.3 ± 3.2
AE	1.687	42.85
AF	4.250	108.0
AG	2.250	57.15

Millimetre dimensions have been derived from inches.

BOILER UNIT



2060C
BC
BD
6 HOLES THREADED
5/16-24 U.N.F. EQUALLY
SPACED ON BE PCD.
WATER INLET
5/8-24 U.N.E.F.
BF
ØBG
SEE
NOTE 1
WATER OUTLET
1 1/4-16 U.N.
BH
BJ
ØBK
SEE
NOTE 2
BA
BL
ØBN
BM
ØBB
SEE DETAIL



Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres
BA	22.562 ± 0.093	573.1 ± 2.4
BB	11.125 ± 0.015	282.6 ± 0.4
BC	10.250 ± 0.125	260.4 ± 3.2
BD	9.000	228.6
BE	10.500	266.7
BF	2.000 ± 0.125	50.80 ± 3.18
BG	6.000	152.4
BH	7.750	196.9

Ref	Inches	Millimetres
BJ	0.500	12.70
BK	11.125 ± 0.015	282.6 ± 0.4
BL	20.687	525.4
BM	2.937 ± 0.125	74.60 ± 3.18
BN	9.750	247.7
BP	0.312	7.92
BQ	10.500	266.7
BR	0.394	10.00

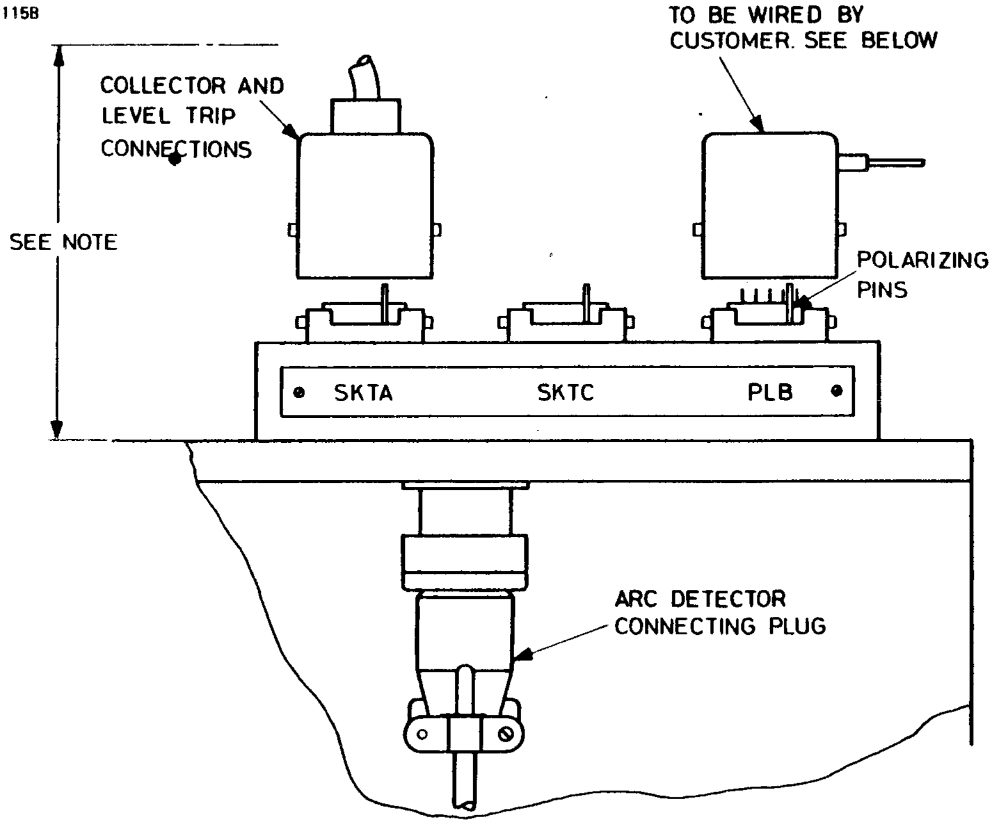
Millimetre dimensions have been derived from inches except dimension BR.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the siphon provided.

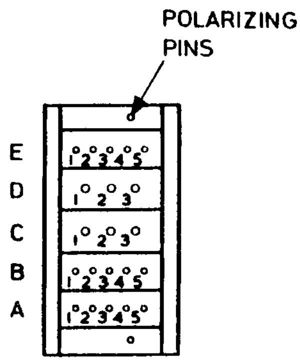
PLUG AND SOCKET CONNECTIONS

21158



Input Socket Connections
(to be wired by customer)

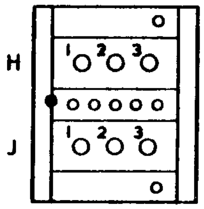
Water level trip circuit	B1, B2
Collector connection	C1
Arc detector circuit:	
photo resistor	E4, E5
bulb	E2, E3
screen and earth	E1
link	B4, B5
Focus coils:	
positive	C3
negative	D3



Input socket
View on solder connections
with cover removed

Note Clearance for connector removal 5.750 inches (146 mm) minimum.

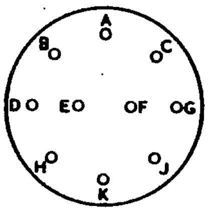
Collector Plug



2116

Pin	Element
H1	Collector
H2	–
H3	–
J1	Water level trip
J2	Water level trip
J3	–

Arc Detector Plug



Pin	Element
A	Photo resistor
B	Photo resistor
C	Bulb
D	Link
E	Screen and earth
F	Screen and earth
G	Bulb
H	Link
J	No connection
K	No connection

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K3217HBCD series klystrons have white, unmarked, aluminium oxide ceramics in ★ all cavities. However, on a few tubes the third and output cavity ceramics may be made of **beryllium oxide**; these ceramics are **coloured blue, or marked with a black line.**

Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics; if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

★ Indicates a change.

English Electric Valve Company Limited

Chelmsford, Essex, England

Printed in England

K3230BCD
K3231BCD

HIGH POWER AMPLIFIER KLYSTRONS FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacements for K3230 and K3231 klystrons featuring:

- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam current reduction during picture information.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing. 40% typical sync. efficiency at 32 kW output in standard operational mode.
- **Output Power** 32 kW output in vision amplifier service.
- **Long Life** High reliability electron gun with barium aluminate cathode for long tube life.
- **All ceramics aluminium oxide** No beryllium oxide ceramics.
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Water Cooled Collector**
- **High Efficiency Replacement for 4KM100LA and 4KM100LF**

DESCRIPTION

The K3230BCD and K3231BCD are high efficiency four-cavity amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The tubes are electro-magnetically focused and operate in the frequency ranges 470–596 MHz and 590–704 MHz respectively.

A rugged beam current control electrode allows the beam current to be reduced during the picture region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to set the sync. level perveance and by pulsing the B.C.D. electrode voltage (see note 1).

February 1986
Supersedes November 1984 Issue

DESCRIPTION – Continued

The klystrons can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

The modulating anode enables the klystron to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is water cooled and has an integral water jacket.

Forced-air cooling of the electron gun and the output and penultimate cavities is required. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The ceramic insulators on this series of tubes are made of aluminium oxide.

ABRIDGED DATA

Klystron	Frequency in the range	Channel Numbers European	Channel Numbers U.S.A.	Circuit Assembly
K3230BCD	470 to 596 MHz	21–36	14–34	K4204
K3231BCD	590 to 704 MHz	36–49	34–52	K4205

Output power at klystron flange	32	kW
Typical power gain	38	dB
Beam voltage	19	kV

GENERAL

Electrical

Cathode	barium aluminate, indirectly heated	
Heater voltage (see note 2)	8.25 ± 3%	V ★
Heater current range	35 to 46	A ★
Heater starting current (peak)	200	A max
Cathode pre-heating time	5	minutes

★ Indicates a change.

Mechanical

Overall length (see note 3)	60.875 inches (154.6 cm) nom
Overall diameter	10.000 inches (25.4 cm) nom
Mounting position	vertical, collector end down
Net weight of klystron	120 pounds (54 kg) approx

Circuit Assembly

Electro-magnet current (see note 4)	11	A min
	13.5	A max
Electro-magnet resistance:		
cold (20 °C)	9.5 ± 1	Ω
hot (20 °C ambient)	13	Ω max
hot (45 °C ambient)	14	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities:		
for K3230BCD		120 pounds (54 kg) approx
for K3231BCD		90 pounds (41 kg) approx
Total lifting weight of klystron and cavities:		
K3230BCD		250 pounds (114 kg) approx
K3231BCD		220 pounds (100 kg) approx
Net weight of magnet assembly		1150 pounds (523 kg) approx

Arc Detector

Arc detector type MA693A is fitted to the output and penultimate cavities.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test bulb		28 V, 0.04 A
Photo-resistor connection		coaxial cable 900 mm long fitted with BNC 50 Ω coaxial plug
Test lamp connection		twin flexible insulated cable, 900 mm long. No plug provided.

COOLING

At sea level, the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Inlet air temperature	40	°C max
Air flow to electron gun	5.0	ft³/min
	0.14	m³/min
Air flow to output and penultimate cavities	50	ft³/min each
	1.42	m³/min each
Static pressure head (see note 5)	2.0	inch w.g.
	51	mm
Water flow to body and electro-magnet in series (see notes 6 and 7)	2.0	imp. gal/min
	9.0	l./min
Pressure drop, 5 drift tube sections in series (see note 7)	25	lb/in² max
	1.8	kg/cm² max
Water flow to collector (see note 6)	25	imp. gal/min
	114	l./min
Collector pressure drop	15.0	lb/in² max
	1.1	kg/cm² max
Outlet water temperature	70	°C max
Inlet water pressure to collector	100	lb/in² max
	7.0	kg/cm² max
Inlet water pressure to body	50	lb/in² max
	3.5	kg/cm² max

Recommended Coolants

Good quality demineralized water should be used for cooling when there is no danger from freezing. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use.

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:		
continuous	24	kV max
switch-on surge (up to 8500 ft altitude)	27	kV max
Beam current (mean)	6.0	A max
B.C.D. voltage (relative to cathode) (see note 1)	−2.0	kV max
B.C.D. current (see note 8)	4.0	mA max
Body current	150	mA max
Output power (see note 9)	32	kW max
Collector dissipation	100	kW max
Load v.s.w.r. (see note 10)	1.5:1	max
Temperature of any external part of the klystron	175	°C max

TYPICAL OPERATION (Vision Amplifier without

Operating Conditions (B.C.D. electrode connected to cathode)

Beam voltage (see note 11)	19	kV
Beam power	80	kW
Modulating anode voltage (with respect to cathode)	17	kV
Beam current	4.2	A
Electro-magnet current	12	A
Bandwidth (see note 12)	8.0	MHz
Efficiency	40	%
Modulating anode current	6.0	mA max
Body current (see note 13)	150	mA max
Body current (see note 14)	50	mA max

K3230BCD in K4204

Frequency	470–476	590–596	MHz
Channel number (U.S.A.)	14	34	
Body current, with no input power	20	20	mA
Drive power for 32 kW output (see note 15)	4.5	5.0	W
Output power (peak sync.)	32	32	kW

K3231BCD in K4205

Frequency	590–596	698–704	MHz
Channel number (U.S.A.)	34	52	
Body current, with no input power	20	20	mA
Drive power for 32 kW output (see note 15)	3.5	4.0	W
Output power (peak sync.)	32	32	kW

SOUND SERVICE

Output power	3.2	kW
Modulating anode voltage (nominal) relative to cathode potential (see note 16)	5.5	kV
Bandwidth	1.5	MHz
Beam voltage	19	kV max
Beam current (see note 16)	0.73	A max
Body current (see note 17)	50	mA max
Efficiency (see note 18)	23	% min
R.F. drive power (see note 15)	2.0	W max

NOTES

1. The K3230BCD and K3231BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 32 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to cathode.

   (b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.

2. For this klystron, the heater voltage should be in the range 8.0 – 8.25 V. ★ After 10 000 hours of operation, the heater voltage should be increased to be in the range 8.25 – 8.5 V.

3. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 127 inches (3.23 m) is required. This is measured to the top of the lifting harness and does not include the hoist.

4. Under TV picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within the current range stated. Maximum stability is obtained by adjusting the magnet current within the above range and stabilizing it to ± 2% about the optimum value.

★ Indicates a change.

5. Measured at the air input pipes to the circuit assembly.

6. These values apply when the coolant used is distilled water with the dissolved oxygen removed. EEV should be consulted if it is intended to use alternative coolants.

7. When these tubes are used as replacements for 4KM100 series tubes in existing circuit assemblies, the electro-magnet is usually water cooled in series with the klystron body. The EEV circuit assemblies described in this data sheet require no water cooling.

8. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	19	kV
Beam current	4.2	A
Heater voltage	8.5	V
B.C.D. voltage	zero with respect to cathode	

The B.C.D. voltage must then be increased to −600 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 4 mA and typically will be less than 2 mA. At end-of-life, the B.C.D. current will not exceed 6 mA.

With a B.C.D.-to-cathode voltage of −600 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow better than 60% efficiency to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Designers of B.C.D. pulsing equipment for these klystrons are advised to allow for a B.C.D. current value of about 10 mA. Typical values of interelectrode capacitance are:–

B.C.D. to cathode	75	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

9. The tube may be operated at up to 35 kW peak sync. for test purposes only at 110% of rated transmitter output power.

10. This applies to television service. EEV should be consulted regarding other conditions of service.

11. For optimum efficiency at reduced power levels, a beam voltage of 24 kV may be used, with modulating anode voltage set to give the required output power.

12. The klystron is tuned so that, for constant input power, the variation in output power is less than 1 dB over the specified bandwidth at all power levels between −2 dB and −14 dB with respect to the specified output power.

13. The combined body current of one sound and one vision klystron will not exceed this value.

14. The body current of one sound and one vision klystron in the absence of r.f. drive.

15. Defined as the power measured into a matched load substituted for the input cavity of the klystron.

16. For operation at the same beam voltage as the vision amplifier and one tenth of the vision output power, the beam current is reduced by means of the modulating anode. The graph on page 11 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the maximum value of the modulating anode current is 1.5 mA. The potential divider network must be designed accordingly.

17. The current stated applies to a single sound klystron only.

18. Minimum efficiency for the output power stated.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

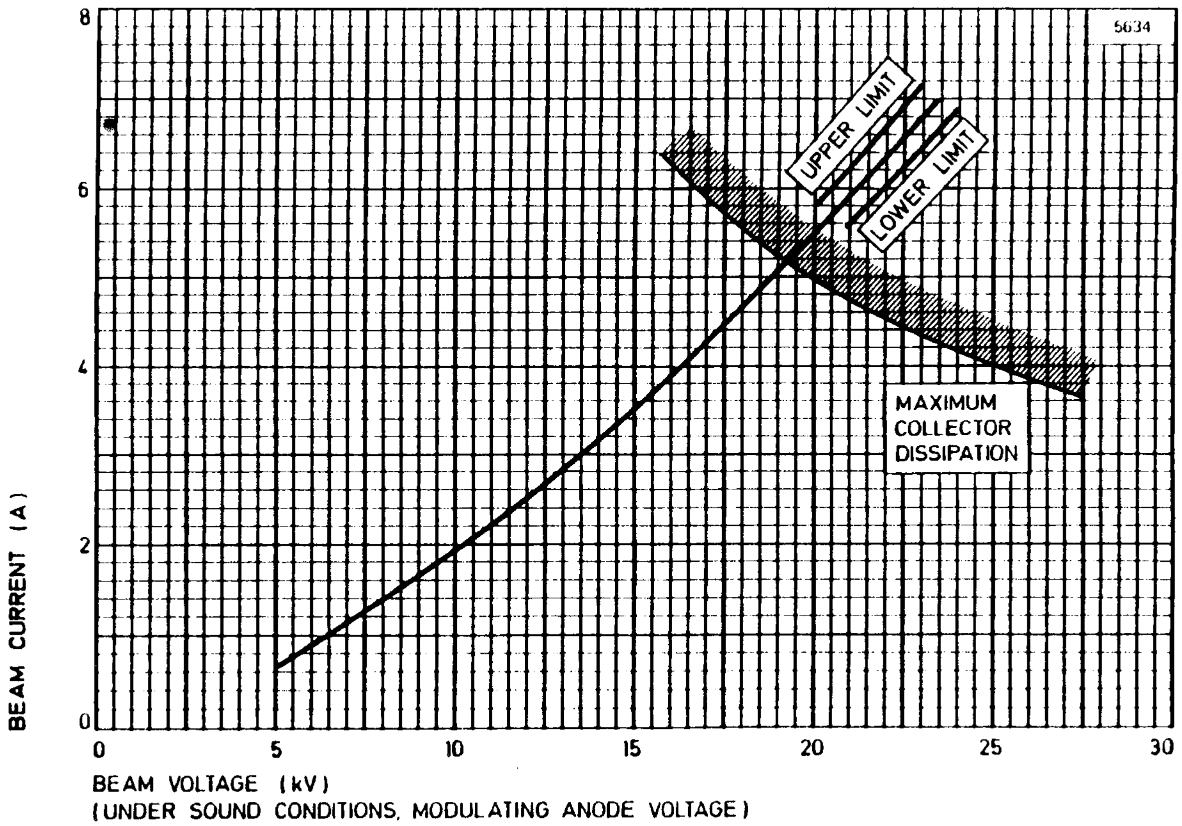
R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

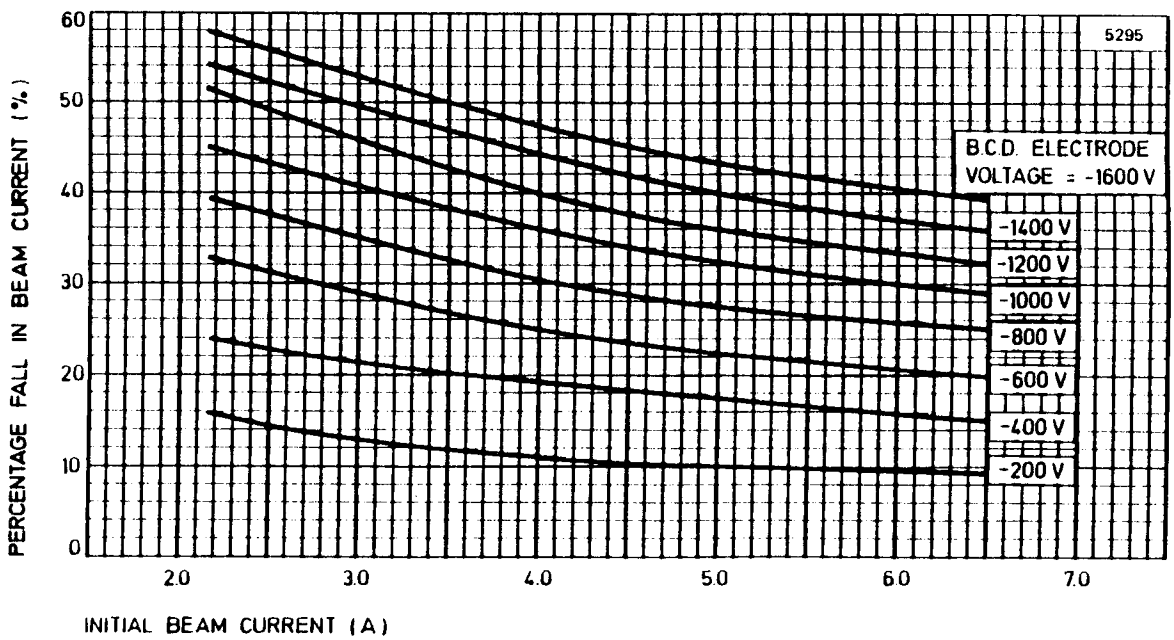
X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

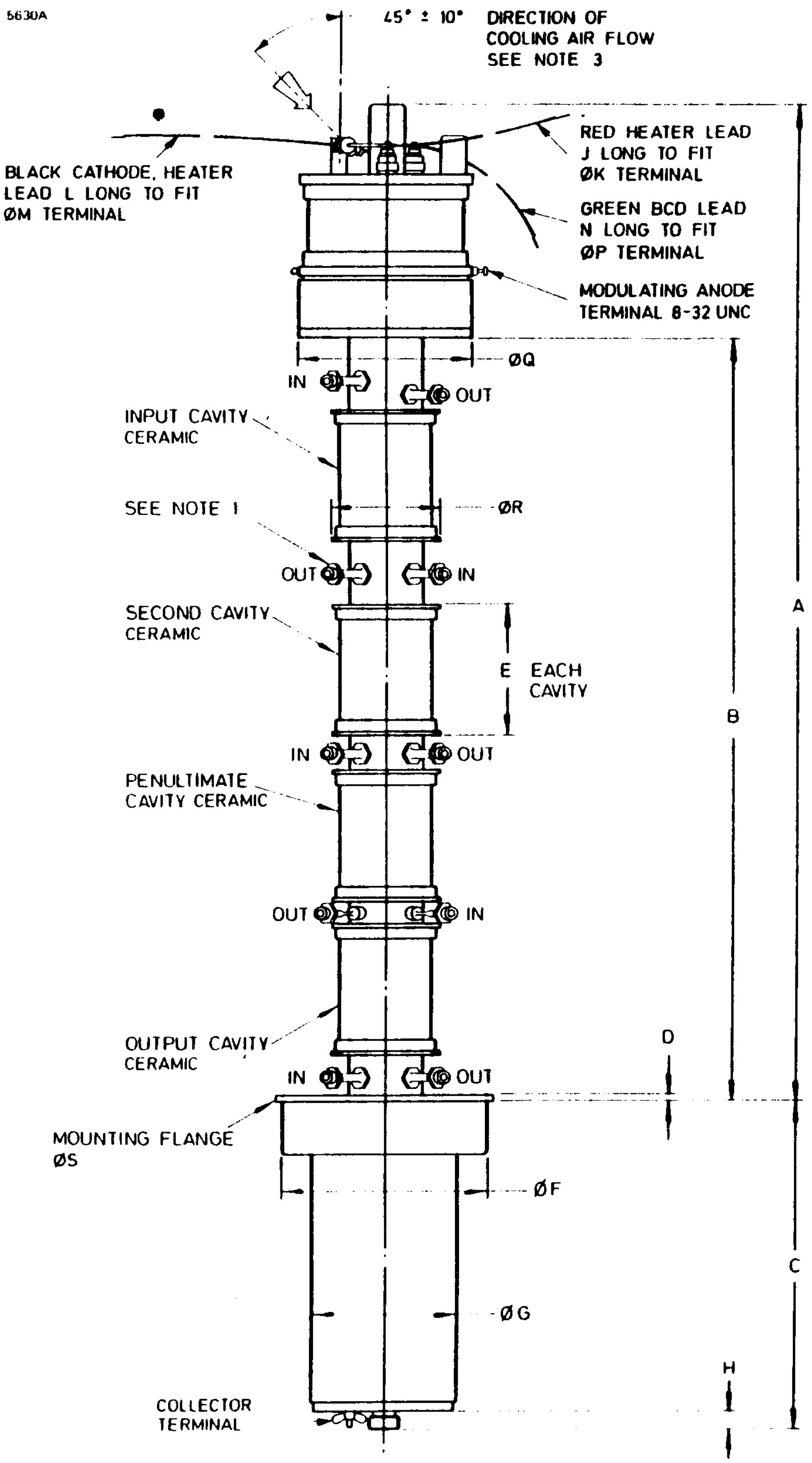
TYPICAL BEAM CHARACTERISTIC

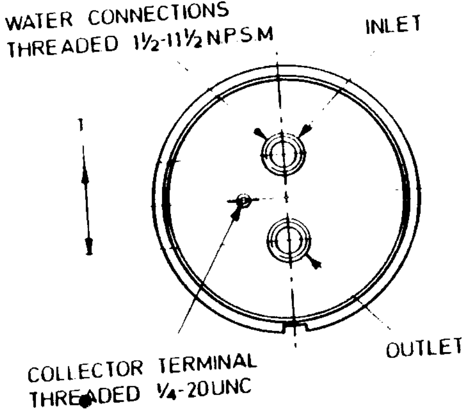


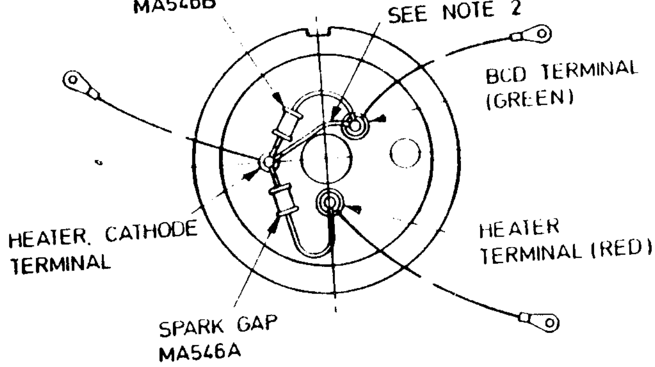
B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE FOR K3230BCD







Outline Dimensions (nominal)

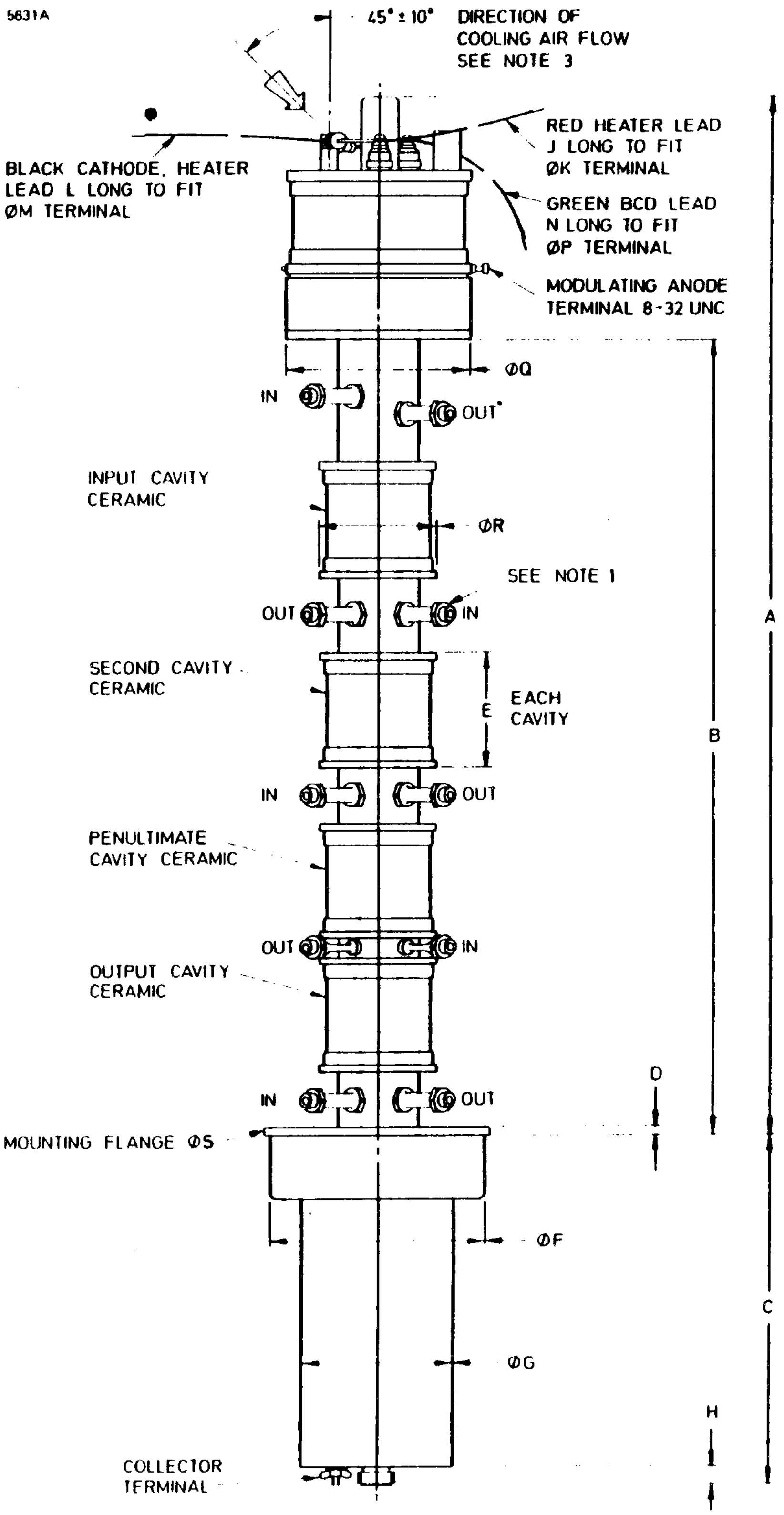
Ref	Inches	Millimetres
A	45.300 max	1150.6 max
B	34.250 min	870.0 min
C	15.707	399.0
D	0.375	9.53
E	6.000	152.4
F	9.244 max	234.8 max
G	6.754	171.6
H	0.812	20.62
J	15.000	381.0
K	0.250	6.35
L	15.000	381.0
M	0.312	7.92
N	15.000	381.0
P	0.250	6.35
Q	8.100	205.7
R	5.125	130.2
S	10.000	254.0
T	3.125	79.38

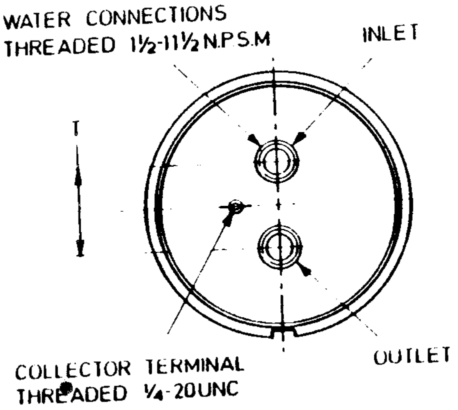
Millimetre dimensions have been derived from inches.

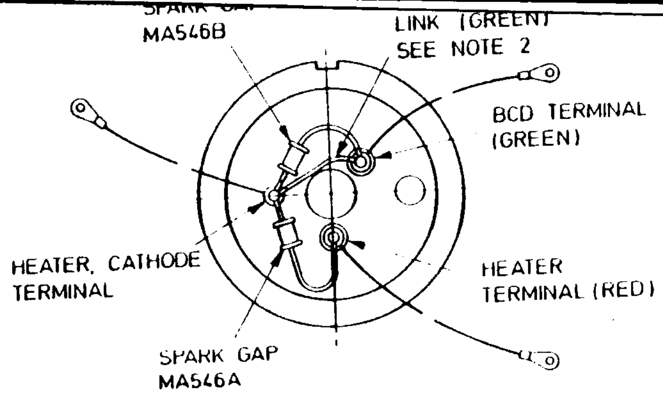
Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.
2. The klystron is delivered with a spark gap connected between the B.C.D. terminal and cathode. In addition, a shorting link is connected across the same two terminals. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.
3. Specified cathode air flow should be directed as indicated.

OUTLINE FOR K3231BCD







Outline Dimensions (nominal)

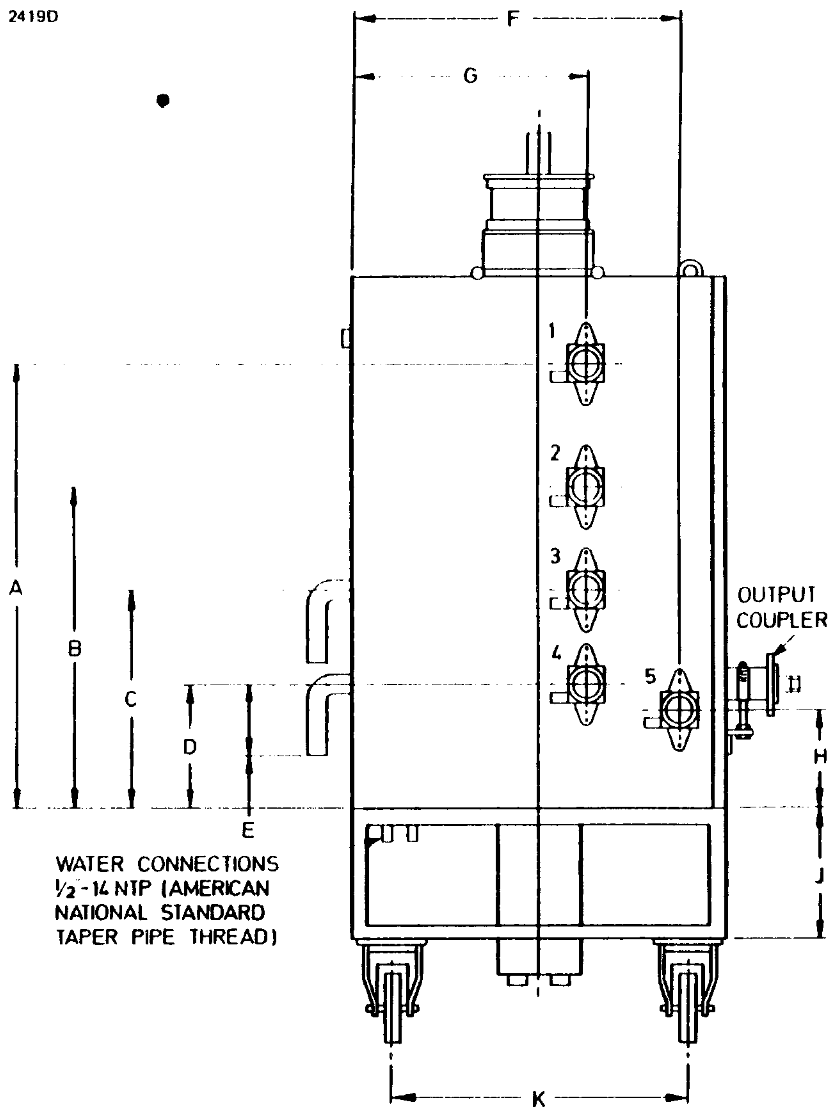
Ref	Inches	Millimetres
A	45.300 max	1150.6 max
B	34.250 min	870.0 min
C	15.707	399.0
D	0.375	9.53
E	5.000	127.0
F	9.244 max	234.8 max
G	6.754	171.6
H	0.812	20.62
J	15.000	381.0
K	0.250	6.35
L	15.000	381.0
M	0.312	7.92
N	15.000	381.0
P	0.250	6.35
Q	8.100	205.7
R	5.125	130.2
S	10.000	254.0
T	3.125	79.38

Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.
2. The klystron is delivered with a spark gap connected between the B.C.D. terminal and cathode. In addition, a shorting link is connected across the same two terminals. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.
3. Specified cathode air flow should be directed as indicated.

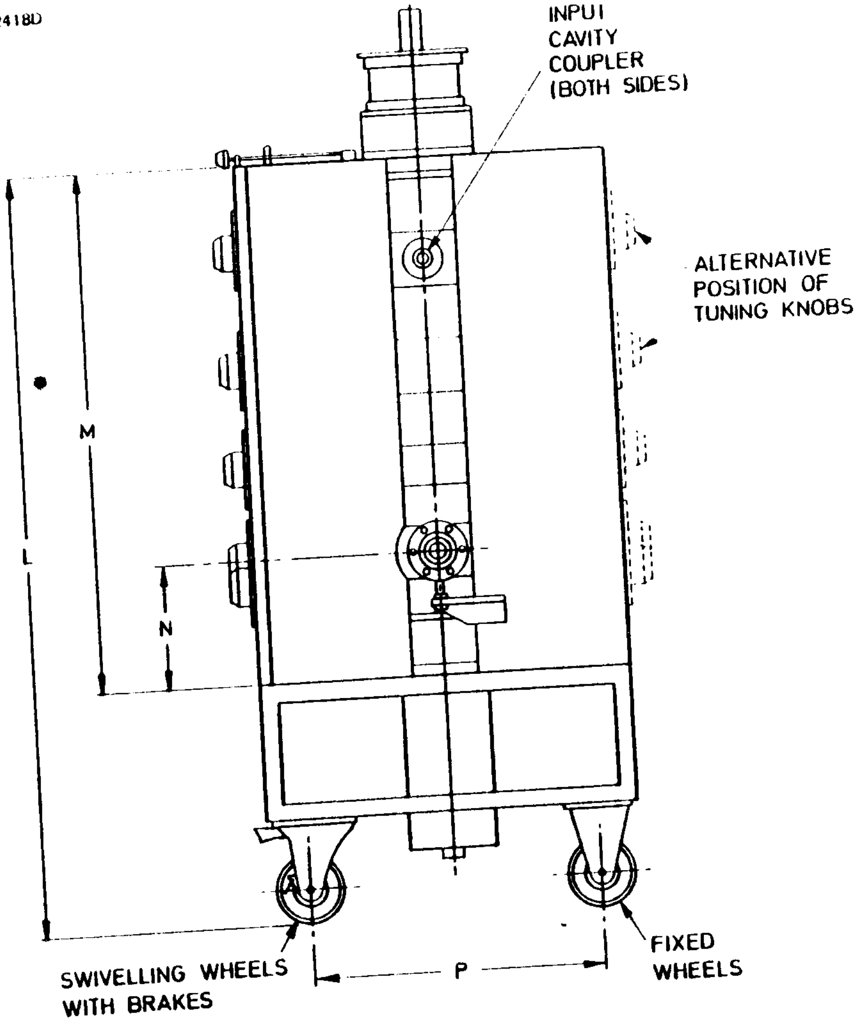
OUTLINE FOR K4204 AND K4205



Controls

1. Input cavity tuning
2. Second cavity tuning
3. Penultimate cavity tuning
4. Output cavity tuning
5. Output coupling

2418D

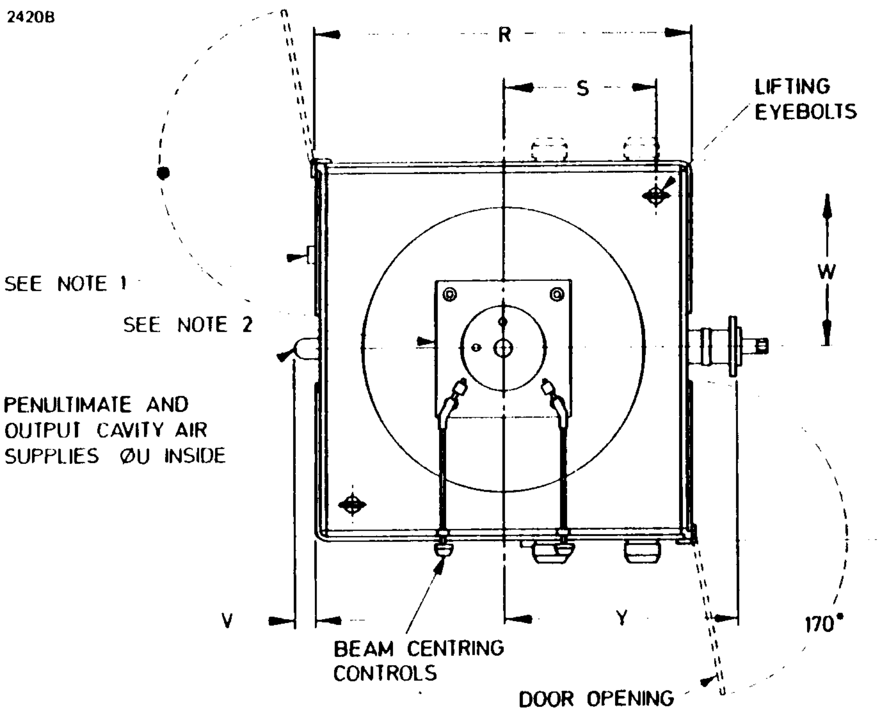


Ref	Inches	Millimetres
A	32.312	820.7
B	23.500	596.9
C	16.000	406.4
D	9.125	231.8
E	5.375	136.5
F	24.531	623.1
G	17.500	444.5

Ref	Inches	Millimetres
H	7.250	184.2
J	9.875	250.8
K	21.875	555.6
L	56.375	1432
M	38.875	987.5
N	9.125	231.8
P	22.250	565.2

Millimetre dimensions have been derived from inches.

OUTLINE FOR K4204 AND K4205 (All dimensions without limits nominal)



Ref	Inches	Millimetres
R	28.000 ± 0.125	711.2 ± 3.2
S	11.250	285.8
U	1.500	38.1
V	2.250	57.15

Ref	Inches	Millimetres
W	11.250	285.8
X	28.000 ± 0.125	711.2 ± 3.2
Y	15.550	395.0

Millimetre dimensions have been derived from inches.

Outline Notes

1. Coil connections, box receptacle 3102A-24-19P.

Pin	Connection
A	Coil 1 (top) positive
B	Coil 1 negative
C	Coil 2 positive
D	Coil 2 negative
E	Coil 3 positive

Pin	Connection
F	Coil 3 negative
H	Coil 4 positive
J	Coil 4 negative
K	Coil 5 (collector) positive
L	Coil 5 negative

2. Flux plates.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K3270BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacement for YK1223 in circuit assembly type TE1188.

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing. 40% minimum sync. efficiency at 15 kW output in standard operational mode.
- **Output Power** Rated up to 15 kW in vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Collector Cooling** Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Pre-adjusted, external cavities mean that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3270BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 15 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

April 1986

Supersedes June 1985 Issue

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
European channel numbers	21 to 68	
Output power (saturated) at klystron flange	15	kW
Power gain	30	dB
Beam voltage	13 to 19	kV
Modulating anode to cathode voltage (see note 1)	10 to 15	kV

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see page 12)	4.5 to 5.5	Vd.c.
Heater current range	19 to 26	A
Cathode pre-heating time	5	minutes

Mechanical

Overall length	49.21 inches (125 cm) max
Overall diameter	6.95 inches (17.65 cm) max
Mounting position	vertical, collector end up
Net weight of klystron	55 pounds (25 kg) approx

Circuit Assembly K4275 or K4275W ★

For vapour cooling of collector, order K4275.

For water cooling of collector, order K4275W.

Electro-magnet current, stabilized to ± 2% (see note 2)	8 to 11	A
Electro-magnet resistance:		
cold	8.3 ± 1.2	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output	3⅛ inch 50 Ω coaxial line	
Net weight of tuning cavities	100 pounds (45 kg) approx	
Net weight of magnet assembly	485 pounds (220 kg) approx	

Cooling

Air flow to cavities and body	50	ft^3/min
	1.4	m^3/min
Static pressure head (see note 3)	1.6 inches (41 mm) w.g.	
Air flow to cathode terminal	5.0	ft^3/min
	0.14	m^3/min
K4275 (vapour cooled) (see page 10):		
volume of steam produced by collector dissipation	1.5	$ft^3/min/kW$
	0.043	$m^3/min/kW$
volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4275W (water cooled) (see page 10):		
water flow required		see page 11
pressure drop		see page 11
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature	90	°C max
water inlet temperature	40	°C max

★ Indicates a change.

Arc Detector

Arc detector type MA257 is fitted to the output cavity.

Photo-resistor type	NSL 462	
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections	1500 mm cable fitted with MS3106F-18-19S Socket.	

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater starting current (peak)	60	A max
Beam voltage	21	kV max
Modulating anode to cathode voltage (see note 1)	21	kV max
Beam current (mean)	3.0	A max
Body current:		
with no input power	50	mA max
r.f. on	150	mA max
Modulating anode current	5.0	mA max
Mean output power	11	kW max
Collector dissipation	45	kW max
Load v.s.w.r. (see note 4)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see note 5)	−1250	V max
B.C.D. current (see note 6)	1.0	mA max

TYPICAL OPERATION

10 kW vision amplifier (B.C.D. electrode at cathode potential) ★

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*
Beam voltage (see page 14)	13.2	15	16.4	kV
Modulating anode to cathode voltage (approx) (see page 14)	12.3	10.5	10.3	kV
Beam current	2.03	1.63	1.56	A
Body current:				
with no input power	10	5.0	5.0	mA
black level + sync. (see note 7)	60	60	50	mA
Saturated output power	11	11	11	kW
Electro-magnet current	10	9.0	9.0	A
Drive power for 11 kW output (see note 8)	15	10	8.0	W
Efficiency:				★
typical	43	47	45	%
minimum	40	44	43	%

Sound amplifier (B.C.D. electrode at cathode potential) ★

	1.0 kW		**2.0 kW**		
Beam voltage	13.2	16.4	13.2	16.4	kV
Modulating anode to cathode voltage (approx)	4.0	3.5	4.7	4.1	kV
Beam current	0.38	0.31	0.49	0.39	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		A
Output power	1.1		2.2		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	22		34		%

★ Indicates a change.

15 kW vision amplifier (B.C.D. electrode at cathode potential)

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*
Beam voltage (see page 14)	15.5	17.5	19	kV
Modulating anode to cathode voltage (approx) (see page 14)	14.5	12.5	12	kV
Beam current	2.6	2.05	1.95	A
Body current:				
with no input power	15	10	10	mA
black level + sync. (see note 7)	85	60	50	mA
Saturated output power	16	16	16	kW
Electro-magnet current	10	9.0	8.0	A
Drive power for 16 kW output (see note 8)	15	10	8.0	W
Efficiency: ★				
typical	43	47	45	%
minimum	41	45	43	%

Sound amplifier (B.C.D. electrode at cathode potential) ★

	1.5 kW		3.0 kW		
Beam voltage	15.5	19	15.5	19	kV
Modulating anode to cathode voltage (approx)	3.9	3.4	5.6	4.9	kV
Beam current	0.37	0.30	0.63	0.51	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		A
Output power	1.65		3.3		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	29		34		%

★ Indicates a change.

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a modulating anode current of 1.5 mA.
2. Under TV picture conditions the klystron will focus satisfactorily within the specified range. Adjust the magnet current for maximum stability within this range and stabilize to ± 2% about the optimum value.
3. Measured by a manometer at the input pipe to the circuit assembly.
4. This value applies to television service. EEV should be consulted regarding other conditions of service.
5. The K3270BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 15 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to the cathode.

   (b) The B.C.D. voltage must **not** exceed −1250 V with respect to the cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.
6. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	13.5	kV
Beam current	2.3	A
Heater voltage	5.5	V
B.C.D. voltage	zero with respect to cathode	

   The B.C.D. voltage must then be increased to −500 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 1 mA and typically will be less than 0.5 mA. At end-of-life, the B.C.D. current will not exceed 2 mA.

With a B.C.D.-to-cathode voltage of −500 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 60% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	65	pF
Cathode to modulating anode (B.C.D. connected to cathode)	30	pF
Modulating anode to klystron body	20	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

7. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
8. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

RECOMMENDED COOLANTS

K4275W (Liquid Cooled)

Good quality demineralized water should be used for cooling when there is no danger from freezing. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 11 for flow rates).

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

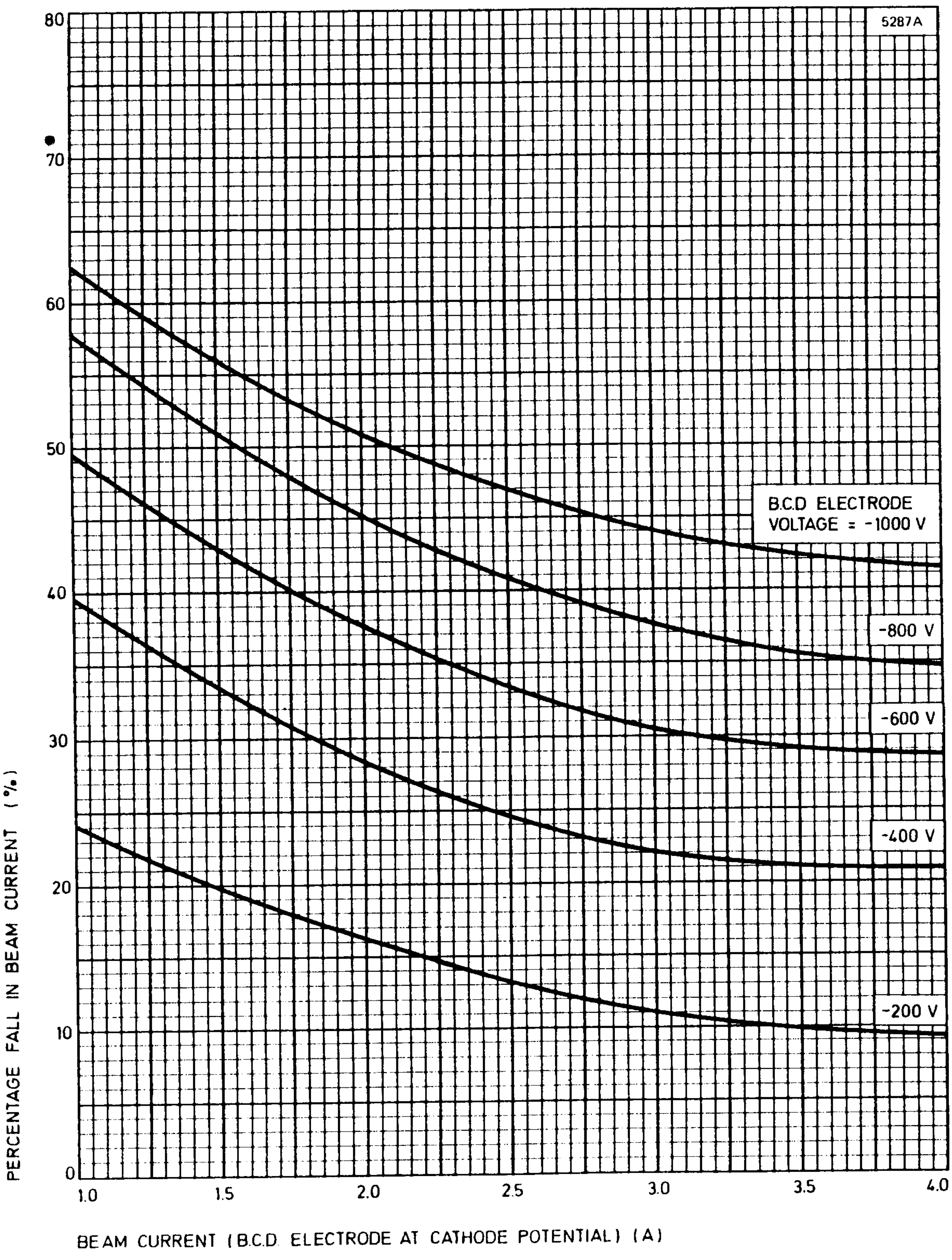
It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

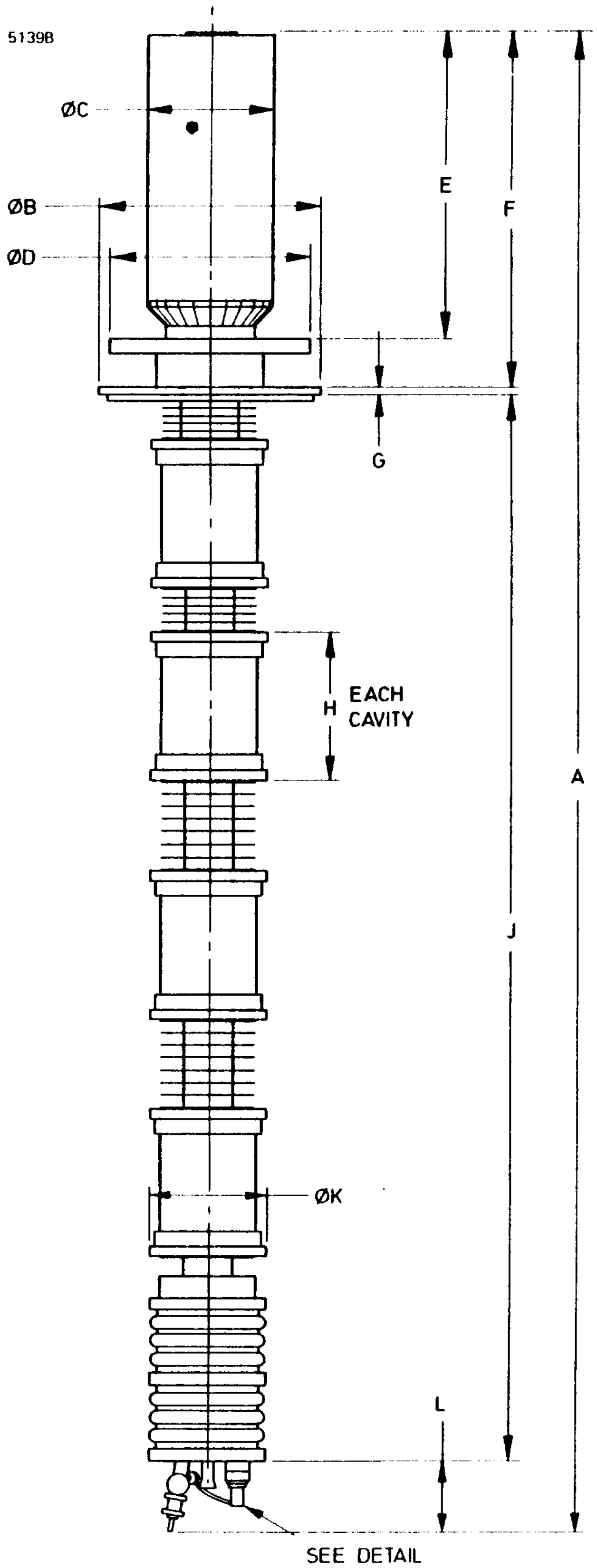
K4275 (Vapour Cooled)

Only pure demineralized water should be used in the boiler.

B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3270BCD

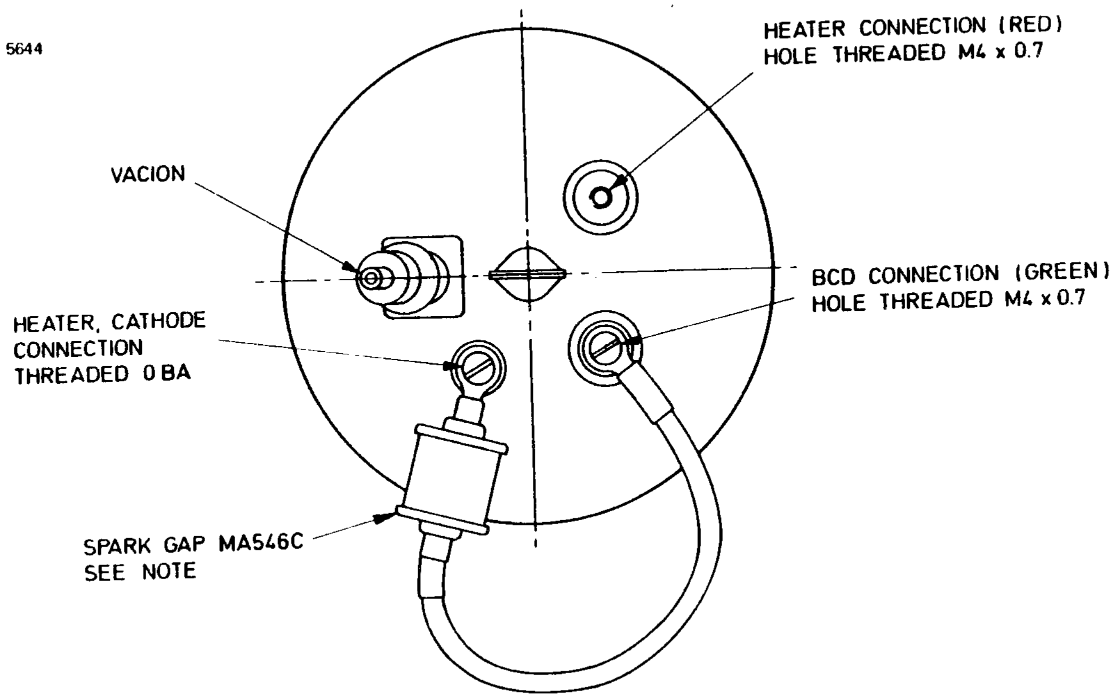


Outline Dimensions (All dimensions without limits are nominal)

Ref	Millimetres	Inches
A	1250 max	49.213 max
B	176.0	6.929
C	99.2	3.906
D	156.2	6.150
E	240.0	9.449
F	286.25	11.270
G	5.00	0.197
H	117.0	4.606
J	840.0 $^{+4.0}_{-1.0}$	33.071 $^{+0.157}_{-0.039}$
K	93.0	3.661
L	115 max	4.528 max

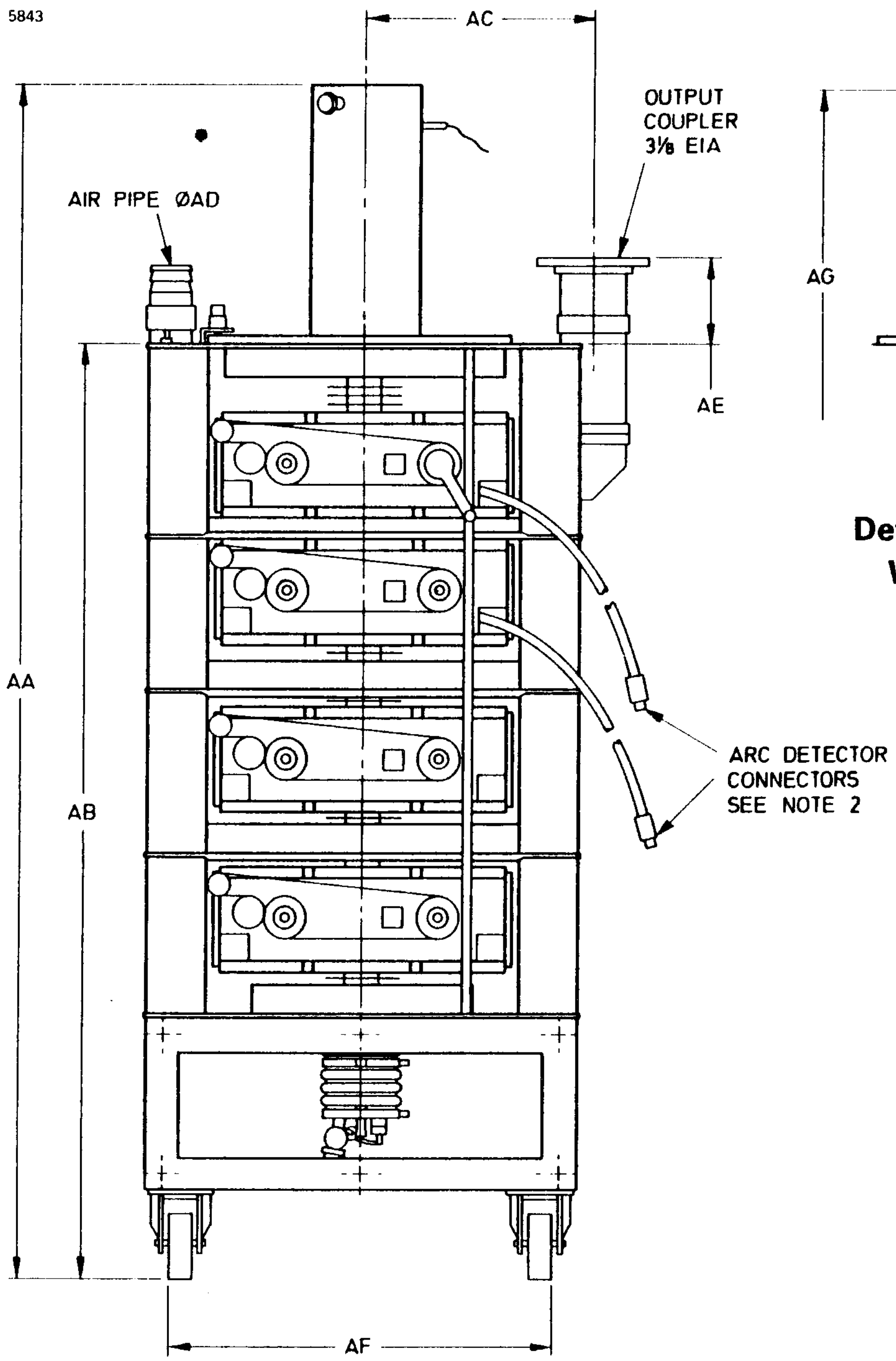
Inch dimensions have been derived from millimetres.

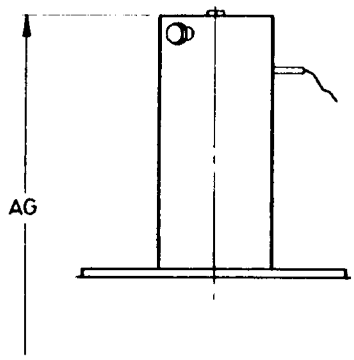
Enlarged View on Gun End of Klystron



Note The spark gap shown connected between the B.C.D. and cathode terminals is replaced by a shorting link for shipping. ***If the B.C.D. electrode is to be used, this link must be replaced by the spark gap as shown.*** Failure to fit the spark gap will result in failure of the B.C.D. insulation in the event of an internal flashover.

OUTLINE OF CIRCUIT ASSEMBLY K4275 ★

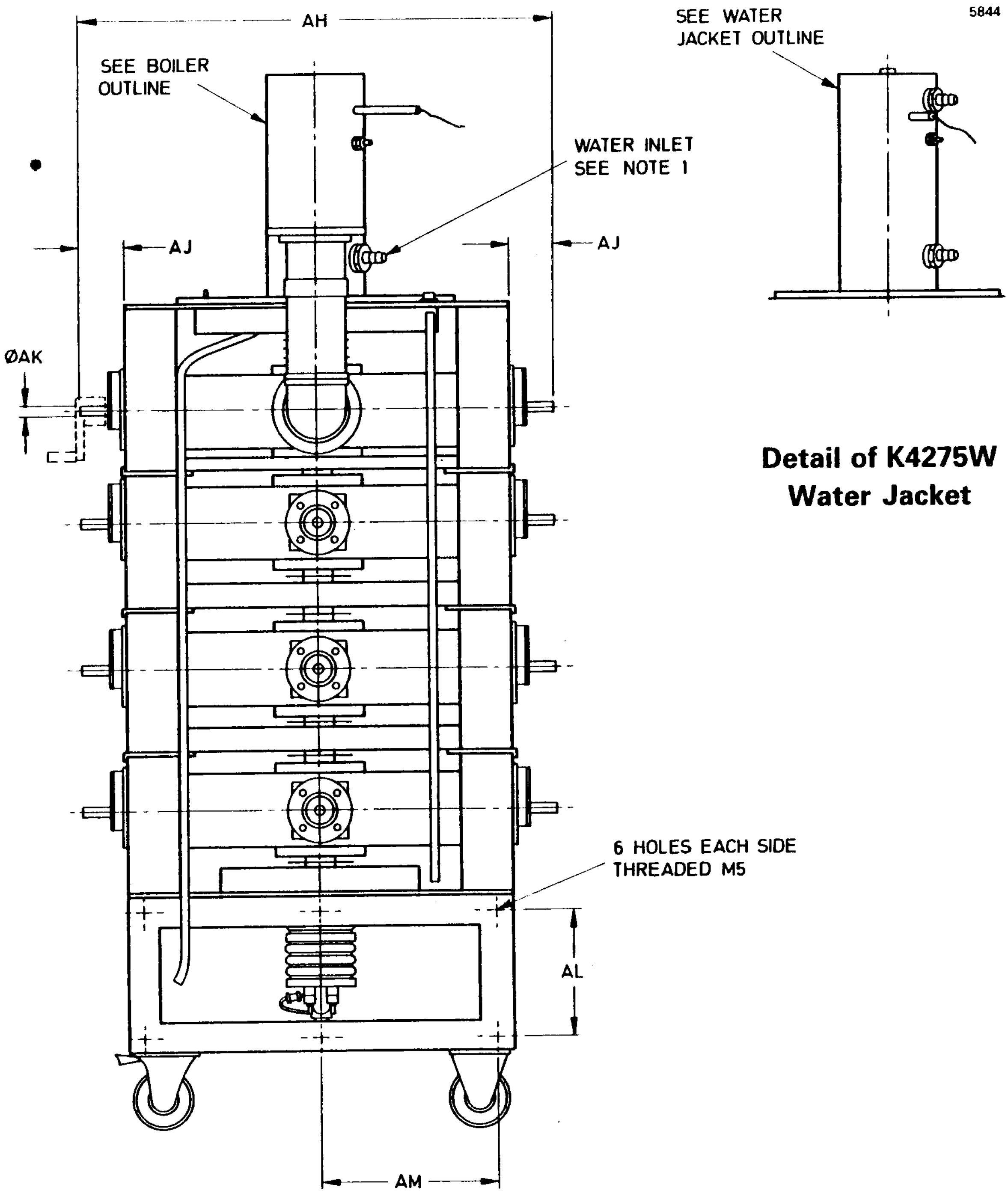




Detail of K4275W Water Jacket

★ Indicates a change.

OUTLINE OF CIRCUIT ASSEMBLY K4275 ★

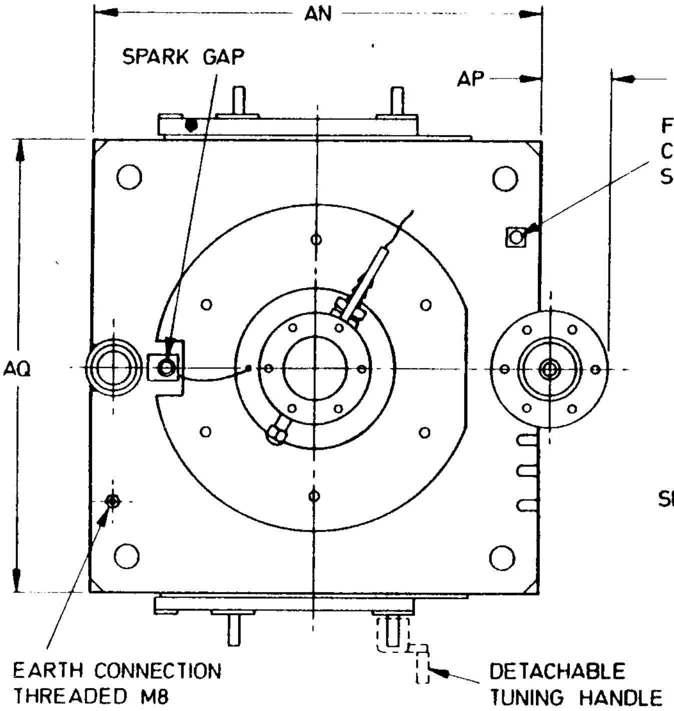


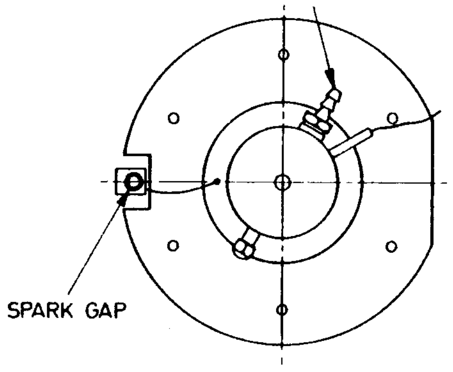
Detail of K4275W Water Jacket

★ Indicates a change.

Top View of Circuit Assembly K4275 ★

(All dimensions without limits are nominal)





Detail of K4275W Water Jacket

Ref	Millimetres	Inches
AA	1378.6 ± 3.0	54.276 ± 0.118
AB	1086.0 ± 3.0	42.756 ± 0.118
AC	264.0	10.394
AD	50.0	1.969
AE	100.0	3.937
AF	453.0 ± 2.0	17.835 ± 0.079
AG	1370.5 ± 3.0	53.957 ± 0.118
AH	630.0 max	24.803 max

Ref	Millimetres	Inches
AJ	61.0 max	2.402 max
AK	14.3	0.563
AL	162.0	6.378
AM	234.0	9.213
AN	508.0	20.000
AP	75.0	2.953
AQ	508.0	20.000

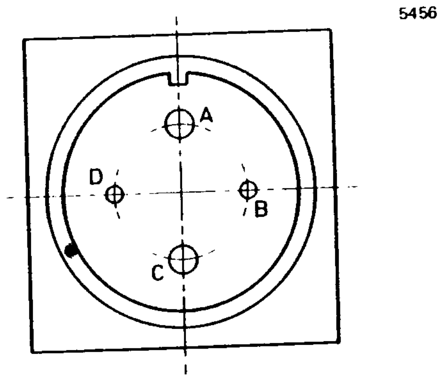
Inch dimensions have been derived from millimetres.

Outline Notes

1. Orientation of boiler or water jacket set by the user to bring connections to most convenient position.
2. An arc detector for the third cavity is available as an optional extra. ★

★ Indicates a change.

View on Focus Coil Connector

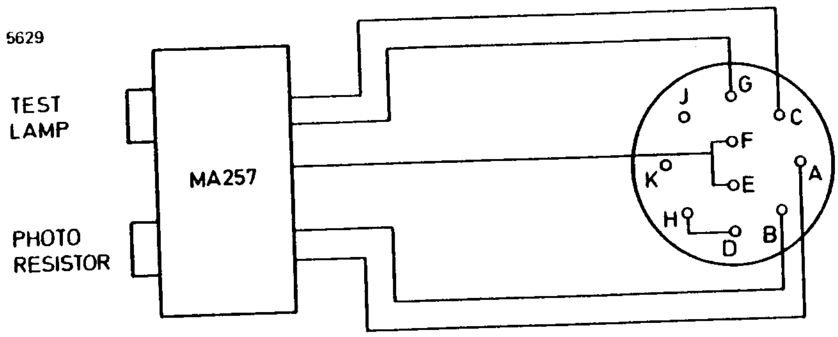


Connections

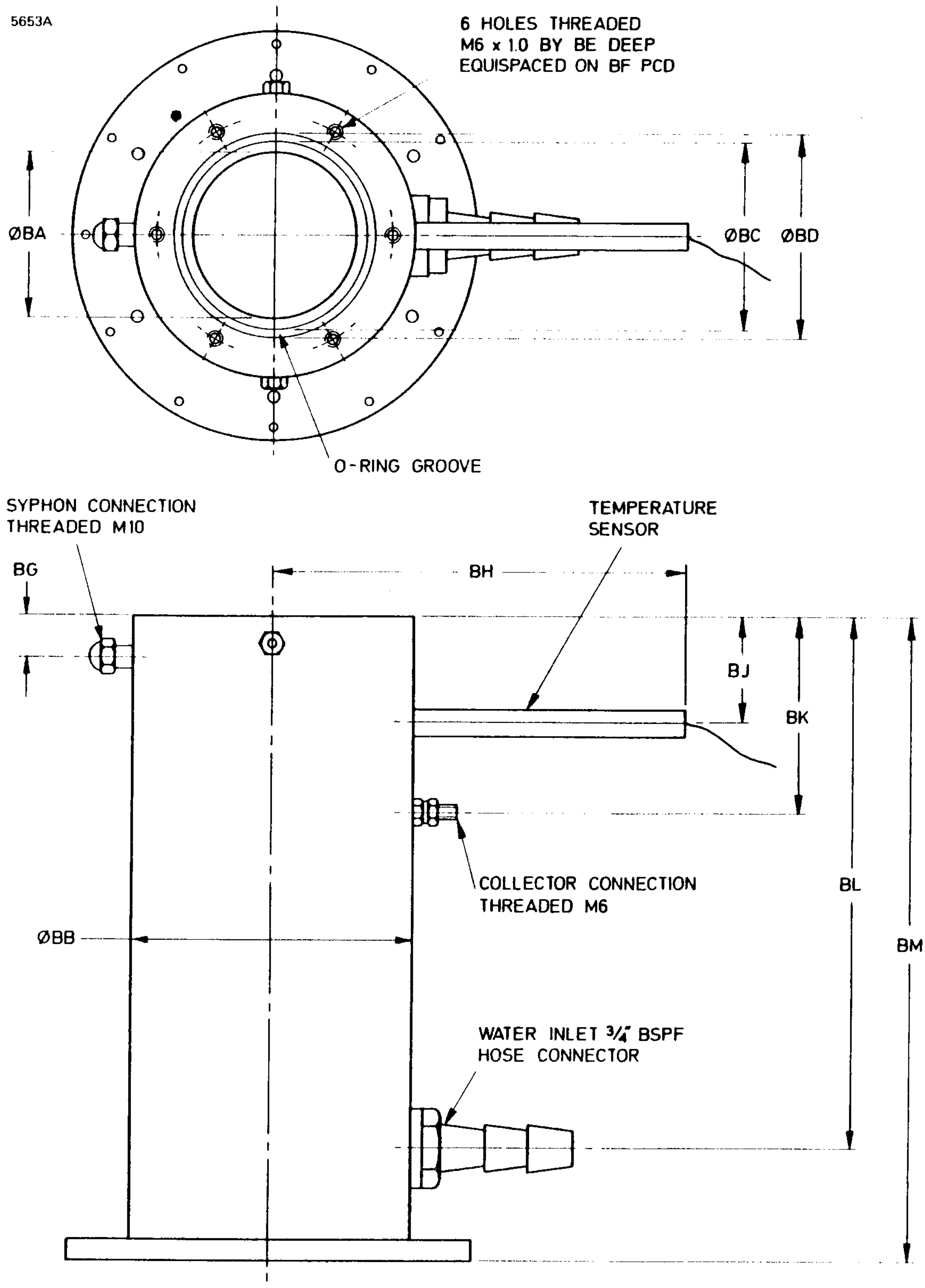
Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

Arc Detector Connections to socket type MS3106F-18-19S



OUTLINE OF BOILER UNIT ★



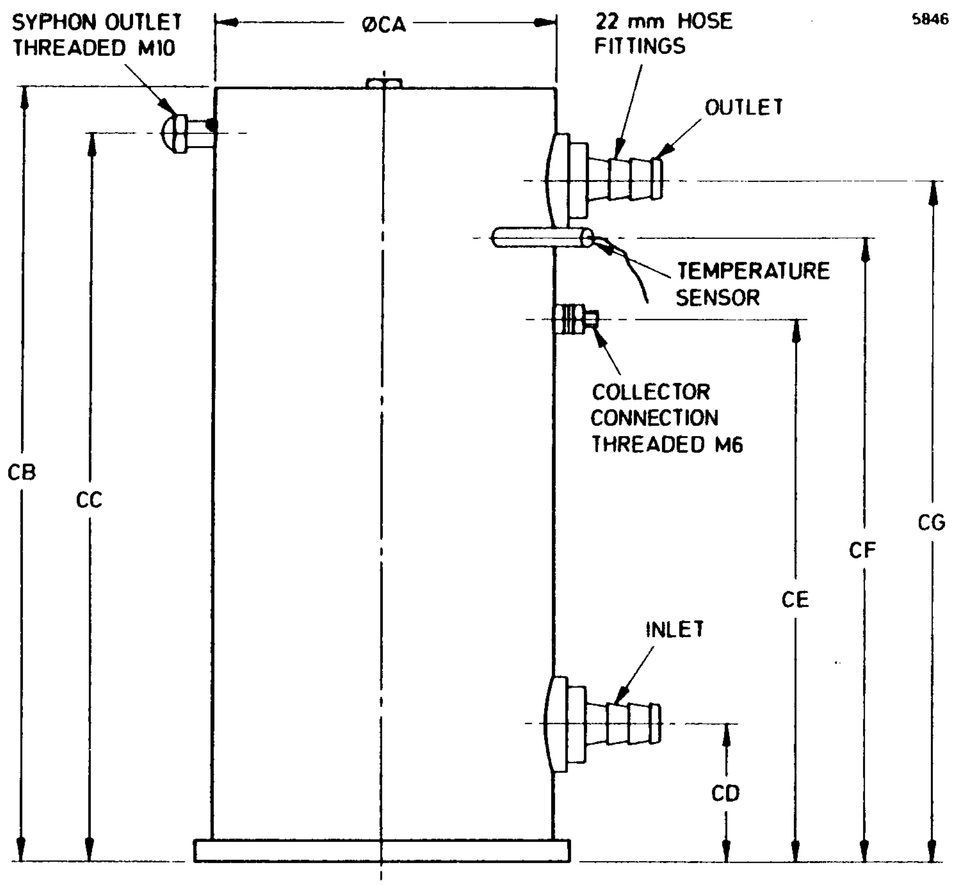
★ Indicates a change.

Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches
BA	74.6	2.937
BB	128.6	5.063
BC	84.1	3.311
BD	92.1	3.626
BE	9.0	0.354
BF	108.0	4.252
BG	19.1	0.752
BH	189.7	7.469
BJ	48.1	1.894
BK	89.1	3.508
BL	239.7	9.437
BM	292.1	11.500

Inch dimensions have been derived from millimetres.

OUTLINE OF WATER JACKET ★



Ref	Millimetres	Inches
CA	128.6	5.063
CB	290.0	11.417
CC	273.0	10.748
CD	52.0	2.047
CE	203.0	7.992
CF	237.0	9.331
CG	255.0	10.039

Inch dimensions have been derived from millimetres.

★ Indicates a change.

English Electric Valve Company Limited

Chelmsford, Essex, England

Printed in England

K3271BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacement for YK1233 in circuit assembly type TE1188.

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing. 40% minimum sync. efficiency at 30 kW output in standard operational mode.
- **Output Power** Rated up to 30 kW in vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Collector Cooling** Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Pre-adjusted, external cavities mean that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3271BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 30 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

April 1986

Supersedes November 1984 Issue

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
European channel numbers	21 to 68	
Output power (saturated) at klystron flange	30	kW
Power gain	30	dB
Beam voltage	19 to 25	kV
Modulating anode to cathode voltage (see note 1)	13 to 19	kV

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see page 12)	4.5 to 5.5	Vd.c.
Heater current range	19 to 26	A
Cathode pre-heating time	5	minutes

Mechanical

Overall length	51.18 inches (130 cm) max
Overall diameter	7.34 inches (18.65 cm) max
Mounting position	vertical, collector end up
Net weight of klystron	66 pounds (30 kg) approx

Circuit Assembly K4276 or K4276W ★

For vapour cooling of collector, order K4276.
For water cooling of collector, order K4276W.

Electro-magnet current, stabilized to ± 2% (see note 2)	8 to 11	A
Electro-magnet resistance:		
cold	8.3 ± 1.2	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		100 pounds (45 kg) approx
Net weight of magnet assembly		485 pounds (220 kg) approx

Cooling

Air flow to cavities and body	100	ft^3/min
	2.8	m^3/min
Static pressure head (see note 3)		6.5 inches (165 mm) w.g.
Air flow to cathode terminal	5.0	ft^3/min
	0.14	m^3/min
K4276 (vapour cooled) (see page 10):		
volume of steam produced by collector dissipation	1.5	ft^3/min/kW
	0.043	m^3/min/kW
volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4276W (water cooled) (see page 10):		
water flow required		see page 11
pressure drop		see page 11
inlet pressure to water jacket	100	lb/in² max
	7.0	kg/cm² max
water outlet temperature	90	°C max
water inlet temperature	40	°C max

★ Indicates a change.

Arc Detector ★

Arc detector type MA257 is fitted to the output cavity.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test lamp	28	V
	0.04	A
Connections		1500 mm cable fitted with MS3106F-18-19S Socket.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater starting current (peak)	60	A max
Beam voltage	26	kV max
Modulating anode to cathode voltage (see note 1)	26	kV max
Beam current (mean)	4.0	A max
Body current:		
with no input power	50	mA max
r.f. on	150	mA max
Modulating anode current	5.0	mA max
Mean output power	22	kW max
Collector dissipation	85	kW max
Load v.s.w.r. (see note 4)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see note 5)	−1250	V max
B.C.D. current (see note 6)	1.0	mA max

★ Indicates a change.

TYPICAL OPERATION

25 kW vision amplifier (B.C.D. electrode at cathode potential)

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*
Beam voltage (see page 14)	19.0	21.5	23.5	kV
Modulating anode to cathode voltage (approx) (see page 14)	17.5	15.5	14.5	kV
Beam current	3.45	2.8	2.6	A
Body current:				
with no input power	15	10	10	mA
black level + sync. (see note 7)	85	60	50	mA
Saturated output power	26.5	26.5	26.5	kW
Electro-magnet current	10	9.0	9.0	A
Drive power for 26.5 kW output (see note 8)	25	10	10	W ★
Efficiency: ★				
typical	41	46	45	%
minimum	40	44	43	%

Sound amplifier (B.C.D. electrode at cathode potential) ★

	2.5 kW		**5.0 kW**		
Beam voltage	19	23.5	19	23.5	kV
Modulating anode to cathode voltage (approx)	4.2	3.6	5.8	5.1	kV
Beam current	0.4	0.32	0.7	0.55	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		A
Output power	2.7		5.4		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	35		42		%

★ Indicates a change.

30 kW vision amplifier (B.C.D. electrode at cathode potential)

Frequency	*470 to 478 (channel 21)*	*662 to 670 (channel 45)*	*846 to 854 (channel 68)*	*MHz*	
Beam voltage (see page 14)	20.5	23	25.0	kV	
Modulating anode to cathode voltage (approx) (see page 12)	19	16.5	15.7	kV	
Beam current	3.8	3.1	2.9	A	
Body current:					
with no input power	15	10	10	mA	
black level + sync. (see note 7)	85	60	50	mA	
Saturated output power	31.5	32	32	kW	
Electro-magnet current	11	11	11	A	
Drive power for 31.5 kW output (see note 8)	25	10	10	W	★
Efficiency:					★
typical	41	46	45	%	
minimum	40	44	43	%	

Sound amplifier (B.C.D. electrode at cathode potential) ★

	3.0 kW		6.0 kW		
Beam voltage	20.5	25	20.5	25	kV
Modulating anode to cathode voltage (approx)	4.1	3.6	6.1	5.3	kV
Beam current	0.4	0.32	0.7	0.6	A
Body current (approx)	15		15		mA
Focus current (approx)	10		10		A
Output power	3.2		6.4		kW
Drive power:					
channel 21	4.0		4.0		W
channel 45	2.0		2.0		W
channel 68	1.0		1.0		W
Efficiency	40		44		%

★ Indicates a change.

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a modulating anode current of 1.5 mA.
2. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for minimum body current and stabilize to ± 2% about this optimum value.
3. Measured by a manometer at the input pipe to the circuit assembly.
4. This value applies to television service. EEV should be consulted regarding other conditions of service.
5. The K3271BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 30 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to the cathode.

   (b) The B.C.D. voltage must **not** exceed −1250 V with respect to the cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.
6. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	16.5	kV
Beam current	3.1	A
Heater voltage	5.5	V
B.C.D. voltage	zero with respect to cathode	

   The B.C.D. voltage must then be increased to −500 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 1 mA and typically will be less than 0.5 mA. At end-of-life, the B.C.D. current will not exceed 2 mA.

With a B.C.D.-to-cathode voltage of −500 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 60% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	65	pF
Cathode to modulating anode (B.C.D. connected to cathode)	30	pF
Modulating anode to klystron body	20	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

7. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
8. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

RECOMMENDED COOLANTS

K4276W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 11 for flow rates).

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

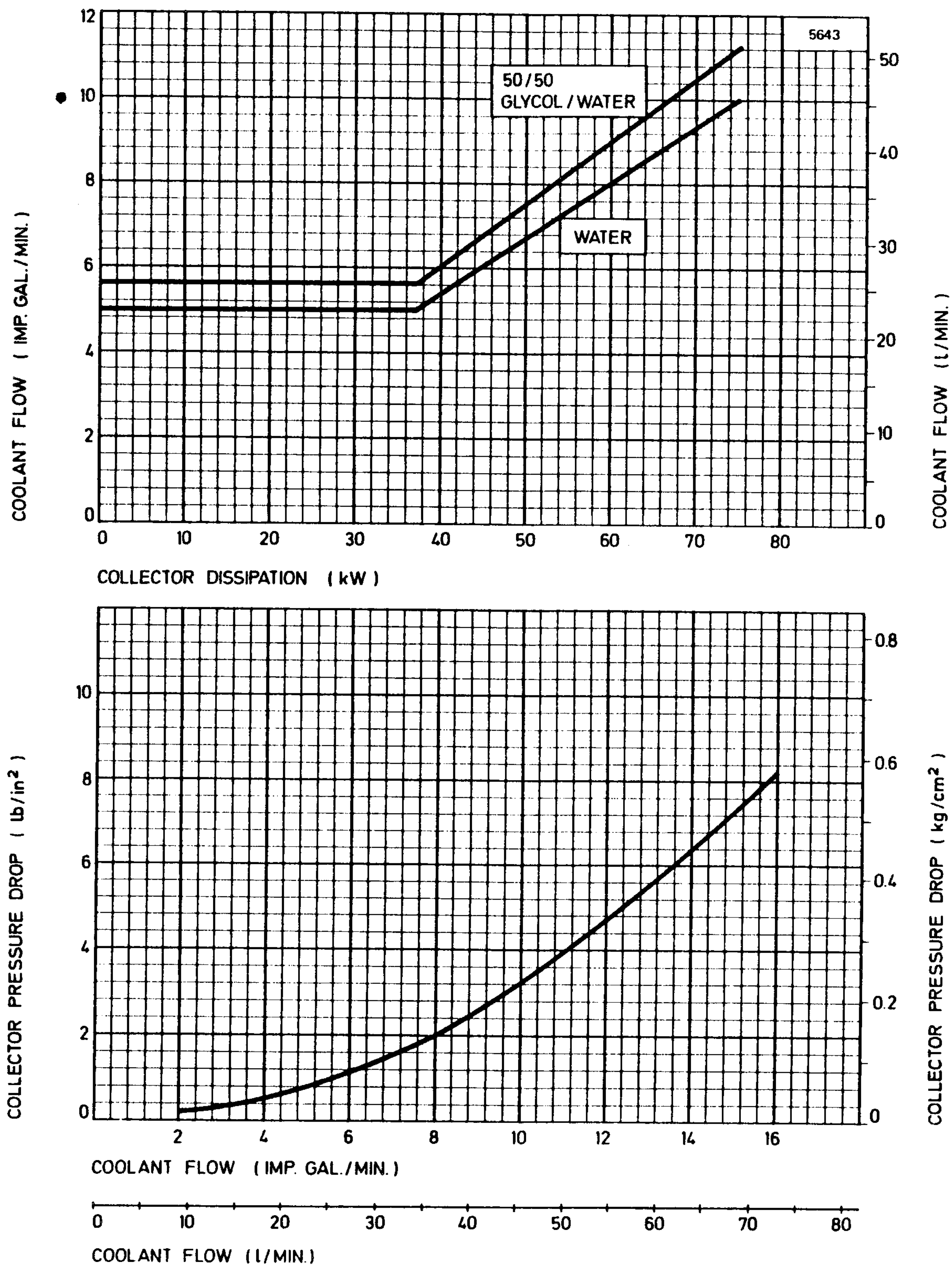
It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4276 (Vapour Cooled)

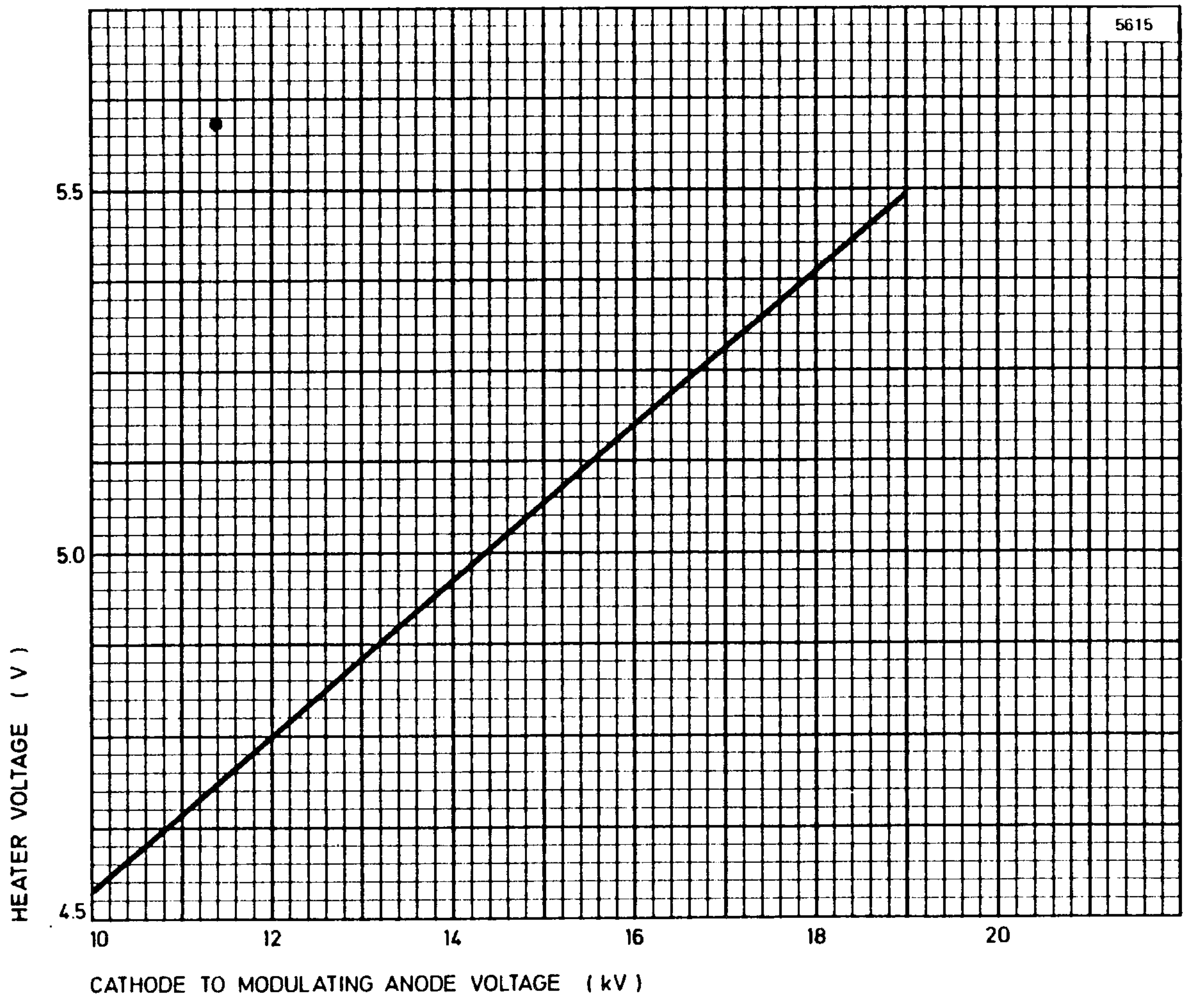
Only pure demineralized water should be used in the boiler; local water supplies are usually suitable for the secondary circuit of a water cooled condenser.

LIQUID COOLING REQUIREMENTS FOR K4276W



Note 1 U.S. gal = 0.832 Imp. gal.

RECOMMENDED HEATER VOLTAGE



Notes

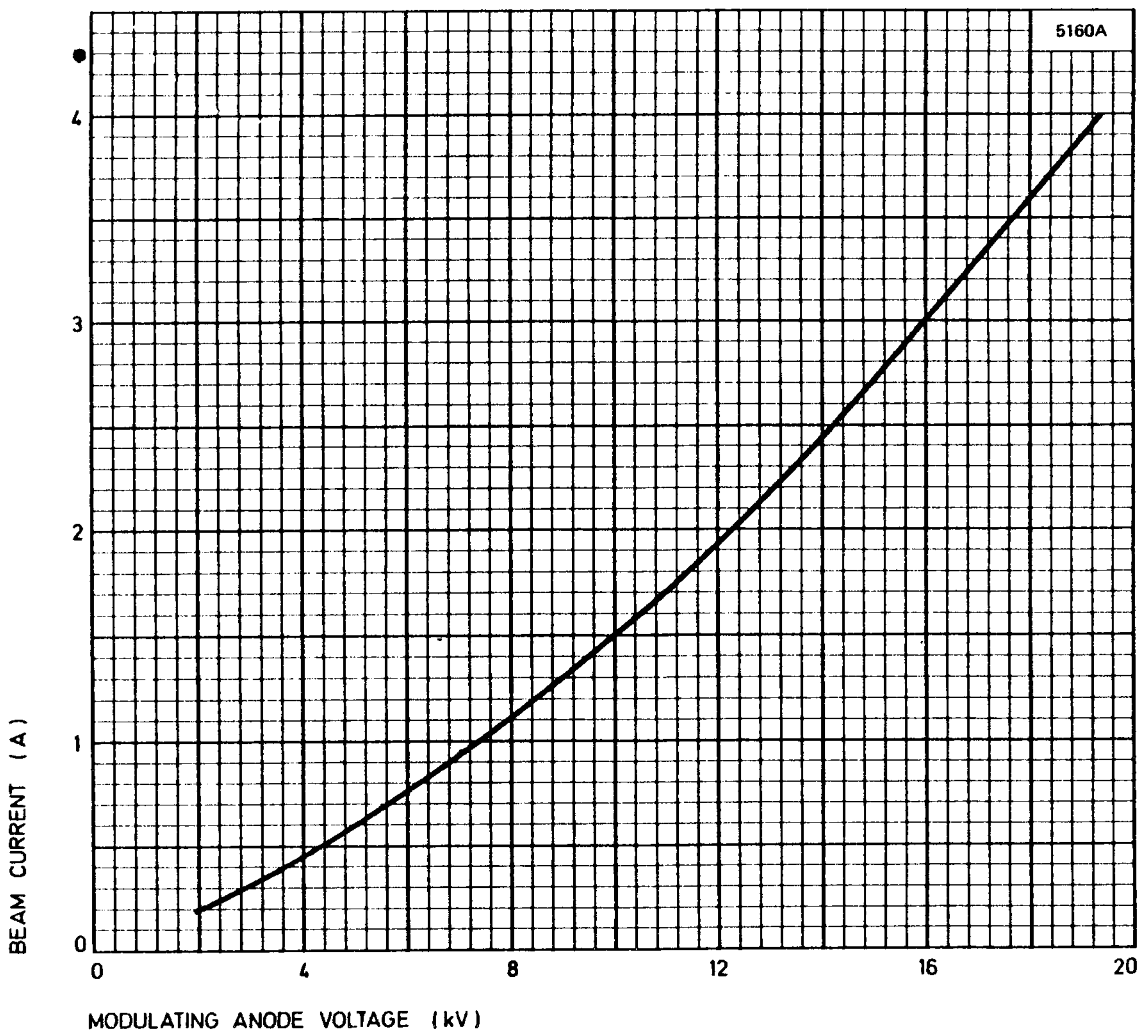
1. This information applies to klystrons with serial number greater than 40.
2. For extended periods of heater-only operation, a black heat voltage of 4.5 V is recommended.
3. The klystron must not be operated, even under sound conditions, with a heater voltage less than 4.5 V.
4. If a continuously variable supply is not available the following values should be used:

	below 670 MHz	above 670 MHz	
30 kW operation	5.5	5.2	V
25 kW operation	5.3	5.1	V

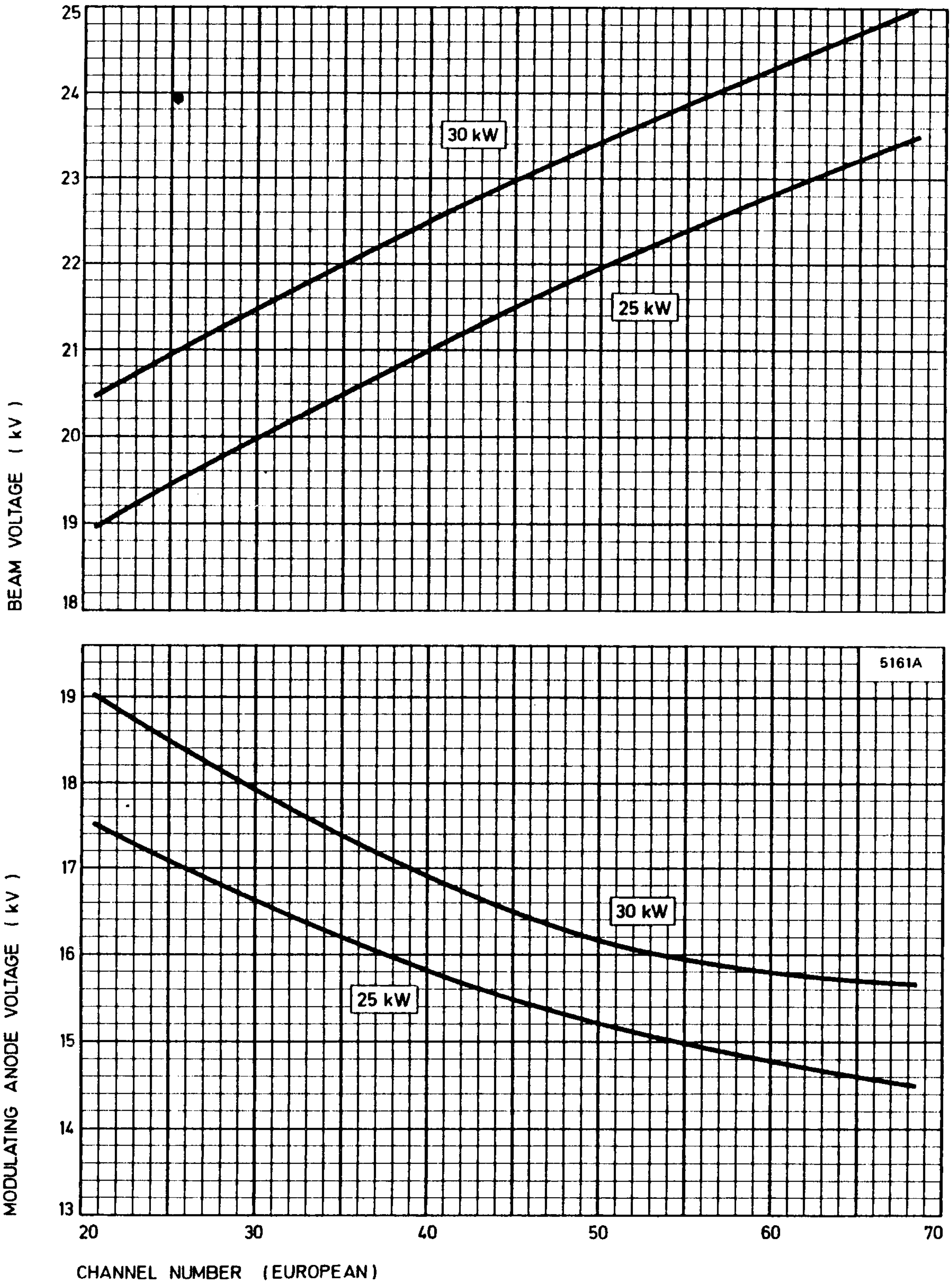
5. The klystron must be operated with a heater voltage of 5.5 V for the first 1000 hours ★

★ Indicates a change.

