T.P.D.

AEI

INDUSTRIAL and MICROWAVE VALVES

DATA HANDBOOK

No. 4400-50

Associated Electrical Industries Limited
ELECTRONIC APPARATUS DIVISION
Valve and Semiconductor Sales Department
Carholme Road, Lincoln. Phone Lincoln 26435

AEI British Services Types

This list shows the British Services CV types which may be obtained from AEI and certain obsolete types which may still be in use. The inclusion of a type does not necessarily imply availability.

The suitability of an AEI commercial type should be determined by a comparison of its characteristics with those of the CV type or with the requirements of the particular application. Where any doubt exists, reference should be made to the address given below.

CV	AEI Type	CV	AEI Type	CV	AEI Type	CV	AEI Type
12	BT49 *	488	BS90	2119	BM1009	2333	
13	BT9B *	489	BT75	2120	BM1010	2334	
22	BT45 *	1144	BT19	2121	BM1011	2335	
80	VF01 *	1145	BT9A *	2122	BM1012	2336	
81	VF08 *	1146	BT9A *	2123	BM1013	2337	
120A	BM1014	1147	BT5	2124	BK24	2399	BD236
120B	BM1015	1147	BT35 *	2125	BD78	2474	
120C	BM1016	1149	BT41 *	2167	BM1041	2475	
160	*	1495	BM1017	2168		2476	
189	BS4 *	1496	BM1018	2169		2477	
209	MX57 *	1497	BM1019	2170		2478	
232	*	1498	BM1020	2181	BS104	2518	BD166
233	BS5	1499	BM1021	2186	BM1031	3521	
251	*	1500	BM1022	2210	BT91	3868	BT69G *
295	BS54	1742	BK44	2215	BT77	3875	BT107
306	MX52 *	1743	BS64 *	2261	BM1038	5141	BT95
348	*	1743	BS112	2262	BM1039	5167	BM1040
372	BT79	1841	BS52	2274	BS114	5466	BT117
381	BT85 *	1858	BS62	2306	BS156	6029	
388	*	1859	BS4A	2307	BS158	6030	
402	BS68	1881		2308	BS116	6031	
460	BS48	2109	BT89	2309	BS118	6032	
461	BS92	2110	BT83	2313		6033	
462	BS84	2117	BM1007	2319	BM1006	6070	BS310
463	BS82	2118	BM1008	2320	BM1000		

* Obsolete or obsolescent.

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AEI TYPE NUMBERS WITH CV EQUIVALENTS

AEI Type	CV	AEI Type	CV	AEI Type	CV
BD78	2125	BM1039	2262	BT9A *	1145
BD166	2518	BM1040	5167	BT9A *	1146
BD236	2399	BM1041	2167	BT9B *	13
BK24	2124	BS4 *	189	BT19	1144
BK44	1742	BS4A	1859	BT35 *	1147
BM1000	2320	BS5	233	BT41 *	1149
BM1006	2319	BS48	460	BT45	22
BM1007	2117	BS52	1841	BT49 *	12
BM1008	2118	BS54	295	BT69G *	3868
BM1009	2119	BS62	1858	BT75	489
BM1010	2120	BS64 *	1743	BT77	2215
BM1011	2121	BS68	402	BT79	372
BM1012	2122	BS82	463	BT83	2110
BM1013	2123	BS84	462	BT85 *	381
BM1014	120A	BS90	488	BT89	2109
BM1015	120B	BS92	461	BT91	2210
BM1016	120C	BS104	2181	BT95	5141
BM1017	1495	BS112	1743	BT107	3875
BM1018	1496	BS114	2274	BT117	5466
BM1019	1497	BS116	2308	MX52 *	306
BM1020	1498	BS118	2309	MX57 *	209
BM1021	1499	BS156	2306	VF01 *	80
BM1022	1500	BS158	2307	VF08 *	81
BM1031	2186	BS310	6070		
BM1038	2261	BT5	1147		

* Obsolete or obsolescent.

AEI Industrial and Microwave Valves

CONTENTS

When complete, the two volumes of this handbook will cover the following range of valves. Following this issue, the remaining data sheets, which are being prepared, will be mailed to you automatically.

Associated Electrical Industries Limited
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Issue 3
May, 1964
4400-50/Con

VOLUME 2

MAGNETRONS

General Information

Pulsed, S-band

BM1000
BM1001 T
BM1003-1005
BM1006
BM1007-1013
BM1014-1016
BM1017-1022
BM1042-1046
(T=tunable)

Pulsed, X-band

BM1002
BM1023-1025
BM1026-1030
BM1031
BM1032 T
BM1033-1037 T
BM1038-1039 T
BM1040 T
BM1041 T
(T=tunable)

CW Magnetrons

BM25L
BM1047
BM6787

TR AND TB CELLS

General Information

TR, S-band

Notes

BS104	BS286
BS198	BS306
BS204	BS316
BS272	BS318
BS280	BS324
BS282	

TR, X-band

Notes

BS52	BS156
BS120	BS158
BS122	BS328
BS140	BS332
BS154	

TB, X-band

Notes

BS48	BS116
BS82	BS118
BS84	BS148
BS92	BS248
BS114	BS310

MICROWAVE SWITCHES

General Information

BS336	BS338

VOLUME 2 (continued)

SPARK GAPS

General Information

Style A
BS4A
BS5
BS54
BS62
BS68
BS72
BS80
BS90
BS112
BS190

Style B
BS142
BS290

Style E
BS136
BS180
BS208

Style F
BS192
BS212
BS234
BS344

Style G
BS172A
BS174A
BS294
BS298

Style H
BS210
BS214
BS216
BS218
BS220
BS222
BS224
BS226
BS228
BS242
BS244
BS246
BS250
BS252
BS254
BS258
BS260
BS266
BS268
BS270
BS322
BS326

Style J
BS128
BS240

Style K
BS232

Style L
BS292
BS296
BS320

MISCELLANEOUS

Nernst Filaments
NFT1-2

Ozotrons

Windonuts
S26-31

Vacuum Switch
BS378

Noise Tube
BS384

Flame Detector
27F12

Magnetrons

4400/55

AEI Magnetrons

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ADDITIONAL RECOMMENDATIONS FOR MAGNETRONS

1. Introduction

The recommendations in this section apply to magnetrons for both pulse and c.w. operation. They are additional to and should be read in conjunction with the information outlined in Section 2, 'General recommendations for all electronic valves'.

2. Ratings—General

Magnetrons have minimum and maximum ratings and operation is likely to be unsatisfactory and perhaps damaging to the valve below the minimum rating as well as above the maximum rating.

