E713B

DIRECT VIEW STORAGE TUBE

Service Type CV9422

The data should be read in conjunction with the Storage Tube Preamble.

INTRODUCTION

The E713B is a direct view storage tube with a useful viewing screen diameter of 4 inches (102mm). It is of ruggedized construction and is designed to provide very bright displays of information ranging from single transients and recurrent waveforms to half tone pictures. The writing gun beam is magnetically deflected. E713B is particularly suitable for the daylight viewing of radar displays and is recommended for airborne and other applications where vibration and low pressure conditions may be encountered.

The tube has two electron guns, one for writing the signal on to the storage surface and the other, the flood gun, for displaying written information on the viewing screen. The writing gun is similar to that in a conventional cathode ray tube, except that it need only be operated for a single trace. In writing, a charge pattern is deposited on the storage surface, which consists of an insulator coating on a metal mesh (the backing electrode). Low velocity electrons from the flood gun approach the storage mesh normally and at constant current density over the useful area. They penetrate the mesh in those areas where a charge pattern has been written, the number doing so being determined by the amount of charge deposited, and are then accelerated to the viewing screen where they produce an image.

Since the flood gun is normally continuously operative, the image on the viewing screen persists without deterioration for about one minute and is visible for periods up to ten minutes. Extended storage periods may be obtained by switching off the flood beam until viewing is required, provided that no writing takes place while the flood gun is inoperative. The image can be completely erased in a fraction of a second by applying a small positive pulse to the backing electrode and controlled persistence can be obtained by varying the duration of shorter repetitive pulses.

GENERAL

Electrical and General

	Writing Gun	Flood Gun	
Cathodes, indirectly heated, oxide coated	one	one	
Heater voltage	6.3	6.3	V
Heater current	0.6	0.6	A
Cathode heating time (minimum)	see note 1	45	s
Inter-electrode capacitances:			
cathode to all other electrodes	4.0	—	pF
grid 1 to all other electrodes	7.0	—	pF
writing gun grid 1 to writing gun cathode*	1.5	—	pF
backing electrode to all other electrodes	—	66	pF
screen to all other electrodes	—	32	pF
Focus method	electrostatic	electrostatic	
Deflection method	magnetic	none	
Phosphor	—	aluminized P20	
Fluorescent colour (see spectral characteristic)		yellow-green	

Mechanical

Overall length	12.187 inches (309.6mm) max
Overall diameter (excluding flexible lead)	5.635 inches (143.1mm) max
Bulb diameter	*5.300 inches (134.6mm) max*
Useful viewing screen diameter	4.000 inches (101.6mm) min
Net weight	2 pounds (0.9kg) approx
Mounting position (see note 2)	any, except with base up and with the tube axis at an angle less than 20° from vertical
Connections:	
writing gun	flexible leads
flood gun	flexible leads
Bulb cavity caps (five)	B.S.448-CT8 (JEDEC no. J1-21)
Viewing screen connection	flexible lead

* With all other electrodes earthed

MAXIMUM AND MINIMUM RATINGS (Absolute values)

No individual rating should be exceeded

All voltages are with respect to the flood gun cathode unless otherwise stated

Writing Gun

	Min	Max	
Heater voltage	6.0	6.6	V
Grid 4 voltage			see note 3
Grid 3 voltage (negative value)	—	2000	V
Grid 2 voltage	—	200	V
Grid 1 voltage:			
negative bias*	0	200	V
positive peak*	—	2.0	V
Cathode voltage (negative value)	—	2300	V
Peak heater to cathode voltage:			
heater positive with respect to cathode	—	125	V
heater negative with respect to cathode	—	125	V
Cathode current (peak)	—	1.0	mA
Grid to cathode circuit impedance	—	1.0	MΩ