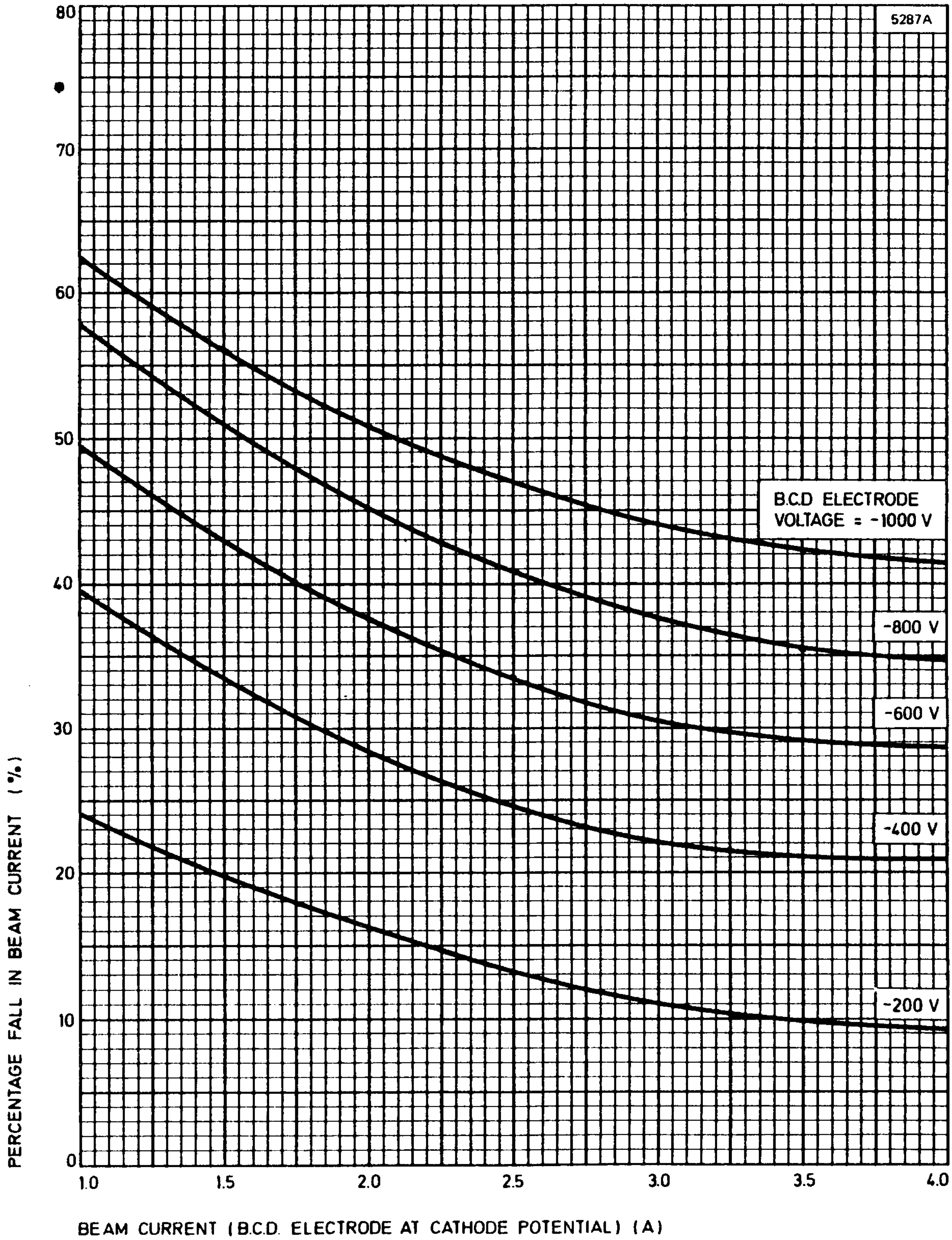
BEAM CURRENT CHARACTERISTIC
(B.C.D. electrode at cathode potential)



TYPICAL VARIATION OF OPTIMUM VOLTAGES WITH FREQUENCY

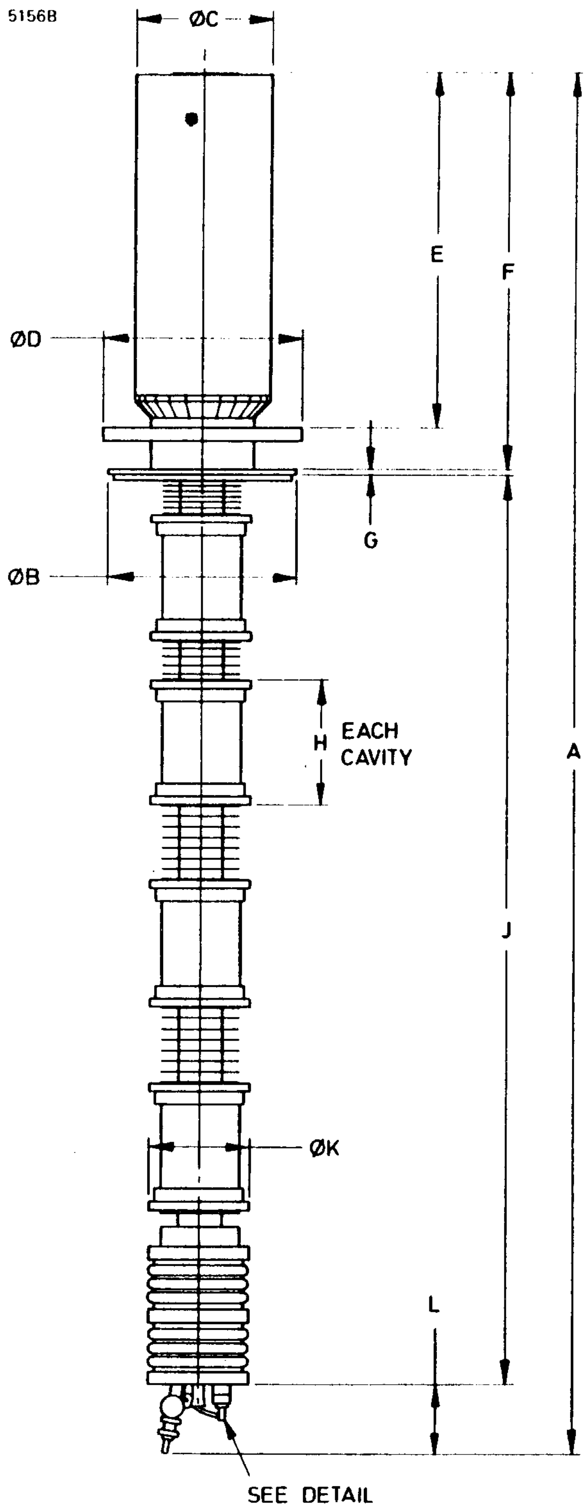


B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS ★



★ Indicates a change.

OUTLINE OF K3271BCD

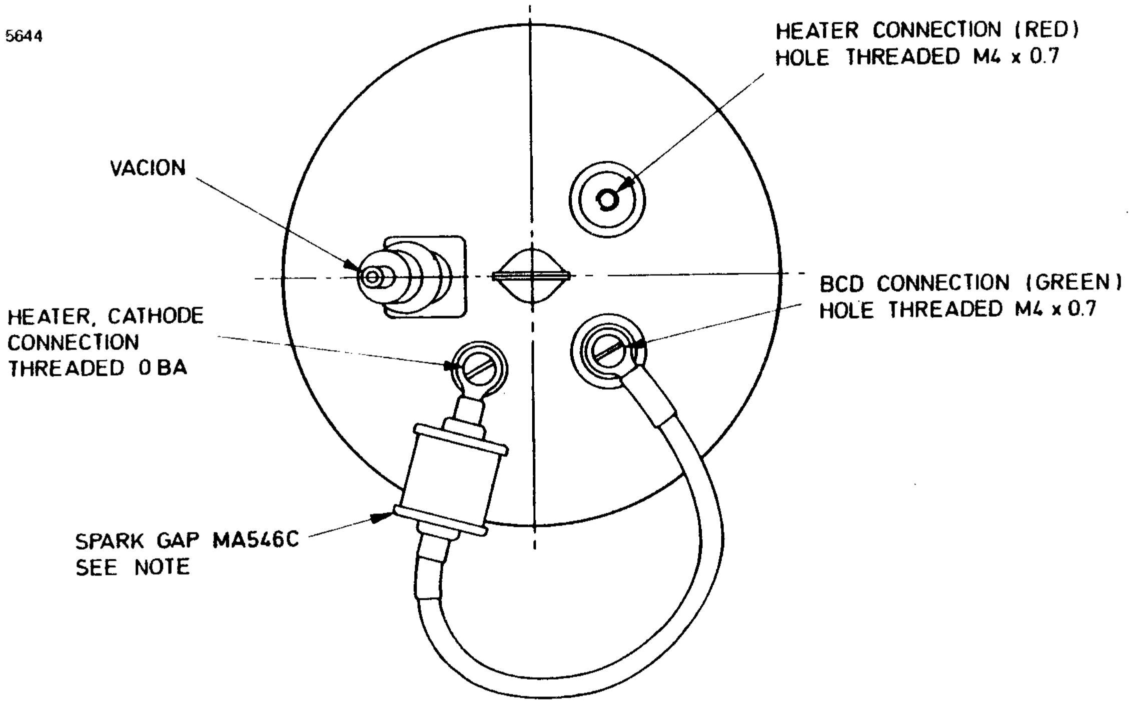


Outline Dimensions (All dimensions without limits are nominal) ★

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	1340 max	52.756 max	G	5.00	0.197
B	• 176.0	6.929	H	117.0	4.606
C	125.0	4.921	J	840.0 + 4.0 − 1.0	33.071 + 0.157 − 0.039
D	186.0	7.323			
E	329.5	12.972	K	93.0	3.661
F	373.0	14.685	L	115 max	4.528 max

Inch dimensions have been derived from millimetres.

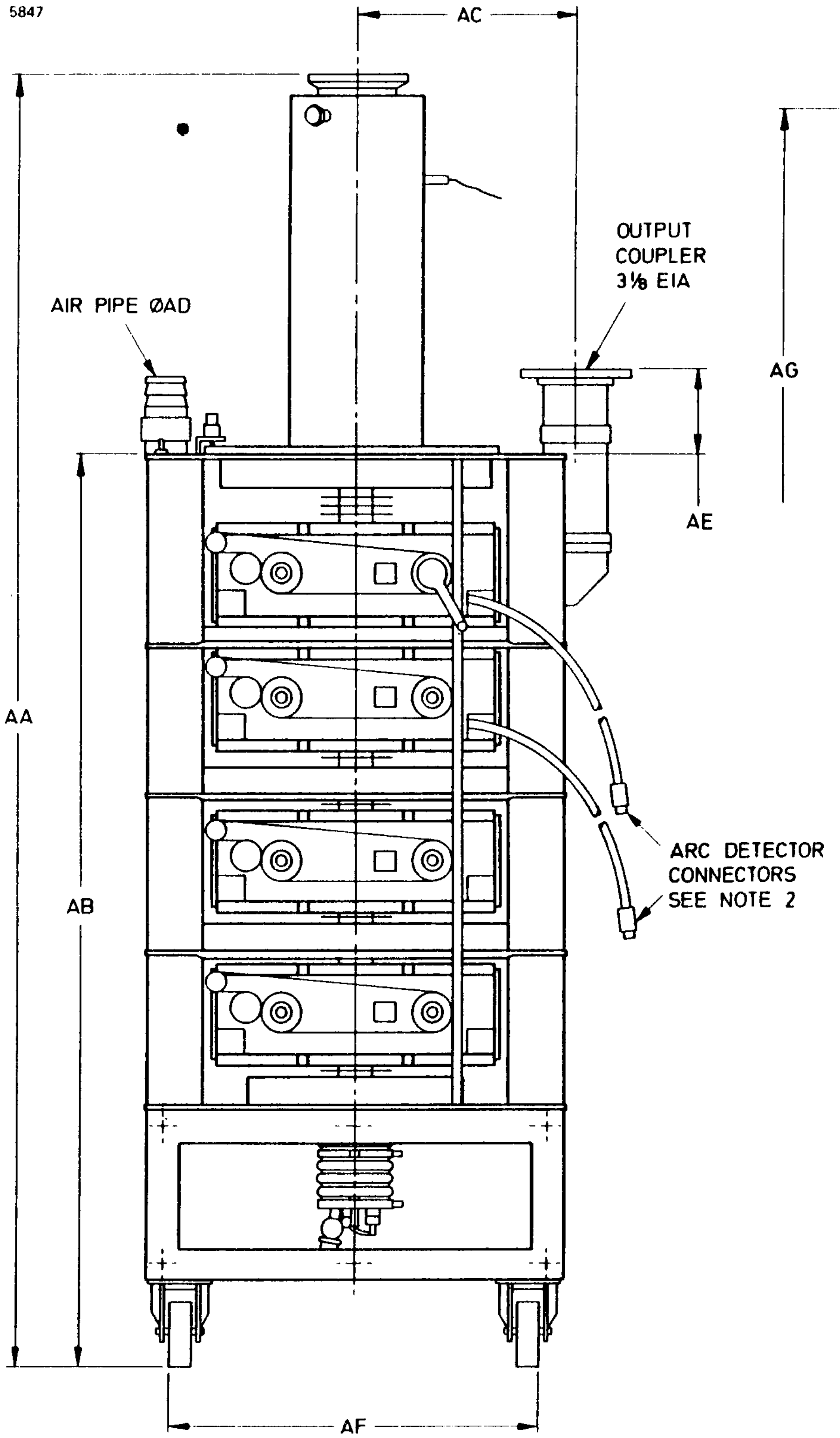
Enlarged View on Gun End of Klystron

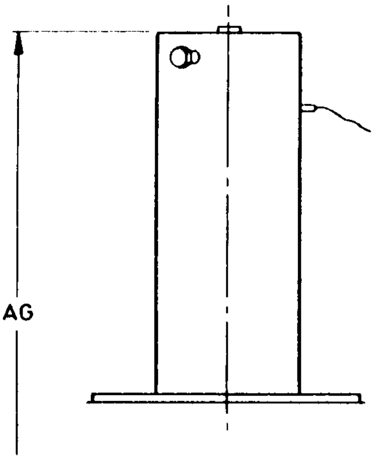


Note The spark gap shown connected between the B.C.D. and cathode terminals is replaced by a shorting link for shipping. ***If the B.C.D. electrode is to be used, this link must be replaced by the spark gap as shown.*** Failure to fit the spark gap will result in failure of the B.C.D. insulation in the event of an internal flashover.

★ Indicates a change.

OUTLINE OF CIRCUIT ASSEMBLY K4276 ★

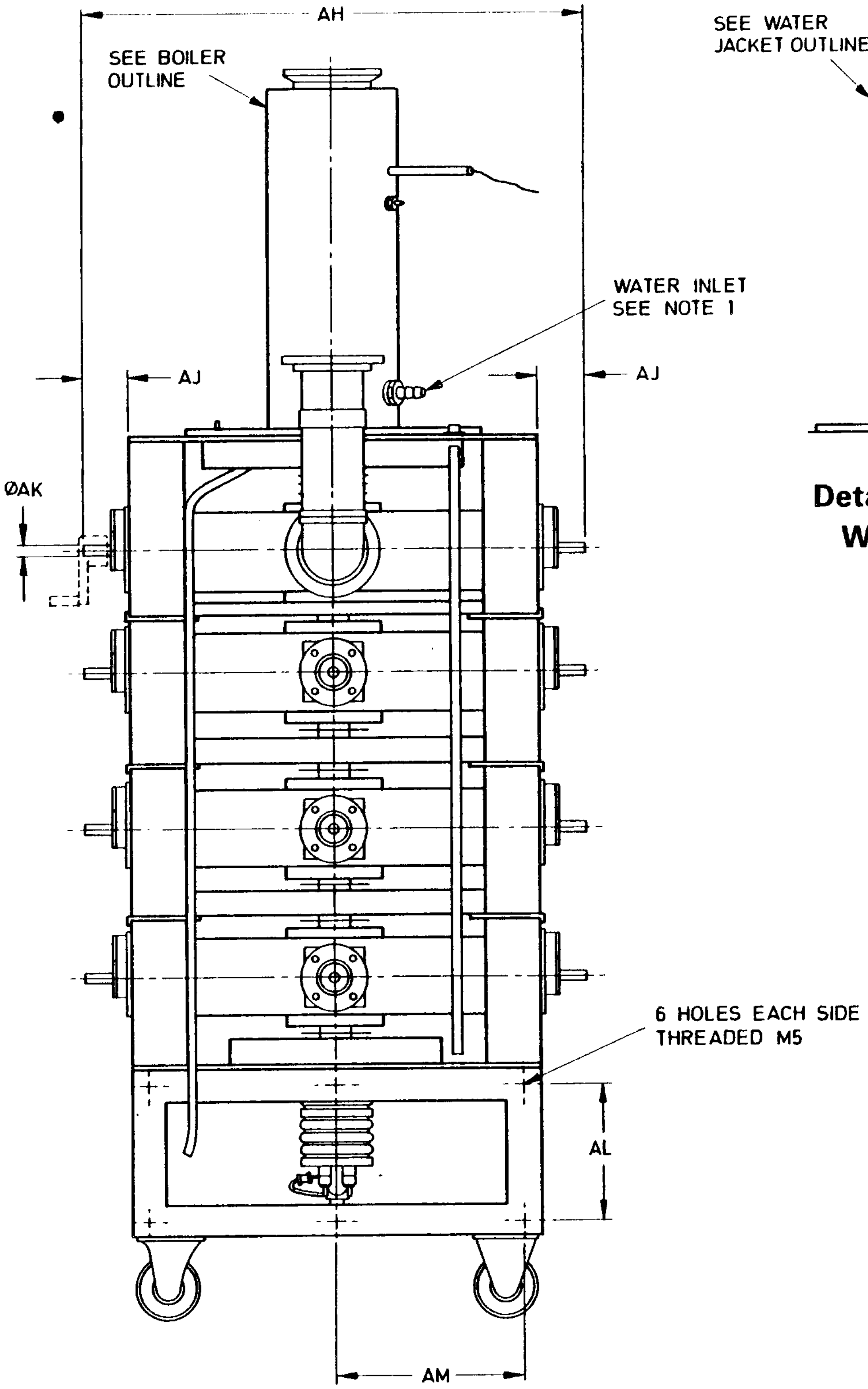


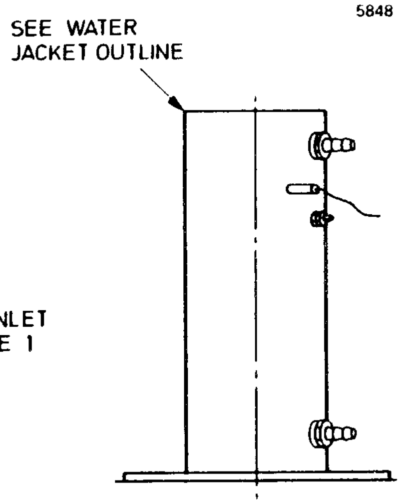


Detail of K4276W Water Jacket

★ Indicates a change.

OUTLINE OF CIRCUIT ASSEMBLY K4276 ★



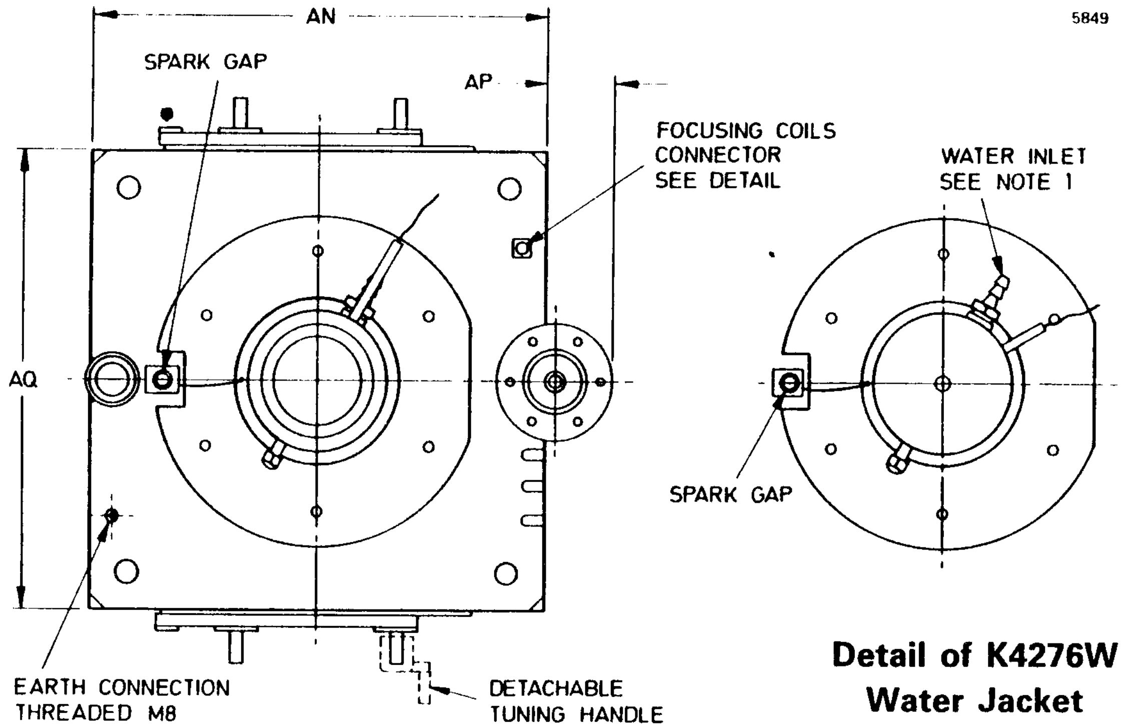


Detail of K4276W Water Jacket

★ Indicates a change.

Top View of Circuit Assembly K4276 ★

(All dimensions without limits are nominal)



Detail of K4276W Water Jacket

Ref	Millimetres	Inches	Ref	Millimetres	Inches
AA	1542.0 ± 3.0	60.709 ± 0.118	AJ	61.0 max	2.402 max
AB	1086.0 ± 3.0	42.756 ± 0.118	AK	14.3	0.563
AC	264.0	10.394	AL	162.0	6.378
AD	50.0	1.969	AM	234.0	9.213
AE	100.0	3.937	AN	508.0	20.000
AF	453.0 ± 2.0	17.835 ± 0.079	AP	75.0	2.953
AG	1500.0 ± 3.0	59.055 ± 0.118	AQ	508.0	20.000
AH	630.0 max	24.803 max			

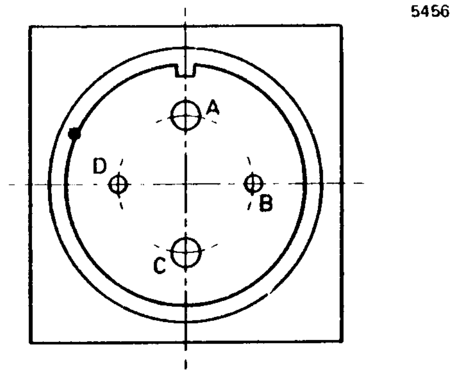
Inch dimensions have been derived from millimetres.

Outline Notes

1. Orientation of boiler or water jacket set by the user to bring connections to most convenient position.
2. An arc detector for the third cavity is available as an optional extra. ★

★ Indicates a change.

View on Focus Coil Connector

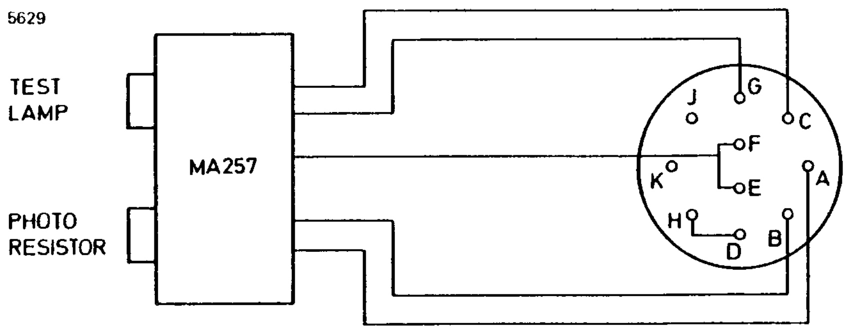


Connections

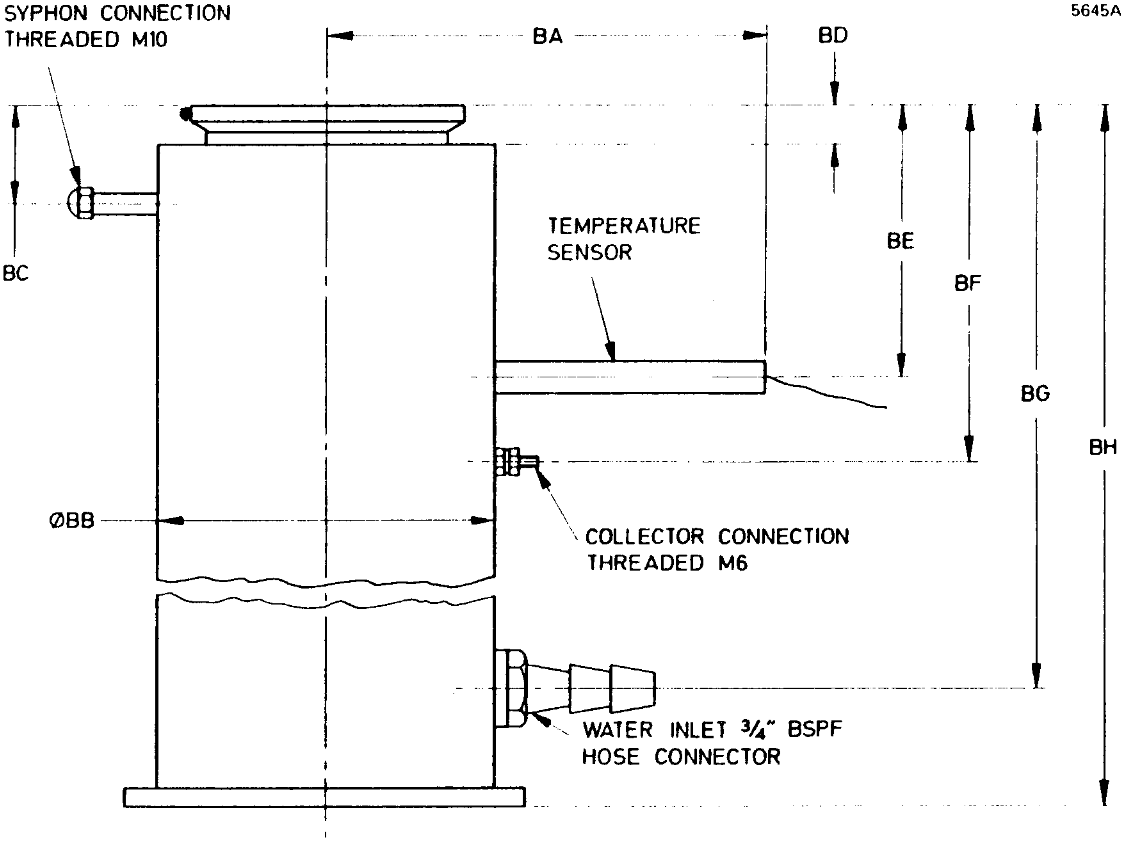
Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

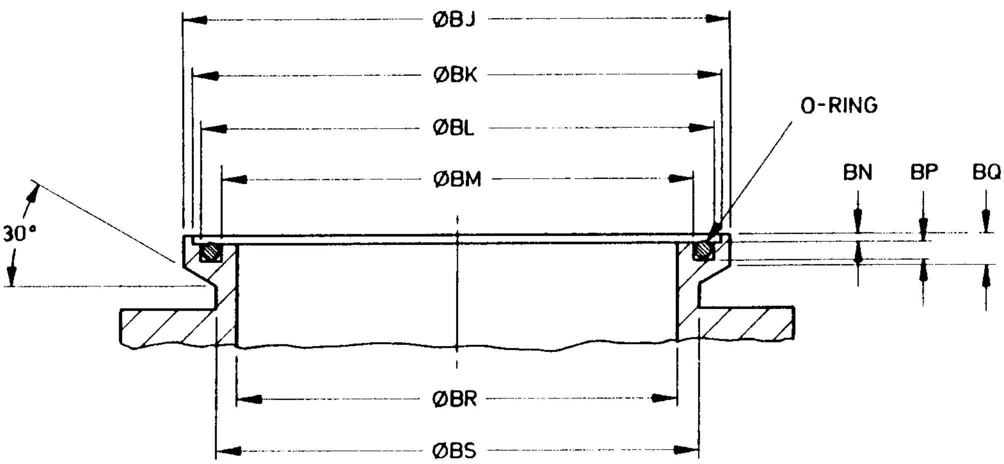
Arc Detector Connections to socket type MS3106F-18-19S



OUTLINE OF BOILER UNIT ★



Enlarged Section of Steam Outlet Coupling



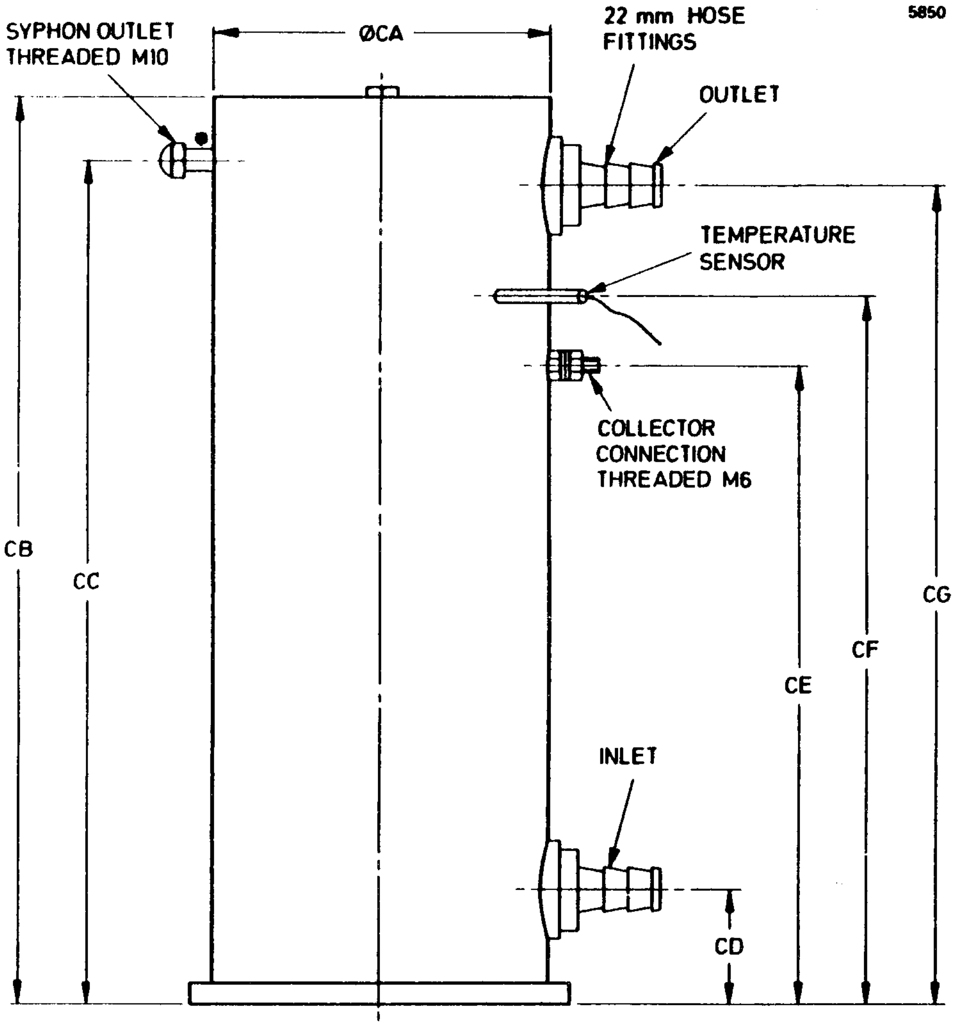
★ Indicates a change.

Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches
BA	204.5	8.051
BB	158.2	6.228
BC	45.0	1.772
BD	17.0	0.669
BE	125.0	4.921
BF	165.0	6.496
BG	405.5	15.965
BH	460.0	18.110
BJ	128.0	5.039
BK	124.5	4.902
BL	120.73	4.753
BM	111.13	4.375
BN	1.75	0.069
BP	4.50	0.177
BQ	7.00	0.276
BR	104.5	4.114
BS	113.0	4.449

Inch dimensions have been derived from millimetres.

OUTLINE OF WATER JACKET ★



Ref	Millimetres	Inches
CA	158.0	6.220
CB	418.0	16.457
CC	389.0	15.315
CD	52.0	2.047
CE	295.0	11.614
CF	327.0	12.874
CG	378.0	14.882

Inch dimensions have been derived from millimetres.

★ Indicates a change.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K3272WBCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube. ★
- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam pulsing.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **High Efficiency** With appropriate corrections, efficiencies greater than 60% can be achieved by beam pulsing. Sync. efficiency 40% minimum at 40 kW output and 38% at 58 kW, in standard operational mode.
- **Output Power** Rated at 40 kW and 58 kW in vision amplifier service.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Simple Tube Exchange** Pre-adjusted, external cavities mean that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Water Cooled Collector.**

DESCRIPTION

The K3272WBCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 58 kW.

A rugged beam current control electrode allows the beam current to be pulsed up during the sync. pulse region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to reduce the perveance and by pulsing the B.C.D. electrode voltage.

★ Indicates a change.

January 1984

Supersedes April 1983 Issue

The klystron can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

The modulating anode enables the klystron to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is also water cooled and has an integral water jacket.

The electron gun and cavities require forced-air cooling; cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

ABRIDGED DATA

Frequency range	470 to 860	MHz	★
Channel numbers:			
European	21 to 68		
U.S.A.	14 to 78		
Output power (saturated) at klystron flange	40/58	kW	
Power gain	40	dB	
Beam voltage	20.5 to 25.5	kV	
Modulating anode to cathode voltage (typical) (see note 1)	21.5	kV	

★ Indicates a change.

GENERAL

Electrical

Cathode	barium aluminate indirectly heated	
Heater voltage (d.c.)	8.5 ± 3%	V
Heater current range	37 to 46	A
Cathode pre-heating time	5	minutes

Mechanical

Overall length (see note 2)	60.875 inches (1546 mm) max
Overall diameter	10.000 inches (254 mm) max
Mounting position	vertical, collector end up ★
Net weight of klystron	80 pounds (36 kg) approx

Circuit Assembly K4251W ★

Electro-magnet current, stabilized to ± 2% (see note 3)	11.0	A min
	13.5	A max
Electro-magnet resistance:		
cold	11.2 ± 0.2	Ω
hot (20 °C ambient)	14.0	Ω max
hot (45 °C ambient)	15.0	Ω max
R.F. input connector	type N coaxial	
R.F. output	3⅛ inch 50 Ω coaxial line	
Net weight of tuning cavities	130 pounds (59 kg) approx	
Net weight of magnet assembly	780 pounds (355 kg) approx	

EEV arc detector type MA257 is fitted to the third and output cavities.

Circuit Assembly K4247W ★

As an alternative to the K4251W type circuit assembly, the K3272WBCD klystron can be operated in a larger K4247W circuit assembly.

★ Indicates a change.

Cooling

At sea level and with inlet air temperature of 20 °C the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Air flow to output and penultimate cavities	50	ft^3/min each
	1.4	m^3/min each
Air flow to cathode terminal	5.0	ft^3/min
	0.14	m^3/min
Static pressure head (see note 4)		2 inch w.g.
Inlet air temperature	40	°C max
Water flow to body (see note 5)	2.0	U.S. gal/min
	7.5	l./min
Pressure drop, 5 drift tube sections in series	25	lb/in^2 max
	1.8	kg/cm^2 max
Water flow to collector (see note 5)	60	imp. gal/min
	70	U.S. gal/min
Collector pressure drop	65	lb/in^2 max
	4.57	kg/cm^2 max
Outlet water temperature	70	°C max
Inlet water pressure to collector	100	lb/in^2 max
	7.0	kg/cm^2 max
Inlet water pressure to body	50	lb/in^2 max
	3.5	kg/cm^2 max

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Heater starting current (peak)	200	A max
Beam voltage:		
continuous	26	kV max
switch-on surge	30	kV max
Modulating anode to cathode voltage (see note 1)	26	kV max
Beam current (mean)	7.0	A max
B.C.D. voltage (relative to cathode) (see note 6)	−2.0	kV max
Body current:		
with no input power	50	mA max
r.f. on	150	mA max
Modulating anode current	6.0	mA max
Collector dissipation	170	kW max
Load v.s.w.r. (see note 7)	1.5:1	max
Temperature of any part of tube envelope	175	°C max

Typical Operation (45 kW Vision Amplifier)
(B.C.D. electrode connected to cathode)

Frequency	470 to 478	646 to 654	846 to 854	MHz	
Channel (European)	21	43	68		
Beam voltage	20.5	22.0	23.0	kV	
Modulating anode to cathode voltage (approx)	19.6	18.9	18.2	kV	
Beam current	5.5	5.2	4.9	A	
Body current:					
with no r.f. input power	15	15	15	mA	
black level + sync. (see note 8)	55	50	50	mA	
Saturated output power	47.5	47.5	47.5	kW	★
Drive power (sync.) (see note 9)	2.5	2.5	4.0	W	
Efficiency	42	42	42	%	★

★ Indicates a change.

Typical Operation (55 kW Vision Amplifier)
(B.C.D. electrode connected to cathode)

Frequency	470 to 476	638 to 644	800 to 806	MHz ★
Channel number (USA)	14	42	69	
Beam voltage	22.8	24.0	25.5	kV
Modulating anode to cathode voltage (approx)	21.94	20.8	20.1	kV
Beam current	6.7	6.0	5.7	A
Body current:				
with no input power	20	20	20	mA
black level + sync. (see note 8)	80	75	90	mA
Saturated output power	58	58	58	kW
Drive power for 58 kW output (see note 9)	4.5	4.0	5.0	W
Efficiency	38	40	40	%

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a modulating anode current of 1.5 mA.
2. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 127 inches (3.23 m) is required. This is measured to the top of the lifting harness and does not include the hoist.
3. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for minimum body current and stabilize to ± 2% about this optimum value.
4. Measured at the air input pipes to the circuit assembly.
5. These values apply when the coolant used is distilled water with the dissolved oxygen removed. EEV should be consulted if it is intended to use alternative coolants.

★ Indicates a change.

6. The K3272WBCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be increased during the synchronising pulse region of the video signal so that up to 55 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to the cathode.

   (b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to the cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.

7. This value applies to television service. EEV should be consulted regarding other conditions of service.

8. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.

9. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV cannot assume responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

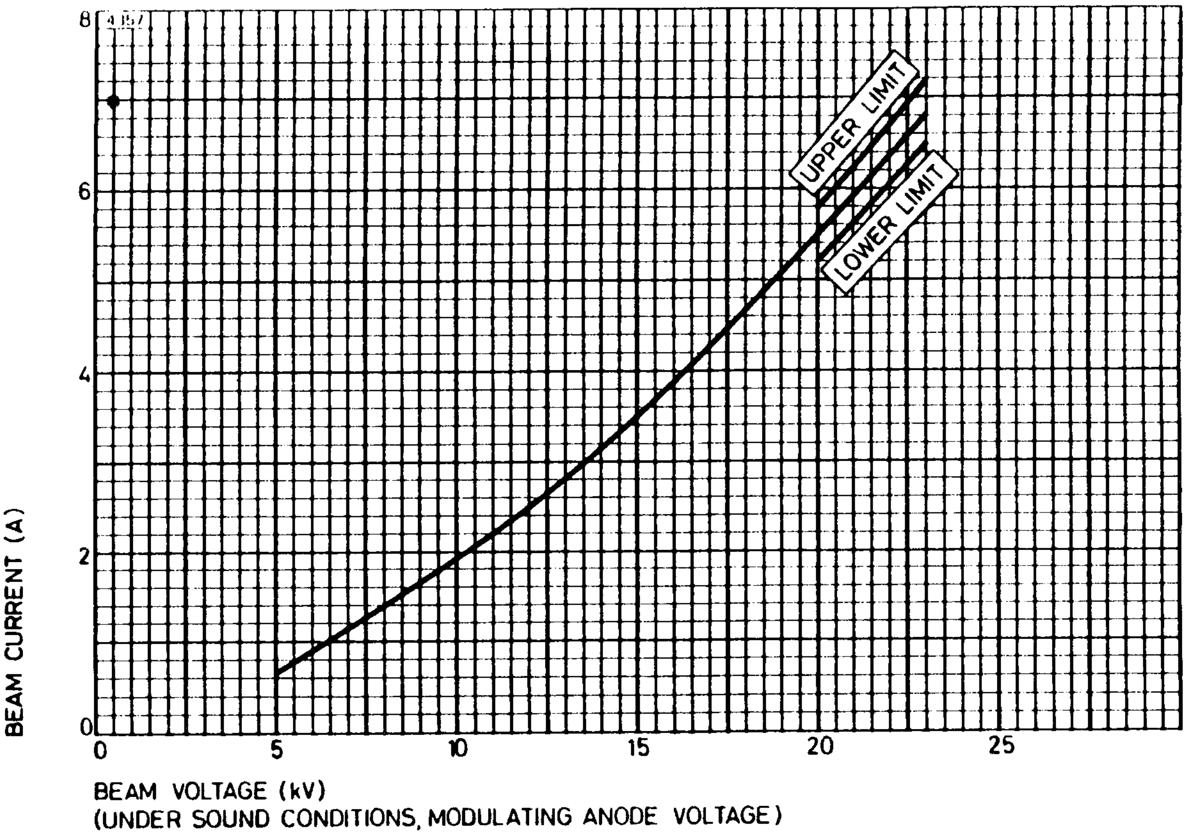
R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

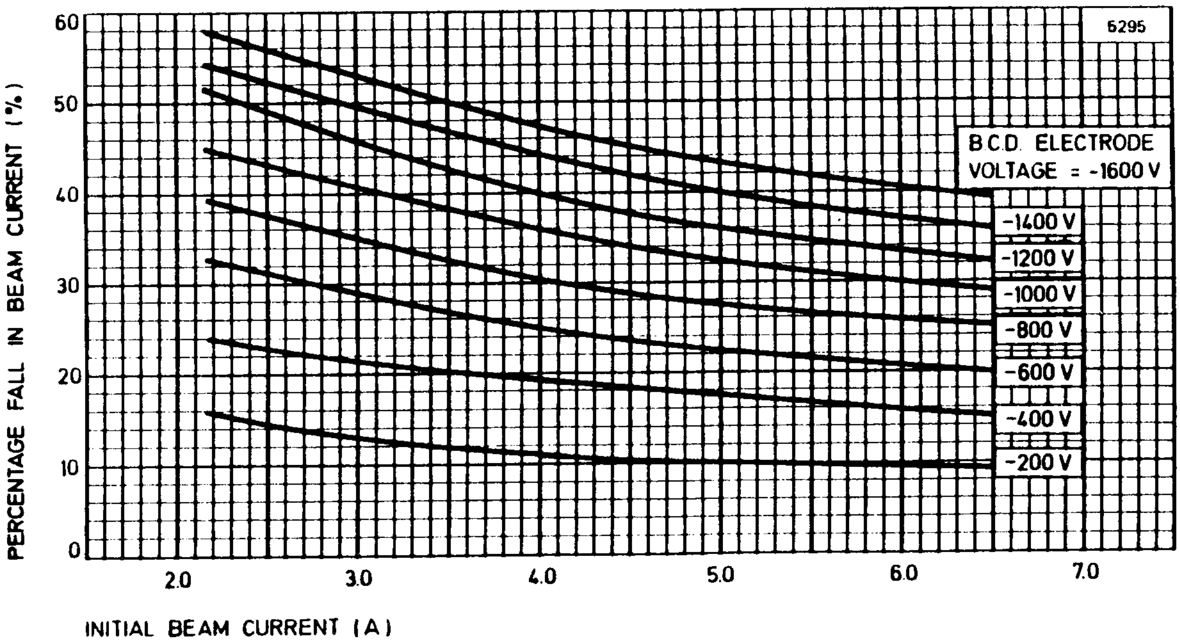
X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

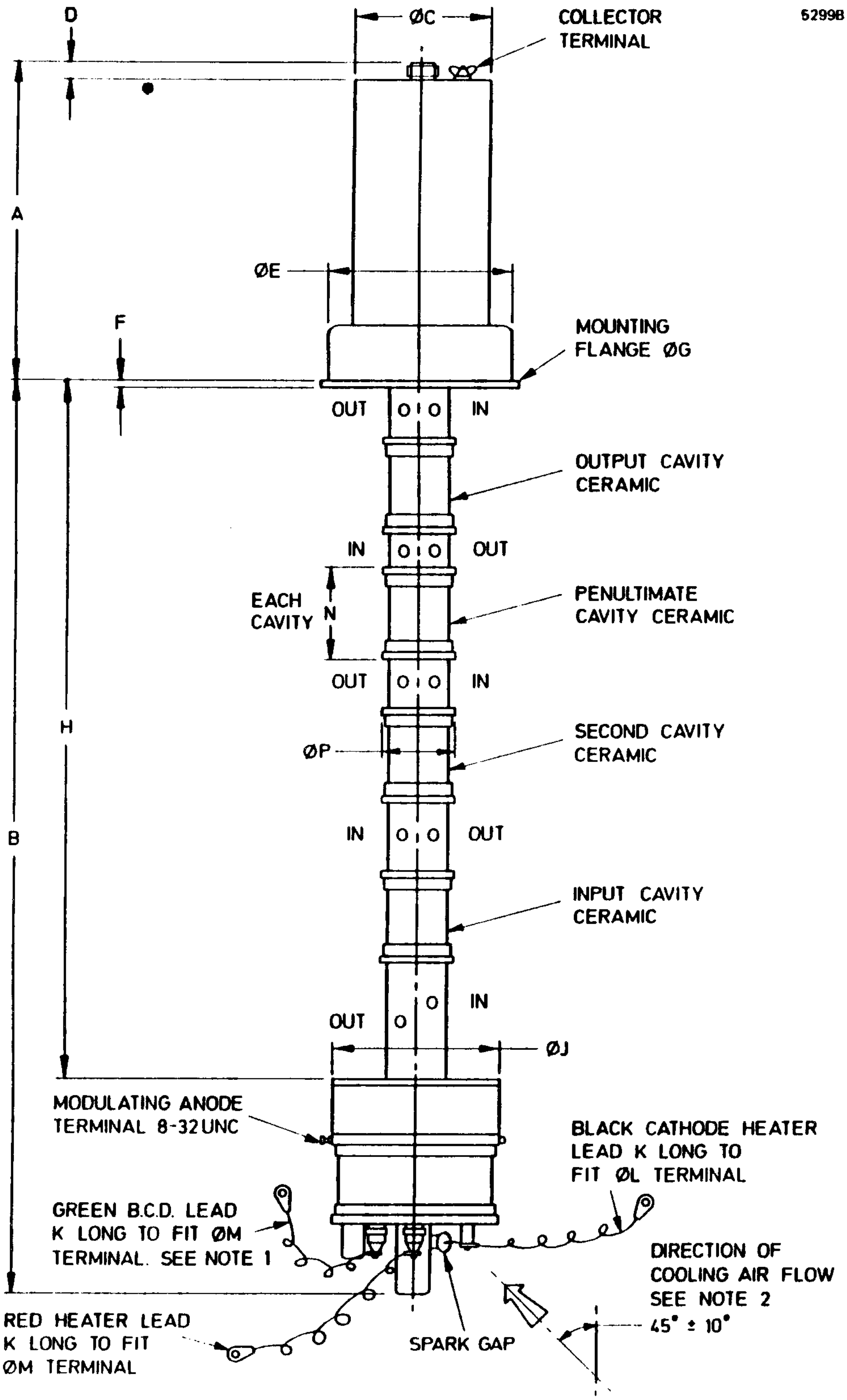
TYPICAL BEAM CHARACTERISTIC



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS

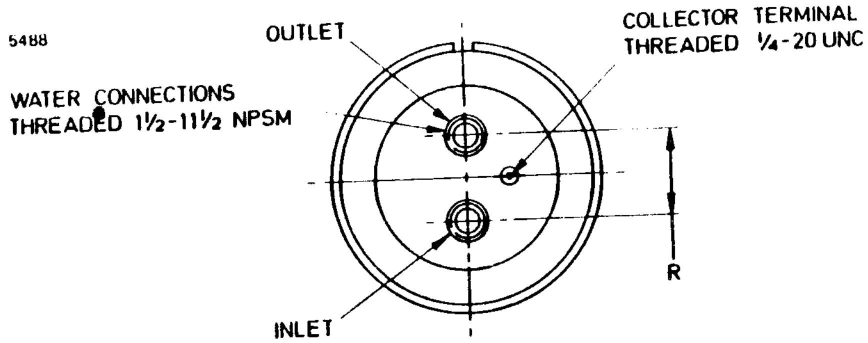


OUTLINE FOR K3272WBCD ★



★ Indicates a change.

OUTLINE FOR K3272WBCD



Outline Dimensions (nominal)

Ref	Inches	Millimetres
A	15.707	399.0
B	45.300 max	1150.6 max
C	6.754	171.6
D	0.812	20.62
E	9.224	234.3
F	0.375	9.53
G	10.000	254.0
H	34.250 min	870.0 min
J	8.100	205.7
K	15.000	381.0
L	0.312	7.92
M	0.250	6.35
N	4.606	117.0 ★
P	3.661	93.0 ★
R	3.125	79.38

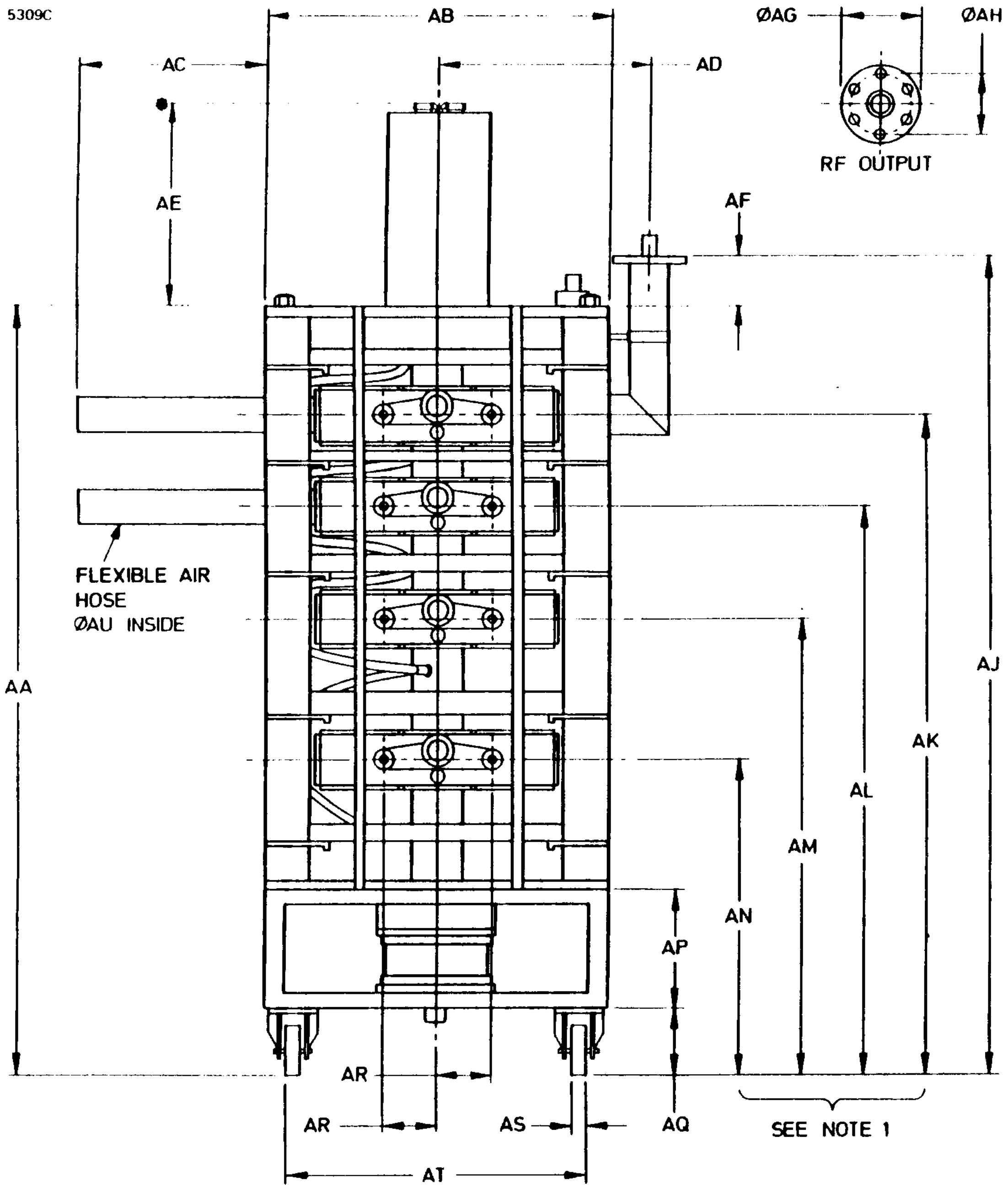
Millimetre dimensions have been derived from inches.

Outline Notes

1. The klystron is delivered with a shorting link connecting the B.C.D. terminal to cathode. The green B.C.D. lead shown is supplied with the klystron, for fitting by the customer when required.
2. The specified cathode air flow should be directed as shown.

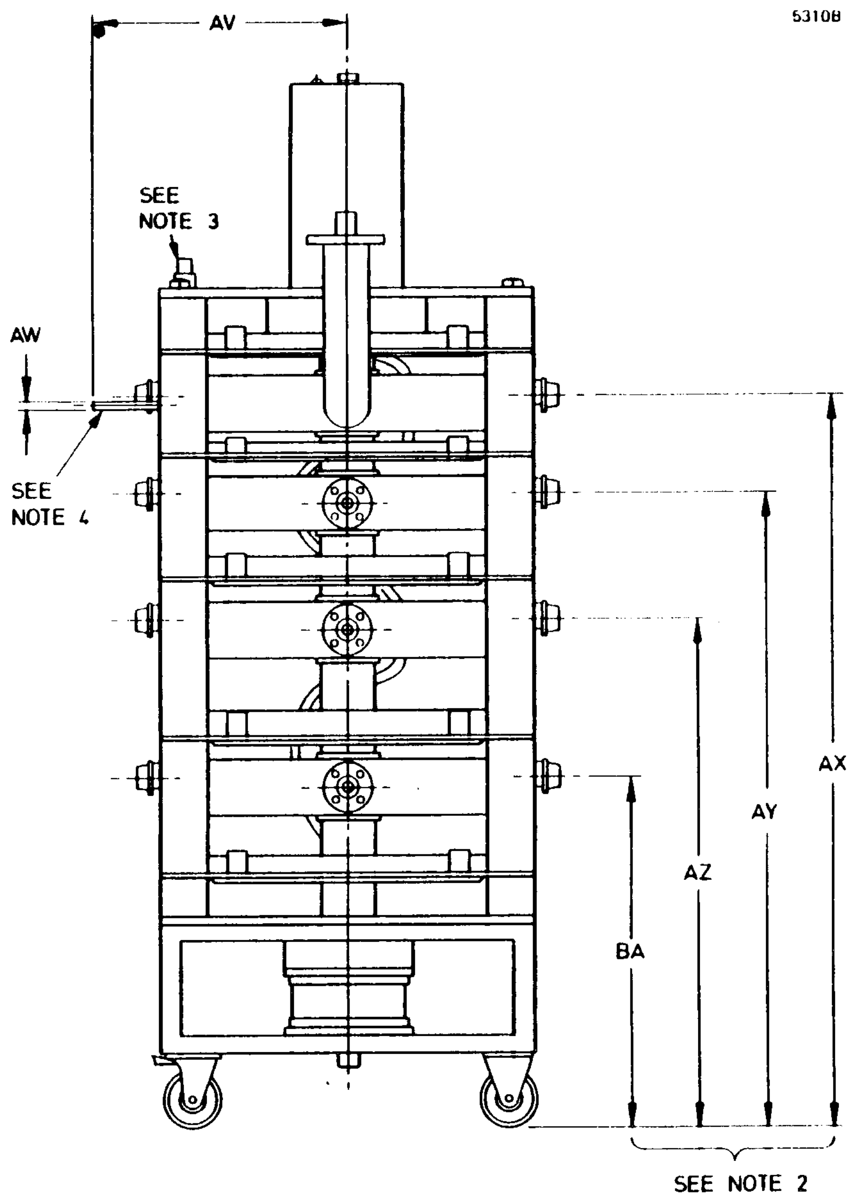
★ Indicates a change.

OUTLINE FOR K4251W (See page 14 for Dimensions and Notes) ★



★ Indicates a change.

OUTLINE FOR K4251W (See page 14 for Dimensions and Notes) ★



★ Indicates a change.

Dimensions for K4251W (All dimensions are nominal)

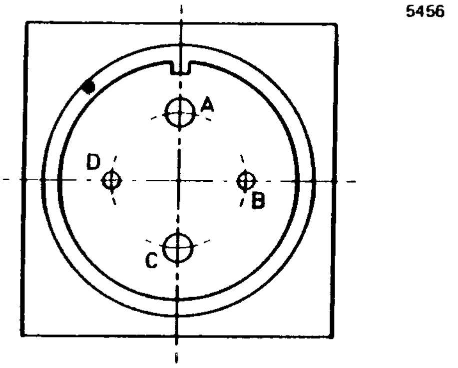
Ref	Millimetres	Inches	Ref	Millimetres	Inches
AA	1320	51.968	AP	255.0	10.039
AB	544.0	21.417	AQ	92.0	3.622
AC	308.0	12.126	AR	88.0	3.465
AD	335.0	13.189	AS	25.4	1.000
AE	292.0	11.496	AT	484.0	19.055
AF	100.0	3.937	AU	36.5	1.437
AG	132.0	5.197	AV	380.0 max	14.961 max
AH	111.12	4.375	AW	14.28	0.562
AJ	1420	55.905	AX	1097	43.189
AK	1082	42.598	AY	947.0	37.283
AL	932.0	36.693	AZ	759.0	29.882
AM	744.0	29.291	BA	552.0	21.732
AN	537.0	21.142			

Inch dimensions have been derived from millimetres.

Outline Notes

1. Measured to the centre of the cavities.
2. Measured to the centre of the tuning knobs.
3. Socket Amphenol type MS3102A-16P-9P, plug supplied Amphenol type MS3106A-16-9S.
4. Dimension AV refers to the maximum extension of the cavity tuning rods, and applies to both halves of each cavity.

View on Focus Coil Connector



Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

K3276HBCD K3277HBCD K3278HBCD

HIGH POWER AMPLIFIER KLYSTRONS FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacements for K3276H Series klystrons featuring:

- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam current reduction during picture information.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing at 58 kW output. 38% minimum sync. efficiency at 58 kW output in standard operational mode.
- **Output Power** 58 kW output in vision amplifier service.
- **Long Life** High reliability electron gun with barium aluminate cathode for long tube life.
- **All ceramics aluminium oxide** No beryllium oxide ceramics (see page 2).
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Water Cooled Collector**
- **High Efficiency Replacement for 4KM150LA, 4KM150LF and 4KM150LH.**

DESCRIPTION

The K3276HBCD, K3277HBCD and K3278HBCD are high efficiency four-cavity amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The tubes are electro-magnetically focused and operate in the frequency ranges 470–598 MHz, 590–710 MHz and 702–860 MHz respectively.

A rugged beam current control electrode allows the beam current to be reduced during the picture region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to set the sync. level perveance and by pulsing the B.C.D. electrode voltage (see note 1).

February 1986

Supersedes October 1985 Issue

DESCRIPTION – Continued

The klystrons can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

The modulating anode also enables the klystron to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is water cooled and has an integral water jacket.

Forced-air cooling of the electron gun and the output and penultimate cavities is required. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The ceramic insulators on this series of tubes are typically made of aluminium oxide. A few tubes may have beryllium oxide ceramics on the third and output cavities. Please see safety notes for beryllium oxide on page 24.

ABRIDGED DATA

Klystron	Frequency in the range	Channel Numbers European	Channel Numbers U.S.A.	Circuit Assembly
K3276HBCD	470 to 598 MHz	21–36	14–34	K4204
K3277HBCD	590 to 710 MHz	36–50	34–53	K4205
K3278HBCD	702 to 860 MHz	50–68	53–78	K4206

Output power at klystron flange	58	kW
Typical power gain	40	dB
Beam voltage	24	kV

GENERAL

Electrical

Cathode	barium aluminate, indirectly heated	
Heater voltage (see note 2)	8.25 ± 3%	V ★
Heater current range	35 to 46	A ★
Heater starting current (peak)	200	A max
Cathode pre-heating time	5	minutes

★ Indicates a change.

Mechanical

Overall length (see note 3):	
K3276HBCD, K3277HBCD	60.875 inches (154.6 cm) nom
K3278HBCD	56.310 inches (143.0 cm) nom
Overall diameter	10.000 inches (25.4 cm) nom
Mounting position	vertical, collector end down
Net weight of klystron:	
K3276HBCD, K3277HBCD	120 pounds (54 kg) approx
K3278HBCD	80 pounds (36 kg) approx

Circuit Assembly

Electro-magnet current (see note 4)	11.0	A min
	13.5	A max
Electro-magnet resistance:		
cold (20 °C)	9.5 ± 1	Ω
hot (20 °C ambient)	13	Ω max
hot (45 °C ambient)	14	Ω max
R.F. input connector	type N coaxial	
R.F. output	3⅛ inch 50 Ω coaxial line	
Net weight of tuning cavities:		
for K3276HBCD	120 pounds (54 kg) approx	
for K3277HBCD	90 pounds (41 kg) approx	
for K3278HBCD	70 pounds (32 kg) approx	
Total lifting weight of klystron and cavities:		
K3276HBCD	250 pounds (114 kg) approx	
K3277HBCD	220 pounds (100 kg) approx	
K3278HBCD	160 pounds (72 kg) approx	
Net weight of magnet assembly	1150 pounds (523 kg) approx	

Arc Detector

Arc detector type MA693A is fitted to the output and penultimate cavities.

Photo-resistor type	NSL 462	
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C

Continued on page 4

Arc Detector – Continued

Layer	cadmium sulphide
Test bulb	28 V, 0.04 A
Photo-resistor connection	coaxial cable 900 mm long fitted with BNC 50 Ω coaxial plug
Test lamp connection	twin flexible insulated cable, 900 mm long. No plug provided.

COOLING

At sea level, the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron but this practice is not recommended.

Inlet air temperature	40	50	°C
Air flow to electron gun	5.0	6.0	ft^3/min
	0.14	0.17	m^3/min
Air flow to output and penultimate cavities	50	55	ft^3/min each
	1.42	1.6	m^3/min each
Static pressure head (see note 5)	2.0	2.4	inch w.g.
	51	61	mm
Water flow to body and electro-magnet in series (see notes 6 and 7)	2.0		U.S. gal/min
	7.5		l./min
Pressure drop, 5 drift tube sections in series (see note 7)	25		lb/in^2 max
	1.8		kg/cm^2 max
Water flow to collector (see note 6)	60		imp. gal/min
	70		U.S. gal/min
Collector pressure drop	65		lb/in^2 max
	4.57		kg/cm^2 max
Outlet water temperature	70		°C max
Inlet water pressure to collector	100		lb/in^2 max
	7.0		kg/cm^2 max
Inlet water pressure to body	50		lb/in^2 max
	3.5		kg/cm^2 max

Recommended Coolants

Good quality demineralized water should be used for cooling when there is no danger from freezing. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use.

Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter.

The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:		
continuous	26	kV max
switch-on surge (up to 8500 ft altitude)	30	kV max
Beam current (mean)	7.0	A max
B.C.D. voltage (relative to cathode) (see note 1)	−2.0	kV max
B.C.D. current (see note 8)	4.0	mA max
Body current	150	mA max
Output power (see note 9)	65	kW max
Collector dissipation	170	kW max
Load v.s.w.r. (see note 10)	1.5:1	max
Temperature of any external part of klystron	175	°C max

TYPICAL OPERATION (Vision Amplifier without beam current pulsing)

Operating Conditions (B.C.D. electrode connected to cathode)

Beam voltage	24	kV
Modulating anode voltage (with respect to cathode)	21.5	kV
Beam current	6.0	A
Electro-magnet current	12	A
Bandwidth (to 1 dB points)	8.0	MHz

K3276HBCD in K4204

Frequency	470−476	590−596	MHz
Channel number (U.S.A.)	14	34	
Body current, with no input power	20	20	mA
Drive power for 58 kW output	4.5	5.0	W
Output power (peak sync.)	58	58	kW

K3277HBCD in K4205

Frequency	590−596	704−710	MHz
Channel number (U.S.A.)	34	53	
Body current, with no input power	20	20	mA
Drive power for 58 kW output	3.5	4.0	W
Output power (peak sync.)	58	58	kW

K3278HBCD in K4206

Frequency	704−710	854−860	MHz
Channel number (U.S.A.)	53	78	
Body current, with no input power	20	20	mA
Drive power for 58 kW output	3.5	5.0	W
Output power (peak sync.)	58	58	kW

PERFORMANCE SPECIFICATION

This specification covers use of the klystron with peak sync. vision output powers at the klystron flange in the range 28 kW to 58 kW and sound powers in the range 2.8 kW to 5.8 kW.

GENERAL SPECIFICATION

The following are the test conditions common to vision or sound operation.

Heater voltage	8.25 ± 3%	V	★
Heater current	35 to 46	A	★
B.C.D. electrode	connected to cathode		

VISION SERVICE (Without beam current pulsing)

Test Conditions

Peak sync. power at klystron flange (see note 9)	28	32	kW
Bandwidth	see note 11	see note 11	

Range of Characteristics

	Min	Max	Min	Max	
Efficiency	35	–	40	–	%
Beam power	–	80	–	80	kW
H.T. voltage taps (see note 12)	17.0	19.0	19.0	22.5	kV
Beam current	–	4.7	–	4.25	A
Modulating anode current	–	6.0	–	6.0	mA
Body current (see note 13)	–	150	–	150	mA
Body current (see note 14)	–	50	–	50	mA
R.F. drive power (see note 15)	–	5	–	5	W

Test Conditions

Peak sync. power at klystron flange (see note 9)	45	58	kW
Bandwidth	see note 11	see note 11	

Range of Characteristics

	Min	Max	Min	Max	
Efficiency	38	–	38	–	%
Beam power	–	120	–	170	kW
H.T. voltage taps (see note 12)	20.0	22.5	22.0	24.5	kV
Beam current	–	6.0	–	7.0	A
Modulating anode current	–	6.0	–	6.0	mA
Body current (see note 13)	–	150	–	150	mA
Body current (see note 14)	–	50	–	50	mA
R.F. drive power (see note 15)	–	6	–	6	W

★ Indicates a change.

SOUND SERVICE

Test Conditions

Output power	2.8	3.2	kW
Modulating anode voltage (nominal) relative to cathode (see note 16)	5.0	5.0	kV
Bandwidth	1.5	1.5	MHz

Range of Characteristics

	Min	Max	Min	Max	
Beam voltage	–	19.0	–	22.5	kV
Beam current (see note 16)	–	0.67	–	0.62	A
Body current (see note 17)	–	50	–	50	mA
Efficiency (see note 18)	22	–	23	–	%
R.F. drive power (see note 15)	–	2.0	–	2.0	W

Test Conditions

Output power	4.5	5.8	kW
Modulating anode voltage (nominal) relative to cathode (see note 16)	5.5	5.6	kV
Bandwidth	1.5	1.5	MHz

Range of Characteristics

	Min	Max	Min	Max	
Beam voltage	–	22.5	–	24.5	kV
Beam current (see note 16)	–	0.8	–	0.85	A
Body current (see note 17)	–	50	–	50	mA
Efficiency (see note 18)	25	–	28	–	%
R.F. drive power (see note 15)	–	2.0	–	2.0	W

NOTES

1. The K3276HBCD series klystrons may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 58 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power. The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to cathode.

   (b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.

2. For this klystron, the heater voltage should be in the range 8.0 – 8.25 V. ★ After 10 000 hours of operation, the heater voltage should be increased to be in the range 8.25 – 8.5 V.
3. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 127 inches (3.23 m) is required for • K3276HBCD or K3277HBCD, and 123 inches (3.12 m) for K3278HBCD. This is measured to the top of the lifting harness and does not include the hoist.
4. Under TV picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within the current range stated. Maximum stability is obtained by adjusting the magnet current within the above range and stabilizing it to ± 2% about the optimum value.
5. Measured at the air input pipes to the circuit assembly.
6. These values apply when the coolant used is distilled water with the dissolved oxygen removed. EEV should be consulted if it is intended to use alternative coolants.
7. When these tubes are used as replacements for 4KM150 series tubes in existing circuit assemblies, the electro-magnet is usually water cooled in series with the klystron body. The EEV circuit assemblies described in this data sheet require no water cooling but transmitter cubicle air cooling must be increased if necessary to ensure that the heat dissipated in the magnet (about 1.5 kW) is extracted from the cubicle without producing excessive circuit assembly temperatures.
8. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	24	kV
Beam current	6.0	A
Heater voltage	8.5	V
B.C.D. voltage	zero with respect to cathode	

The B.C.D. voltage must then be increased to −700 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 4 mA and typically will be less than 2 mA. At end-of-life, the B.C.D. current will not exceed 6 mA.

With a B.C.D.-to-cathode voltage of −700 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow better than 60% efficiency to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

★ Indicates a change.

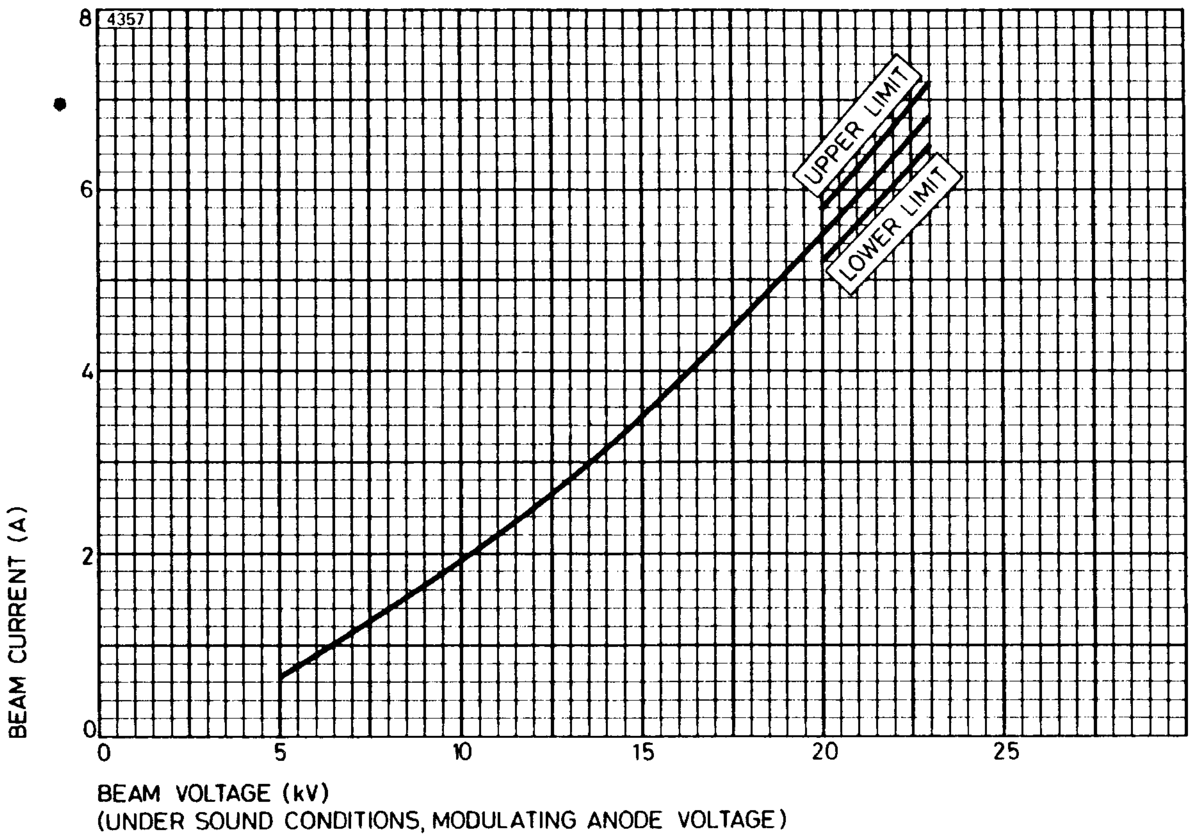
Designers of B.C.D. pulsing equipment for these klystrons are advised to allow for a B.C.D. current value of about 10 mA. Typical values of interelectrode capacitance are:–

B.C.D. to cathode	75	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

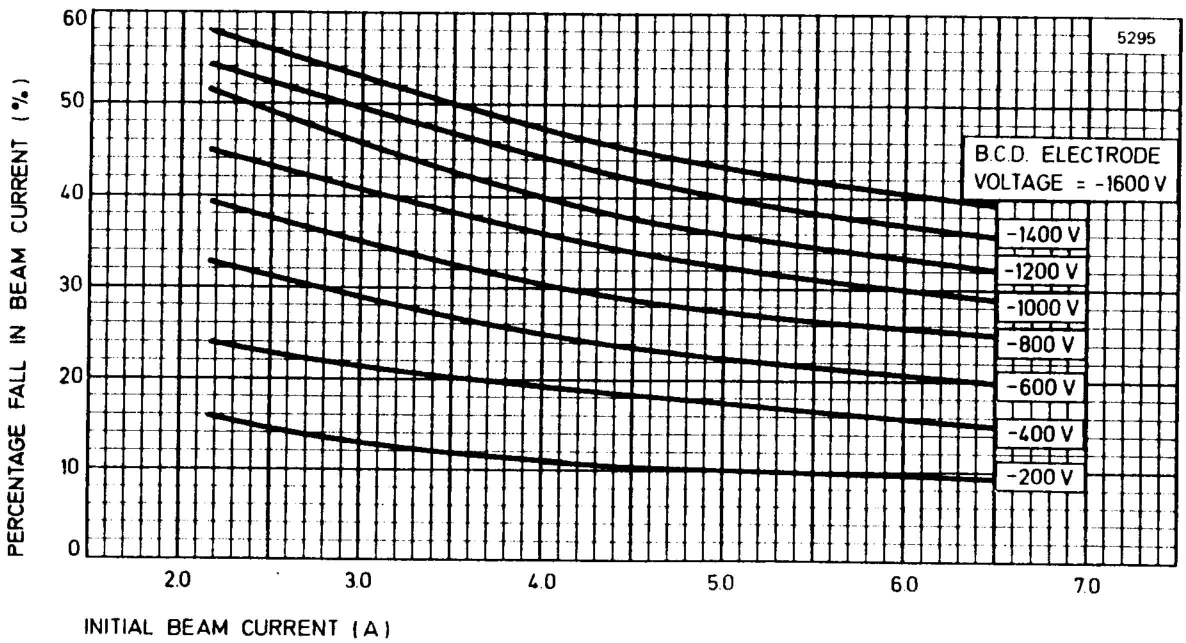
Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

9. The tube may be operated at up to 65 kW peak sync. for test purposes only at 110% of rated transmitter output power.
10. This applies to television service. EEV should be consulted regarding other conditions of service.
11. The klystron is tuned so that, for constant input power, the variation in output power is less than 1 dB over the specified bandwidth at all power levels between −2 dB and −14 dB with respect to the specified output power.
12. For optimum efficiency at reduced power levels, a beam voltage of 24 kV may be used, with modulating anode voltage set to give the required output power.
13. The combined body current of one sound and one vision klystron will not exceed this value.
14. The body current of one sound and one vision klystron in the absence of r.f. drive.
15. Defined as the power measured into a matched load substituted for the input cavity of the klystron.
16. For operation at the same beam voltage as the vision amplifier and one tenth of the vision output power, the beam current is reduced by means of the modulating anode. The graph on page 11 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the maximum value of the modulating anode current is 1.5 mA. The potential divider network must be designed accordingly.
17. The current stated applies to a single sound klystron only.
18. Minimum efficiency for the output power stated.

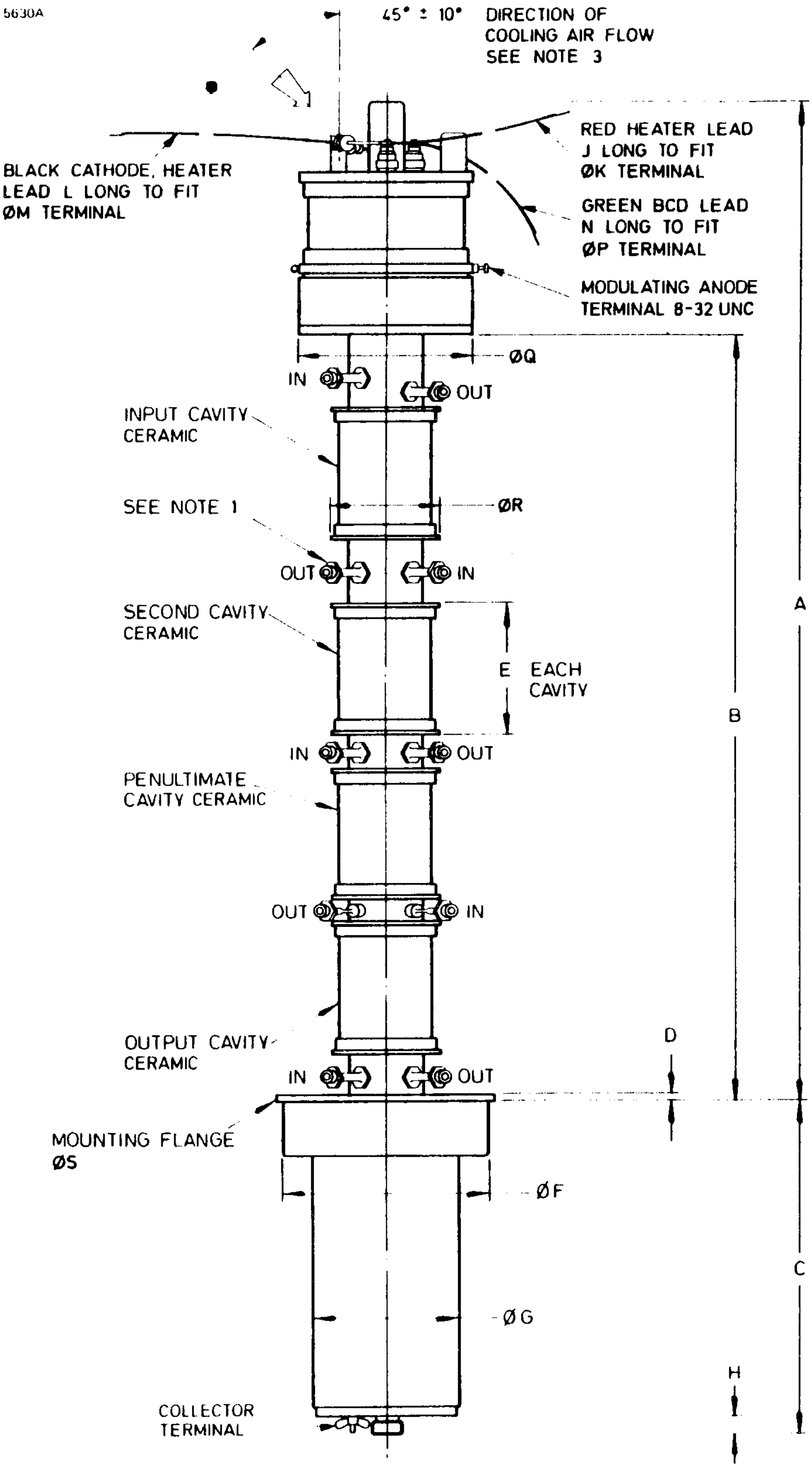
TYPICAL BEAM CHARACTERISTIC



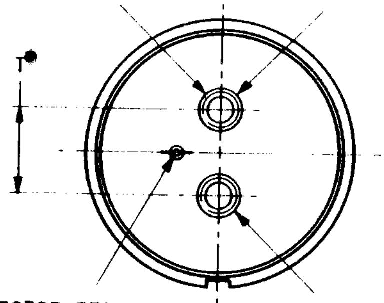
B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS

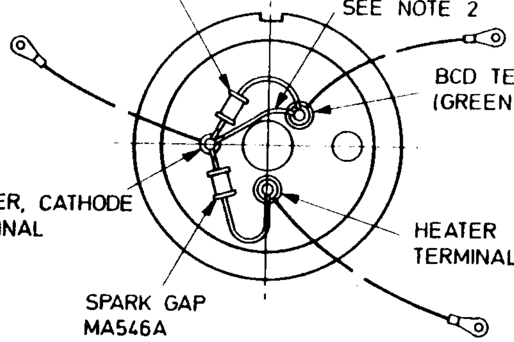


OUTLINE FOR K3276HBCD



OUTLINE FOR K3276HBCD





Outline Dimensions (nominal)

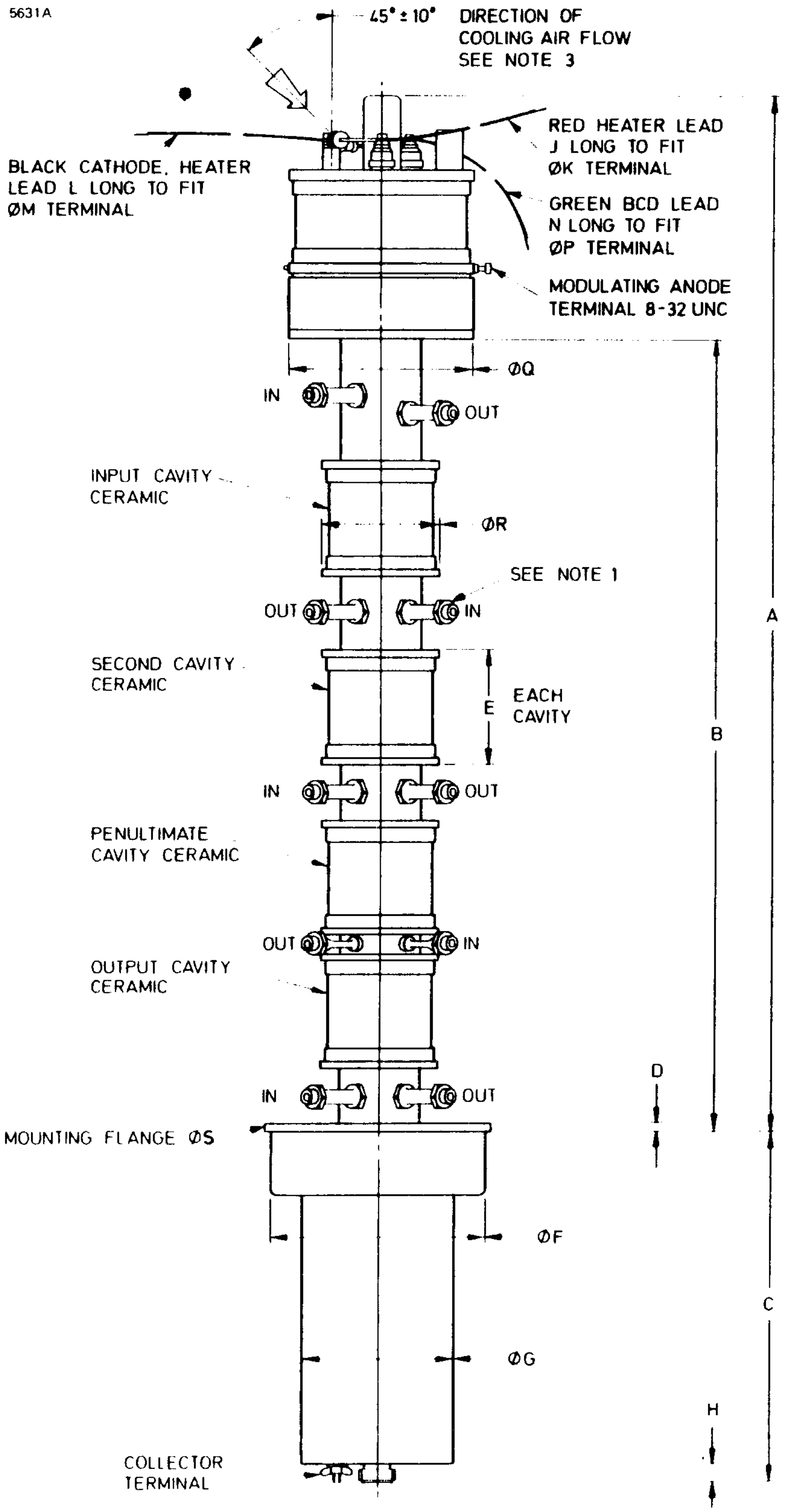
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	45.300 max	1150.6 max	K	0.250	6.35
B	34.250 min	870.0 min	L	15.000	381.0
C	15.707	399.0	M	0.312	7.92
D	0.375	9.53	N	15.000	381.0
E	6.000	152.4	P	0.250	6.35
F	9.244 max	234.8 max	Q	8.100	205.7
G	6.754	171.6	R	5.125	130.2
H	0.812	20.62	S	10.000	254.0
J	15.000	381.0	T	3.125	79.38

Millimetre dimensions have been derived from inches.

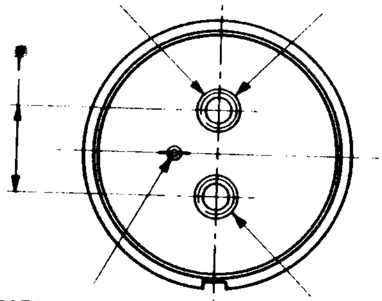
Outline Notes

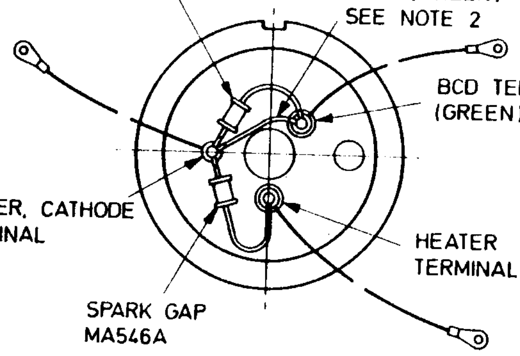
1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.
2. The klystron is delivered with a spark gap connected between the B.C.D. terminal and cathode. In addition, a shorting link is connected across the same two terminals. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.
3. Specified cathode air flow should be directed as indicated.

OUTLINE FOR K3277HBCD



OUTLINE FOR K3277HBCD





Outline Dimensions (nominal)

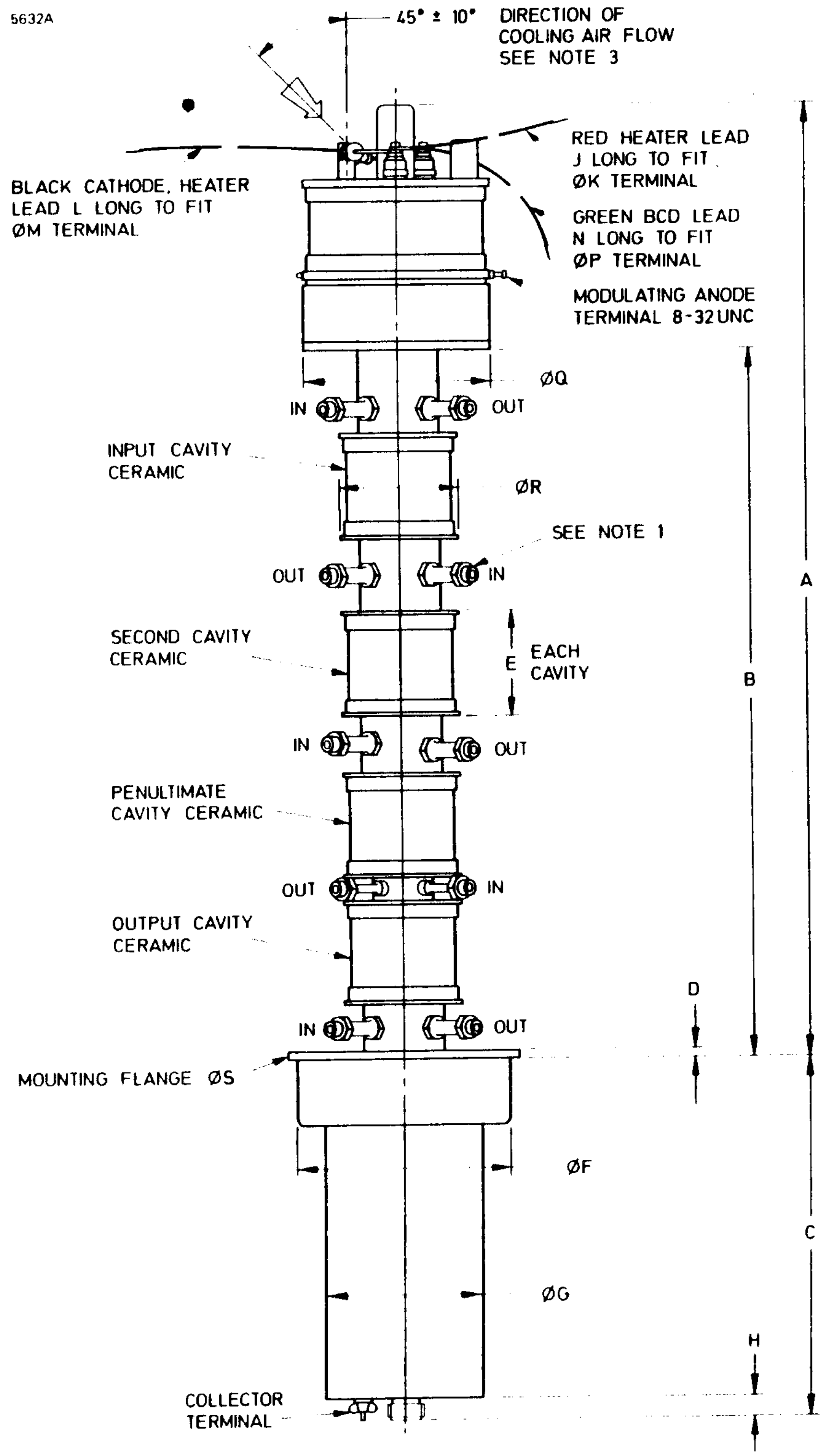
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	45.300 max	1150.6 max	K	0.250	6.35
B	34.250 min	870.0 min	L	15.000	381.0
C	15.707	399.0	M	0.312	7.92
D	0.375	9.53	N	15.000	381.0
E	5.000	127.0	P	0.250	6.35
F	9.244 max	234.8 max	Q	8.100	205.7
G	6.754	171.6	R	5.125	130.2
H	0.812	20.62	S	10.000	254.0
J	15.000	381.0	T	3.125	79.38

Millimetre dimensions have been derived from inches.

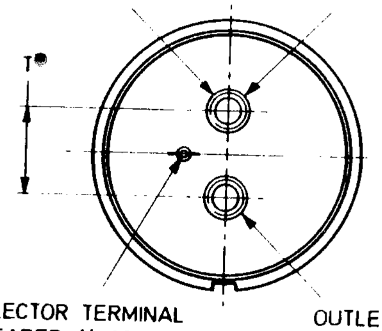
Outline Notes

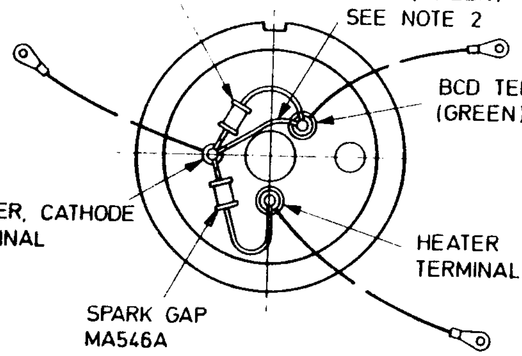
1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.
2. The klystron is delivered with a spark gap connected between the B.C.D. terminal and cathode. In addition, a shorting link is connected across the same two terminals. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.
3. Specified cathode air flow should be directed as indicated.

OUTLINE FOR K3278HBCD



OUTLINE FOR K3278HBCD





Outline Dimensions (nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	40.600	1031.2	K	0.250	6.35
B	29.875	758.8	L	15.000	381.0
C	15.707	399.0	M	0.312	7.92
D	0.375	9.53	N	15.000	381.0
E	4.500	114.3	P	0.250	6.35
F	9.244 max	234.8 max	Q	8.100	205.7
G	6.754	171.6	R	4.125	104.8
H	0.812	20.62	S	10.000	254.0
J	15.000	381.0	T	3.125	79.38

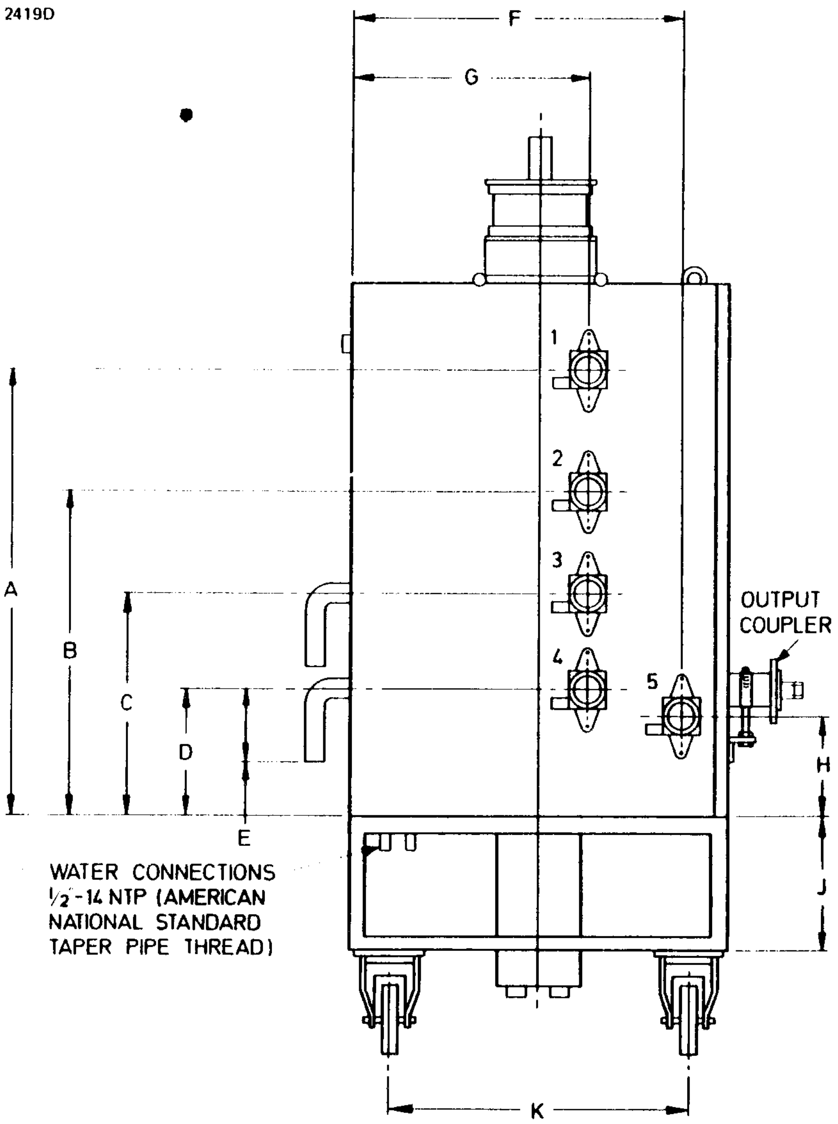
Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. and a set of connecting pipes is included in the circuit assembly.
2. The klystron is delivered with a spark gap connected between the B.C.D. terminal and cathode. In addition, a shorting link is connected across the same two terminals. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.
3. Specified cathode air flow should be directed as indicated.