The absolute ratings are not intended to be applied simultaneously; they represent maximum and minimum allowable values of the various parameters taken individually.

In addition to the absolute ratings the manufacturer may publish typical operating conditions in which some only of the individual figures reach the absolute ratings for their particular parameters. Attempts to achieve all the other limiting parameters as well will be dangerous for the valve.

Should more than one operating condition be given, each will have been compiled for the best performance for such an application. Individual ratings may not be interchanged between one set of operating conditions and another without risk of damage or deterioration; for example, a high peak current permitted with a very short pulse may not be used in a long pulse application even at a reduced pulse recurrence frequency. Also it cannot be assumed that more consistent or satisfactory performance will necessarily be achieved by reducing the input.

If an operating condition is desired which differs from those published the manufacturer should be consulted.

3. Special characteristics

Many of the recommendations are made as a result of particular characteristics peculiar to magnetrons and for ease of reference these are briefly explained below:

a. Current/voltage characteristics. When the applied anode voltage is increased from zero, oscillation does not commence until a certain value is reached, and it ceases when the voltage falls again below this value.

In the oscillating condition the current rises rapidly with increasing voltage. Thus the dynamic impedance, that is, the rate of change of applied voltage with anode current, is quite small; it may be very much smaller than the ratio of the actual values of voltage and current.

At voltages below that at which oscillation commences, for both rising and falling values, the conduction current is comparatively small, but finite. This 'waste' current (non-productive of oscillation) should be kept as low as possible as it represents wasted energy dissipated within the magnetron. Waste current will be kept to a minimum by careful attention to pulse shape (as recommended in Clause 5 *c.*). At high rates of rise or fall of voltage it may be masked by the inter-electrode capacitive current.

continued

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b. Frequency stability. Magnetrons are designed to oscillate in one particular mode, corresponding to the desired frequency (which may, of course, be varied at will in a tunable design). Under certain conditions oscillation may take place in other modes, at unwanted frequencies: such operation is known as 'moding'.

For each mode of oscillation the output may be spread over a band of frequencies giving a frequency spectrum. The bandwidth is in all cases a function of the form of the modulation: for example in the special case of pulse modulation the minimum possible bandwidth is inversely proportional to the pulse width. Even in the absence of modulation, however, there is a frequency spread which, while much smaller than that associated with modulation, may sometimes be of significant importance. In all cases the bandwidth may be seriously increased by incorrect operating conditions. The mean frequency is affected by the operating conditions and may be modified by 'frequency pushing' and by 'frequency pulling'. The mean frequency can also be influenced by the temperature of the anode block, which will be affected by variations in both input and load conditions.

'Frequency pushing' indicates the dependence of frequency on the input conditions and particularly on the value of the anode current. The 'frequency pushing figure', given in megacycles per ampere, is not a constant, but refers to specific conditions of operation, for example, of anode current and magnetic field.

'Frequency pulling' denotes the changes in frequency associated with changes in output conditions, particularly the presence and position of reflecting discontinuities. The 'frequency pulling figure' is the maximum change of oscillation frequency caused by variation through all phases of reflection from a discontinuity producing a voltage standing wave ratio of 1·5 : 1 in an otherwise matched output feeder.

Two special cases of 'frequency pulling' are associated with long output feeders. In c.w. valves, variation of the phase of a distant discontinuity causes frequency jumps, while in pulsed valves successive pulses (or groups of pulses) have different frequencies, resulting in a frequency spectrum with two main peaks. This is known as 'frequency splitting'.

4. Heater operation

a. In the magnetron the heater is subject to appreciable stress due to interaction between the heater current and the magnetic field. When the magnetron is operated with a d.c. heater supply, correct polarity must be observed or the heater may be displaced and a short circuit may result.

b. Some magnetrons have cathode heaters operating at high currents and temperatures; attention is called to Clause 204 *k*, 'Switching of tungsten filament valves'.

c. The published ratings for a magnetron usually contain information relating cathode heating power, voltage or current to the average anode input power. The purpose is to maintain the cathode temperature at the desired level. The heater voltage should be at the nominal value when first applied and should be reduced subsequently as specified by the manufacturer. In the case of magnetrons having cathodes of small thermal capacity it may be necessary to reduce the heater power immediately the anode voltage is applied.

Either too high or too low a cathode temperature may lead to unsatisfactory operation, such as moding and arcing, involving short life and loss of efficiency. During operation, some fraction of the input power is dissipated by back bombard-

continued

ment of the cathode by electrons. To prevent the cathode temperature from rising too high under this 'back heating', it is necessary to reduce the cathode heating power. In many cases this effect is a major factor in rating. For pulsed magnetrons, for example, it may determine the maximum duration of pulse which can be allowed at a given peak power level.

5. H.T. supply

a. Smoothing. The amount of smoothing required in the h.t. supply depends on the amount of frequency modulation that can be tolerated; the relation between these two factors is a function of the frequency pushing and of the dynamic impedance of the valve, on which the manufacturer's data should be consulted.

The dynamic impedance may be quite low, and small variations in h.t. voltage can cause appreciable changes in anode current, with consequent variations in both power and frequency.

b. C.W. magnetrons. A series resistor or current stabilizer should be connected in the supply line between the final smoothing capacitor and the magnetron to limit the magnitude of arc currents should these develop. It is desirable also to fit an overload trip to interrupt excessive arcs.

In a c.w. valve an arc once started will continue with destructive violence unless measures are taken to extinguish it. Conditions are different from those in a pulsed valve, in which, if an arc occurs, there is a rest period during which deionisation can take place before h.t. is again applied at the next pulse.

Under certain operational conditions a c.w. magnetron can develop a negative resistance characteristic; this is another reason for inserting a current limiter.

c. Pulsed magnetrons. In addition to the requirements outlined above for h.t. supply, it is necessary to control four distinct aspects of the pulse shape; i.e. rate of rise, spike, flat and rate of fall.

The performance of a magnetron in a system is often a sensitive function of the shape of the pulse that it receives. It is important that any observations of the shape of the pulse, either of voltage or of current, supplied by the modulator should be made with a magnetron load and not with a dummy load. One reason for this is that during the most critical part of the pulse, that immediately preceding and during the initiation of oscillation, the magnetron acts as a highly non-linear element whose characteristics are changing rapidly with time.

(i) *Rate of rise*. Both maximum and minimum rates of rise of voltage (and sometimes of current) may be specified. The most critical value is that obtaining just before and during the initiation of oscillation.