Flood Gun

	Min	Max	
Heater voltage	6.0	6.6	V
Viewing screen voltage	—	12	kV
Backing electrode voltage (peak) (see note 4)	—	20	V
Grid 4 (collector mesh) voltage	—	300	V
Grid 3A voltage	—	300	V
Grid 3 voltage	—	300	V
Grid 2 voltage (see note 3)	—	150	V
Grid 1 voltage	—	150	V
Peak heater to cathode voltage:			
heater positive with respect to cathode	—	125	V
heater negative with respect to cathode	—	125	V
Cathode current	—	10	mA
Viewing screen dissipation	—	6.0	W
Backing electrode supply impedance	—	5000	Ω
Viewing screen supply impedance (see note 5)	1.0	5.0	MΩ

* With respect to Writing Gun Cathode.

TYPICAL OPERATION

All voltages are with respect to the flood gun cathode unless otherwise stated

WRITING GUN

Operational Conditions

Grid 4 voltage	see note 3	
Grid 3 voltage (usual range for focus)*	400 to 700	V
Grid 2 voltage	0	V
Grid 1 voltage (range for writing beam cut-off)*	−30 to −55	V
Cathode voltage	−1800	V

Typical Performance

Writing beam current (50V modulation) *(see note 6)*	45	μA
Cathode current (50V modulation) (see note 6)	550	μA

FLOOD GUN

Operational Conditions

Screen voltage	10	kV
Backing electrode d.c. voltage	5.0	V
Erase pulse amplitude for screen cut-off (see notes 7 and 8)	3.9	V
Grid 4 (collector mesh) voltage	225	V
Grid 3A voltage	150	V
Grid 3 voltage (see note 9)	65	V
Grid 2 voltage (see note 3)	70	V
Grid 1 voltage	30	V
Cathode voltage	0	V

Typical Performance

Screen current for full brightness	0.4	mA
Cathode current	3.75	mA
Screen luminance (see note 10)	1800	ft-lamberts
	6170	cd/m^2
Viewing time (see note 11)	20	*s min*

* With respect to Writing Gun Cathode.

NOTES

1. To prevent the occurrence of transients when switching on or off, the writing gun heater voltage may be applied simultaneously with, or after, the other writing gun voltages, and switched off before these voltages are removed, provided the writing gun is biased to beyond cut-off.
2. Two silicone rubber rings are bonded to the bulb (see outline drawing) and these provide means for positive location of the tube in equipment.
3. Grid 4 (writing gun) is internally connected to grid 2 (flood gun).
4. Except when the faults mentioned under Pulse Erasure, part (c), of the General Instructions on pages 6 and 7 are being corrected.
5. The viewing screen supply impedance should be less than 5MΩ to prevent excessive changes in screen voltage during erasure.
6. Writing is a charge deposition process and the current required for a *given brightness level is proportional to the writing speed and inversely* proportional to the number of times the information is written in one place.
7. With manual erasure (approximately 1 second) and the screen voltage simultaneously removed.
8. Maximum screen brightness is obtained when the storage mesh surface has stabilized at approximately zero potential, i.e. flood gun cathode potential. The application of a positive manual erase pulse to the backing electrode produces a corresponding positive increase in the storage mesh surface potential. This surface potential is reduced to near flood gun cathode potential by flood beam electrons. When the erase pulse is removed the surface acquires a negative potential relative to that at full brightness and equal in value to the erase pulse amplitude.
9. To achieve collimation of the flood beam, the voltages applied to the flood gun grids 2, 3, 3A and 4 should be preset to the fixed values given on page 4. The voltage of grid 1 should then be adjusted to just give maximum uniform display over the screen. The voltage of grid 3 should be adjusted to give the most uniform erasure when a train of erasing pulses is applied to the backing electrode. Slight readjustment of grid 1 and grid 3A voltages may assist in obtaining the most uniform erasure.
10. The meter used for measuring screen luminance has been corrected to the frequency response of the human eye.

11. Time for background to rise from cut-off to 10% of maximum brightness. An increase in viewing time can be obtained by switching off the flood beam by pulses at a frequency sufficiently high to prevent flicker, the apparent brightness of the display being proportionately reduced.