OUTLINE FOR K4204 AND K4205

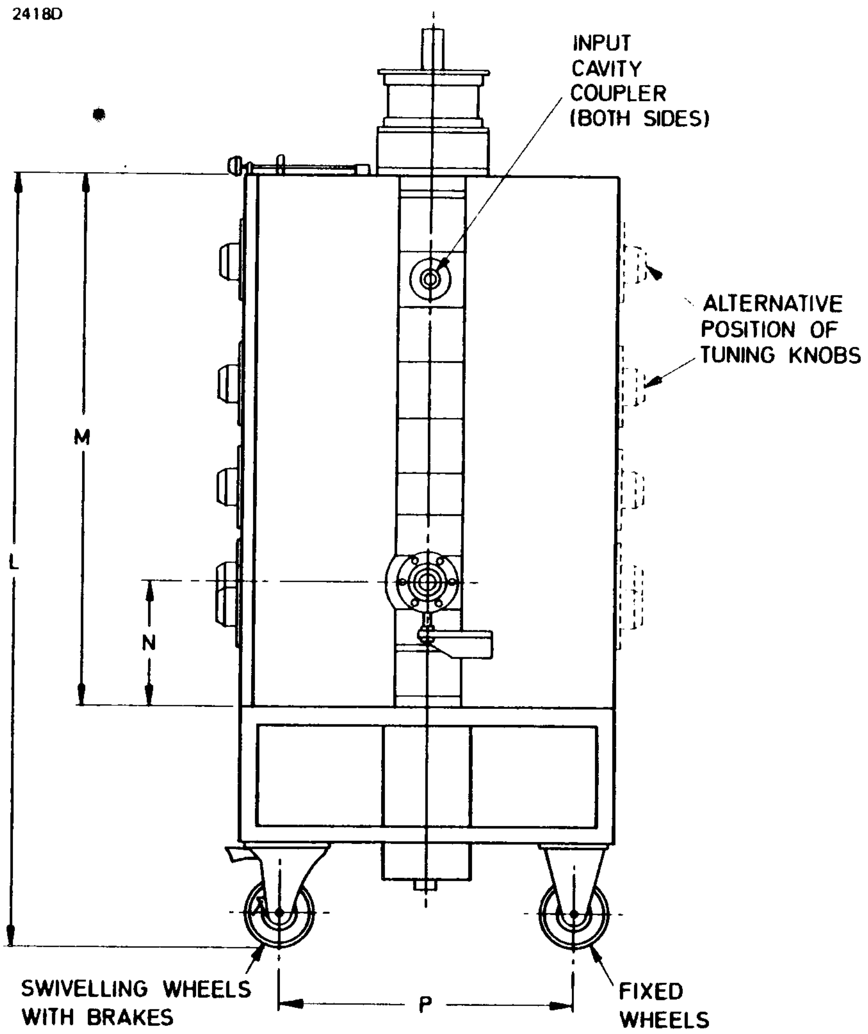
2419D



Controls

1. Input cavity tuning
2. Second cavity tuning
3. Penultimate cavity tuning
4. Output cavity tuning
5. Output coupling

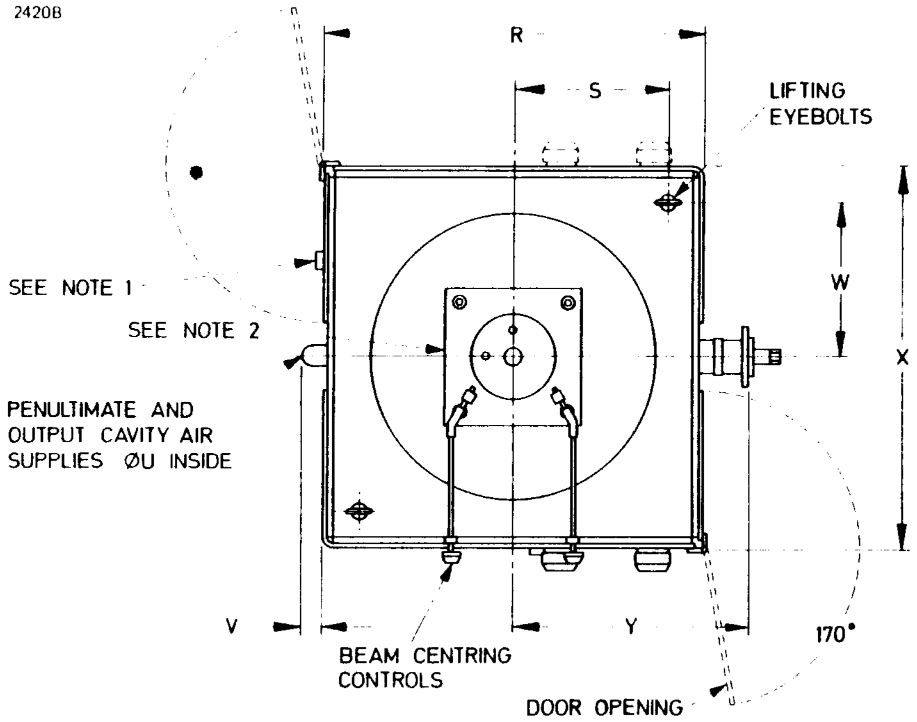
OUTLINE FOR K4204 AND K4205 (All dimensions nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	32.312	820.7	H	7.250	184.2
B	23.500	596.9	J	9.875	250.8
C	16.000	406.4	K	21.875	555.6
D	9.125	231.8	L	56.375	1432
E	5.375	136.5	M	38.875	987.5
F	24.531	623.1	N	9.125	231.8
G	17.500	444.5	P	22.250	565.2

Millimetre dimensions have been derived from inches.

OUTLINE FOR K4204 AND K4205 (All dimensions without limits nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
R	28.000 ± 0.125	711.2 ± 3.2	W	11.250	285.8
S	11.250	285.8	X	28.000 ± 0.125	711.2 ± 3.2
U	1.500	38.1	Y	15.550	395.0
V	2.250	57.15			

Millimetre dimensions have been derived from inches.

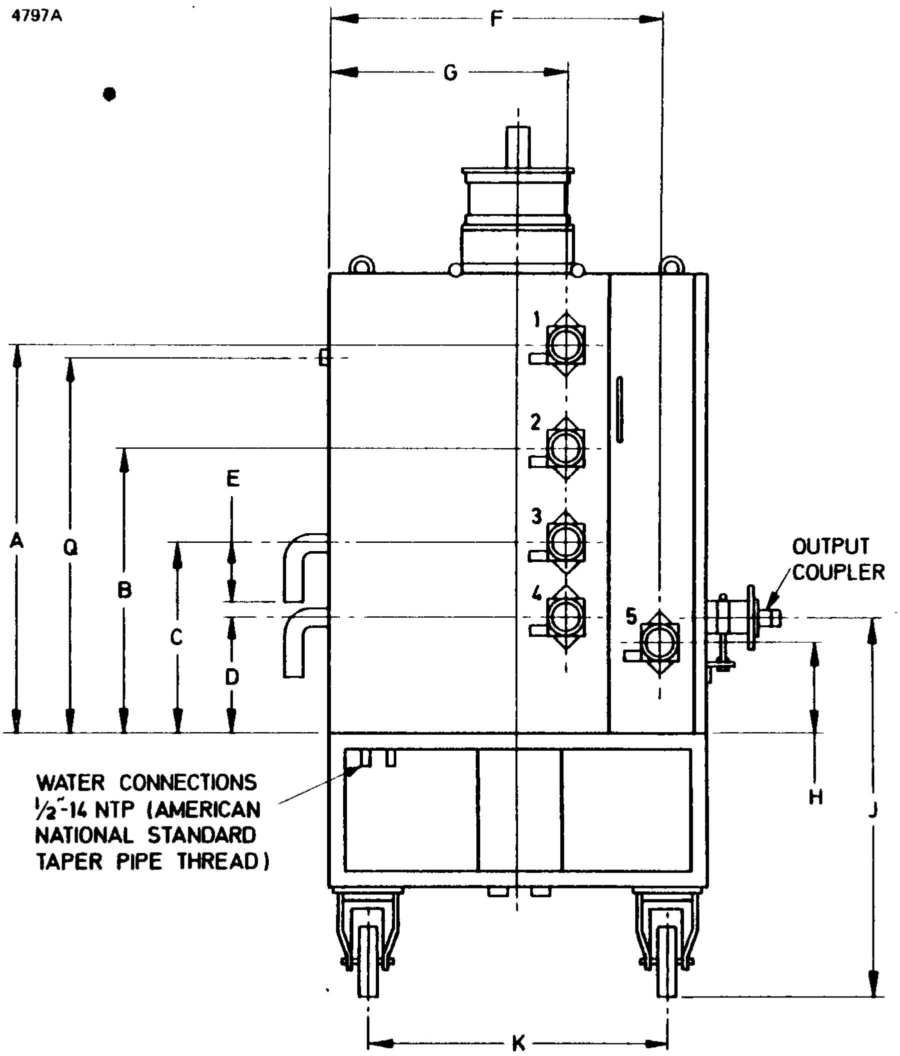
Outline Notes

1. Coil connections, box receptacle 3102A-24-19P.

Pin	Connection	Pin	Connection
A	Coil 1 (top) positive	F	Coil 3 negative
B	Coil 1 negative	H	Coil 4 positive
C	Coil 2 positive	J	Coil 4 negative
D	Coil 2 negative	K	Coil 5 (collector) positive
E	Coil 3 positive	L	Coil 5 negative

2. Flux plates.

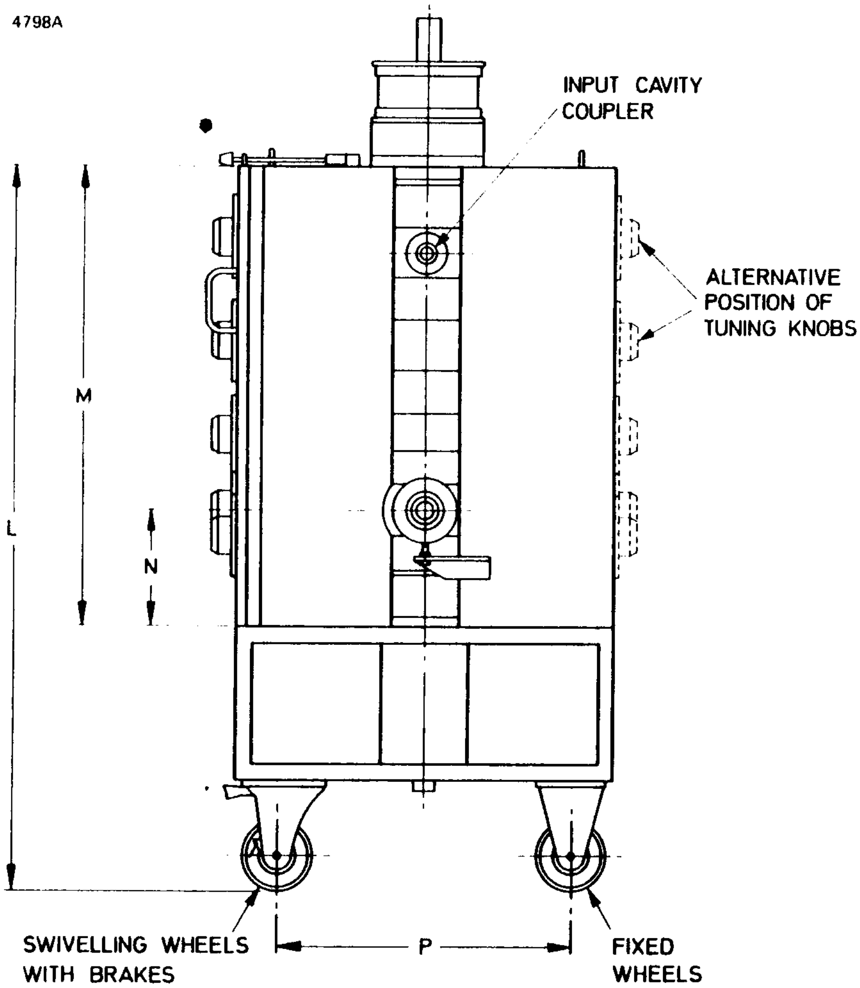
OUTLINE FOR K4206



Controls

1. Input cavity tuning
2. Second cavity tuning
3. Penultimate cavity tuning
4. Output cavity tuning
5. Output coupling

OUTLINE FOR K4206 (All dimensions nominal)

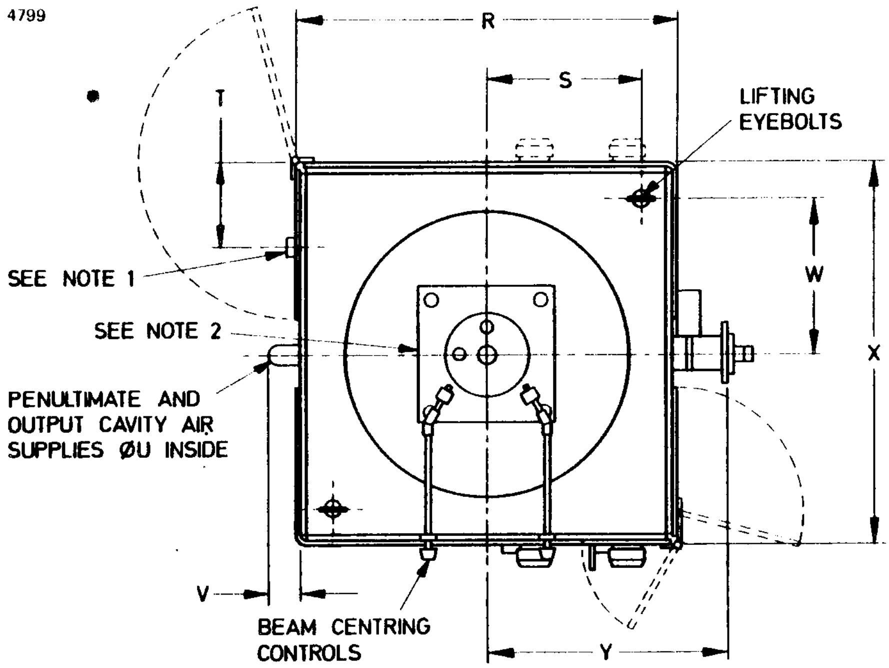


Ref	Millimetres	Inches
A	722.5	28.445
B	532.0	20.945
C	355.5	13.996
D	216.5	8.524
E	136.5	5.374
F	625.5	24.626
G	444.5	17.500
H	170.0	6.693

Ref	Millimetres	Inches
J	676.3	26.626
K	555.6	21.875
L	1340	52.756
M	880.0	34.646
N	216.5	8.524
P	555.6	21.875
Q	700.0	27.559

Inch dimensions have been derived from millimetres.

OUTLINE FOR K4206 (All dimensions without limits nominal)



Ref	Millimetres	Inches	Ref	Millimetres	Inches
R	711.2 ± 3.2	28.000 ± 0.125	V	57.15	2.250
S	286.0	11.260	W	286.0	11.260
T	155.0	6.102	X	711.2 ± 3.2	28.000 ± 0.125
U	38.10	1.500	Y	395.0	15.550

Inch dimensions have been derived from millimetres.

Outline Notes for K4206

1. Coil connections, box receptacle 3102A-24-19P.

Pin	Connection	Pin	Connection
A	Coil 1 (top) positive	F	Coil 3 negative
B	Coil 1 negative	H	Coil 4 positive
C	Coil 2 positive	J	Coil 4 negative
D	Coil 2 negative	K	Coil 5 (collector) positive
E	Coil 3 positive	L	Coil 5 negative

2. Flux plates.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K3276HBCD series klystrons have white, unmarked, aluminium oxide ceramics in all cavities. However, on a few tubes the third and output cavity ceramics may be made of beryllium oxide; these ceramics are coloured blue, or marked with a black line.

Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics; if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

English Electric Valve Company Limited
Chelmsford, Essex, England

Printed in England

K3282BCD K3283BCD K3284BCD

HIGH POWER AMPLIFIER KLYSTRONS FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacements for K3282 Series klystrons featuring:

- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam current reduction during picture information.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **Efficiency** With appropriate correction, efficiencies greater than 50% can be achieved by beam pulsing at 45 kW output. 30% minimum sync. efficiency at 45 kW output in standard operational mode.
- **Output Power** Operates over a wide range of output power up to 45 kW.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **High Gain** Fully compatible with solid-state drive.
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Simple, Efficient Vapour Cooling** A single water supply of 9 litres/minute cools both body and collector.
- **Simple Tube Exchange** Pre-adjusted cavities and loops. Settings not upset by tube exchange.

DESCRIPTION

The K3282BCD, K3283BCD and K3284BCD are four-cavity amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The three tubes operate in the frequency bands 470–610 MHz, 590–720 MHz and 700–860 MHz respectively.

A rugged beam current control electrode allows the beam current to be reduced during the picture region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to set the sync. level perveance and by pulsing the B.C.D. electrode voltage (see note 1).

February 1986

Supersedes January 1985 Issue

The klystrons can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

The modulating anode enables the klystrons to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The tubes are electro-magnetically focused and their associated circuit assemblies are designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing either the tuning or the loading loop settings, so that the replacement klystron is coarse-tuned at switch-on and requires only a trimming adjustment to meet the full transmission specification.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied). The boiler is fitted with a visual water level indicator and a fail-safe electric low water level alarm sensor.

The electron gun and the output and penultimate cavities require forced-air cooling; suitable air ducts are provided for the cavities. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

ABRIDGED DATA

Klystron	**Frequency in the range**	**Channels**	**Circuit Assembly**
K3282BCD	470 to 610 MHz	21–37	K4170
K3283BCD	590 to 720 MHz	36–51	K4171
K3284BCD	700 to 860 MHz	50–68	K4172

Note These klystrons may be used as direct replacements for K3082, K3083 and K3084 respectively in earlier circuit assemblies of the K4102BDS and K4158 series.

Output power at klystron flange .	22.5	28	45	kW
Power gain (typical):				
K3282BCD	44	45	47	dB
K3283BCD	43	44	47	dB
K3284BCD	43	44	47	dB
Beam voltage	18	18.5	22	kV

GENERAL

Electrical

Cathode	indirectly heated		
Heater voltage (see note 2)	8.25 ± 3%	V	★
Heater current range	35 to 46	A	★
Heater starting current (peak)	200	A max	
Cathode pre-heating time	5	minutes	

Mechanical

Overall length (see note 3):	
K3282BCD, K3283BCD	63.75 inches (161.9 cm) max
K3284BCD	59.5 inches (151.1 cm) max
Overall diameter	11.125 inches (283 mm) nom
Mounting position	vertical, collector end up
Net weight of klystron:	
K3282BCD, K3283BCD	160 pounds (73 kg) approx
K3284BCD	155 pounds (70 kg) approx

Circuit Assembly

Electro-magnet current, stabilized to ± 2% (see note 4)	10.8	A min
	12.5	A max

Electro-magnet resistance:	K4170	K4171	K4172	
cold (20 °C)	9.5 ± 1	9.0 ± 1	8.5 ± 1	Ω
hot (20 °C ambient)	13	13	12	Ω max
hot (45 °C ambient)	14	14	13	Ω max

R.F. input connector	type N coaxial
R.F. output	3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities:	
K4170 (for K3282BCD)	120 pounds (54 kg) approx
K4171 (for K3283BCD)	90 pounds (41 kg) approx
K4172 (for K3284BCD)	70 pounds (32 kg) approx
Total lifting weight of klystron, cavities, boiler and mounting collar:	
K3282BCD	390 pounds (177 kg) approx
K3283BCD	360 pounds (164 kg) approx
K3284BCD	335 pounds (152 kg) approx
Net weight of magnet assembly	1800 pounds (816 kg) approx

EEV arc detector type MA257 is fitted to the output cavity. See pages 24 and 25 for connection details.

★ Indicates a change.

Cooling

Volume of steam produced by collector dissipation	1.5	ft^3/min/kW ($0.043\ m^3$/min/kW)
Volume of water converted to steam	0.006	imp.gal/min/kW (0.027 litre/min/kW)
Inlet water flow to body and collector in series (see note 5)	2.0	imp.gal/min (9 litres/min)
Body pressure drop at 2.0 imp.gal/min	28	lb/in^2 ($2.0\ kg/cm^2$)
Inlet water temperature	80	°C max
Air flow to penultimate and output cavities	50	ft^3/min ($1.42\ m^3$/min) each
Static pressure head (see note 6)	1	inch (25 mm) water gauge
Air flow to cathode	5.0	ft^3/min ($0.142\ m^3$/min)
Inlet air temperature	40	°C max
Temperature of any external part of the klystron must not exceed	175	°C max

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:		
continuous	23	kV max
switch-on surge	27	kV max
Beam current (mean)	7.0	A max
B.C.D. voltage (relative to cathode) (see note 1)	−2.0	kV max
B.C.D. current (see note 7)	2.0	mA max
Body current	150	mA max
Output power	50	kW max
Collector dissipation	150	kW max
Load v.s.w.r. (see note 8)	1.5:1	max

TYPICAL OPERATION (Vision amplifier without beam current pulsing)

Operating Conditions (B.C.D. electrode connected to cathode)

Beam voltage	22	kV
Beam current	6.2	A
Electro-magnet current	11	A
Bandwidth (to 1 dB points)	8.0	MHz

K3282BCD in K4170 Circuit

Frequency	470 to 478 (channel 21)	526 to 534 (channel 28)	598 to 606 (channel 37)	MHz
Body current:				
with no input power	15	15	15	mA
at 45 kW c.w. output, vision frequency	50	50	50	mA
Drive power for 45 kW output	1.25	0.7	1.0	W
Saturated output power	49	50	48	kW

K3283BCD in K4171 Circuit

Frequency	590 to 598 (channel 36)	654 to 662 (channel 44)	710 to 718 (channel 51)	MHz
Body current:				
with no input power	15	15	15	mA
at 45 kW c.w. output, vision frequency	65	60	55	mA
Drive power for 45 kW output	1.0	0.85	1.0	W
Saturated output power	46	48	47	kW

K3284BCD in K4172 Circuit

Frequency	702 to 710 (channel 50)	774 to 782 (channel 59)	846 to 854 (channel 68)	MHz
Body current:				
with no input power	15	15	15	mA
at 45 kW c.w. output, vision frequency	90	85	100	mA
Drive power for 45 kW output	0.8	0.9	1.2	W
Saturated output power	47	46	45	kW

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

K3282BCD IN K4170 CIRCUIT, VISION AMPLIFIER

Test Conditions (Tuning and output coupling optimized at the two output power test levels stated)

Output power (see note 9)	***28***	***45***	***kW***
Bandwidth (see note 10)	8.0	8.0	MHz
Frequency range	470 to 610	470 to 610	MHz
Electro-magnet current	10.8 to 12.5	10.8 to 12.5	A
Heater voltage	8.5	8.5	V

Range of Characteristics

	Min	Max	Min	Max	
Heater current	37	46	37	46	A
Body current (see note 11)	–	150	–	150	mA
Modulating anode current	–	6.0	–	6.0	mA
R.F. drive power (see note 12)	–	1.25	–	1.25	W
Efficiency:					
frequency range 494 to 606 MHz	30	–	32	–	%
frequency range 470 to 494 MHz	30	–	30	–	%
Beam voltage (see note 13):					
frequency range 494 to 606 MHz	–	19.0	–	22.5	kV
frequency range 470 to 494 MHz	–	19.0	–	23.0	kV

K3283BCD IN K4171 CIRCUIT, VISION AMPLIFIER

Test Conditions (Tuning and output coupling optimized at the two output power test levels specified)

Output power (see note 9)	*28*	*45*	*kW*
Bandwidth (see note 10)	8.0	8.0	MHz
Frequency range	590 to 720	590 to 720	MHz
Electro-magnet current	10.8 to 12.5	10.8 to 12.5	A
Heater voltage	8.5	8.5	V

Range of Characteristics

	Min	Max	Min	Max	
Heater current	37	46	37	46	A
Body current (see note 11)	–	150	–	150	mA
Modulating anode current	–	6.0	–	6.0	mA
R.F. drive power (see note 12)	–	1.25	–	1.25	W
Efficiency:					
frequency range 590 to 650 MHz	30	–	32	–	%
frequency range 650 to 720 MHz	28	–	32	–	%
Beam voltage (see note 13):					
frequency range 590 to 650 MHz	–	19.0	–	22.5	kV
frequency range 650 to 720 MHz	–	20.0	–	22.5	kV

K3284BCD IN K4172 CIRCUIT, VISION AMPLIFIER

Test Conditions (Tuning and output coupling optimized at the two output power test levels specified)

Output power (see note 9)	*28*	*45*	*kW*
Bandwidth (see note 10)	8.0	8.0	MHz
Frequency range	700 to 860	700 to 860	MHz
Electro-magnet current	10.8 to 12.5	10.8 to 12.5	A
Heater voltage	8.5	8.5	V

Range of Characteristics

	Min	Max	Min	Max	
Heater current	37	46	37	46	A
Body current (see note 11)	–	150	–	150	mA
Modulating anode current	–	6.0	–	6.0	mA
R.F. drive power (see note 12)	–	1.25	–	1.25	W
Efficiency:					
frequency range 700 to 790 MHz	30	–	32	–	%
frequency range 790 to 860 MHz	28	–	30	–	%
Beam voltage (see note 13):					
frequency range 700 to 790 MHz	–	19.0	–	22.5	kV
frequency range 790 to 860 MHz	–	20.0	–	23.0	kV

Sound Amplifier Service

For operation at the same beam voltage as the vision amplifier and one fifth of the output power, the beam current is reduced to one fifth that of the vision amplifier klystron by means of the modulating anode. The graph on page 11 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the maximum value of the modulating anode current is 1.5 mA. The potential divider network must be designed accordingly.

NOTES

1. The K3282BCD series klystrons may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 45 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

The following conditions must be observed when operating in this mode:

(a) The B.C.D. voltage must **never** be positive with respect to cathode.

(b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to cathode.

The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.

2. For this klystron, the heater voltage should be in the range 8.0 – 8.25 V. ★ After 10 000 hours of operation, the heater voltage should be increased to be in the range 8.25 – 8.5 V.
3. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 135 inches (3.43 m) is required. This is measured to the top of the lifting harness and does not include the hoist.
4. Under T.V. picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within an electro-magnet current range of 10.8 to 12.5 A. Maximum stability is obtained by adjusting the magnet current within the above range and stabilizing to ± 2% about this optimum value.
5. Alternative cooling arrangements can be used.
6. Measured by a manometer at the input pipes to the circuit assembly.
7. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	22	kV
Beam current	6.2	A
Heater voltage	8.5	V
B.C.D. voltage	zero with respect to cathode	

The B.C.D. voltage must then be increased to −700 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 4 mA and typically will be less than 2 mA. At end-of-life, the B.C.D. current will not exceed 6 mA.

With a B.C.D.-to-cathode voltage of −700 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow better than 50% efficiency to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

★ Indicates a change.

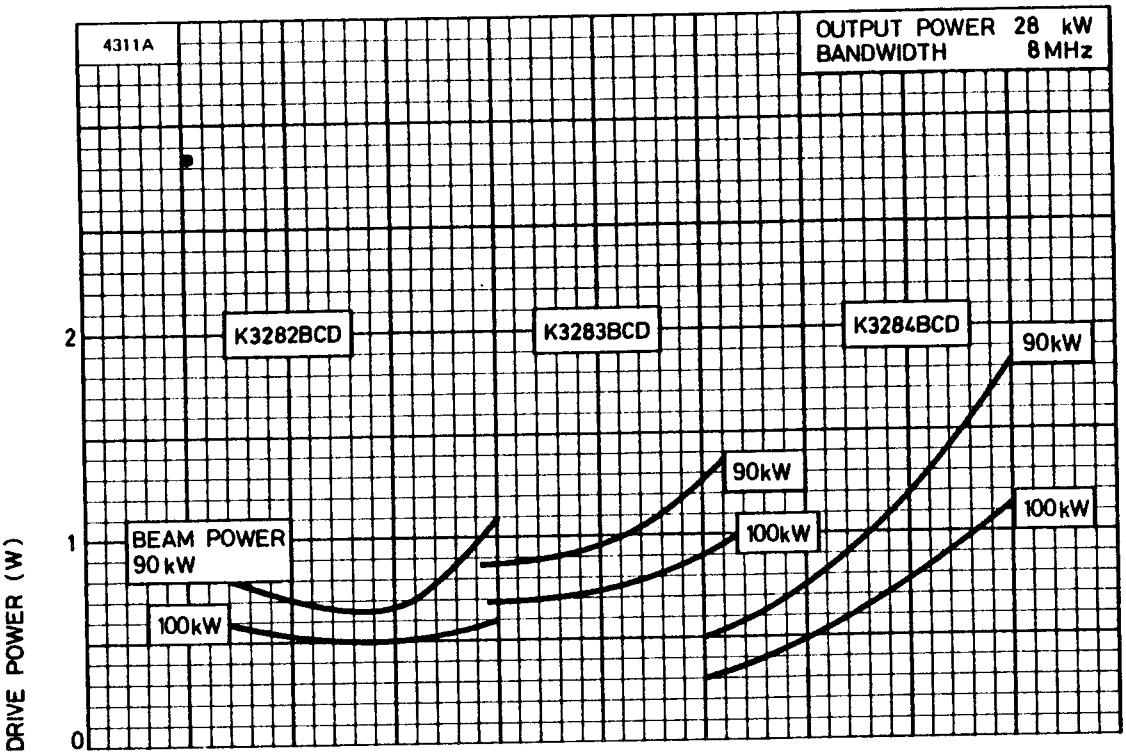
Designers of B.C.D. pulsing equipment for these klystrons are advised to allow for a B.C.D. current value of about 10 mA. Typical values of inter-electrode capacitance are:–

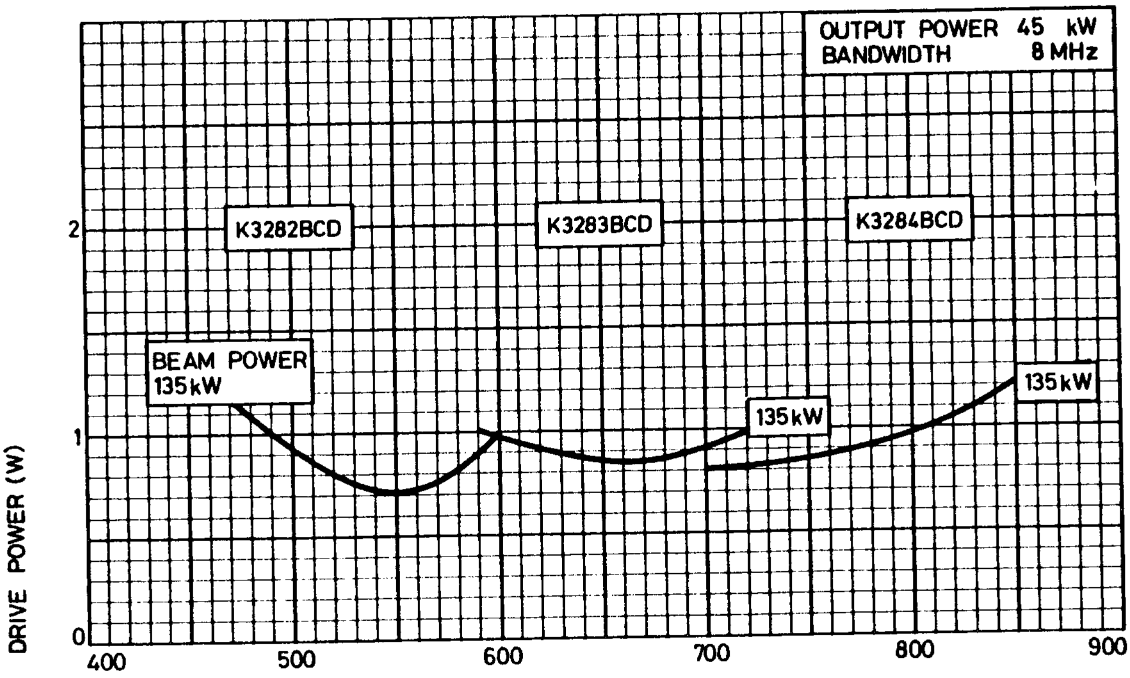
B.C.D. to cathode	75	pF
Cathode to modulating anode *(B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

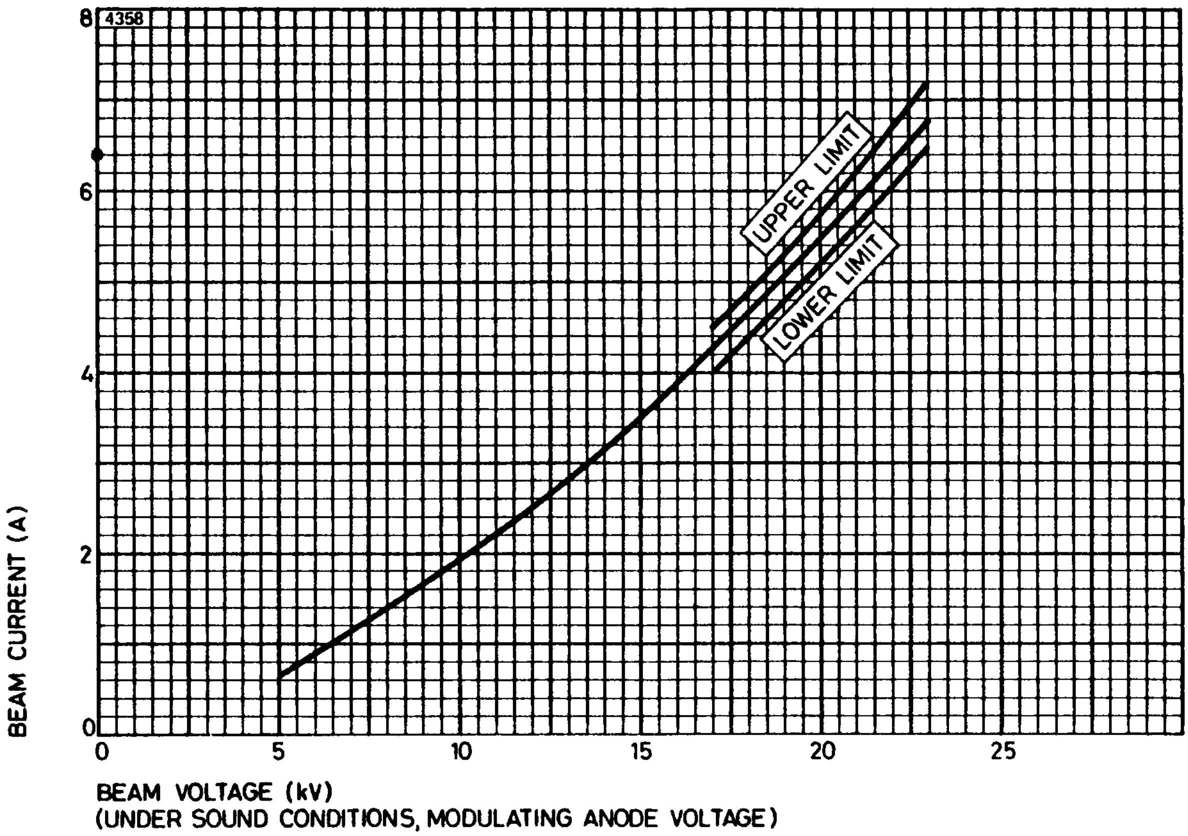
8. This applies to television service. EEV should be consulted regarding other conditions of service.
9. Input frequency set 2.75 MHz below the centre of the 8 MHz channel, and the input power and beam power adjusted to give the specified output.
10. The klystron is tuned so that, for constant input power, the variation in output power is less than 1 dB over the specified bandwidth at all power levels between −2 dB and −14 dB with respect to the specified output power.
11. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
12. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.
13. With the modulating anode connected to the body via a 10 kΩ resistor the beam current will be within ± 5% of the value given by the graph on page 11.

TYPICAL DRIVE REQUIREMENTS (klystron not BCD pulsed)

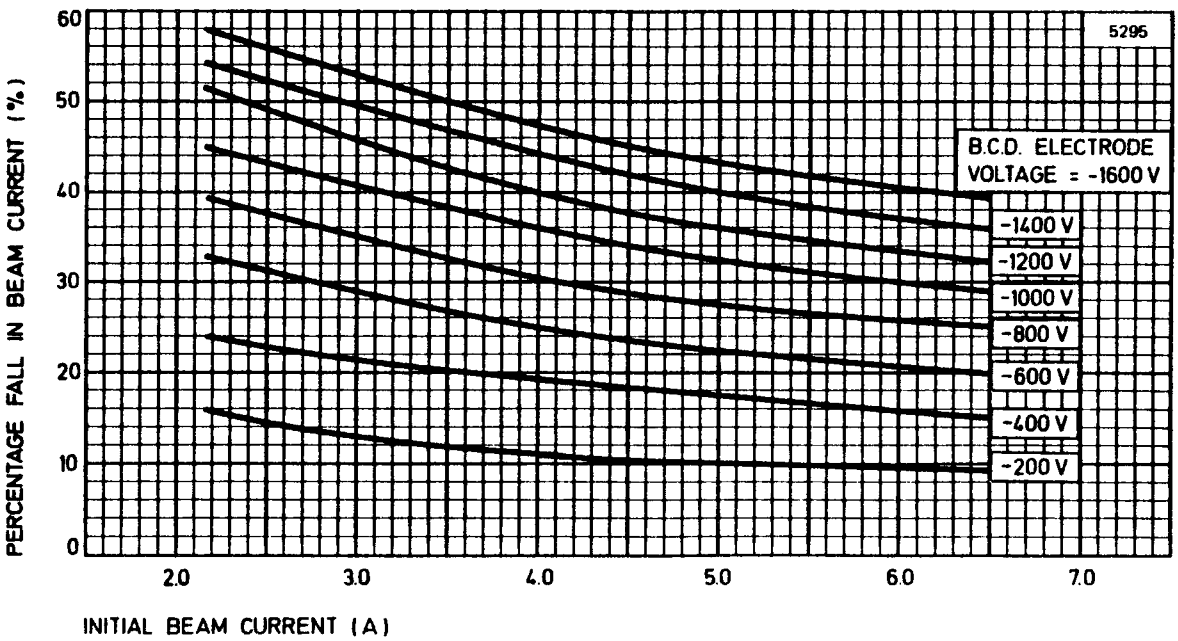




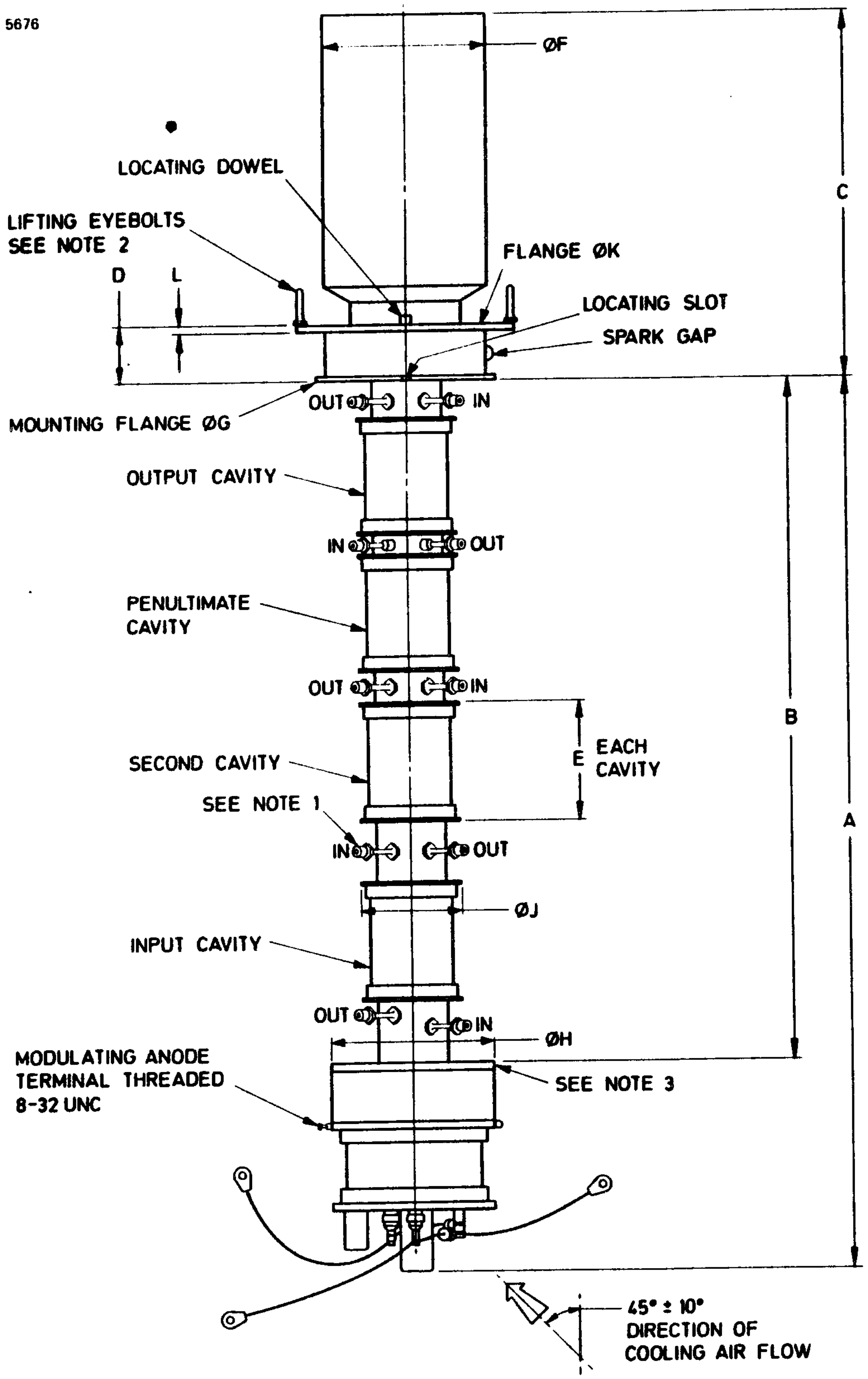
TYPICAL BEAM CHARACTERISTIC



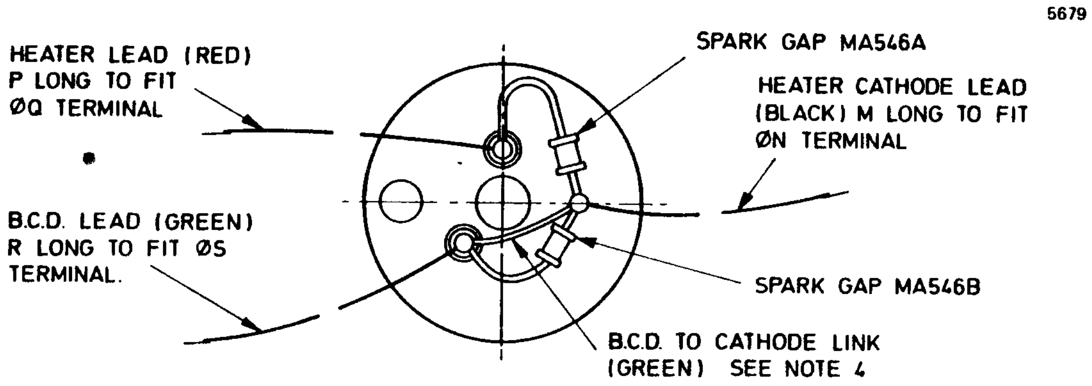
B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE FOR K3282BCD



Outline Dimensions for K3282BCD (All dimensions nominal)



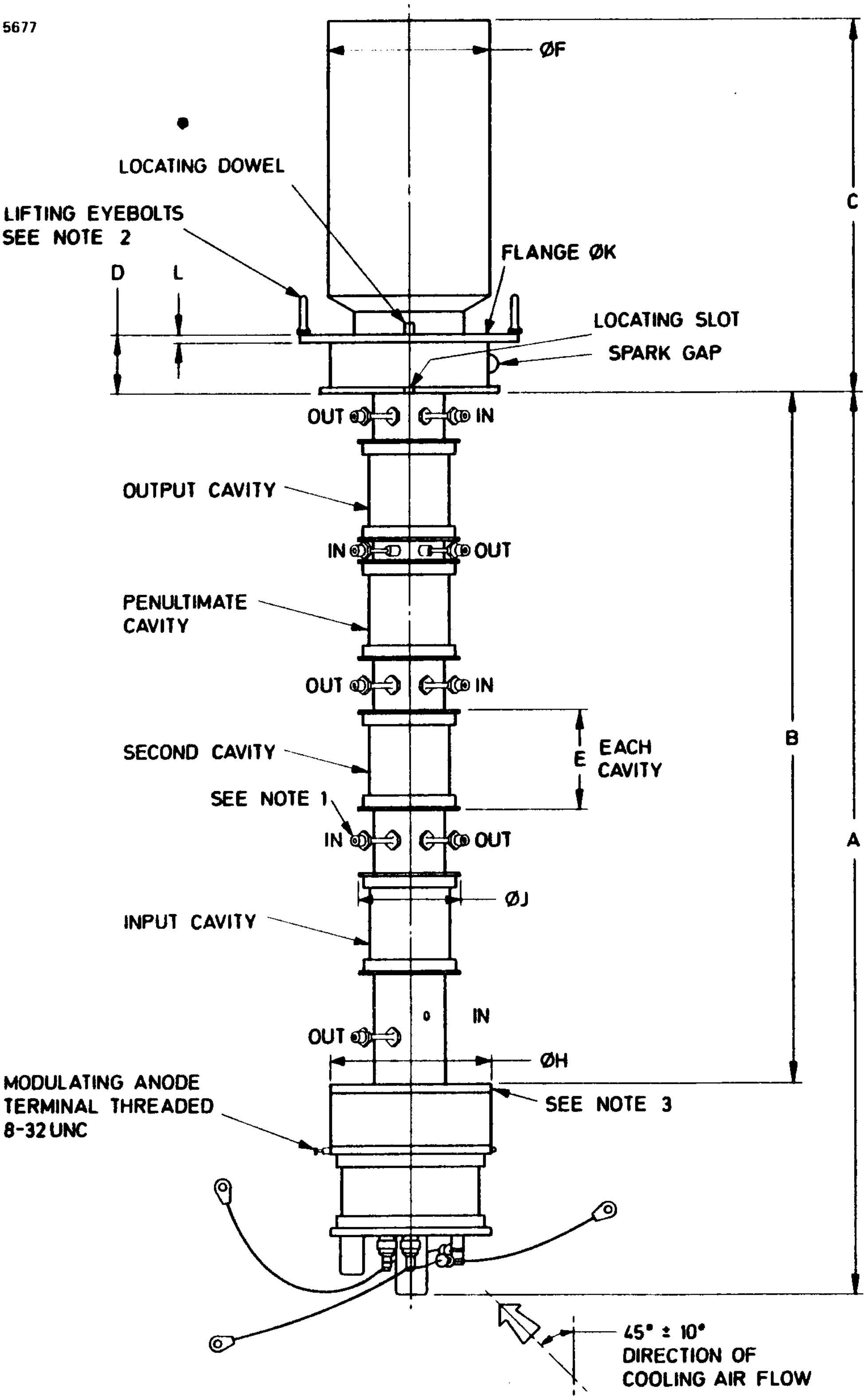
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	44.812	1138.2	K	11.125	282.6
B	34.090	865.9	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	5.990	152.1	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	5.125	130.2			

Millimetre dimensions have been derived from inches.

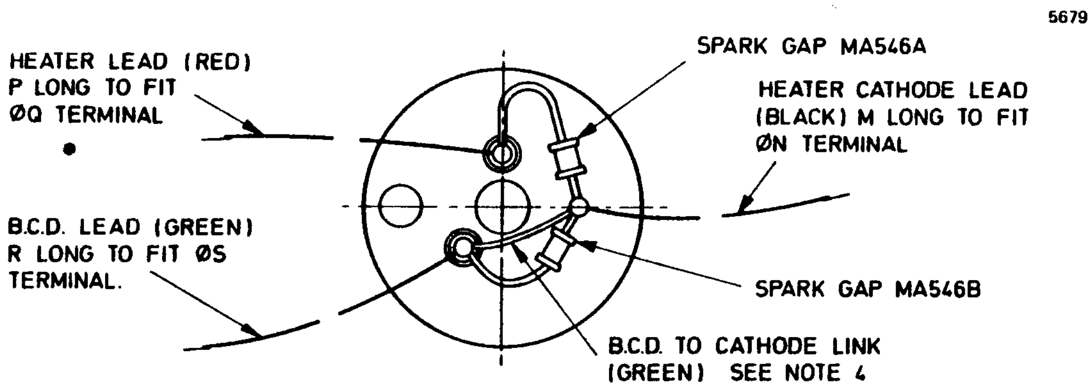
Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 26). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

OUTLINE FOR K3283BCD



Outline Dimensions for K3283BCD (All dimensions nominal)



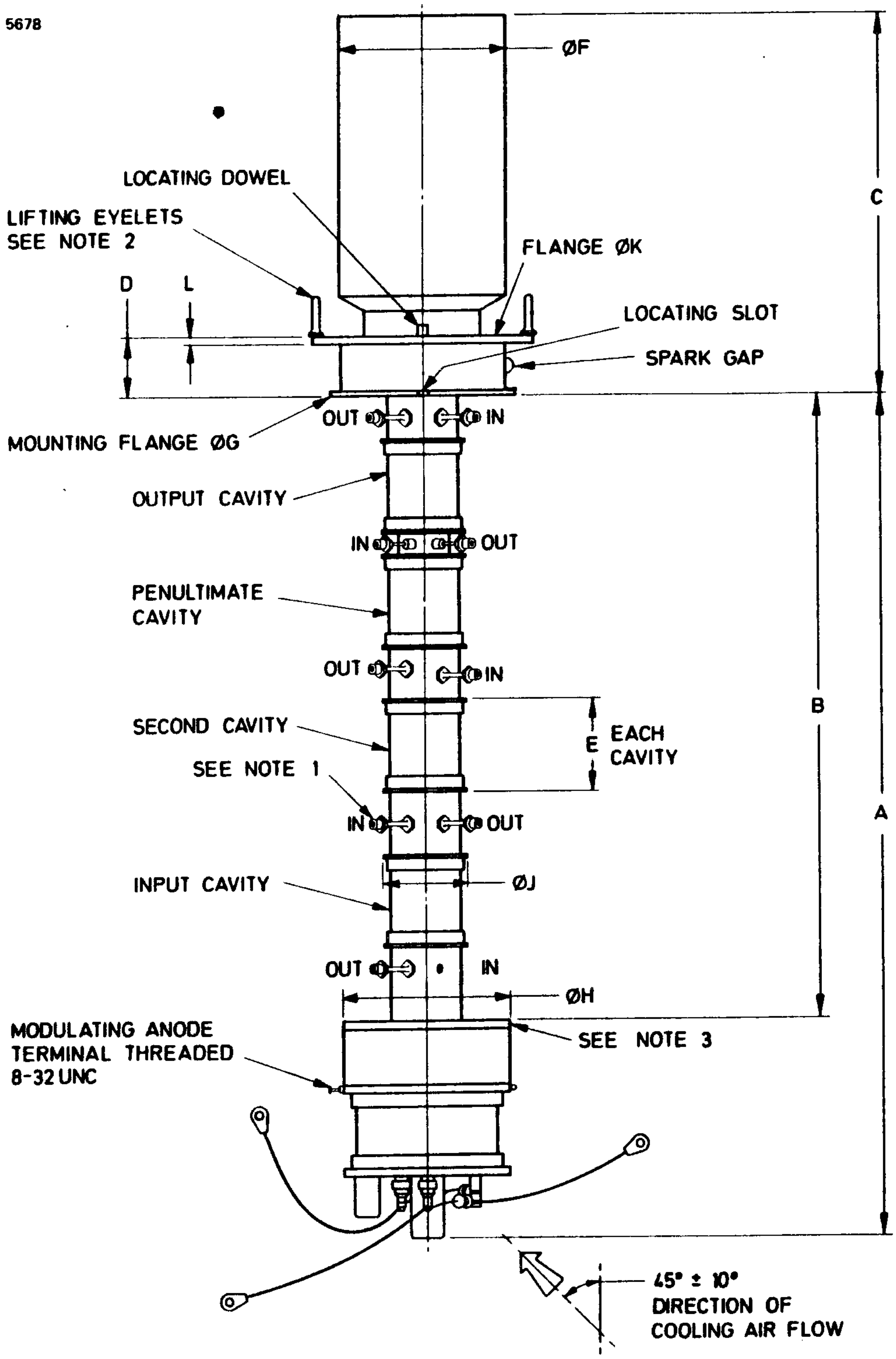
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	44.812	1138.2	K	11.125	282.6
B	34.090	865.9	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	4.990	126.7	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	5.125	130.2			

Millimetre dimensions have been derived from inches.

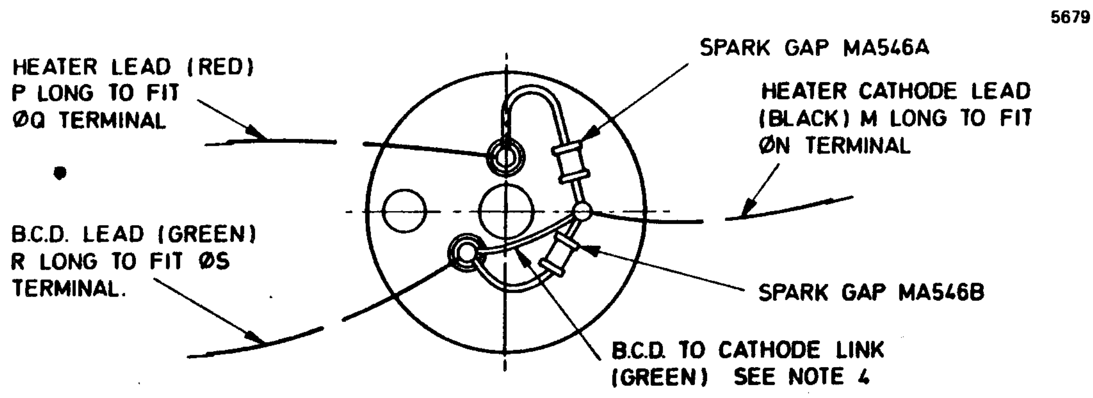
Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 26). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

OUTLINE FOR K3284BCD



Outline Dimensions for K3284BCD (All dimensions nominal)



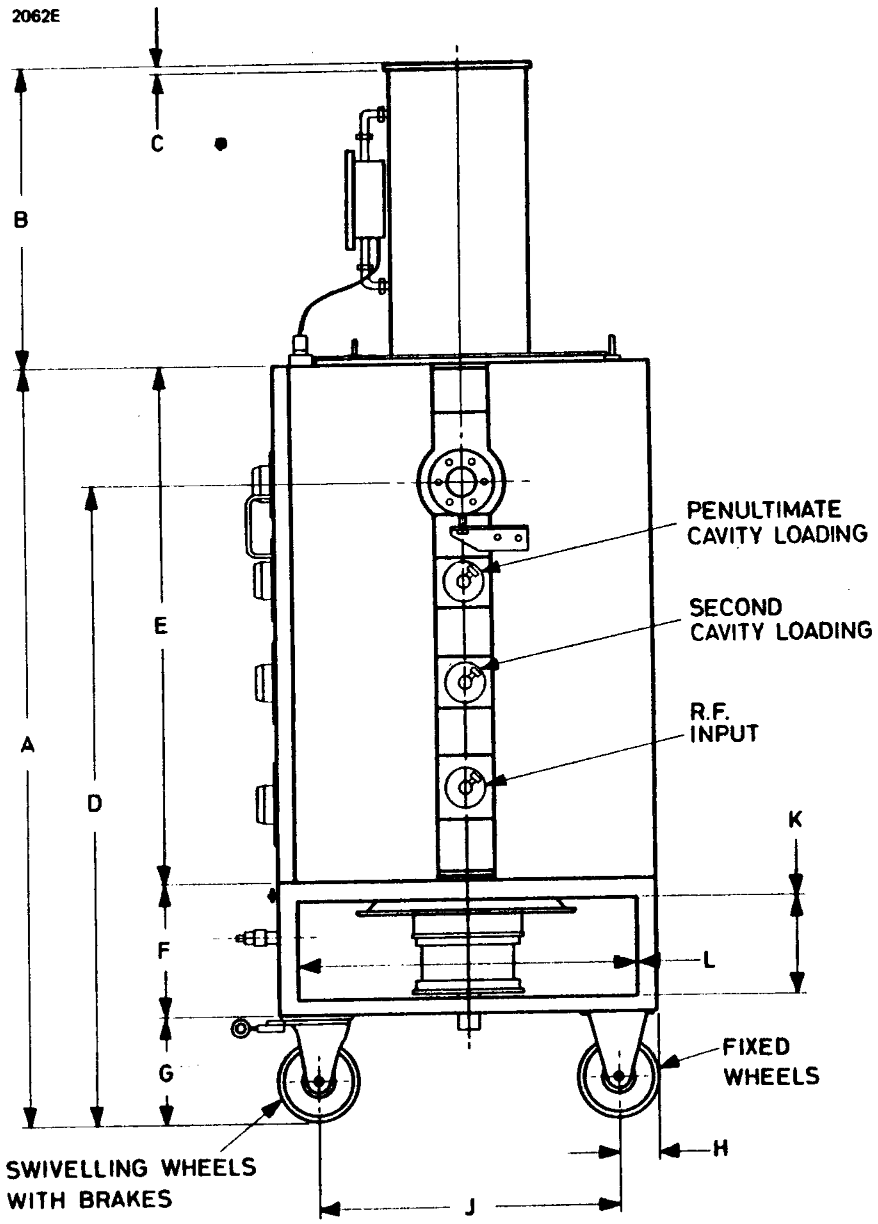
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	40.600	1031.2	K	11.125	282.6
B	29.875	758.8	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	4.490	114.0	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	4.125	104.8			

Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 26). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

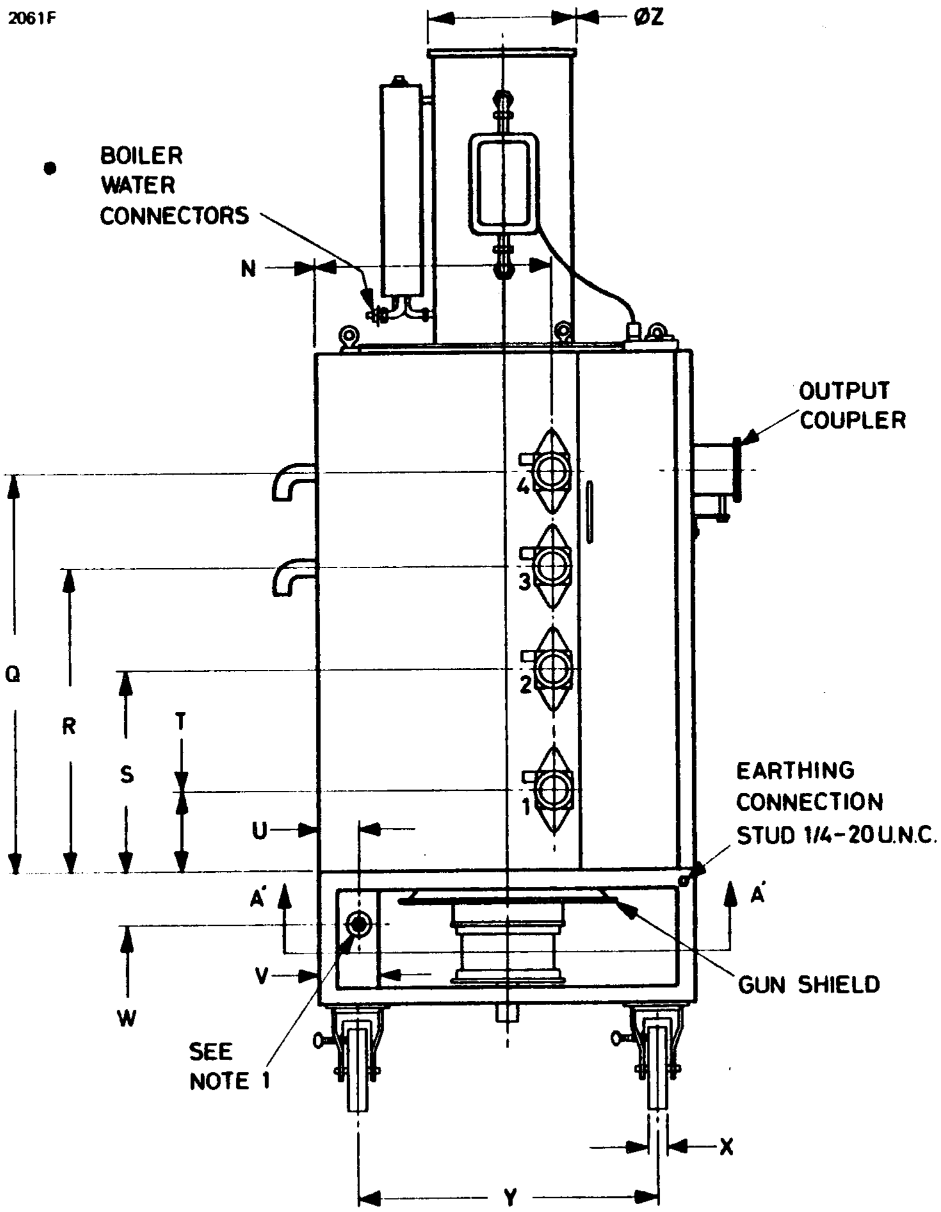
OUTLINE FOR CIRCUIT ASSEMBLIES



Note This drawing is not to scale for the K4172.

See page 21 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES



Controls

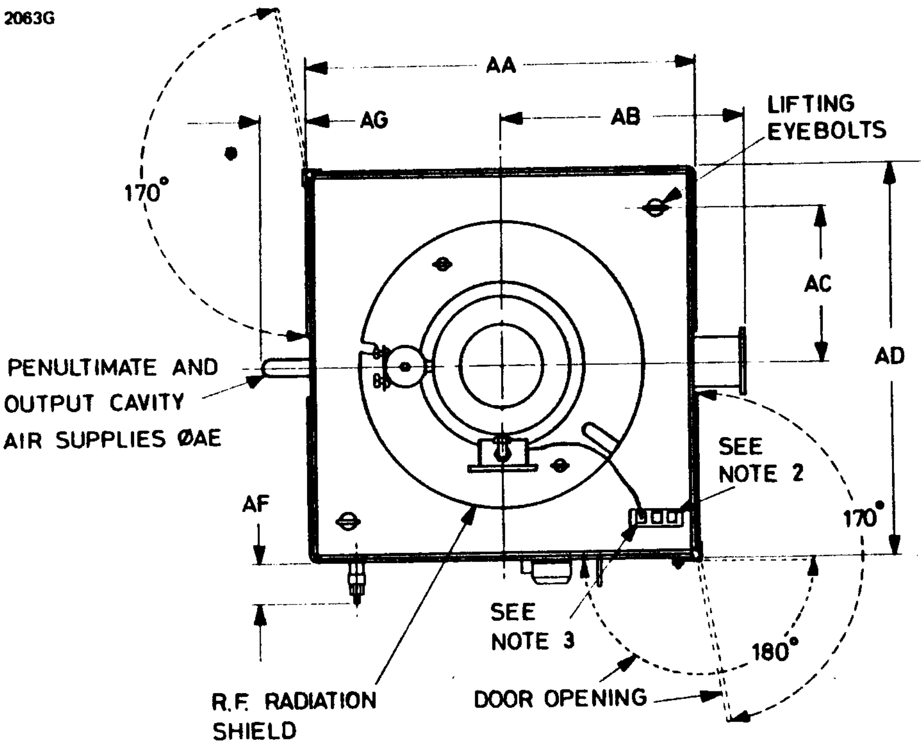
1 Input cavity tuning
2 Second cavity tuning
3 Penultimate cavity tuning
4 Output cavity tuning

Note This drawing is not to scale for the K4172.

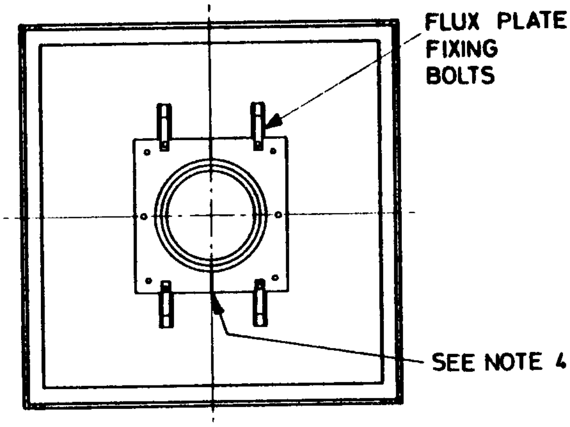
See page 21 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES

2063G



View from above



Section A'-A' with gun shield omitted showing centring plate

Outline Notes

1. Water inlet connection Hitemp Minilock Self Sealing Coupling, threaded ½-inch B.S.P.
2. Connections to external circuits; see page 24.
3. Collector and level trip socket, accepts plug wired to boiler.
4. Position of colour code band to match that of klystron.

Outline Dimensions for K4170 and K4171
(All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	• 55.125 ± 0.125	1400.2 ± 3.2	T	5.750	146.1
B	21.437 ± 0.125	554.5 ± 3.2	U	3.000 ± 0.062	76.20 ± 1.57
C	0.500	12.70	V	4.500 ± 0.062	114.3 ± 1.57
D	46.250 ± 0.250	1174.8 ± 6.4	W	3.500	88.90
E	37.813 ± 0.062	960.5 ± 1.6	X	1.750 ± 0.016	44.45 ± 0.41
F	9.688 ± 0.062	246.1 ± 1.6	Y	21.875 ± 0.125	555.6 ± 3.2
G	7.625 ± 0.062	193.7 ± 1.6	Z	11.125	282.6
H	3.500 ± 0.187	88.90 ± 4.75	AA	28.750 ± 0.125	730.3 ± 3.2
J	22.250 ± 0.062	565.2 ± 1.6	AB	15.750 max	400.1 max
K	5.688 ± 0.187	144.48 ± 4.75	AC	11.250	285.8
L	25.000 ± 0.187	635.0 ± 4.75	AD	28.750 ± 0.125	730.3 ± 3.2
N	17.500	444.5	AE	1.687	42.85
Q	28.937	735.0	AF	4.250	108.0
R	22.062	560.4	AG	2.500	63.50
S	14.562	369.9			

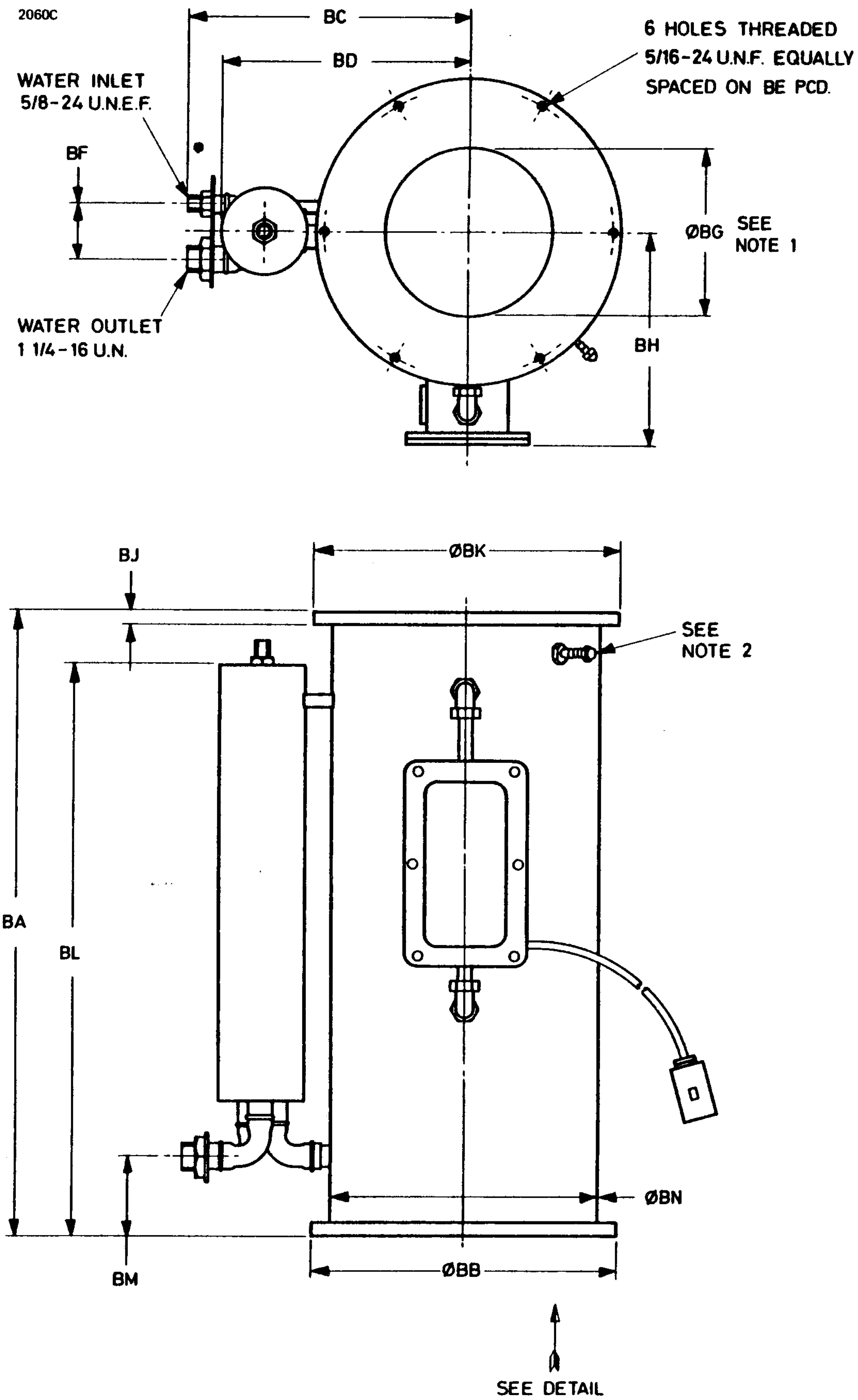
Millimetre dimensions have been derived from inches.

Outline Dimensions for K4172
(All dimensions without limits are nominal)

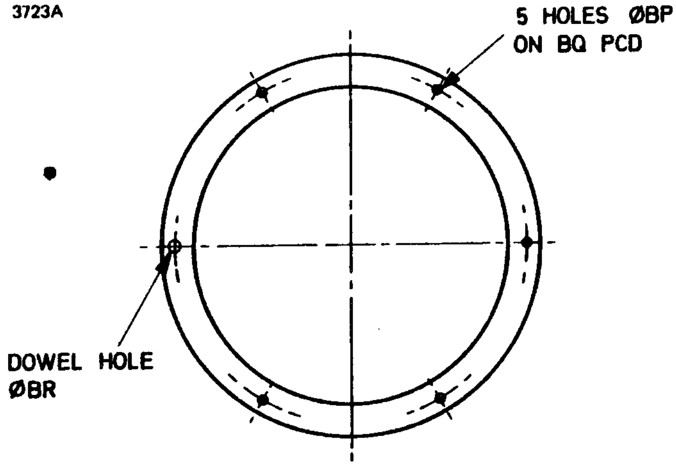
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	54.562 ± 0.125	1385.9 ± 3.2	T	5.125	130.2
B	21.437 ± 0.125	554.5 ± 3.2	U	3.000 ± 0.062	76.20 ± 1.57
C	0.500	12.70	V	4.500 ± 0.062	114.3 ± 1.57
D	46.250 ± 0.250	1174.8 ± 6.4	W	3.500	88.90
E	33.375 ± 0.062	847.7 ± 1.6	X	1.750 ± 0.016	44.45 ± 0.41
F	13.562 ± 0.062	344.5 ± 1.6	Y	21.875 ± 0.125	555.6 ± 3.2
G	7.625 ± 0.062	193.7 ± 1.6	Z	11.125	282.6
H	3.500 ± 0.187	88.90 ± 4.75	AA	28.750 ± 0.125	730.3 ± 3.2
J	22.250 ± 0.062	565.2 ± 1.6	AB	15.5 max	393.7 max
K	5.688 ± 0.187	144.48 ± 4.75	AC	11.250	285.8
L	25.000 ± 0.187	635.0 ± 4.75	AD	28.750 ± 0.125	730.3 ± 3.2
N	17.500	444.5	AE	1.687	42.85
Q	25.062	636.6	AF	4.250	108.0
R	19.562	496.9	AG	2.250	57.15
S	12.625	320.7			

Millimetre dimensions have been derived from inches.

BOILER UNIT


2060C
BC
BD
6 HOLES THREADED
5/16-24 U.N.F. EQUALLY
SPACED ON BE PCD.
WATER INLET
5/8-24 U.N.E.F.
BF
ØBG
SEE
NOTE 1
WATER OUTLET
1 1/4-16 U.N.
BH
BJ
ØBK
SEE
NOTE 2
BA
BL
ØBN
ØBB
BM
SEE DETAIL

Detail of Mounting Flange



Outline Dimensions (All dimensions without limits are nominal)

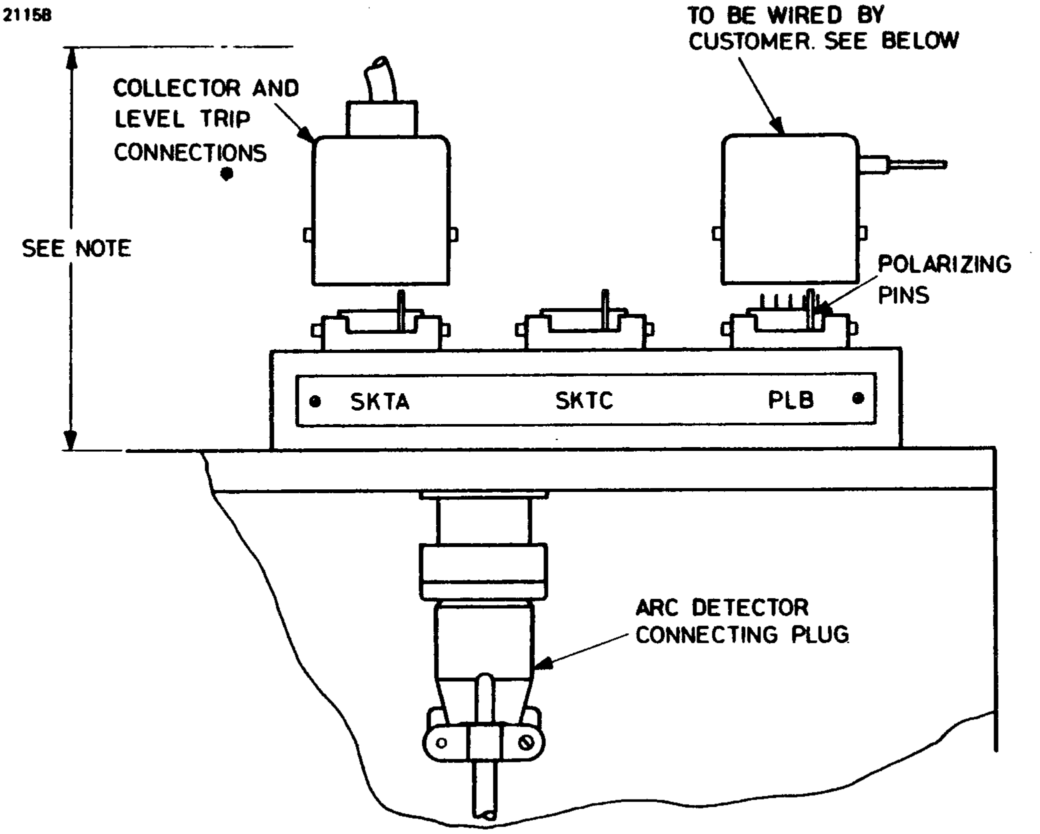
Ref	Inches	Millimetres	Ref	Inches	Millimetres
BA	22.562 ± 0.093	573.1 ± 2.4	BJ	0.500	12.70
BB	11.125 ± 0.015	282.6 ± 0.4	BK	11.125 ± 0.015	282.6 ± 0.4
BC	10.250 ± 0.125	260.4 ± 3.2	BL	20.687	525.4
BD	9.000	228.6	BM	2.937 ± 0.125	74.60 ± 3.18
BE	10.500	266.7	BN	9.750	247.7
BF	2.000 ± 0.125	50.80 ± 3.18	BP	0.312	7.92
BG	6.000	152.4	BQ	10.500	266.7
BH	7.750	196.9	BR	0.394	10.00

Millimetre dimensions have been derived from inches except dimension BR.

Outline Notes

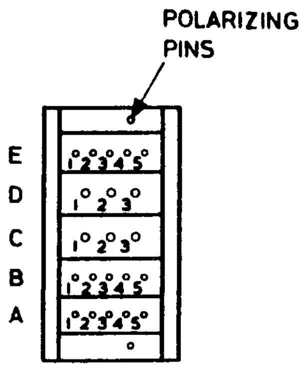
1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the siphon provided.

PLUG AND SOCKET CONNECTIONS



Input Socket Connections
(to be wired by customer)

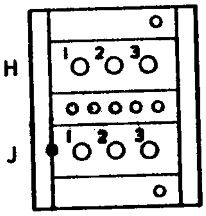
Water level trip circuit	B1, B2
Collector connection	C1
Arc detector circuit:	
photo resistor	E4, E5
bulb	E2, E3
screen and earth	E1
link	B4, B5
Focus coils:	
positive	C3
negative	D3



Input socket
View on solder connections
with cover removed

Note Clearance for connector removal 5.750 inches (146 mm) minimum.

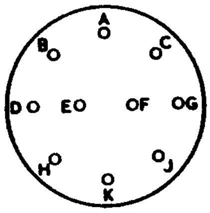
Collector Plug



2116

Pin	Element
H1	Collector
H2	–
H3	–
J1	Water level trip
J2	Water level trip
J3	–

Arc Detector Plug



Pin	Element
A	Photo resistor
B	Photo resistor
C	Bulb
D	Link
E	Screen and earth
F	Screen and earth
G	Bulb
H	Link
J	No connection
K	No connection

ITEMS SUPPLIED WITH KLYSTRON

The following parts, packed in a polythene bag, are despatched with each klystron.

Item	Quantity Supplied K3282BCD	Quantity Supplied K3283BCD or K3284BCD
Round water connecting pipes H7298A complete with one each brass nut H18952A, rubber washer MA717C and 'O' ring MA424	8	7
Flat water connecting pipes FM11369A complete with one each brass nut H18952A, rubber washer MA717C and rubber washer MA767A	2	2
Inlet water pipe assembly 25 inches long MA369	1	–
Outlet water pipe assembly 25 inches long MA370	1	1
Inlet water pipe assembly 24 inches long MA387	–	1
Boiler 'O' ring MA431	1	1
¼–20 U.N.C. boiler bolts MWX161 with plain washer DWP004	6	6
Knurled spanner FMP11690B for flat water connecting pipes	1	1
R.F. radiation shield sealing gasket MA716A	1	1
Spare rubber washers MA717C	2	2
Spare rubber washers MA767A	2	2
Spare 'O' rings MA424	2	2
Spare rubber washer MA766A	1	1
Flux plates MA534A (see note)	1	1

Note A pair of new flux plates, colour coded to match the klystron, is supplied and **must** be installed with the klystron.

CIRCUIT ASSEMBLY COMPONENT LIST

Item	Quantity	Type number K4170	K4171	K4172
Magnet frame	1	MA500D	MA500D	MA503B
Input cavity	1	MA88E	MA76A	MA200
Second cavity	1	MA88H	MA77A	MA200
Third cavity	1	MA88A	MA78A	MA200A
Output cavity	1	MA89A	MA75A	MA200B
Output coupler	1	MA83D	MA83E	MA83E
Boiler	1	MA423	MA423	MA423
Air pipe	2	MA697A	MA697B	MA697B
Radiation shield	1	MA308	MA308	MA308
Gun shield	1	MA354	MA354	MA354
Water pipes	4	MA230	MA231	MA295
Input loop	1	MA505B	MA505C	MA505D
Second cavity loop	1	MA505A	MA505C	MA505D
Penultimate cavity loop	1	MA505A	MA505C	MA505D
Complete anode connector assembly	1	FM15253A	FM15253A	FM15253A
Connecting stems	4	MA784A	MA784C	MA784B
Coupler support bracket	1	H7426A	H7426A	H7426A
Tool kit	1	MA666A	MA666A	MA666A

ASSEMBLY STAND

An assembly stand type MA492A is available to order, for use when fitting the water connections and cavities to the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K3282BCD series klystrons have white, unmarked, aluminium oxide ceramics in all cavities. However, on a few tubes the third and output cavity ceramics may be made of **beryllium oxide**; these ceramics are **coloured blue, or marked with a black line.**

Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics; if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

English Electric Valve Company Limited
Chelmsford, Essex, England

Printed in England

K3382BCD K3383BCD K3384BCD

HIGH POWER AMPLIFIER KLYSTRONS FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacements for K3382 Series klystrons featuring:

- **Beam Control Device (B.C.D.)** A rugged beam current control electrode allows beam current reduction during picture information.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **High Efficiency** With appropriate correction, efficiencies greater than 60% can be achieved by beam pulsing at 58 kW output. 38.5% minimum sync. efficiency at 58 kW output in standard operational mode.
- **Output Power** 58 kW output in vision amplifier service.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Bandwidth** 8 MHz between 1 dB points over the tuning range.
- **High Stability** Water cooled body and air blown cavities ensure high operational stability.
- **Simple, Efficient Vapour Cooling** A single water supply of 9 litres/minute cools both body and collector. Cold-weir type boiler.
- **Simple Tube Exchange** Pre-adjusted cavities and loops in circuit assembly. Settings not upset by tube exchange.

DESCRIPTION

The K3382BCD, K3383BCD and K3384BCD are four-cavity amplifier klystrons for use in the output stages of sound and vision transmitters in u.h.f. television service. The three tubes operate in the frequency bands 470–590 MHz, 590–702 MHz and 702–860 MHz respectively.

A rugged beam current control electrode allows the beam current to be reduced during the picture region of the video waveform. Optimum efficiency can be achieved by biasing the modulating anode to set the sync. level perveance and by pulsing the B.C.D. electrode voltage (see note 1).

The klystrons can be operated conventionally by making a simple external connection which ensures that the B.C.D. electrode remains at cathode potential.

February 1986
Supersedes January 1985 Issue

The modulating anode enables the klystrons to operate at lower power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

The tubes are electro-magnetically focused and their associated circuit assemblies are designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing either the tuning or the loading loop settings, so that the replacement klystron is coarse-tuned at switch-on and requires only a trimming adjustment to meet the full transmission specification.

The klystron body is water cooled and for best stability the water inlet temperature should be stabilized. The klystron collector is vapour cooled in a cold-weir type boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied). The boiler is fitted with a visual water level indicator and a fail-safe electric low water level alarm sensor.

The electron gun and the output and penultimate cavities require forced-air cooling; suitable air ducts are provided for the cavities. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

ABRIDGED DATA

Klystron	Frequency Range	European Channel Numbers	Circuit Assembly
K3382BCD	470 to 590 MHz	21 to 35	K4170
K3383BCD	590 to 702 MHz	36 to 49	K4171
K3384BCD	702 to 860 MHz	50 to 68	K4172

The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

Output power at klystron flange	58	kW
Power gain (typical):		
K3382BCD, K3383BCD	41	dB
K3384BCD	40	dB
Beam voltage:		
K3382BCD, K3383BCD	23.5	kV
K3384BCD	24	kV
Output	3⅛ inch 50 Ω coaxial line	
Cooling (see page 4)	vapour, water and forced-air	

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage (see note 2)	8.25 ± 3% V	★
Heater current range	35 to 46 A	★
Heater starting current (peak)	200 A max	
Cathode pre-heating time	5 minutes	

Mechanical

Overall length (see note 3):

K3382BCD, K3383BCD	63.75 inches (161.9 cm) max
K3384BCD	59.5 inches (151.1 cm) max
Overall diameter	11.125 inches (283 mm) nom
Mounting position	vertical, collector end up

Net weight of klystron:

K3382BCD, K3383BCD	210 pounds (95 kg) approx
K3384BCD	155 pounds (70 kg) approx

Circuit Assembly

Electro-magnet current, stabilized to ± 2% (see note 4) . . . 10.8 A min; 12.5 A max

Electro-magnet resistance:	K4170	K4171	K4172	
cold (20 °C)	9.5 ± 1	9.0 ± 1	8.5 ± 1	Ω
hot (20 °C ambient)	13	13	12	Ω max
hot (45 °C ambient)	14	14	13	Ω max

R.F. input connector	type N coaxial
R.F. output	3⅛ inch 50 Ω coaxial line

Net weight of tuning cavities:

K4170 (for K3382BCD)	120 pounds (54 kg) approx
K4171 (for K3383BCD)	90 pounds (41 kg) approx
K4172 (for K3384BCD)	70 pounds (32 kg) approx

Total lifting weight of klystron, cavities, boiler and mounting collar:

K3382BCD	440 pounds (200 kg) approx
K3383BCD	410 pounds (186 kg) approx
K3384BCD	335 pounds (152 kg) approx
Net weight of magnet assembly	1150 pounds (523 kg) approx

EEV arc detector type MA257 is fitted to the output cavity. See pages 26 and 27 for connection details.

★ Indicates a change.

Cooling

Volume of steam produced by collector dissipation		1.5	ft³/min/kW
		0.043	m³/min/kW
Volume of water converted to steam		0.006	imp. gal/min/kW
		0.027	litre/min/kW
Inlet water flow to body and collector in series (see note 5)		2.0	imp. gal/min
		9.0	litre/min
Body pressure drop at 2.0 imp. gal/min		28	lb/in²
		2.0	kg/cm²
Inlet water temperature		80	°C max
Inlet air temperature	40	50	°C max
Air flow to penultimate and output cavities	50	55	ft³/min each
	1.42	1.6	m³/min each
Static pressure head (see note 6)	2.0	2.4	inch water gauge
	51	61	mm water gauge
Air flow to electron gun	5.0	6.0	ft³/min
	0.142	0.17	m³/min

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5 s.

Beam voltage:		
continuous	24	kV max
switch-on surge (up to 8500 ft altitude)	30	kV max
Beam current (mean)	7.0	A max
B.C.D. voltage (relative to cathode) (see note 1)	−2.0	kV max
B.C.D. current (see note 7)	4.0	mA max
Body current	150	mA max
Output power (see note 8)	65	kW max
Collector dissipation	170	kW max
Load v.s.w.r. (see note 9)	1.5:1	max
Temperature of any external part of the klystron must not exceed	175	°C max

TYPICAL OPERATION (Vision amplifier)

Operating Conditions (B.C.D. Electrode connected to cathode)

Cathode voltage:		
K3382BCD, K3383BCD	−23.5	kV
K3384BCD	−24.0	kV
Modulating anode voltage (with respect to cathode)	21.5	kV
Beam current:		
K3382BCD, K3383BCD	6.15	A
K3384BCD	6.0	A
Electro-magnet current	12.0	A
Bandwidth (to 1 dB points) (see note 10)	8.0	MHz

Typical Performance

K3382BCD in K4170 Circuit

Frequency	470−478	526−534	582−590	MHz
European channel	21	28	35	
Saturated output power	63	64	63	kW
Sync. output power	58	58	58	kW
Body current:				
with no r.f. input power	15	15	15	mA
black level + sync. (58 kW)	65	60	55	mA
Drive power (sync.)	3.5	3.5	4.0	W
Linearity (see note 11)	60	60	60	%
Differential gain (see note 12)	70	70	70	%
Differential phase (see note 13)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	44	44	44	%

Continued on page 6

Typical Performance – continued

K3383BCD in K4171 Circuit

Frequency	590–598	646–654	694–702	MHz
European channel	36	43	49	
Saturated output power	63	63	63	kW
Sync. output power	58	58	58	kW
Body current:				
with no r.f. input power	15	15	15	mA
black level + sync. (58 kW)	55	60	65	mA
Drive power (sync.)	3.0	3.0	3.5	W
Linearity (see note 11)	60	60	60	%
Differential gain (see note 12)	70	70	70	%
Differential phase (see note 13)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	44	44	44	%

K3384BCD in K4172 Circuit

Frequency	702–710	774–782	846–854	MHz
European channel	50	59	68	
Saturated output power	62	62	62	kW
Sync. output power	58	58	58	kW
Body current:				
with no r.f. input power	20	20	20	mA
black level + sync. (58 kW)	85	87	90	mA
Drive power (sync.)	3.5	4.5	5.0	W
Linearity (see note 11)	60	60	60	%
Differential gain (see note 12)	70	70	70	%
Differential phase (see note 13)	6	6	6	deg
Sync. efficiency	40	40	40	%
Saturated efficiency	43	43	43	%

PERFORMANCE SPECIFICATION

This specification covers use of the klystron with peak sync. vision output power of 58 kW at the klystron flange and as a sound amplifier with 5.8 kW output. In both cases the B.C.D.. electrode is assumed to be connected to cathode.

GENERAL SPECIFICATION

The following are the test conditions common to vision or sound operation.

Heater voltage	8.5 ± 3%	V
Heater current	37 to 46	A

VISION SERVICE

Test Conditions

Peak sync. power at klystron flange (see note 8)	58	kW
Bandwidth		see note 10

Range of Characteristics

	Min	Max	
Efficiency (sync.)	38.5	–	%
Beam power	–	150	kW
Cathode voltage taps	22	24	kV
Modulating anode voltage (with respect to cathode)	20	24	kV
Beam current	–	7.0	A
Modulating anode current	–	6.0	mA
Body current (see note 14)	–	150	mA
Body current (see note 15)	–	50	mA
R.F. drive power (see note 16)	–	6.0	W
Linearity (see note 11)	50	–	%
Differential gain (see note 12)	65	–	%
Differential phase (see note 13)	–	10	degrees
A.M. noise (see note 17)	–	−60	dB
R.F. radiation (see note 18)	–	10	mW/cm^2
X-radiation (see note 19)	–	5	mR/hr

SOUND SERVICE

Test Conditions

Output power	5.8	kW
Modulating anode voltage (nominal) relative to cathode potential (see note 20)	5.5	kV

Range of Characteristics

	Min	Max	
Beam voltage	–	24.0	kV
Beam current (see note 20)	–	0.75	A
Body current (see note 21)	–	50	mA
Efficiency (see note 22)	27	–	%
R.F. drive power (see note 16)	–	2.0	W

NOTES

1. The K3382BCD series klystrons may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 58 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

   The following conditions must be observed when operating in this mode:

   (a) The B.C.D. voltage must **never** be positive with respect to cathode.

   (b) The B.C.D. voltage must **not** exceed −2.0 kV with respect to cathode.

   The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph.
2. For this klystron, the heater voltage should be in the range 8.0 – 8.25 V. ★ After 10 000 hours of operation, the heater voltage should be increased to be in the range 8.25 – 8.5 V.
3. To lift the klystron clear of the circuit assembly, using the lifting harness provided, a total height of 135 inches (3.43 m) is required. This is measured to the top of the lifting harness and does not include the hoist.
4. Under TV picture conditions (black level + sync. pulses) the klystron will focus satisfactorily within an electro-magnet current range of 10.8 to 12.5 A. Maximum stability is obtained by adjusting the magnet current within the above range and stabilizing it to ± 2% about this optimum value.

★ Indicates a change.

5. Alternative cooling arrangements can be used.
6. Measured by a manometer at the input pipes to the circuit assembly.
7. To establish the B.C.D. current, the klystron must be operated undisturbed for a period of **one hour** under the following conditions.

Beam voltage	24	kV
Beam current	6.0	A
Heater voltage	8.5	V
B.C.D. voltage	zero with respect to cathode	

The B.C.D. voltage must then be increased to −700 V with respect to cathode. The B.C.D. current on a new klystron will not exceed 4 mA and typically will be less than 2 mA. At end-of-life, the B.C.D. current will not exceed 6 mA.

With a B.C.D.-to-cathode voltage of −700 V, a beam current reduction of about 25% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow better than 60% efficiency to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Designers of B.C.D. pulsing equipment for these klystrons are advised to allow for a B.C.D. current value of about 10 mA. Typical values of inter-electrode capacitance are:–

B.C.D. to cathode	75	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

8. The tube may be operated at up to 65 kW peak sync. for test purposes only at 110% of rated transmitter output power.
9. This applies to television service. EEV should be consulted regarding other conditions of service.

10. **Bandwidth** The klystron can be tuned to any vision carrier frequency within the stated frequency range.

Then at a power output corresponding to black level it will produce an output having a -1 dB bandwidth from (f_0 -2) MHz to (f_0 $+6$) MHz. Over this bandwidth and when driven by a u.h.f. swept frequency signal, the output power will remain within the limits $\pm$ 1 dB as the swept input level is varied from white to peak sync. In the frequency range (f_0 $-$ 1) MHz to (f_0 + 5) MHz the output power will remain within the limits $\pm$ 0.5 dB as the swept input level is varied from white to black levels.

The amplitude/frequency response, as measured using a Marconi Instruments Ltd. UHF Sideband Analyser (or other approved instrument) will be that shown on page 12. The following conditions apply:

(a) There will be no vestigial sideband filter in circuit.

(b) The depth of modulation is 10% (single amplitude peak).

(c) The specification set-up levels are 30%, 48% and 66% on the output waveform.

The frequency response 'step' shown on page 12 occurs over the frequency region where both upper and lower sidebands are present (see EEV Technical Publication 'Klystron Amplifiers for Television Applications').

11. **Linearity** The klystron, when operating at the appropriate peak sync. output level, will be driven with a video test waveform consisting of a 10-step staircase from black level to peak white occurring on each line.

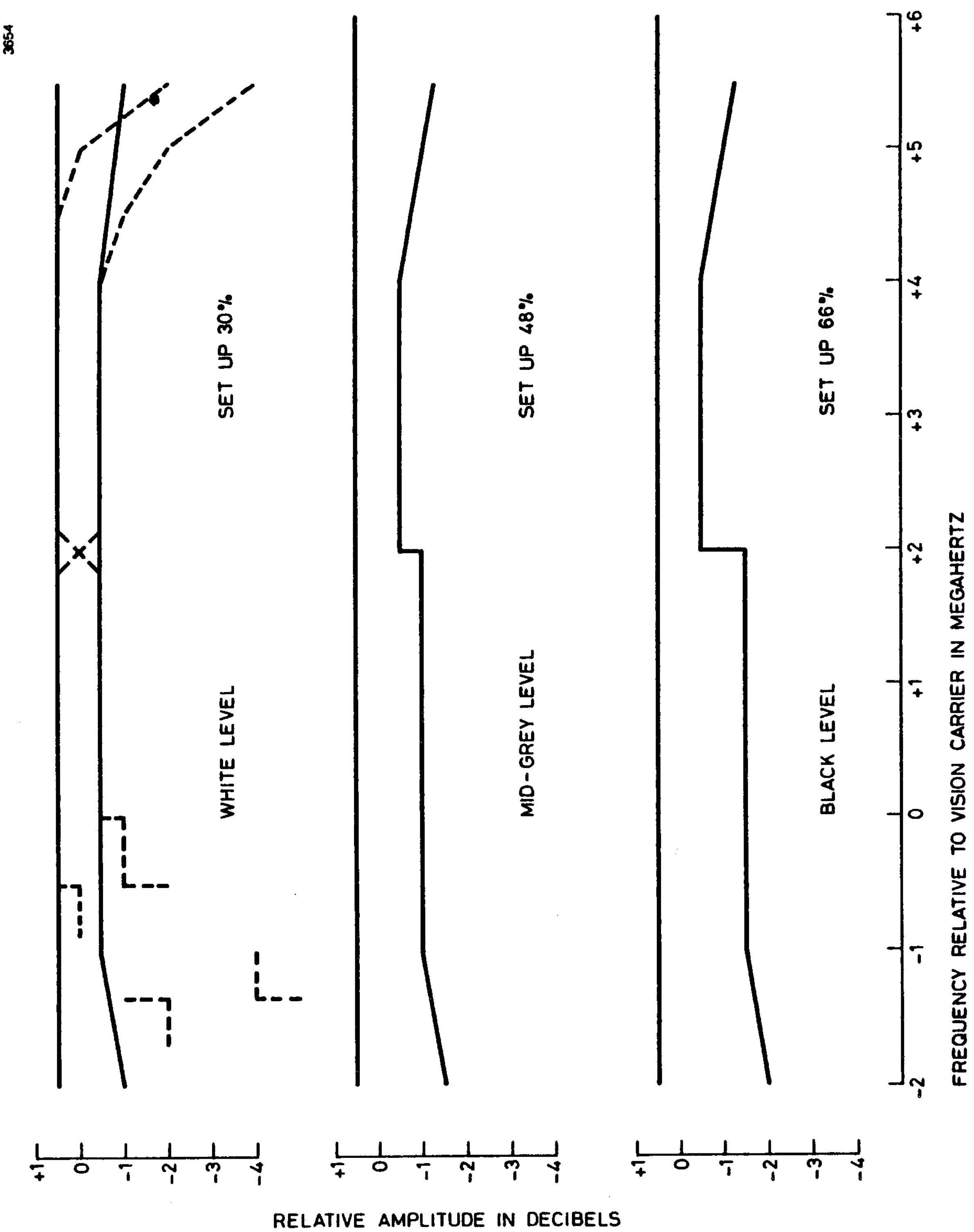
The ratio of the minimum step amplitude to the maximum step amplitude measured at the output of the klystron is the definition of linearity. For this test the klystron will deliver into its output transmission line, correctly terminated, an envelope waveform with amplitudes as follows:

Black level signal	76% amplitude of rated carrier at sync.
Peak white signal	20% amplitude of rated carrier at sync.

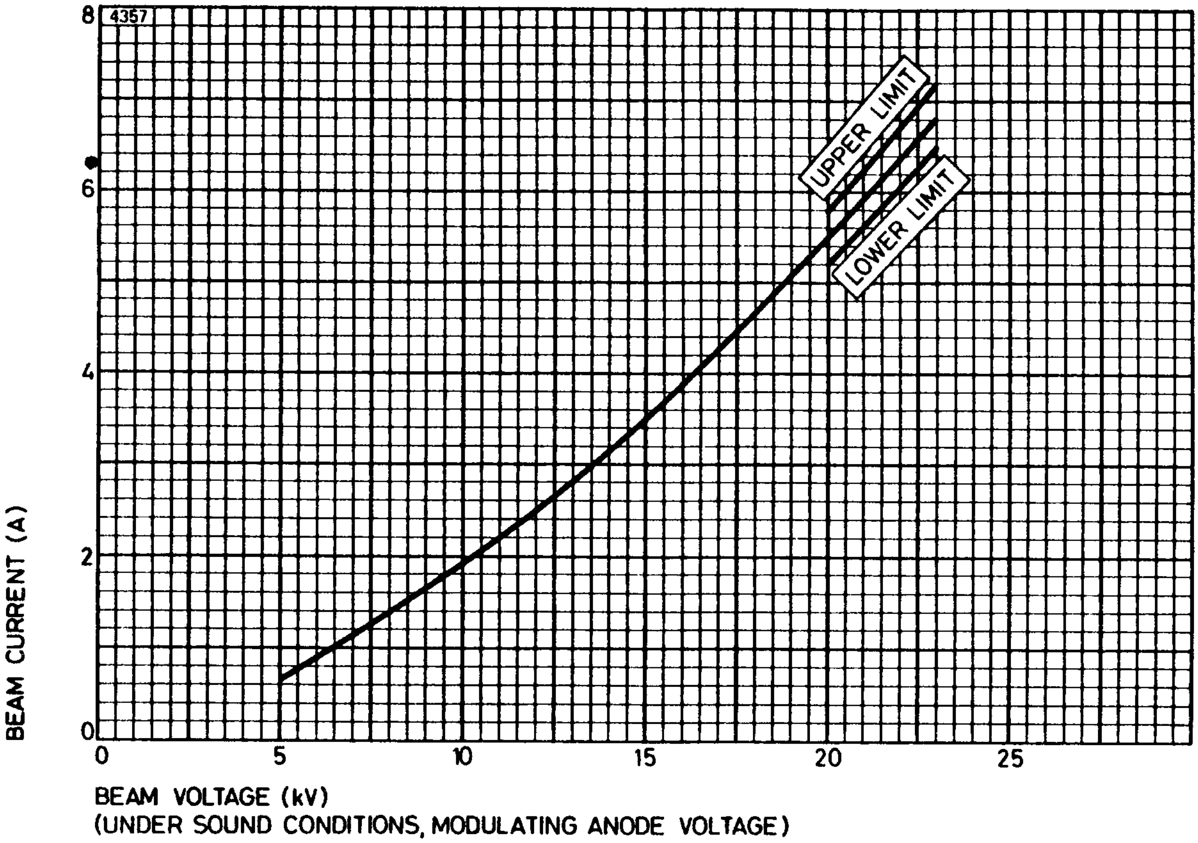
12. **Differential Gain** With a test waveform as that described in note 11 but with sine waves of 4.43 MHz and 10% (peak-to-peak of the maximum carrier) amplitude superimposed on each step of the staircase from black level to peak white, the ratio of the minimum to maximum amplitude of the sine wave, after passing the demodulated waveform at the output of the klystron through a suitable bandpass filter is the definition of differential gain.