Too high or too low a rate of rise may accentuate the tendency to moding.

Too high a rate of rise may cause operation in the wrong mode or even failure to oscillate; either condition may lead to arcing due to overheating or to excessive voltages. Further, a high standing wave ratio in some phases on the output side may accentuate the tendency to incorrect operation due to a high rate

continued

of rise: (see Clause 10, 'Loading'). Operation at a low rate of rise may cause oscillation for an appreciable period at less than full current, and the frequency pushing effect will cause a broad and unsymmetrical frequency spectrum to be produced.

With many modulators the voltage rise is relatively linear and measurement of the average value between, for example, the 20 per cent and 80 per cent points will give a good measure of the rate at the onset of oscillation, but this is not always so. For accuracy, especially when the rise is distinctly non-linear, it is advisable to measure the rate of rise by means of a differentiating circuit.

(ii) *Spike*. It is important that the pulse should not have a high spike on the leading edge. Measures taken to reduce the spike must not also reduce the rate of rise below the specified minimum.

Such a spike may cause the value to start in an undesired mode. Even though this operation may not be sustained, the transient condition may lead to destructive arcing.

(iii) *Flat*. The top of the voltage pulse should be free from ripple or droop.

The magnetron has a low dynamic impedance, resulting in large current variations from a small voltage ripple or droop. The frequency pushing effect then produces frequency modulation during the pulse, leading to a broad and unsymmetrical spectrum or to mode instability. This effect may be increased by the loading conditions on the magnetron.

(iv) *Rate of fall*. The fall of voltage must be rapid at least to the point where oscillation ceases, to avoid appreciable periods of operation below full current with the attendant frequency pushing; this point is normally reached when the voltage has fallen to about 80 per cent of the peak value.

Beyond this point a lower rate of fall is generally permissible, but a significant amount of noise will be generated, and this may be detrimental, for example, to the performance of radar systems with a very short minimum range; some magnetrons may emit a short burst of oscillation in the wrong mode if the fall period is prolonged.

With magnetrons which exhibit a tendency to pass 'waste' current, an abnormally slow rate of fall of voltage after oscillation may lead to an appreciable increase in the mean current passed by the magnetron and possibly to overloading, overheating and arcing.

A caution is given that, with many pulse-forming-networks, the rate of fall is considerably lower than the rate of rise.

6. Magnet design

When the magnet is not integral with the magnetron the valve manufacturer should be consulted as to an approved design of magnet.

In cases where the pole pieces are integral with the valve the magnet must form a smooth continuation of these pole pieces. It is therefore necessary that advice should be sought on the shape and dimensions of the area of the pole pieces. This information will also be necessary for designing dummy pole pieces used in estimating the field strength.

continued

This information is necessary to ensure correct concentration of the magnetic field within the valve and in the case of a permanent magnet to avoid partial demagnetization through leakage from mechanical mismatch.

7. Stray fields

a. Magnets. The stray magnetic field may be large enough to affect operation of neighbouring components. (See Clause 205 *k.*) If a magnetic screen is used to prevent this, correct spacing depends on the type of magnetron, and the manufacturer should be consulted.

b. R. F. shielding. In many valves some r.f. energy is radiated from the cathode stem or from the pumping stem or other apertures. Although the amount may be small compared with the energy delivered by the valve, it may be sufficient to interfere with or damage other components of the system, and it is usually desirable to provide sufficient shielding. Radiation may also occur at air-spaced couplings if the spacing is incorrect. The manufacturer should be asked for advice on spacing dimensions and limits. (See also Clause 12, 'Dangerous radiations'.)

8. Cathode connections

a. Cooling. Attention is drawn to Clause 206 *d.*, and to Clause 704*c.*

b. Pulse to common cathode/heater terminal. Steps should be taken to prevent excessively high transient voltages between the free end(s) of the heater and the cathode by connecting their terminals together through a suitable capacitor or other device. The connections must be made as close to the valve terminals as the physical layout permits. The negative high voltage excitation should be applied to the cathode terminal. If this is not done the anode current and transients will pass through the heater and may contribute to burnout.

When a pulse transformer of bifilar construction is used the earth connection to the secondaries should be made to that winding which is connected to the cathode of the magnetron.

9. Output connections

It is important that the type of output connection should be that specified by the manufacturer.

Connections to the output should be designed to be sufficiently tight to avoid arcing and other contact faults. It is also important to avoid undue stressing of the output section because this would either deform the metal or break the glass or ceramic vacuum seals. It is therefore necessary that any mechanical pressure be applied uniformly. The insertion of flexible waveguide sections may sometimes be desirable to avoid the danger of undue stress. In designing the connections consideration should be given to any requirements arising from pressurization of the waveguide.

The use of flat plate coupling instead of choke coupling or *vice versa* may upset the window matching and possibly cause failure of the window.

continued

10. Loading

Incorrect loading, if it should produce a standing wave in an appropriate phase, may reduce the range of stable operation and can cause unsatisfactory operation such as moding or arcing. Manufacturers' published information will indicate any limitations on standing wave ratio.

11. Installation

a. General. Before installation the valve should be visually examined, particularly to see that the glass or ceramic parts of the envelope are clean and free from cracks. If the magnet is not integral the valve should be inserted with the cathode connection on the side towards the N-seeking pole unless otherwise specified. All electrical connections should be tight.

Either dirt on the insulating members or loose connections may give rise to arcing.

Steel wool should not be used for cleaning at any time; the magnetic field may cause particles to be retained, providing points for high voltage breakdown.

It is usually desirable to start the magnetron under reduced input. If the valve has not been operated for a time, a slight amount of gas may be present, but this will clean up during operation provided excessive arcing does not occur. Most magnetrons will stand some arcing without excessive damage. Arcing does, however, tend to drive off gas and may, therefore, counteract the processing of clean-up; it also has other undesirable effects and should be kept to a minimum.

In some cases, particularly when valves have been out of operation for a long time, it may be necessary to age them for long periods. The manufacturer should be asked for a suitable schedule.

The symptoms of arcing vary according to the system in which the valve is being used. When it occurs there may be fluctuations on the magnetron mean-current meter; certain lines on the frequency spectrum as displayed by a spectrum analyser may be missing; or the voltage and current pulses viewed on an oscilloscope may show occasional traces of amplitude higher or lower than normal. It is also possible that flashes may be seen through the glass seals. (See also Clause 12, 'Dangerous radiations'.)

b. Valve operating with permanent magnets. When valves are being fitted into fixed permanent magnets they should be handled carefully to avoid damage due to mechanical shock, as the valves may be magnetic.