GENERAL INSTRUCTIONS

Handling

The tube should be transported screen upwards to prevent particles falling on the storage elements. It should be handled with care to avoid damage to the metal seals and the encapsulated screen lead.

Pulse Erasure

(a) The speed of erasure is controlled by the adjustment of the pulse duration in conjunction with the pulse repetition rate, which should be sufficiently high to prevent flicker, and preferably in the range between 100 and 2000 pulses per second. By increasing the pulse duration or the pulse repetition rate, the erasure time may be reduced proportionately. The pulse amplitude also alters the erase rate but primarily determines the final potential to which the storage mesh is driven in the absence of writing. Normally a pulse amplitude two to three times the manual erase value is applied, which gives an approximately uniform rate of erasure for visible signals but tends to suppress small non-integrating signals such as noise. A much lower pulse amplitude must be used if the grey scale is to be preserved with no loss of information.

(b) If it can be conveniently arranged for the screen h.t. to be switched off simultaneously with either manual or pulse train erase then two advantages will ensue:

(i) Contrast during pulse train erase will improve.
(ii) The time taken for erasure will decrease.

(c) The normal erasure procedure may be inadequate or ineffective under the following conditions:

(i) When writing beam electrons have penetrated the surface of the storage insulator and have built up charges within it. Low velocity flood beam electrons cannot neutralize these charges and after the normal erasure procedure has been carried out the original screen image may still be faintly visible as the background illumination increases.

(ii) When parts of the storage mesh surface are driven so positive that the number of secondary electrons produced by the flood beam exceeds those arriving at the surface. This condition is known as runaway charging and can occur when a pulse exceeding 20 volts in amplitude is applied to the backing electrode. It can also occur when an excessively high writing charge is deposited, e.g. with a stationary spot or line and particularly when writing takes place in the absence of flood beam current. Damage may be done to the storage mesh if this fault is not quickly corrected.

Both faults can be corrected by operating a switch to disconnect the backing electrode from its supply and connecting it to the flood gun grid 4 through a protective resistor; this switch must make and break quickly and need be operated once only. The screen should then be at uniform full brightness and normal erasure will prepare the tube for operation. Care should be taken to ensure that this switch cannot be left in the 'on' condition. The above procedure is known as 'clearance'.

Flood Gun

To prevent the occurrence of runaway charging, the flood gun beam must always be operative before the writing gun supplies are switched on.