13. **Differential Phase** With a test waveform as that described in note 11 but with sine waves of 4.43 MHz and 10% (peak-to-peak of the maximum carrier) amplitude superimposed on each step of the staircase from black level to white level, the phase difference between the phase of the 4.43 MHz signal on the white level step and that on the black level step is the definition of differential phase.
14. The combined body current of one sound and one vision klystron will not exceed this value.
15. The body current of one sound and one vision klystron in the absence of r.f. drive.
16. Defined as the power measured into a matched load substituted for the input cavity of the klystron.
17. There shall be no random or periodic noise generated within the klystron having a level greater than that stated, measured as a peak-to-peak voltage referred to the rectified level of the peak sync. signal. The focus current shall be adjusted for minimum noise. The level stated shall be maintained over a range of ±2% of this optimum focus current value.
18. The radiation will not exceed the stated level at a distance of 300 mm (11.8 inches) from the klystron or circuit assembly. The measurement is to be performed with an isotropic r.f. radiation monitor such as the Narda Model 8300 with a hand-held isotropic probe such as the model 8321.
19. With the klystron operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission will not exceed the stated level at a distance of 300 mm (11.8 inches) from the klystron or circuit assembly.
20. For operation at the same beam voltage as the vision amplifier and one tenth of the vision output power, the beam current is reduced by means of the modulating anode. The graph on page 13 shows approximately the modulating anode voltage required for a given beam current. Under these conditions the maximum value of the modulating anode current is 1.5 mA. The potential divider network must be designed accordingly.
21. The current stated applies to a single sound klystron only.
22. Minimum efficiency for the output power stated.

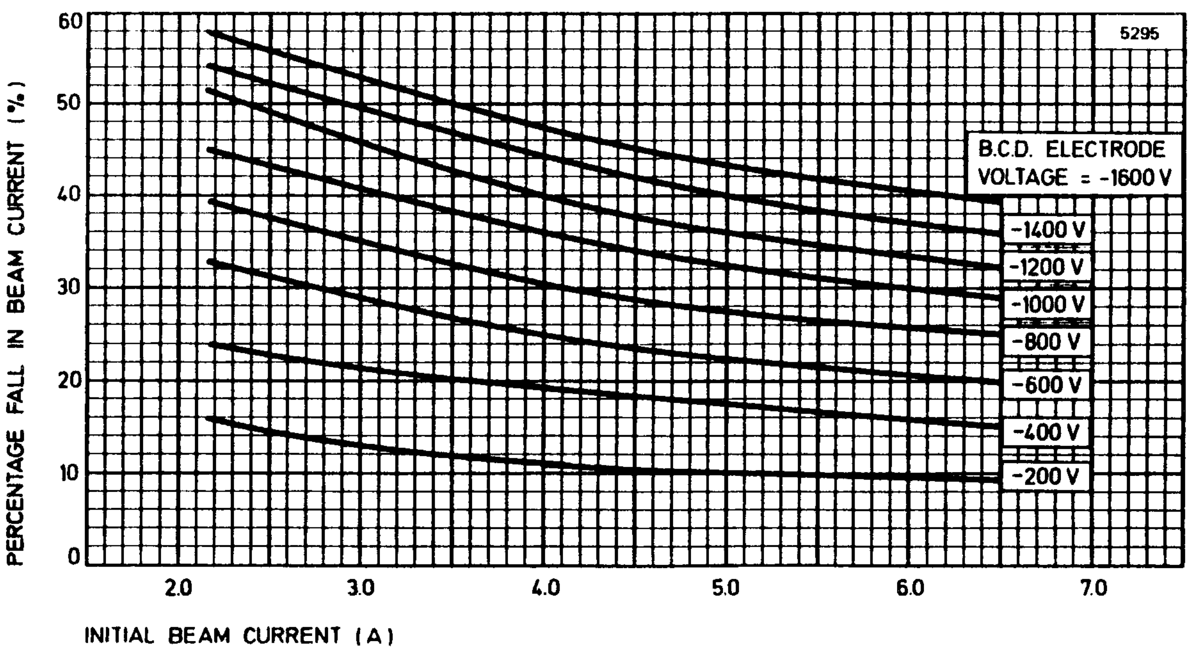
VISION AMPLIFIER KLYSTRON FREQUENCY RESPONSE



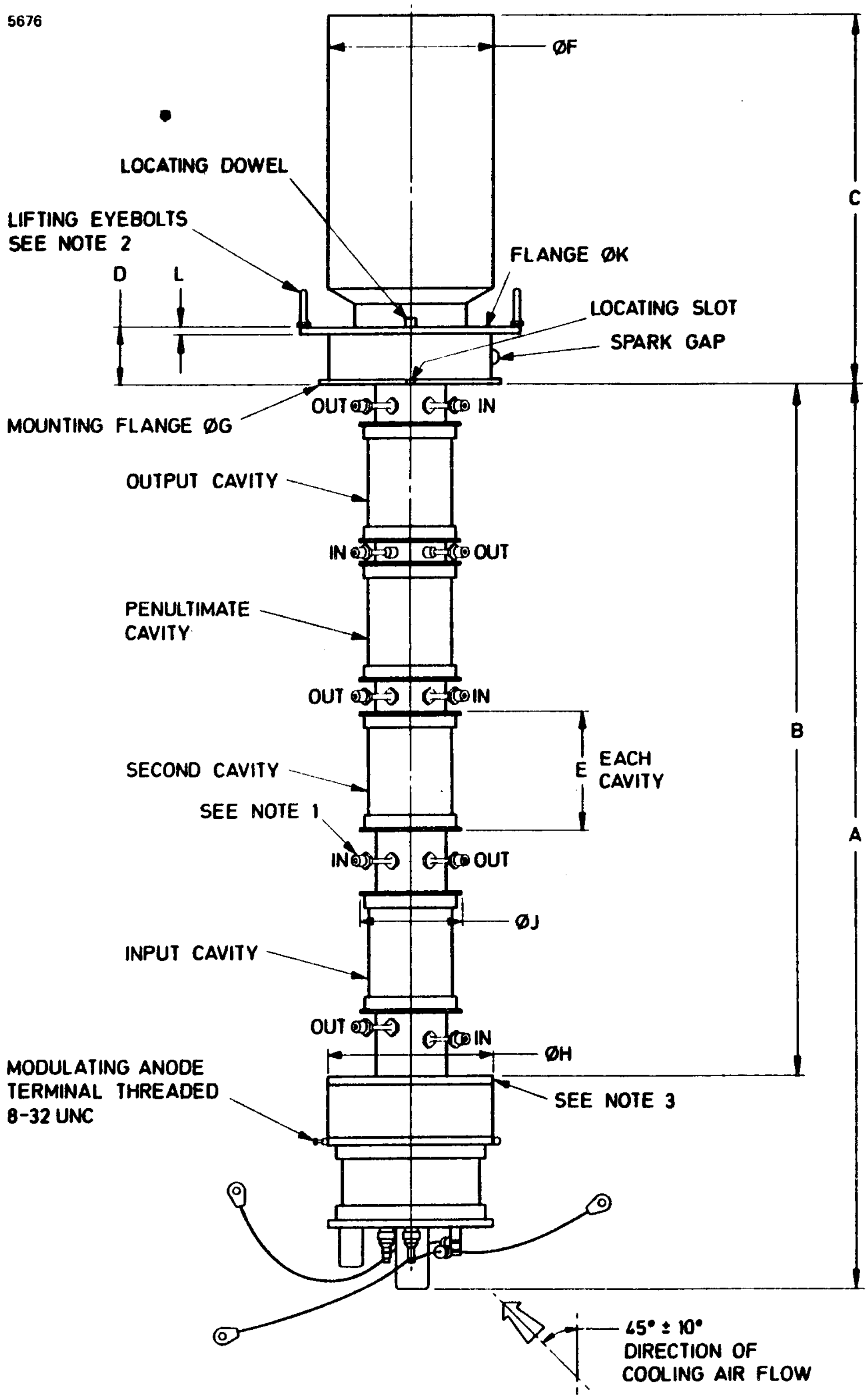
TYPICAL BEAM CHARACTERISTIC



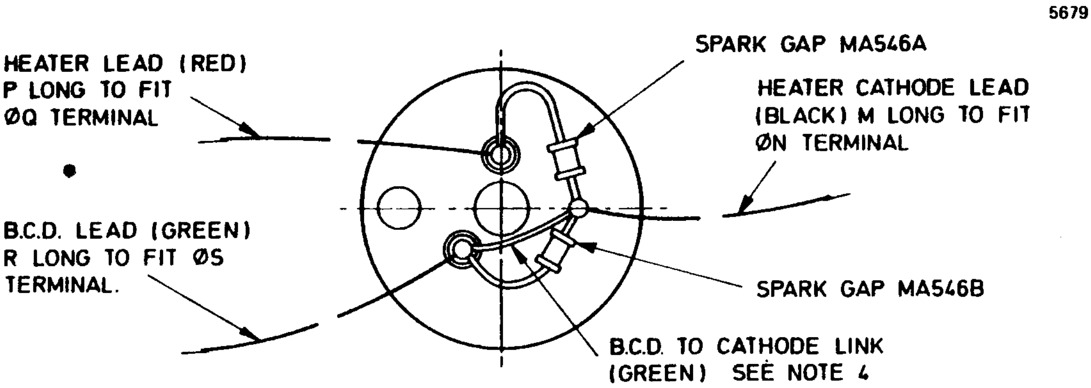
B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE FOR K3382BCD



View on Gun End of Klystron



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	44.812	1138.2	K	11.125	282.6
B	34.090	865.9	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	5.990	152.1	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	5.125	130.2			

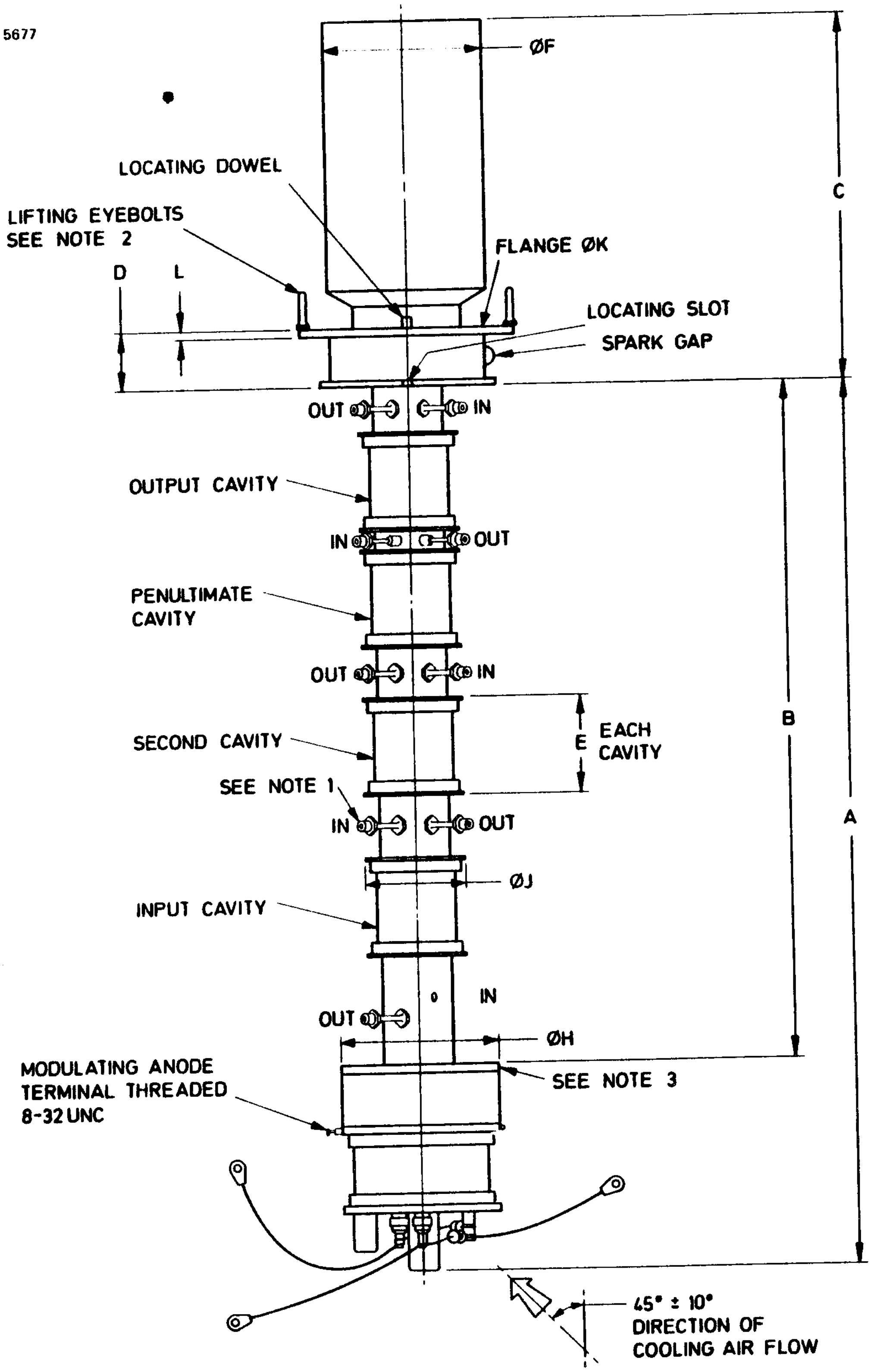
Millimetre dimensions have been derived from inches.

Outline Notes

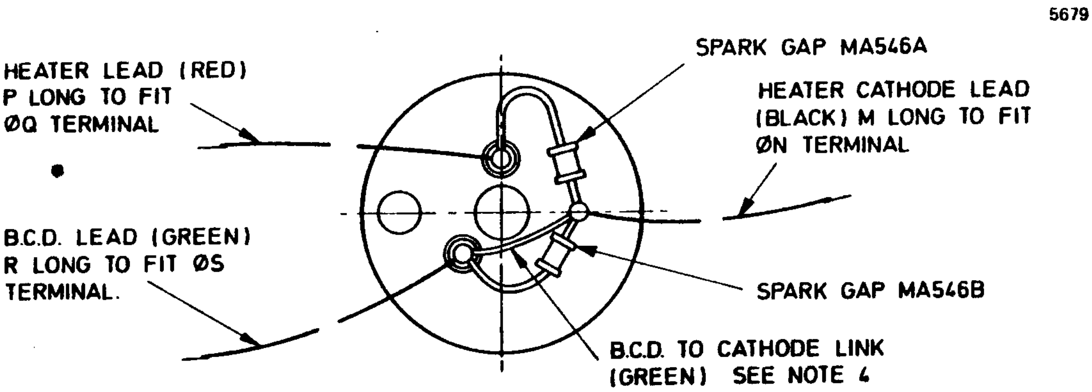
1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 28). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

OUTLINE FOR K3383BCD

5677



View on Gun End of Klystron



Ref	Inches	Millimetres
A	44.812	1138.2
B	34.090	865.9
C	18.500	469.9
D	3.000	76.20
E	4.990	126.7
F	8.100 max	205.7 max
G	9.125	231.8
H	8.100	205.7
J	5.125	130.2

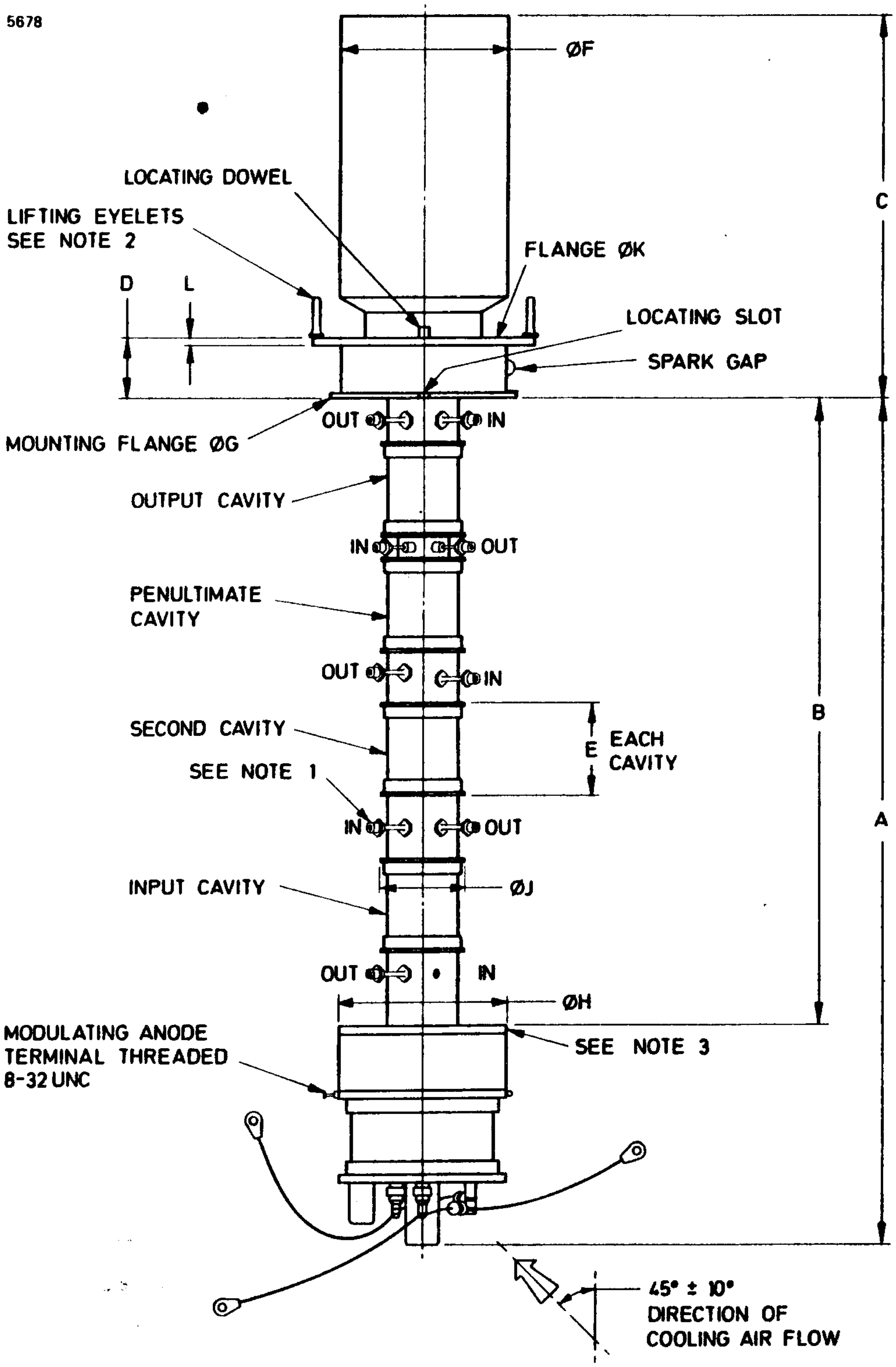
Ref	Inches	Millimetres
K	11.125	282.6
L	0.500	12.70
M	23.000	584.2
N	0.313	7.95
P	23.000	584.2
Q	0.250	6.35
R	23.000	584.2
S	0.250	6.35

Millimetre dimensions have been derived from inches.

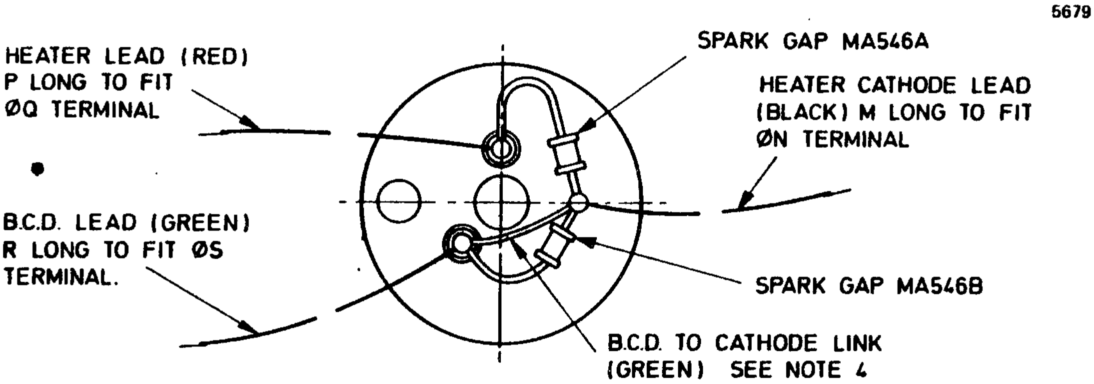
Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 28). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

OUTLINE FOR K3384BCD



View on Gun End of Klystron



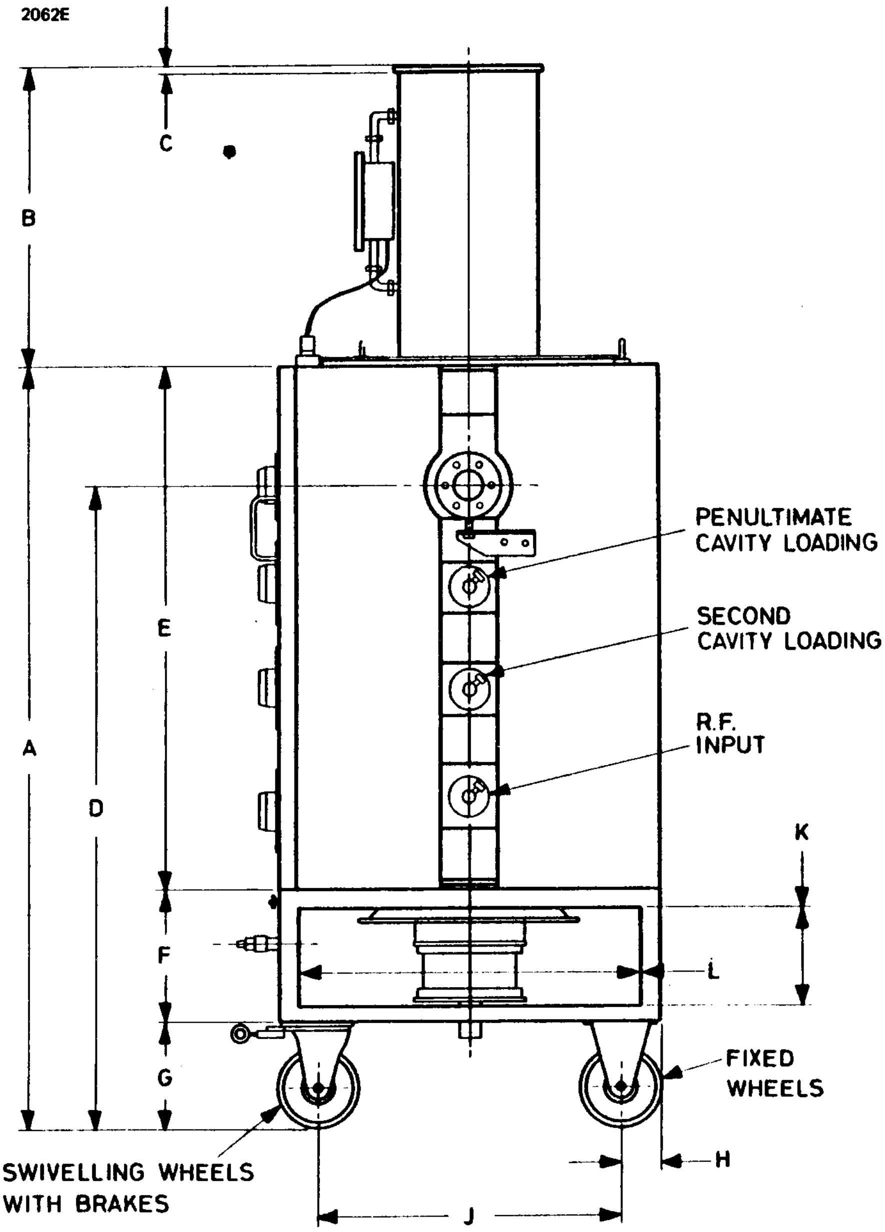
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	40.600	1031.2	K	11.125	282.6
B	29.875	758.8	L	0.500	12.70
C	18.500	469.9	M	23.000	584.2
D	3.000	76.20	N	0.313	7.95
E	4.490	114.0	P	23.000	584.2
F	8.100 max	205.7 max	Q	0.250	6.35
G	9.125	231.8	R	23.000	584.2
H	8.100	205.7	S	0.250	6.35
J	4.125	104.8			

Millimetre dimensions have been derived from inches.

Outline Notes

1. The water extensions are shown fitted to the klystron; they are supplied with the klystron but are not fitted. The outer ends are threaded ⅝ U.N.E.F. Two flexible water pipe assemblies, marked with the klystron type and serial number, are supplied with each klystron and must be used with that klystron only, throughout its life (see page 28). The other connecting pipes necessary to complete the cooling system are included in the circuit assembly.
2. These eyebolts must be removed when the boiler is fitted.
3. Each klystron is marked in this position with a coloured band. Only flux plates marked with the same colour are to be used with the klystron.
4. The klystron is delivered with a spark gap and a shorting link connected between the B.C.D. terminal and cathode. ***For B.C.D. operation, the shorting link only should be removed.*** The spark gap must remain in position at all times.

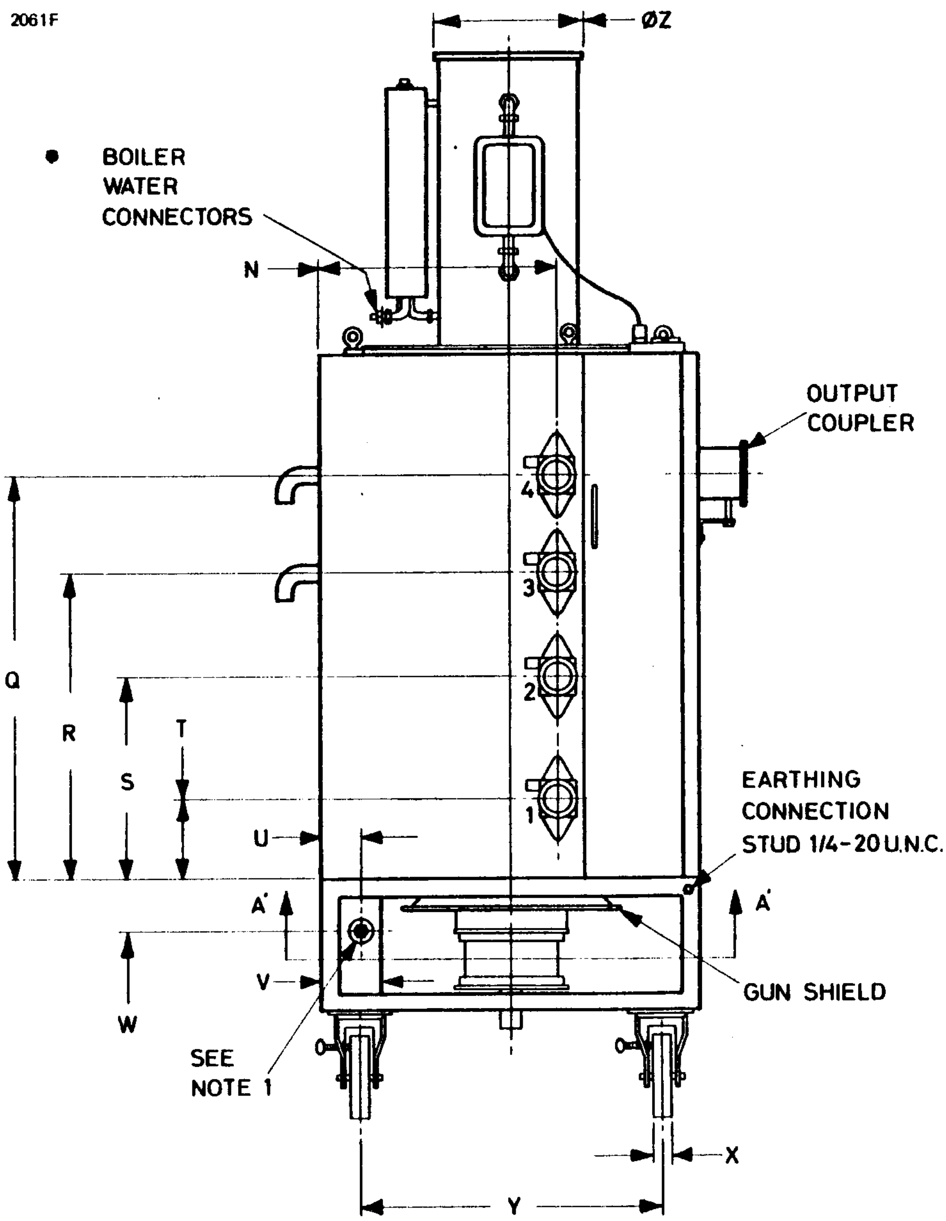
OUTLINE FOR CIRCUIT ASSEMBLIES



Note This drawing is not to scale for the K4172

See page 23 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES



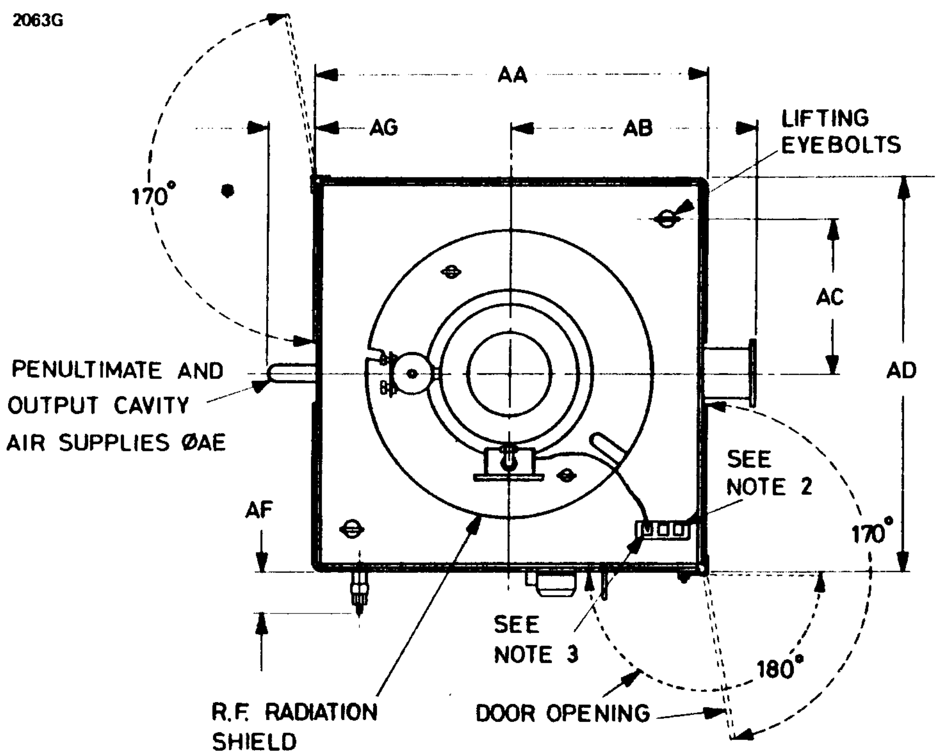
Controls

1 Input cavity tuning
2 Second cavity tuning
3 Penultimate cavity tuning
4 Output cavity tuning

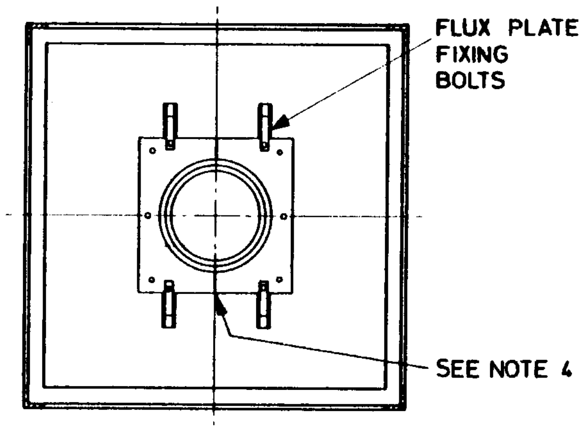
Note This drawing is not to scale for the K4172.

See page 23 for Outline Dimensions

OUTLINE FOR CIRCUIT ASSEMBLIES



View from above



Section A'-A' with gun shield omitted showing centring plate

Outline Notes

1. Water inlet connection Hitemp Minilock Self Sealing Coupling, threaded ½-inch B.S.P.
2. Connections to external circuits; see page 26.
3. Collector and level trip socket, accepts plug wired to boiler.
4. Position of colour code band to match that of klystron.

Outline Dimensions for K4170 and K4171
(All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A •	55.125 ± 0.125	1400.2 ± 3.2	T	5.750	146.1
B	21.437 ± 0.125	554.5 ± 3.2	U	3.000 ± 0.062	76.20 ± 1.57
C	0.500	12.70	V	4.500 ± 0.062	114.3 ± 1.57
D	46.250 ± 0.250	1174.8 ± 6.4	W	3.500	88.90
E	37.813 ± 0.062	960.5 ± 1.6	X	1.750 ± 0.016	44.45 ± 0.41
F	9.688 ± 0.062	246.1 ± 1.6	Y	21.875 ± 0.125	555.6 ± 3.2
G	7.625 ± 0.062	193.7 ± 1.6	Z	11.125	282.6
H	3.500 ± 0.187	88.90 ± 4.75	AA	28.750 ± 0.125	730.3 ± 3.2
J	22.250 ± 0.062	565.2 ± 1.6	AB	15.750 max	400.1 max
K	5.688 ± 0.187	144.48 ± 4.75	AC	11.250	285.8
L	25.000 ± 0.187	635.0 ± 4.75	AD	28.750 ± 0.125	730.3 ± 3.2
N	17.500	444.5	AE	1.687	42.85
Q	28.937	735.0	AF	4.250	108.0
R	22.062	560.4	AG	2.500	63.50
S	14.562	369.9			

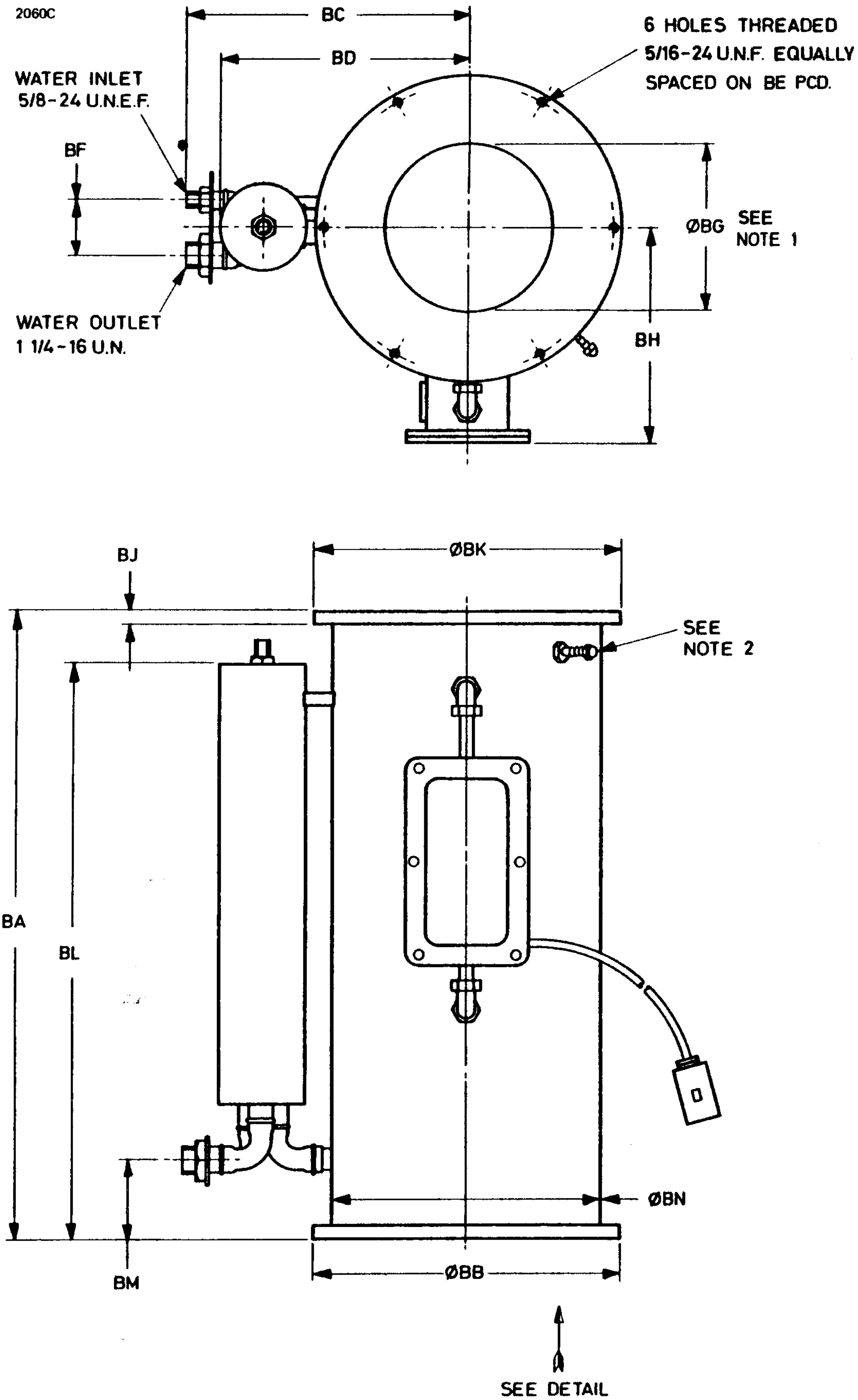
Millimetre dimensions have been derived from inches.

Outline Dimensions for K4172
(All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	54.562 ± 0.125	1385.9 ± 3.2	T	5.125	130.2
B	21.437 ± 0.125	554.5 ± 3.2	U	3.000 ± 0.062	76.20 ± 1.57
C	0.500	12.70	V	4.500 ± 0.062	114.3 ± 1.57
D	46.250 ± 0.250	1174.8 ± 6.4	W	3.500	88.90
E	33.375 ± 0.062	847.7 ± 1.6	X	1.750 ± 0.016	44.45 ± 0.41
F	13.562 ± 0.062	344.5 ± 1.6	Y	21.875 ± 0.125	555.6 ± 3.2
G	7.625 ± 0.062	193.7 ± 1.6	Z	11.125	282.6
H	3.500 ± 0.187	88.90 ± 4.75	AA	28.750 ± 0.125	730.3 ± 3.2
J	22.250 ± 0.062	565.2 ± 1.6	AB	15.5 max	393.7 max
K	5.688 ± 0.187	144.48 ± 4.75	AC	11.250	285.8
L	25.000 ± 0.187	635.0 ± 4.75	AD	28.750 ± 0.125	730.3 ± 3.2
N	17.500	444.5	AE	1.687	42.85
Q	25.062	636.6	AF	4.250	108.0
R	19.562	496.9	AG	2.250	57.15
S	12.625	320.7			

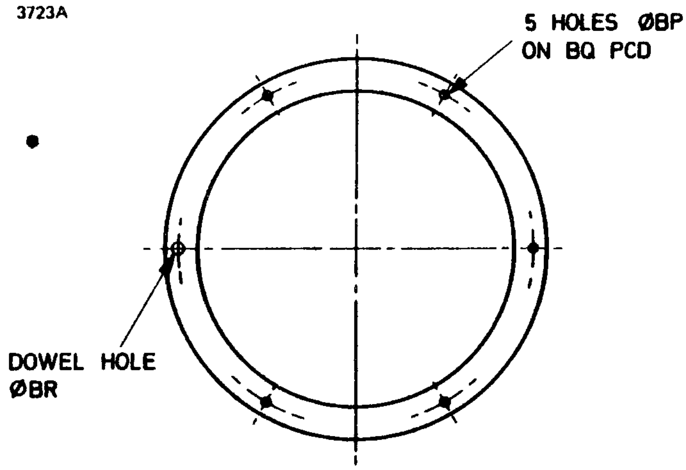
Millimetre dimensions have been derived from inches.

BOILER UNIT



2060C
BC
BD
6 HOLES THREADED
5/16-24 U.N.F. EQUALLY
SPACED ON BE PCD.
WATER INLET
5/8-24 U.N.E.F.
BF
ØBG
SEE
NOTE 1
WATER OUTLET
1 1/4-16 U.N.
BH
BJ
ØBK
SEE
NOTE 2
BA
BL
ØBN
BM
ØBB
SEE DETAIL

Detail of Mounting Flange



Outline Dimensions (All dimensions without limits are nominal)

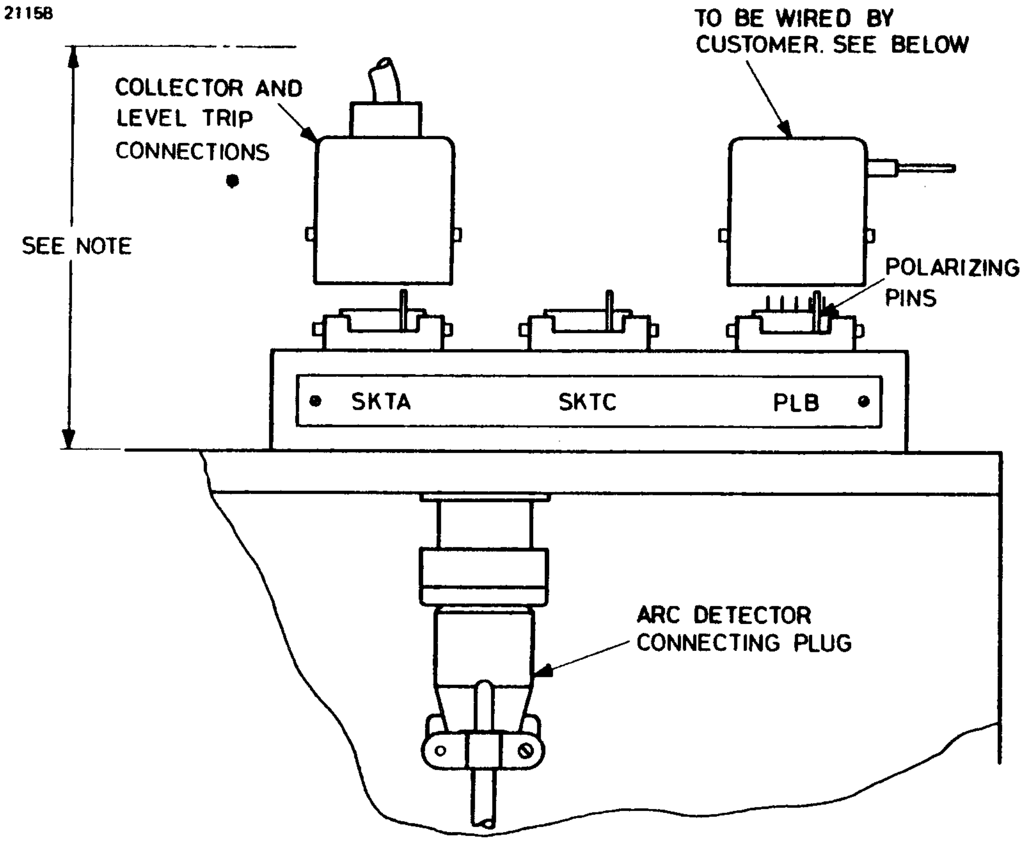
Ref	Inches	Millimetres
BA	22.562 ± 0.093	573.1 ± 2.4
BB	11.125 ± 0.015	282.6 ± 0.4
BC	10.250 ± 0.125	260.4 ± 3.2
BD	9.000	228.6
BE	10.500	266.7
BF	2.000 ± 0.125	50.80 ± 3.18
BG	6.000	152.4
BH	7.750	196.9
BJ	0.500	12.70
BK	11.125 ± 0.015	282.6 ± 0.4
BL	20.687	525.4
BM	2.937 ± 0.125	74.60 ± 3.18
BN	9.750	247.7
BP	0.312	7.92
BQ	10.500	266.7
BR	0.394	10.00

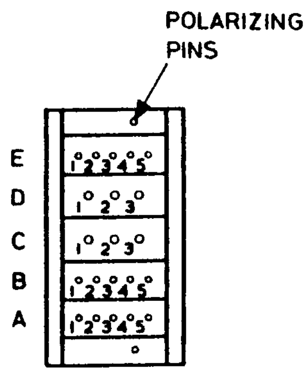
Millimetre dimensions have been derived from inches except dimension BR.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the siphon provided.

PLUG AND SOCKET CONNECTIONS





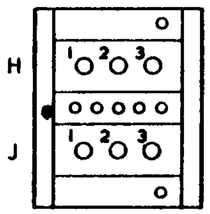
Input socket
View on solder connections
with cover removed

Input Socket Connections
(to be wired by customer)

Water level trip circuit	B1, B2
Collector connection	C1
Arc detector circuit:	
photo resistor	E4, E5
bulb	E2, E3
screen and earth	E1
link	B4, B5
Focus coils:	
positive	C3
negative	D3

Note Clearance for connector removal 5.750 inches (146 mm) minimum.

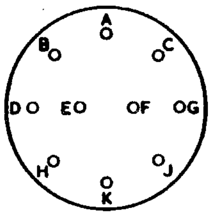
Collector Plug



2116

Pin	Element
H1	Collector
H2	–
H3	–
J1	Water level trip
J2	Water level trip
J3	–

Arc Detector Plug



Pin	Element
A	Photo resistor
B	Photo resistor
C	Bulb
D	Link
E	Screen and earth
F	Screen and earth
G	Bulb
H	Link
J	No connection
K	No connection

ITEMS SUPPLIED WITH KLYSTRON

The following parts, packed in a polythene bag, are despatched with each klystron.

Item	Quantity Supplied K3382BCD	Quantity Supplied K3383BCD or K3384BCD
Round water connecting pipes H7298A complete with one each brass nut H18952A, rubber washer MA717C and 'O' ring MA424	8	7
Flat water connecting pipes FM11369A complete with one each brass nut H18952A, rubber washer MA717C and rubber washer MA767A	2	2
Inlet water pipe assembly 25 inches long MA369	1	–
Outlet water pipe assembly 25 inches long MA370	1	1
Inlet water pipe assembly 24 inches long MA387	–	1
Boiler 'O' ring MA431	1	1
¼–20 U.N.C. boiler bolts MWX161 with plain washer DWP004	6	6
Knurled spanner FMP11690B for flat water connecting pipes	1	1
R.F. radiation shield sealing gasket MA716A	1	1
Spare rubber washers MA717C	2	2
Spare rubber washers MA767A	2	2
Spare 'O' rings MA424	2	2
Spare rubber washer MA766A	1	1
Flux plates MA534A (see note)	1	1

Note A pair of new flux plates, colour coded to match the klystron, is supplied and **must** be installed with the klystron.

CIRCUIT ASSEMBLY COMPONENT LIST

Item	Quantity	Type number		
		K4170	K4171	K4172
Magnet frame	1	MA500D	MA500D	MA503B
Input cavity	1	MA88E	MA76A	MA200
Second cavity	1	MA88H	MA77A	MA200
Third cavity	1	MA88A	MA78A	MA200A
Output cavity	1	MA89A	MA75A	MA200B
Output coupler	1	MA83D	MA83E	MA83E
Boiler	1	MA423	MA423	MA423
Air pipe	2	MA697A	MA697B	MA697B
Radiation shield	1	MA308	MA308	MA308
Gun shield	1	MA354	MA354	MA354
Water pipes	4	MA230	MA231	MA295
Input loop	1	MA505B	MA505C	MA505D
Second cavity loop	1	MA505A	MA505C	MA505D
Penultimate cavity loop	1	MA505A	MA505C	MA505D
Complete anode connector assembly	1	FM15253A	FM15253A	FM15253A
Connecting stems	4	MA784A	MA784C	MA784B
Coupler support bracket	1	H7426A	H7426A	H7426A
Tool kit	1	MA666A	MA666A	MA666A

ASSEMBLY STAND

An assembly stand type MA492A is available to order, for use when fitting the water connections and cavities to the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Beryllium Oxide Ceramics

Most K3382BCD series klystrons have white, unmarked, aluminium oxide ceramics in all cavities. However, on a few tubes the third and output cavity ceramics may be made of **beryllium oxide**; these ceramics are **coloured blue, or marked with a black line.**

Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics; if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K3572BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacement for YK1263 in circuit assembly type TE1222.

FEATURING

- **Frequency Range** 470 to 810 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 65% can be achieved by beam pulsing. 43% typical sync. efficiency at 58 kW output in standard operational mode at the least efficient channel. ★
- **Output Power** Rated for 55 kW and 40 kW vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Cooling** Air-cooled body and cavities. Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3572BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 810 MHz at sync. power levels up to 58 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

★ Indicates a change

November 1986

Supersedes May 1986 Issue

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification. A feature of the cavity design is that tuning of both halves of each cavity is by means of a single knob. A digital indication of the cavity frequency is provided.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range (see note 1)	470 to 810	MHz	
US channel numbers	14 to 69		
Sync. output power at klystron flange	up to 58	kW	
Maximum drive power requirements:			★
conventional operation	25	W	
pulsed operation	100	W	
Power gain (conventional operation)	34 to 42	dB	
Beam voltage (for 58 kW sync. power)	23.0 to 26.5	kV	★
Modulating anode to cathode voltage (see note 2)	17.0 to 21.5	kV	★

★ Indicates a change.

GENERAL

Electrical

Cathode	indirectly heated		
Heater voltage	8.5 ± 3%	Vd.c.	
Heater current range	25 to 28	A	
Black heat heater voltage (see note 3)	6.0	Vd.c.	★
Cathode pre-heating time:			
from cold (see note 4)	5	minutes	
from black heat (see note 5)	0	minutes	★
Vacion pump to cathode voltage	+3.0 to 4.0	kV	
Internal impedance of vacion supply	500	kΩ approx	★

Mechanical

Overall length	62.56 inches (160 cm) nom
Overall diameter	11.12 inches (28.25 cm) nom
Mounting position	vertical, collector end up
Net weight of klystron	176 pounds (80 kg) approx

Circuit Assembly K4651 or K4651W

For vapour cooling of collector, order K4651.

For water cooling of collector, order K4651W.

Electro-magnet current, stabilized to ± 2% (see note 6)		
vision service	10 to 12	A
sound service	9 to 12	A
Electro-magnet resistance:		
cold	8.4 ± 1.1	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector	type N coaxial	
R.F. output	3⅛ inch 50 Ω coaxial line	
Net weight of tuning cavities	100 pounds (45 kg) approx	
Net weight of magnet assembly	505 pounds (230 kg) approx	

★ Indicates a change.

Cooling

Air flow to cavities and body (see note 7)	100	ft^3/min
	2.8	m^3/min
Static pressure head (see note 8)	5.0 inches (127 mm) w.g.	
Air flow to cathode terminal (see note 7)	5.0	ft^3/min
	0.14	m^3/min
K4651 (vapour cooled) (see page 14):		
volume of steam produced by collector dissipation	1.5	$ft^3/min/kW$
	0.043	$m^3/min/kW$
volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4651W (water cooled) (see page 14):		
minimum water flow required		see page 15
maximum collector pressure drop	5.0	lb/in^2
	0.35	kg/cm^2
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature (see note 9)	90	°C max
water inlet temperature	55	°C max ★

Arc Detector

Arc detector type MA257 is fitted to the third and output cavities. See page 23 for connection details

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections	1500 mm cable fitted with MS3106F-18-19S Socket.	

★ Indicates a change.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater voltage	9.5	V max
Heater starting current (peak)	65	A max
Beam voltage	28	kV max
Modulating anode to cathode voltage (see note 2)	23	kV max
Beam current	7.0	A max
Body current:		
with no input power	35	mA max
r.f. on (see note 10)	150	mA max
Modulating anode current	6.0	mA max
Mean output power	45	kW max
Collector dissipation	150	kW max
Load v.s.w.r. (see note 11)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see notes 12 and 13)	−1400	V max

TYPICAL OPERATION ★

55 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 476	638 to 644	800 to 806	MHz
US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	20.9	19.2	19.0	kV
Beam current	5.85	5.15	5.1	A
Body current:				
with no input power	9.0	7.0	7.0	mA
black level + sync.	80	45	35	mA
Sync. output power	58	58	58	kW
Saturated output power	60	60	60	kW
Electro-magnet current	11	10	10	A
Peak drive power for 58 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	43.1	45.0	43.7	%
Saturated efficiency	44.6	46.6	45.2	%
1 dB bandwidth	7.0	7.0	7.0	MHz

5.5 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	6.1	5.5	5.0	kV
Beam current	0.9	0.75	0.7	A
Output power	6.0	6.0	6.0	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

★ Indicates a change.

11 kW sound amplifier ★

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	8.6	7.9	7.5	kV
Beam current	1.5	1.3	1.2	A
Output power	12	12	12	kW
Electro-magnet current . . .	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

22 kW sound amplifier ★

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	12.9	11.7	11.0	kV
Beam current	2.8	2.4	2.3	A
Output power	23.5	23.5	23.5	kW
Electro-magnet current . . .	11	10	10	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.5	1.5	1.5	MHz

★ Indicates a change.

TYPICAL OPERATION ★

40 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency •	470 to 476	638 to 644	800 to 806	MHz
US channel	14	42	69	
Beam voltage	21.0	22.5	24.5	kV
Modulating anode to cathode voltage (approx)	18.8	17.4	16.7	kV
Beam current	5.0	4.4	4.2	A
Body current:				
with no input power	8.0	6.0	6.0	mA
black level + sync.	55	35	25	mA
Sync. output power	43	43	43	kW
Saturated output power	45	45	45	kW
Electro-magnet current	11	10	10	A
Peak drive power for 43 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	41.0	43.4	41.8	%
Saturated efficiency	42.9	45.5	43.7	%
1 dB bandwidth	7.0	7.0	7.0	MHz

4.0 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	21.0	22.5	24.5	kV
Modulating anode to cathode voltage (approx)	5.7	5.0	4.5	kV
Beam current	0.8	0.7	0.6	A
Output power	4.5	4.5	4.5	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

★ Indicates a change.

8.0 kW sound amplifier ★

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	21.0	22.5	24.5	kV
Modulating anode to cathode voltage (approx)	7.9	7.3	6.6	kV
Beam current	1.3	1.15	1.0	A
Output power	9.0	9.0	9.0	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

NOTES

1. For operation in the range 810 to 860 MHz, please consult EEV.
2. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 2.5 mA.
3. Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation. ★
4. In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode pre-heating time. ★
5. For black heat operation, a heater voltage of 6.0 V must have been applied to the Klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to 8.5 V. ★
6. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for best TV performance and stabilize to ± 2% about this optimum value.
7. This value applies to transmitters at sea level where the air density is 0.076 lb/ft^3 (1.22 kg/m^3). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow. ★

★ Indicates a change.

8. Measured by a manometer at the input pipe to the circuit assembly.

9. For operation at high altitudes where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude. ★

10. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.

11. This value applies to television service. EEV should be consulted regarding other conditions of service.

12. The K3572BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 58 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

    The following conditions must be observed when operating in this mode:

    (a) The B.C.D. voltage must **never** be positive with respect to cathode.

    (b) The B.C.D. voltage must **not** exceed −1400 V with respect to cathode.

    The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph (see page 13).

13. To measure the B.C.D. current, the klystron must be operated undisturbed for a period of **45 minutes** under the following conditions. ★

Beam voltage	21.5	kV
Modulating anode to cathode voltage	21.5	kV
Heater voltage	8.5	V
B.C.D. to cathode voltage	−1.0	kV

The B.C.D. current on a new klystron will not exceed 2.0 mA and typically will be less than 1.0 mA.

With a B.C.D.-to-cathode voltage of −1.0 kV, a beam current reduction of about 35% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 65% to be obtained, where efficiency is defined as:–

★ Indicates a change.

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	80	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

14. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

★ Indicates a change.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

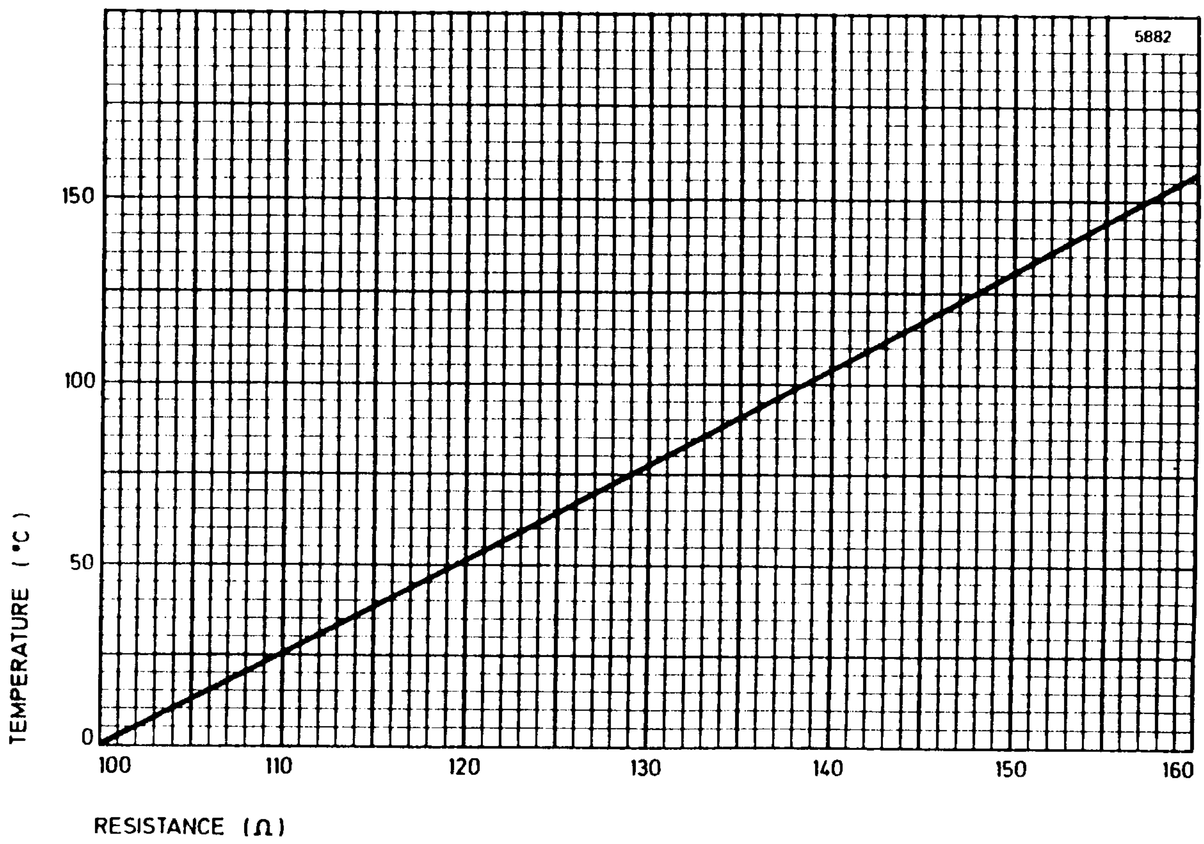
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 MΩ at 20 °C. The probes are tested to 240 V d.c. between probe and element.

Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4651W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 15 for flow rates).

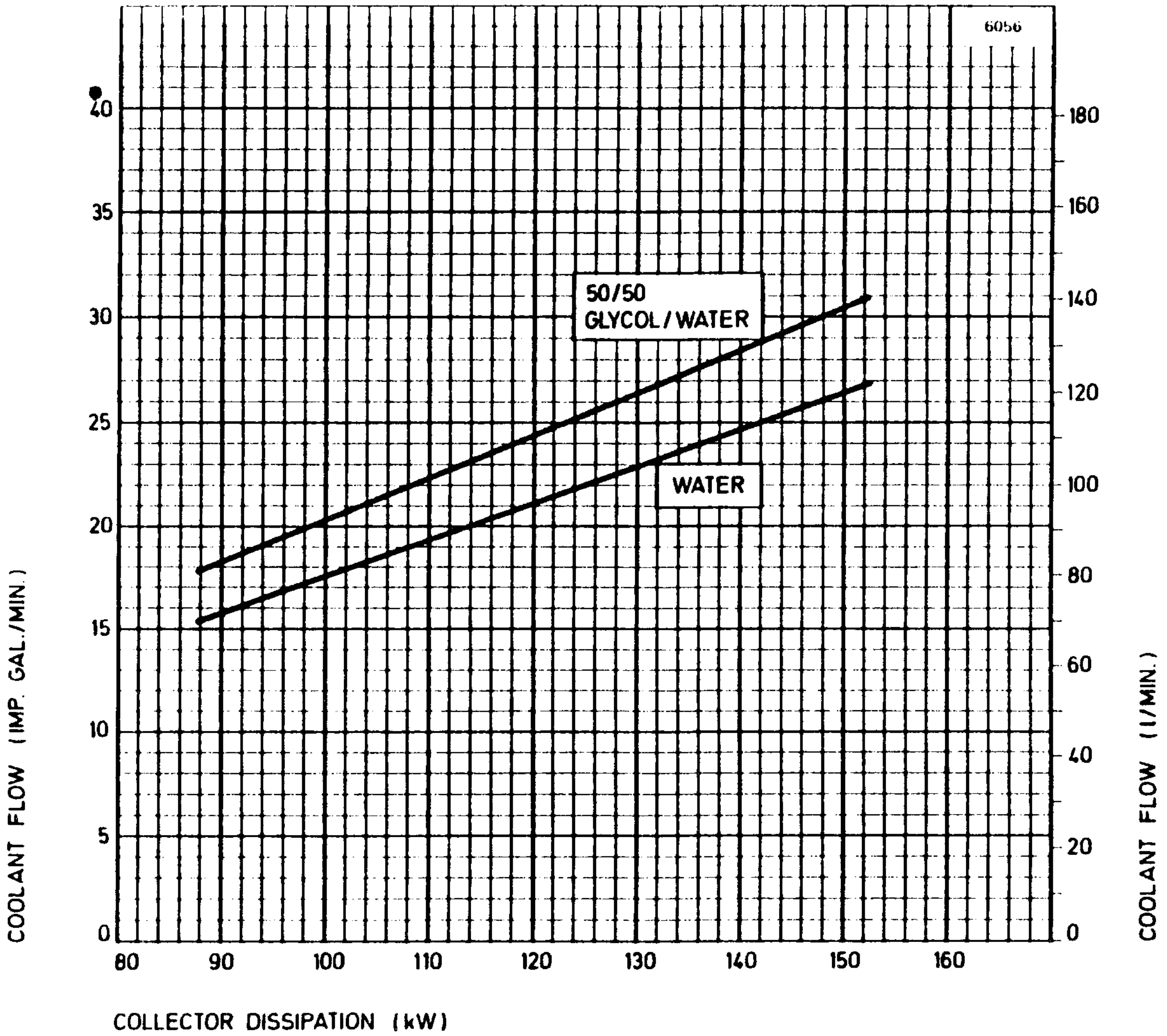
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4651 (Vapour Cooled)

Only pure demineralized water should be used in the boiler; local water supplies are usually suitable only for the secondary circuit of a water cooled condenser.

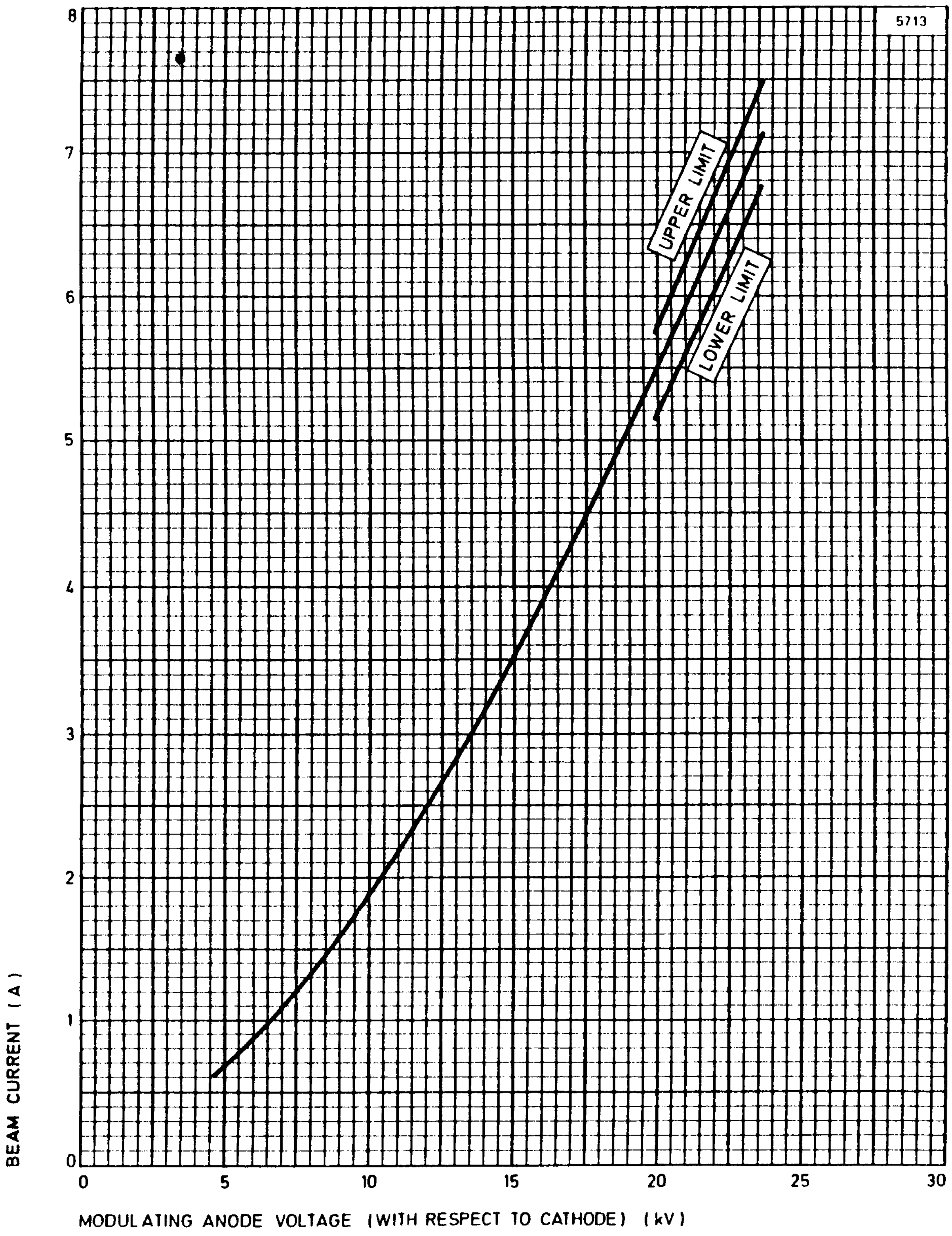
LIQUID COOLING REQUIREMENTS FOR K4651W



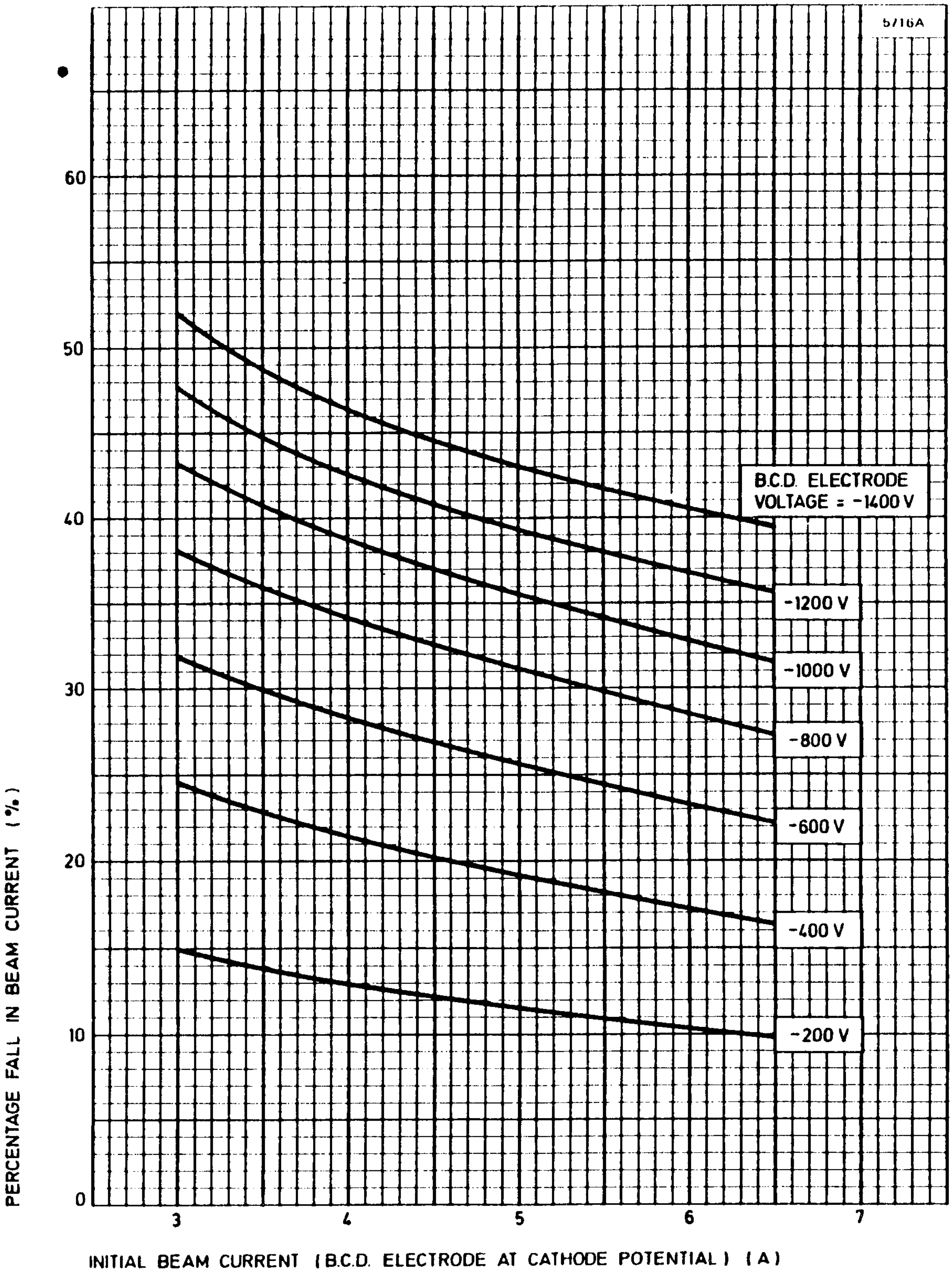
Note 1 U.S. gal = 0.832 Imp. gal.

BEAM CURRENT CHARACTERISTIC

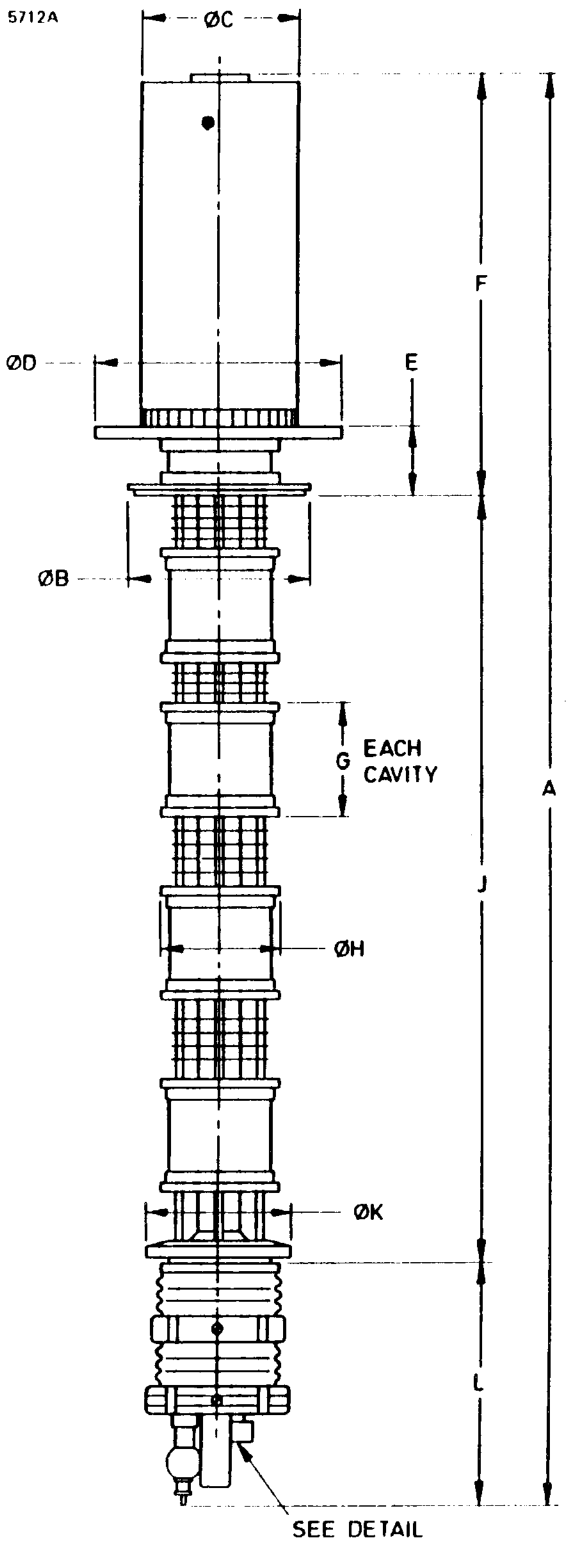
(B.C.D. electrode at cathode potential)



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3572BCD

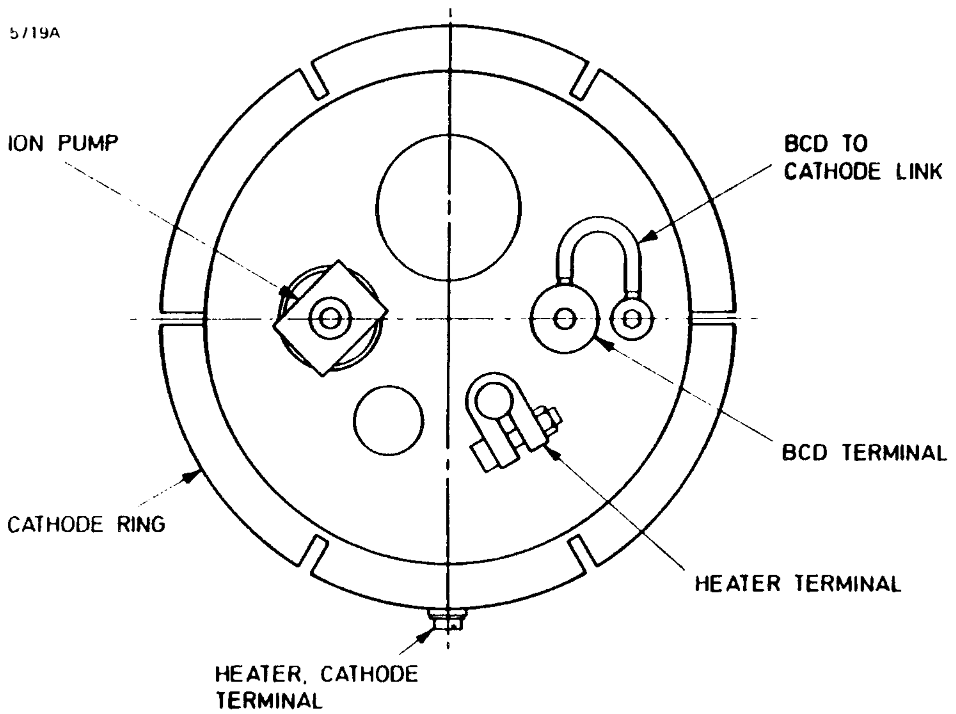


Outline Dimensions (All dimensions nominal) ★

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	• 1588.0	62.520	G	127.0	5.000
B	202.0	7.953	H	130.2	5.126
C	175.0	6.890	J	846.5	33.327
D	282.5	11.122	K	160.0	6.299
E	75.4	2.969	L	275.0	10.827
F	466.5	18.366			

Inch dimensions have been derived from millimetres.

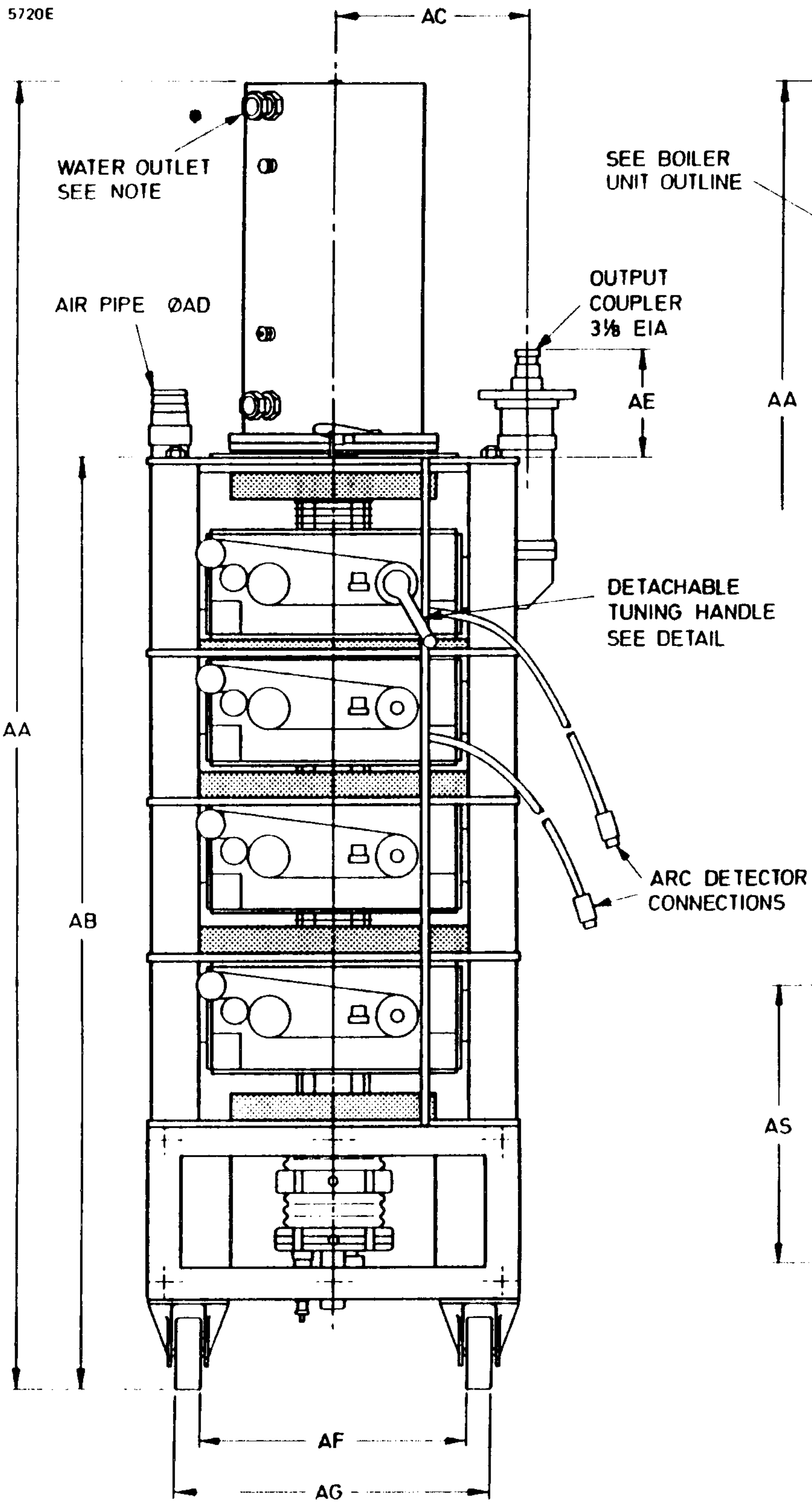
Enlarged View on Gun End of Klystron

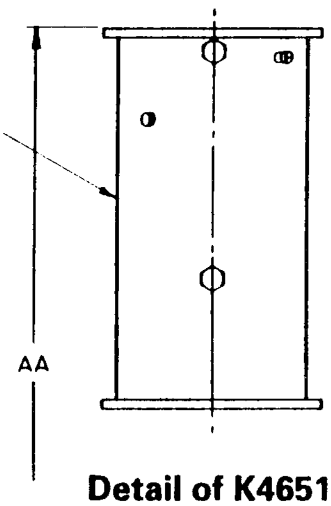


Note The klystron is supplied with a shorting link connected between the B.C.D. terminal and cathode. ***If the B.C.D. electrode is to be used, this link must be removed.***

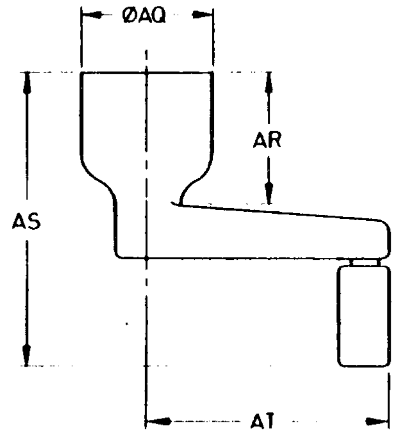
★ Indicates a change.

OUTLINE OF CIRCUIT ASSEMBLY K4651W ★





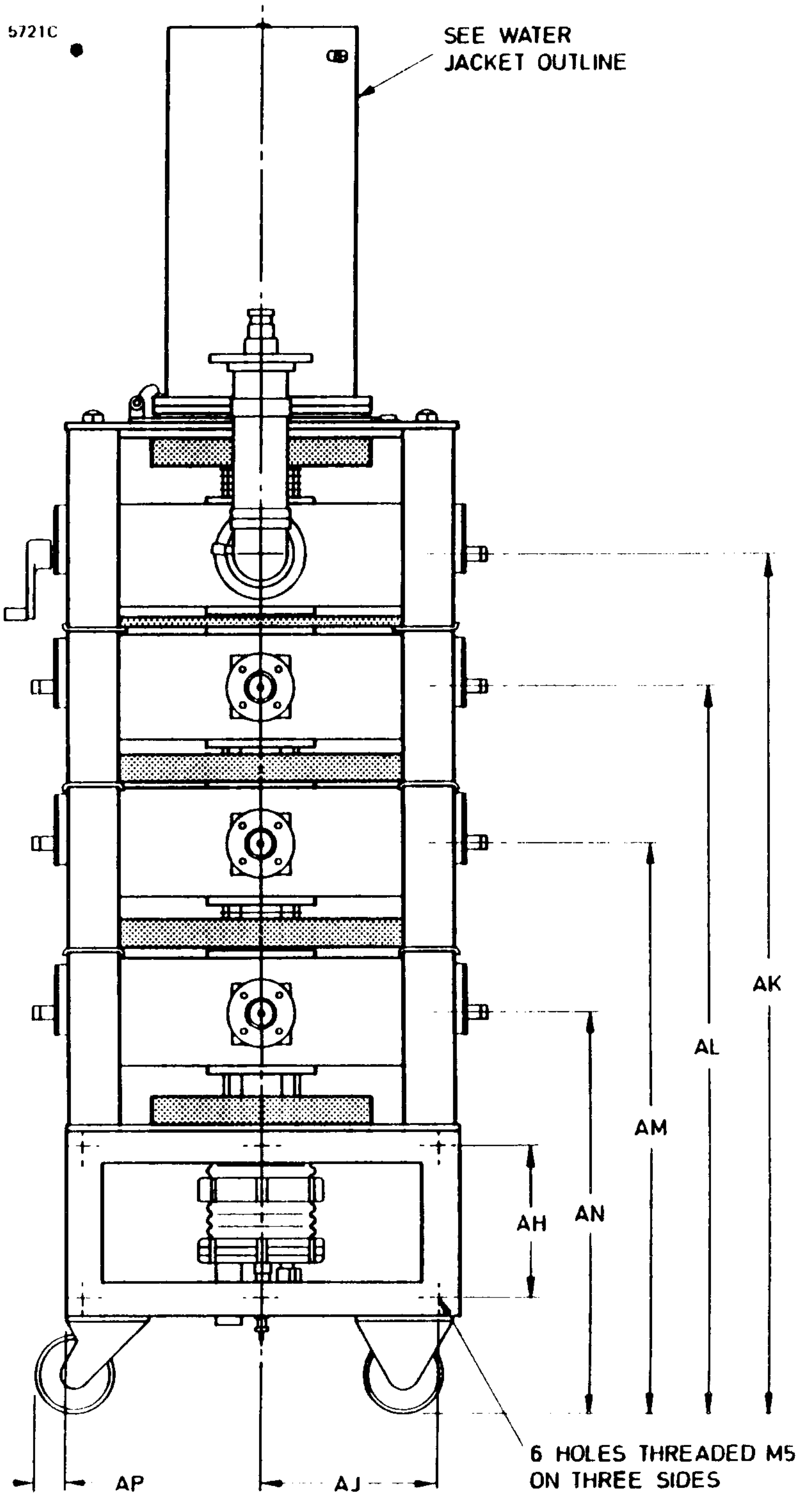
Detail of K4651 Boiler Unit



Detail of MA992A ★ Tuning Handle

★ Indicates a change.

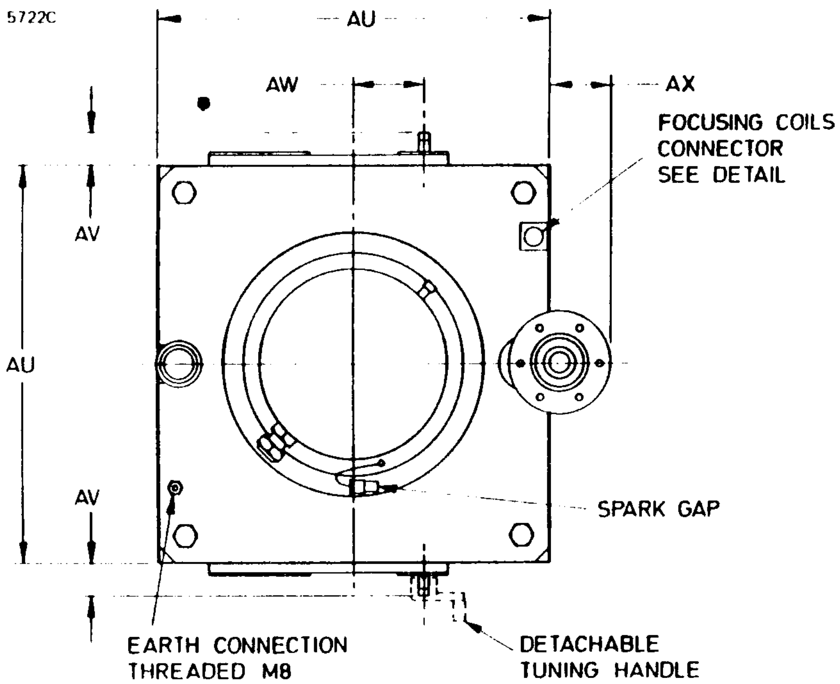
OUTLINE OF CIRCUIT ASSEMBLY K4651W ★

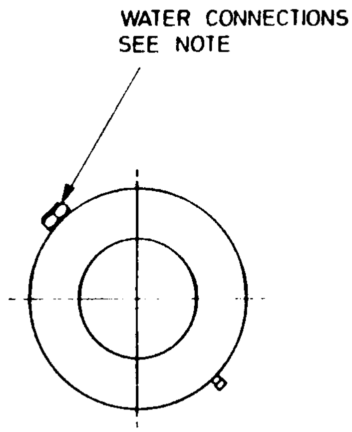


★ Indicates a change.

Top View of Circuit Assembly K4651W ★

(All dimensions without limits are nominal)





Detail of K4651 Boiler Unit

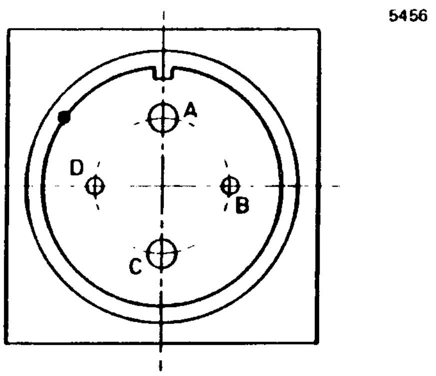
Ref	Millimetres	Inches	Ref	Millimetres	Inches
AA	1785.0	70.276	AM	722.0	28.425
AB	1264.0	49.764	AN	507.0	19.961
AC	265.0	10.433	AP	45.0	1.772
AD	50.0	1.969	AQ	40.0	1.575
AE	150.0	5.906	AR	60.0	2.362
AF	320.0	12.598	AS	130.0	5.118
AG	405.0	15.945	AT	90.0 max	3.543
AH	192.0	7.559	AU	508.0	20.000
AJ	234.0	9.213	AV	55.0	2.165
AK	1090.0	42.913	AW	88.0	3.465
AL	922.0	36.299	AX	78.0	3.071

Inch dimensions have been derived from millimetres.

Note Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

★ Indicates a change.

View on Focus Coil Connector

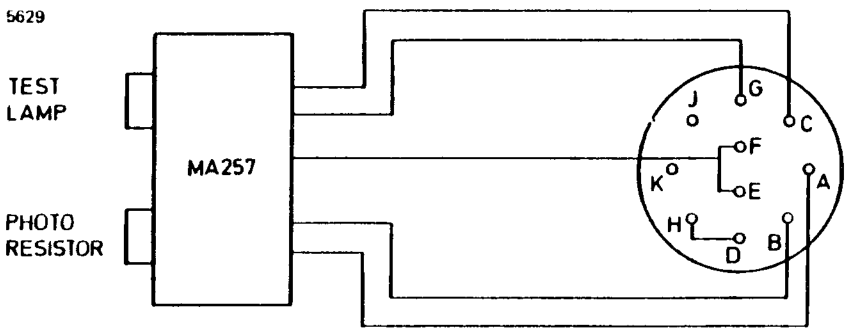


Connections

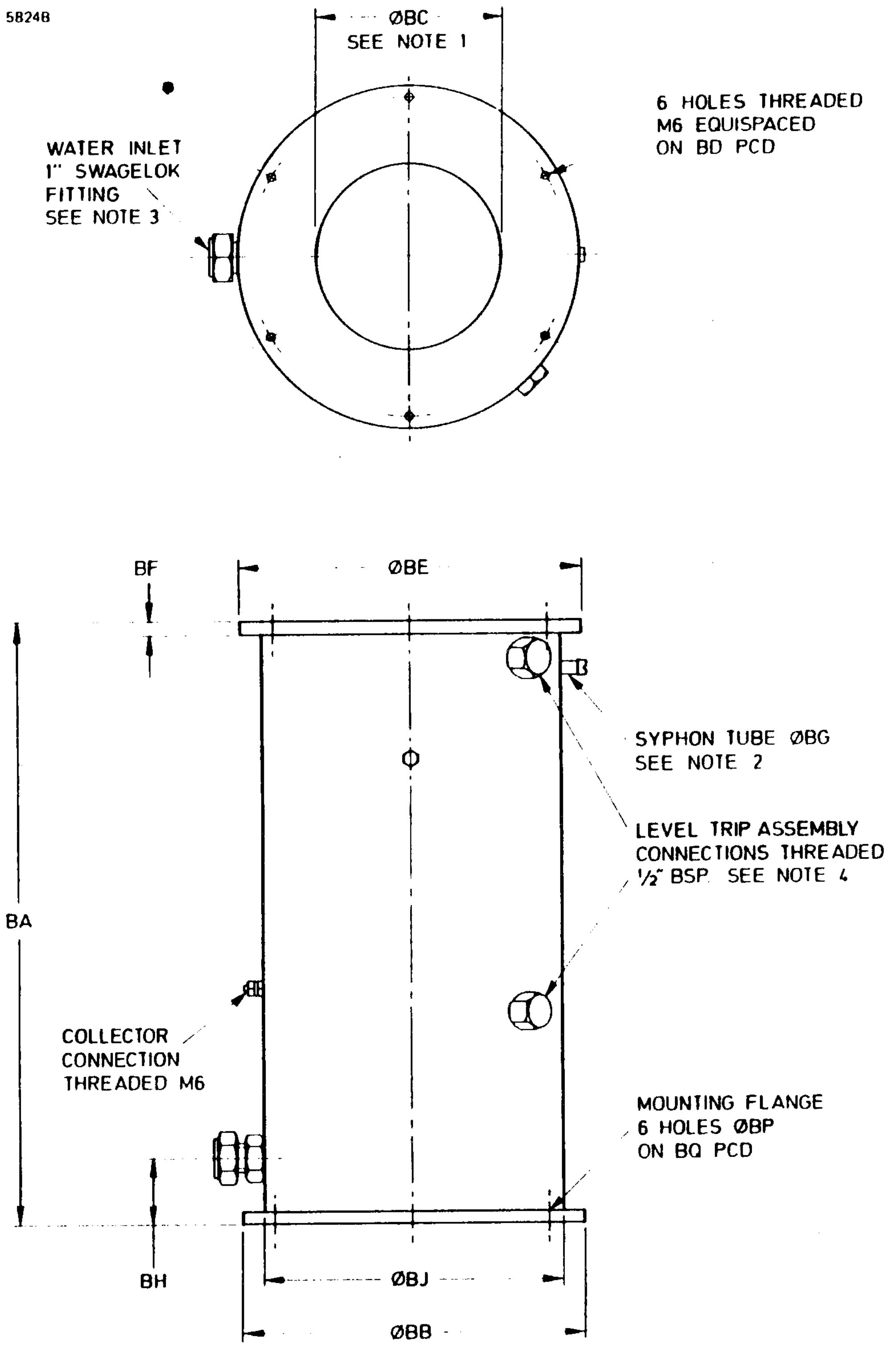
Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

Arc Detector Connections to socket type MS3106F-18-19S



OUTLINE OF BOILER UNIT ★



★ Indicates a change.

Outline Dimensions (All dimensions without limits are nominal)

Ref	Millimetres	Inches
BA	498.0	19.606
BB	282.5	11.122
BC	152.5	6.004
BD	266.0	10.472
BE	282.5	11.122
BF	13.0	0.512

Ref	Millimetres	Inches
BG	10.0	0.394
BH	55.5	2.185
BJ	248.0	9.764
BP	7.25 ± 0.25	0.285 ± 0.010
BQ	266.0	10.472

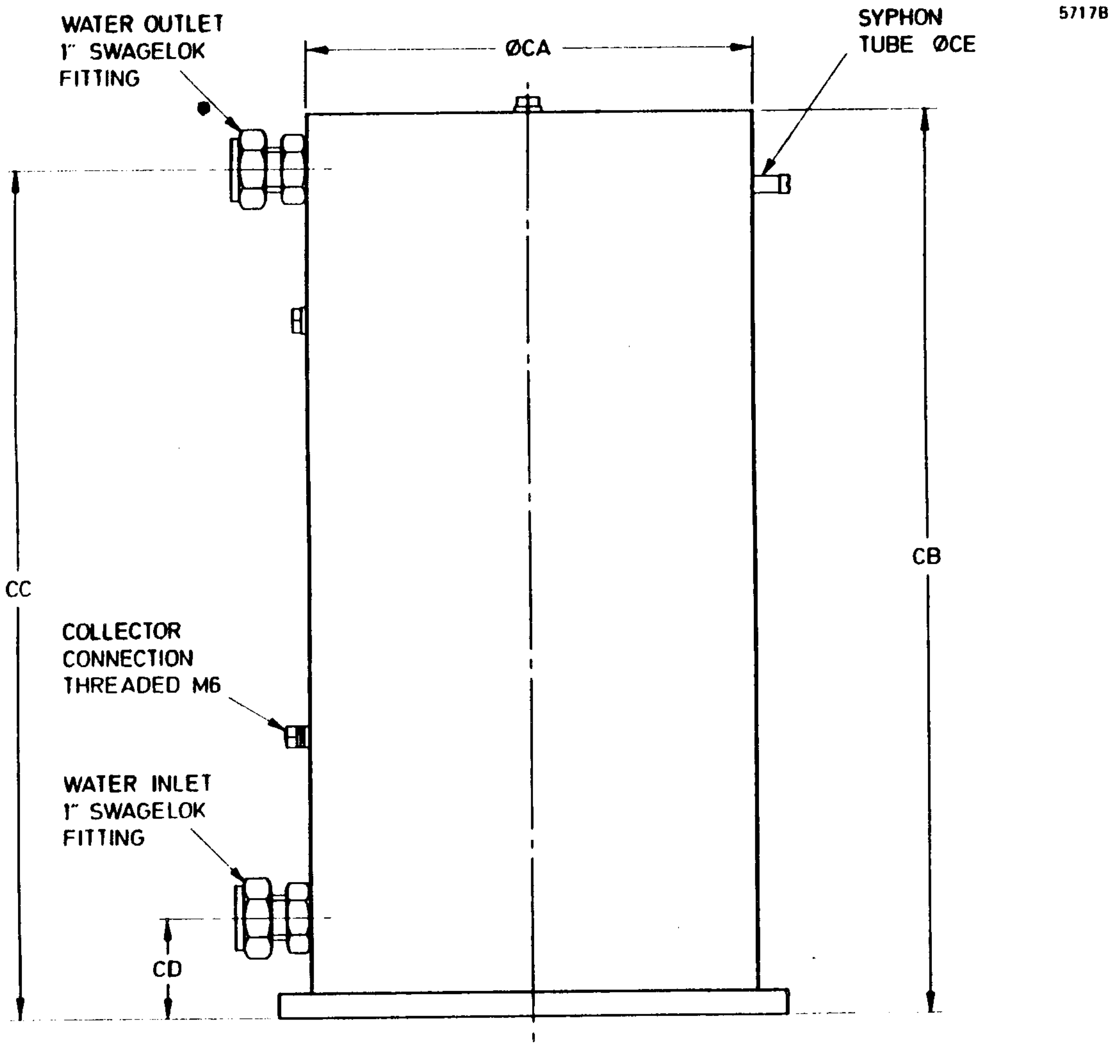
Inch dimensions have been derived from millimetres.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the syphon provided.
3. A weir, designed to maintain the water level in the boiler constant when operating with a pumped system, is available from EEV, part no, MA963C. ★
4. A sight glass and level trip assembly to fit the boiler is available from EEV, part no. MA213. ★

★ Indicates a change.