Iron, nickel or other foreign magnetic objects should be kept out of close contact with magnets (whether integral or otherwise). Such contact may produce demagnetization by modification of the magnetic field; in some cases there may also be some demagnetization by mechanical shock when the magnetic materials make contact. For this reason, only non-magnetic tools and materials should be used for any purpose during installation of the valve; for example, for tightening connections or cleaning connectors.

In no circumstances should the magnets be removed from an integral magnet valve. In general, such valves contain internal pole pieces which form part of the magnetic circuit. Removal of the magnet(s) will therefore modify this circuit and increase its reluctance. The magnets will be partially demagnetized by removal.

continued

12. Dangerous radiations

a. R.F. radiation. The r.f. power which may be emitted, not only through the output coupling but also through the cathode stem and other apertures, may be sufficiently intense to cause danger to the human body, particularly to the eyes. Such radiation may be increased if the magnetron is functioning incorrectly. In such cases, looking into the magnetron for any reason, for example for observation of cathode temperature, or to watch for arcing, may seriously endanger the eyesight. If such observation is necessary, adequate r.f. screening, such as copper gauze or mesh small compared with the wavelength, must be provided. When possible, the observations may advantageously be made through a small hole or an attenuating tube set in the wall of the output waveguide, e.g. at a bend.

In general, the shorter the wavelength the greater the absorption by body tissues, and hence, for comparable power radiated, the greater the danger. In certain conditions of operation there may be spurious radiations at wavelengths shorter than that for the proper mode of oscillation.

b. X-rays. High voltage magnetrons emit a significant intensity of x-rays, and protection for the operators may be necessary. The manufacturer should be consulted regarding the intensity to be expected. When observations are being made by looking through an aperture, it is important to protect the eye, e.g. by interposing a piece of lead glass, if x-rays are likely to be present.

There is evidence of the emission of an appreciable intensity of x-rays corresponding to a voltage much higher than that of the anode.

NOTE. The recommendation of the International Commission on Radiological Protection is that any electronic tube operating at potentials above 5000V shall be considered a possible source of x-rays.

13. Storage and transit

Magnetrons not installed in the equipment should be stored in their original packing or in suitable racks.

If integral-magnet valves are stored at a closer distance than that set by the size of the original packing, the interaction between the magnets may cause some permanent demagnetization.

Good storage conditions should be provided to prevent damage or deterioration such as corrosion of conducting parts or impairment of electrical insulation.

Magnetrons in which parts of the envelope are liable to rust in a damp atmosphere should be stored in protective packing containing desiccants and the valves should not be removed until they are required for use. The atomic hydrogen liberated when steel rusts may penetrate through the steel into the valve, which thus becomes gassy.

Magnetrons should always be transported in the packing designed for the purpose.

S Band Pulsed Magnetrons

AEI S Band Magnetron BM1001

The BM 1001 is a non-packaged, tunable, 2 megawatt, S-Band, pulsed Magnetron which has an indirectly heated cathode and a water cooled anode. It has been designed for linear accelerators, as a substitute for the non-tunable VX 4061 (BM 1000), to give more efficient operation, longer life and easier interchangeability.

DESIGN RATINGS

Minimum peak power output	2·0	MW
Tuning range	2994–3002	Mc/s
Peak anode voltage	40–46	kV
Peak anode current	75–110	A
Heater voltage	8·5	V
Heater current	8–10	A
Magnetic field	1550±25	G
Pulse length	2·0	μs
Pulse repetition frequency	750	p/s

MECHANICAL DATA

Water cooling (minimum)	1·2	L/s
Mounting position	Any	
Weight	18	lb
Weight packed	64	lb
Output waveguide	See Note 1	

MAXIMUM RATINGS

Maximum mean power input	5·0	kW
Maximum pulse length	5·0	μs
Maximum duty cycle	0·0015	
Maximum v.s.w.r.	1·5:1	
Maximum rate of rise of voltage	100	kV/μs
Maximum outlet water temperature	50	°C

TYPICAL OPERATING CONDITIONS

Field strength	1550±25	1375±25	G
Pulse duration	2·0	5·0	μs
Pulse repetition frequency	500	300	p/s
Peak anode voltage	43	35	kV
Peak anode current	90	70	A
Peak power output	2·0	1·25	MW

NOTES

1. The power is fed into a No. 10 Waveguide by means of a transition section which must have a v.s.w.r. better than 1·1:1 and be free of resonances over the range 9·7 – 10·3 cm. Such a transition is shown on page 7.
2. The tuning range specified is covered by approximately four turns of the tuner.
3. For the most favourable life conditions the valve should always be operated at the lowest possible standing wave ratio.
4. The waveguide output dome must be coupled at atmospheric pressure.
5. The heater voltage must be applied for not less than three minutes before the application of H.T. voltage and during operation must be adjusted according to the curve on page 8.

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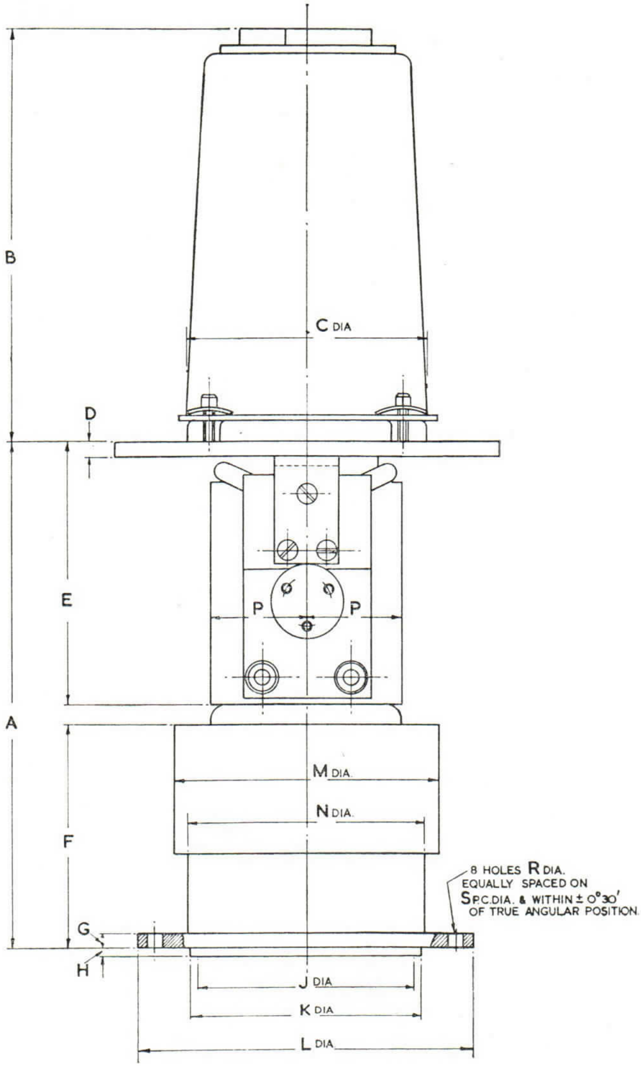
Dimension	Inches	Millimetres
A	7·780 ± 0·025	197·62 ± 0·635
B	6·375 ± 0·062	162 ± 1·6
C	4 max	101·6 max
D	0·250 ± 0·005	6·350 ± 0·13
E	4·035 ± 0·030	102·5 ± 0·77
F	3·4375 ± 0·032	87·31 ± 0·80
G	$\frac{7}{32}$	5·6
H	0·125 ± 0·005	3·175 ± 0·13
J	3·375 ± 0·005	85·725 ± 0·13
K	3·625 ± 0·006	92·07 ± 0·152
L	5·250 ± 0·062	133·35 ± 1·6
M	4·125 ± 0·016	104·78 ± 0·41
N	3·6875 ± 0·062	93·66 ± 1·6
P	1·485 max	37·72 max
R	0·250 + 0·0005	6·350 + 0·012
S	4·750 ± 0·005	120·65 ± 0·13