Writing Gun

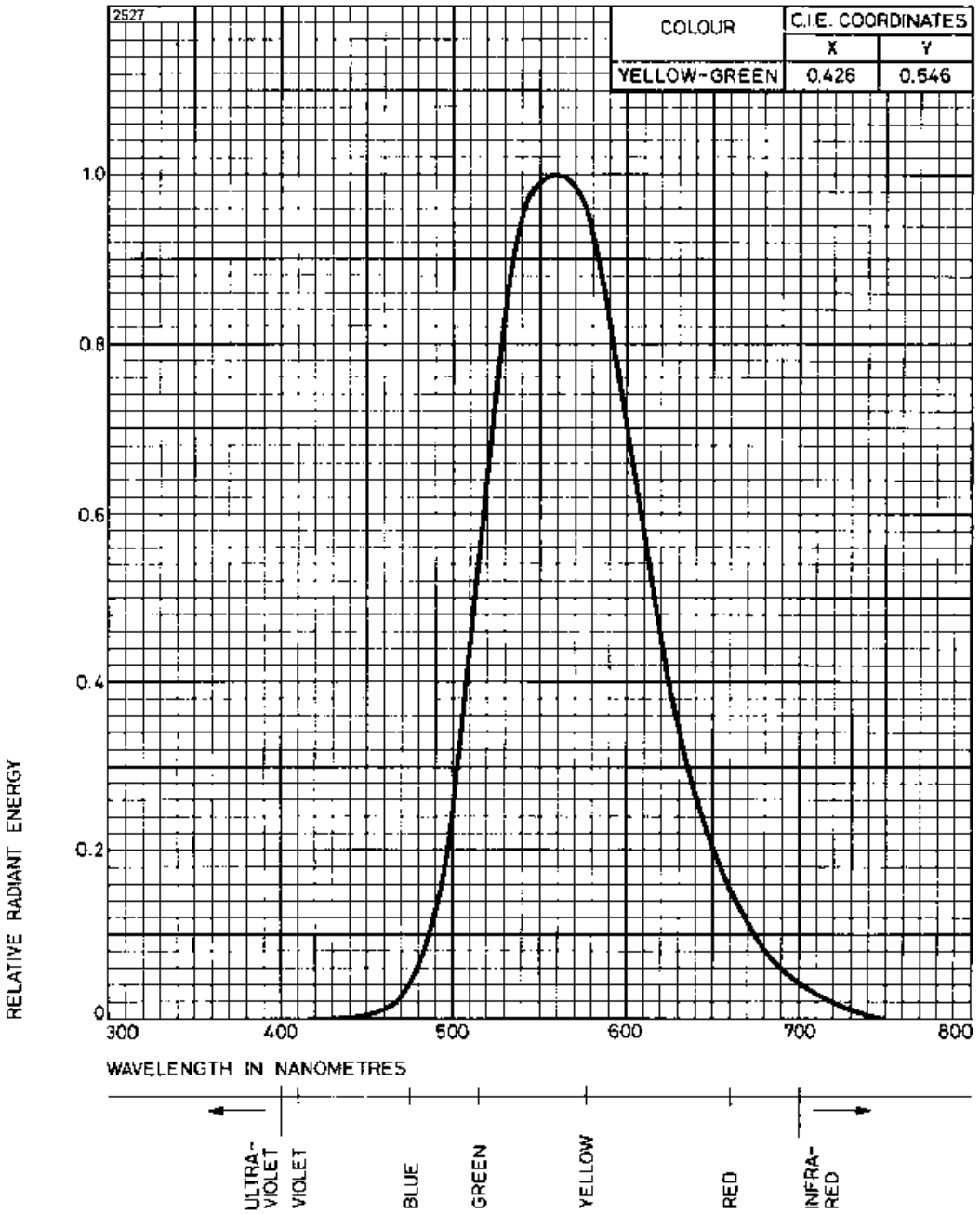
The writing gun cathode is operated at a potential in the region of −1.5 to −2.3kV; consequently the heater supply should be adequately insulated. The cathode supply must be free from ripple to prevent modulation of the writing beam and have good stability to maintain constant modulation depth and focus.

Care should be taken to prevent heavy transient writing beam currents when switching on. The writing beam should be adjusted so that the highlight brightness of the display is not saturated as this will result in a rapid deterioration in resolution.