OUTLINE OF WATER JACKET (All dimensions nominal)



Ref	Millimetres	Inches
CA	248.0	9.764
CB	498.0	19.606
CC	467.0	18.386
CD	55.5	2.185
CE	10.0	0.394

Inch dimensions have been derived from millimetres.

English Electric Valve Company Limited
Chelmsford, Essex, England

Printed in England
Subsidiary of The General Electric Company, p.l.c. of England

K3573BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 65% can be achieved by beam pulsing. 42% typical sync. efficiency at 58 kW output in standard operational mode at the least efficient channel.
- **Output Power** Rated for 55 kW and 40 kW vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Cooling** Air-cooled body and cavities. Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3573BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 58 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

May 1988

Supersedes January 1988 Issue

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification. A feature of the cavity design is that tuning of both halves of each cavity is by means of a single knob. A digital indication of the cavity frequency is provided.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
US channel numbers	14 to 78	
European channel numbers	21 to 68	
Sync. output power at klystron flange	up to 58	kW
Maximum drive power requirements:		
conventional operation	25	W
pulsed operation	100	W
Power gain (conventional operation)	34 to 42	dB
Beam voltage (for 58 kW sync. power) . . .	23.0 to 26.5	kV
Modulating anode to cathode voltage (see note 1)	17.0 to 21.5	kV

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	8.5 ± 3%	Vd.c.
Heater current range	25 to 28	A
Black heat heater voltage (see note 2)	6.0	Vd.c.
Cathode pre-heating time:		
from cold (see note 3)	5	minutes
from black heat (see note 4)	0	minutes
Ion pump to cathode voltage	+3.0 to 4.0	kV
Internal impedance of vacion supply	500	kΩ approx

Mechanical

Overall length	62.56 inches (160 cm) nom
Overall diameter	11.12 inches (28.25 cm) nom
Mounting position	vertical, collector end up
Net weight of klystron	176 pounds (80 kg) approx

Circuit Assembly K4653 or K4653W

For vapour cooling of collector, order K4653.

For water cooling of collector, order K4653W.

Electro-magnet current, stabilized to ± 2% (see note 5)		
vision klystron	10 to 12	A
sound klystron	9 to 12	A
Electro-magnet resistance:		
cold	8.4 ± 1.1	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector	type N coaxial	
R.F. output	3⅛ inch 50 Ω coaxial line	
Net weight of tuning cavities	100 pounds (45 kg) approx	
Net weight of magnet assembly	505 pounds (230 kg) approx	

Cooling

Air flow to cavities and body (see note 6) .	100	ft^3/min
	2.8	m^3/min
Static pressure head (see note 7)	5.0 inches (127 mm) w.g.	
Air flow to cathode terminal ★		
during black heat operation (see note 6) . .	5.0	ft^3/min
	0.14	m^3/min
Air flow to drift tube 5 (see note 6)	100	ft^3/min
	2.8	m^3/min
K4653 (vapour cooled) (see page 12):		
volume of steam produced by collector dissipation	1.5	$ft^3/min/kW$
	0.043	$m^3/min/kW$
volume of water converted to steam . . .	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4653W (water cooled) (see page 12):		
minimum water flow required		see page 13
maximum collector pressure drop	5.0	lb/in^2
	0.35	kg/cm^2
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature (see note 8) . .	90	°C max
water inlet temperature	55	°C max

Arc Detector

Arc detector type MA257C is fitted to the third and output cavities. See page 21 for connection details.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections		see page 21

★ Indicates a change.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater voltage	9.5	V max
Heater starting current (peak)	65	A max
Beam voltage	28	kV max
Modulating anode to cathode voltage (see note 1)	23	kV max
Beam current	7.0	A max
Body current:		
with no input power	35	mA max
r.f. on (see note 9)	150	mA max
Modulating anode current	6.0	mA max
Mean output power	45	kW max
Collector dissipation	150	kW max
Load v.s.w.r. (see note 10)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see notes 11 and 12)	−1400	V max

TYPICAL OPERATION

55 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency•	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	23	25	26.5	kV
Modulating anode to cathode voltage (approx)	20.9	19.2	19.4	kV
Beam current	5.85	5.15	5.25	A
Body current:				
with no input power	9.0	7.0	7.0	mA
black level + sync.	80	45	35	mA
Sync. output power	58	58	58	kW
Saturated output power	60	60	60	kW
Electro-magnet current	11	10	10	A
Peak drive power for 58 kW output (see note 13)	16	8.0	5.0	W
Sync. efficiency	43.1	45.0	41.7	%
Saturated efficiency	44.6	46.6	43.1	%
1 dB bandwidth	7.0	7.0	7.0	MHz

5.5 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	23	25	26.5	kV
Modulating anode to cathode voltage (approx)	6.1	5.5	5.7	kV
Beam current	0.9	0.75	0.8	A
Output power	6.0	6.0	6.0	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

TYPICAL OPERATION

40 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	18.8	17.4	16.5	kV
Beam current	5.0	4.4	4.1	A
Body current:				
with no input power	8.0	6.0	6.0	mA
black level + sync.	55	35	25	mA
Sync. output power	43	43	43	kW
Saturated output power	45	45	45	kW
Electro-magnet current	11	10	10	A
Peak drive power for 43 kW output (see note 13)	16	8.0	5.0	W
Sync. efficiency	41.0	43.4	40.3	%
Saturated efficiency	42.9	45.5	42.2	%
1 dB bandwidth	7.0	7.0	7.0	MHz

4.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	5.7	5.0	4.5	kV
Beam current	0.8	0.7	0.6	A
Output power	4.5	4.5	4.5	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 2.5 mA.
2. Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode pre-heating time.
4. For black heat operation, a heater voltage of 6.0 V must have been applied to the klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to 8.5 V.
5. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for best TV performance and stabilize to ± 2% about this optimum value.
6. This value applies to transmitters at sea level where the air density is 0.076 lb/ft^3 (1.22 kg/m^3). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.
7. Measured by a manometer at the input pipe to the circuit assembly.
8. For operation at high altitude where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
9. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
10. This value applies to television service. EEV should be consulted regarding other conditions of service.
11. The K3573BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 58 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

    The following conditions must be observed when operating in this mode:

    (a) The B.C.D. voltage must **never** be positive with respect to cathode.

(b) The B.C.D. voltage must **not** exceed −1400 V with respect to cathode.

The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph (see page 15).

12. To measure the B.C.D. current, the klystron must be operated undisturbed for a period of **45 minutes** under the following conditions.

Beam voltage	21.5	kV
Modulating anode to cathode voltage	21.5	kV
Heater voltage	8.5	V
B.C.D. to cathode voltage	−1.0	kV

The B.C.D. current will typically be less than 1 mA on a new klystron and is warranted not to exceed 2 mA during the warranty period; in some cases it may exceed 2 mA during the remainder of the tube's life. To ensure that maximum useful life is achieved from all klystrons, the B.C.D. drive circuit should be able to give the required voltage variations at currents well in excess of 2 mA.

With a B.C.D. to cathode voltage of −1.0 kV, a beam current reduction of about 35% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 65% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	80	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

13. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

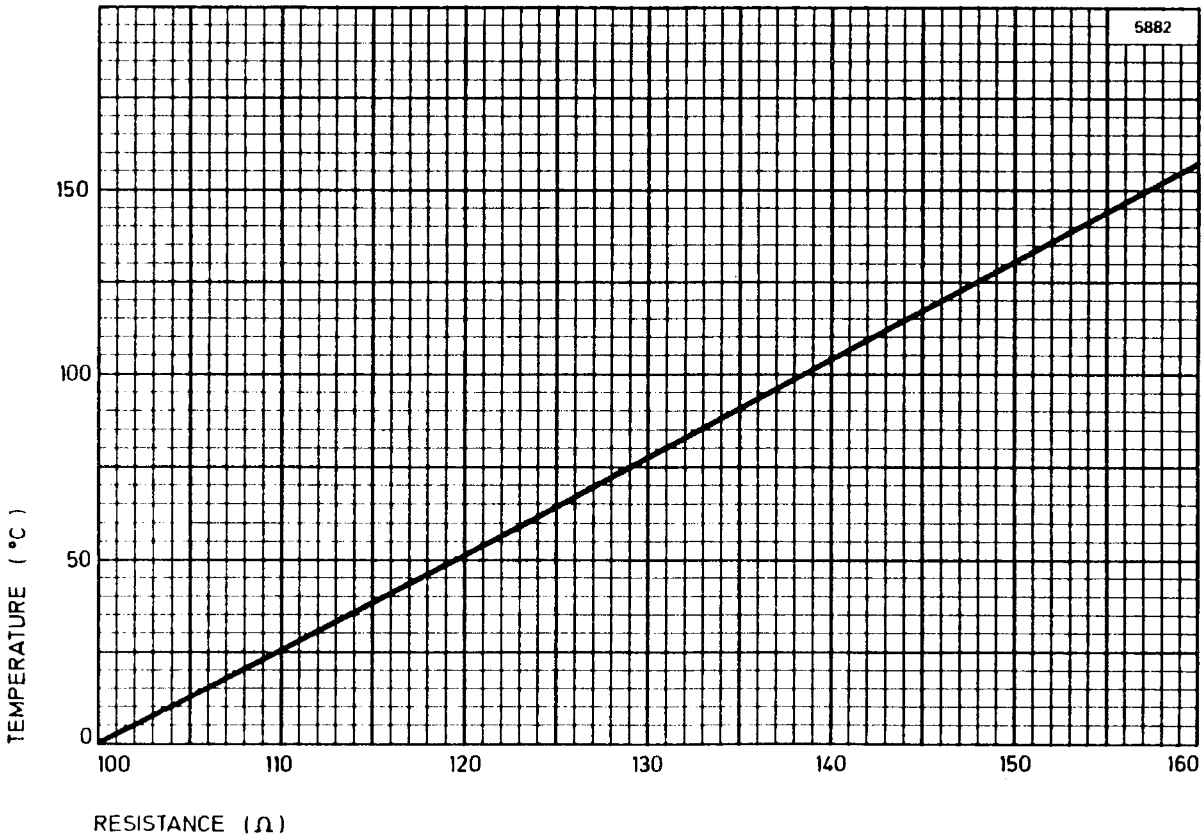
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 MΩ at 20 °C. The probes are tested to 240 V d.c. between probe and element.

Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4653W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 13 for flow rates).

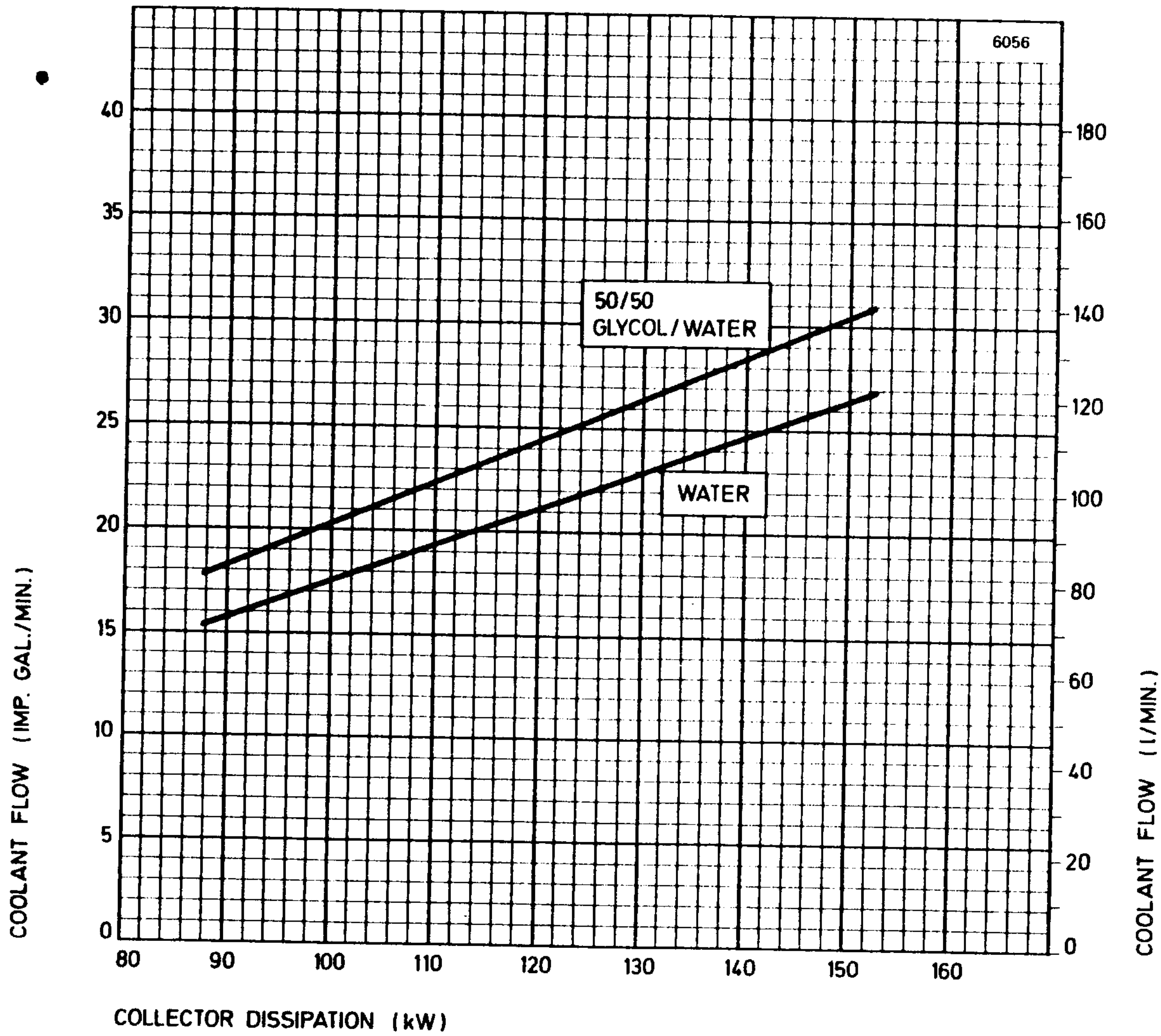
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4653 (Vapour Cooled)

Only pure demineralized water should be used in the boiler; local water supplies are usually suitable only for the secondary circuit of a water cooled condenser.

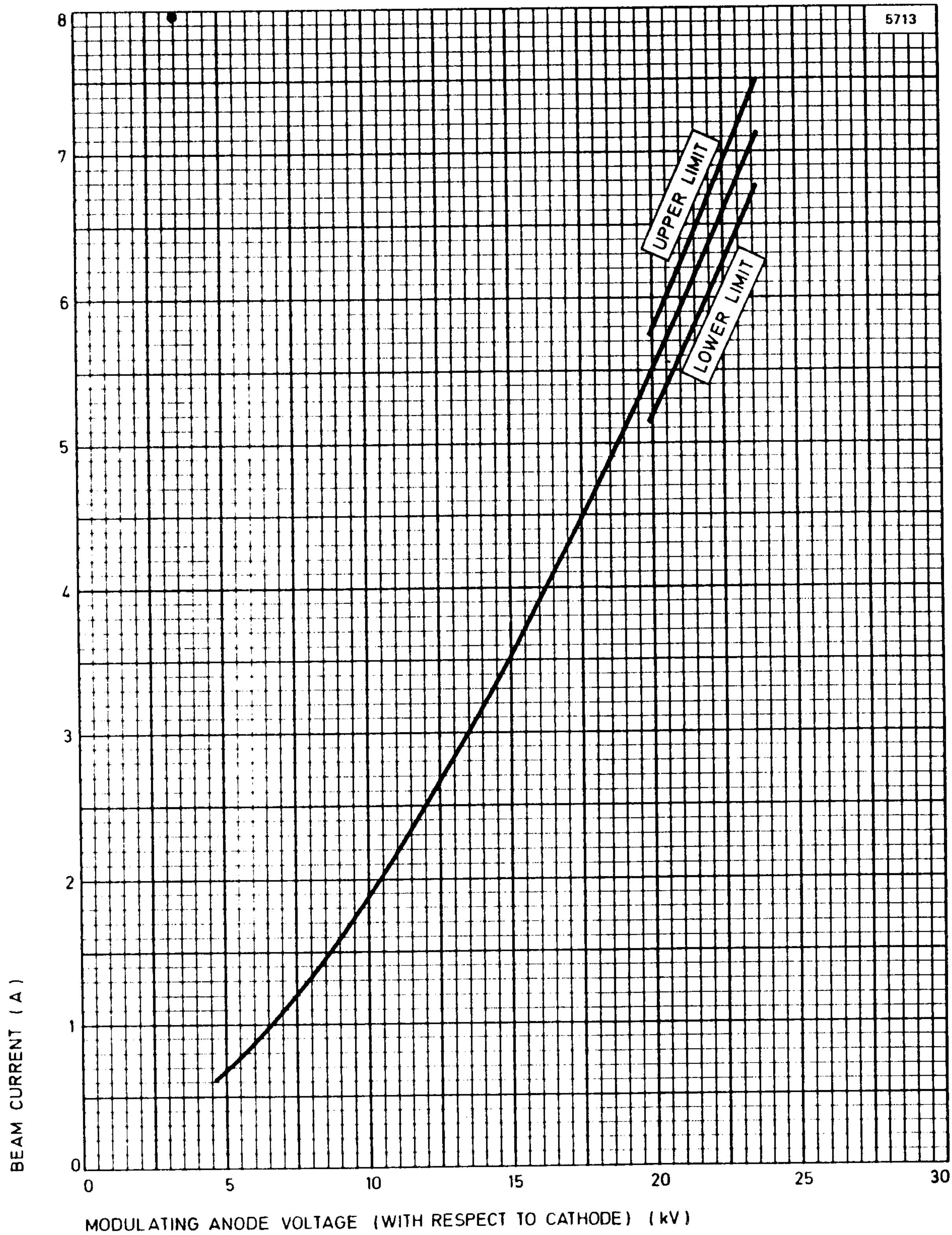
LIQUID COOLING REQUIREMENTS FOR K4653W



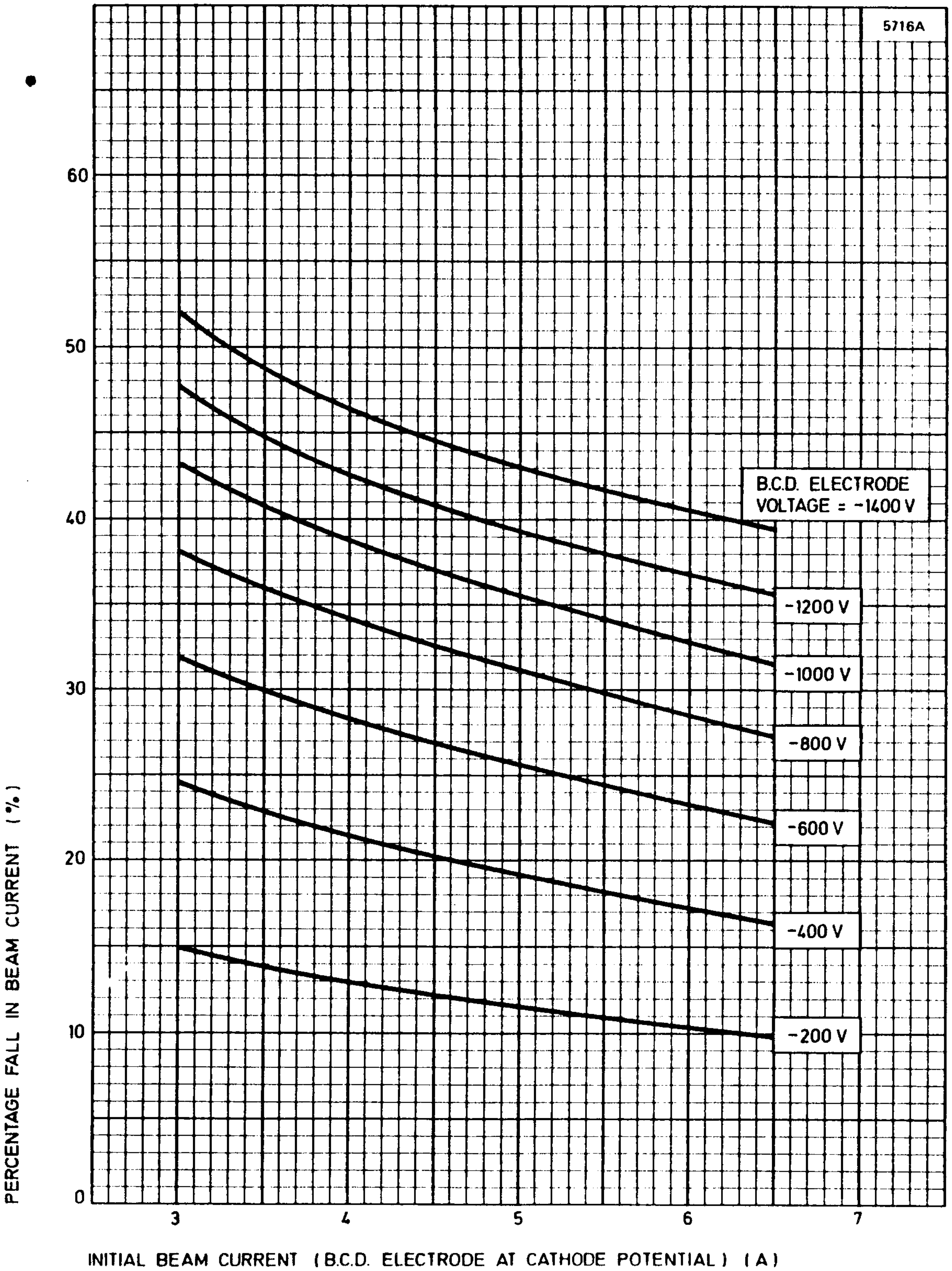
Note 1 U.S. gal = 0.832 Imp. gal.

BEAM CURRENT CHARACTERISTIC

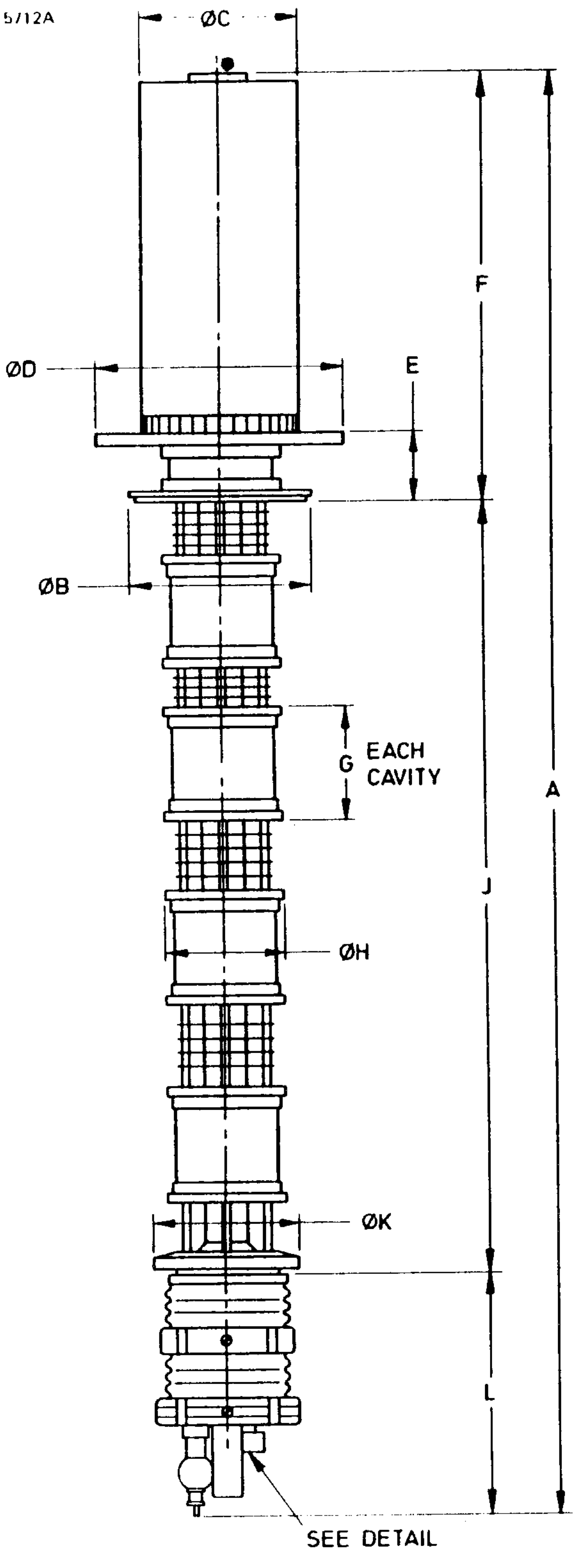
(B.C.D. electrode at cathode potential)



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3573BCD



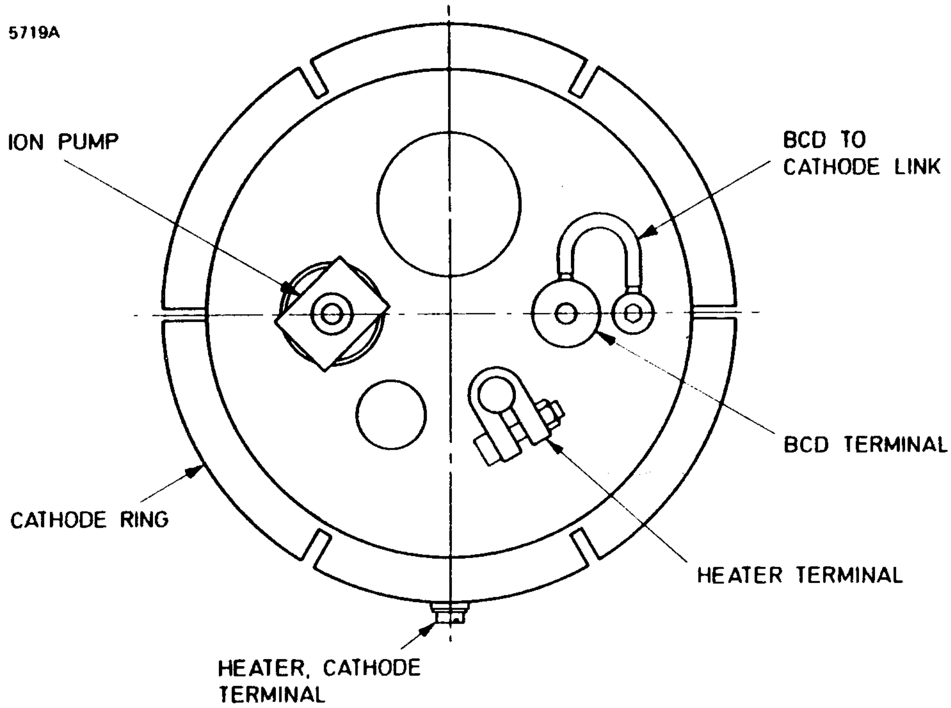
Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches
A	1588.0	62.520
B	202.0	7.953
C	175.0	6.890
D	282.5	11.122
E	75.4	2.969
F	466.5	18.366

Ref	Millimetres	Inches
G	127.0	5.000
H	130.2	5.126
J	846.5	33.327
K	160.0	6.299
L	275.0	10.827

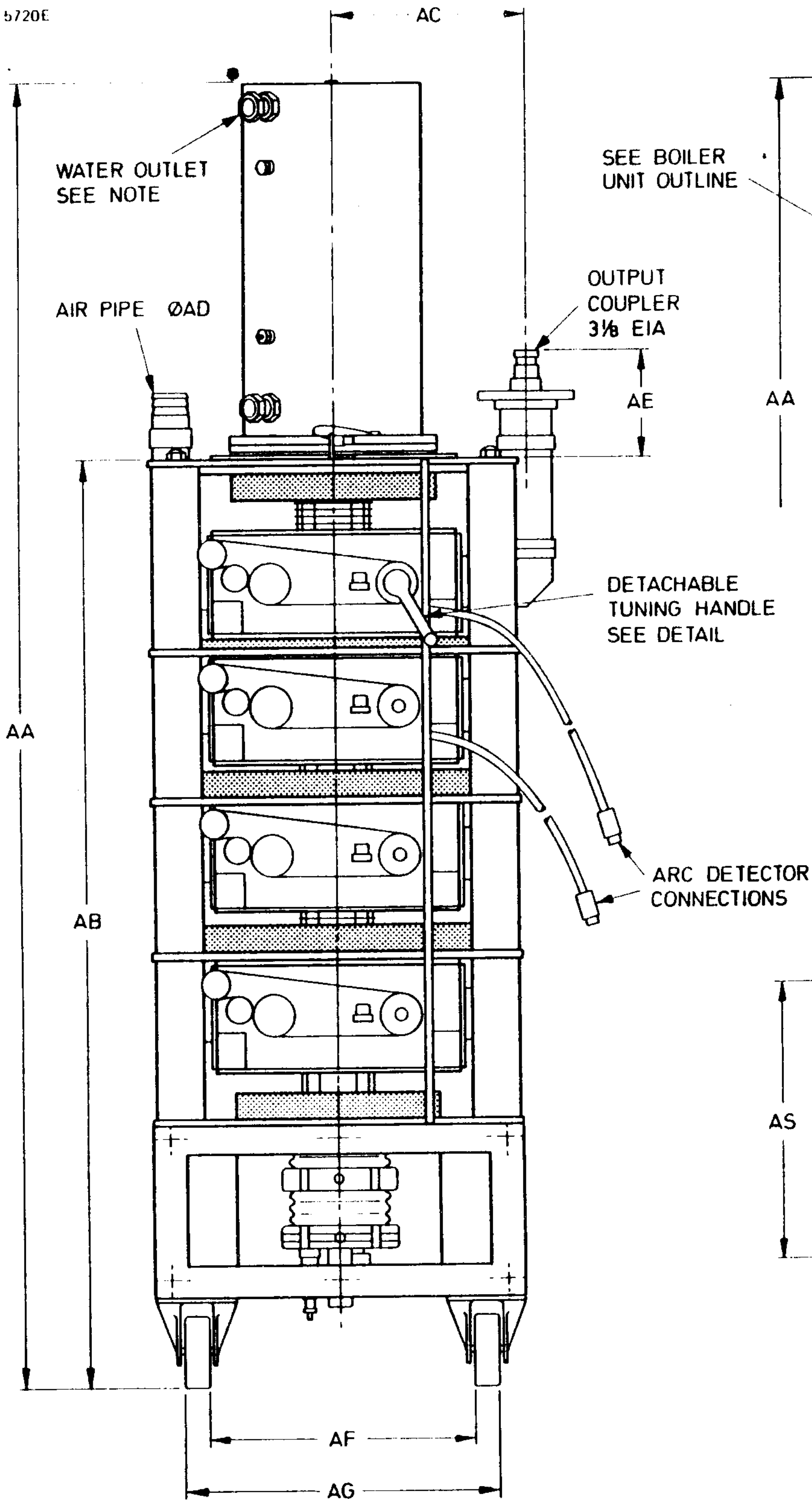
Inch dimensions have been derived from millimetres.

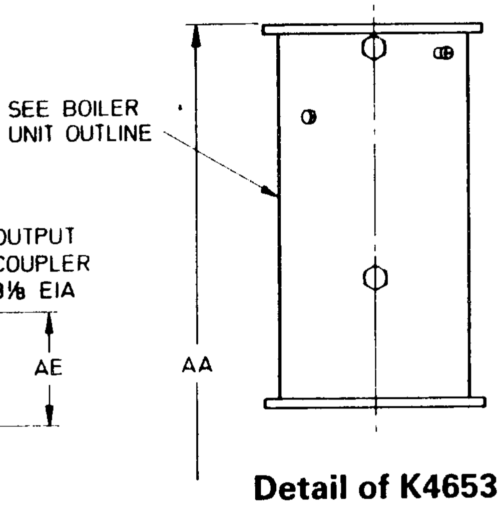
Enlarged View on Gun End of Klystron



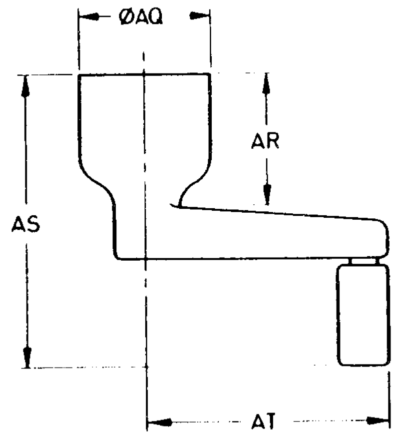
Note The klystron is supplied with a shorting link connected between the B.C.D. terminal and cathode. *If the B.C.D. electrode is to be used, this link must be removed.*

OUTLINE OF CIRCUIT ASSEMBLY K4653W



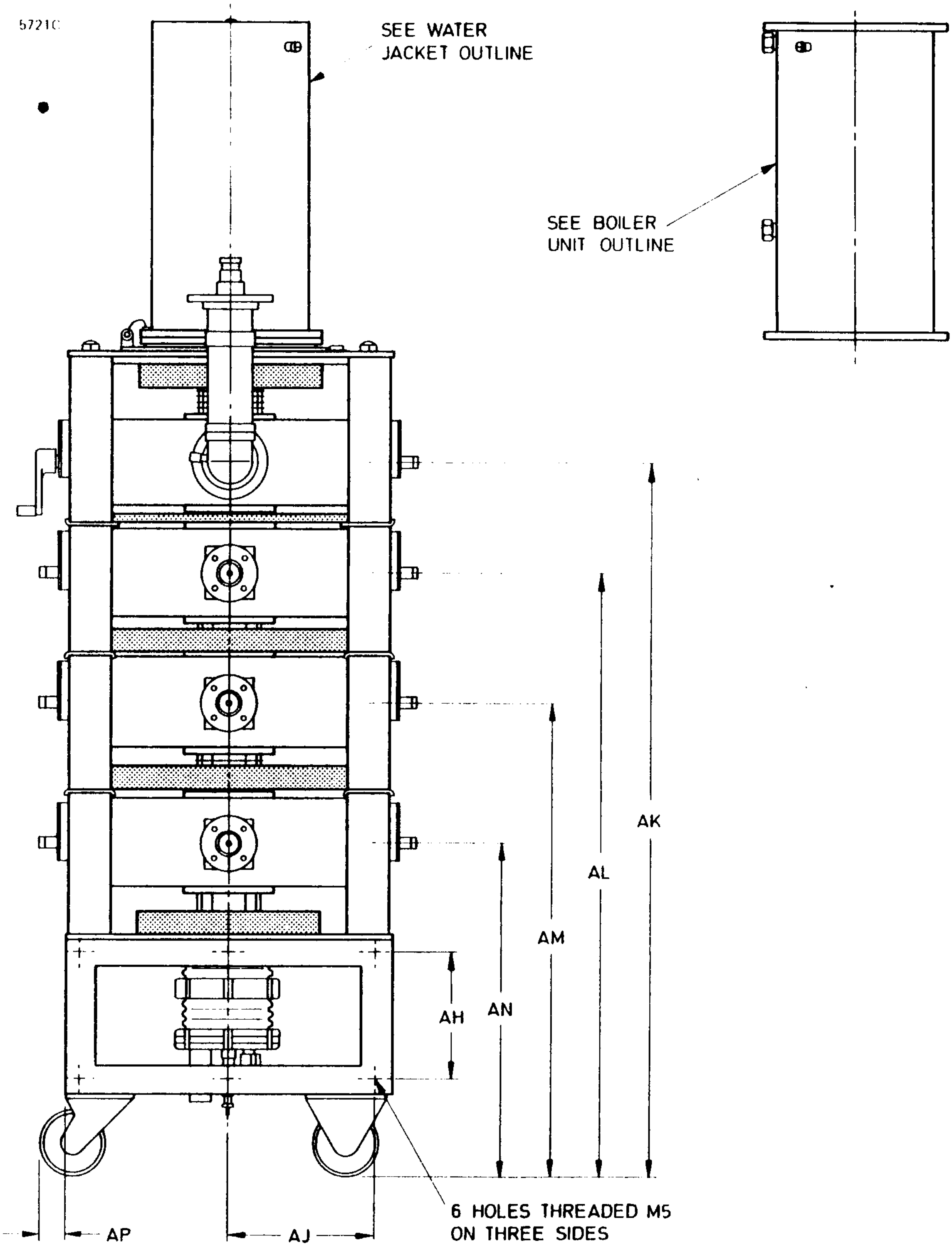


Detail of K4653 Boiler Unit



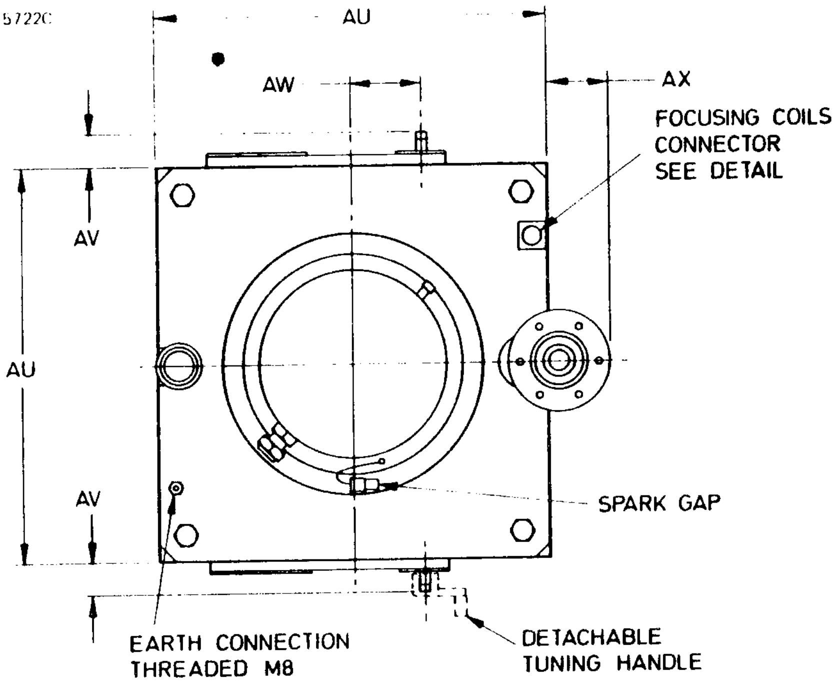
Detail of MA992A Tuning Handle

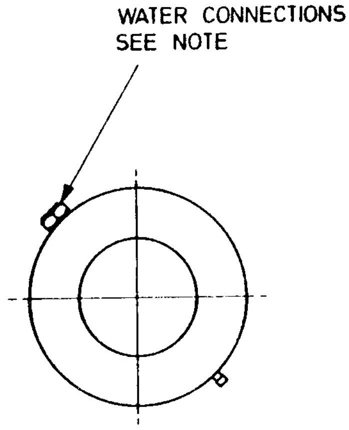
OUTLINE OF CIRCUIT ASSEMBLY K4653W



Top View of Circuit Assembly K4653W

(All dimensions without limits are nominal)





Detail of K4653 Boiler Unit

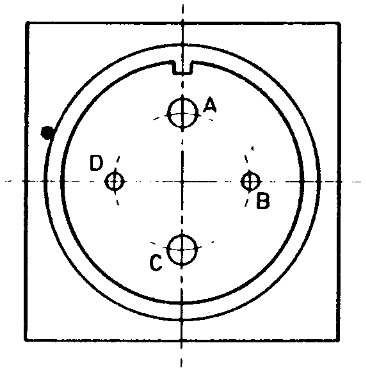
Ref	Millimetres	Inches	Ref	Millimetres	Inches
AA	1785.0	70.276	AM	722.0	28.425
AB	1264.0	49.764	AN	507.0	19.961
AC	265.0	10.433	AP	45.0	1.772
AD	50.0	1.969	AQ	40.0	1.575
AE	150.0	5.906	AR	60.0	2.362
AF	320.0	12.598	AS	130.0	5.118
AG	405.0	15.945	AT	90.0 max	3.543
AH	192.0	7.559	AU	508.0	20.000
AJ	234.0	9.213	AV	55.0	2.165
AK	1105.0	43.504	AW	88.0	3.465
AL	922.0	36.299	AX	78.0	3.071

Inch dimensions have been derived from millimetres.

Note Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

View on Focus Coil Connector

5456



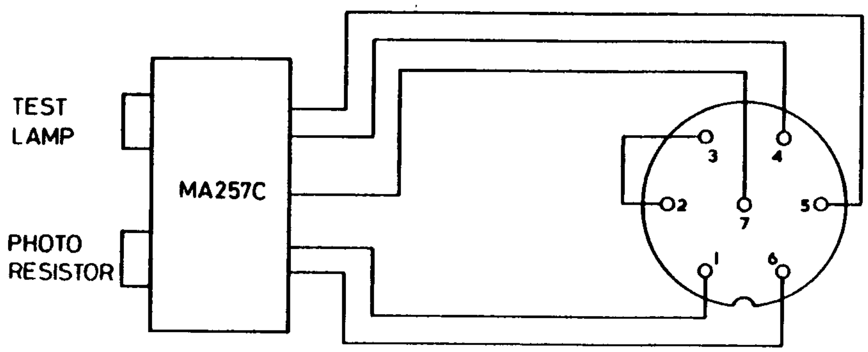
Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

Arc Detector Connections to socket type Amphenol T3476-001 ★

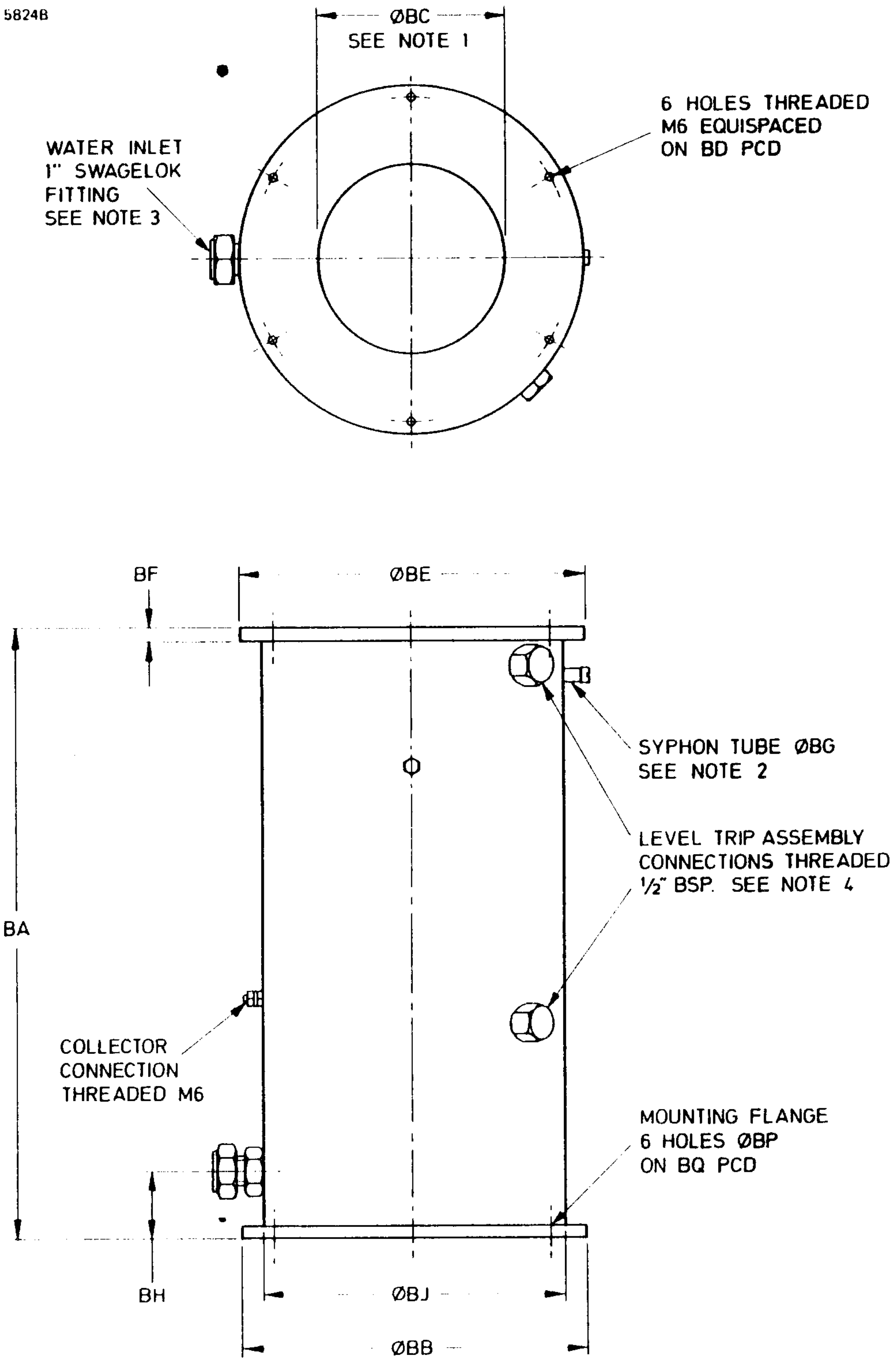
6223



MA257C uses a free plug and socket at the end of a 1500 mm cable.

★ Indicates a change.

OUTLINE OF BOILER UNIT



Outline Dimensions (All dimensions without limits are nominal)

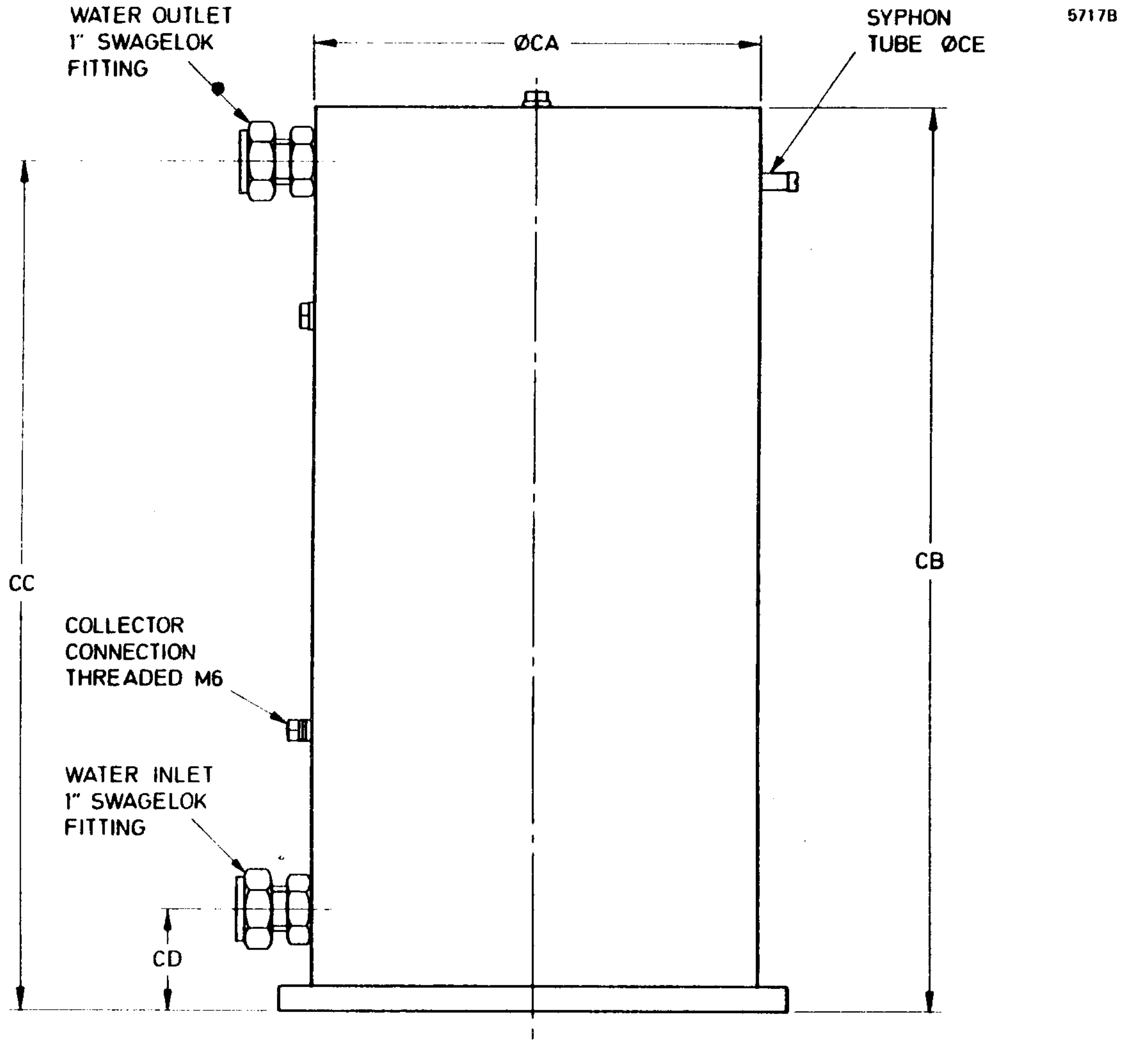
Ref	Millimetres	Inches	Ref	Millimetres	Inches
BA	498.0	19.606	BG	10.0	0.394
BB	282.5	11.122	BH	55.5	2.185
BC	152.5	6.004	BJ	248.0	9.764
BD	266.0	10.472	BP	7.25 ± 0.25	0.285 ± 0.010
BE	282.5	11.122	BQ	266.0	10.472
BF	13.0	0.512			

Inch dimensions have been derived from millimetres.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the syphon provided.
3. A weir, designed to maintain the water level in the boiler constant when operating with a pumped system, is available from EEV, part no. MA963C.
4. A sight glass and level trip assembly to fit the boiler is available from EEV, part no. MA213.

OUTLINE OF WATER JACKET (All dimensions nominal)



Ref	Millimetres	Inches
CA	248.0	9.764
CB	498.0	19.606
CC	467.0	18.386
CD	55.5	2.185
CE	10.0	0.394

Inch dimensions have been derived from millimetres.

English Electric Valve Company Limited
Chelmsford, Essex, England

Printed in England

Subsidiary of The General Electric Company, p.l.c. of England

K3672BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

Direct plug-in replacement for YK1265 in circuit assembly type TE1222.

FEATURING

- **Frequency Range** 470 to 810 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 65% can be achieved by beam pulsing. 44% typical sync. efficiency at 64 kW output in standard operational mode at the least efficient channel.
- **Output Power** Rated for 60 kW, 55 kW and 40 kW vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Cooling** Air-cooled body and cavities. Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3672BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 810 MHz at sync. power levels up to 64 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

May 1988

Supersedes November 1986 Issue

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification. A feature of the cavity design is that tuning of both halves of each cavity is by means of a single knob. A digital indication of the cavity frequency is provided.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range (see note 1)	470 to 810	MHz
US channel numbers	14 to 69	
Sync. output power at klystron flange	up to 64	kW
Maximum drive power requirements:		
conventional operation	25	W
pulsed operation	100	W
Power gain (conventional operation)	34 to 42	dB
Beam voltage (for 64 kW sync. power) . . .	24.5 to 27.5	kV
Modulating anode to cathode voltage (see note 2)	17.0 to 21.5	kV

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage	8.5 ± 3%	Vd.c.
Heater current range	25 to 28	A
Black heat heater voltage (see note 3)	6.0	Vd.c.
Cathode pre-heating time:		
from cold (see note 4)	5	minutes
from black heat (see note 5)	0	minutes
Vacion pump to cathode voltage	+3.0 to 4.0	kV
Internal impedance of vacion supply	500	kΩ approx

Mechanical

Overall length	62.56 inches (160 cm) nom
Overall diameter	11.12 inches (28.25 cm) nom
Mounting position	vertical, collector end up
Net weight of klystron	176 pounds (80 kg) approx

Circuit Assembly K4651 or K4651W

For vapour cooling of collector, order K4651.

For water cooling of collector, order K4651W.

Electro-magnet current, stabilized to ± 2% (see note 6)		
vision klystron	10 to 12	A
sound klystron	9 to 12	A
Electro-magnet resistance:		
cold	8.4 ± 1.1	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		100 pounds (45 kg) approx
Net weight of magnet assembly		505 pounds (230 kg) approx

Cooling

Air flow to cavities and body (see note 7)	100	ft^3/min
	2.8	m^3/min
Static pressure head (see note 8)	5.0 inches (127 mm) w.g.	
Air flow to cathode terminal ★		
during black heat operation (see note 7)	5.0	ft^3/min
	0.14	m^3/min
Air flow to drift tube 5 (see notes 7 and 9)	100	ft^3/min
	2.8	m^3/min
K4651 (vapour cooled) (see page 14):		
volume of steam produced by collector dissipation	1.5	ft^3/min/kW
	0.043	m^3/min/kW
volume of water converted to steam	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4651W (water cooled) (see page 14):		
minimum water flow required		see page 15
maximum collector pressure drop	5.0	lb/in^2
	0.35	kg/cm^2
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature (see note 10)	90	°C max
water inlet temperature	55	°C max

Arc Detector

Arc detector type MA257C is fitted to the third and output cavities. See page 23 for connection details.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections		see page 23

★ Indicates a change.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater voltage	9.5	V max
Heater starting current (peak)	65	A max
Beam voltage	28	kV max
Modulating anode to cathode voltage (see note 2)	23	kV max
Beam current	7.0	A max
Body current:		
with no input power	35	mA max
r.f. on (see note 11)	150	mA max
Modulating anode current	6.0	mA max
Mean output power	45	kW max
Collector dissipation	150	kW max
Load v.s.w.r. (see note 12)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see notes 13 and 14)	−1400	V max

TYPICAL OPERATION

60 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency •	470 to 476	638 to 644	800 to 806	MHz
US channel	14	42	69	
Beam voltage	25	26	27	kV
Modulating anode to cathode voltage (approx)	20.7	19.6	19.5	kV
Beam current	5.8	5.35	5.3	A
Body current:				
with no input power . . .	10	8.0	8.0	mA
black level + sync. . . .	85	65	40	mA
Sync. output power	64	64	64	kW
Saturated output power . .	67	67	67	kW
Electro-magnet current . . .	11.0	10.5	10.0	A
Peak drive power for 64 kW output (see note 15) . . .	16	8.0	5.0	W
Sync. efficiency	44.1	46.0	44.7	%
Saturated efficiency	46.2	48.1	46.8	%
1 dB bandwidth	7.0	7.0	7.0	MHz

6.0 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	25	26	27	kV
Modulating anode to cathode voltage (approx)	5.9	5.7	5.5	kV
Beam current	0.85	0.8	0.75	A
Output power	6.5	6.5	6.5	kW
Electro-magnet current . . .	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

12 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	25	26	27	kV
Modulating anode to cathode voltage (approx)	8.6	8.1	7.9	kV
Beam current	1.5	1.35	1.3	A
Output power	13	13	13	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

24 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	25	26	27	kV
Modulating anode to cathode voltage (approx)	12.9	12.0	11.7	kV
Beam current	2.8	2.5	2.4	A
Output power	25.5	25.5	25.5	kW
Electro-magnet current	11	10	10	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.5	1.5	1.5	MHz

TYPICAL OPERATION

55 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency •	470 to 476	638 to 644	800 to 806	MHz
US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	20.9	19.2	19.0	kV
Beam current	5.85	5.15	5.1	A
Body current:				
with no input power	9.0	7.0	7.0	mA
black level + sync.	80	45	35	mA
Sync. output power	58	58	58	kW
Saturated output power	60	60	60	kW
Electro-magnet current	11	10	10	A
Peak drive power for 58 kW output (see note 15)	16	8.0	5.0	W
Sync. efficiency	43.1	45.0	43.7	%
Saturated efficiency	44.6	46.6	45.2	%
1 dB bandwidth	7.0	7.0	7.0	MHz

5.5 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	23	25	26	kV
Modulating anode to cathode voltage (approx)	6.1	5.5	5.0	kV
Beam current	0.9	0.75	0.7	A
Output power	6.0	6.0	6.0	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

TYPICAL OPERATION

40 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 476	638 to 644	800 to 806	MHz
US channel	14	42	69	
Beam voltage	21.0	22.5	24.5	kV
Modulating anode to cathode voltage (approx)	18.8	17.4	16.7	kV
Beam current	5.0	4.4	4.2	A
Body current:				
with no input power	8.0	6.0	6.0	mA
black level + sync.	55	35	25	mA
Sync. output power	43	43	43	kW
Saturated output power	45	45	45	kW
Electro-magnet current	11	10	10	A
Peak drive power for 43 kW output (see note 15)	16	8.0	5.0	W
Sync. efficiency	41.0	43.4	41.8	%
Saturated efficiency	42.9	45.5	43.7	%
1 dB bandwidth	7.0	7.0	7.0	MHz

4.0 kW sound amplifier

B.C.D. electrode at cathode potential

US channel	14	42	69	
Beam voltage	21.0	22.5	24.5	kV
Modulating anode to cathode voltage (approx)	5.7	5.0	4.5	kV
Beam current	0.8	0.7	0.6	A
Output power	4.5	4.5	4.5	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

NOTES

1. For operation in the range 810 to 860 MHz, please consult EEV.
2. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 2.5 mA.
3. Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation.
4. In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode pre-heating time.
5. For black heat operation, a heater voltage of 6.0 V must have been applied to the klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to 8.5 V.
6. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for best TV performance and stabilize to ± 2% about this optimum value.
7. This value applies to transmitters at sea level where the air density is 0.076 lb/ft^3 (1.22 kg/m^3). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.
8. Measured by a manometer at the input pipe to the circuit assembly.
9. A separate supply of air to the fifth drift tube is necessary for operation at 60 kW. The air pipe on the manifold which is directed at the fifth drift tube must be blocked and an air flow of 100 ft^3/min (2.8 m^3/min) blown through a rectangular duct of 7 square inches (45 cm^2) cross-section directed at the drift tube.
10. For operation at high altitude where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
11. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
12. This value applies to television service. EEV should be consulted regarding other conditions of service.

13. The K3672BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 64 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

The following conditions must be observed when operating in this mode:

(a) The B.C.D. voltage must **never** be positive with respect to cathode.

(b) The B.C.D. voltage must **not** exceed −1400 V with respect to cathode.

The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph (see page 17).

14. To measure the B.C.D. current, the klystron must be operated undisturbed for a period of **45 minutes** under the following conditions.

Beam voltage	21.5	kV
Modulating anode to cathode voltage	21.5	kV
Heater voltage	8.5	V
B.C.D. to cathode voltage	−1.0	kV

The B.C.D. current on a new klystron will not exceed 2.0 mA and typically will be less than 1.0 mA.

With a B.C.D.-to-cathode voltage of −1.0 kV, a beam current reduction of about 35% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 65% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	80	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

15. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

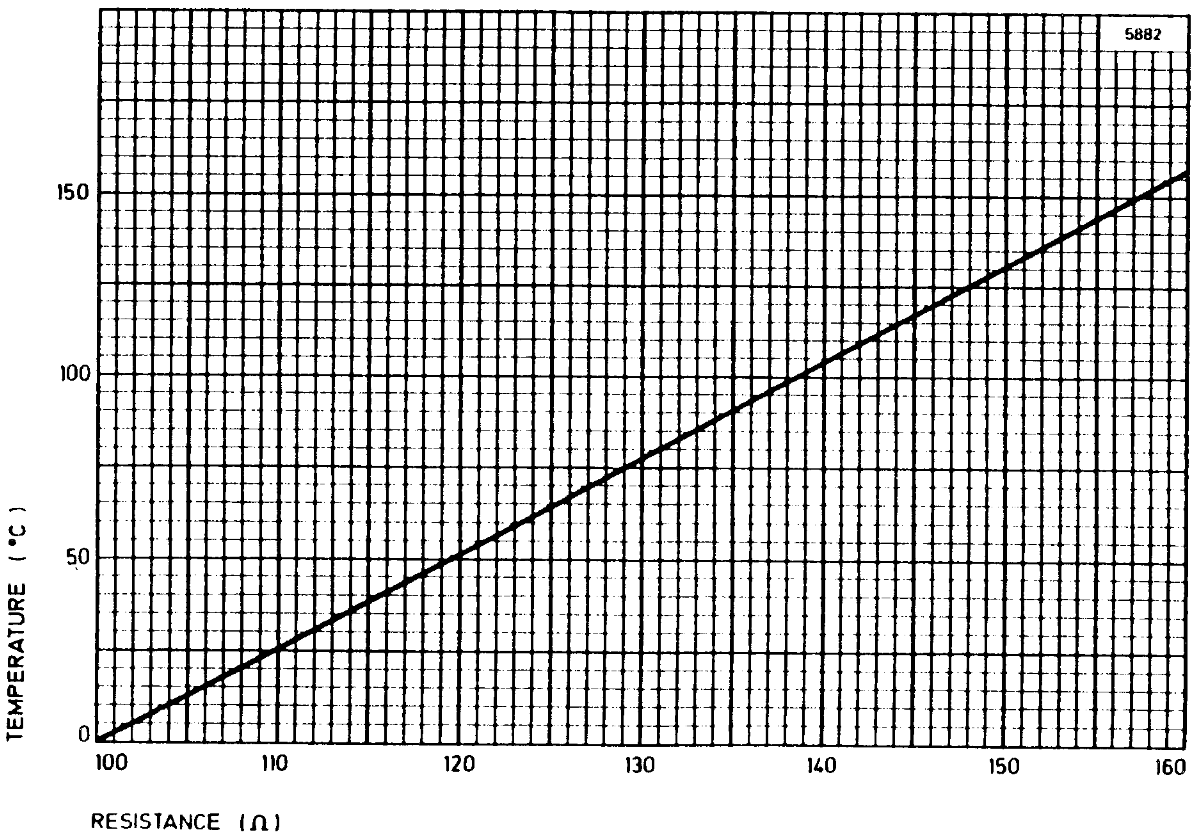
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 MΩ at 20 °C. The probes are tested to 240 V d.c. between probe and element.

Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4651W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 15 for flow rates).

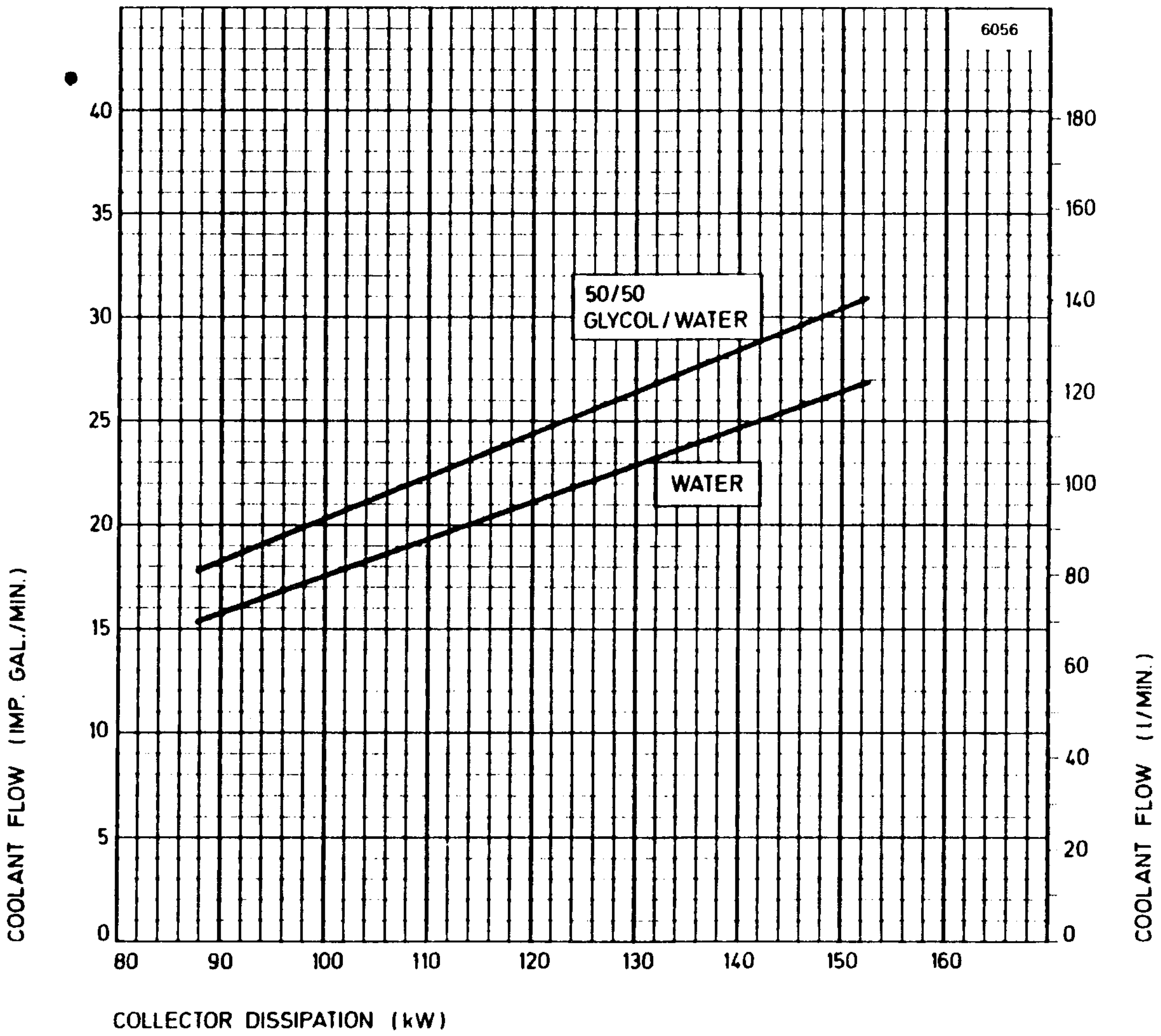
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4651 (Vapour Cooled)

Only pure demineralized water should be used in the boiler; local water supplies are usually suitable only for the secondary circuit of a water cooled condenser.

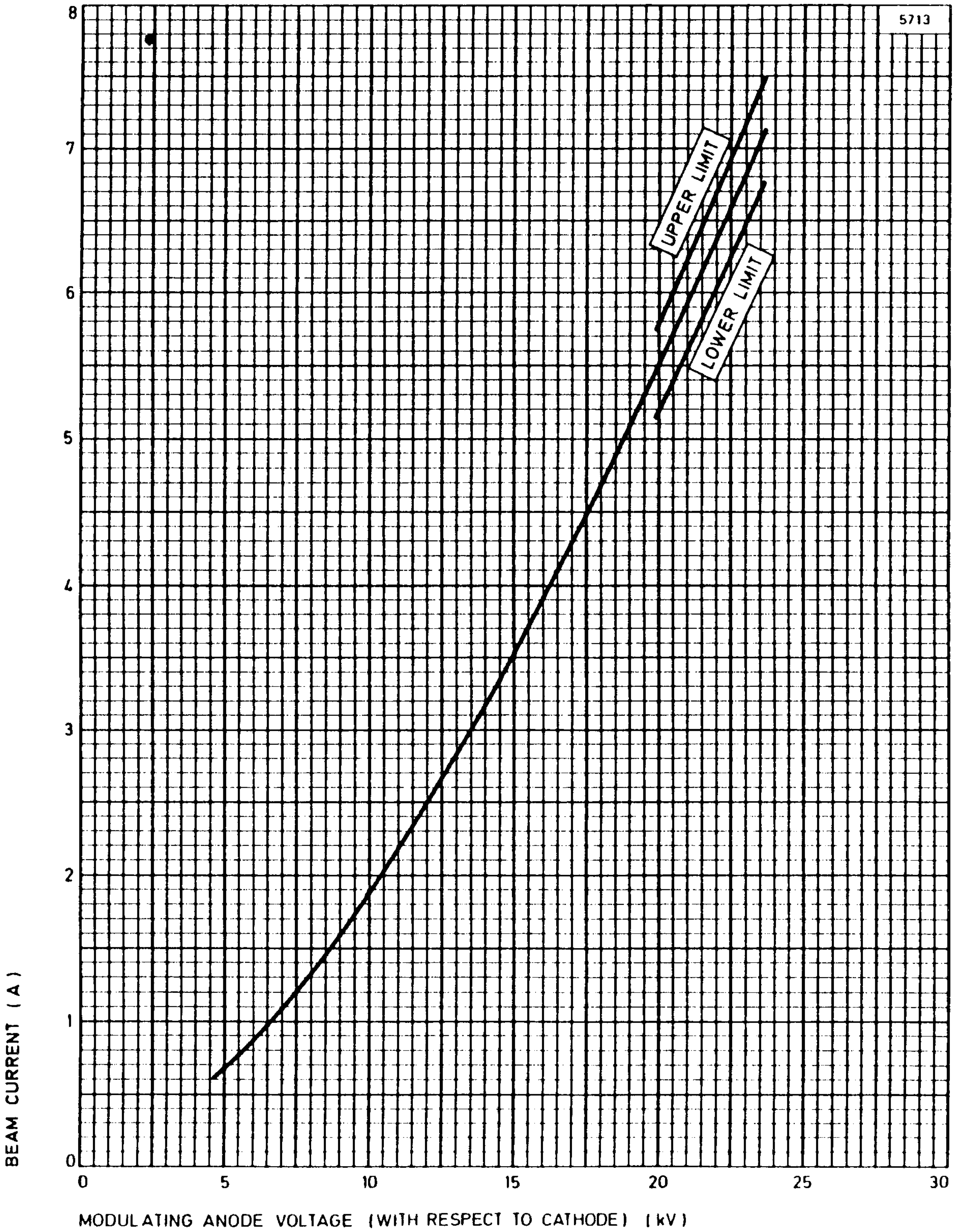
LIQUID COOLING REQUIREMENTS FOR K4651W



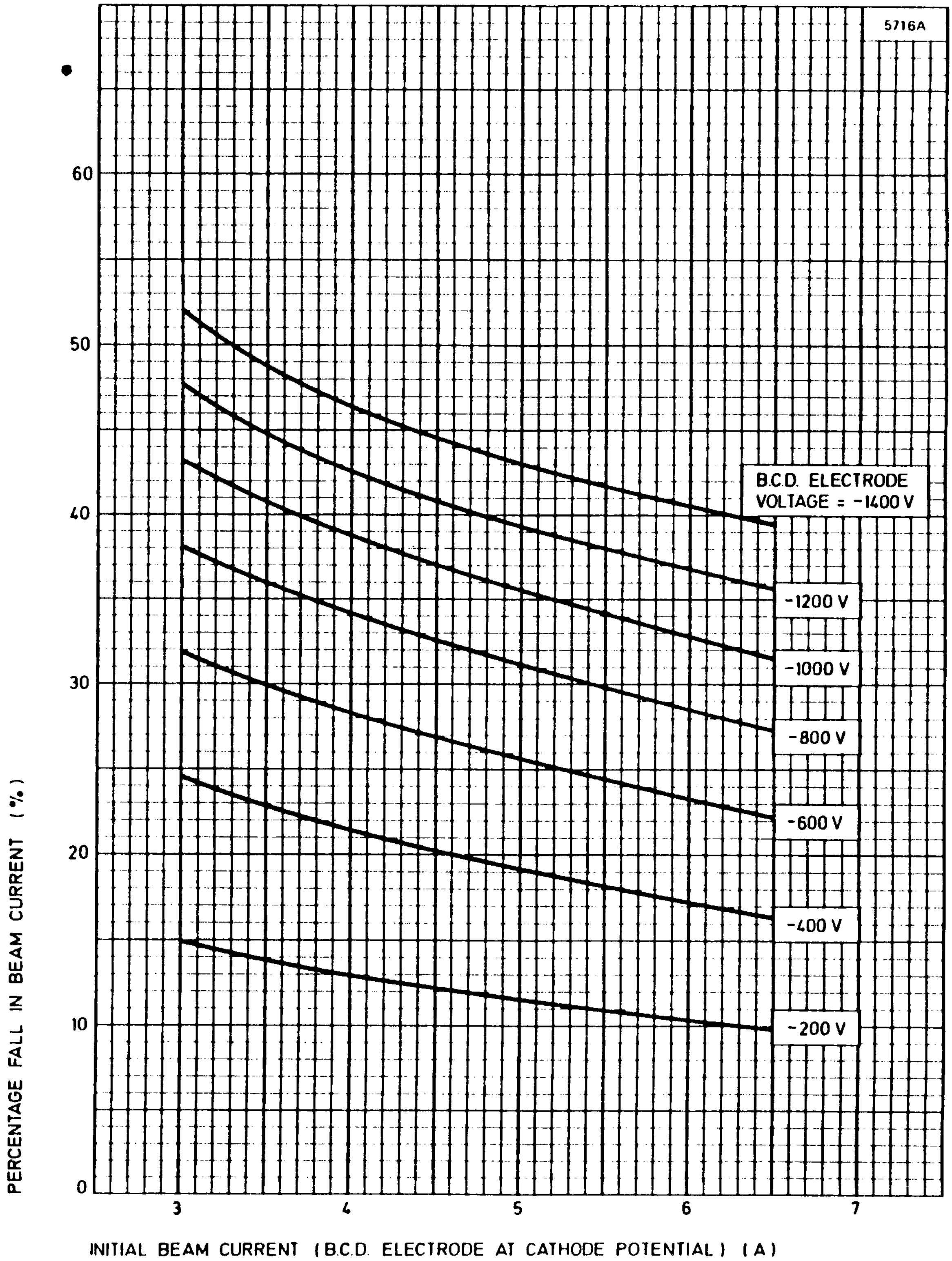
Note 1 U.S. gal = 0.832 Imp. gal.

BEAM CURRENT CHARACTERISTIC

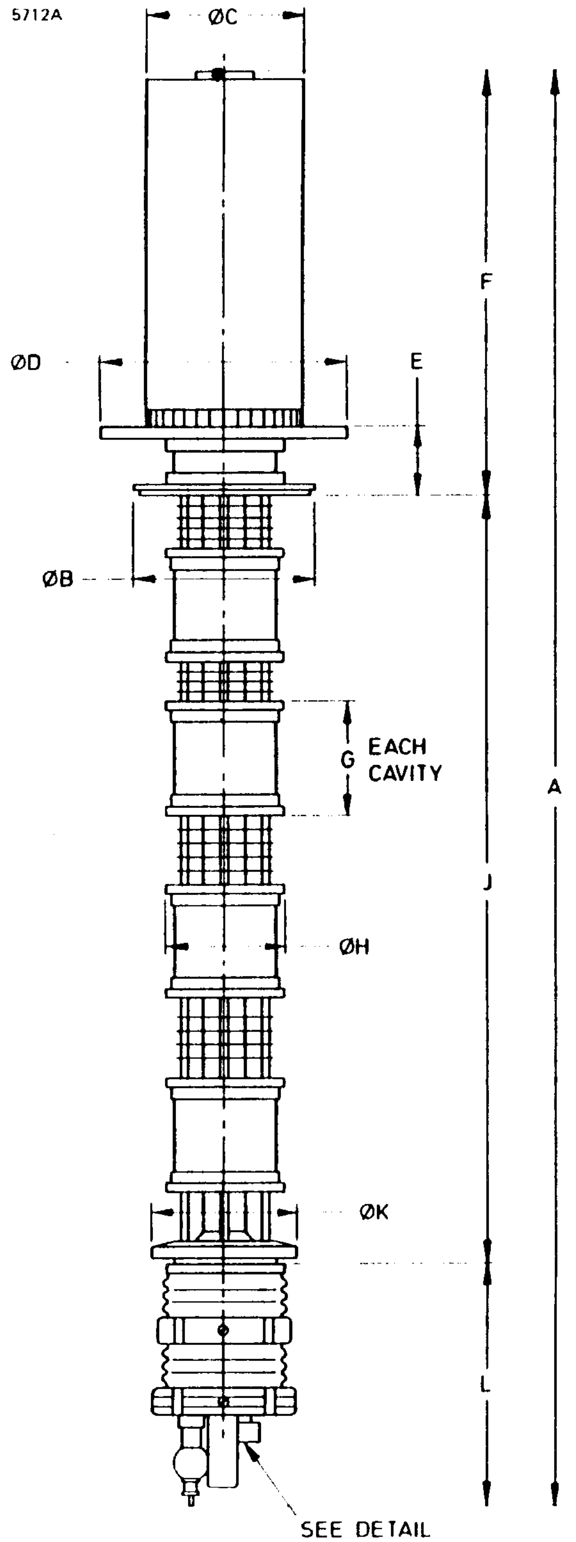
(B.C.D. electrode at cathode potential)



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3672BCD

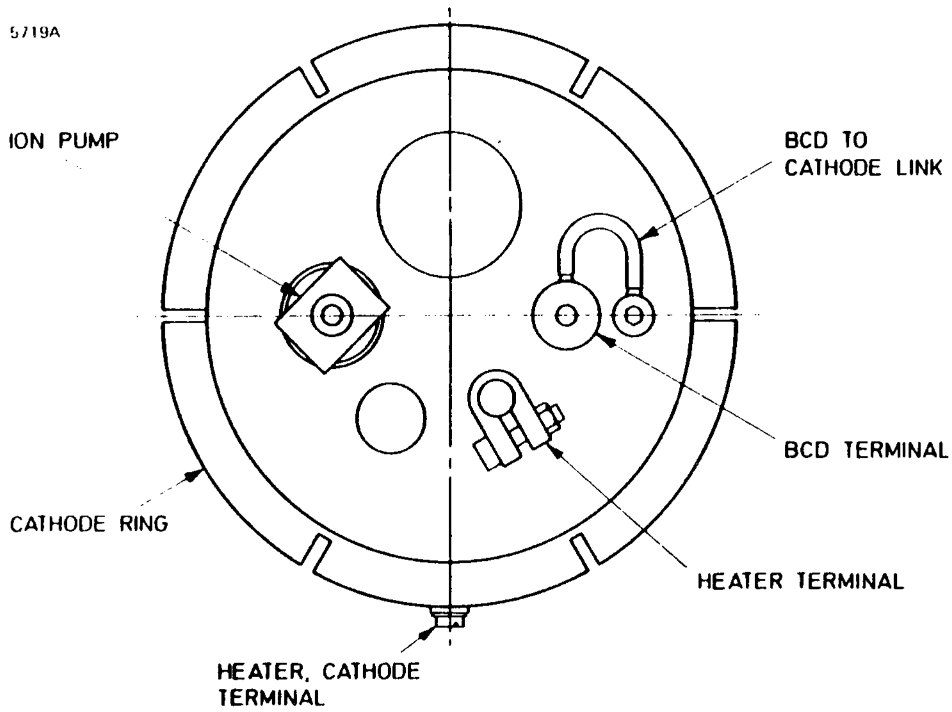


Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	1588.0	62.520	G	127.0	5.000
B	202.0	7.953	H	130.2	5.126
C	175.0	6.890	J	846.5	33.327
D	282.5	11.122	K	160.0	6.299
E	75.4	2.969	L	275.0	10.827
F	466.5	18.366			

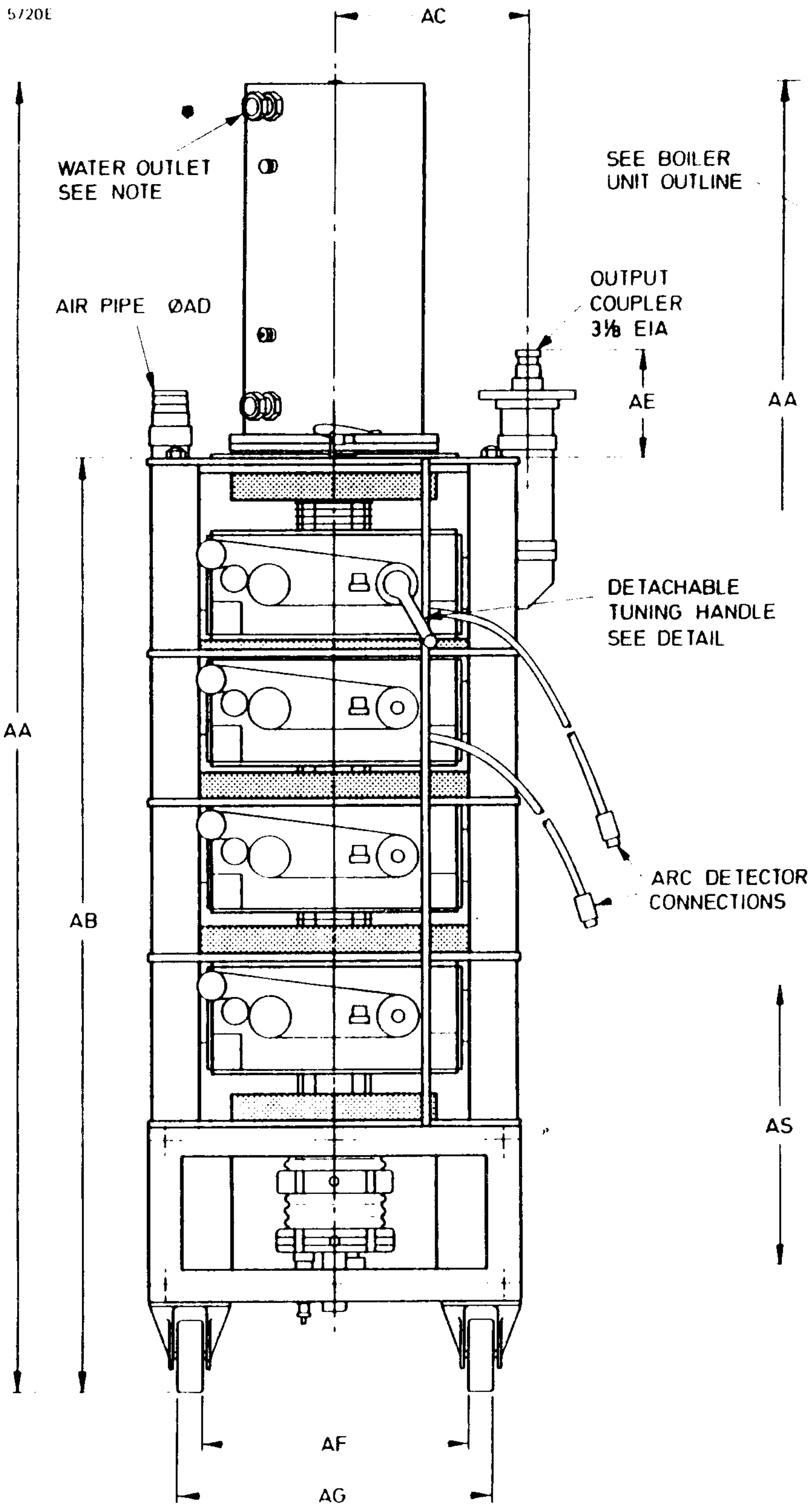
Inch dimensions have been derived from millimetres.

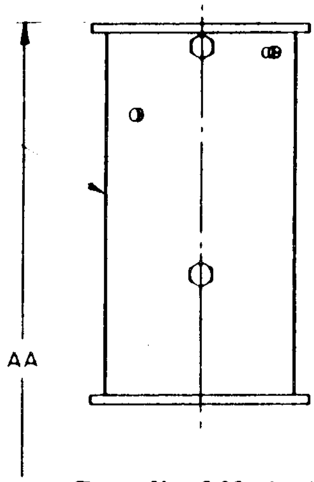
Enlarged View on Gun End of Klystron



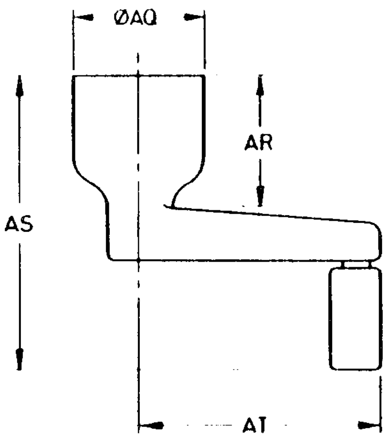
Note The klystron is supplied with a shorting link connected between the B.C.D. terminal and cathode. *If the B.C.D. electrode is to be used, this link must be removed.*

OUTLINE OF CIRCUIT ASSEMBLY K4651W



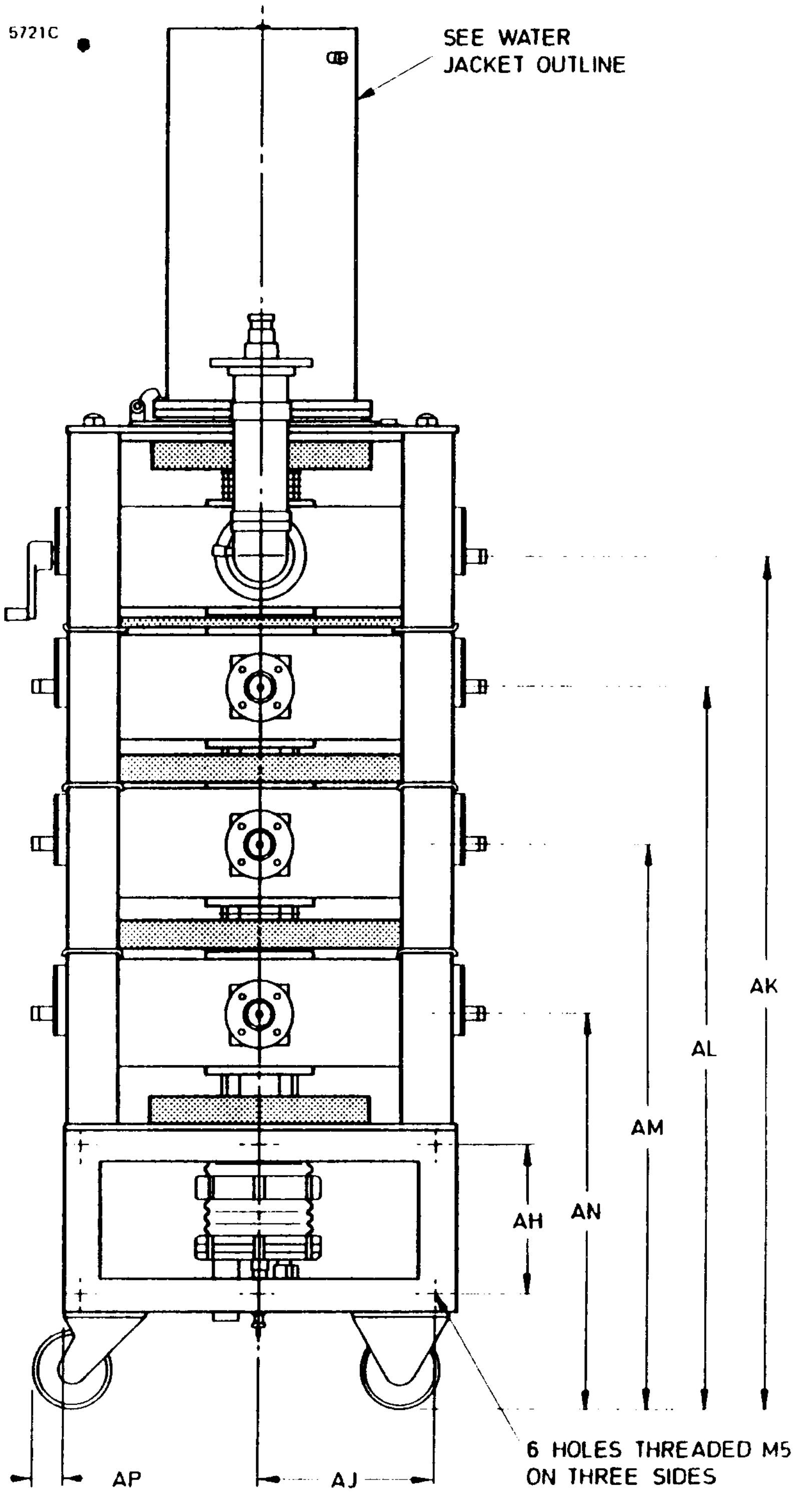


Detail of K4651 Boiler Unit



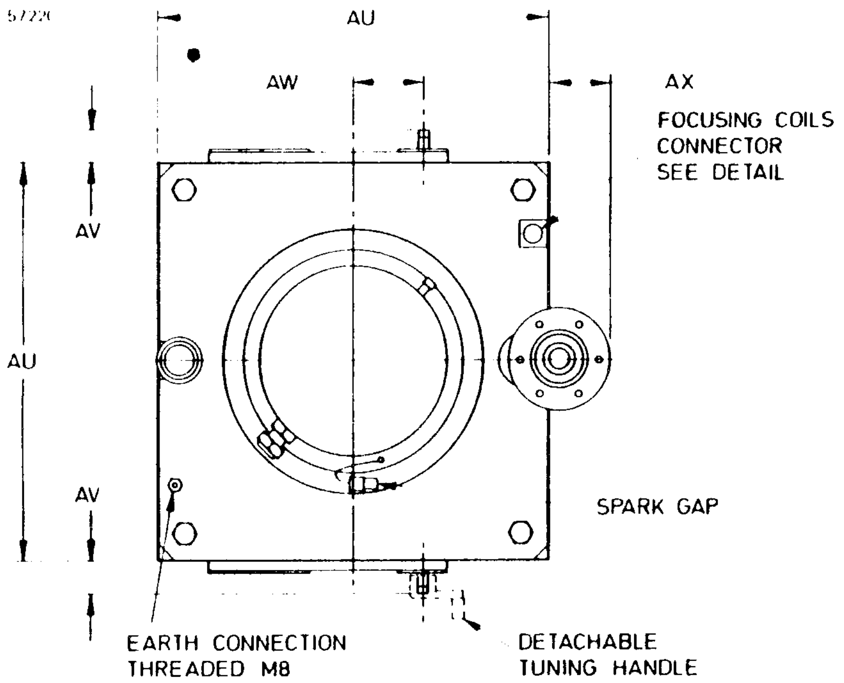
Detail of MA992A Tuning Handle

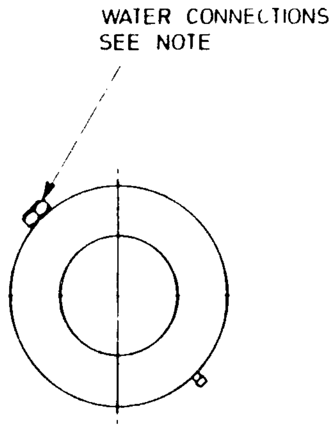
OUTLINE OF CIRCUIT ASSEMBLY K4651W



Top View of Circuit Assembly K4651W

(All dimensions without limits are nominal)





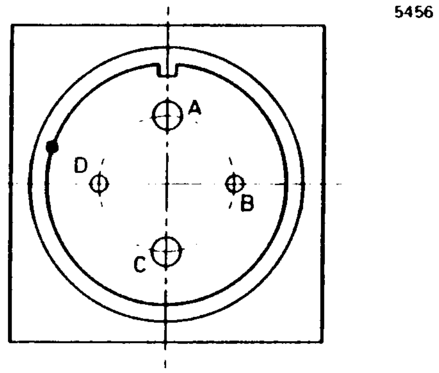
Detail of K4651 Boiler Unit

Ref	Millimetres	Inches	Ref	Millimetres	Inches
AA	1785.0	70.276	AM	722.0	28.425
AB	1264.0	49.764	AN	507.0	19.961
AC	265.0	10.433	AP	45.0	1.772
AD	50.0	1.969	AQ	40.0	1.575
AE	150.0	5.906	AR	60.0	2.362
AF	320.0	12.598	AS	130.0	5.118
AG	405.0	15.945	AT	90.0 max	3.543
AH	192.0	7.559	AU	508.0	20.000
AJ	234.0	9.213	AV	55.0	2.165
AK	1090.0	42.913	AW	88.0	3.465
AL	922.0	36.299	AX	78.0	3.071

Inch dimensions have been derived from millimetres.

Note Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

View on Focus Coil Connector

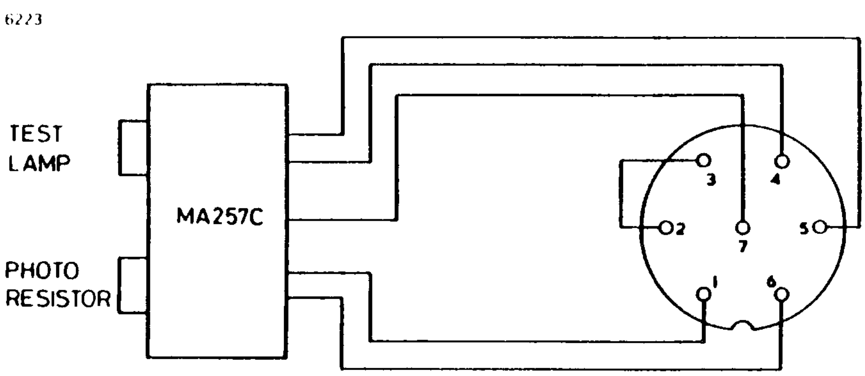


Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

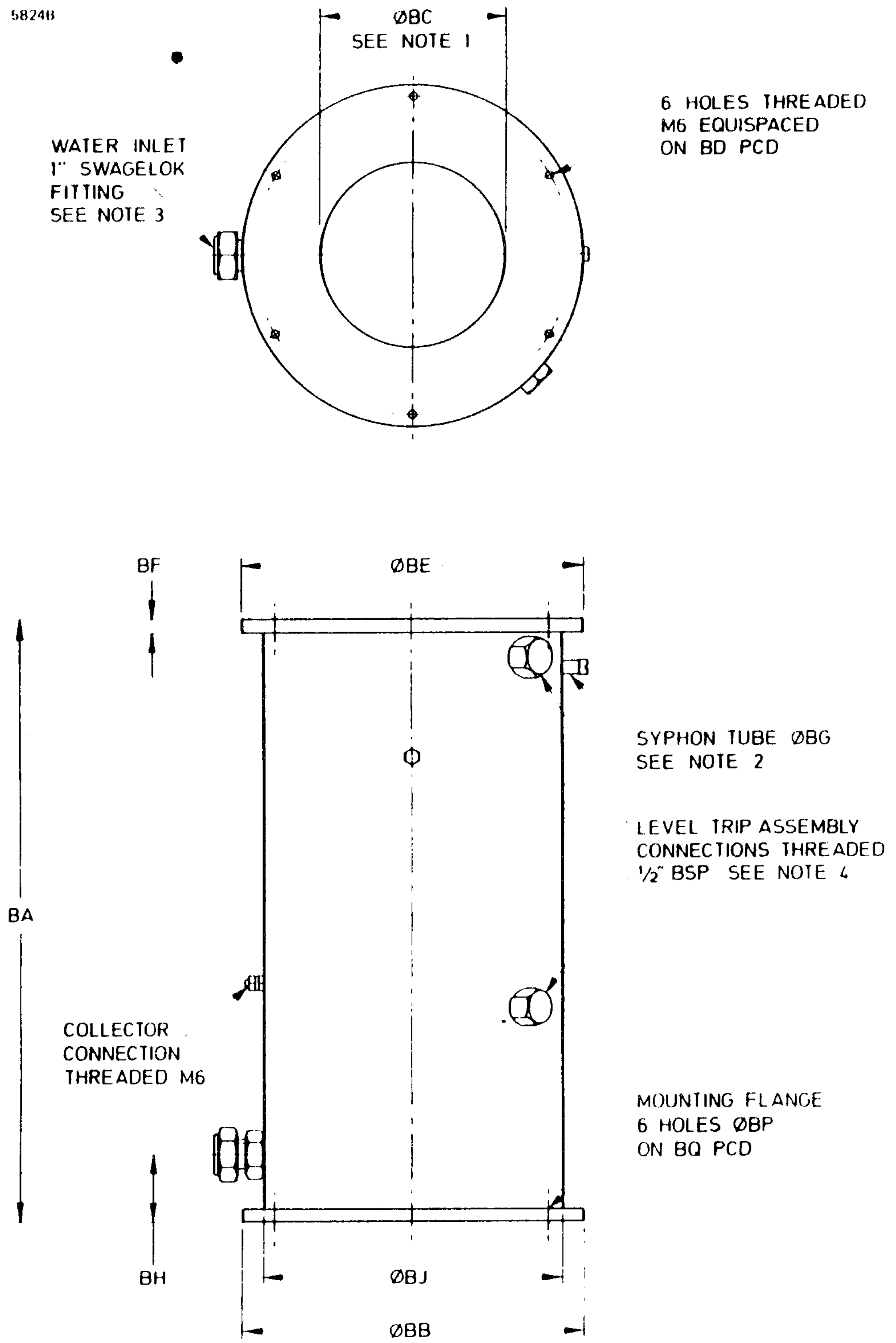
Arc Detector Connections to socket type Amphenol T3476-001 ★



MA257C uses a free plug and socket at the end of a 1500 mm cable.

★ Indicates a change.