All dimensions in inches.
Millimetre dimensions derived.

S Band Magnetron



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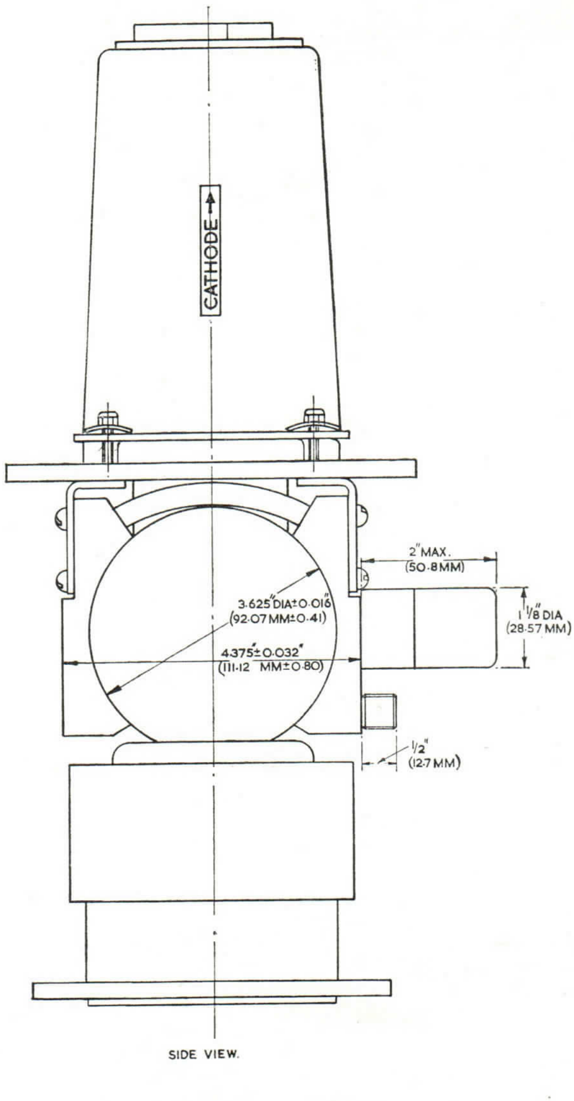
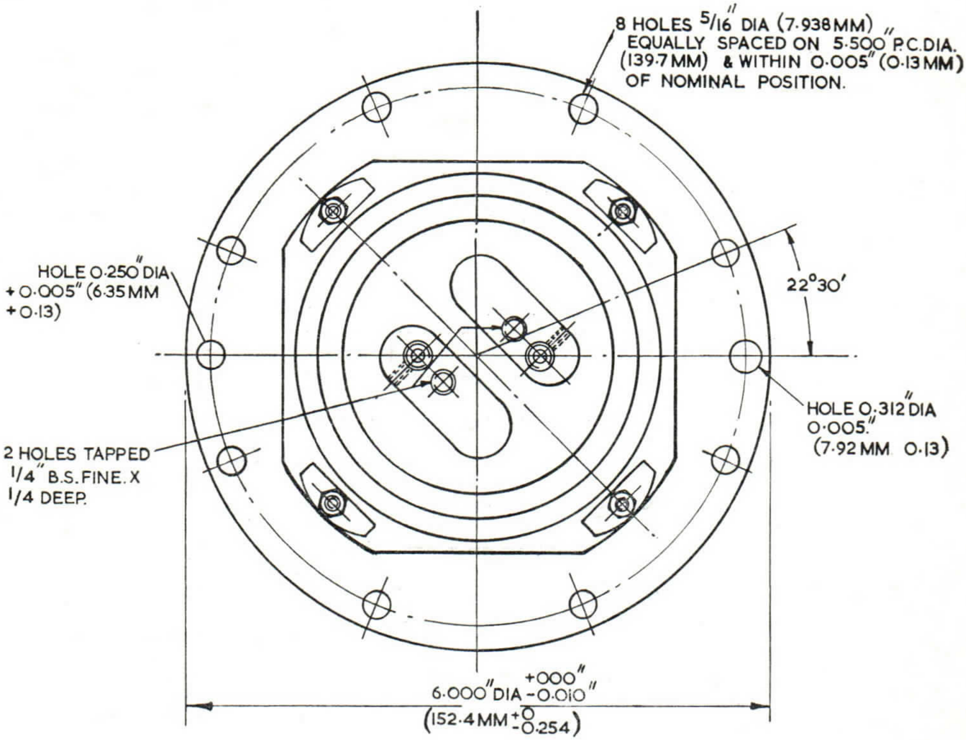

CATHODE
2" MAX.
(50·8MM)
3·625" DIA ± 0·016"
(92·07MM ± 0·41)
1 1/8" DIA
(28·57 MM)
4·375" ± 0·032"
(111·12 MM ± 0·80)
1/2"
(12·7MM)

SIDE VIEW.

S Band Magnetron BM1001



PLAN.