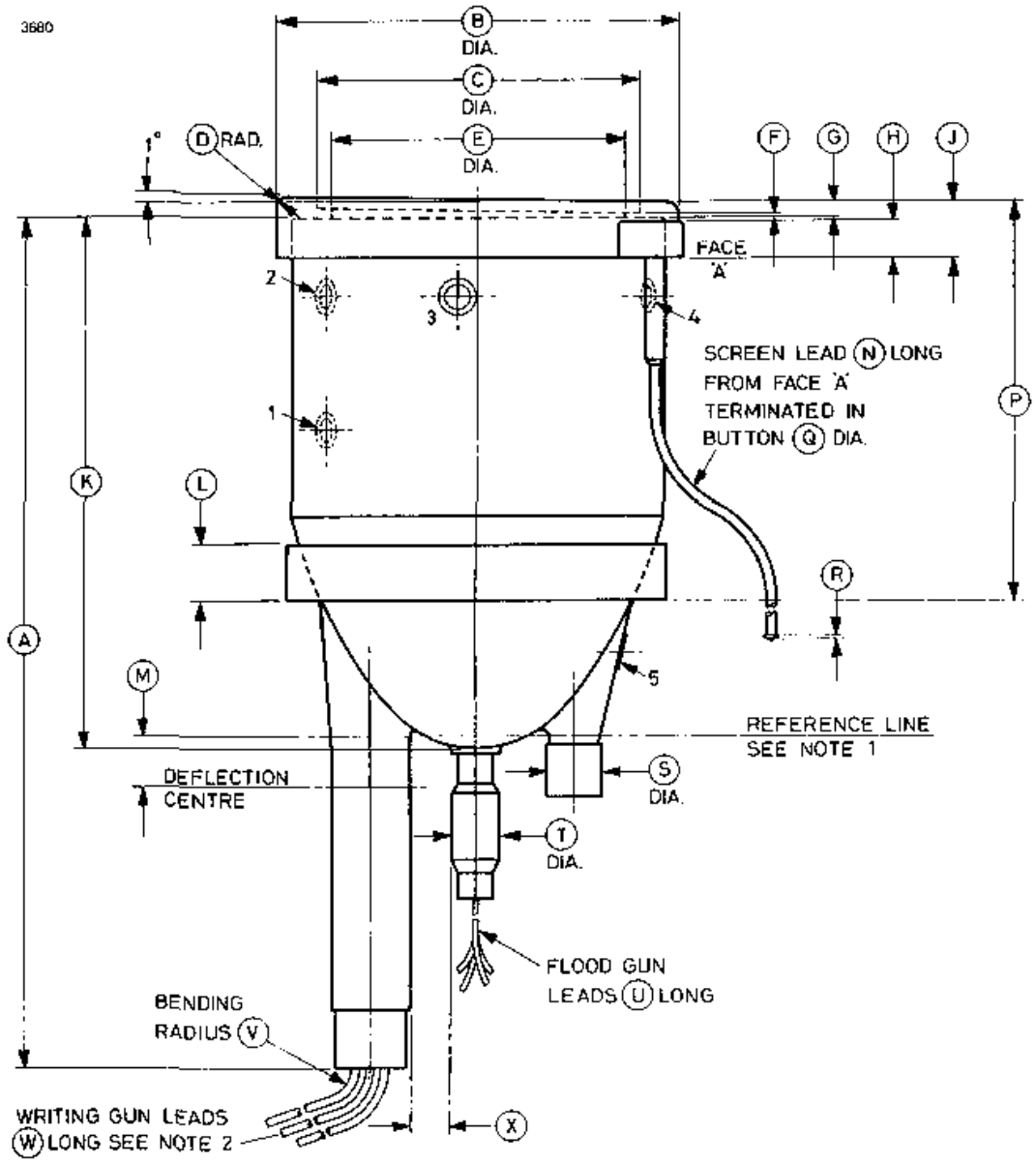
Deflection Supplies

Any failure of the deflection drive that may result in the production of a stationary spot or line may cause runaway charging, even with the flood beam on. Provision should be made for automatically cutting off the writing gun beam in the event of any such failure.