OUTLINE OF BOILER UNIT



Outline Dimensions (All dimensions without limits are nominal)

Ref	Millimetres	Inches	Ref	Millimetres	Inches
BA	498.0	19.606	BG	10.0	0.394
BB	282.5	11.122	BH	55.5	2.185
BC	152.5	6.004	BJ	248.0	9.764
BD	266.0	10.472	BP	7.25 ± 0.25	0.285 ± 0.010
BE	282.5	11.122	BQ	266.0	10.472
BF	13.0	0.512			

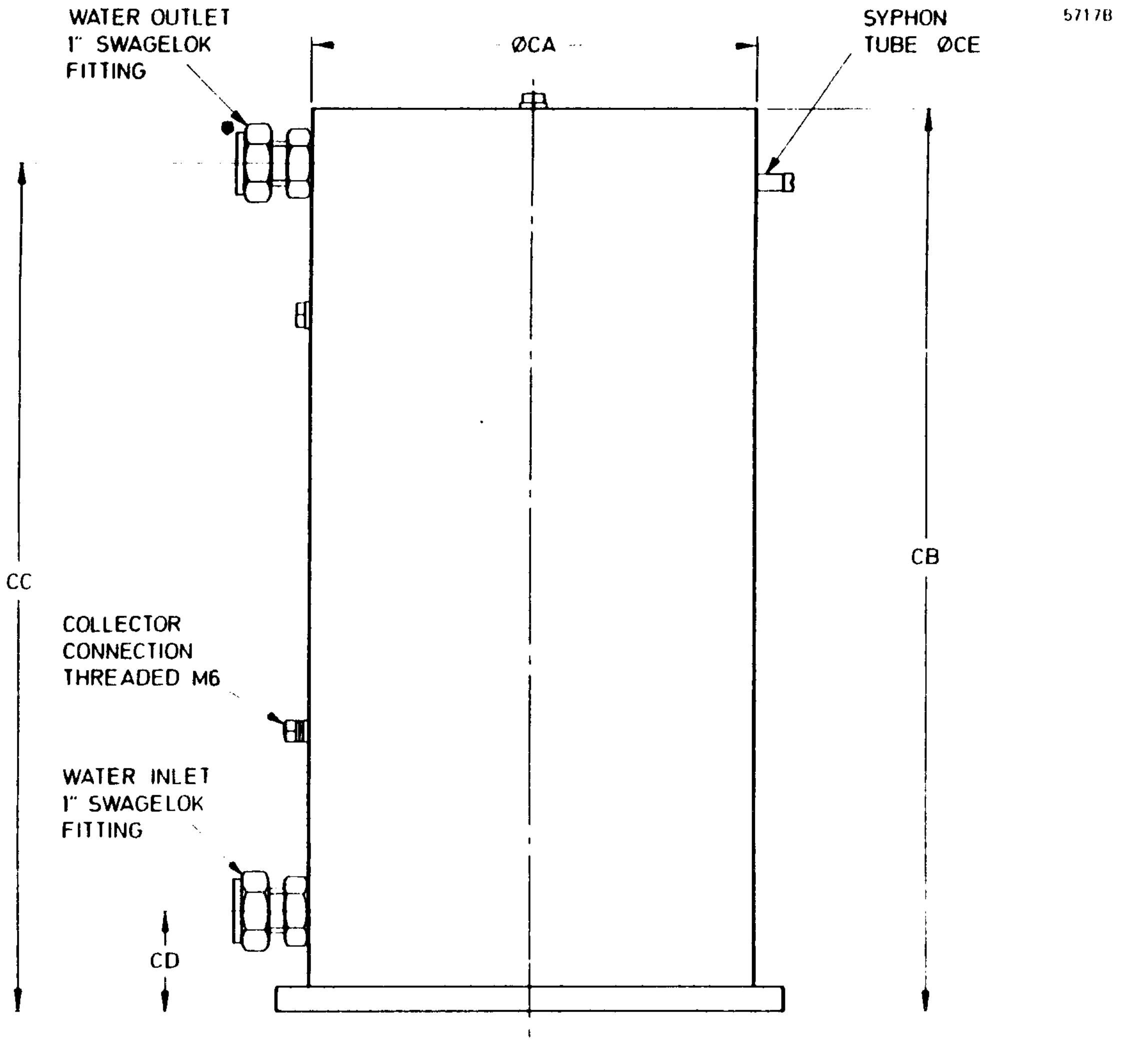
Inch dimensions have been derived from millimetres.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the syphon provided.
3. A weir, designed to maintain the water level in the boiler constant when operating with a pumped system, is available from EEV, part no. MA963C. A circuit assembly type K4651J, incorporating a boiler fitted with a weir and level trip is available ★
4. A sight glass and level trip assembly to fit the boiler is available from EEV, part no. MA213A. It is incorporated in circuit assembly K4651H. ★

★ Indicates a change.

OUTLINE OF WATER JACKET (All dimensions nominal)



Ref	Millimetres	Inches
CA	248.0	9.764
CB	498.0	19.606
CC	467.0	18.386
CD	55.5	2.185
CE	10.0	0.394

Inch dimensions have been derived from millimetres.

English Electric Valve Company Limited

Chelmsford, Essex, England

Printed in England

Subsidiary of The General Electric Company, p.l.c. of England

K3673BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 65% can be achieved by beam pulsing. 42% typical sync. efficiency at 64 kW output in standard operational mode at the least efficient channel.
- **Output Power** Rated for 60 kW, 55 kW and 40 kW vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Cooling** Air-cooled body and cavities. Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3673BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 64 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

May 1988

Supersedes October 1987 Issue

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification. A feature of the cavity design is that tuning of both halves of each cavity is by means of a single knob. A digital indication of the cavity frequency is provided.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
US channel numbers	14 to 78	
European channel numbers	21 to 68	
Sync. output power at klystron flange	up to 64	kW
Maximum drive power requirements:		
conventional operation	25	W
pulsed operation	100	W
Power gain (conventional operation)	34 to 42	dB
Beam voltage (for 64 kW sync. power)	24.5 to 27.5	kV
Modulating anode to cathode voltage (see note 1)	17.0 to 21.5	kV

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage		8.5 ± 3% Vd.c.
Heater current range	25 to 28	A
Black heat heater voltage (see note 2)	6.0	Vd.c.
Cathode pre-heating time:		
from cold (see note 3)	5	minutes
from black heat (see note 4)	0	minutes
Vacion pump to cathode voltage	+3.0 to 4.0	kV
Internal impedance of vacion supply	500	kΩ approx

Mechanical

Overall length	62.56 inches (160 cm) nom
Overall diameter	11.12 inches (28.25 cm) nom
Mounting position	vertical, collector end up
Net weight of klystron	176 pounds (80 kg) approx

Circuit Assembly K4653 or K4653W

For vapour cooling of collector, order K4653.

For water cooling of collector, order K4653W.

Electro-magnet current, stabilized to ± 2% (see note 5)		
vision klystron	10 to 12	A
sound klystron	9 to 12	A
Electro-magnet resistance:		
cold	8.4 ± 1.1	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		100 pounds (45 kg) approx
Net weight of magnet assembly		505 pounds (230 kg) approx

Cooling

Air flow to cavities and body (see note 6) .	100	ft^3/min
	2.8	m^3/min
Static pressure head (see note 7)	5.0 inches (127 mm) w.g.	
Air flow to cathode terminal during black heat operation (see note 6) . .	5.0	ft^3/min ★
	0.14	m^3/min
Air flow to drift tube 5 (see notes 6 and 8) .	100	ft^3/min
	2.8	m^3/min
K4653 (vapour cooled) (see page 14):		
volume of steam produced by collector dissipation	1.5	ft^3/min/kW
	0.043	m^3/min/kW
volume of water converted to steam . . .	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4653W (water cooled) (see page 14):		
minimum water flow required		see page 15
maximum collector pressure drop	5.0	lb/in^2
	0.35	kg/cm^2
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature (see note 9) . .	90	°C max
water inlet temperature	55	°C max

Arc Detector

Arc detector type MA257C is fitted to the third and output cavities. See page 23 for connection details.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections		see page 23

★ Indicates a change.

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater voltage	9.5	V max
Heater starting current (peak)	65	A max
Beam voltage	28	kV max
Modulating anode to cathode voltage (see note 1)	23	kV max
Beam current	7.0	A max
Body current:		
with no input power	35	mA max
r.f. on (see note 10)	150	mA max
Modulating anode current	6.0	mA max
Mean output power	45	kW max
Collector dissipation	150	kW max
Load v.s.w.r. (see note 11)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see notes 12 and 13)	−1400	V max

TYPICAL OPERATION

60 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	20.7	19.6	20.0	kV
Beam current	5.8	5.35	5.5	A
Body current:				
with no input power	10	8.0	8.0	mA
black level + sync.	85	65	40	mA
Sync. output power	64	64	64	kW
Saturated output power	67	67	67	kW
Electro-magnet current	11.0	10.5	10.0	A
Peak drive power for 64 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	44.1	46.0	42.3	%
Saturated efficiency	46.2	48.1	44.3	%
1 dB bandwidth	7.0	7.0	7.0	MHz

6.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	5.9	5.7	5.7	kV
Beam current	0.85	0.8	0.8	A
Output power	6.5	6.5	6.5	kW
Electro-magnet current	10.0	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

12 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	8.6	8.1	7.9	kV
Beam current	1.5	1.35	1.5	A
Output power	13	13	13	kW
Electro-magnet current	10.0	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

24 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	12.9	12.0	11.7	kV
Beam current	2.8	2.5	2.5	A
Output power	25.5	25.5	25.5	kW
Electro-magnet current	11	10	10	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.5	1.5	1.5	MHz

TYPICAL OPERATION

55 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency●	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	23	25	26.5	kV
Modulating anode to cathode voltage (approx)	20.9	19.2	19.4	kV
Beam current	5.85	5.15	5.25	A
Body current:				
with no input power	9.0	7.0	7.0	mA
black level + sync.	80	45	35	mA
Sync. output power	58	58	58	kW
Saturated output power	60	60	60	kW
Electro-magnet current	11	10	10	A
Peak drive power for 58 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	43.1	45.0	41.7	%
Saturated efficiency	44.6	46.6	43.1	%
1 dB bandwidth	7.0	7.0	7.0	MHz

5.5 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	23	25	26.5	kV
Modulating anode to cathode voltage (approx)	6.1	5.5	5.7	kV
Beam current	0.9	0.75	0.8	A
Output power	6.0	6.0	6.0	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

TYPICAL OPERATION

40 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	18.8	17.4	16.5	kV
Beam current	5.0	4.4	4.1	A
Body current:				
with no input power	8.0	6.0	6.0	mA
black level + sync.	55	35	25	mA
Sync. output power	43	43	43	kW
Saturated output power	45	45	45	kW
Electro-magnet current	11	10	10	A
Peak drive power for 43 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	41.0	43.4	40.3	%
Saturated efficiency	42.9	45.5	42.2	%
1 dB bandwidth	7.0	7.0	7.0	MHz

4.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	5.7	5.0	4.5	kV
Beam current	0.8	0.7	0.6	A
Output power	4.5	4.5	4.5	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 2.5 mA.
2. Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode preheating time.
4. For black heat operation, a heater voltage of 6.0 V must have been applied to the klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to 8.5 V.
5. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for best TV performance and stabilize to ± 2% about this optimum value.
6. This value applies to transmitters at sea level where the air density is 0.076 lb/ft^3 (1.22 kg/m^3). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.
7. Measured by a manometer at the input pipe to the circuit assembly.
8. A separate supply of air to the fifth drift tube is necessary for operation at 60 kW. The air pipe on the manifold which is directed at the fifth drift tube must be blocked and an air flow of 100 ft^3/min (2.8 m^3/min) blown through a rectangular duct of 7 square inches (45 cm^2) cross-section directed at the drift tube.
9. For operation at high altitude where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
10. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
11. This value applies to television service. EEV should be consulted regarding other conditions of service.

12. The K3673BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 64 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

The following conditions must be observed when operating in this mode:

(a) The B.C.D. voltage must **never** be positive with respect to cathode.

(b) The B.C.D. voltage must **not** exceed −1400 V with respect to cathode.

The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph (see page 17).

13. To measure the B.C.D. current, the klystron must be operated undisturbed for a period of **45 minutes** under the following conditions.

Beam voltage	21.5	kV
Modulating anode to cathode voltage	21.5	kV
Heater voltage	8.5	V
B.C.D. to cathode voltage	−1.0	kV

The B.C.D. current will typically be less than 1 mA on a new klystron and is warranted not to exceed 2 mA during the warranty period; in some cases it may exceed 2 mA during the remainder of the tube's life. To ensure that maximum useful life is achieved from all klystrons, the B.C.D. drive circuit should be able to give the required voltage variations at currents well in excess of 2 mA.

With a B.C.D. to cathode voltage of −1.0 kV, a beam current reduction of about 35% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 65% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	80	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

14. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

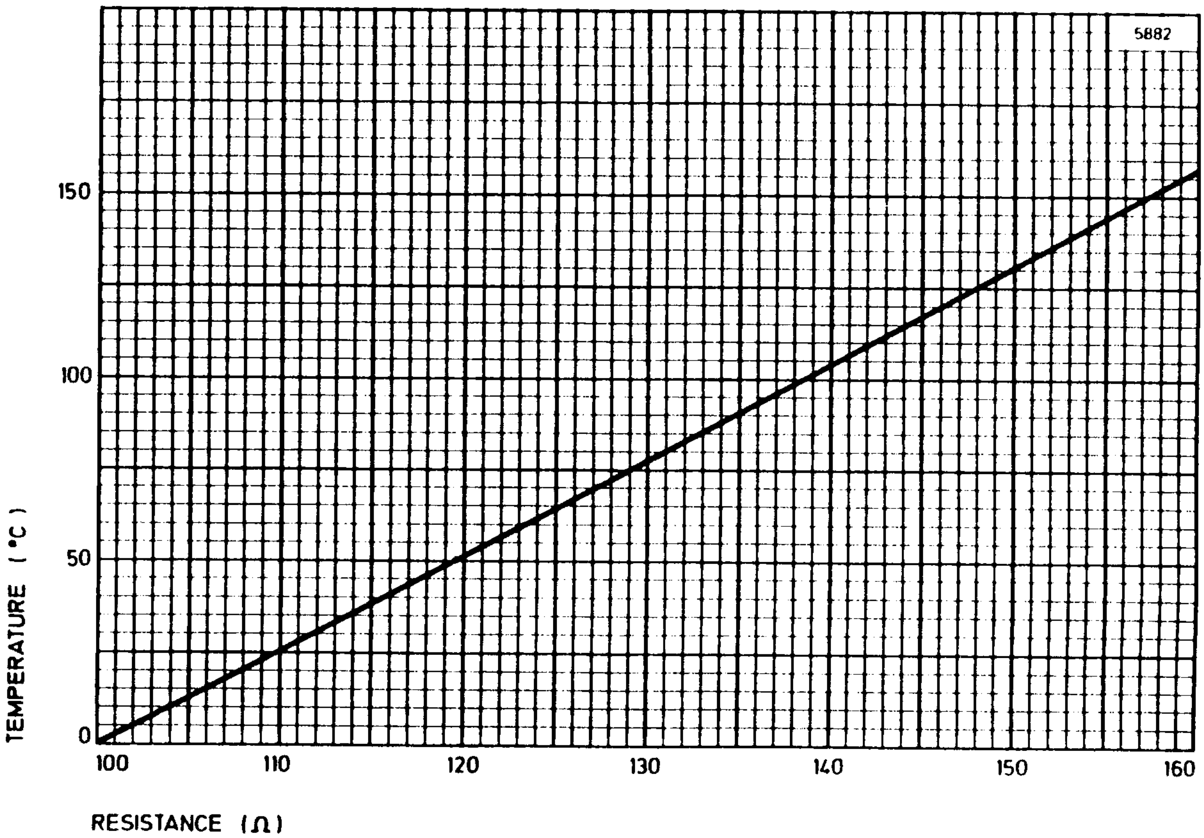
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 MΩ at 20 °C. The probes are tested to 240 V d.c. between probe and element.

Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4653W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 15 for flow rates).

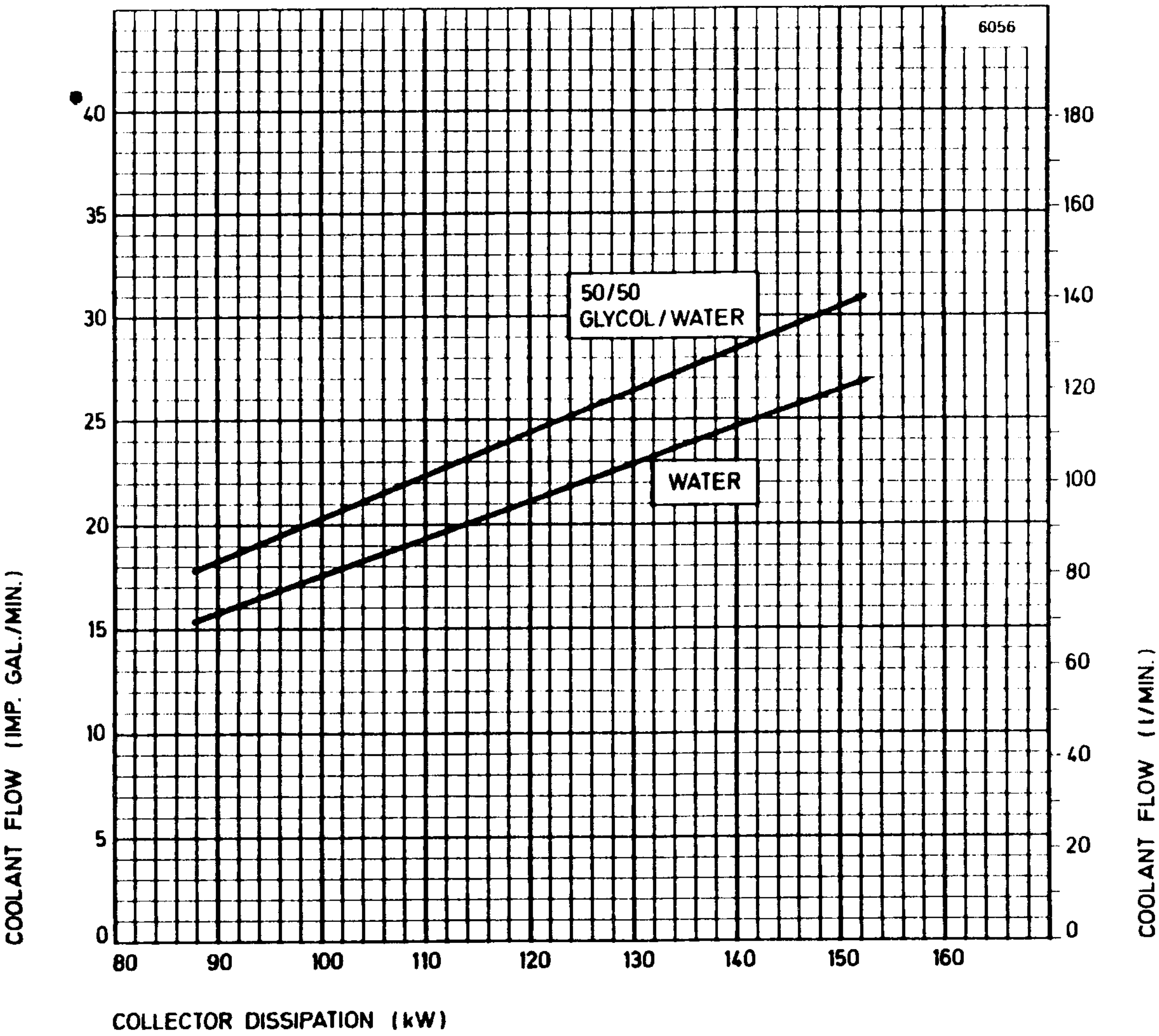
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4653 (Vapour Cooled)

Only pure demineralized water should be used in the boiler; local water supplies are usually suitable only for the secondary circuit of a water cooled condenser.

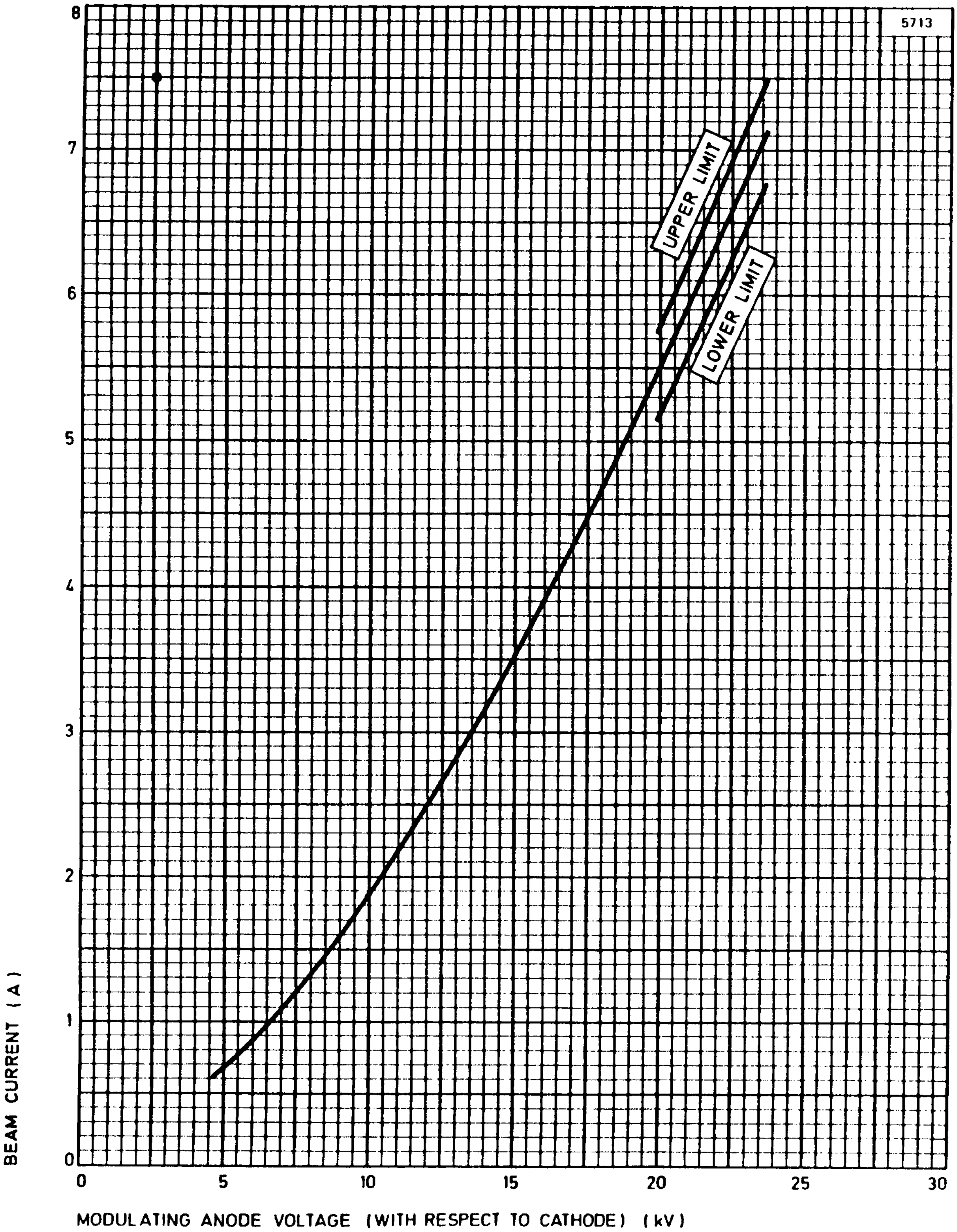
LIQUID COOLING REQUIREMENTS FOR K4653W



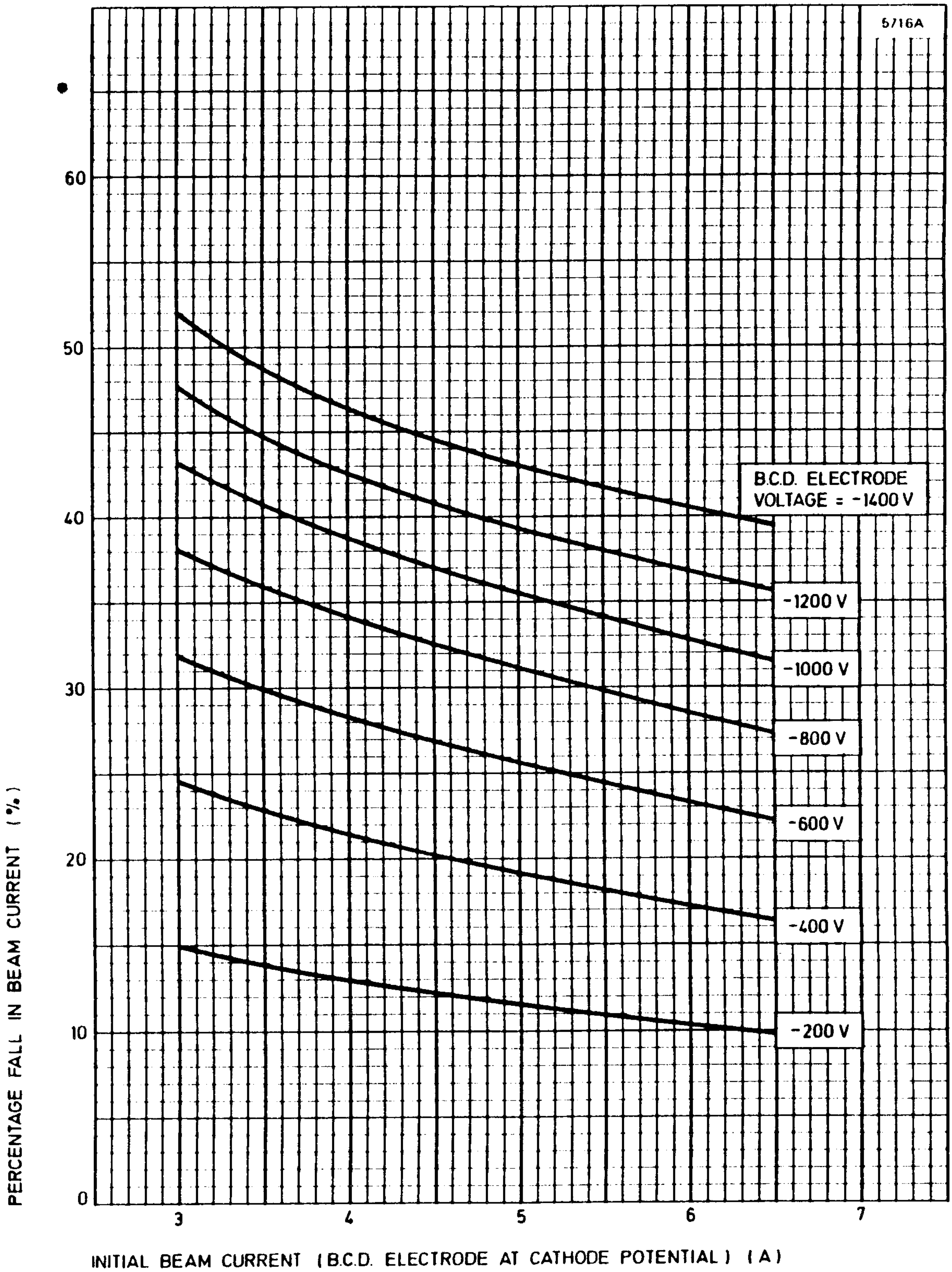
Note 1 U.S. gal = 0.832 Imp. gal.

BEAM CURRENT CHARACTERISTIC

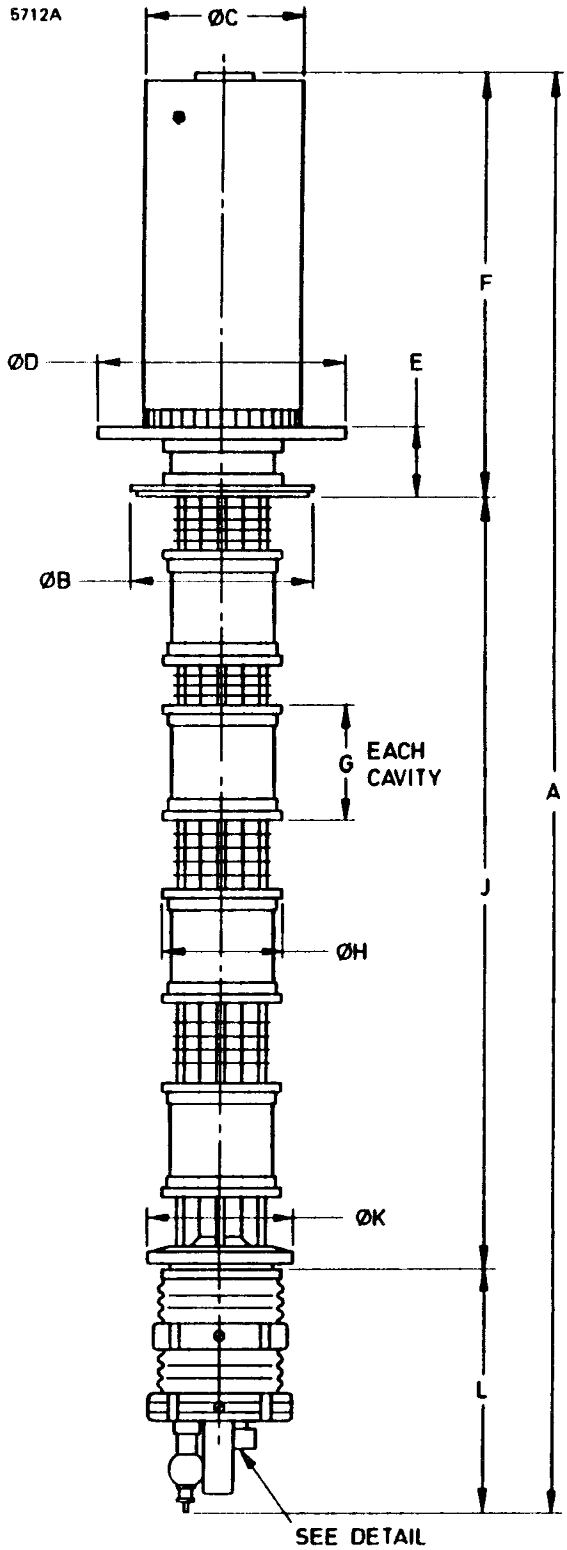
(B.C.D. electrode at cathode potential)



B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3673BCD

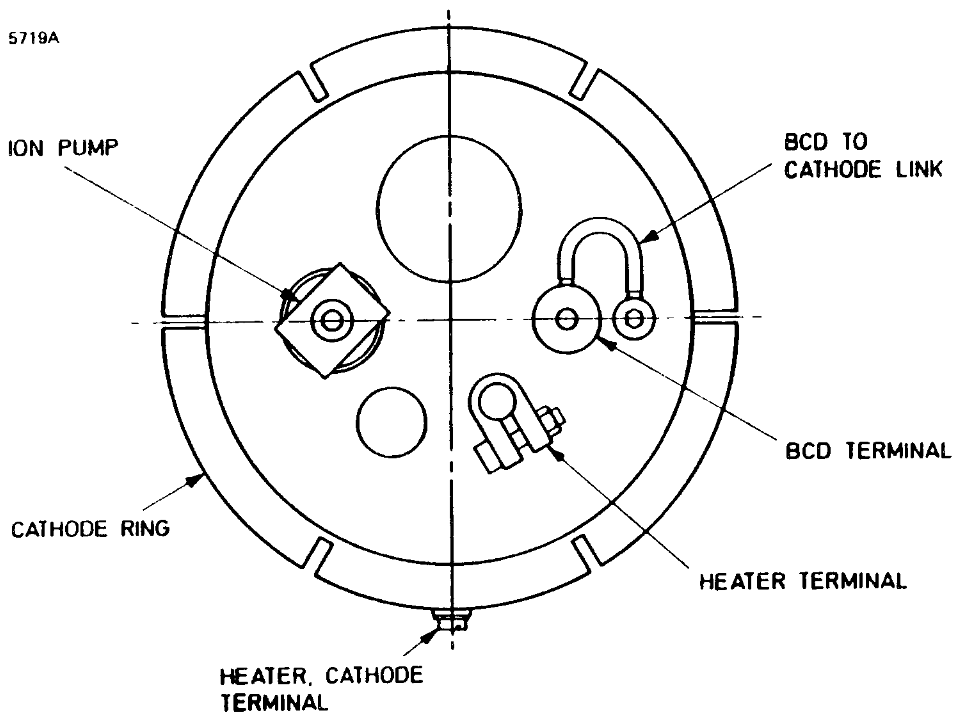


Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches	Ref	Millimetres	Inches
A	1588.0	62.520	G	127.0	5.000
B	202.0	7.953	H	130.2	5.126
C	175.0	6.890	J	846.5	33.327
D	282.5	11.122	K	160.0	6.299
E	75.4	2.969	L	275.0	10.827
F	466.5	18.366			

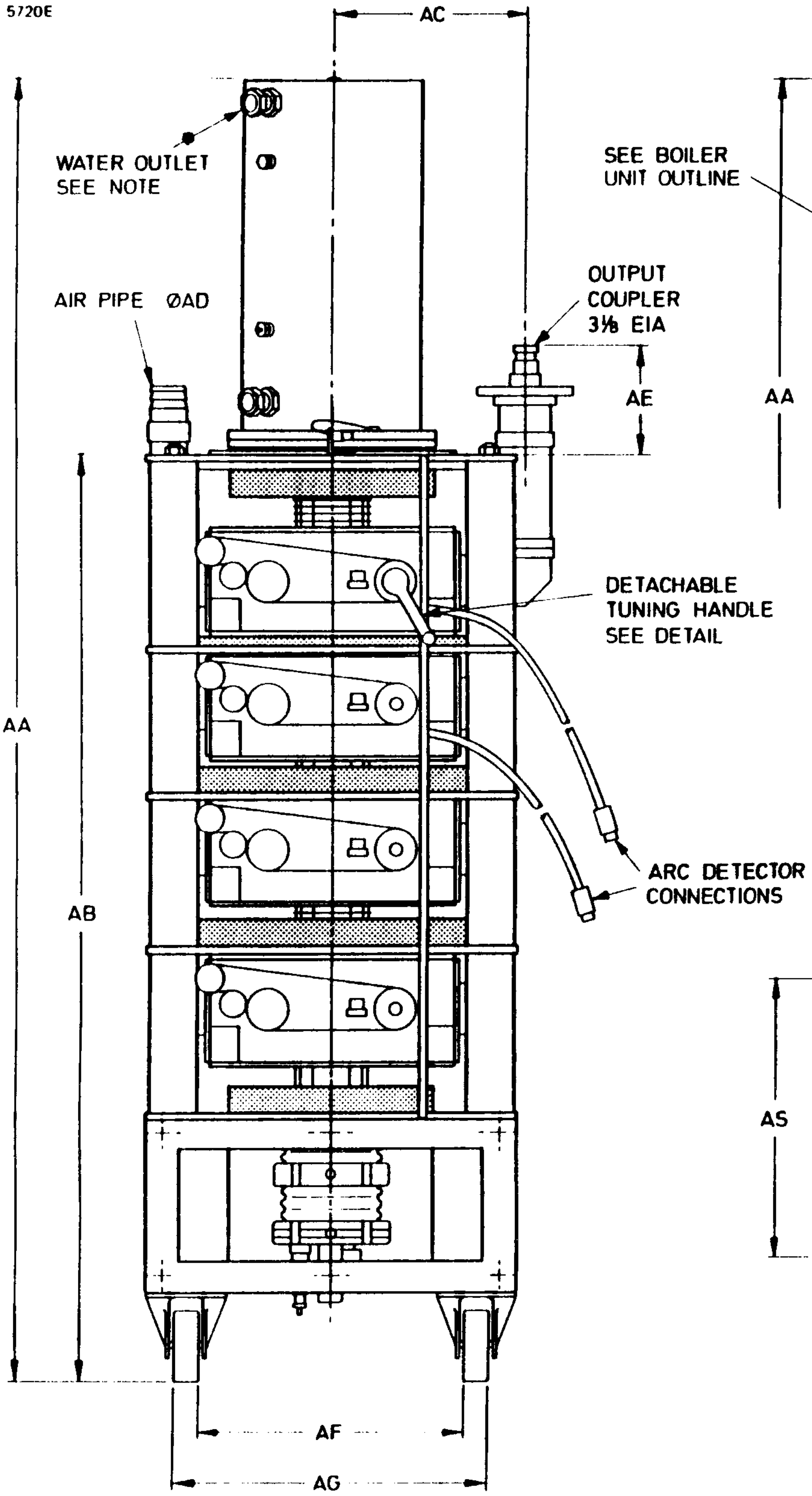
Inch dimensions have been derived from millimetres.

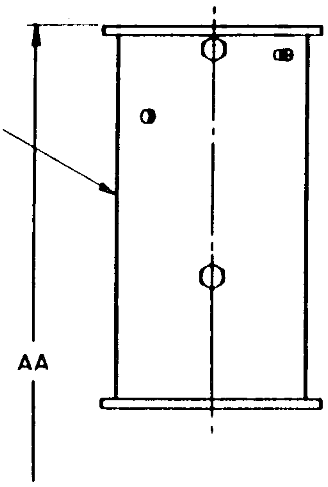
Enlarged View on Gun End of Klystron



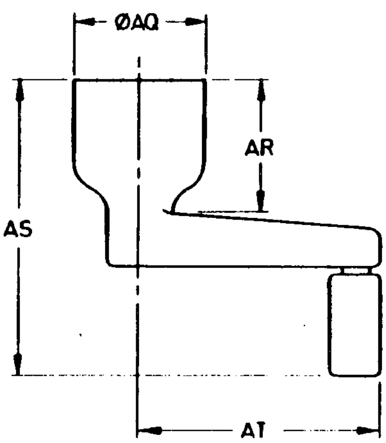
Note The klystron is supplied with a shorting link connected between the B.C.D. terminal and cathode. ***If the B.C.D. electrode is to be used, this link must be removed.***

OUTLINE OF CIRCUIT ASSEMBLY K4653W



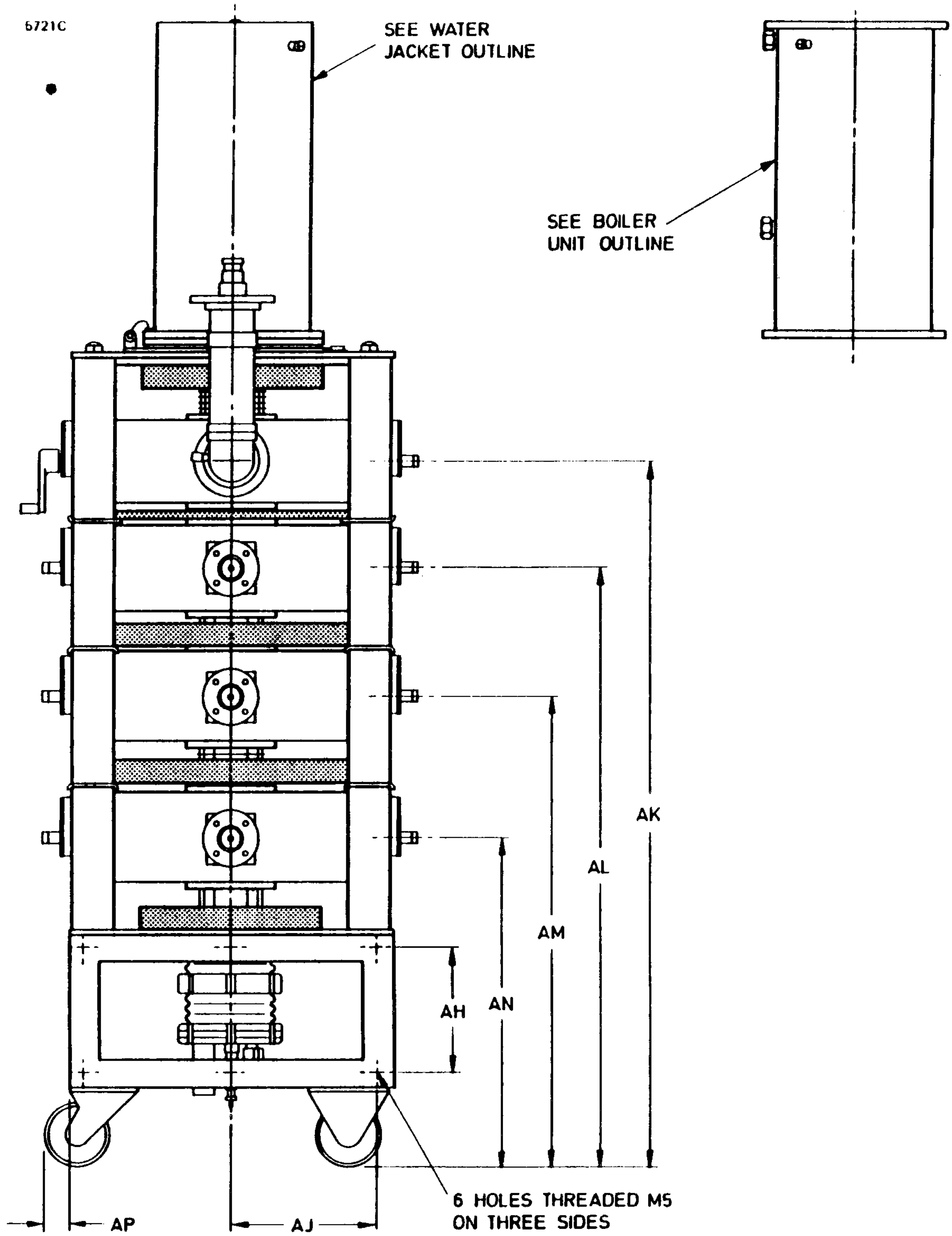


Detail of K4653 Boiler Unit



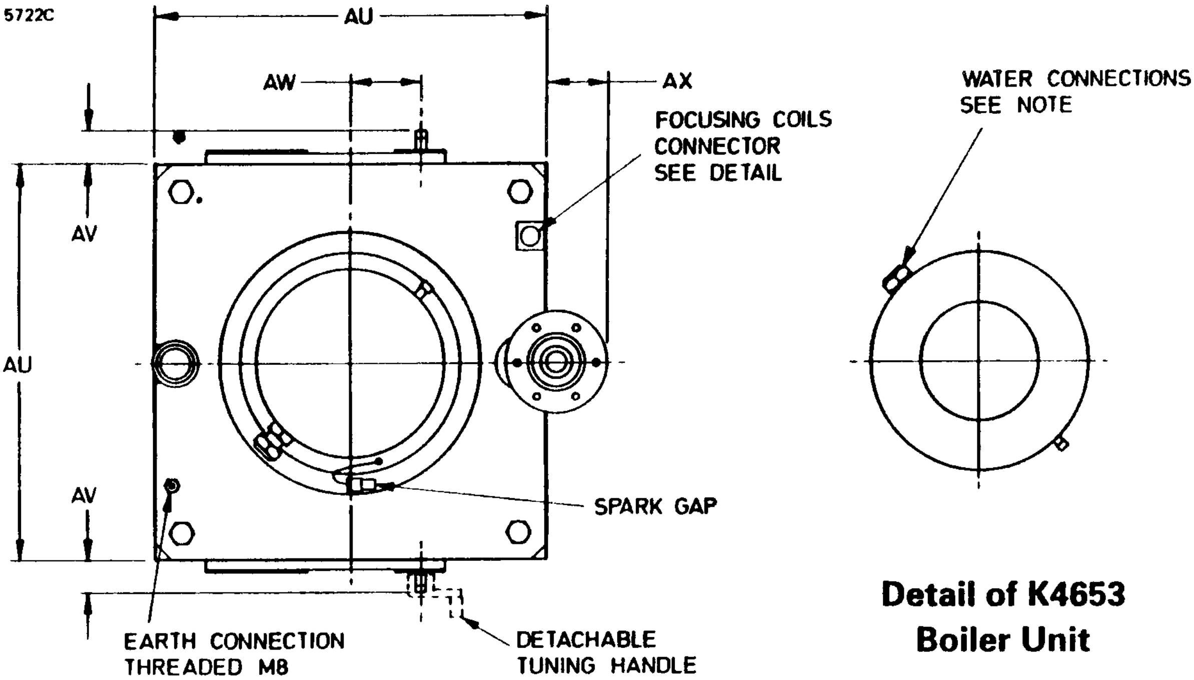
Detail of MA992A Tuning Handle

OUTLINE OF CIRCUIT ASSEMBLY K4653W



Top View of Circuit Assembly K4653W

(All dimensions without limits are nominal)



Detail of K4653 Boiler Unit

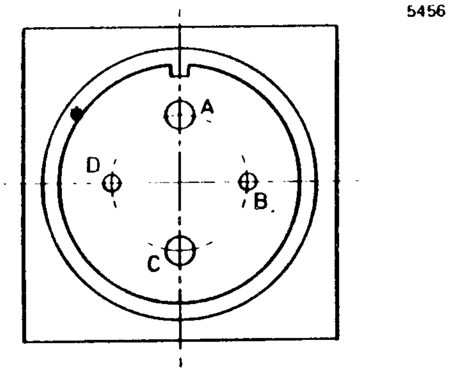
Ref	Millimetres	Inches
AA	1785.0	70.276
AB	1264.0	49.764
AC	265.0	10.433
AD	50.0	1.969
AE	150.0	5.906
AF	320.0	12.598
AG	405.0	15.945
AH	192.0	7.559
AJ	234.0	9.213
AK	1105.0	43.504
AL	922.0	36.299

Ref	Millimetres	Inches
AM	722.0	28.425
AN	507.0	19.961
AP	45.0	1.772
AQ	40.0	1.575
AR	60.0	2.362
AS	130.0	5.118
AT	90.0 max	3.543
AU	508.0	20.000
AV	55.0	2.165
AW	88.0	3.465
AX	78.0	3.071

Inch dimensions have been derived from millimetres.

Note Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

View on Focus Coil Connector

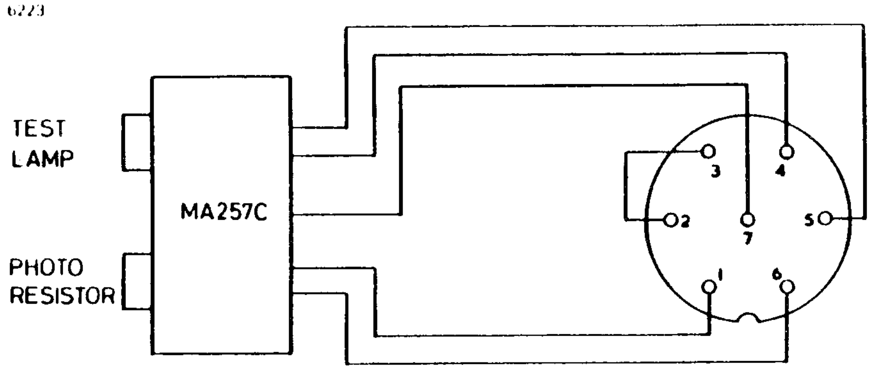


Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

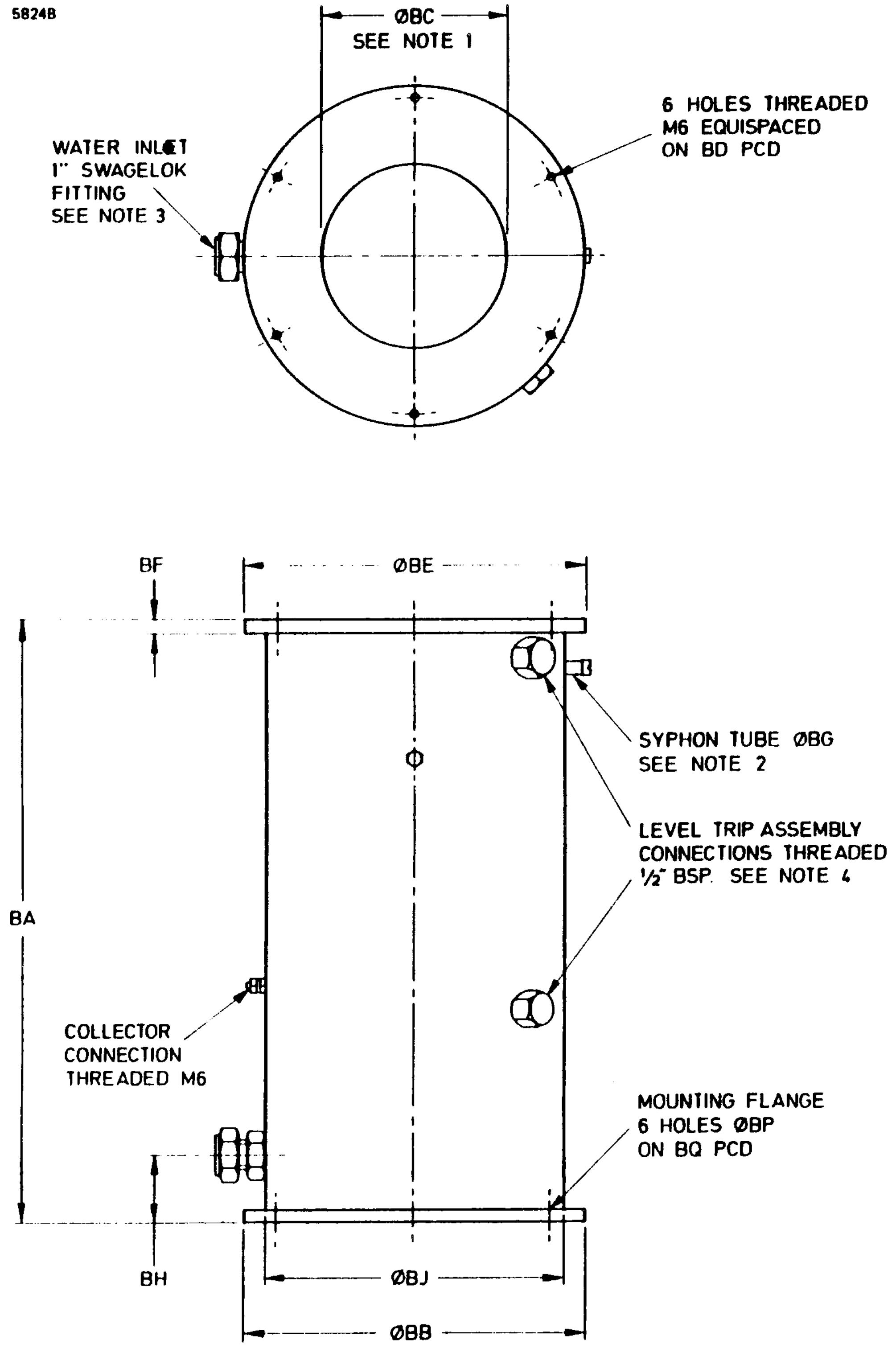
Arc Detector Connections to socket type Amphenol T3476-001 ★



MA257C uses a free plug and socket at the end of a 1500 mm cable.

★ Indicates a change.

OUTLINE OF BOILER UNIT



Outline Dimensions (All dimensions without limits are nominal)

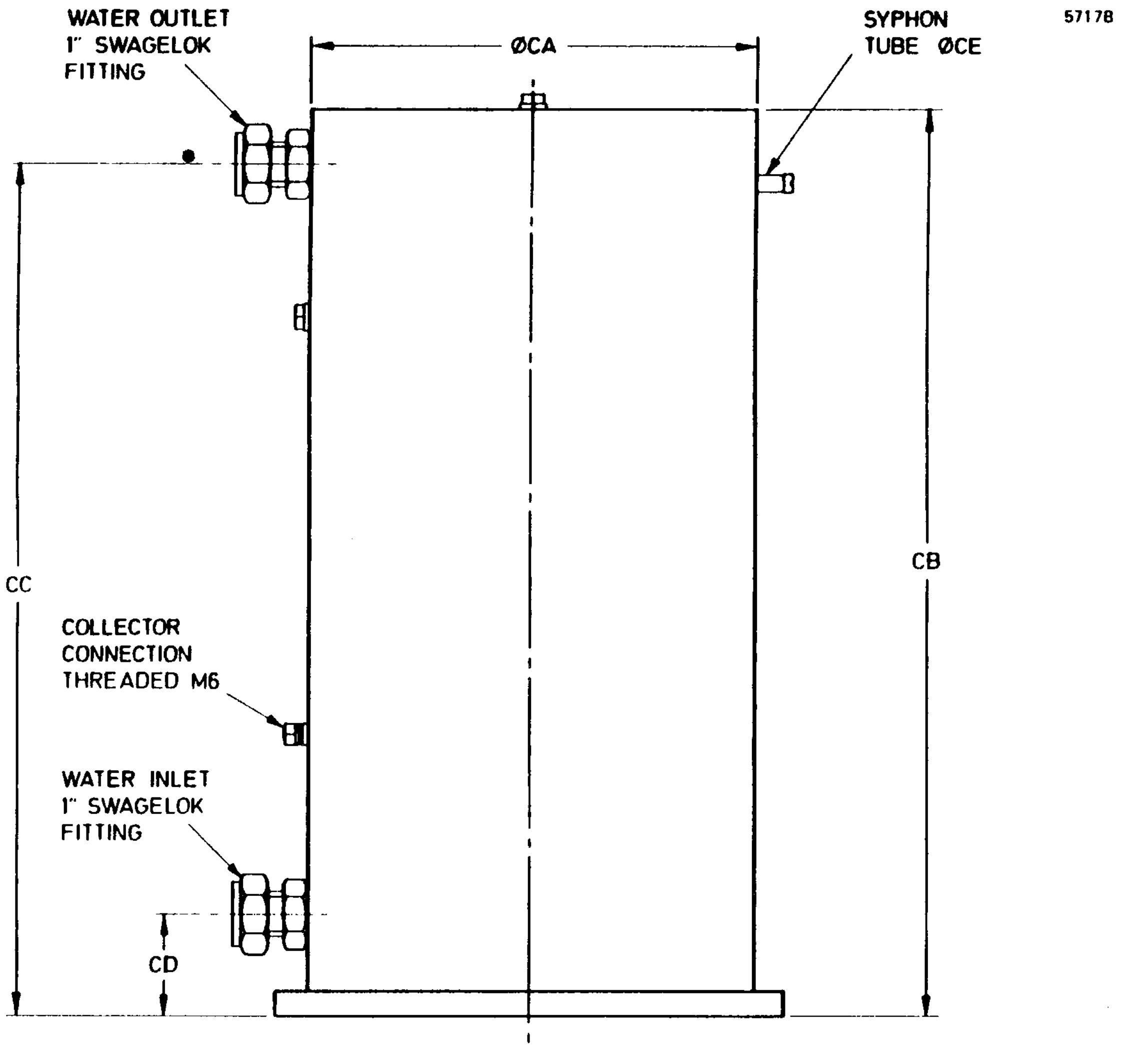
Ref	Millimetres	Inches	Ref	Millimetres	Inches
BA	498.0	19.606	BG	10.0	0.394
BB	282.5	11.122	BH	55.5	2.185
BC	152.5	6.004	BJ	248.0	9.764
BD	266.0	10.472	BP	7.25 ± 0.25	0.285 ± 0.010
BE	282.5	11.122	BQ	266.0	10.472
BF	13.0	0.512			

Inch dimensions have been derived from millimetres.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the syphon provided.
3. A weir, designed to maintain the water level in the boiler constant when operating with a pumped system, is available from EEV, part no. MA963C.
4. A sight glass and level trip assembly to fit the boiler is available from EEV, part no. MA213.

OUTLINE OF WATER JACKET (All dimensions nominal)



Ref	Millimetres	Inches
CA	248.0	9.764
CB	498.0	19.606
CC	467.0	18.386
CD	55.5	2.185
CE	10.0	0.394

Inch dimensions have been derived from millimetres.

English Electric Valve Company Limited
Chelmsford, Essex, England

Printed in England

Subsidiary of The General Electric Company, p.l.c. of England

K3773BCD

HIGH POWER AMPLIFIER KLYSTRON FOR U.H.F. TELEVISION SERVICE

FEATURING

- **Frequency Range** 470 to 860 MHz (Bands IV and V) in a single tube.
- **High Efficiency** With appropriate correction, efficiencies greater than 65% can be achieved by beam pulsing. 44% typical sync. efficiency at 74 kW output in standard operational mode at the least efficient channel.
- **Output Power** Rated for 70 kW, 60 kW and 40 kW vision amplifier service.
- **Beam Control Device (B.C.D.)** For low voltage beam current reduction during picture information.
- **Long Life** High reliability electron gun with barium aluminate cathode for longer tube life.
- **Simple, Efficient Cooling** Air-cooled body and cavities. Collector may be either vapour or water cooled using a simple boiler or water jacket.
- **Simple Tube Exchange** Continuously tunable external cavities, with digital frequency indicators. This means that a replacement tube will be coarse tuned on installation, needing only trimming adjustments.
- **Operational Mode Options** Klystron can be operated as a conventional TV klystron or the beam current can be pulsed.
- **All Ceramics Aluminium Oxide** No beryllium oxide ceramics.

DESCRIPTION

K3773BCD is a four cavity, high efficiency amplifier klystron for use in the output stages of sound and vision transmitters in u.h.f. television service. The tube operates in the frequency range 470 to 860 MHz at sync. power levels up to 74 kW. A modulating anode is fitted, enabling:

i) efficiency optimization of beam voltage and current over the frequency range, and

ii) operation at reduced power levels in sound amplifiers using the same beam voltage supply as the vision amplifier.

In addition the electron gun incorporates a cylindrical, non-intercepting Beam Control Device for low voltage beam current modulation.

The tube is electro-magnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The cavities can be detached from the vacuum tube and refitted on a replacement without disturbing the tuning, so that the replacement klystron is coarse tuned at switch-on and requires only loading loop setting and trimming adjustments to meet the full transmission specification. A feature of the cavity design is that tuning of both halves of each cavity is by means of a single knob. A digital indication of the cavity frequency is provided.

The electron gun, klystron body and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust on insulators.

The klystron collector may be either vapour cooled in a boiler with an upward steam exit from which the steam must be ducted to a separate condenser (not supplied), or water cooled in a water jacket from which the water must be led to a separate heat exchanger (not supplied).

ABRIDGED DATA

Frequency range	470 to 860	MHz
US channel numbers	14 to 78	
European channel numbers	21 to 68	
Sync. output power at klystron flange	up to 74	kW
Maximum drive power requirements:		
conventional operation	25	W
pulsed operation	100	W
Power gain (conventional operation)	34 to 42	dB
Beam voltage (for 74 kW sync. power)	26.0 to 29	kV
Modulating anode to cathode voltage (see note 1)	17.0 to 22.5	kV

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage	$8.5 \pm 3\%$	Vd.c.
Heater current range	25 to 28	A
Black heat heater voltage (see note 2)	6.0	Vd.c.
Cathode pre-heating time:		
from cold (see note 3)	5	minutes
from black heat (see note 4)	0	minutes
Ion pump to cathode voltage	+3.0 to 4.0	kV
Internal impedance of vacion supply	500	kΩ approx

Mechanical

Overall length	62.56 inches (160 cm) nom
Overall diameter	11.12 inches (28.25 cm) nom
Mounting position	vertical, collector end up
Net weight of klystron	176 pounds (80 kg) approx

Circuit Assembly K4653 or K4653W

For vapour cooling of collector, order K4653.

For water cooling of collector, order K4653W.

Electro-magnet current, stabilized to ± 2% (see note 5)		
vision klystron	10 to 12	A
sound klystron	9 to 12	A
Electro-magnet resistance:		
cold	8.4 ± 1.1	Ω
hot (20 °C ambient)	11	Ω max
R.F. input connector		type N coaxial
R.F. output		3⅛ inch 50 Ω coaxial line
Net weight of tuning cavities		100 pounds (45 kg) approx
Net weight of magnet assembly		505 pounds (230 kg) approx

Cooling

Air flow to cavities and body (see note 6) .	125	ft^3/min
	3.5	m^3/min
Static pressure head (see note 7)	8.0 inches (203 mm) w.g.	
Air flow to cathode terminal during black heat operation (see note 6) . .	5.0	ft^3/min
	0.14	m^3/min
Air flow to drift tube 4 (see notes 6 and 8) .	50	ft^3/min
	1.4	m^3/min
Air flow to drift tube 5 (see notes 6 and 8) .	100	ft^3/min
	2.8	m^3/min
K4653 (vapour cooled) (see page 14):		
volume of steam produced by collector dissipation	1.5	ft^3/min/kW
	0.043	m^3/min/kW
volume of water converted to steam . . .	0.006	imp.gal/min/kW
	0.027	l/min/kW
K4653W (water cooled) (see page 14):		
minimum water flow required		see page 15
maximum collector pressure drop	6.5	lb/in^2
	0.45	kg/cm^2
inlet pressure to water jacket	100	lb/in^2 max
	7.0	kg/cm^2 max
water outlet temperature (see note 9) . .	90	°C max
water inlet temperature	55	°C max

Arc Detector

Arc detector type MA257C is fitted to the third and output cavities. See page 23 for connection details.

Photo-resistor type		NSL 462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer	cadmium sulphide	
Test lamp	28	V
	0.04	A
Connections		see page 23

MAXIMUM RATINGS (Absolute values)

If any maximum rating is exceeded, the beam voltage must be removed within 100 ms from the instant at which the rating is exceeded, and must not be re-applied within 5s.

Heater voltage	9.5	V max
Heater starting current (peak)	65	A max
Beam voltage	30	kV max
Modulating anode to cathode voltage (see note 1)	23	kV max
Beam current	7.0	A max
Body current:		
with no input power	35	mA max
r.f. on (see note 10)	150	mA max
Modulating anode current	6.0	mA max
Mean output power	45	kW max
Collector dissipation	170	kW max
Load v.s.w.r. (see note 11)	1.5:1	max
Temperature of any part of tube envelope	175	°C max
B.C.D. electrode voltage (see notes 12 and 13)	−1400	V max

TYPICAL OPERATION

70 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	26.5	27.7	28.5	kV
Modulating anode to cathode voltage (approx)	22.0	21.0	20.5	kV
Beam current	6.3	5.8	5.7	A
Body current:				
with no input power	12	10	10	mA
black level + sync.	80	45	35	mA
Sync. output power	74	74	74	kW
Saturated output power	76	76	76	kW
Electro-magnet current	11	10	10	A
Peak drive power for 74 kW output (see note 14)	20	8.0	5.0	W
Sync. efficiency	44	46	45	%
Saturated efficiency	45	47	46	%
1 dB bandwidth	7.0	7.0	7.0	MHz

7.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	26.5	27.7	28.5	kV
Modulating anode to cathode voltage (approx)	6.5	6.0	6.2	kV
Beam current	1.0	0.85	0.9	A
Output power	7.5	7.5	7.5	kW
Electro-magnet current	10	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

TYPICAL OPERATION

60 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	20.7	19.6	20.0	kV
Beam current	5.8	5.35	5.5	A
Body current:				
with no input power	10	8.0	8.0	mA
black level + sync.	85	65	40	mA
Sync. output power	64	64	64	kW
Saturated output power	67	67	67	kW
Electro-magnet current	11.0	10.5	10.0	A
Peak drive power for 64 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	44.1	46.0	42.3	%
Saturated efficiency	46.2	48.1	44.3	%
1 dB bandwidth	7.0	7.0	7.0	MHz

6.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	5.9	5.7	5.7	kV
Beam current	0.85	0.8	0.8	A
Output power	6.5	6.5	6.5	kW
Electro-magnet current	10.0	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

12 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	8.6	8.1	7.9	kV
Beam current	1.5	1.35	1.5	A
Output power	13	13	13	kW
Electro-magnet current	10.0	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

24 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	25	26	27.5	kV
Modulating anode to cathode voltage (approx)	12.9	12.0	11.7	kV
Beam current	2.8	2.5	2.5	A
Output power	25.5	25.5	25.5	kW
Electro-magnet current	11	10	10	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.5	1.5	1.5	MHz

TYPICAL OPERATION

40 kW vision amplifier

B.C.D. electrode at cathode potential

Frequency	470 to 478	638 to 646	846 to 854	MHz
European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	18.8	17.4	16.5	kV
Beam current	5.0	4.4	4.1	A
Body current:				
with no input power	8.0	6.0	6.0	mA
black level + sync.	55	35	25	mA
Sync. output power	43	43	43	kW
Saturated output power	45	45	45	kW
Electro-magnet current	11	10	10	A
Peak drive power for 43 kW output (see note 14)	16	8.0	5.0	W
Sync. efficiency	41.0	43.4	40.3	%
Saturated efficiency	42.9	45.5	42.2	%
1 dB bandwidth	7.0	7.0	7.0	MHz

4.0 kW sound amplifier

B.C.D. electrode at cathode potential

European channel	21	42	68	
Beam voltage	21.0	22.5	26.0	kV
Modulating anode to cathode voltage (approx)	5.7	5.0	4.5	kV
Beam current	0.8	0.7	0.6	A
Output power	4.5	4.5	4.5	kW
Electro-magnet current	9.5	9.0	9.0	A
Drive power	5.0	4.0	4.0	W
1 dB bandwidth	1.0	1.0	1.0	MHz

NOTES

1. The modulating anode voltage must not be positive with respect to the klystron body. The modulating anode should be connected to its supply via a 10 kΩ resistor. A voltage divider for adjusting the cathode current should allow for a typical modulating anode current of 2.5 mA.
2. Continuous periods of black heat operation should not exceed two weeks and should be separated by similar periods of rest or full operation.
3. In the event of a power failure a maximum interruption time of 30 seconds can be tolerated without the need for a repeated cathode preheating time.
4. For black heat operation, a heater voltage of 6.0 V must have been applied to the klystron heater for a minimum of 10 minutes before the beam voltage may be switched on. On application of the beam voltage the heater voltage must simultaneously be increased to 8.5 V.
5. Under TV picture conditions the klystron will focus satisfactorily within the specified range. For maximum stability, adjust the magnet current for best TV performance and stabilize to ± 2% about this optimum value.
6. This value applies to transmitters at sea level where the air density is 0.076 lb/ft^3 (1.22 kg/m^3). At high altitudes where air density is significantly reduced the volume flow must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow.
7. Measured by a manometer at the input pipe to the circuit assembly.
8. For operation at 60 kW, the air pipe on the manifold which is directed at the fifth drift tube must be blocked and an air flow of 100 ft^3/min (2.8 m^3/min) blown through a rectangular duct of 7 square inches (45 cm^2) cross-section directed at the drift tube. For operation at 70 kW, the fourth drift tube also requires 50 ft^3/min (1.4 m^3/min), supplied in the same way.
9. For operation at high altitude where atmospheric pressure is reduced and water boils at a lower temperature, the maximum water outlet temperature is 10 °C below the boiling point at that altitude.
10. The combined body current of one sound and one vision klystron in parallel will not exceed the limit specified.
11. This value applies to television service. EEV should be consulted regarding other conditions of service.
12. The K3773BCD may be operated with a pulsed voltage applied to the B.C.D. electrode. This enables the beam power to be decreased during the picture region of the video signal so that up to 74 kW sync. pulses can be produced at the klystron flange with an appreciable reduction in mean beam power.

The following conditions must be observed when operating in this mode:

(a) The B.C.D. voltage must **never** be positive with respect to cathode.

(b) The B.C.D. voltage must **not** exceed −1400 V with respect to cathode.

- The effect of increasing the negative B.C.D. voltage with respect to the cathode is to reduce the beam current. This effect is shown in the B.C.D. beam current characteristic graph (see page 17).

13. To measure the B.C.D. current, the klystron must be operated undisturbed for a period of **45 minutes** under the following conditions.

Beam voltage	21.5	kV
Modulating anode to cathode voltage	21.5	kV
Heater voltage	8.5	V
B.C.D. to cathode voltage	−1.0	kV

The B.C.D. current will typically be less than 1 mA on a new klystron and is warranted not to exceed 2 mA during the warranty period; in some cases it may exceed 2 mA during the remainder of the tube's life. To ensure that maximum useful life is achieved from all klystrons, the B.C.D. drive circuit should be able to give the required voltage variations at currents well in excess of 2 mA.

With a B.C.D. to cathode voltage of −1.0 kV, a beam current reduction of about 35% should be expected. In a typical transmitter with appropriate pulsing, r.f. drive and correction arrangements, this value of beam current reduction should allow efficiencies better than 65% to be obtained, where efficiency is defined as:–

$$\text{efficiency (\%)} = \frac{\text{sync. output (kW)}}{\text{average beam power (kW)}} \times 100$$

Typical values of interelectrode capacitance are:–

B.C.D. to cathode	80	pF
Cathode to modulating anode (B.C.D. connected to cathode)	35	pF
Modulating anode to klystron body	30	pF

Appropriate measures must be taken to protect the klystron and the pulse drive in the event of a d.c. arc between the B.C.D. electrode and anode.

14. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the klystron assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

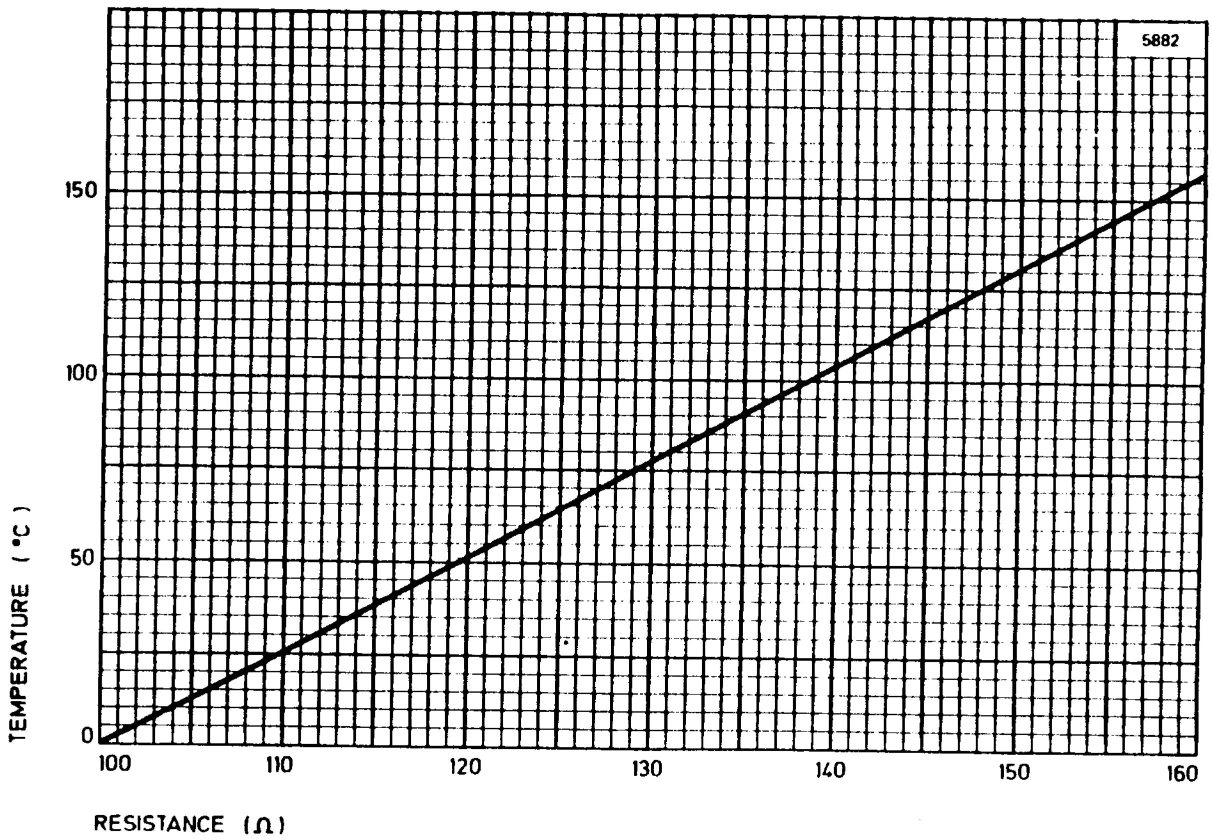
TEMPERATURE SENSOR MA971A

Temperature sensor type MA971A is a platinum film resistance type sensor for monitoring the temperature of the klystron collector when being water or vapour cooled. The sensor conforms to BS1904 and DIN 43760. The resistance-temperature relationship is shown below.

The resistance element is insulated from the body of the probe unit. The resistance between element and probe is typically better than 10 MΩ at 20 °C. The probes are tested to 240 V d.c. between probe and element.

Protective circuits must be provided so that the probe body (collector potential) to resistance element voltage does not exceed 200 V, even under short-term fault conditions.

To avoid errors due to element heating and damage to the resistance element, circuits should be designed to draw as little current as possible through the element. The recommended maximum current is 3 mA.



RECOMMENDED COOLANTS

K4653W (Liquid Cooled)

In the liquid cooled mode, when there is no danger from freezing, the coolant should be good quality demineralized water. Where outside ambient temperatures are such that there is a danger that pure water will freeze, the coolant should be a mixture of equal volumes of pure demineralized water and a commercial glycol anti-freeze preparation containing appropriate corrosion inhibitors and pH buffers. The coolant flow will need to be increased when the glycol-water mixture is in use (see page 15 for flow rates).

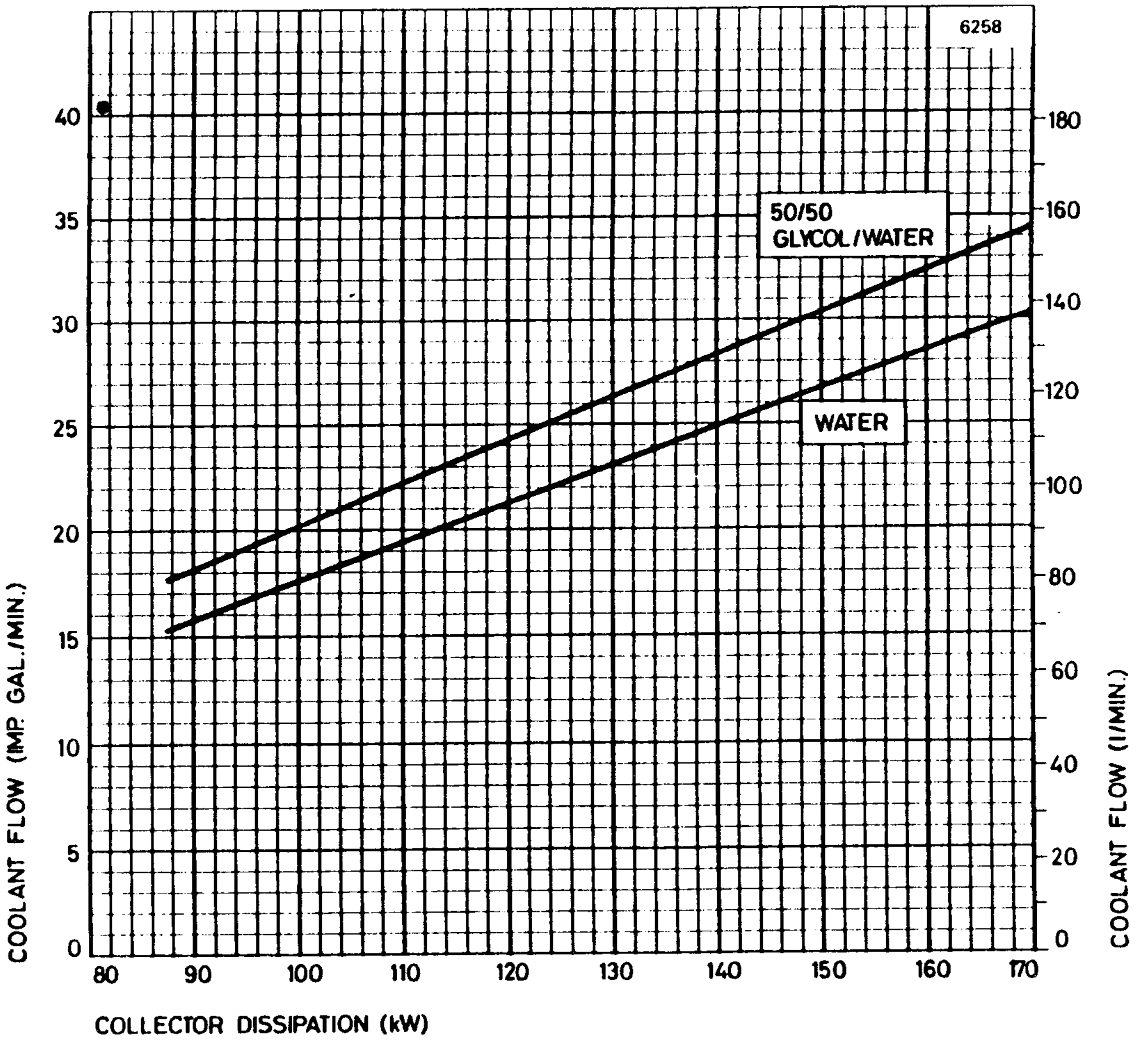
Glycol anti-freeze mixtures are liable to thermal degradation with prolonged life, especially where the coolant is oxygenated. Cooling system designers should ensure that oxygenation of the coolant is avoided wherever possible by, for example, ensuring that return pipes discharge below the level of coolant in the reservoir tank. Commercial glycol preparations such as Dowcal 10 or Dowtherm SR-1 have been examined by EEV and are believed to contain suitable inhibitor and pH buffer additives.

It is recommended that the glycol coolant is discarded after being used for one winter season. The transmitter should then be operated with demineralized water during the summer before changing to a new glycol solution for the next winter. The long term use of commercial grade, un-buffered and uninhibited ethylene glycol will lead to corrosive damage to the transmitter cooling system and consequential damage to the klystron. Such coolants may only be used for a short time (not more than one week) in an emergency.

K4653 (Vapour Cooled)

Only pure demineralized water should be used in the boiler; local water supplies are usually suitable only for the secondary circuit of a water cooled condenser.

LIQUID COOLING REQUIREMENTS FOR K4653W

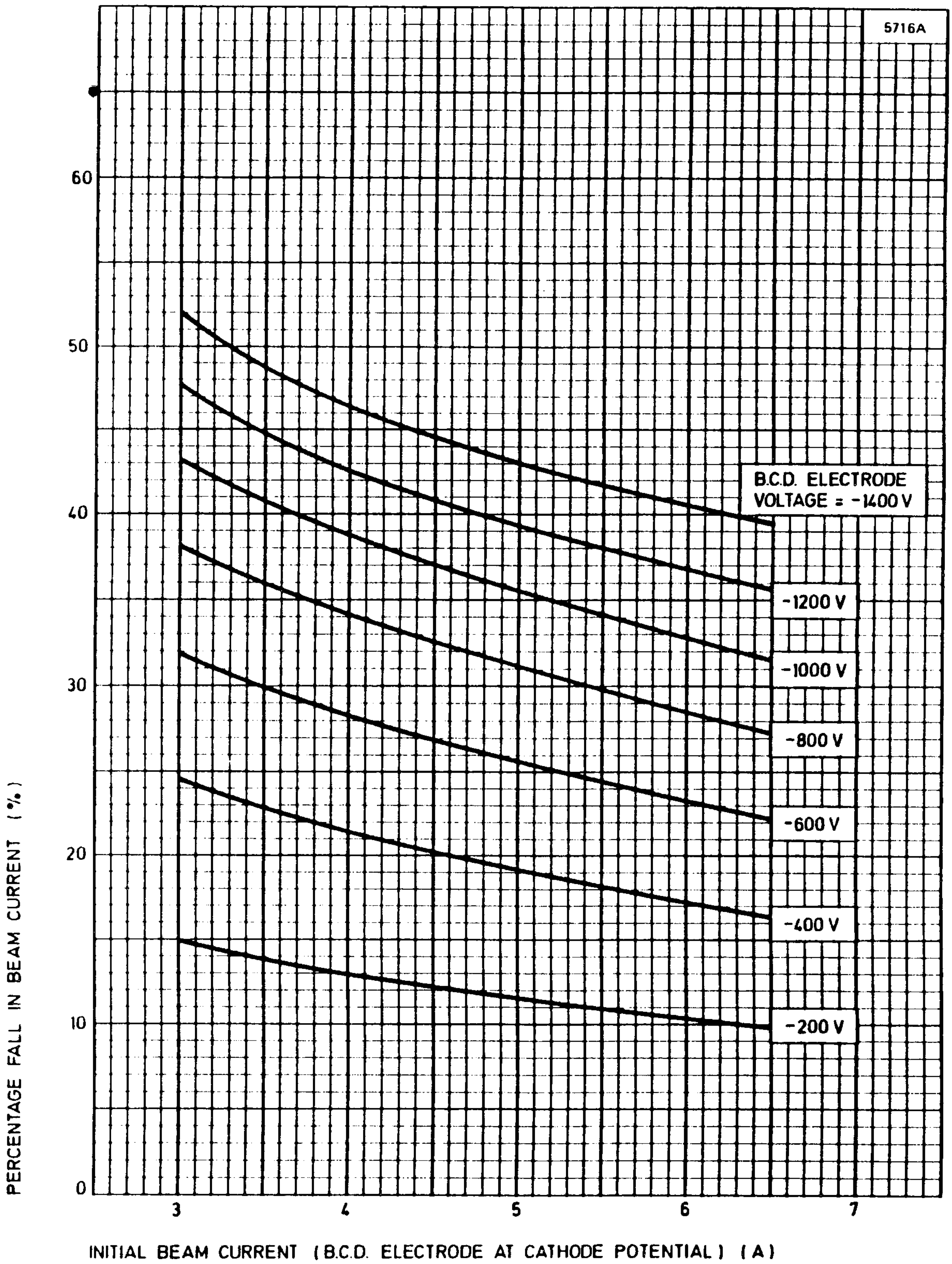


Note 1 U.S. gal = 0.832 Imp. gal.

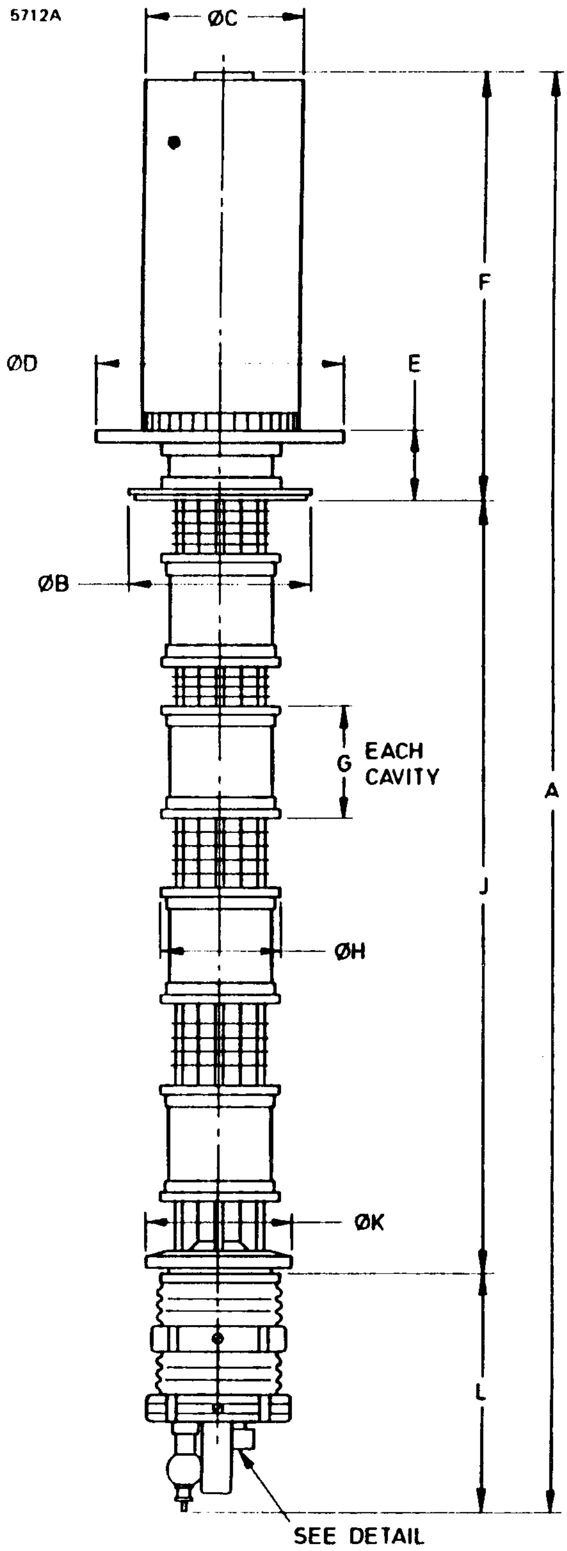
BEAM CURRENT CHARACTERISTIC

(B.C.D. electrode at cathode potential)

B.C.D. ELECTRODE VOLTAGE CHARACTERISTICS



OUTLINE OF K3773BCD



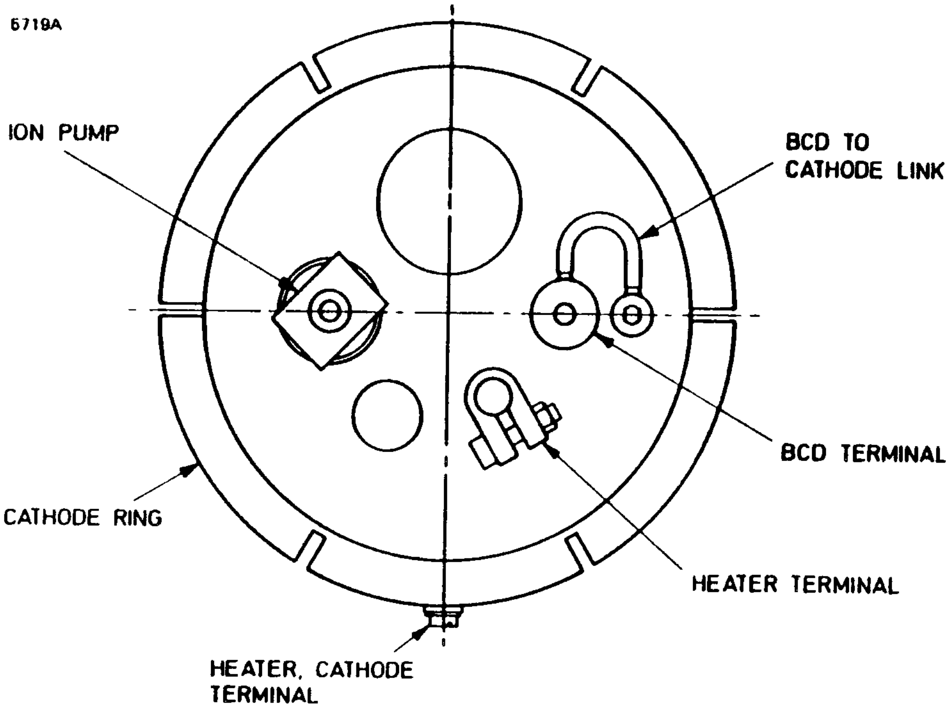
Outline Dimensions (All dimensions nominal)

Ref	Millimetres	Inches
A	•1588.0	62.520
B	202.0	7.953
C	175.0	6.890
D	282.5	11.122
E	75.4	2.969
F	466.5	18.366

Ref	Millimetres	Inches
G	127.0	5.000
H	130.2	5.126
J	846.5	33.327
K	160.0	6.299
L	275.0	10.827

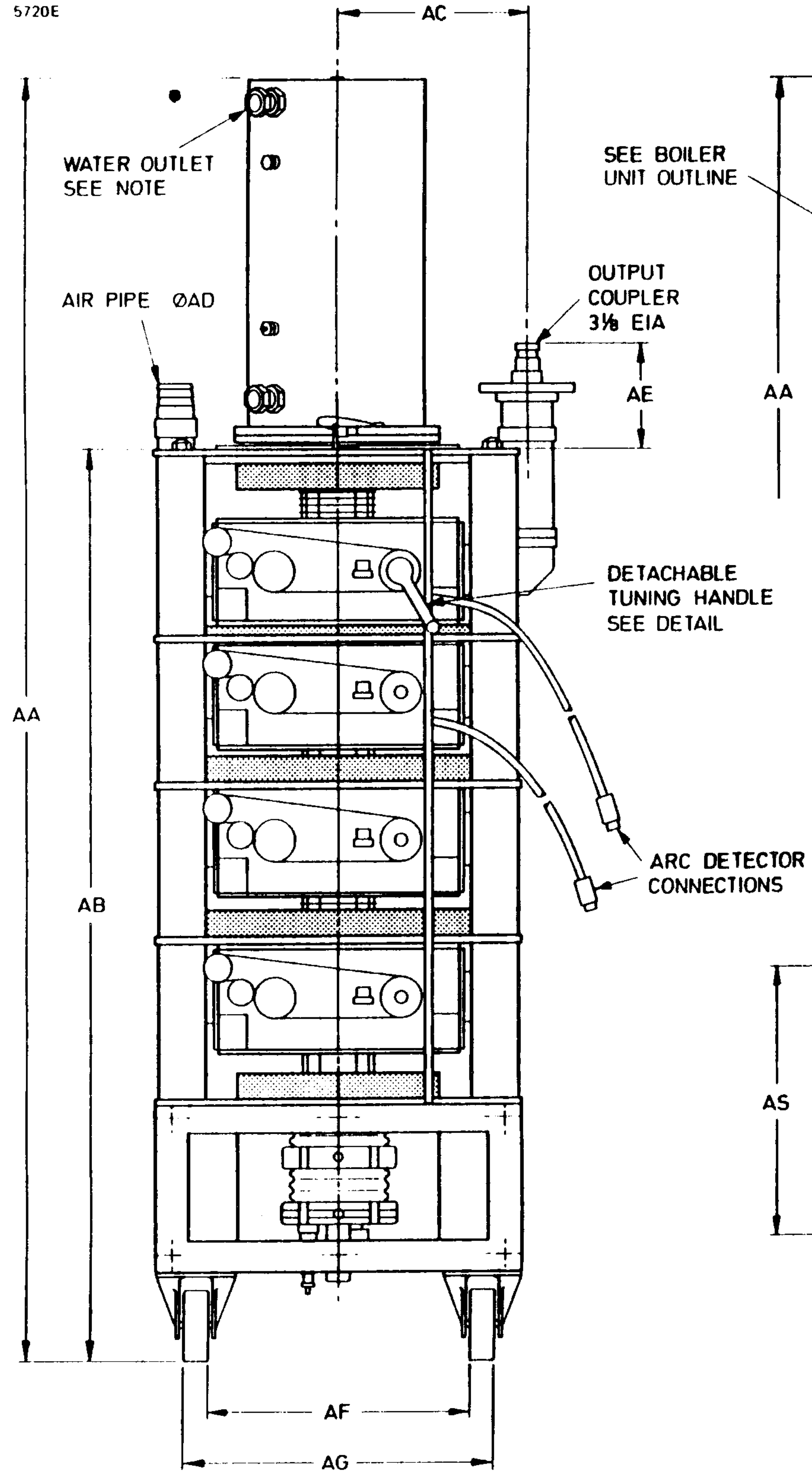
Inch dimensions have been derived from millimetres.

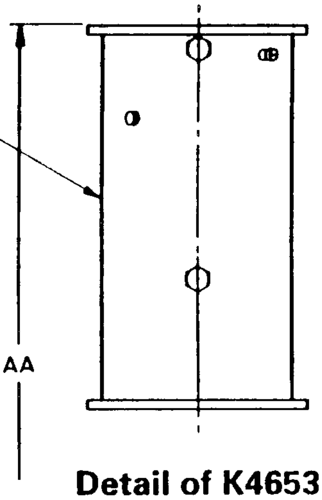
Enlarged View on Gun End of Klystron



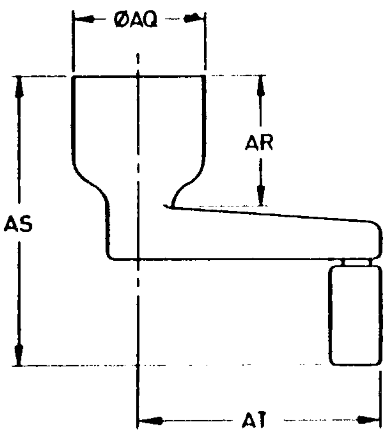
Note The klystron is supplied with a shorting link connected between the B.C.D. terminal and cathode. *If the B.C.D. electrode is to be used, this link must be removed.*

OUTLINE OF CIRCUIT ASSEMBLY K4653W



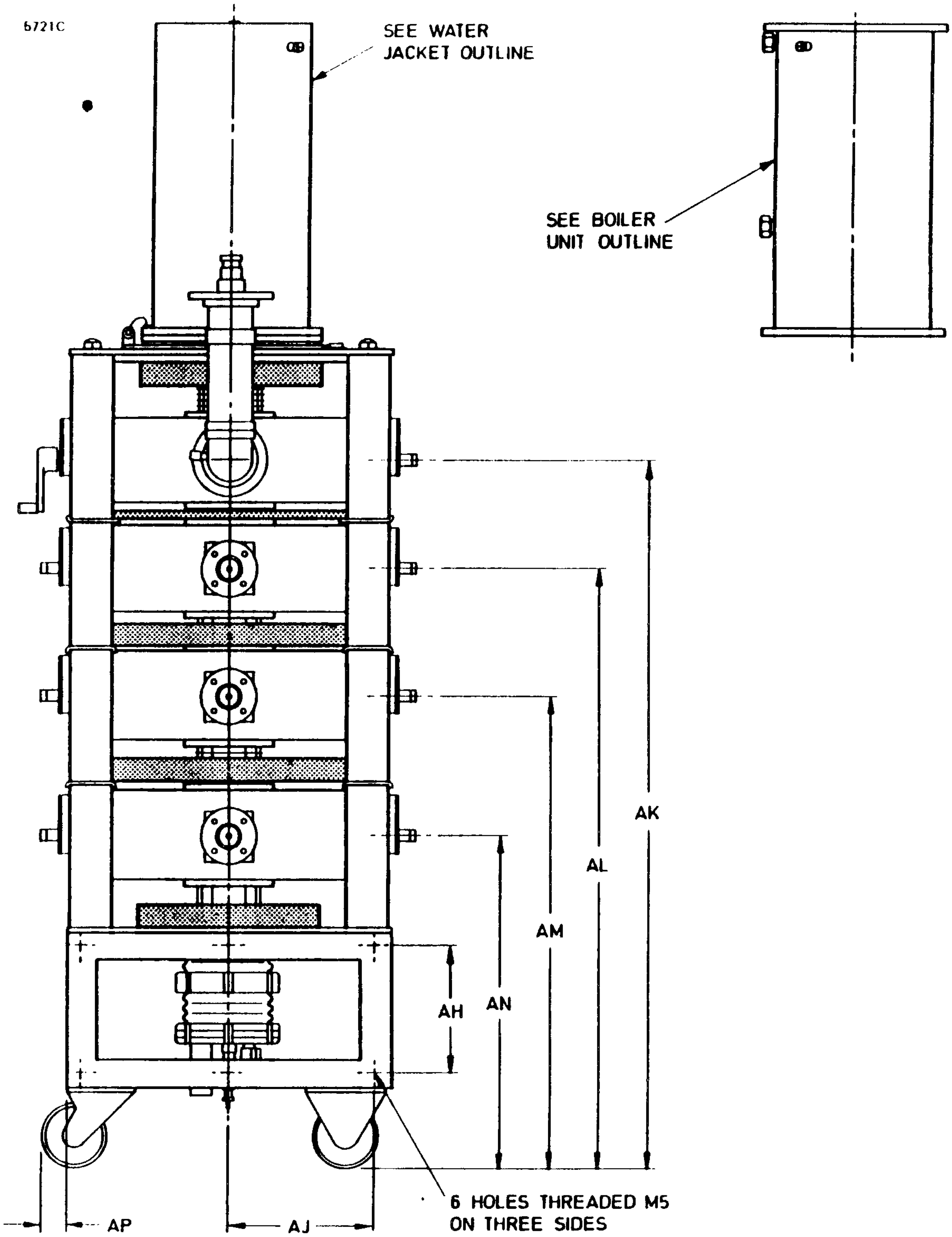


Detail of K4653 Boiler Unit



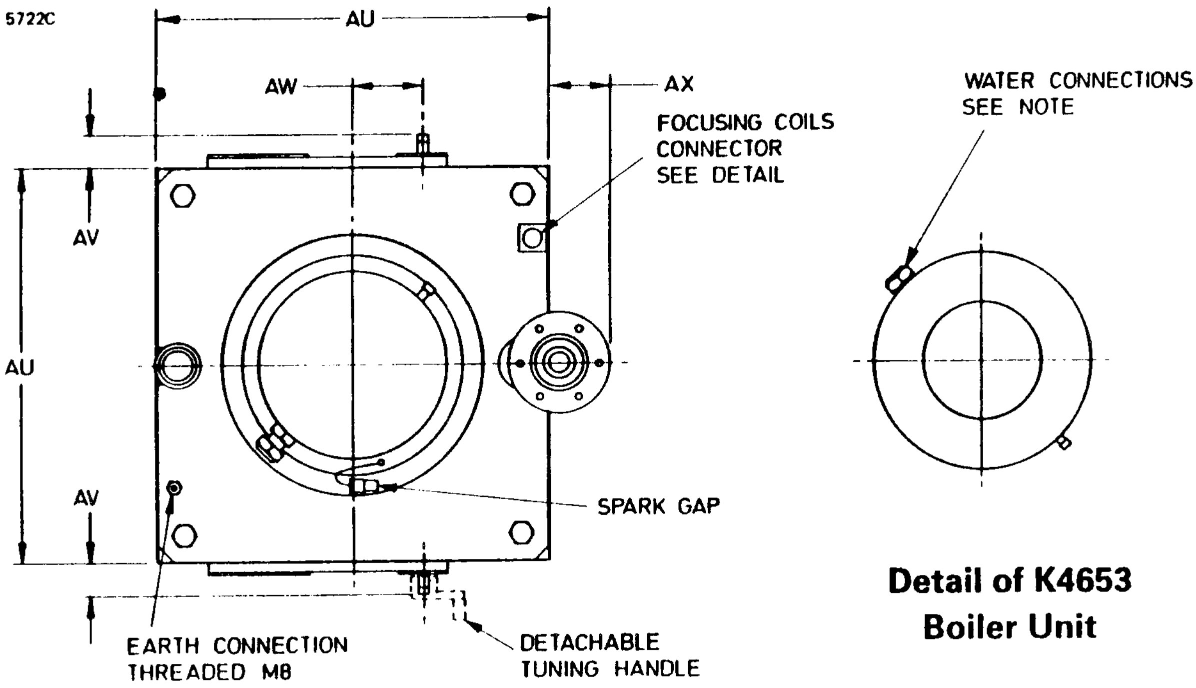
Detail of MA992A Tuning Handle

OUTLINE OF CIRCUIT ASSEMBLY K4653W



Top View of Circuit Assembly K4653W

(All dimensions without limits are nominal)



Detail of K4653 Boiler Unit

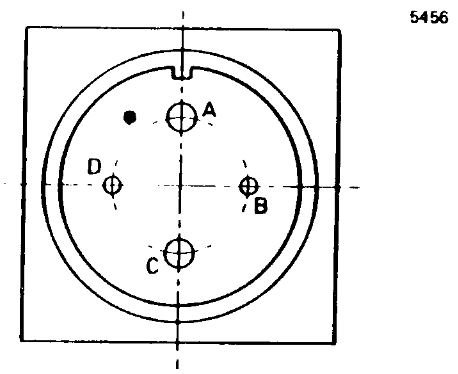
Ref	Millimetres	Inches
AA	1785.0	70.276
AB	1264.0	49.764
AC	265.0	10.433
AD	50.0	1.969
AE	150.0	5.906
AF	320.0	12.598
AG	405.0	15.945
AH	192.0	7.559
AJ	234.0	9.213
AK	1105.0	43.504
AL	922.0	36.299

Ref	Millimetres	Inches
AM	722.0	28.425
AN	507.0	19.961
AP	45.0	1.772
AQ	40.0	1.575
AR	60.0	2.362
AS	130.0	5.118
AT	90.0 max	3.543
AU	508.0	20.000
AV	55.0	2.165
AW	88.0	3.465
AX	78.0	3.071

Inch dimensions have been derived from millimetres.