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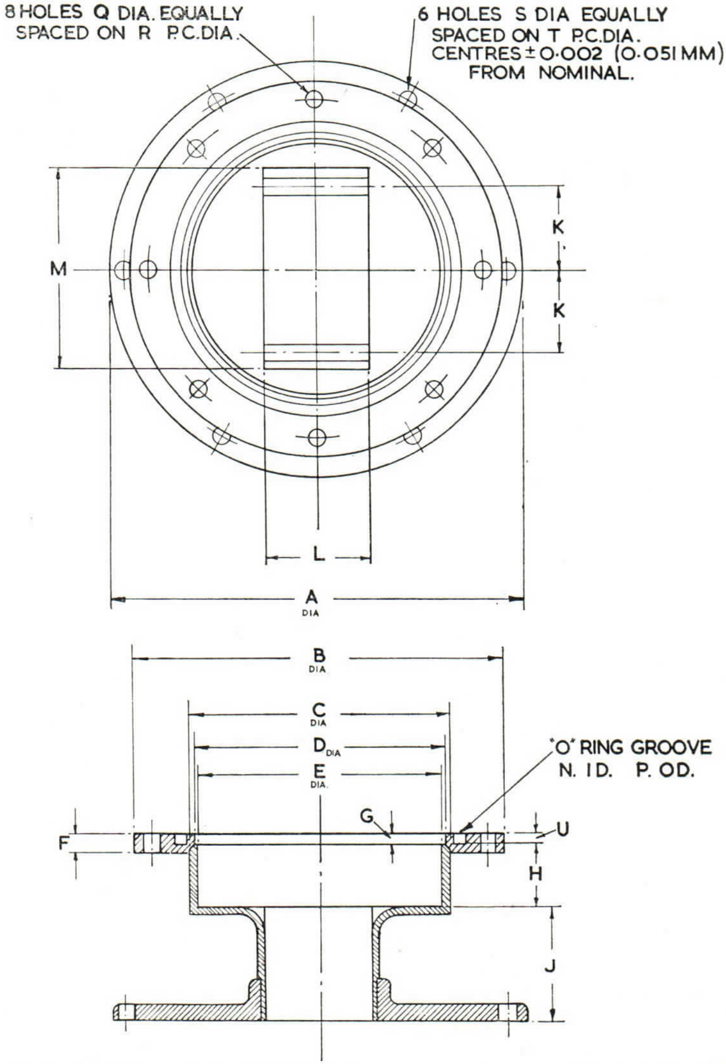
S Band Magnetron

AEI

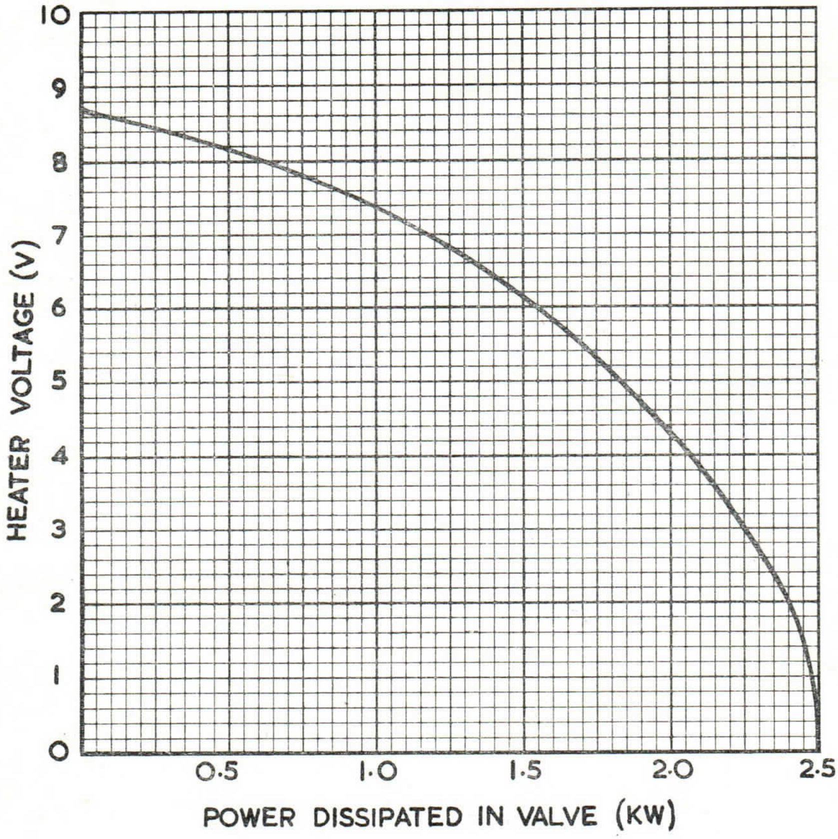
Dimension	Inches	Millimetres
A	$5\frac{7}{8}$ max	149 max
B	$5\frac{1}{4}$ max	133 max
C	3·687 ± 0·015	93·66 ± 0·40
D	3·643 ± 0·002	92·53 ± 0·05
E	3·375 ± 0·005	85·72 ± 0·13
F	$\frac{1}{4}$	6·3
G	0·120 – 0·003	3·050 – 0·07
H	0·875 ± 0·005	22·225 ± 0·13
J	1·648 ± 0·005	41·859 ± 0·13
K	1·176 ± 0·002	29·870 ± 0·05
L	1·340 ± 0·004	24·036 ± 0·10
M	2·840 ± 0·004	72·136 ± 0·10
N	3·760	95·504
P	4·170	105·92
Q	$\frac{1}{4}$	6·3
R	4·750 ± 0·005	120·65 ± 0·13
S	0·257 + 0·005	6·52 + 0·13
T	$5\frac{3}{8}$	13
U	0·086	2·18

All dimensions in inches.
Millimetre dimensions derived.