TYPICAL SPECTRAL OUTPUT CHARACTERISTIC FOR P20 PHOSPHOR



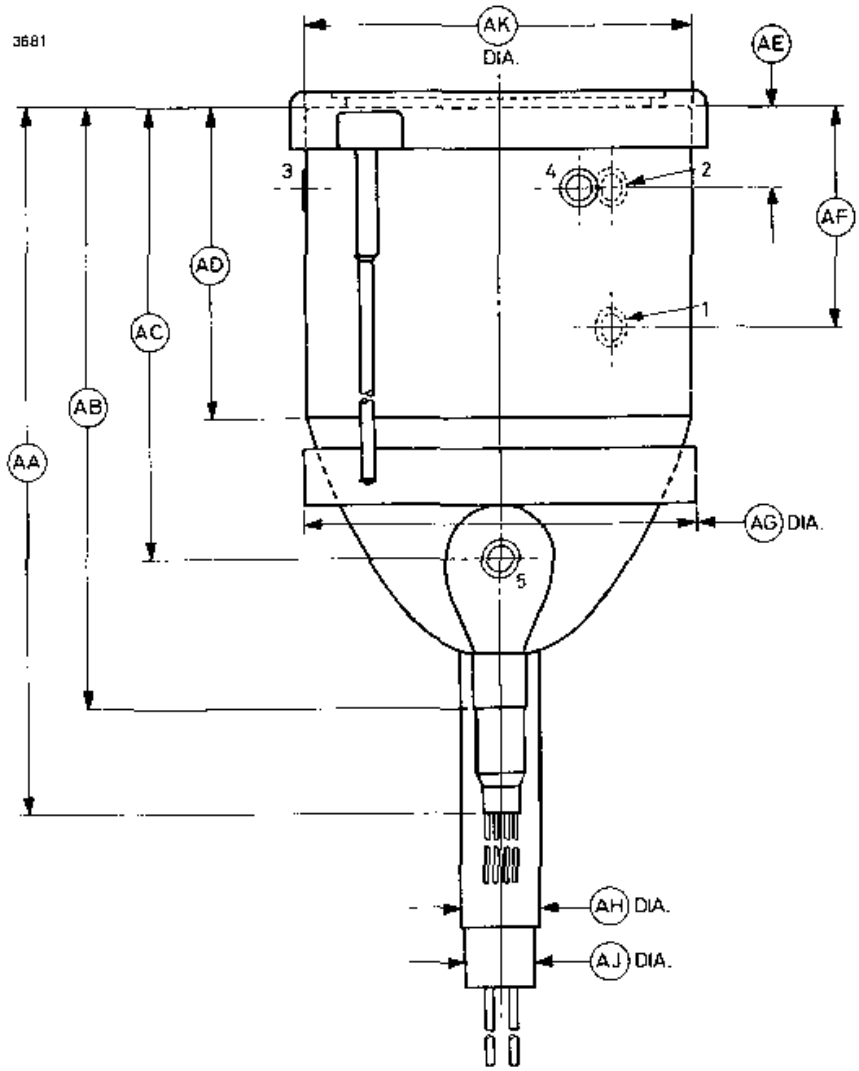
OUTLINE (See page 11 for dimensions)



Outline Notes

1. The reference line is defined by the position of the end of the gauge shown on page 11.
2. The leads to the writing gun are tinned copper wire, 0.50mm^2, stranded 16/0.20mm, silicone rubber insulated to 3.20mm diameter.

OUTLINE



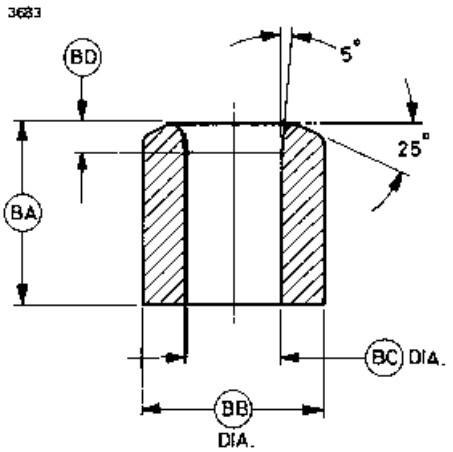
Outline Dimensions

Ref	Inches	Millimetres
A	12.000 max	304.8 max
B	$5.625^{+0.010}_{-0.020}$	$142.9^{+0.25}_{-0.51}$
C	4.525 ± 0.010	114.9 ± 0.25
D	0.187	4.75
E	4.125 ± 0.030	104.8 ± 0.76
F	0.040 ± 0.005	1.02 ± 0.13
G	0.165 ± 0.015	4.19 ± 0.38
H	0.563 max	14.30 max
J	0.800 ± 0.050	20.32 ± 1.27
K	7.500 max	190.5 max
L	0.800 ± 0.050	20.32 ± 1.27
M	0.750	19.05
N	12.125 ± 0.250	308.0 ± 6.35
P	5.625 ± 0.150	142.9 ± 3.8
Q	0.188	4.78
R	0.063	1.60
S	0.750 max	19.05 max
T	0.688 max	17.48 max