Note Orientation of boiler or water jacket set by the user to bring connections to most convenient position.

View on Focus Coil Connector

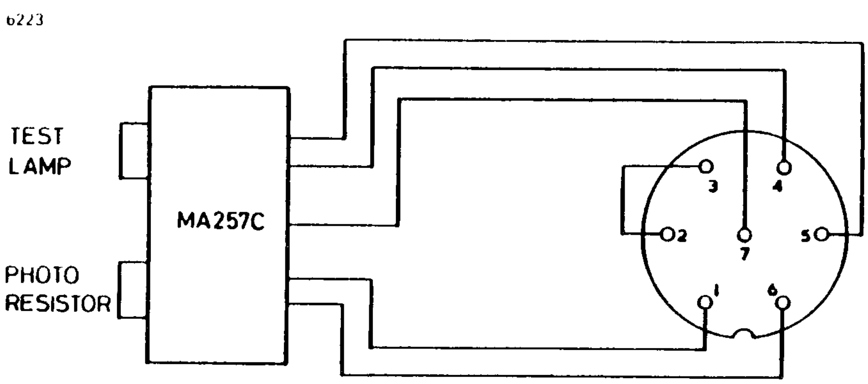


Connections

Pin	Element
A	Focus coil positive
B	Interlock
C	Focus coil negative
D	Interlock

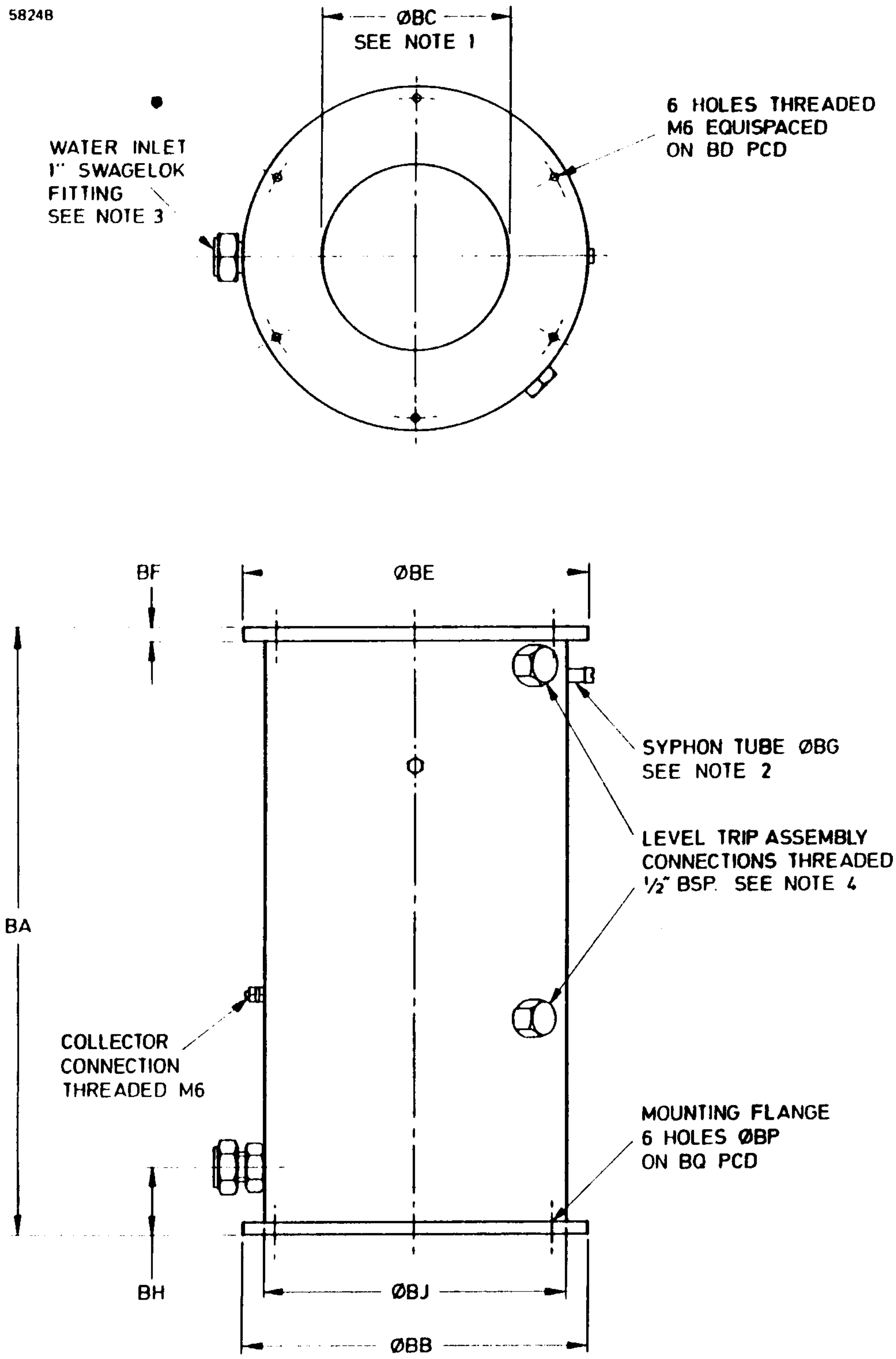
Note Pins B and D are connected within the circuit assembly for use as an interlock circuit; this connection may be removed by the customer if required for other purposes.

Arc Detector Connections to socket type Amphenol T3476-001



MA257C uses a free plug and socket at the end of a 1500 mm cable.

OUTLINE OF BOILER UNIT



Outline Dimensions (All dimensions without limits are nominal)

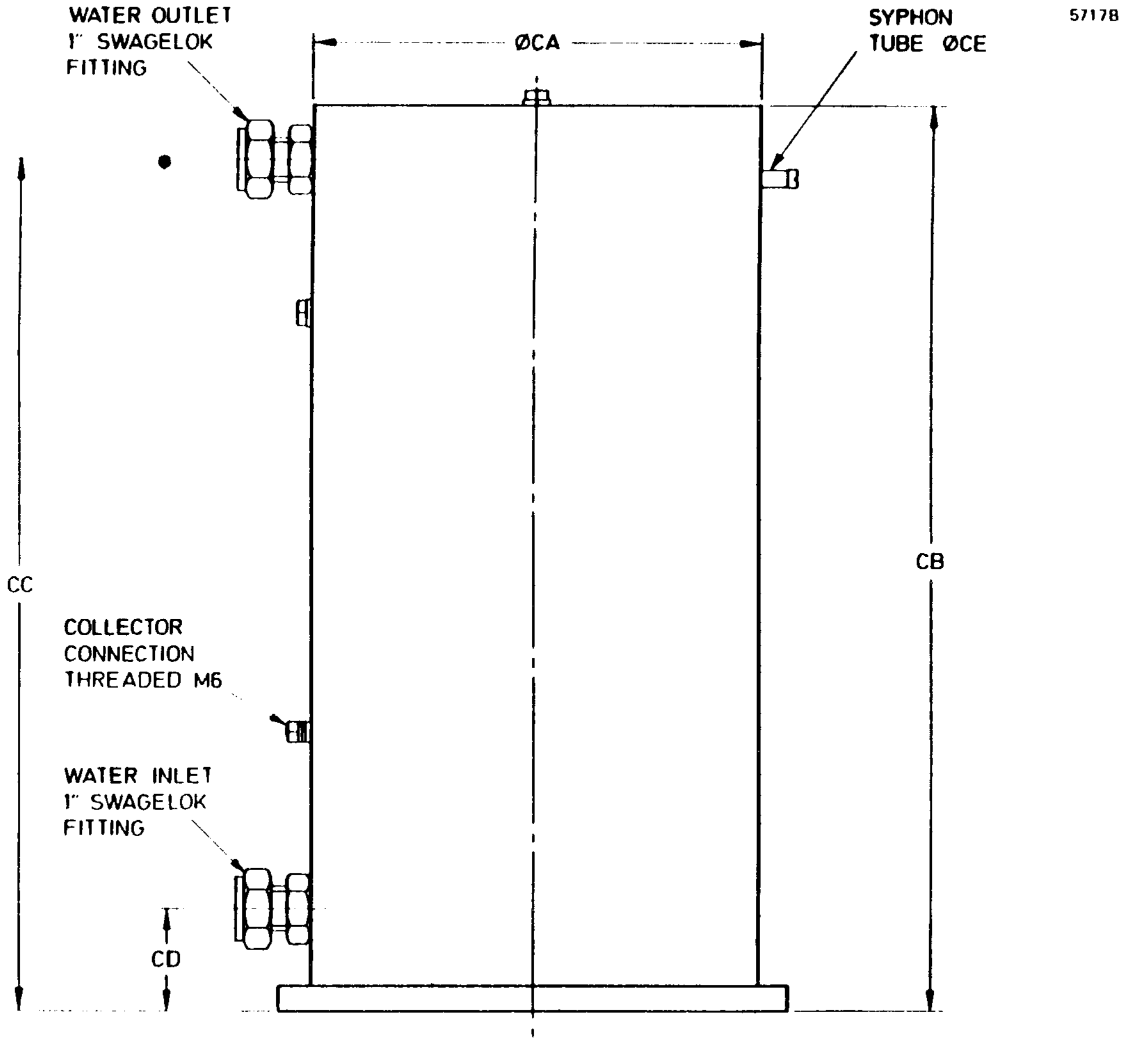
Ref	Millimetres	Inches	Ref	Millimetres	Inches
BA	498.0	19.606	BG	10.0	0.394
BB	282.5	11.122	BH	55.5	2.185
BC	152.5	6.004	BJ	248.0	9.764
BD	266.0	10.472	BP	7.25 ± 0.25	0.285 ± 0.010
BE	282.5	11.122	BQ	266.0	10.472
BF	13.0	0.512			

Inch dimensions have been derived from millimetres.

Outline Notes

1. To ensure efficient separation of carried over water from the steam, a vertical section of 6-inch (152 mm) nominal bore steam pipe at least 18 inches (457 mm) long must be coupled to the boiler steam outlet. The remainder of the steam pipe may be reduced to 4-inch (102 mm) nominal bore.
2. Water drain outlet; do not remove cap when klystron is operating. To drain boiler, remove cap and attach the syphon provided.
3. A weir, designed to maintain the water level in the boiler constant when operating with a pumped system, is available from EEV, part no. MA963C.
4. A sight glass and level trip assembly to fit the boiler is available from EEV, part no. MA213.

OUTLINE OF WATER JACKET (All dimensions nominal)



Ref	Millimetres	Inches
CA	248.0	9.764
CB	498.0	19.606
CC	467.0	18.386
CD	55.5	2.185
CE	10.0	0.394

Inch dimensions have been derived from millimetres.

English Electric Valve Company Limited

Chelmsford, Essex, England

Printed in England

Subsidiary of The General Electric Company, p.l.c. of England

3K3000LQ

AMPLIFIER KLYSTRON

ABRIDGED DATA

Three cavity, electro-magnetically focused, forced-air cooled amplifier klystron with separate tuning cavities, for u.h.f. c.w. service. The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

Frequency range	610 to 985	MHz
Output power (narrow-band)	2.0	kW min
Power gain (narrow-band)	25	dB
Beam voltage	9.0	kV max
Cooling		forced-air

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage	5.0	V
Heater current	31	A
Heater starting current (peak)	60	A max
Cathode heating time (minimum)	5	min

Mechanical

Overall length	34.935 inches (887.3 mm) max
Overall diameter	5.132 inches (130.4 mm) max
Mounting position	vertical, cathode end up
Net weight	32 pounds (14.5 kg) approx

Cooling

Air flow to collector	150 ft^3/min (4.2 m^3/min)
Collector pressure drop	1.6 inches (40.6 mm) w.g.
Air flow to output cavity	50 ft^3/min (1.4 m^3/min)
Cavity pressure drop	1.0 inch (25 mm) w.g.
Air flow to cathode	5 ft^3/min (0.14 m^3/min)
Cathode pressure drop	0.4 inch (10 mm) w.g.
Inlet air temperature	20 °C

MAXIMUM RATINGS (Absolute values)

No individual rating should be exceeded

Beam voltage	9.0	kV max
Beam current (mean)	0.75	A max
Body current:		
continuous	75	mA max
tuning	100	mA max
Focus electrode voltage (negative)	500	V max
Collector dissipation (see note)	3.0	kW max
Temperature of any external part of the klystron	175	°C max

TYPICAL OPERATION (Narrow-band c.w.)

Frequency	850	850	MHz
Beam voltage	7.0	9.0	kV
Beam current	375	580	mA
Focus electrode voltage	−200	−200	V
Body current	30	30	mA
Driving power	4.0	10	W
Output power	1300	2790	W
Power gain	25	24	dB
Efficiency	50	54	%

NOTE Failure of the r.f. drive power while the klystron is running may result in the collector dissipation rating being exceeded. A thermal trip should be fitted to the collector to cut off the beam if the temperature exceeds 175 °C.

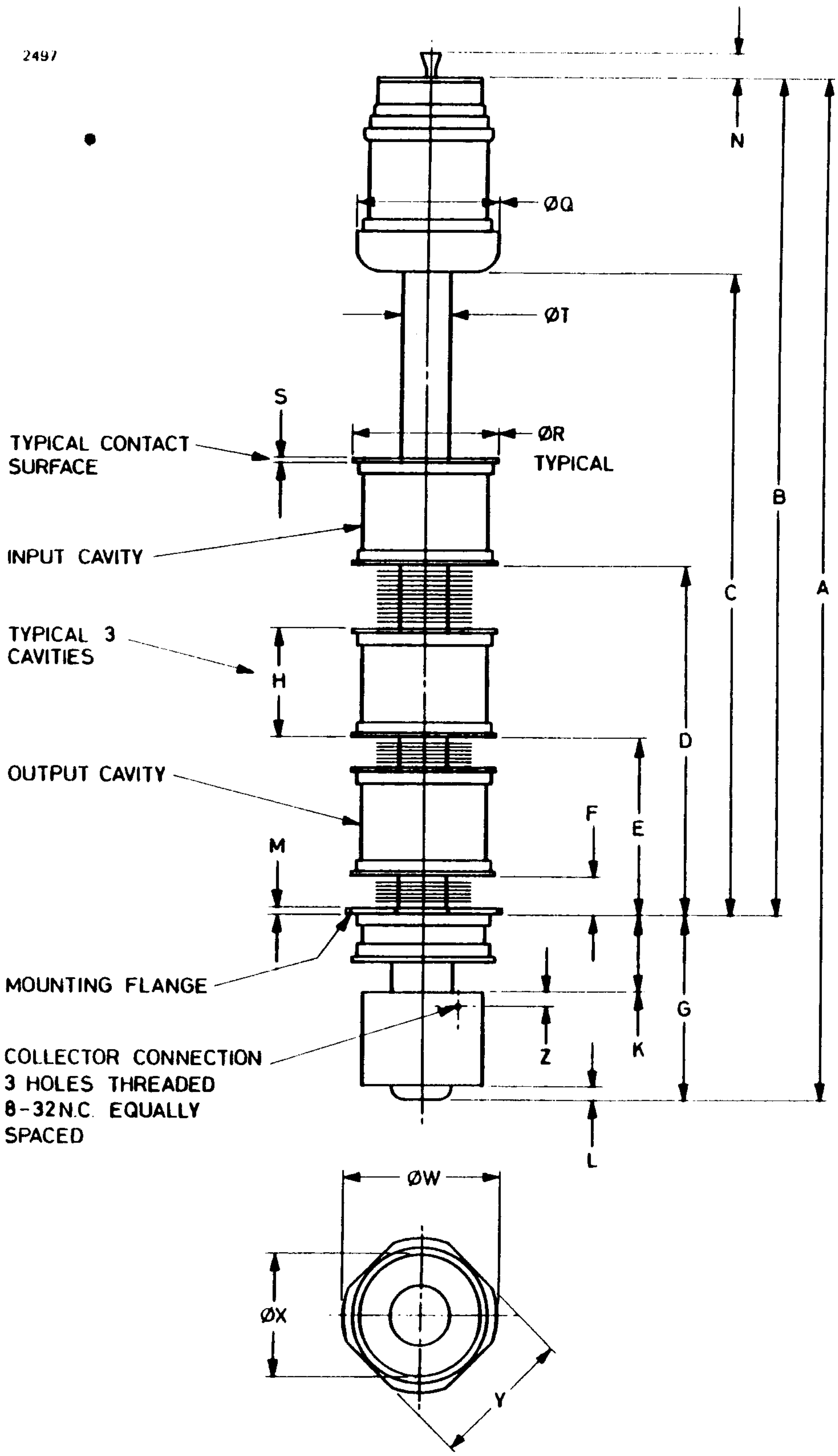
Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	33.187	842.9	M	0.250	6.35
B	27.312	693.7	N	0.750 max	19.05 max
C	20.812	528.6	Q	4.625	117.5
D	11.312	287.3	R	4.625	117.5
E	5.812	147.6	S	0.245	6.22
F	1.312	33.32	T	1.500	38.1
G	5.875	149.2	W	5.125	130.2
H	3.500	88.9	X	4.125	104.8
K	2.500	63.5	Y	4.625	117.5
L	0.375	9.53	Z	0.430	10.92

Millimetre dimensions have been derived from inches.

OUTLINE

2497



Whilst EEV has taken care to ensure the accuracy of the information contained herein it accepts no responsibility for the consequences of any use thereof and also reserves the right to change the specification of goods without notice. EEV accepts no liability beyond that set out in its standard conditions of sale in respect of infringement of third party patents arising from the use of tubes or other devices in accordance with information contained herein.

4KM50,000LR

AMPLIFIER KLYSTRON

ABRIDGED DATA

Four cavity, electro-magnetically focused amplifier klystron with separate tuning cavities, for u.h.f. c.w. service. A modulating anode is fitted which may be used for beam current control or as a protective device.

The operation of the klystron is guaranteed only when it is used with an approved circuit assembly.

Frequency range	755 to 985	MHz
Output power	10	kW
Power gain (narrow-band)	53	dB
Beam voltage	17	kV
Cooling	water and forced-air	

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	7.5	V
Heater current	40	A
Heater starting current (peak)	80	A max
Cathode heating time (minimum)	5	min

Mechanical

Overall length	47.75 inches (121.3cm) nom
Overall diameter (excluding water fittings)	5.125 inches (13.02cm) nom
Net weight	55 pounds (25kg) approx
Mounting position	vertical, cathode end up

November 1980

Supersedes September 1971 Issue

Cooling

At sea level and with an inlet air temperature of 20°C, the water and air flow rates given below are adequate for operation at maximum ratings. The air and water flows should be started before the cathode heater voltage is applied and should be continued for at least two minutes after the removal of power. The simultaneous removal of cooling and power supplies will not normally damage the klystron, but this practice is not recommended.

Air flow to cathode	25	ft^3/min
	0.71	m^3/min
Cathode pressure drop	1.0	inch (25mm) w.g.
Air flow to output cavity	50	ft^3/min
	1.42	m^3/min
Cavity pressure drop	1.5	inches (38mm) w.g.
Water flow to klystron body	1.0	imp.gal/min
	4.5	l/min
Body pressure drop	28	lb/in^2 ($2kg/cm^2$)
Water flow to collector	21	imp.gal/min
	95.5	l/min
Collector pressure drop	28	lb/in^2 ($2kg/cm^2$)

MAXIMUM RATINGS (Absolute values)

No individual rating should be exceeded

Beam voltage	20	kV max
Beam current (mean)	2.5	A max
Body current (mean):		
for continuous operation	100	mA max
for tuning	150	mA max
Focus electrode voltage (negative)	500	V max
Collector dissipation	50	kW max
Inlet water pressure	50	lb/in^2 max
	3.52	kg/cm^2 max
Temperature of any external part of the klystron	175	°C max

TYPICAL OPERATION

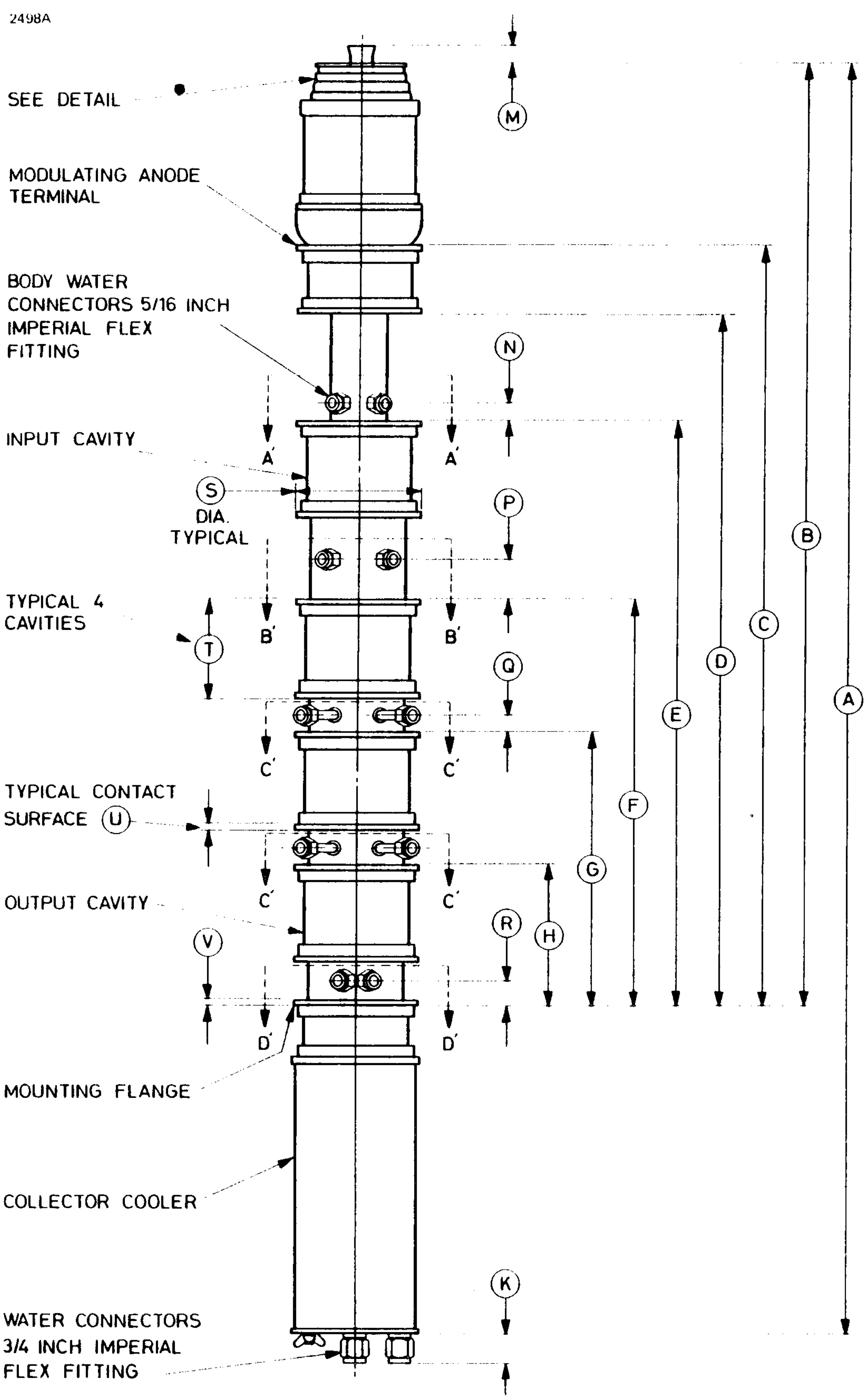
Narrow-band c.w.

Frequency	755	985	MHz
Beam voltage	17	17	kV
Beam current (mean)	1.8	1.8	A
Focus electrode voltage	−200	−200	V
Body current (mean)	30	40	mA
Drive power	50	50	mW
Output power	12.1	11.5	kW
Power gain	53.8	53.6	dB
Efficiency	39.5	37.6	%

Broad-band c.w.

Frequency	762	MHz
Beam voltage	17	kV
Beam current (mean)	1.8	A
Bandwidth to 3 dB points	7.0	MHz
Focus electrode voltage	−200	V
Body current (mean)	50	mA
Drive power	10	W
Output power	10	kW
Power gain	30	dB
Efficiency	32.7	%

OUTLINE



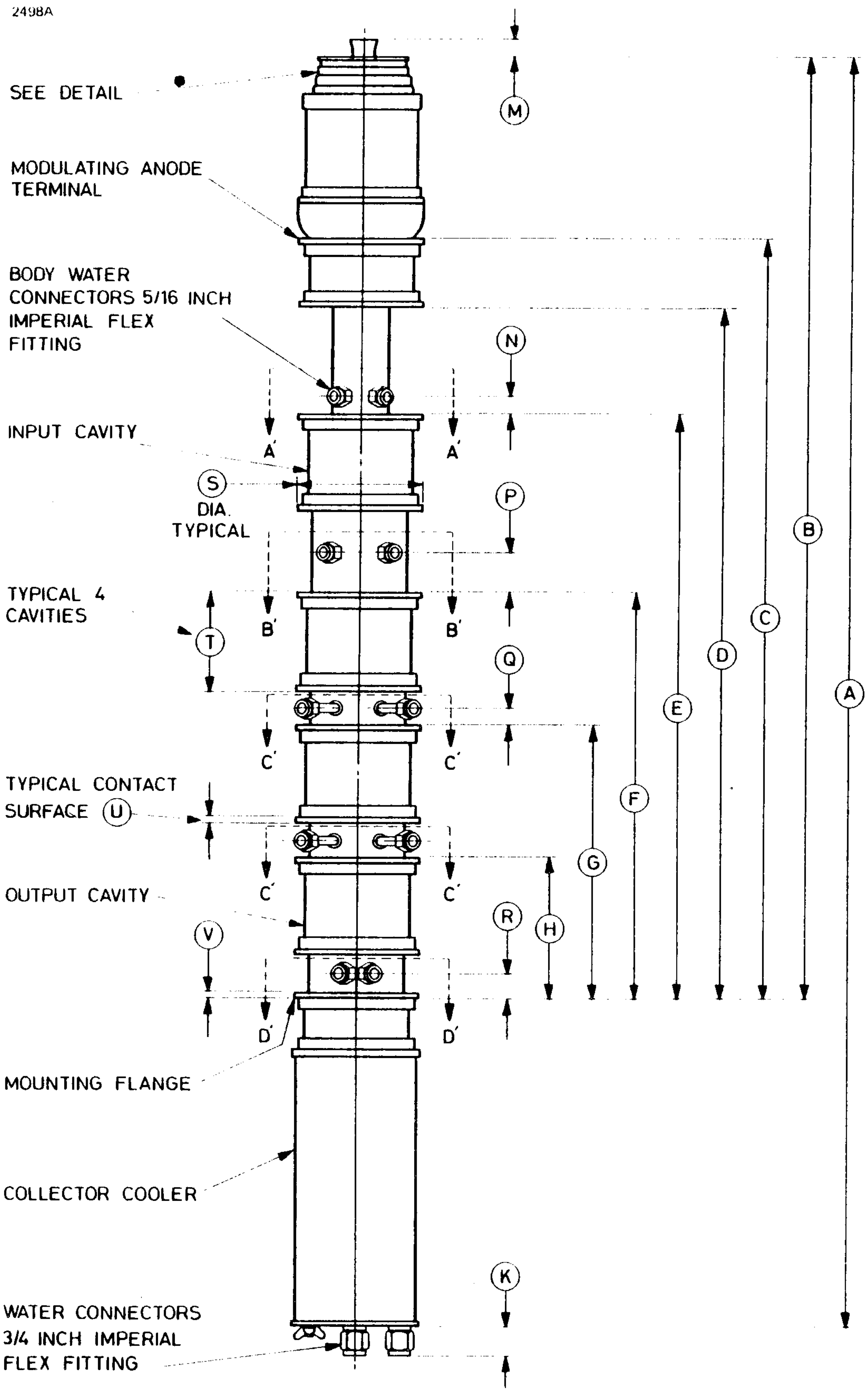
2498A
SEE DETAIL
MODULATING ANODE TERMINAL
BODY WATER CONNECTORS 5/16 INCH IMPERIAL FLEX FITTING
INPUT CAVITY
S
DIA. TYPICAL
TYPICAL 4 CAVITIES
T
TYPICAL CONTACT SURFACE U
OUTPUT CAVITY
V
MOUNTING FLANGE
COLLECTOR COOLER
WATER CONNECTORS 3/4 INCH IMPERIAL FLEX FITTING
A'
B'
C'
D'
M
N
P
Q
R
K
A
B
C
D
E
F
G
H

Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres
A •	44.875	1139.8
B	33.375	847.7
C	26.963	684.9
D	24.375	619.1
E	20.625	523.9
F	14.375	365.1
G	9.687	246.0
H	5.000	127.0
K	1.125	28.58
M	1.750 max	44.45 max
N	0.687	17.45
P	1.375	34.93
Q	0.594	15.09
R	0.687	17.45
S	4.625	117.5
T	3.500	88.90
U	0.250	6.35
V	0.250	6.35

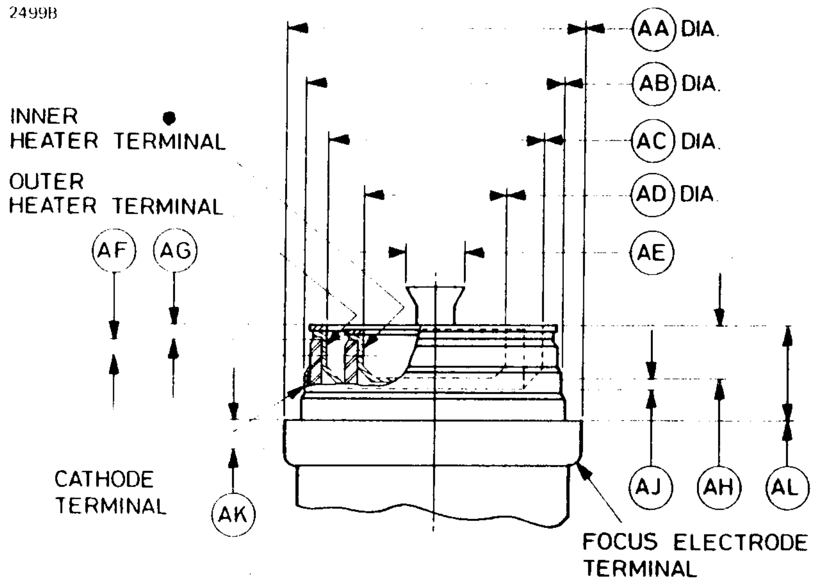
Millimetre dimensions have been derived from inches.

OUTLINE

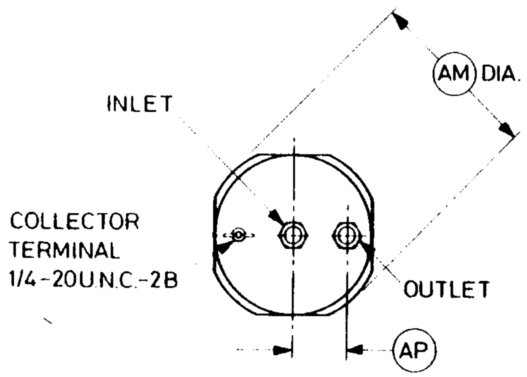


2498A
SEE DETAIL
MODULATING ANODE TERMINAL
BODY WATER CONNECTORS 5/16 INCH IMPERIAL FLEX FITTING
INPUT CAVITY
S
DIA. TYPICAL
TYPICAL 4 CAVITIES
T
TYPICAL CONTACT SURFACE U
OUTPUT CAVITY
V
MOUNTING FLANGE
COLLECTOR COOLER
WATER CONNECTORS 3/4 INCH IMPERIAL FLEX FITTING
A'
A'
B'
B'
C'
C'
C'
C'
D'
D'
M
N
P
Q
R
K
A
B
C
D
E
F
G
H

Outline Details (All dimensions without limits are nominal)



Detail of Cathode End

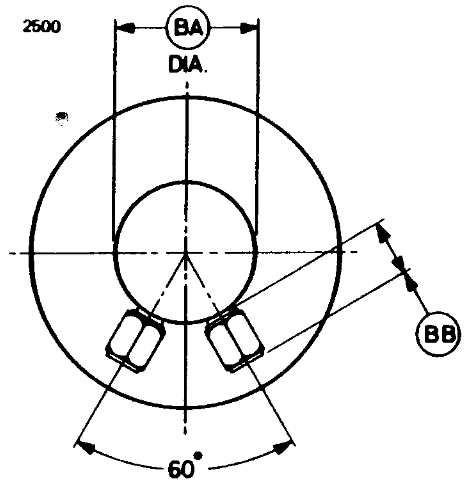


View on Collector End

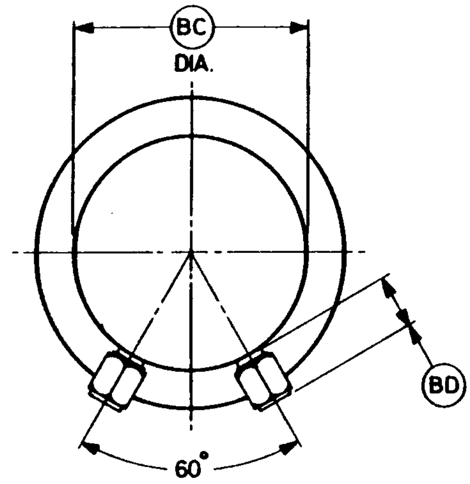
Ref	Inches	Millimetres	Ref	Inches	Millimetres
AA	4.375	111.1	AH	0.750	19.05
AB	3.800	96.52	AJ	0.125 min	3.18 min
AC	3.187	80.95	AK	0.500 min	12.70 min
AD	1.937	49.20	AL	1.312	33.32
AE	1.261 max	32.03 max	AM	5.125	130.2
AF	0.250 min	6.35 min	AP	1.625	41.28
AG	0.150	3.81			

Millimetre dimensions have been derived from inches.

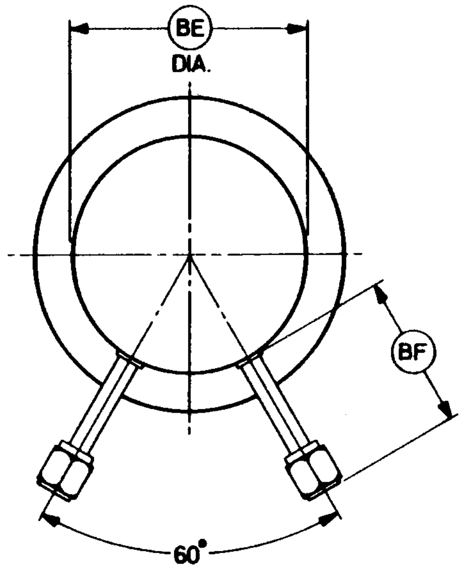
Outline Details (All dimensions nominal)



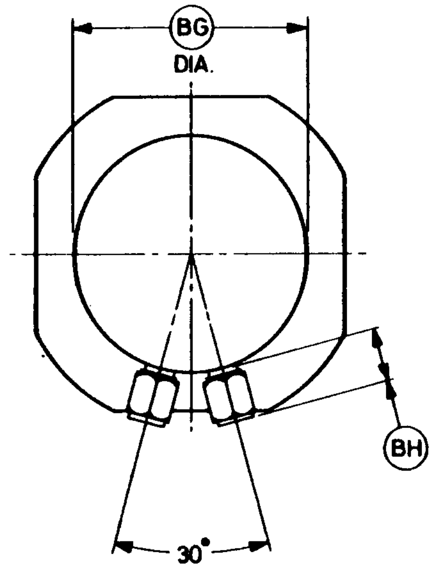
VIEW A'-A'



VIEW B'-B'



VIEW C'-C'



VIEW D'-D'

Ref	Inches	Millimetres	Ref	Inches	Millimetres
BA	2.120	53.85	BE	3.250	82.55
BB	0.850	21.59	BF	2.250	57.15
BC	3.250	82.55	BG	3.250	82.55
BD	0.850	21.59	BH	0.850	21.59

Millimetre dimensions have been derived from inches.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a tube is damaged. English Electric Valve Company cannot accept responsibility for damage or injury resulting from the use of EEV tubes. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities, airpipes and electron gun enclosure fitted.

Beryllium Oxide Ceramics

The **third** and **output** cavity ceramics of these klystrons are made of beryllium oxide (coloured blue, or marked with a black line). **Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics;** if they are touched, the hands must be washed before smoking or eating. **Do not** do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

a) Wear impervious rubber gloves and use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths and discarded rubber gloves wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

English Electric Valve Company Limited
Chelmsford, Essex, England
Printed in England

K386

AMPLIFIER KLYSTRON

FEATURING

- **Output Power** 11 kW minimum, combined with long life and reliable performance.
- **High Gain** Fully compatible with solid state drive.
- **Bandwidth** 8 MHz between 3 dB points over the tuning range.
- **High Stability** Air blown cavities ensure high operational stability.
- **Arc Detector in Output Cavity.** ☆
- **Simple Installation** Pre-adjusted cavities are an integral part of the transmitter. Vacuum tube changes can be carried out by unskilled staff in less than 30 minutes.
- **Simple Vapour Cooling** Collector down configuration with vapour cooling – silent, self-circulating system; no pump.

DESCRIPTION

Four cavity amplifier klystron with separate tuning cavities, for tropospheric scatter service in the frequency range 755 to 985 MHz. A modulating anode is fitted which may be used for beam current control or as a protective device.

The tube is electro-magnetically focused and its associated circuit assembly is designed to reduce tube replacement time to a minimum. With this design, full use is made of the advantages of the external cavity klystron. On initial installation the cavities can be tuned to a specific channel and the coupling loops adjusted for optimum performance. The cavities can be detached from the vacuum tube and refitted on a replacement tube without disturbing the tuning or the coupling loop settings. At switch-on, the replacement klystron will be coarse-tuned, requiring only a trimming adjustment to meet the full specification.

The additional features on this circuit assembly; all cavities air blown, increased airpipe diameter, additional cavity loading loops and arc detector, enable the K386 to meet the latest tropospheric scatter communications system requirements.

☆ Indicates a change.

October 1980

Supersedes February 1976 Issue

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage (see note 1)	in the range 5.0 to 5.5	V
Heater current	38 to 44	A
Heater starting current (peak)	84	A max
Cathode heating time (minimum)	5	minutes

Mechanical

Overall length	39.6 inches (100.6 cm) nom
Overall diameter	8.0 inches (20.3 cm) nom
Mounting position	vertical, cathode end up
Net weight of klystron	55 pounds (25 kg) approx

☆ Circuit Assembly K4148M

Electro-magnet current	11 ± 1	A
Electro-magnet resistance:		
cold (20 °C)	5.7	Ω
hot (20 °C ambient)	7.3	Ω max
R.F. input connector		type N coaxial
☆ R.F. connectors on cavities 2 and 3		type N coaxial
R.F. output		3 ⅛ inch 50 Ω coaxial line
Net weight of magnet assembly		770 pounds (349 kg) approx
Weight of cavities		60 pounds (27 kg) approx

Arc Detector

Arc detector type MA257A is fitted to the output cavity.

Photo-resistor type		NSL462
Minimum dark resistance	20	MΩ
Resistance at 1 foot-candle	28	kΩ
Resistance at 100 foot-candles	600	Ω
Maximum voltage (peak)	70	V
Maximum temperature	75	°C
Layer		cadmium sulphide
Test lamp	28	V
	0.04	A

☆ Indicates a change.

Cooling

The klystron collector is vapour cooled. The boiler, which is part of the circuit assembly, is of the upward steam exit type and intended for use with a separate condenser.

The final drift tube and the cavities are forced-air cooled. This is achieved by means of a single air inlet pipe on the circuit assembly. Cooling air must be adequately filtered to avoid electrostatic precipitation of dust.

Air flow for cavity cooling (minimum)	100	ft^3/min	☆
	2.8	m^3/min	
Air flow to cathode terminal	5.0	ft^3/min	
	0.14	m^3/min	
Static pressure head at 100 ft^3/min (see note 2)	2.0 inch (51 mm) water gauge		☆
Inlet air temperature	55	°C max	
Temperature of any external parts of the klystron must not exceed	175	°C max	
Volume of steam produced by collector dissipation	1.5	ft^3/min/kW	
	0.043	m^3/min/kW	
Volume of water converted to steam	0.006	imp.gal/min/kW	
	0.027	litre/min/kW	

MAXIMUM RATINGS (Absolute values)

No individual rating must be exceeded.

Beam voltage	14	kV max
Beam current (mean)	3.5	A max
Body current:		
with no input power	50	mA max
at saturated output power	150	mA max
Output power	12	kW max
Collector dissipation	45	kW max
Load v.s.w.r.	1.5:1	max

☆ Indicates a change.

TYPICAL OPERATION

The values given are for operation in a 10 kW tropospheric-scatter transmitter.

Beam voltage		12		kV
Beam current		2.7		A
Electro-magnet current		11		A
Bandwidth to 3 dB		8.0		MHz
Centre frequency	760	870	980	MHz
Body current:				
with no input power	15	15	15	mA
at saturation	70	50	35	mA
Drive power	0.8	0.5	0.2	W
Saturated output power	11.4	11.5	11.0	kW

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

Test Conditions

Heater voltage	5.0 to 5.5	V
Electro-magnet current	10 to 12	A
Frequency range	755 to 985	MHz
Bandwidth (see note 3)	8.0	MHz
Output power (see note 4)	11	kW

Range of Characteristics

	Min	Max	
Heater current	38	44	A
Beam voltage (see note 5)	–	12.5	kV
Body current	–	150	mA
R.F. drive power (see note 6)	–	1.1	W
Efficiency (see note 7)	32	–	%

NOTES

1. When a klystron is first installed it must be operated at 5.0 V heater voltage.
2. Measured at the input to the circuit assembly.
3. The klystron cavities shall be tuned so that, for constant input power, the variation in output power at the klystron flange will be less than 3 dB over the specified bandwidth.

4. Input frequency set to band centre.
5. With the modulating anode connected to the body via a 10 kΩ resistor the beam current limits will be within ± 5% of the value given by the graph on page 7.
6. Defined as the power delivered to a matched load substituted for the input cavity of the klystron.
7. The efficiency will not fall below the specified limit for any beam power in the range 30 to 37.5 kW.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. English Electric Valve Company cannot assume responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

R.F. Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and intermediate cavities. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

Beryllium Oxide Ceramics

The **third** and **output** cavity ceramics of these klystrons are made of beryllium oxide (coloured blue, or marked with a black line). **Beryllium oxide dust or fumes are highly toxic if inhaled, or if particles enter a cut or abrasion. Avoid handling the beryllium oxide ceramics;** if they are touched, the hands must be washed before smoking or eating.

Do not do anything to the beryllium oxide ceramics which may produce dust or fumes. Do not grind, grit-blast or clean with acid or abrasive cleaners. Cleaning information is available from EEV on request.

If a beryllium oxide ceramic is broken, proceed as follows:

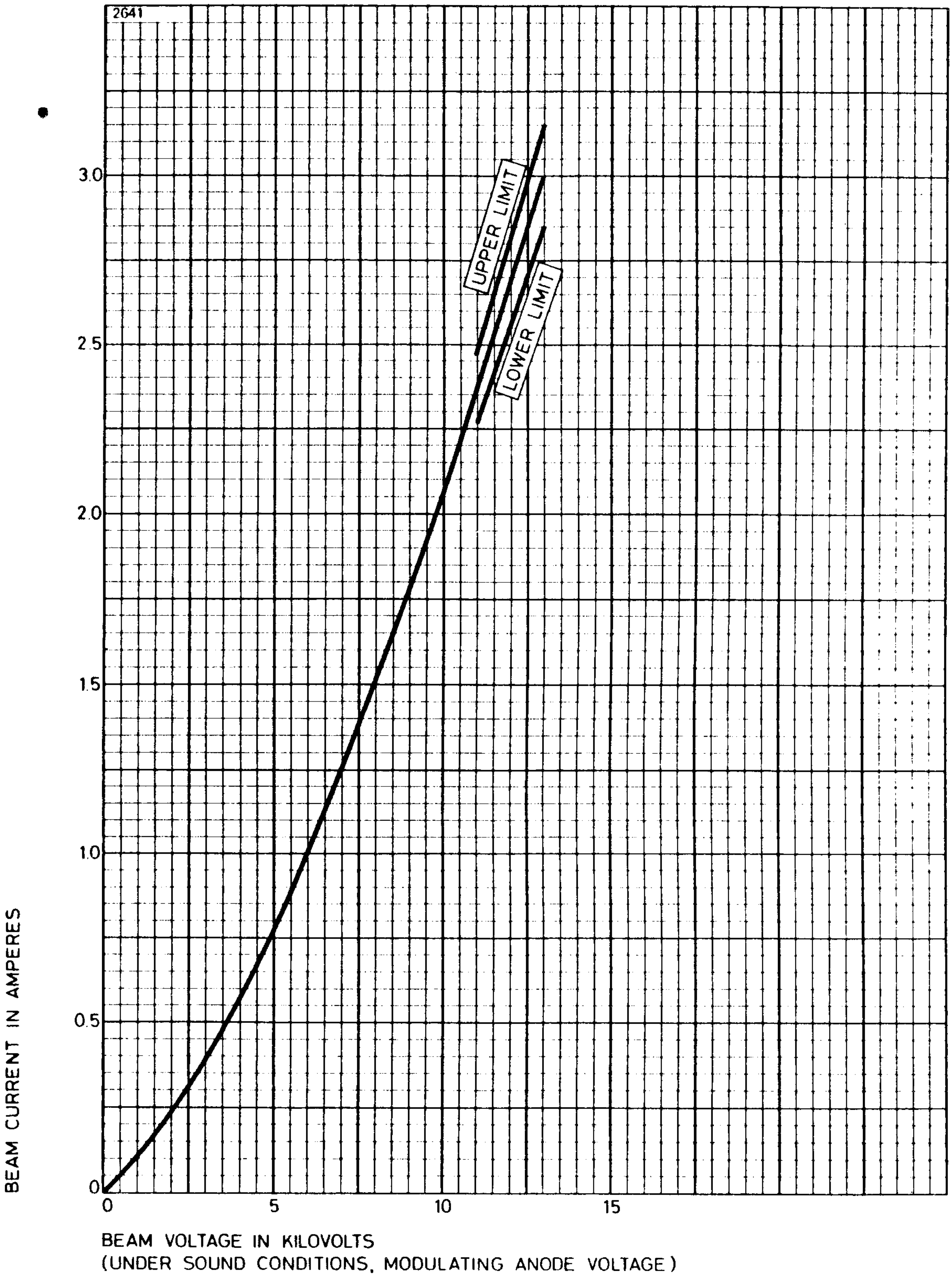
a) Wear impervious rubber gloves and use water and wet cloths to settle beryllium oxide dust and collect particles. Keep the cloths and discarded rubber gloves wet and store wet in a plastic bucket with lid.

b) Wrap several layers of adhesive tape (masking tape is suitable) around the break line of the ceramic. This will prevent any further escape of beryllium oxide dust and chips due to abrasion of the broken parts.

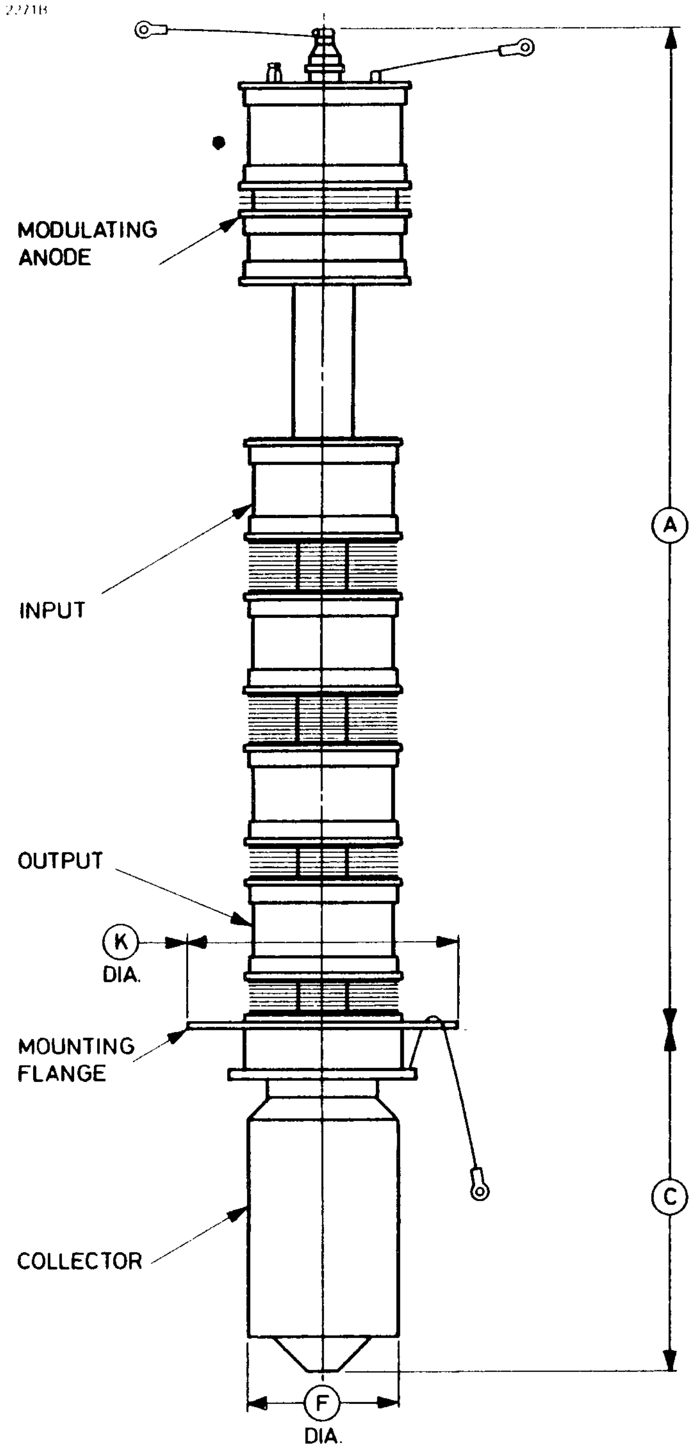
c) Contact EEV who will advise on the disposal of the broken klystron and the cloths contaminated with beryllium oxide debris.

d) Wash hands before smoking or eating.

BEAM CURRENT LIMITS

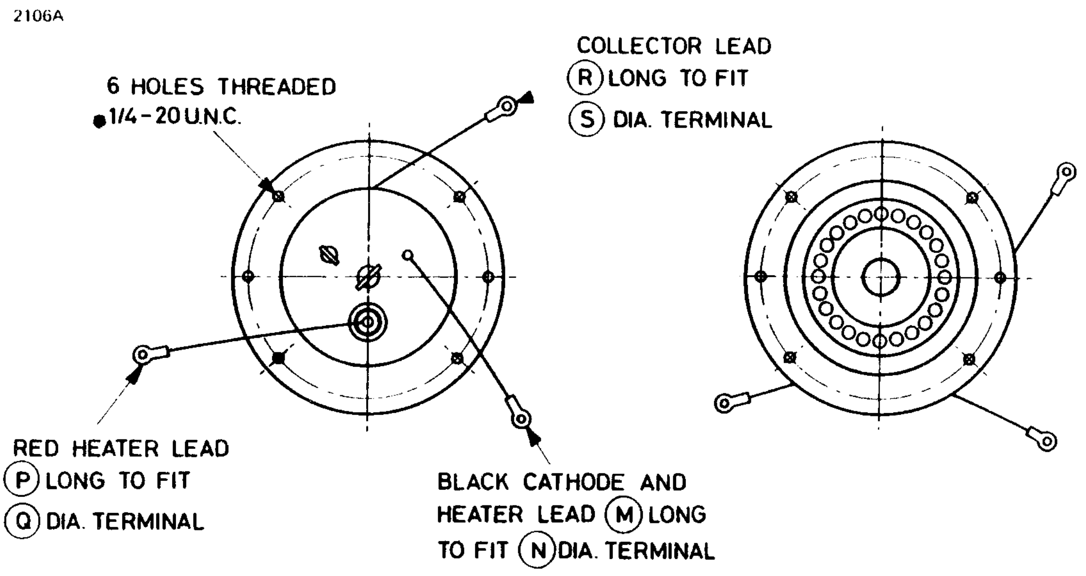


OUTLINE



MODULATING
ANODE
INPUT
OUTPUT
K
DIA.
MOUNTING
FLANGE
COLLECTOR
A
C
F
DIA.

Outline Details (All dimensions without limits are nominal)

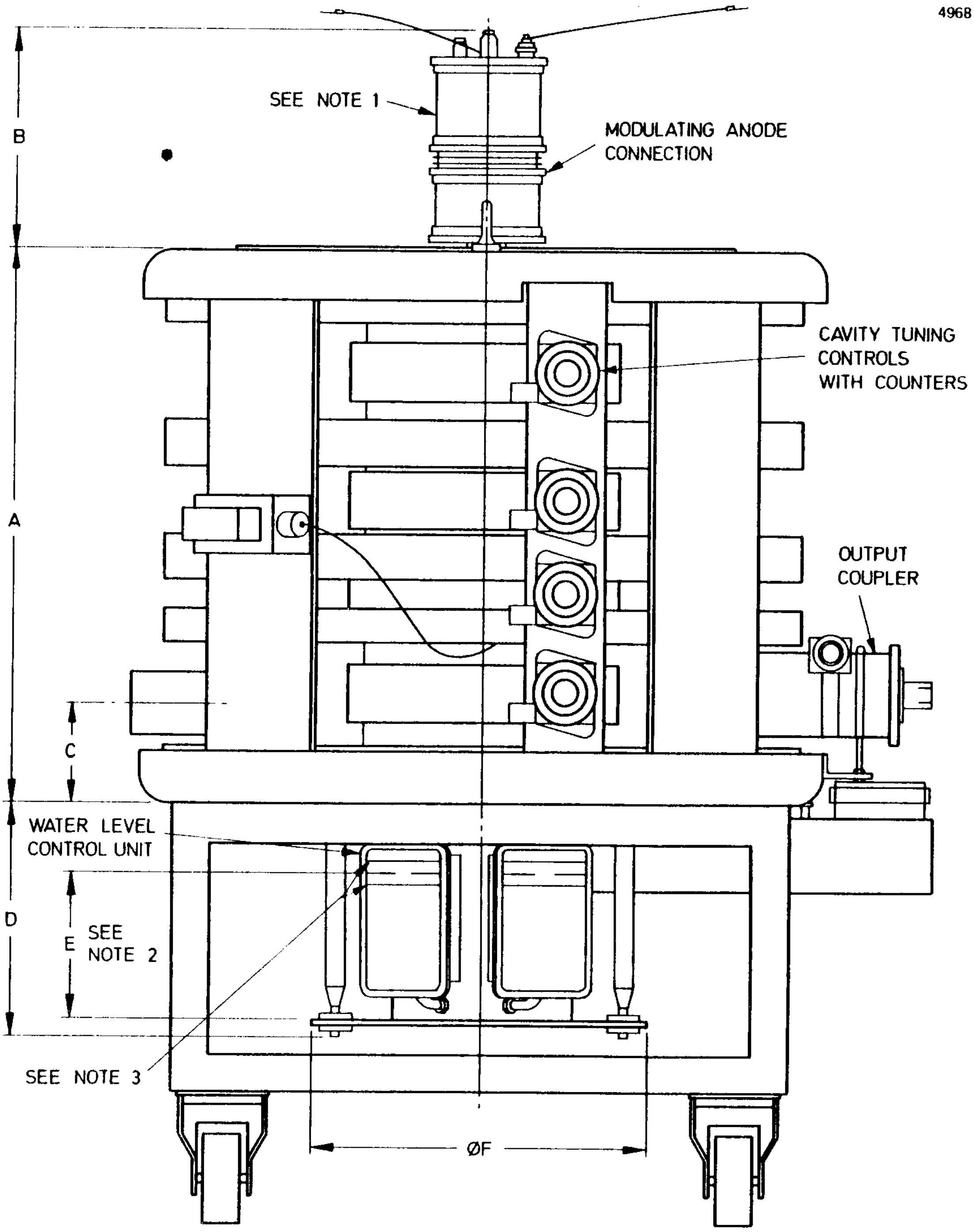


View on Gun End **View on Collector End**

Ref	Inches	Millimetres
A	29.600 ± 0.500	751.8 ± 12.7
C	10.000 ± 0.062	254.0 ± 1.6
F	4.375	111.1
K	8.000	203.2
M	19.000 min	482.6 min
N	0.312	7.92
P	19.000 min	482.6 min
Q	0.250	6.35
R	36.000 min	914.4 min
S	0.196	4.98

Millimetre dimensions have been derived from inches.

☆ OUTLINE OF CIRCUIT ASSEMBLY K4148M

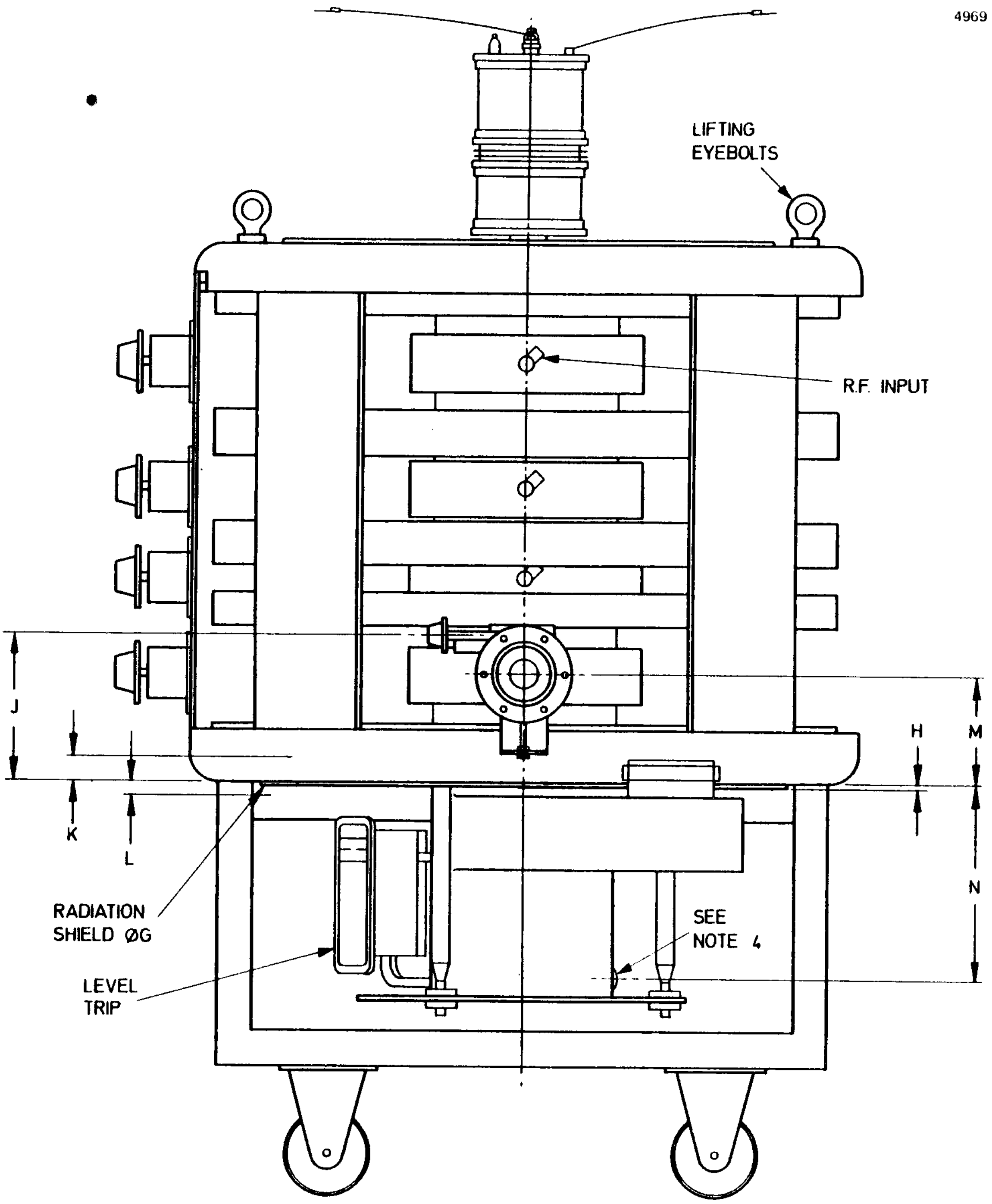


See page 13 for dimensions and notes.

Note The circuit assembly is shown mounted on a trolley. This trolley is not part of the circuit assembly (see page 15).

☆ Indicates a change.

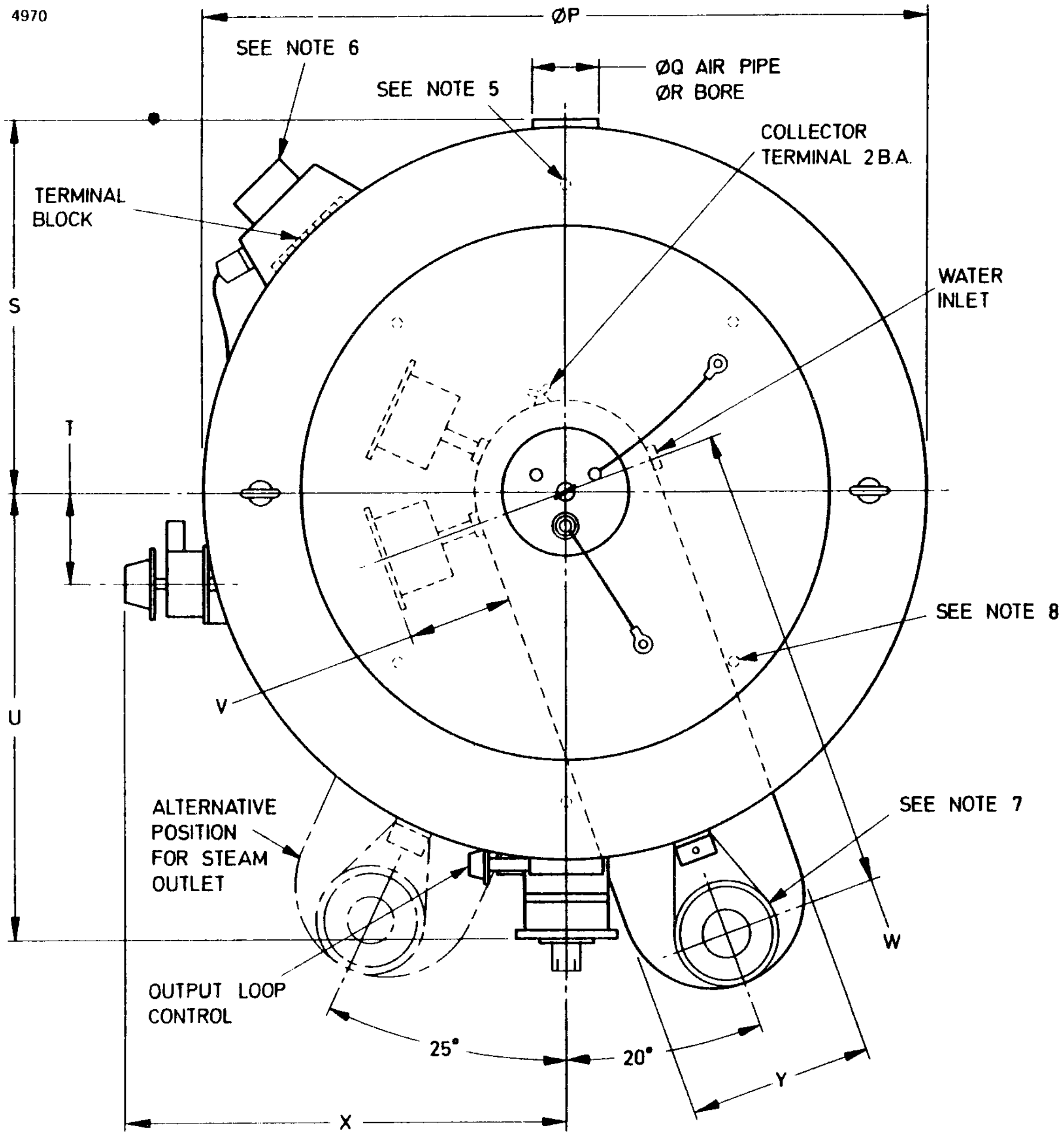
☆ OUTLINE OF CIRCUIT ASSEMBLY K4148M



See page 13 for dimensions and notes.

☆ Indicates a change.

☆ OUTLINE OF CIRCUIT ASSEMBLY K4148M



☆ Indicates a change.

K4148M Outline Dimensions (All dimensions without limits are nominal)

Ref	Inches	Millimetres	Ref	Inches	Millimetres	
A	23.000 max	584.2 max	N	8.125	206.4	
B	8.750 max	222.3 max	P	29.250 max	743.0 max	
C	4.000 ± 0.100	101.6 ± 2.5	Q	2.625	66.68	☆
D	10.750 max	273.1 max	R	2.500	63.50	☆
E	5.900	149.9	S	14.375 ± 0.125	365.1 ± 3.2	
F	14.000	355.6	T	3.500	88.90	
G	22.750	577.9	U	17.125 ± 0.100	435.0 ± 2.5	
H	0.207	5.26	V	4.000 max	101.6 max	
J	6.293	159.8	W	18.000	457.2	
K	1.000 ± 0.125	25.40 ± 3.18	X	17.500 max	444.5 max	
L	0.625 min	15.88 min	Y	7.500	190.5	
M	4.650 ± 0.100	118.1 ± 2.5				

Millimetre dimensions have been derived from inches.

K4148M Outline Notes

1. The klystron is shown installed for clarity.
2. Minimum cold switch-on level. It is recommended that the cold switch-on level should be as near as possible to the maximum operating level.
3. Maximum and minimum operating water levels. The level trip is set up to the minimum operating level.
4. Water inlet ¾ inch B.S.P.F. thread.
5. Four mounting holes in base, threaded M10, equally spaced on 24.000 inches (609.6 mm) pitch circle diameter.
6. Input connector, see page 14.
7. Steam outlet 4½ inch diameter, 4 U.N. class 2A thread.
8. Four mounting holes in base, 0.375 inch (9.53 mm) diameter, equally spaced on 18.000 inches (469.9 mm) pitch circle diameter.

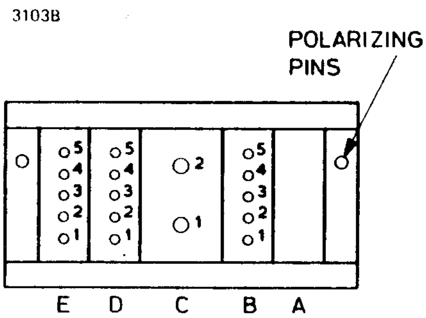
☆ Indicates a change.

ELECTRICAL CONNECTIONS

All connections to the mount are made through a Smiths Hypertac connector. The mating socket is connected to a 10-way terminal block. The focus coils are wired to the terminal block; all other connections are to be made by the customer after assembling the circuit assembly and boiler. The tables below show the connections to the terminal block and input connector.

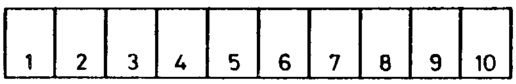
Input Connector
(to be wired by customer)

View on solder connections with cover removed



Water level trip	B1, B2
Collector	B3
Link	B4, B5
Focus coils:	
negative	C1
positive	C2
Water level control	D1, D2
Earth	E3
Arc detector circuit:	
photo resistor	E4, E5
bulb	E1, E2

Terminal Block



Water level trip	1, 2
Collector	3
Focus coils (wired by EEV):	
negative	4
positive	5
Water level control	6, 7
Earth	10

☆ OPTIONAL EXTRAS

The following items are available to order:

Klystron stand	MA421
Lifting yoke	MA365
• Assembly jig	EVQ6481/C
Magnet frame trolley	MA550A or MA550B

☆ Indicates a change.

Chelmsford, Essex, England

Printed in England

K3936G6

HIGH POWER AMPLIFIER KLYSTRON FOR EARTH-TO-SATELLITE SERVICE

The K3936G6 is a direct plug-in replacement for VA936G6 and TH2416A.

FEATURING

- Frequency range 5.925 to 6.425 GHz
- Six preselected channels, field adjustable
- Instantaneous bandwidth at least 45 MHz to −1 dB
- Output power 3 kW
- High gain, 41 dB typical
- Barium aluminate cathode for reliability and long life
- Permanent magnet focused
- Forced-air cooled

DESCRIPTION

The K3936G6 is a five-cavity amplifier klystron intended for use in earth-to-satellite communication systems, mechanically tunable over the range 5.925 to 6.425 GHz. Six channels may be selected within seconds; these channels can be factory preset to customer requirements and are also adjustable on site.

Focusing is by integral permanent magnets. The collector, body and gun require forced-air cooling.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	6.0	V
Heater current	6.0 to 7.0	A
Cathode pre-heating time (minimum)	5.0	minutes

Mechanical

Dimensions	393.7 x 330.2 x 292.1 mm max 15.500 x 13.000 x 11.500 inches max
Net weight	32 kg (70 lb) approx
Mounting position	any
R.F. input connector	type N coaxial
R.F. output	mates with CPR137 flange

 September 1987

Cooling (see note 1)

	lb/hr	kg/hr	m^3/min
Collector air flow	900	409	5.4
Body air flow	90	41	0.54
Gun air flow	85	39	0.51
Collector pressure drop at 900 lb/hr	69 mm (2.7 inches) wg		

MAXIMUM RATINGS (Absolute values)

These ratings cannot necessarily be used simultaneously, and no individual rating should be exceeded.

Beam voltage	10	kV max
Beam current	1.25	A max
Body current (with r.f. drive)	50	mA max
Power reflected from load	120	W max
Heater starting current	14	A max
Collector dissipation	10	kW max

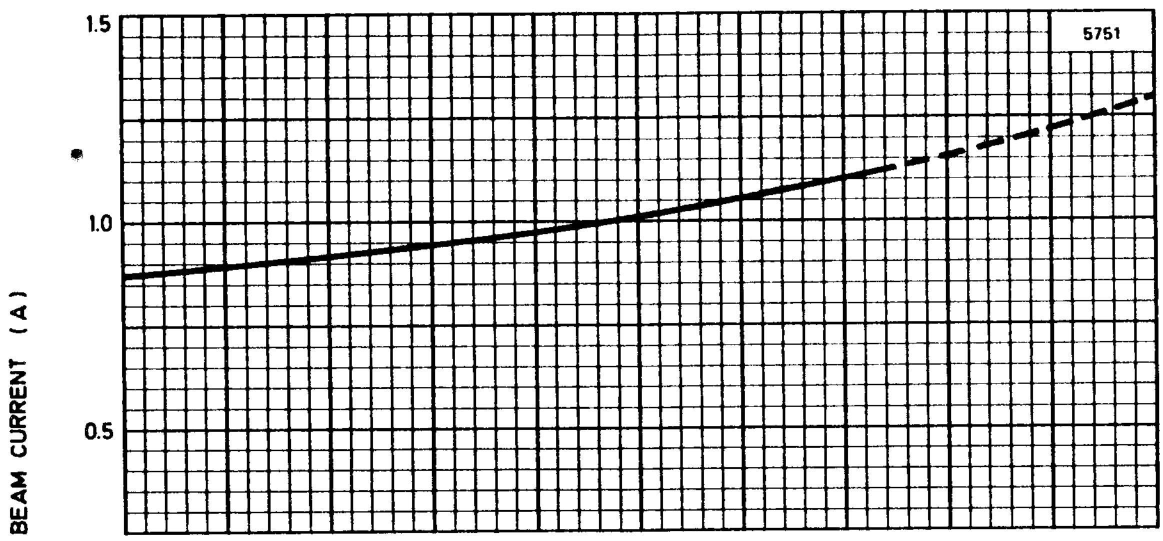
TYPICAL OPERATION

Centre frequency	6.265	GHz
Beam voltage	8.0	kV
Beam current	1.05	A
Drive power (see note 2)	250	mW
Power output	3.1	kW
Bandwidth to −1 dB	48	MHz
Gain	41	dB
Body current (with r.f. drive)	15	mA
Load v.s.w.r.	1.05:1	

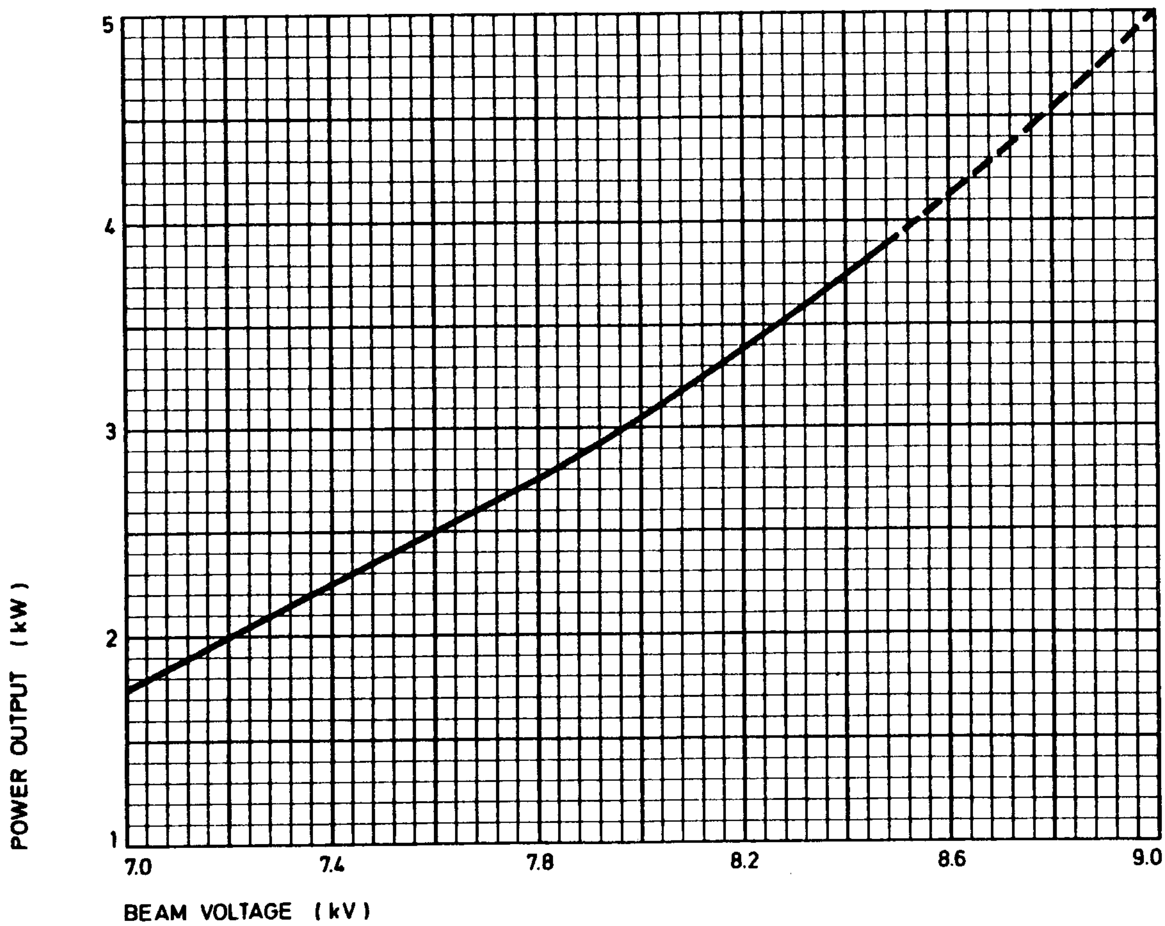
NOTES

1. The flow rates given are minimum values for operation at maximum beam power, at sea level and 20 °C ambient.
2. Defined as the power delivered to a matched load substituted for the klystron input cavity.

BEAM CURRENT CHARACTERISTIC



OUTPUT POWER CHARACTERISTIC

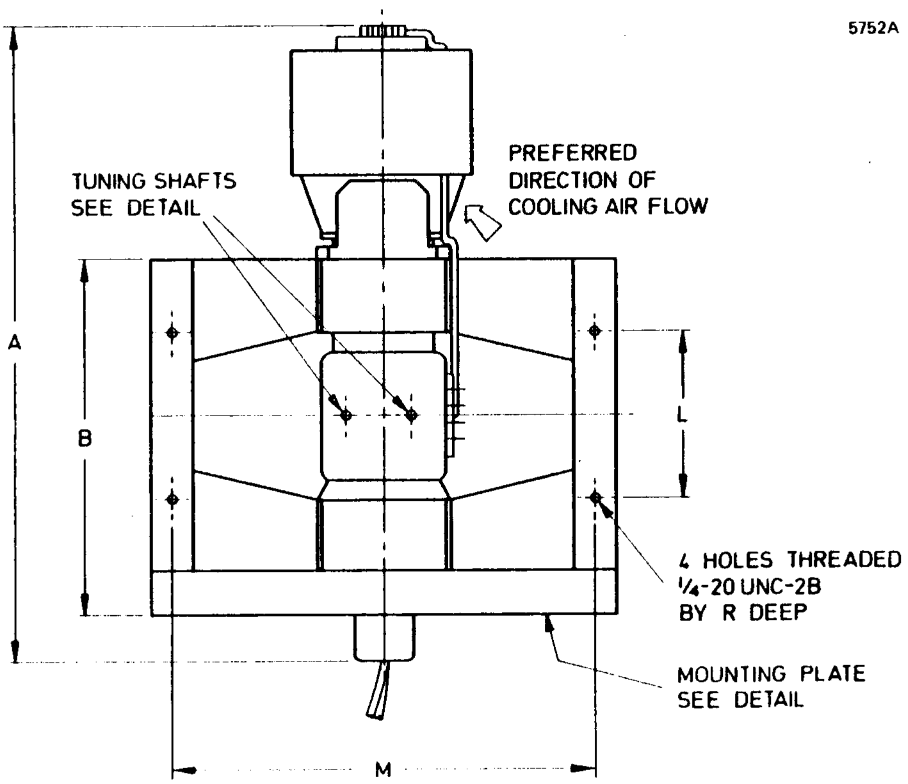


OUTLINE

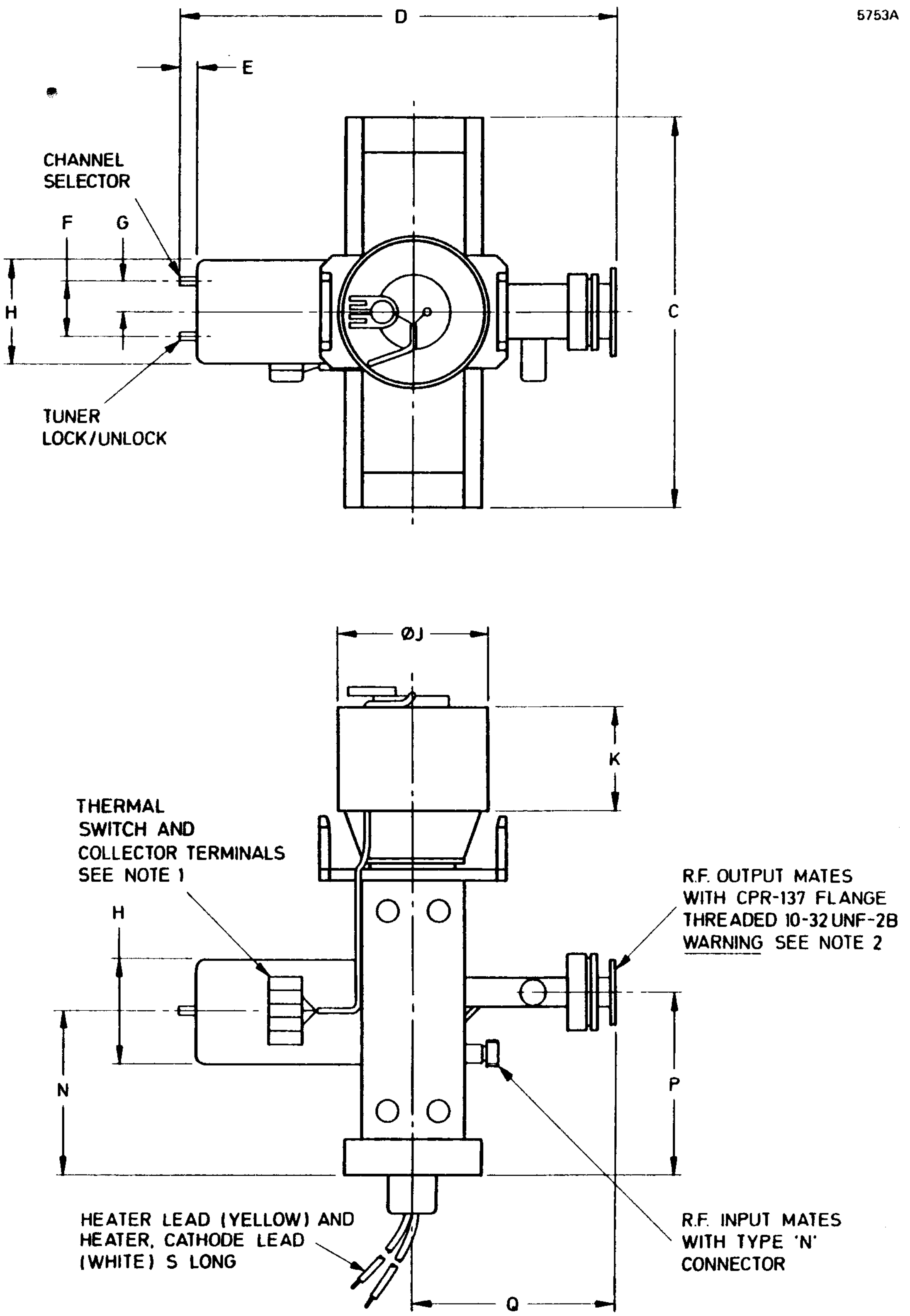
Ref	Inches	Millimetres
A	15.500 max	393.7 max
B	8.600 max	218.4 max
C	11.500 max	292.1 max
D	13.000 max	330.2 max
E	0.450 min	11.43 min
F	1.670 ± 0.031	42.42 ± 0.79
G	0.970 ± 0.031	24.64 ± 0.79
H	3.000 ± 0.063	76.2 ± 1.6
J	4.470 ± 0.031	113.5 ± 0.8

Ref	Inches	Millimetres
K	3.050 min	77.47 min
L	4.000	101.6
M	10.307	261.8
N	4.488 ± 0.094	114.0 ± 2.4
P	5.330 ± 0.094	135.4 ± 2.4
Q	5.988 ± 0.031	152.1 ± 0.8
R	0.512 min	13.0 min
S	18.0 ± 1.0	457 ± 25

Millimetre dimensions have been derived from inches.

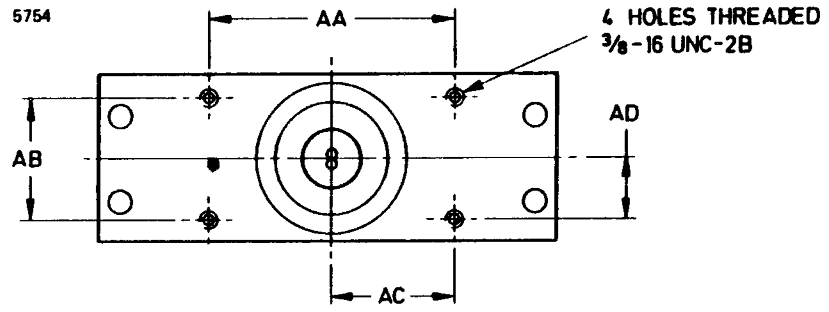


OUTLINE


5753A
D
E
CHANNEL SELECTOR
F
G
H
C
TUNER LOCK/UNLOCK
ØJ
K
THERMAL SWITCH AND COLLECTOR TERMINALS SEE NOTE 1
H
R.F. OUTPUT MATES WITH CPR-137 FLANGE THREADED 10-32 UNF-2B WARNING SEE NOTE 2
N
P
HEATER LEAD (YELLOW) AND HEATER, CATHODE LEAD (WHITE) S LONG
R.F. INPUT MATES WITH TYPE 'N' CONNECTOR
Q

Detail of Mounting Plate

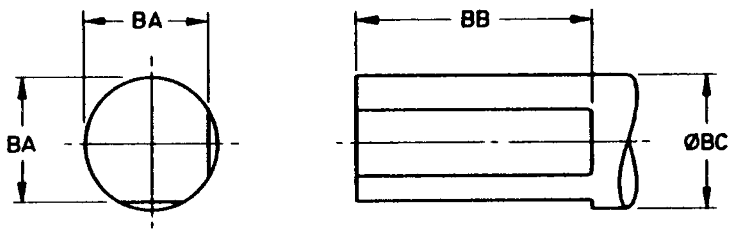
5754



Ref	Inches	Millimetres
AA	6.000 ± 0.031	152.4 ± 0.8
AB	3.000 ± 0.031	76.2 ± 0.8
AC	3.000 ± 0.016	76.2 ± 0.4
AD	1.500 ± 0.016	38.1 ± 0.4

Millimetre dimensions have been derived from inches.

Detail of Tuning Shaft



5755

Ref	Inches	Millimetres
BA	0.230 ± 0.005	5.84 ± 0.13
BB	0.440 ± 0.010	11.18 ± 0.25
BC	0.248 ± 0.002	6.30 ± 0.05

Millimetre dimensions have been derived from inches.

Outline Notes

1. Thermal switch rated 250 V, 3 A a.c. max, connections K1 and K2.
2. The klystron must not be lifted by the output waveguide.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to microwave radiation exceeding 1 mW/cm^2. All r.f. connections must be leakproof and the klystron must not be operated without a suitable r.f. load on the output waveguide. It is particularly dangerous to look into open waveguide or transmitter antennae while the device is operating.

K3936G12

HIGH POWER AMPLIFIER KLYSTRON FOR EARTH-TO-SATELLITE SERVICE

The K3936G12 is a direct plug-in replacement for VA936G12 and TH2416B

FEATURING

- Frequency range 5.925 to 6.425 GHz
- Twelve preselected channels, field adjustable
- Instantaneous bandwidth at least 45 MHz to −1 dB
- Output power 3 kW
- High gain, 41 dB typical
- Barium aluminate cathode for reliability and long life
- Permanent magnet focused
- Forced-air cooled

DESCRIPTION

The K3936G12 is a five-cavity amplifier klystron intended for use in earth-to-satellite communication systems, mechanically tunable over the range 5.925 to 6.425 GHz. 12 channels may be selected within seconds; these channels can be factory preset to customer requirements and are also adjustable on site.

Focusing is by integral permanent magnets. The collector, body and gun require forced-air cooling.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	6.0	V
Heater current	6.0 to 7.0	A
Cathode pre-heating time (minimum)	5.0	minutes

Mechanical

Dimensions	393.7 x 330.2 x 292.1 mm max 15.500 x 13.000 x 11.500 inches max
Net weight	32 kg (70 lb) approx
Mounting position	any
R.F. input connector	type N coaxial
R.F. output	mates with CPR137 flange

 September 1987

Cooling (see note 1)

	lb/hr	kg/hr	m³/min
Collector air flow	900	409	5.4
Body air flow	90	41	0.54
Gun air flow	85	39	0.51
Collector pressure drop at 900 lb/hr	69 mm (2.7 inches) wg		

MAXIMUM RATINGS (Absolute values)

These ratings cannot necessarily be used simultaneously, and no individual rating should be exceeded.

Beam voltage	10	kV max
Beam current	1.25	A max
Body current (with r.f. drive)	50	mA max
Power reflected from load	120	W max
Heater starting current	14	A max
Collector dissipation	10	kW max

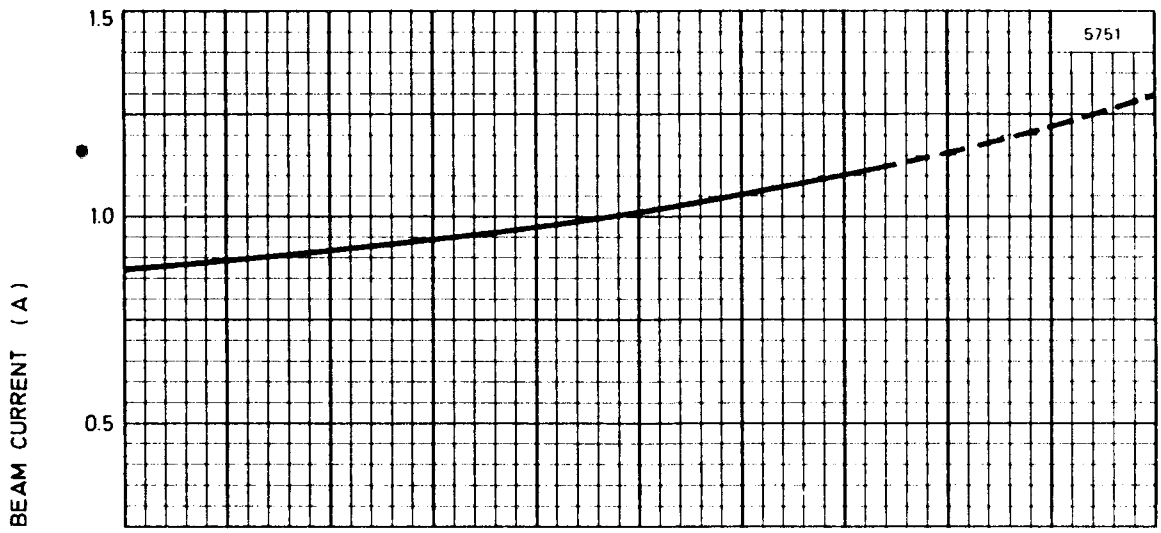
TYPICAL OPERATION

Centre frequency	6.265	GHz
Beam voltage	8.0	kV
Beam current	1.05	A
Drive power (see note 2)	250	mW
Power output	3.1	kW
Bandwidth to −1 dB	48	MHz
Gain	41	dB
Body current (with r.f. drive)	15	mA
Load v.s.w.r.	1.05:1	

NOTES

1. The flow rates given are minimum values for operation at maximum beam power, at sea level and 20 °C ambient.
2. Defined as the power delivered to a matched load substituted for the klystron input cavity.

BEAM CURRENT CHARACTERISTIC

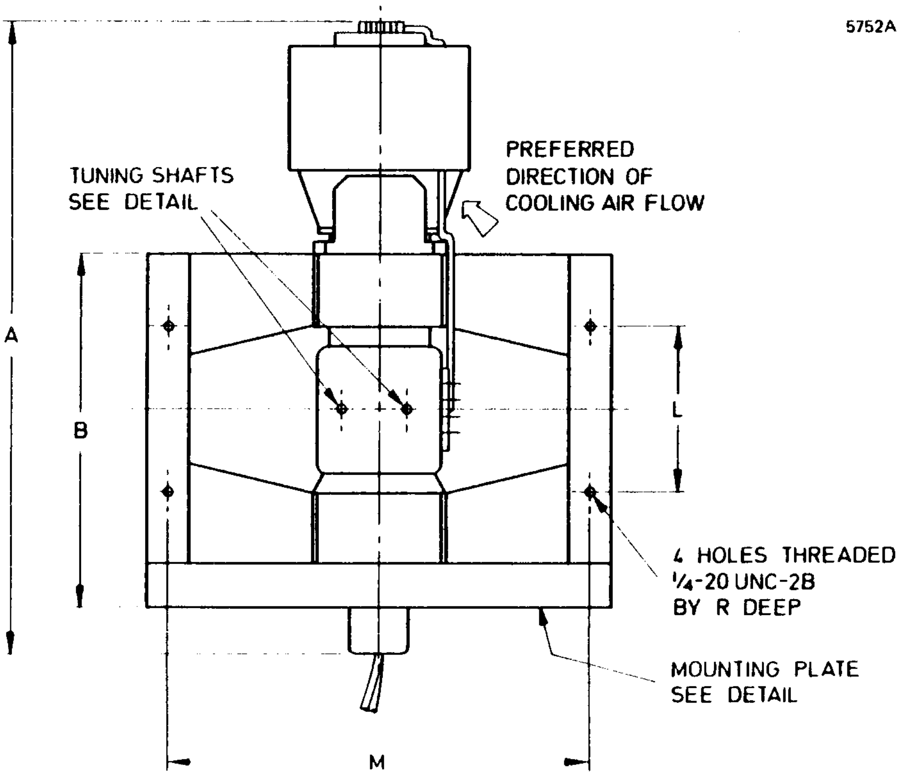


OUTPUT POWER CHARACTERISTIC

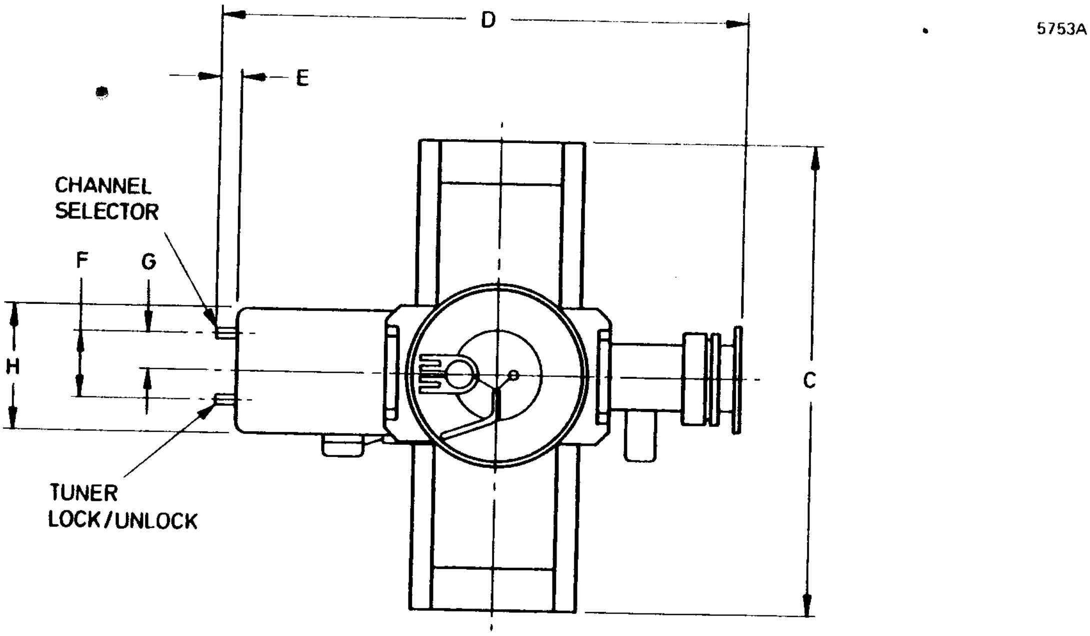
OUTLINE

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	15.500 max	393.7 max	K	3.050 min	77.47 min
B	8.600 max	218.4 max	L	4.000	101.6
C	11.500 max	292.1 max	M	10.307	261.8
D	13.000 max	330.2 max	N	4.488 ± 0.094	114.0 ± 2.4
E	0.450 min	11.43 min	P	5.330 ± 0.094	135.4 ± 2.4
F	1.670 ± 0.031	42.42 ± 0.79	Q	5.988 ± 0.031	152.1 ± 0.8
G	0.970 ± 0.031	24.64 ± 0.79	R	0.512 min	13.0 min
H	3.000 ± 0.063	76.2 ± 1.6	S	18.0 ± 1.0	457 ± 25
J	4.470 ± 0.031	113.5 ± 0.8			

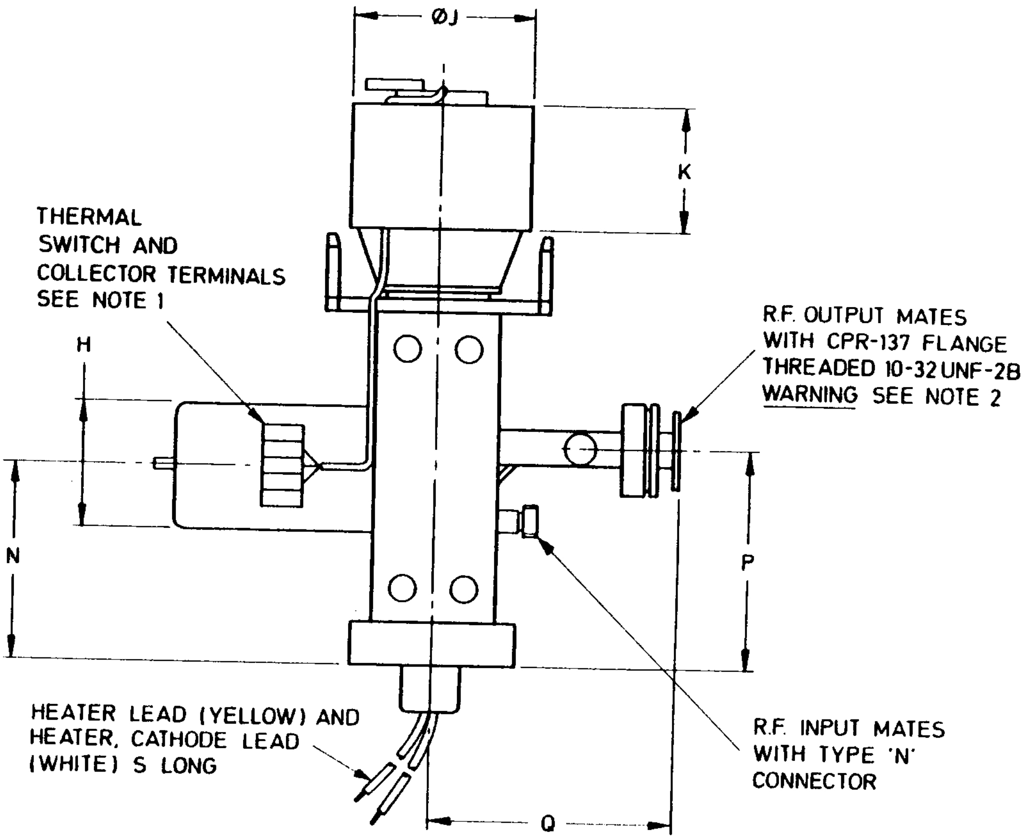
Millimetre dimensions have been derived from inches.