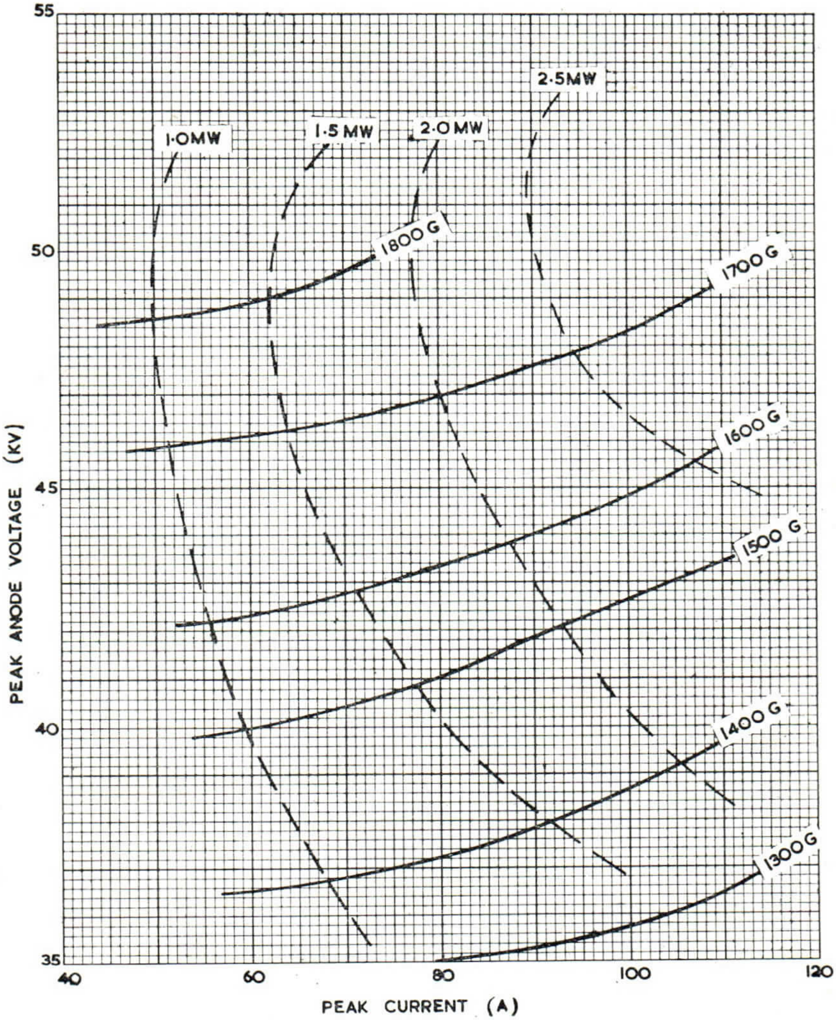
TRANSITION SECTION



HEATER VOLTAGE ADJUSTMENT



PERFORMANCE CHART



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X Band Pulsed Magnetrons

AEI X Band Magnetrons

BM1023
BM1024
BM1025

This series of fixed frequency magnetrons have indirectly heated cathodes and forced air cooled anodes (see note 1).

DESIGN RATINGS

Minimum peak power output		100	kW
Frequency ranges	BM1023	9390–9430	Mc/s
	BM1024	9350–9395	Mc/s
	BM1025	9310–9350	Mc/s
Peak anode voltage		17–21	kV
Peak anode current		21	A
Heater voltage (see note 2)		6·3	V
Heater current		0·8	A

MAXIMUM RATINGS

Maximum mean input power	100	W
Maximum pulse length	0·25	μs
Maximum duty cycle	0·0002	
Maximum v.s.w.r.	1·5:1	
Maximum rate of rise of voltage	250	kV/μs
Maximum frequency pulling figure	15	Mc/s

TYPICAL OPERATING CONDITIONS

Field strength	6500±100	6000±100	G
Pulse length	0·1	0·1	μs
Pulse repetition frequency	2000	2000	p/s
Peak anode voltage	19	16	kV
Peak anode current	21	15	A
Peak power output	140	80	kW

MECHANICAL DATA

Mounting position	Any
Weight	1 lb 7 oz (0·65 kg)
Weight packed	4 lb (1·81 kg)
Output waveguide	No. 15

NOTES

1. Minimum air flow to be such that anode temperature does not rise above 140°C.
2. The heater voltage must be applied for not less than three minutes before the application of H.T. voltage and during operation must be adjusted according to the formula:—

$$V_f = \sqrt{\frac{(1 - \text{Power (w) dissipated in anode})}{120}} \text{ volts}$$

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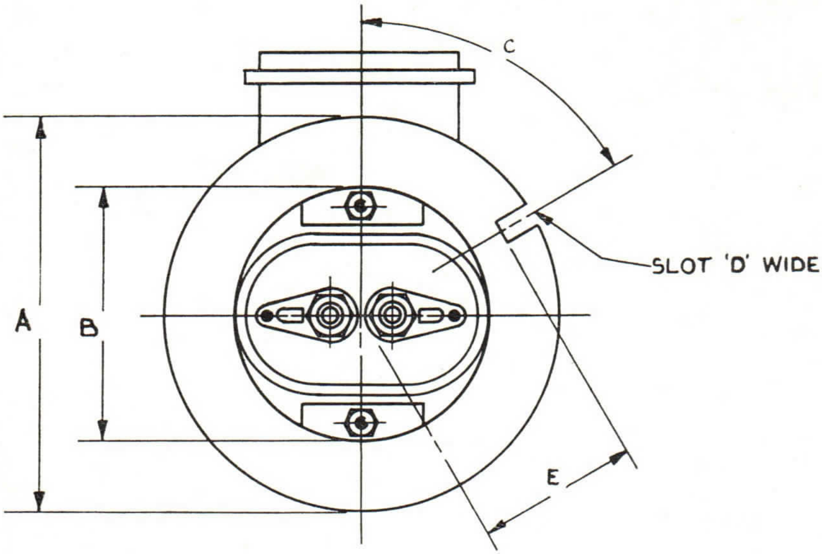
X Band Magnetrons