Ref	Inches	Millimetres
U	8.000 min	203.2 min
V	0.250 min	6.35 min
W	6.000 min	152.4 min
X	0.562 min	14.27 min
AA	9.625 max	244.5 max
AB	8.187 max	208.0 max
AC	6.125 ± 0.250	155.6 ± 6.35
AD	4.250 ± 0.250	108.0 ± 6.35
AE	1.125 ± 0.125	28.58 ± 3.18
AF	3.000 ± 0.375	76.20 ± 9.53
AG	$5.300^{+0.010}_{-0.020}$	$134.6^{+0.25}_{-0.51}$
AH	1.055 max	26.80 max
AJ	1.010 ± 0.010	25.65 ± 0.25
AK	5.250	133.4
AN	0.625 max	15.88 max
AP	0.625 max	15.88 max
AQ	1.500 ± 0.063	38.10 ± 1.60
AR	1.375 ± 0.063	34.93 ± 1.60

Millimetre dimensions have been derived from inches.

Reference Line Gauge

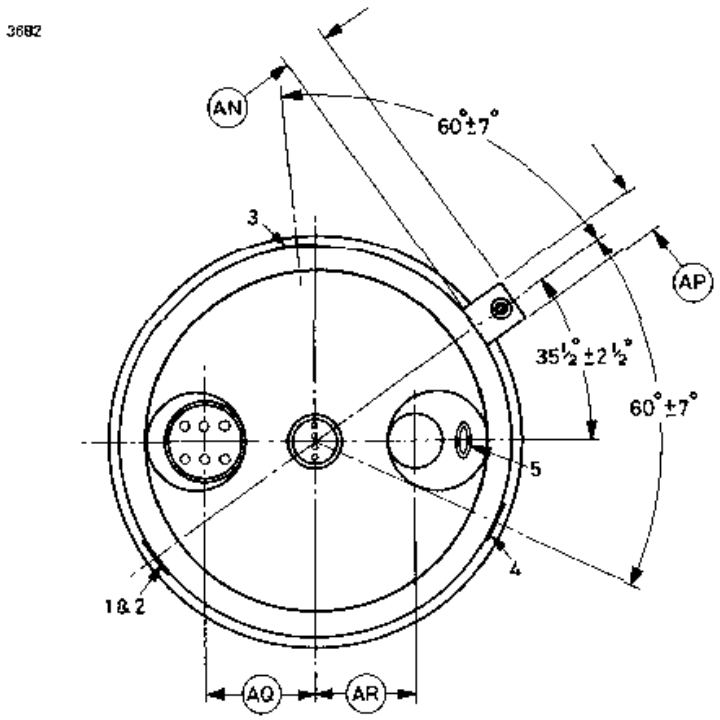


Ref	Inches	Millimetres
BA	2.000 ± 0.010	50.80 ± 0.25
BB	2.000 ± 0.010	50.80 ± 0.25
BC	1.055	26.80
BD	0.312	7.92

Millimetre dimensions have been derived from inches.

OUTLINE (View on base end of tube)

See page 11 for outline dimensions.



Lead Connections, Writing Gun

Lead	Element
Yellow	Cathode
Green	Grid 1
Brown	Heater
Brown	Heater
White	Grid 3
Grey	Grid 2

Lead Connections, Flood Gun

Lead	Element
Yellow	Cathode
Brown	Heater
Brown	Heater
Green	Grid 1

Cavity Cap Connections

Cap	Element
1	Grid 3 (flood gun)
2	Backing electrode
3	Grid 3A (flood gun)
4	Grid 4 (flood gun)
5	Grid 2 (flood gun)

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