OUTLINE

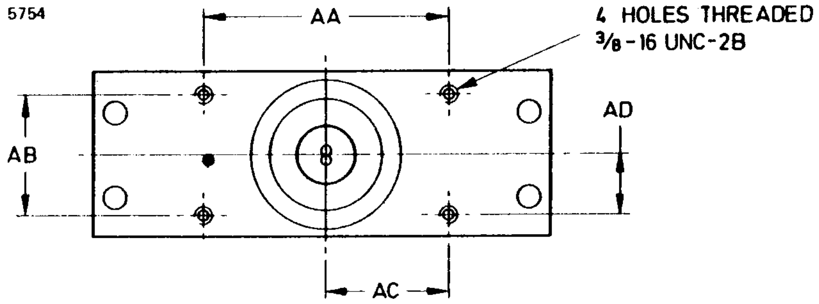


5753A
D
E
CHANNEL SELECTOR
F
G
H
C
TUNER LOCK/UNLOCK



ØJ
K
THERMAL SWITCH AND COLLECTOR TERMINALS SEE NOTE 1
H
R.F. OUTPUT MATES WITH CPR-137 FLANGE THREADED 10-32 UNF-2B WARNING SEE NOTE 2
N
P
HEATER LEAD (YELLOW) AND HEATER, CATHODE LEAD (WHITE) 5 LONG
R.F. INPUT MATES WITH TYPE 'N' CONNECTOR
Q

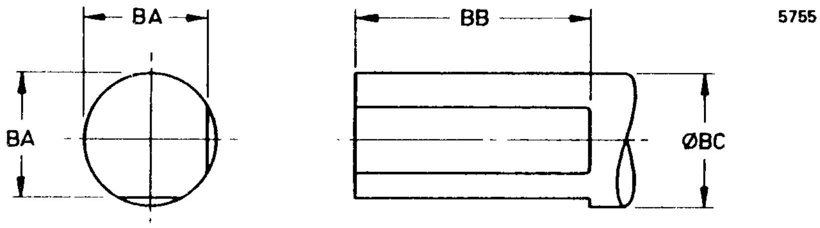
Detail of Mounting Plate



Ref	Inches	Millimetres
AA	6.000 ± 0.031	152.4 ± 0.8
AB	3.000 ± 0.031	76.2 ± 0.8
AC	3.000 ± 0.016	76.2 ± 0.4
AD	1.500 ± 0.016	38.1 ± 0.4

Millimetre dimensions have been derived from inches.

Detail of Tuning Shaft



Ref	Inches	Millimetres
BA	0.230 ± 0.005	5.84 ± 0.13
BB	0.440 ± 0.010	11.18 ± 0.25
BC	0.248 ± 0.002	6.30 ± 0.05

Millimetre dimensions have been derived from inches.

Outline Notes

1. Thermal switch rated 250 V, 3 A a.c. max, connections K1 and K2.
2. The klystron must not be lifted by the output waveguide.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to microwave radiation exceeding 1 mW/cm^2. All r.f. connections must be leakproof and the klystron must not be operated without a suitable r.f. load on the output waveguide. It is particularly dangerous to look into open waveguide or transmitter antennae while the device is operating.

K3936L6

HIGH POWER AMPLIFIER KLYSTRON FOR EARTH-TO-SATELLITE SERVICE

The K3936L6 is a direct plug-in replacement for VA936L6 and TH2417A

FEATURING

- Frequency range 5.925 to 6.425 GHz
- Six preselected channels, field adjustable
- Instantaneous bandwidth at least 45 MHz to −1 dB
- Output power 3.35 kW
- High gain, 41 dB typical
- Barium aluminate cathode for reliability and long life
- Permanent magnet focused
- Forced-air cooled

DESCRIPTION

The K3936L6 is a five-cavity amplifier klystron intended for use in earth-to-satellite communication systems, mechanically tunable over the range 5.925 to 6.425 GHz. Six channels may be selected within seconds; these channels can be factory preset to customer requirements and are also adjustable on site.

Focusing is by integral permanent magnets. The collector, body and gun require forced-air cooling.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	6.0	V
Heater current	6.0 to 7.0	A
Cathode pre-heating time (minimum)	5.0	minutes

Mechanical

Dimensions	393.7 x 330.2 x 292.1 mm max 15.500 x 13.000 x 11.500 inches max
Net weight	32 kg (70 lb) approx
Mounting position	any
R.F. input connector	type N coaxial
R.F. output	mates with CPR137 flange

Cooling (see note 1)

	lb/hr	kg/hr	m³/min
Collector air flow	1000	454	6.0
Body air flow	90	41	0.54
Gun air flow	85	39	0.51
Collector pressure drop at 1000 lb/hr	76 mm (3.0 inches) wg		

MAXIMUM RATINGS (Absolute values)

These ratings cannot necessarily be used simultaneously, and no individual rating should be exceeded.

Beam voltage	10	kV max
Beam current	1.25	A max
Body current (with r.f. drive)	50	mA max
Power reflected from load	120	W max
Heater starting current	14	A max
Collector dissipation	10	kW max

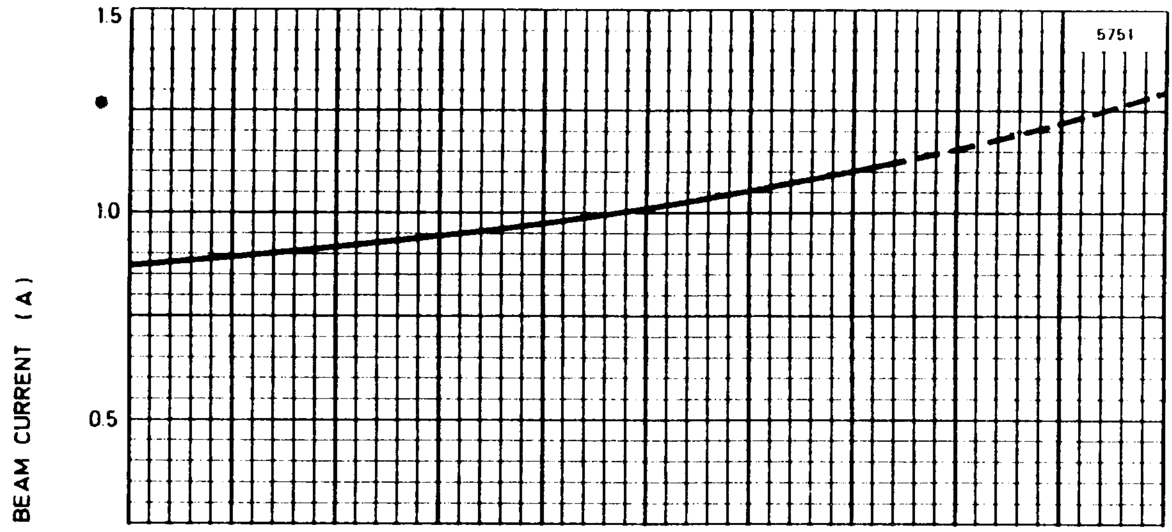
TYPICAL OPERATION

Centre frequency	6.265	GHz
Beam voltage	8.2	kV
Beam current	1.08	A
Drive power (see note 2)	250	mW
Power output	3.4	kW
Bandwidth to −1 dB	48	MHz
Gain	41	dB
Body current (with r.f. drive)	15	mA
Load v.s.w.r.	1.05:1	

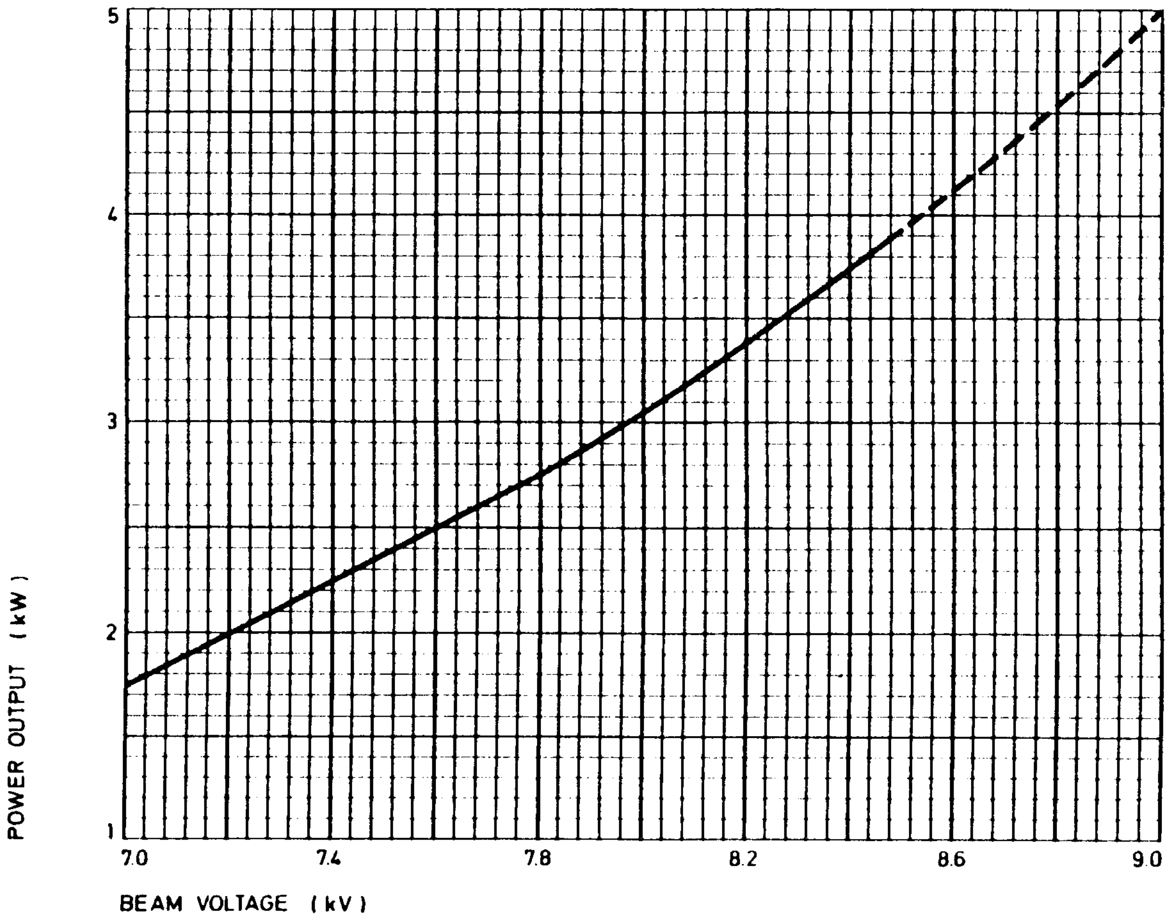
NOTES

1. The flow rates given are minimum values for operation at maximum beam power, at sea level and 20 °C ambient.
2. Defined as the power delivered to a matched load substituted for the klystron input cavity.

BEAM CURRENT CHARACTERISTIC



OUTPUT POWER CHARACTERISTIC

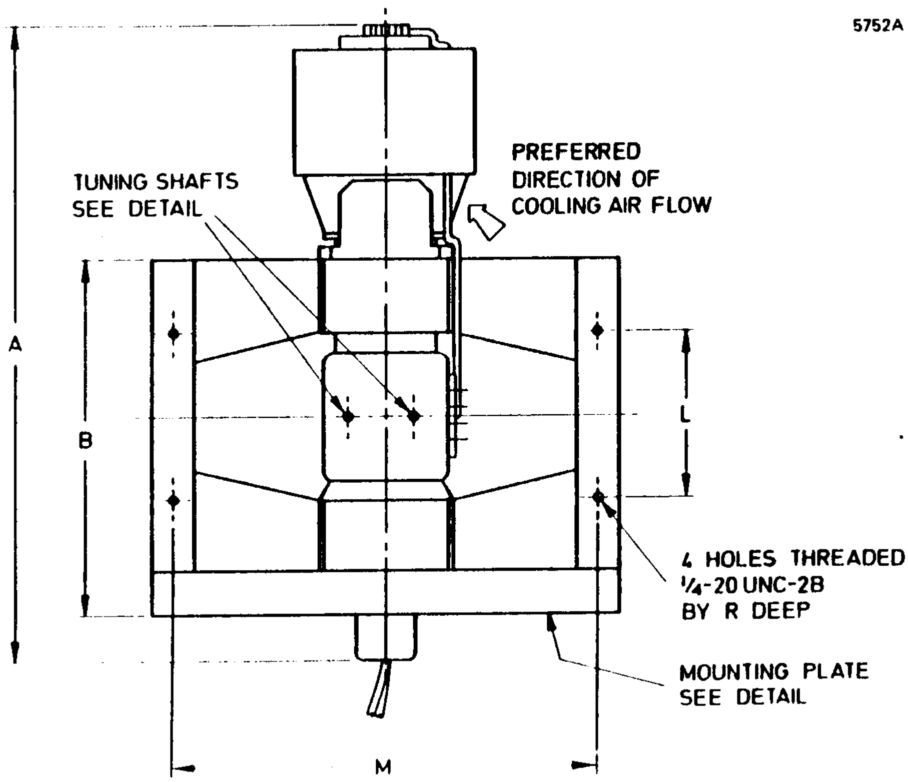


OUTLINE

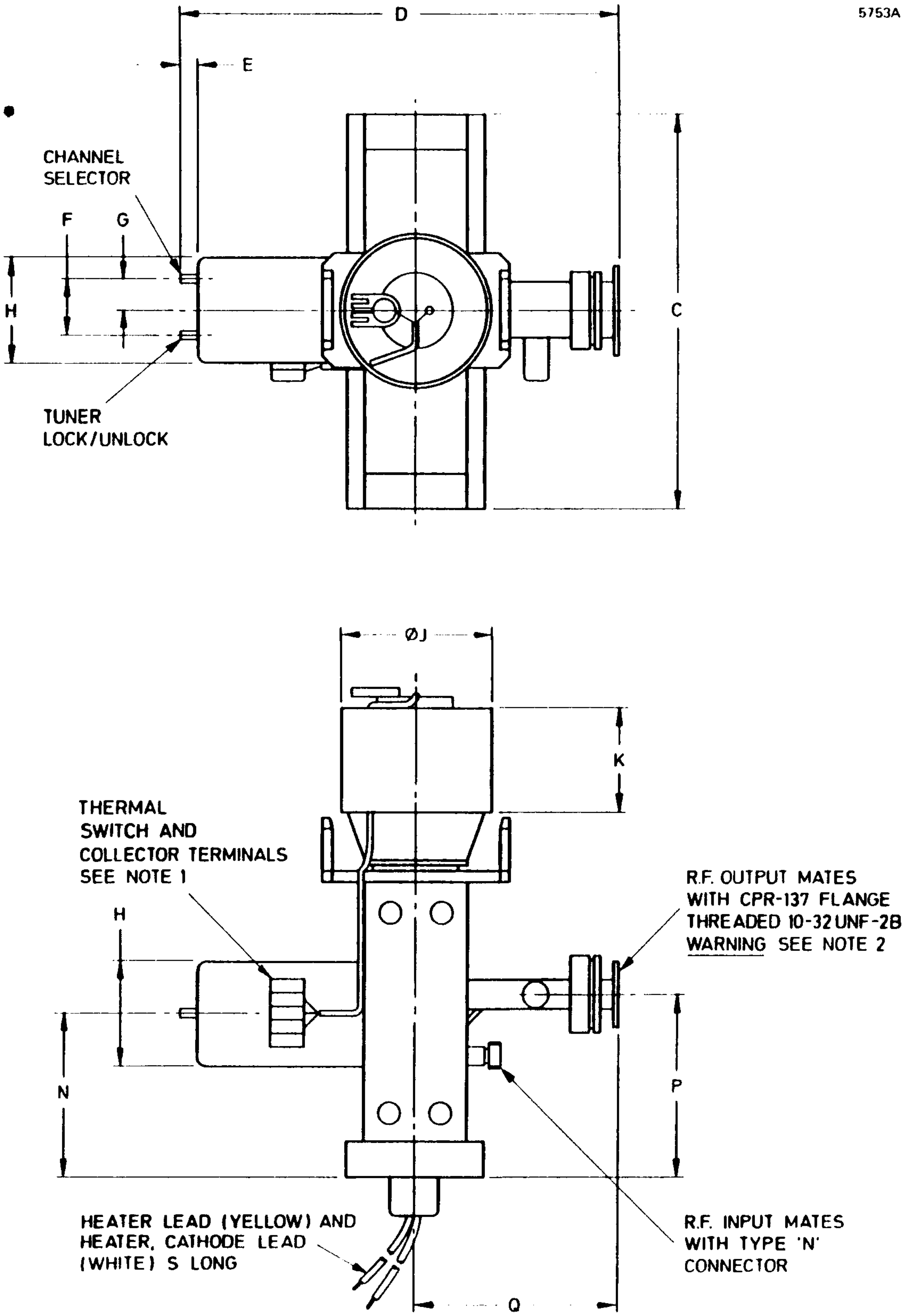
Ref	Inches	Millimetres
A	15.500 max	393.7 max
B	8.600 max	218.4 max
C	11.500 max	292.1 max
D	13.000 max	330.2 max
E	0.450 min	11.43 min
F	1.670 ± 0.031	42.42 ± 0.79
G	0.970 ± 0.031	24.64 ± 0.79
H	3.000 ± 0.063	76.2 ± 1.6
J	4.470 ± 0.031	113.5 ± 0.8

Ref	Inches	Millimetres
K	3.050 min	77.47 min
L	4.000	101.6
M	10.307	261.8
N	4.488 ± 0.094	114.0 ± 2.4
P	5.330 ± 0.094	135.4 ± 2.4
Q	5.988 ± 0.031	152.1 ± 0.8
R	0.512 min	13.0 min
S	18.0 ± 1.0	457 ± 25

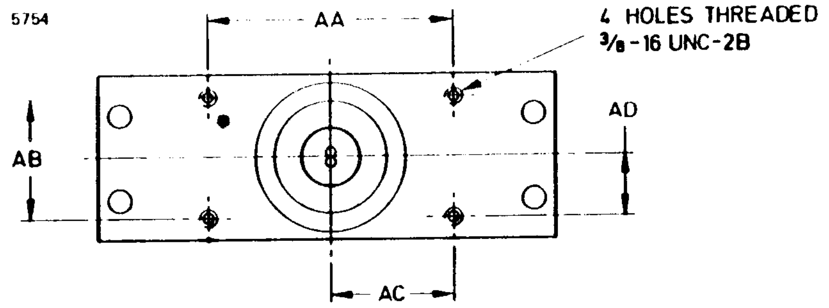
Millimetre dimensions have been derived from inches.



OUTLINE


5753A
D
E
CHANNEL SELECTOR
F
G
H
C
TUNER LOCK/UNLOCK
ØJ
K
THERMAL SWITCH AND COLLECTOR TERMINALS SEE NOTE 1
H
R.F. OUTPUT MATES WITH CPR-137 FLANGE THREADED 10-32UNF-2B
WARNING SEE NOTE 2
N
P
HEATER LEAD (YELLOW) AND HEATER, CATHODE LEAD (WHITE) S LONG
R.F. INPUT MATES WITH TYPE 'N' CONNECTOR
Q

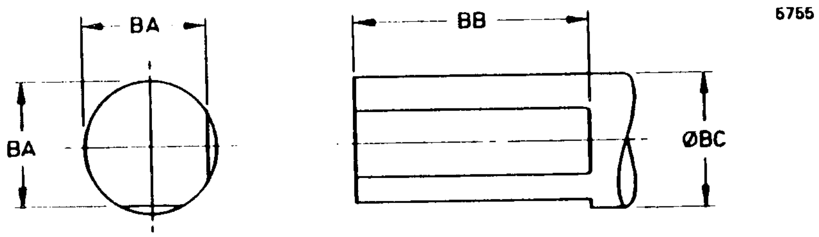
Detail of Mounting Plate



Ref	Inches	Millimetres
AA	6.000 ± 0.031	152.4 ± 0.8
AB	3.000 ± 0.031	76.2 ± 0.8
AC	3.000 ± 0.016	76.2 ± 0.4
AD	1.500 ± 0.016	38.1 ± 0.4

Millimetre dimensions have been derived from inches.

Detail of Tuning Shaft



Ref	Inches	Millimetres
BA	0.230 ± 0.005	5.84 ± 0.13
BB	0.440 ± 0.010	11.18 ± 0.25
BC	0.248 ± 0.002	6.30 ± 0.05

Millimetre dimensions have been derived from inches.

Outline Notes

1. Thermal switch rated 250 V, 3 A a.c. max, connections K1 and K2.
2. The klystron must not be lifted by the output waveguide.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to microwave radiation exceeding 1 mW/cm^2. All r.f. connections must be leakproof and the klystron must not be operated without a suitable r.f. load on the output waveguide. It is particularly dangerous to look into open waveguide or transmitter antennae while the device is operating.

Chelmsford, Essex, England

Subsidiary of The General Electric Company, p.l.c. of England Printed in England

K3936L12

HIGH POWER AMPLIFIER KLYSTRON FOR EARTH-TO-SATELLITE SERVICE

The K3936L12 is a direct plug-in replacement for VA936L12 and TH2417B

FEATURING

- Frequency range 5.925 to 6.425 GHz
- Twelve preselected channels, field adjustable
- Instantaneous bandwidth at least 45 MHz to −1 dB
- Output power 3.35 kW
- High gain, 41 dB typical
- Barium aluminate cathode for reliability and long life
- Permanent magnet focused
- Forced-air cooled

DESCRIPTION

The K3936L12 is a five-cavity amplifier klystron intended for use in earth-to-satellite communication systems, mechanically tunable over the range 5.925 to 6.425 GHz. 12 channels may be selected within seconds; these channels can be factory preset to customer requirements and are also adjustable on site.

Focusing is by integral permanent magnets. The collector, body and gun require forced-air cooling.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	6.0	V
Heater current	6.0 to 7.0	A
Cathode pre-heating time (minimum)	5.0	minutes

Mechanical

Dimensions	393.7 x 330.2 x 292.1 mm max 15.500 x 13.000 x 11.500 inches max
Net weight	32 kg (70 lb) approx
Mounting position	any
R.F. input connector	type N coaxial
R.F. output	mates with CPR137 flange

Cooling (see note 1)

	lb/hr	kg/hr	m³/min
Collector air flow	1000	454	6.0
Body air flow	90	41	0.54
Gun air flow •	85	39	0.51
Collector pressure drop at 1000 lb/hr	76 mm (3.0 inches) wg		

MAXIMUM RATINGS (Absolute values)

These ratings cannot necessarily be used simultaneously, and no individual rating should be exceeded.

Beam voltage	10	kV max
Beam current	1.25	A max
Body current (with r.f. drive)	50	mA max
Power reflected from load	120	W max
Heater starting current	14	A max
Collector dissipation	10	kW max

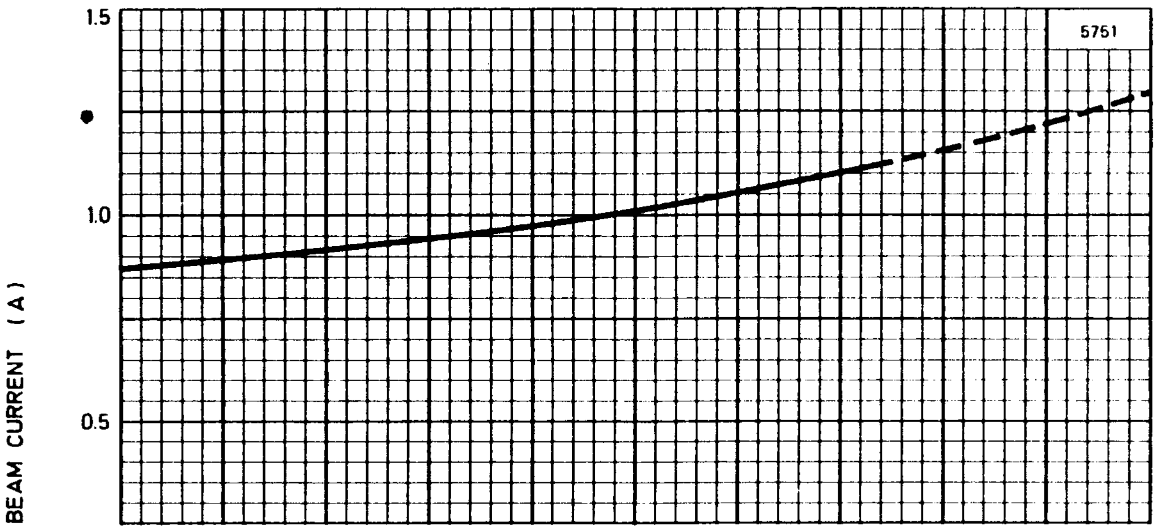
TYPICAL OPERATION

Centre frequency	6.265	GHz
Beam voltage	8.2	kV
Beam current	1.08	A
Drive power (see note 2)	250	mW
Power output	3.4	kW
Bandwidth to −1 dB	48	MHz
Gain	41	dB
Body current (with r.f. drive)	15	mA
Load v.s.w.r.	1.05:1	

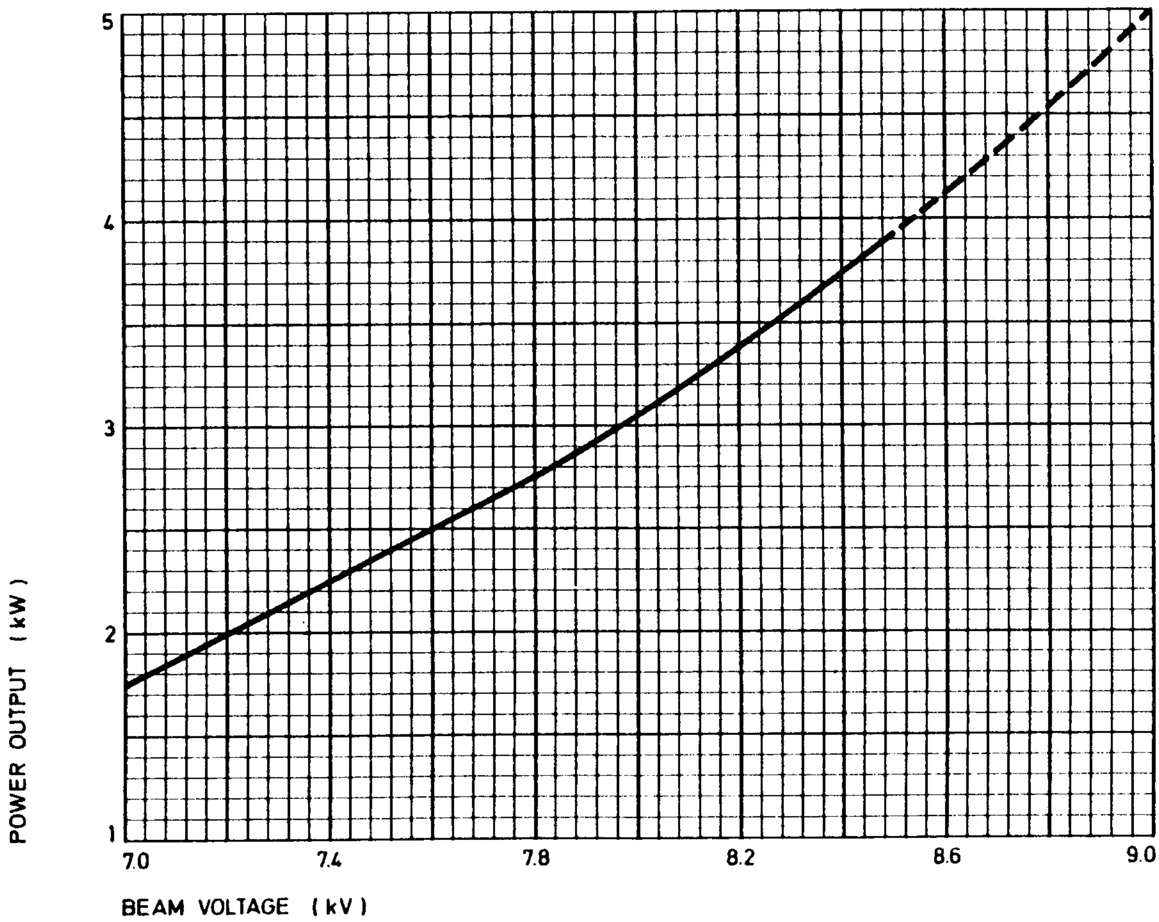
NOTES

1. The flow rates given are minimum values for operation at maximum beam power, at sea level and 20 °C ambient.
2. Defined as the power delivered to a matched load substituted for the klystron input cavity.

BEAM CURRENT CHARACTERISTIC



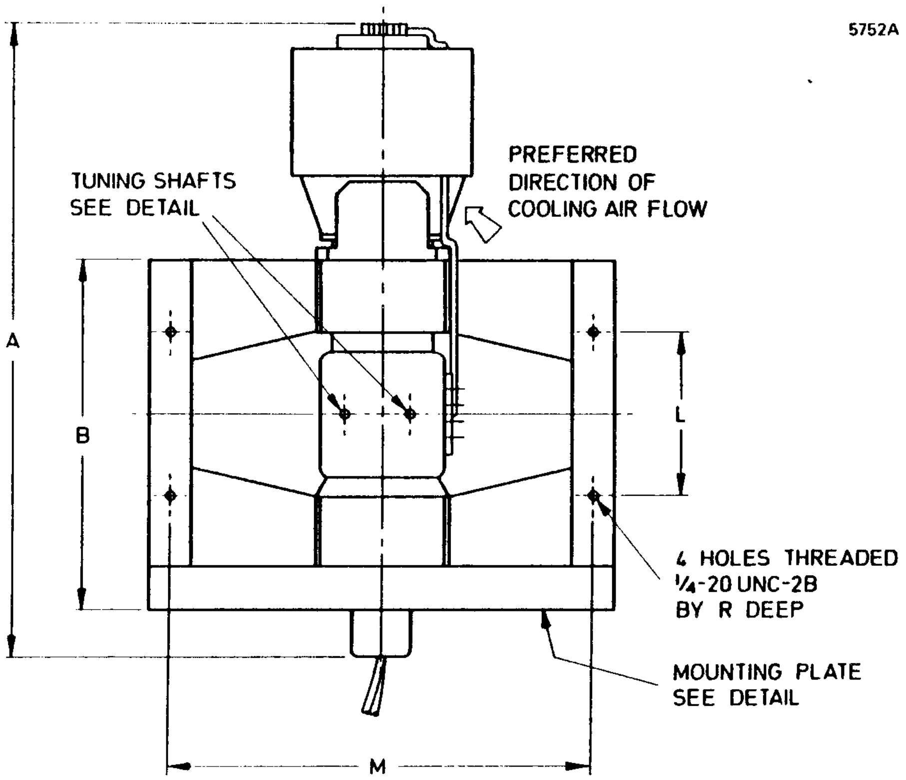
OUTPUT POWER CHARACTERISTIC



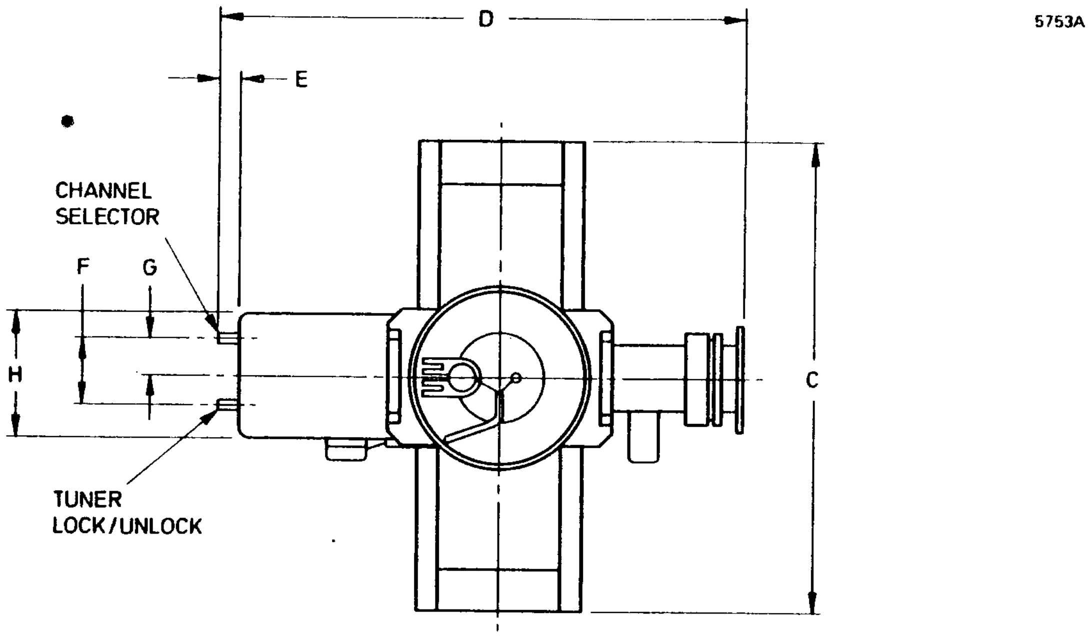
OUTLINE

Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	15.500 max	393.7 max	K	3.050 min	77.47 min
B	8.600 max	218.4 max	L	4.000	101.6
C	11.500 max	292.1 max	M	10.307	261.8
D	13.000 max	330.2 max	N	4.488 ± 0.094	114.0 ± 2.4
E	0.450 min	11.43 min	P	5.330 ± 0.094	135.4 ± 2.4
F	1.670 ± 0.031	42.42 ± 0.79	Q	5.988 ± 0.031	152.1 ± 0.8
G	0.970 ± 0.031	24.64 ± 0.79	R	0.512 min	13.0 min
H	3.000 ± 0.063	76.2 ± 1.6	S	18.0 ± 1.0	457 ± 25
J	4.470 ± 0.031	113.5 ± 0.8			

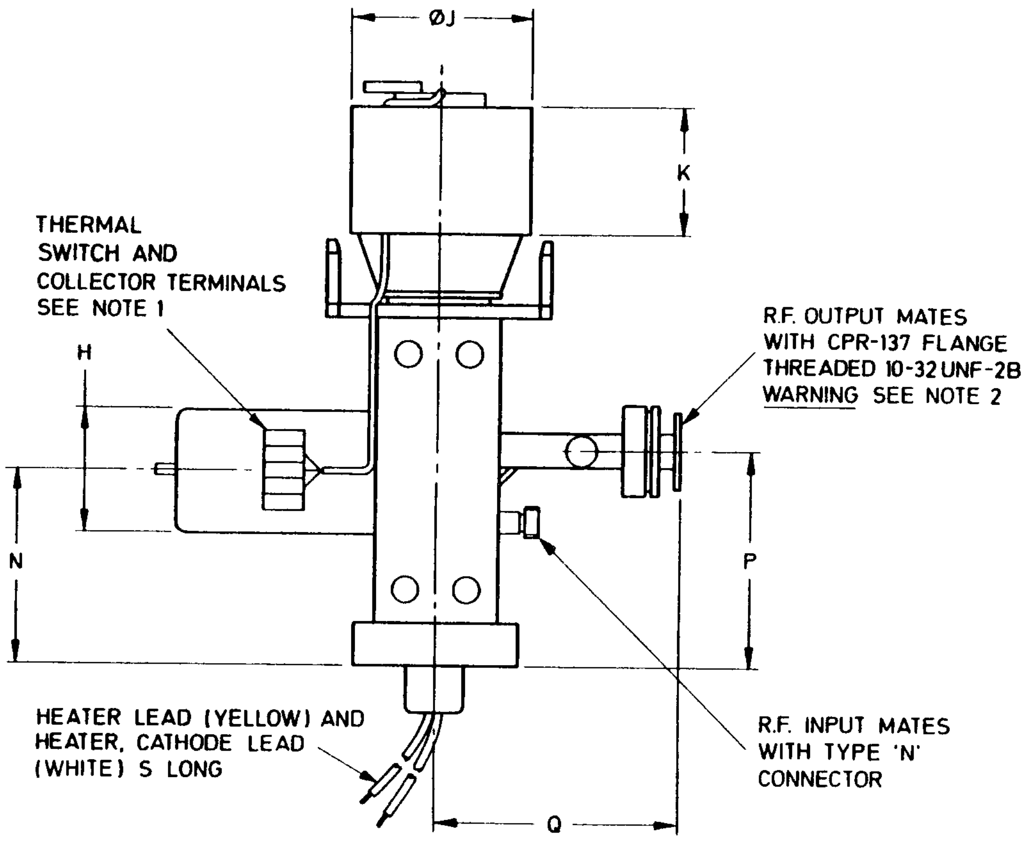
Millimetre dimensions have been derived from inches.



OUTLINE

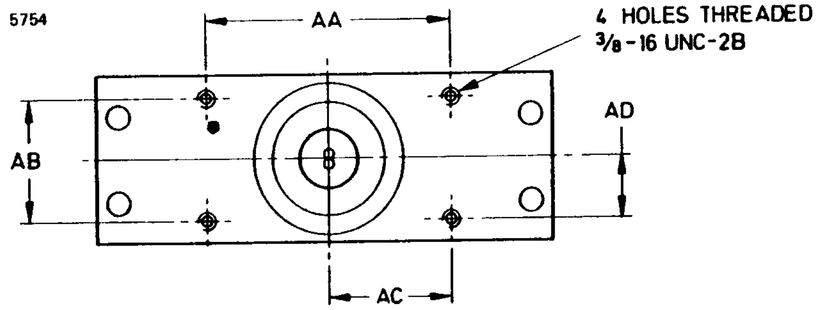


5753A
D
E
CHANNEL
SELECTOR
F
G
H
C
TUNER
LOCK/UNLOCK



ØJ
K
THERMAL
SWITCH AND
COLLECTOR TERMINALS
SEE NOTE 1
H
R.F. OUTPUT MATES
WITH CPR-137 FLANGE
THREADED 10-32 UNF-2B
WARNING SEE NOTE 2
N
P
HEATER LEAD (YELLOW) AND
HEATER, CATHODE LEAD
(WHITE) S LONG
R.F. INPUT MATES
WITH TYPE 'N'
CONNECTOR
Q

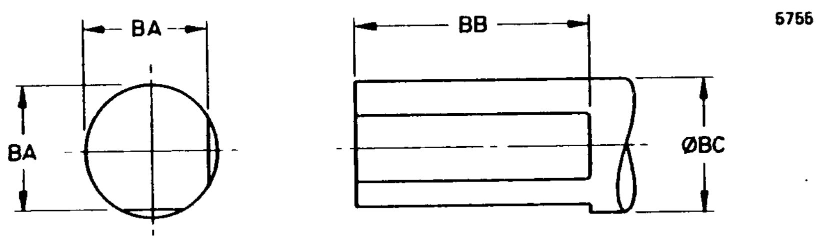
Detail of Mounting Plate



Ref	Inches	Millimetres
AA	6.000 ± 0.031	152.4 ± 0.8
AB	3.000 ± 0.031	76.2 ± 0.8
AC	3.000 ± 0.016	76.2 ± 0.4
AD	1.500 ± 0.016	38.1 ± 0.4

Millimetre dimensions have been derived from inches.

Detail of Tuning Shaft



Ref	Inches	Millimetres
BA	0.230 ± 0.005	5.84 ± 0.13
BB	0.440 ± 0.010	11.18 ± 0.25
BC	0.248 ± 0.002	6.30 ± 0.05

Millimetre dimensions have been derived from inches.

Outline Notes

1. Thermal switch rated 250 V, 3 A a.c. max, connections K1 and K2.
2. The klystron must not be lifted by the output waveguide.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to microwave radiation exceeding 1 mW/cm^2. All r.f. connections must be leakproof and the klystron must not be operated without a suitable r.f. load on the output waveguide. It is particularly dangerous to look into open waveguide or transmitter antennae while the device is operating.

K3936L24

HIGH POWER AMPLIFIER KLYSTRON FOR EARTH-TO-SATELLITE SERVICE

Direct plug-in replacement for VKC7936L24 and TH2417CA.

FEATURING

- Frequency range 5.925 to 6.425 GHz
- 24 preselected channels, field adjustable
- Instantaneous bandwidth at least 45 MHz to −1 dB
- Output power 3.35 kW
- High gain, 41 dB typical
- Barium aluminate cathode for reliability and long life
- Permanent magnet focused
- Forced-air cooled

DESCRIPTION

The K3936L24 is a five-cavity amplifier klystron intended for use in earth-to-satellite communication systems, mechanically tunable over the range 5.925 to 6.425 GHz. 24 channels may be selected within seconds; these channels can be factory preset to customer requirements and are also adjustable on site.

Focusing is by integral permanent magnets. The collector, body and gun require forced-air cooling.

GENERAL

Electrical

Cathode	indirectly heated	
Heater voltage	6.0	V
Heater current	6.0 to 7.0	A
Cathode pre-heating time (minimum)	5.0	minutes

Mechanical

Dimensions	393.7 x 304.8 x 292.1 mm max
	15.500 x 12.000 x 11.500 inches max
Net weight	32 kg (70 lb) approx
Mounting position	any
R.F. input connector	type N coaxial
R.F. output	mates with CPR137 flange

Cooling (see note 1)

	lb/hr	kg/hr	m³/min
Collector air flow	1000	454	6.0
Body air flow	90	41	0.54
Gun air flow	85	39	0.51
Collector pressure drop at 1000 lb/hr	76 mm (3.0 inches) wg		

MAXIMUM RATINGS (Absolute values)

These ratings cannot necessarily be used simultaneously, and no individual rating should be exceeded.

Beam voltage	10	kV max
Beam current	1.25	A max
Body current (with r.f. drive)	50	mA max
Power reflected from load	120	W max
Heater starting current	14	A max
Collector dissipation	10	kW max

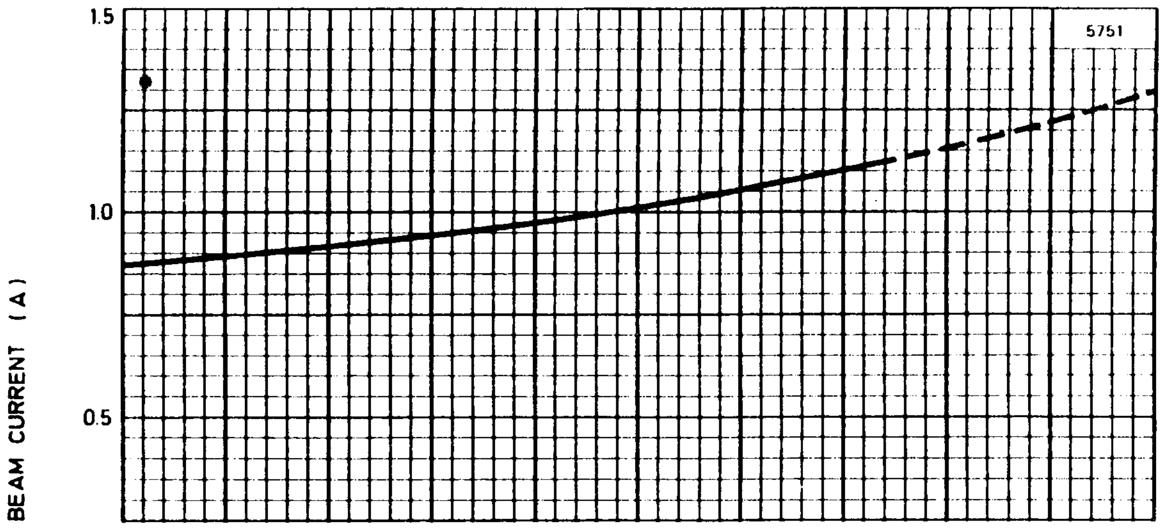
TYPICAL OPERATION

Centre frequency	6.265	GHz
Beam voltage	8.2	kV
Beam current	1.08	A
Drive power (see note 2)	250	mW
Power output	3.4	kW
Bandwidth to −1 dB	48	MHz
Gain	41	dB
Body current (with r.f. drive)	15	mA
Load v.s.w.r.	1.05:1	

NOTES

1. The flow rates given are minimum values for operation at maximum beam power, at sea level and 20 °C ambient.
2. Defined as the power delivered to a matched load substituted for the klystron input cavity.

BEAM CURRENT CHARACTERISTIC



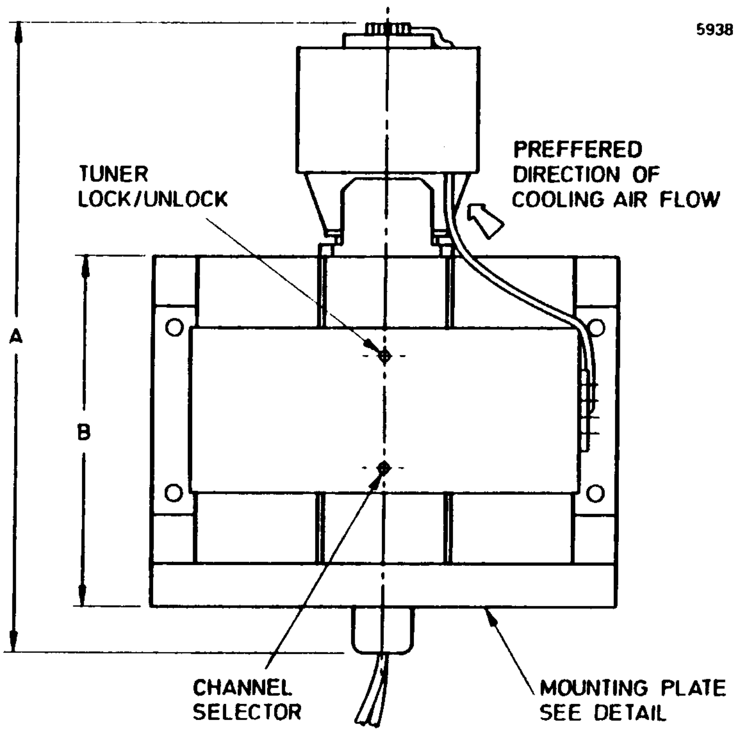
OUTPUT POWER CHARACTERISTIC

OUTLINE

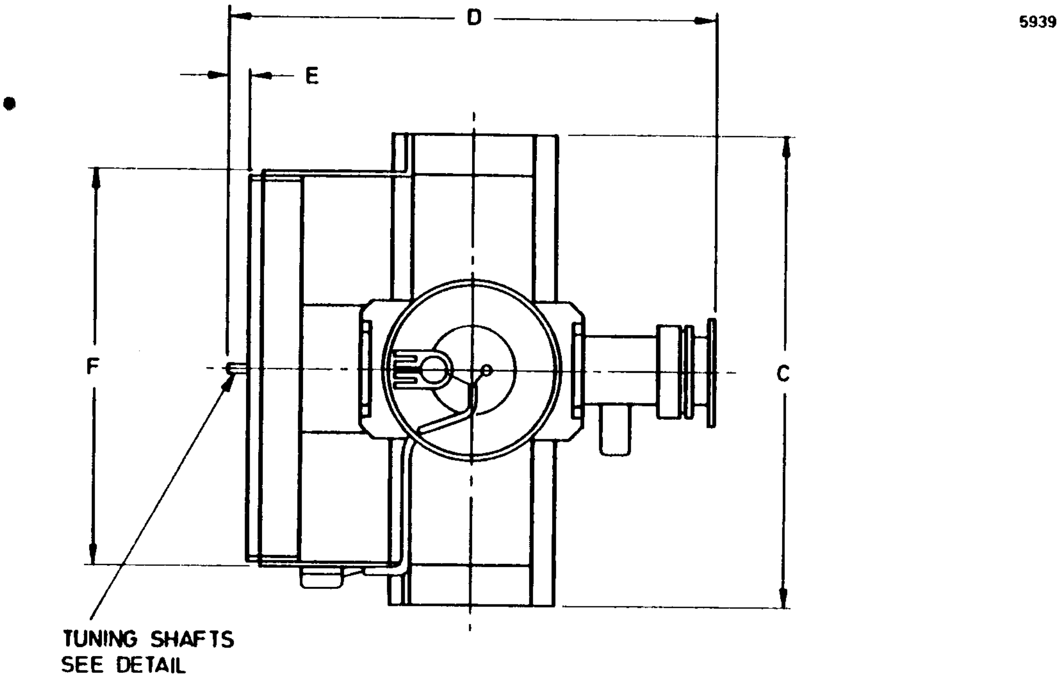
Ref	Inches	Millimetres
A	15.500 max	393.7 max
B	8.600 max	218.4 max
C	11.500 max	292.1 max
D	12.000 max	304.8 max
E	0.450 min	11.43 min
F	9.311 ± 0.125	236.5 ± 3.2
G	4.470 ± 0.031	113.5 ± 0.8
H	3.050 min	77.47 min

Ref	Inches	Millimetres
J	3.990 ± 0.4	101.3 ± 0.4
K	2.751 ± 0.030	69.88 ±0.76
L	4.488 ± 0.094	114.0 ± 2.4
M	5.330 ± 0.094	135.4 ± 2.4
N	3.537 ± 0.094	89.84 ± 2.36
P	5.988 ± 0.031	152.1 ± 0.8
Q	18.0 ± 1.0	457 ± 25

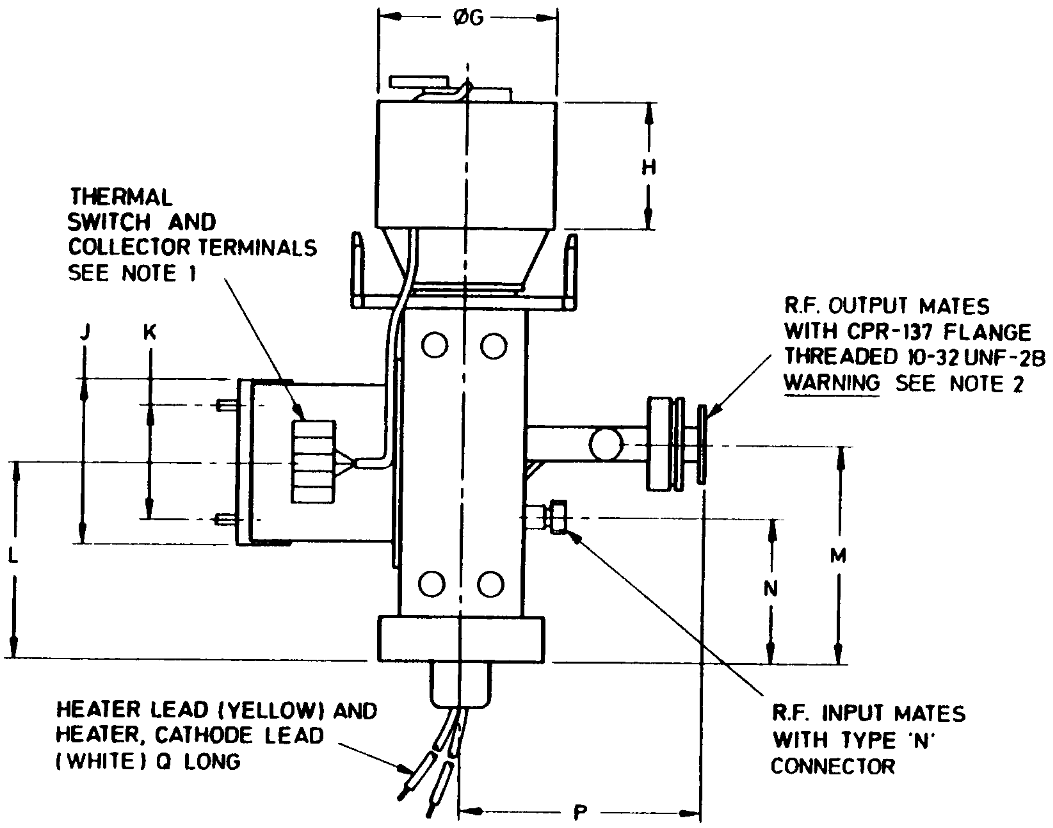
Millimetre dimensions have been derived from inches.



OUTLINE

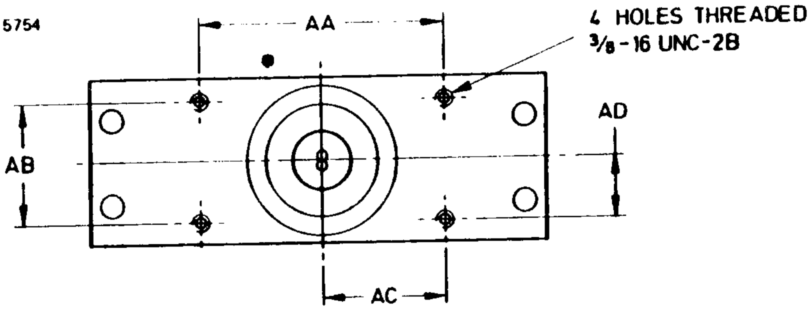


5939
D
E
F
C
TUNING SHAFTS
SEE DETAIL



ØG
H
THERMAL
SWITCH AND
COLLECTOR TERMINALS
SEE NOTE 1
J
K
L
R.F. OUTPUT MATES
WITH CPR-137 FLANGE
THREADED 10-32 UNF-2B
WARNING SEE NOTE 2
M
N
HEATER LEAD (YELLOW) AND
HEATER, CATHODE LEAD
(WHITE) Q LONG
R.F. INPUT MATES
WITH TYPE 'N'
CONNECTOR
P

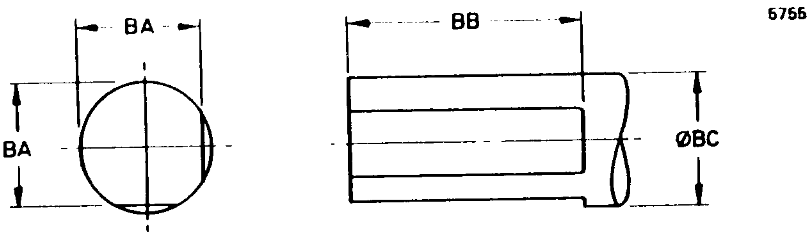
Detail of Mounting Plate



Ref	Inches	Millimetres
AA	6.000 ± 0.031	152.4 ± 0.8
AB	3.000 ± 0.031	76.2 ± 0.8
AC	3.000 ± 0.016	76.2 ± 0.4
AD	1.500 ± 0.016	38.1 ± 0.4

Millimetre dimensions have been derived from inches.

Detail of Tuning Shaft



Ref	Inches	Millimetres
BA	0.230 ± 0.005	5.84 ± 0.13
BB	0.380 ± 0.010	9.65 ± 0.25
BC	0.248 ± 0.002	6.30 ± 0.05

Millimetre dimensions have been derived from inches.

Outline Notes

1. Thermal switch rated 250 V, 3 A a.c. max, connections K1 and K2.
2. The klystron must not be lifted by the output waveguide.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV does not accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

Microwave Radiation

Personnel must not be exposed to microwave radiation exceeding 1 mW/cm^2. All r.f. connections must be leakproof and the klystron must not be operated without a suitable r.f. load on the output waveguide. It is particularly dangerous to look into open waveguide or transmitter antennae while the device is operating.

Chelmsford, Essex, England

Subsidiary of The General Electric Company, p.l.c. of England Printed in England

K347A

AMPLIFIER KLYSTRON

ABRIDGED DATA

Three cavity, electro-magnetically focused amplifier klystron, with separate tuning cavities, for pulsed operation. The operation of the klystron is guaranteed only when used with approved tuning cavities and magnet asssembly.

The K347A is similar to the K347 but has the focus electrode connected internally to the cathode.

Frequency range (see note 1)	580 to 615	MHz
Output power (peak)	600	kW
Beam voltage (peak)	75	kV
Efficiency	40	%
Power gain	33	dB
Cooling		forced-air

GENERAL

Electrical

Cathode		indirectly heated
Heater voltage	6.3	V
Heater current range	27 to 34	A
Heater starting current (peak value, not to be exceeded)	100	A
Magnetic focusing field		35 mT (350 gauss)

Mechanical

Overall length	62.875 inches (1597 mm) max
Overall diameter	8.004 inches (203.3 mm) max
Net weight	65 pounds (29.6 kg) approx
Mounting position	vertical

June 1978

Supersedes May 1972 Issue

Cooling

Air flow to collector and final drift tube	250	ft³/min
	7.1	m³/min
Inlet air temperature	55	°C max
Air pressure manometer reading	4.5 inches (114.3 mm) w.g.	

A supplementary air flow is required to cool the cathode end of the klystron. The required airflows must be delivered before and during the application of h.t. voltage. H.T. power and air supplies may be removed simultaneously.

MAXIMUM AND MINIMUM RATINGS (Absolute values)

No individual rating should be exceeded

	Min	Max	
Heater voltage	5.9	6.7	V
Collector voltage (peak) (see note 3)	–	80	kV
Total current (collector + body) (peak) (see note 4)	–	23	A
Collector current (peak)	–	20	A
Collector dissipation	–	4.0	kW
Body voltage (peak) (see note 3)	–	80	kV
Body current (peak) with no r.f. drive (see note 5)	–	5.0	A
Pulse duration	–	10	μs
Load v.s.w.r.	–	1.5:1	
Temperature of any external part of the klystron (see note 2)	–	180	°C

TYPICAL OPERATION

Operating Conditions

Frequency	600	MHz
Load v.s.w.r.	1.1:1	max
Total current (collector + body) (peak)	20	A
Magnetic field	35	mT
	350	gauss
Pulse duration	6.0	μs
Pulse repetition rate	400	p.p.s.

Typical Performance

Collector voltage (peak) (see note 3)	75	kV
Collector current (peak)	10	A
Body voltage (peak) (see note 3)	75	kV
Body current (peak)	10	A
Gain	33	dB
Output power	600	kW

RANGE OF CHARACTERISTICS FOR EQUIPMENT DESIGN

Test Conditions

Heater voltage	6.3	V
Total current (collector + body) (peak)	20	A
Magnetic field	35	mT
	350	gauss
Duty cycle	0.0024	
Pulse duration	4.0	µs
Pulse repetition rate	600	p.p.s.

Range of Characteristics

	Min	Max	
Heater current	27	34	A
Collector voltage (peak)	73	78	kV
Body voltage (peak)	73	78	kV
Body current (peak)	–	12	A
Mechanical tuning range (see note 1)	580	615	MHz
Gain for maximum efficiency	30	35	dB
Interpulse noise (below output power)	180	–	dB
Output power (peak)	500	–	kW

NOTES

1. The tuning range depends on the external cavities.
2. The drift tube temperature may be measured by the copper-constantan thermocouple attached to the klystron. A temperature of 180 °C corresponds to 5.5 mV approx. with a cold junction temperature of 55 °C.

3. When klystrons have been stored for long periods it is necessary to condition them by increasing the h.t. voltage gradually over a period which should not in general take longer than 2 hours to complete.
4. Provision should be made for monitoring both the body and collector currents; heavy duty shunts are advised. The body must be earthed.
5. With r.f. drive on, the body current may exceed 5 A provided that the drift tube temperature is below 180 °C.

HEALTH AND SAFETY HAZARDS

High power klystrons can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a klystron is damaged. EEV cannot accept responsibility for damage or injury resulting from the use of EEV klystrons. Equipment manufacturers and klystron users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating klystrons and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. Klystron enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

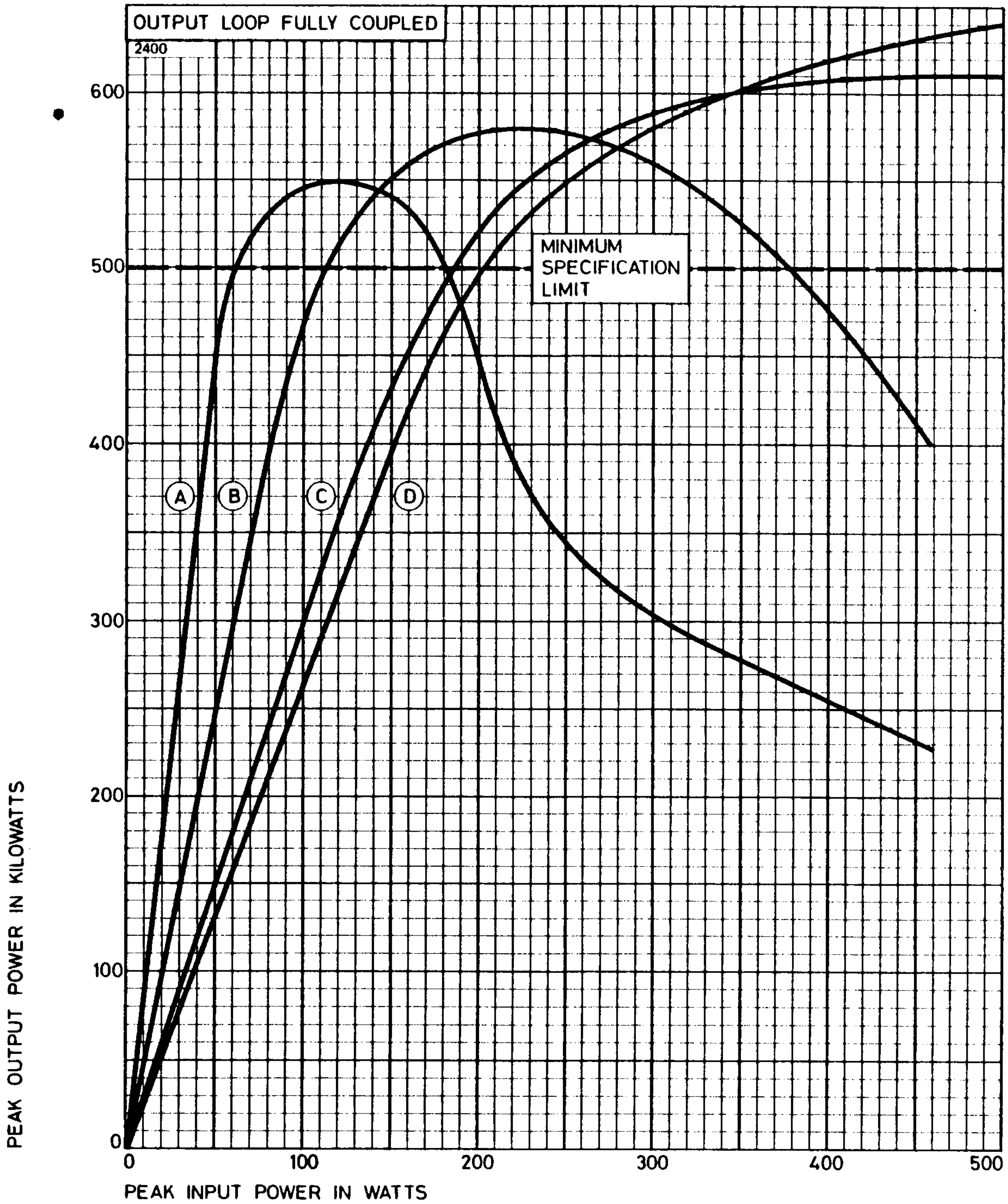
Microwave Radiation

Personnel must not be exposed to excessive r.f. radiation. All r.f. connectors and cavities must be correctly fitted before operation, so that there is no leakage of r.f. energy. Klystrons must not be operated without a suitable r.f. load at the output and output cavity. It is particularly dangerous to look into open waveguide or coaxial feeders, or transmitter antennae.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When EEV klystrons are operated normally with the r.f. cavities fitted and the electron gun area suitably enclosed, the X-ray emission is reduced to a safe level. Klystrons must not be run without the r.f. cavities and electron gun enclosure fitted.

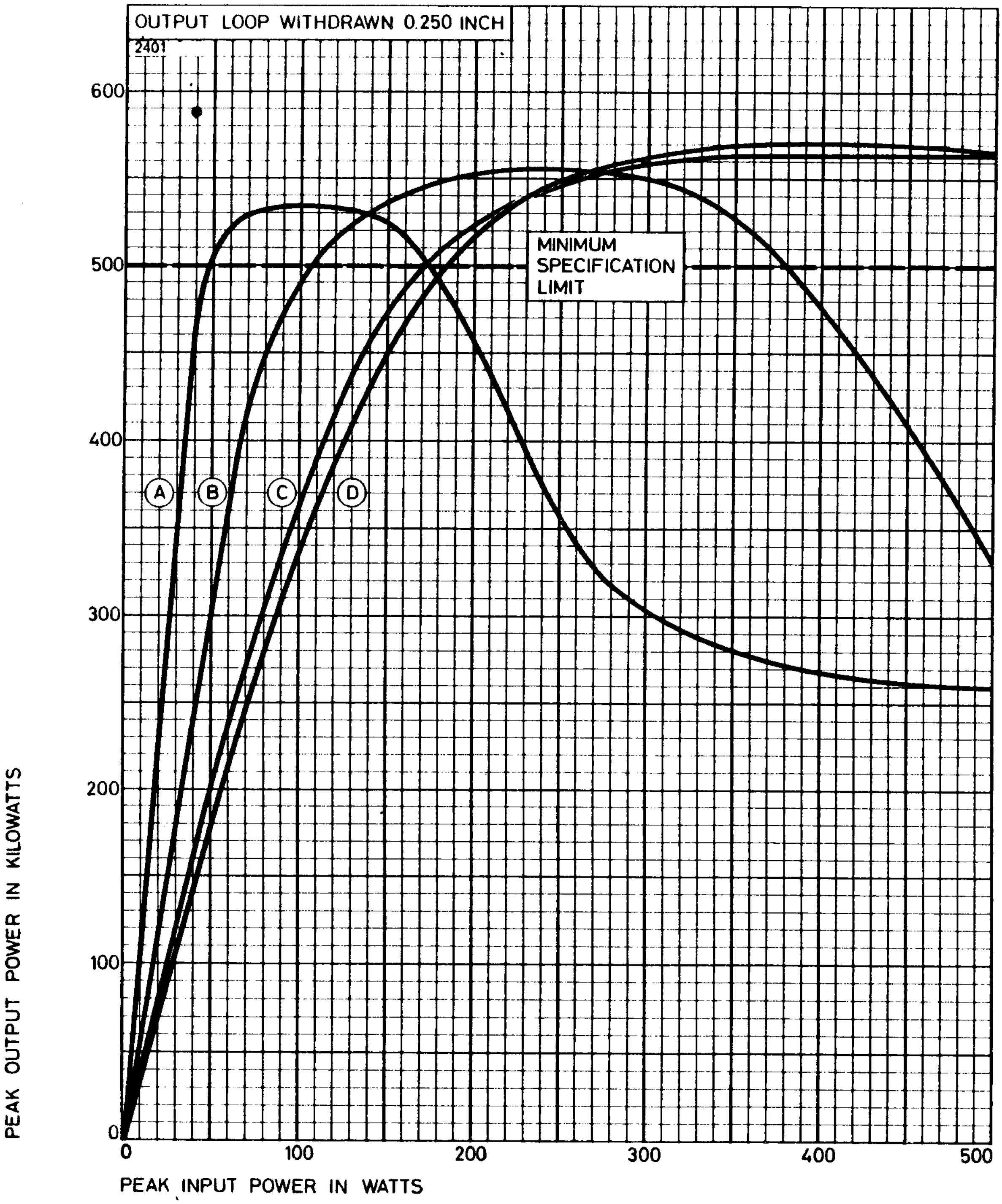
POWER CHARACTERISTICS



Measured with beam voltage 75 kV, frequency 600 MHz and magnetic field 35 mT (350 gauss). Cavities tuned for maximum output power at peak input powers of:

A	100 W	**C**	300 W
B	200 W	**D**	400 W

POWER CHARACTERISTICS

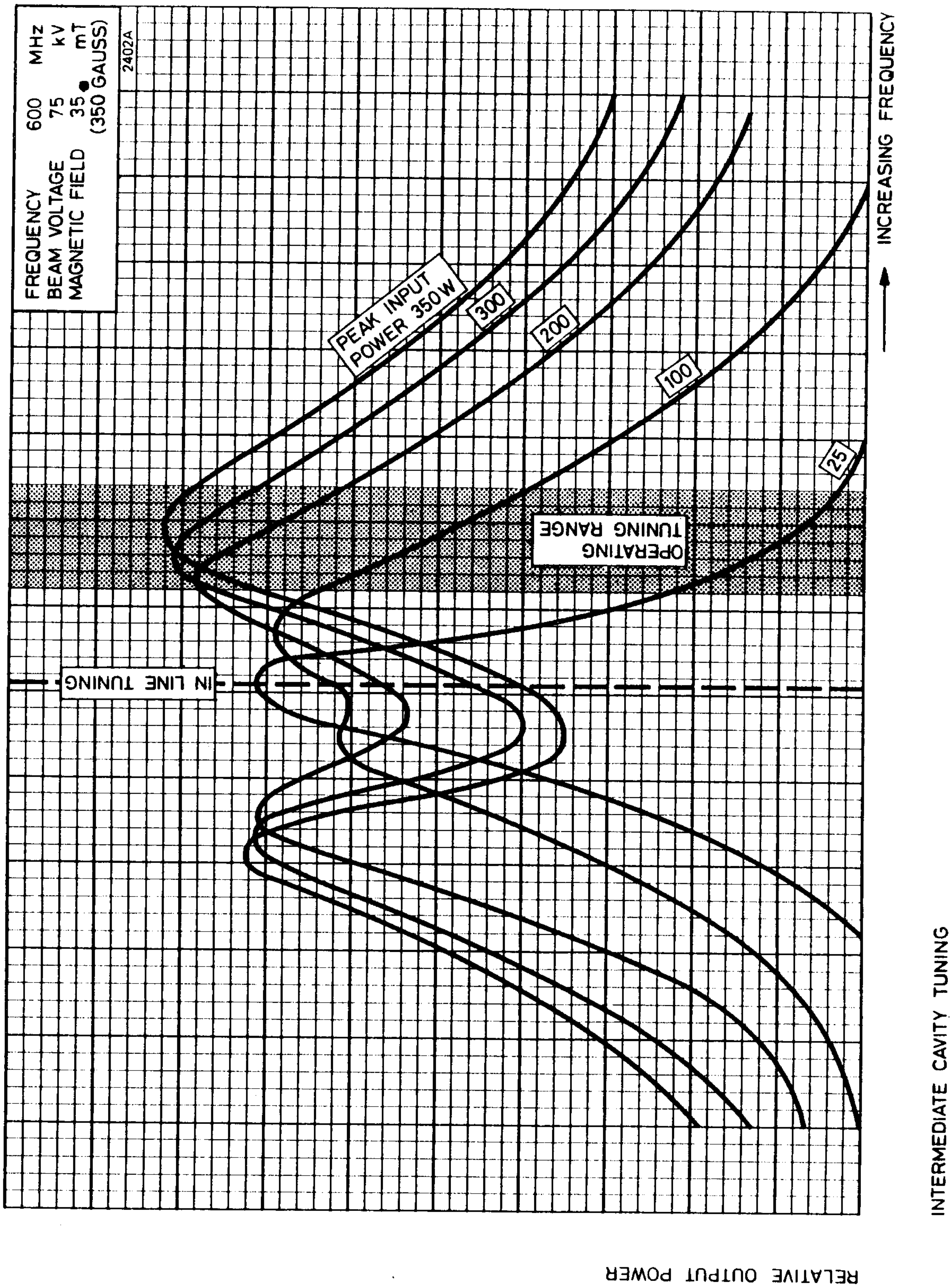


Measured with beam voltage 75 kV, frequency 600 MHz and magnetic field 35 mT (350 gauss). Cavities tuned for maximum output power at peak input powers of:

A 100 W **C** 300 W

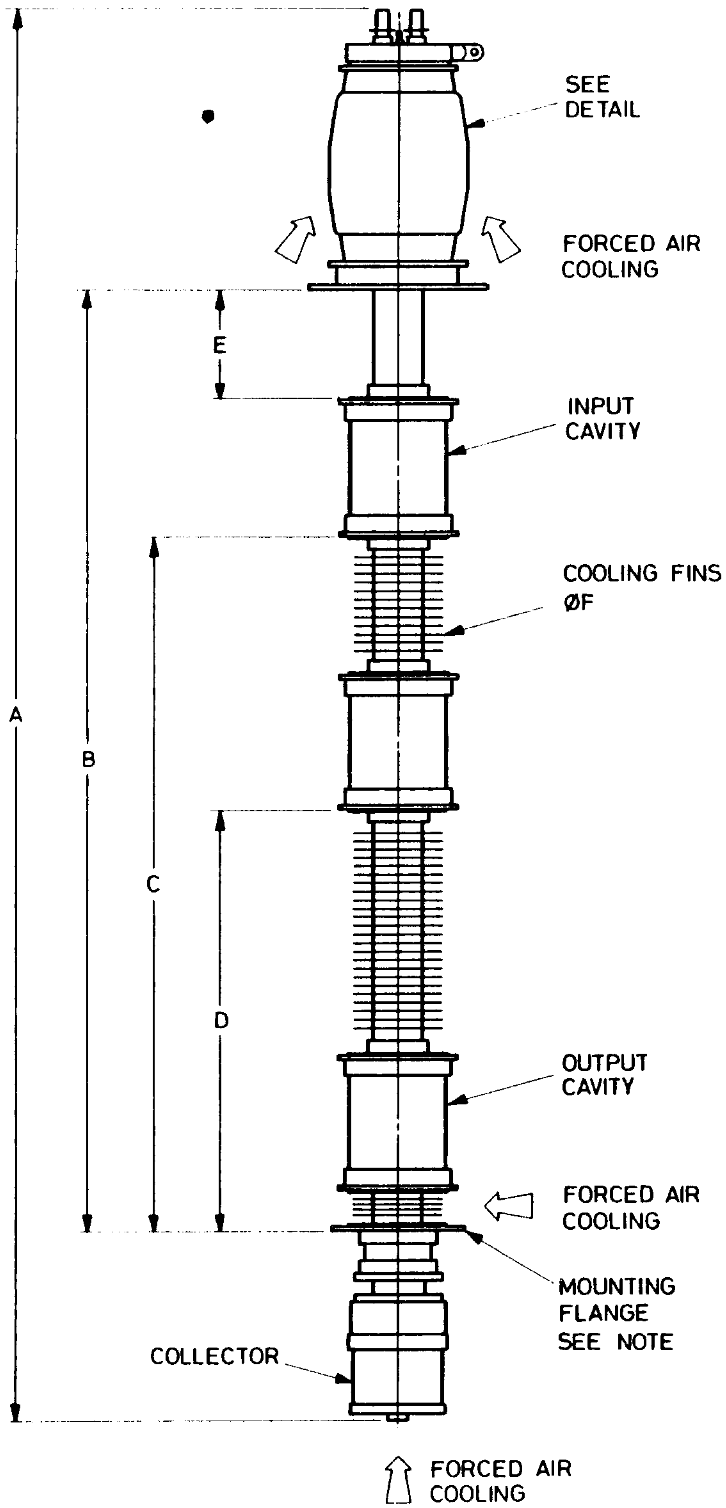
B 200 W **D** 400 W

INTERMEDIATE CAVITY TUNING CHARACTERISTICS



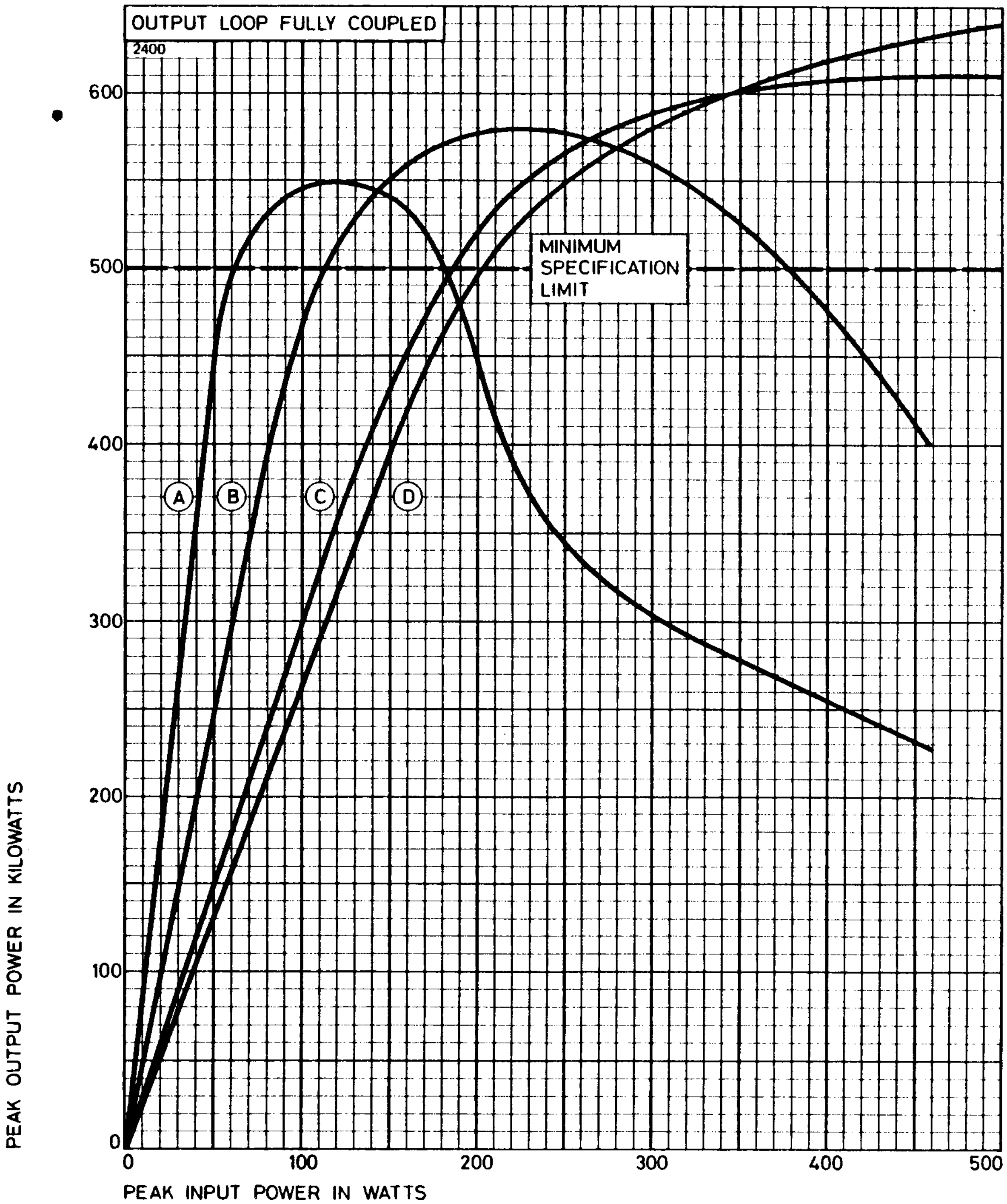
OUTLINE

2403B



Note Square tolerance of lower face at edge 0.010 inch (0.25 mm) wide. Datum, centre line of lifting flange and mounting flange.

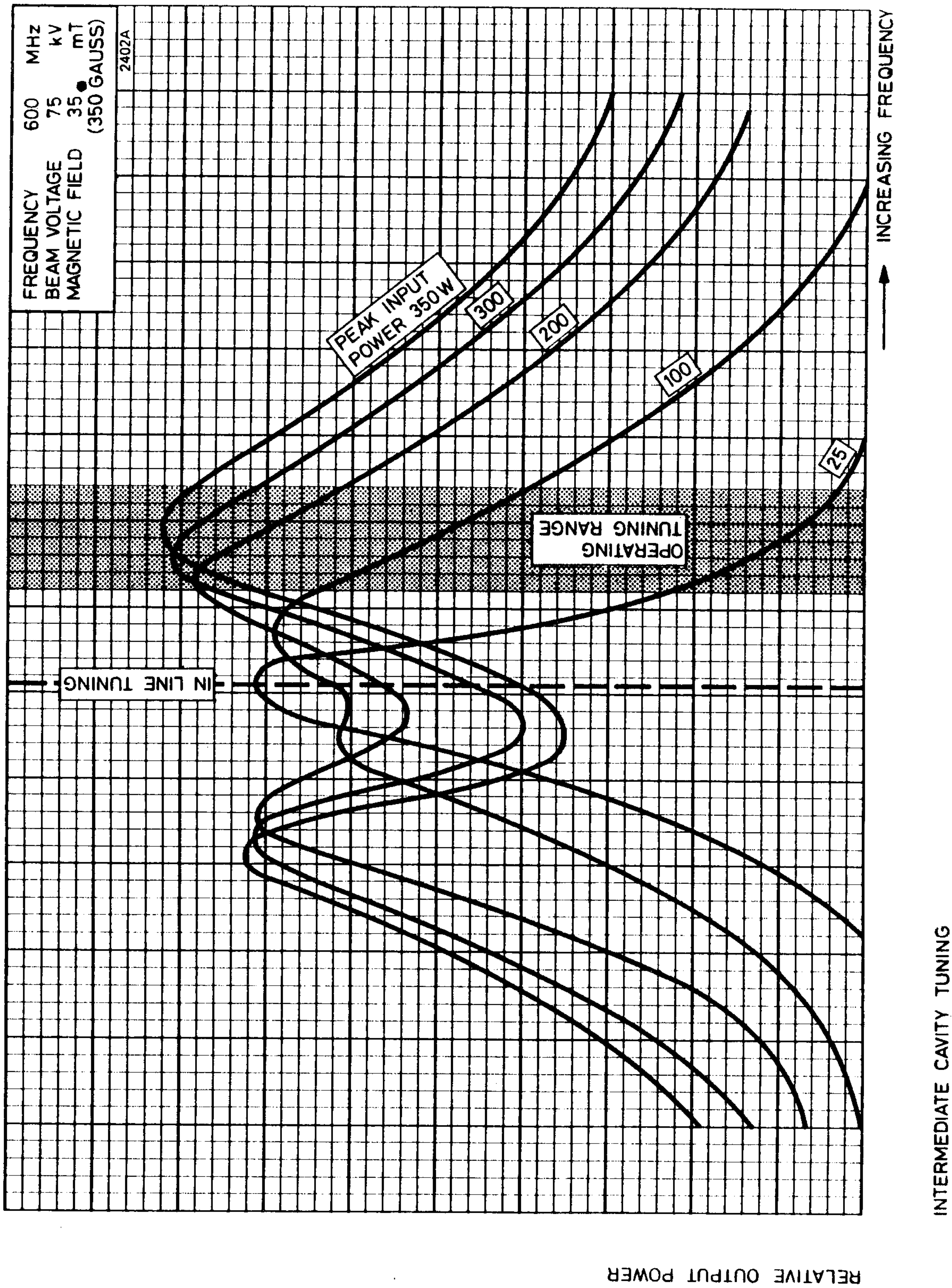
POWER CHARACTERISTICS



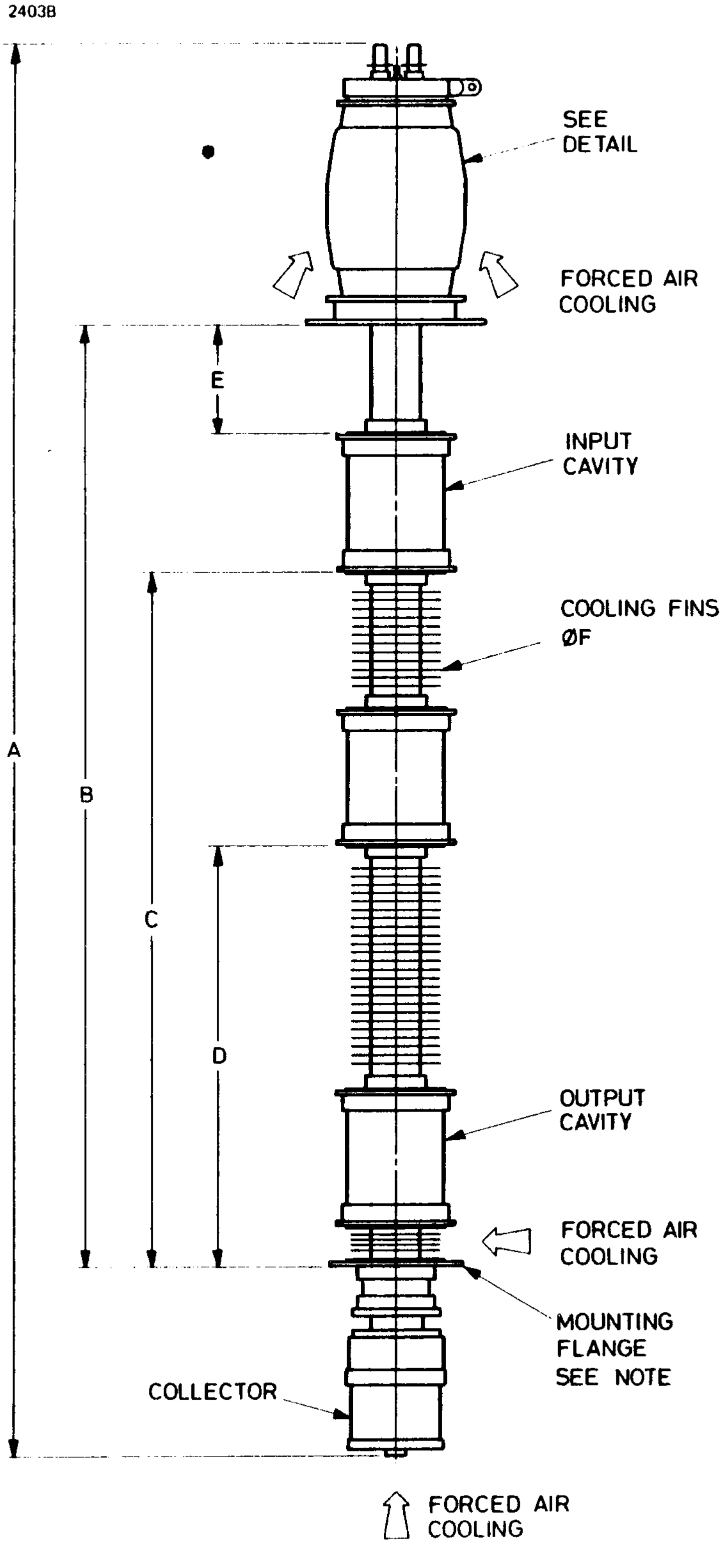
Measured with beam voltage 75 kV, frequency 600 MHz and magnetic field 35 mT (350 gauss). Cavities tuned for maximum output power at peak input powers of:

A	100 W	**C**	300 W
B	200 W	**D**	400 W

INTERMEDIATE CAVITY TUNING CHARACTERISTICS

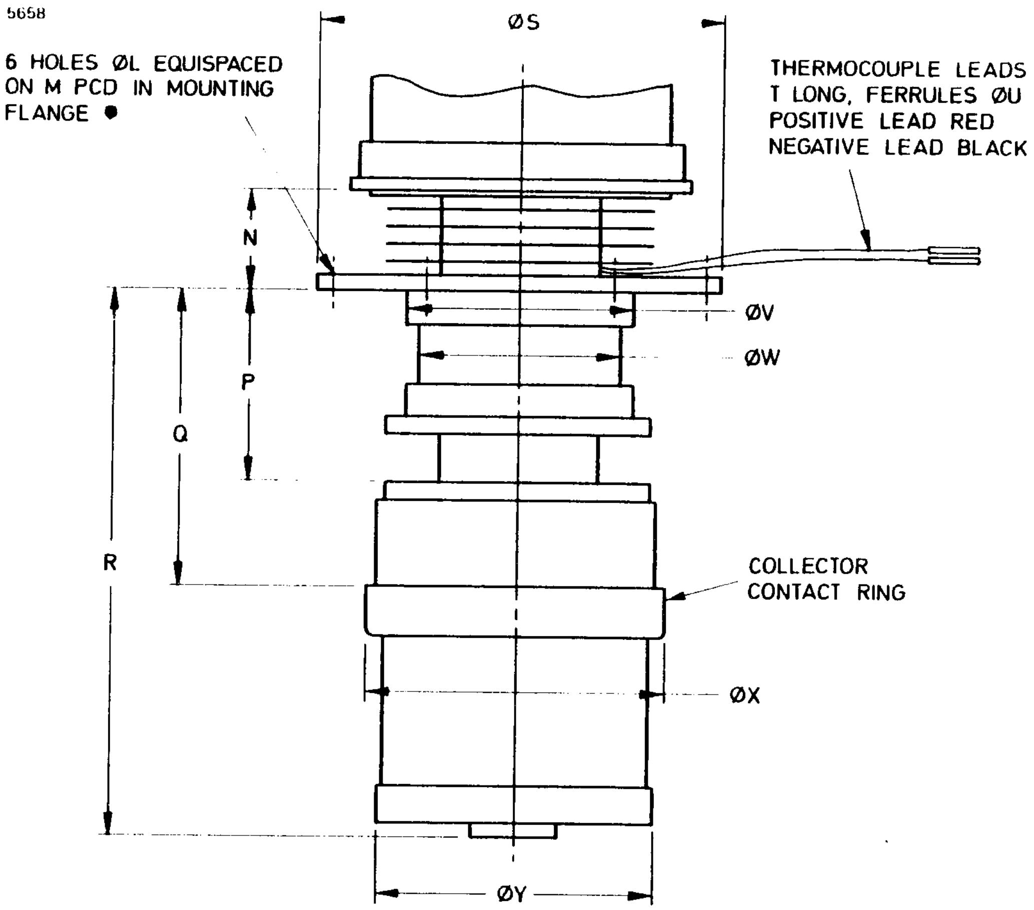


OUTLINE



Note Square tolerance of lower face at edge 0.010 inch (0.25 mm) wide. Datum, centre line of lifting flange and mounting flange.

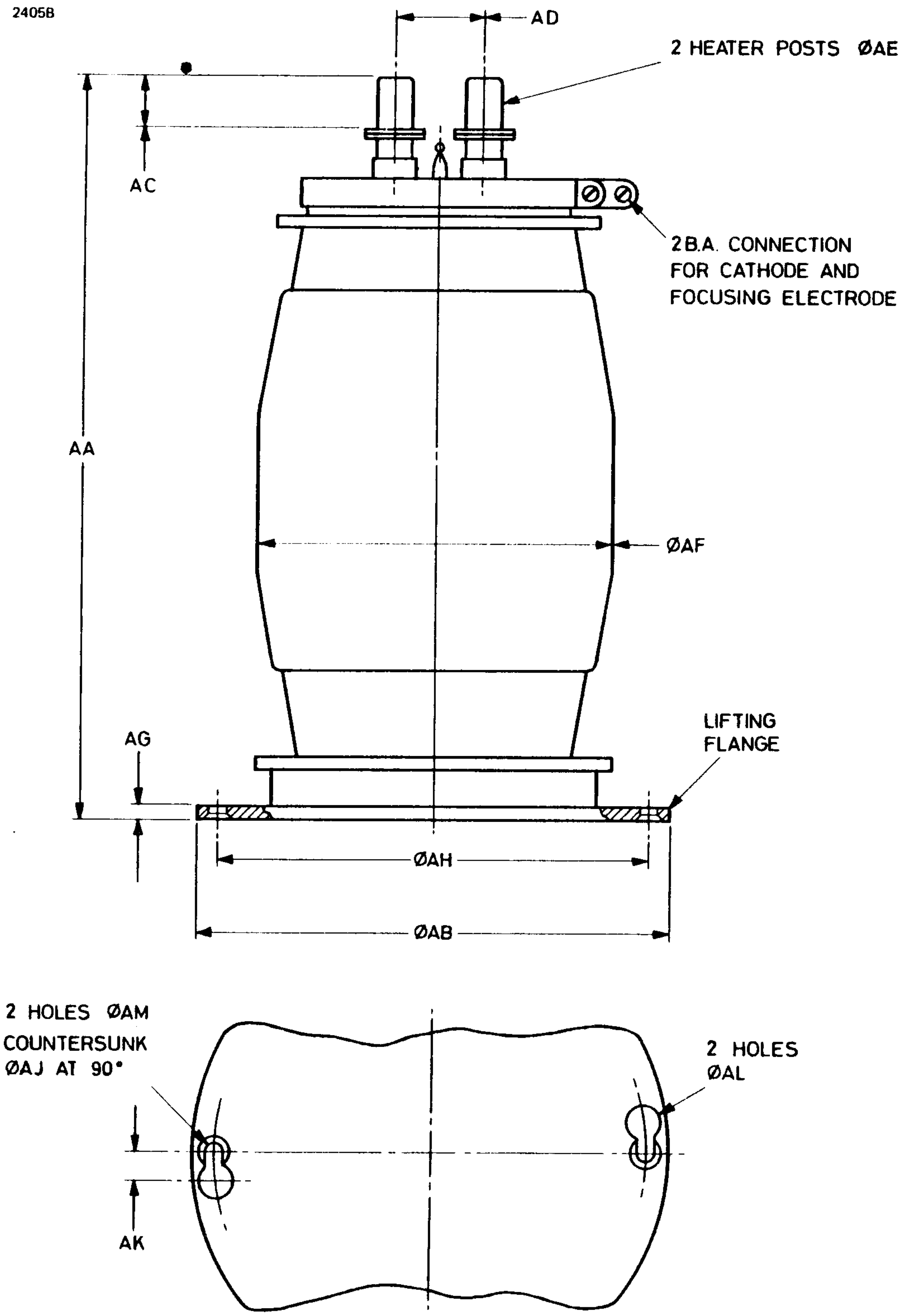
Detail of Collector (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	62.875 max	1597 max	Q	4.560 ± 0.080	115.8 ± 2.0
B	41.250 ± 0.160	1047.8 ± 4.1	R	8.375 max	212.7 max
C	30.440 ± 0.080	773.2 ± 2.0	S	5.994 ± 0.003	152.25 ± 0.08
D	18.440 ± 0.050	468.4 ± 1.3	T	14.000	355.6
E	4.812 ± 0.031	122.2 ± 0.8	U	0.156	3.96
F	3.900 max	99.06 max	V	3.352 max	85.14 max
L	0.264	6.71	W	2.992 max	76.0 max
M	5.562 ± 0.010	141.27 ± 0.25	X	4.437 ± 0.004	112.7 ± 0.1
N	1.438 ± 0.030	36.53 ± 0.76	Y	4.100 max	104.1 max
P	2.500 min	63.5 min			

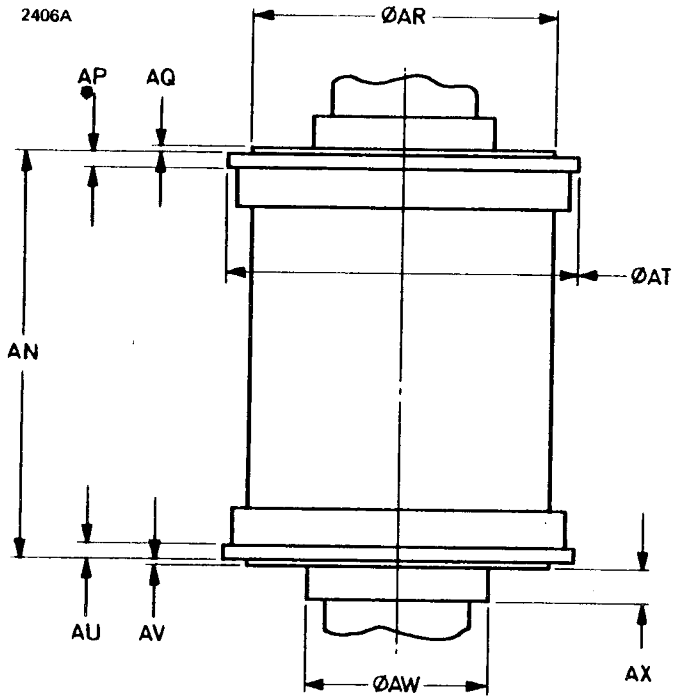
Millimetre dimensions have been derived from inches.

Details of Cathode Terminals and Lifting Flange
(All dimensions without limits are nominal)



See page 11 for dimensions.

Detail of Typical Cavity Assembly



Ref	Inches	Millimetres
AA	12.500	317.5
AB	8.000 ± 0.004	203.2 ± 0.1
AC	0.885 min	22.48 min
AD	1.500	38.1
AE	0.625 ± 0.002	15.875 ± 0.051
AF	6.188 max	157.2 max
AG	0.250	6.35
AH	7.250	184.2
AJ	0.500	12.7
AK	0.500	12.7
AL	0.516	13.11

Ref	Inches	Millimetres
AM	0.250	6.35
AN	5.988 ± 0.035	152.10 ± 0.89
AP	0.250 ± 0.008	6.35 ± 0.20
AQ	0.050 max	1.27 max
AR	4.500 ± 0.050	114.3 ± 1.3
AT	5.245 ± 0.010	133.22 ± 0.25
AU	0.250 ± 0.008	6.35 ± 0.20
AV	0.050 max	1.27 max
AW	2.750 ± 0.004	69.85 ± 0.10
AX	0.500	12.7

Millimetre dimensions have been derived from inches.