AEI

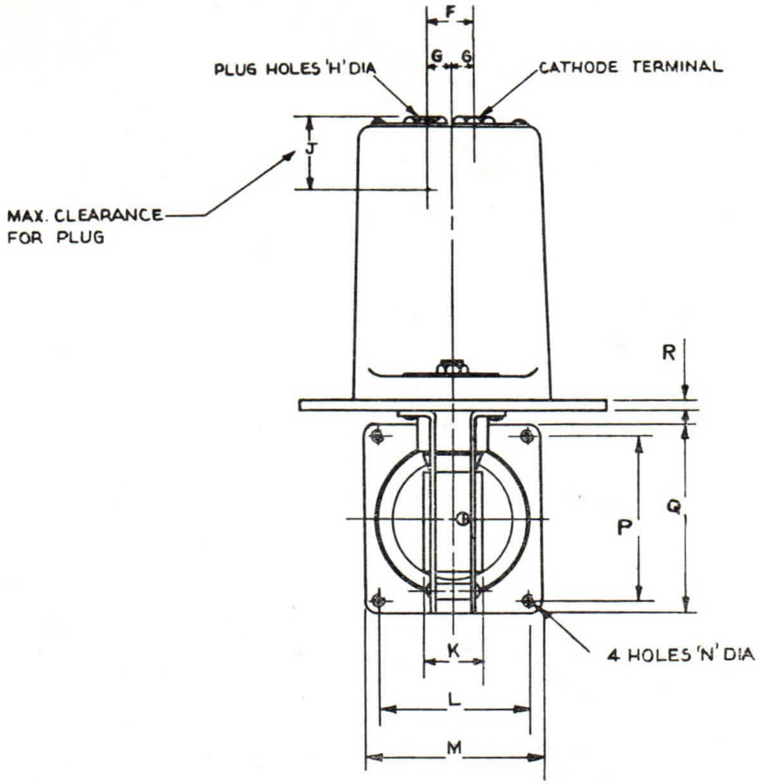


DIMENSIONS

	Inches	Millimetres
A	3·241 — 0·002 dia	82·32 — 0·05 dia
B	$2\frac{1}{8}$ dia	53·97 dia
C	60° ± 0°30′	
D	0·187 ± 0·002	4·75 ± 0·05
E	$1\frac{5}{16}$	33·34

X Band Magnetrons

BM1023
BM1024
BM1025



DIMENSIONS

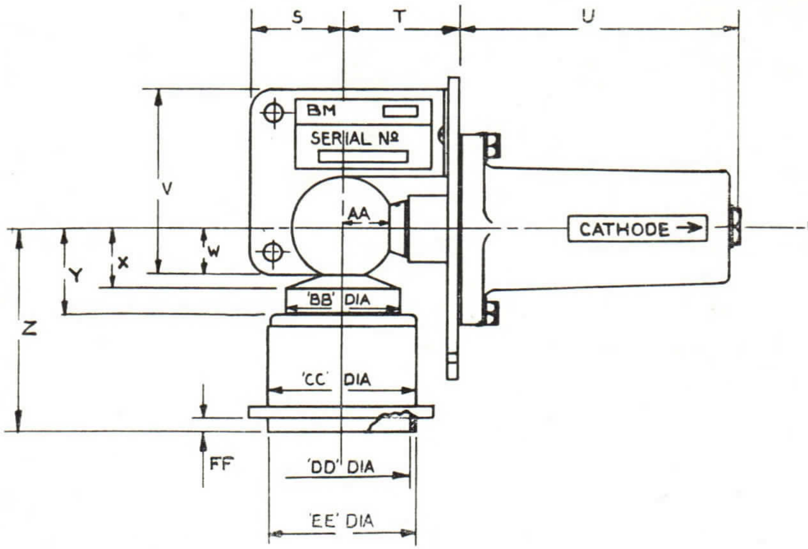
	Inches	*Millimetres*		*Inches*	*Millimetres*
F	0·500 ± 0·010	12·7 ± 0·25	**M**	$1\frac{7}{8}$	47·62
G	See Note (a)	See Note (a)	**N**	Tapped 4BA	
H	0·169 ± 0·002	4·29 ± 0·05	**P**	1·720 ± 0·002	43·69 ± 0·05
J	$\frac{3}{4}$	19·05	**Q**	2	50·8
K	0·620	15·75	**R**	0·125 ± 0·003	3·17 ± 0·08
L	1·540 ± 0·002	39·12 ± 0·05			

Note

(a) Distance of plug holes to be equal within ± 0·010 in (0·25 mm)

X Band Magnetrons

AEI

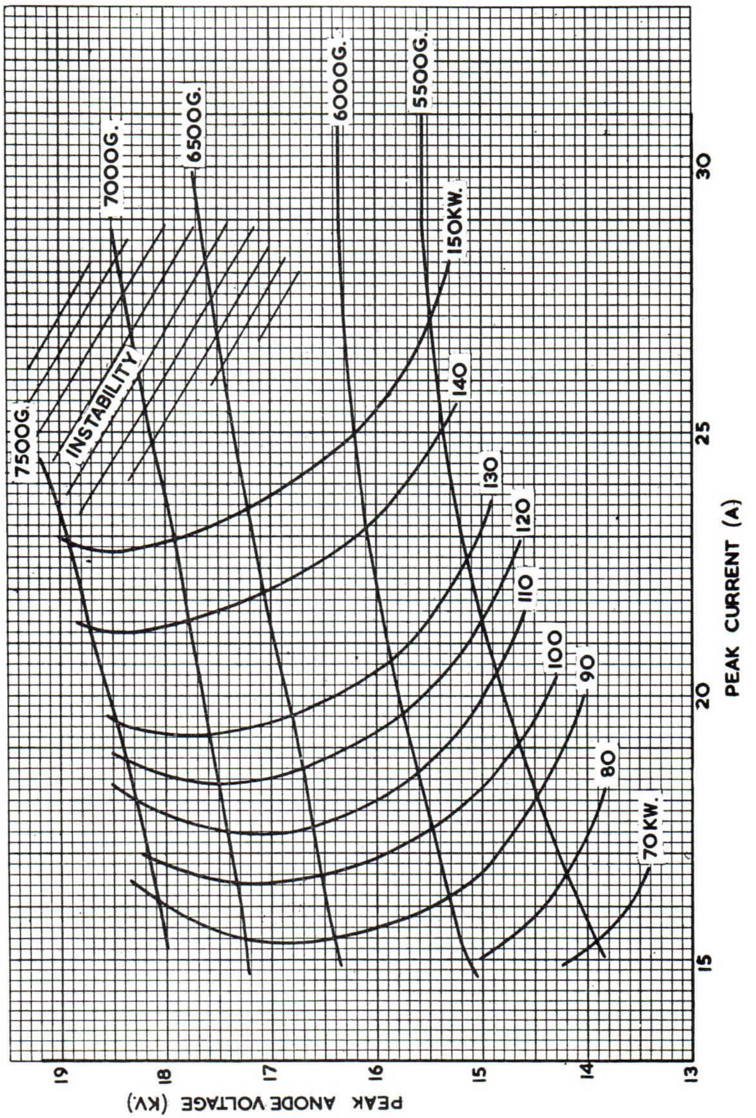


DIMENSIONS

	Inches	Millimetres
S	1	25·4
T	1·250 − 0·031	31·75 − 0·79
U	3·000 ± 0·062	76·2 ± 1·57
V	2	50·8
W	½	12·7
X	0·620 ± 0·020	15·75 ± 0·51
Y	0·871	22·12
Z	2·156 ± 0·015	54·76 ± 0·38
AA	½	12·7
BB	1·024 dia	26·01 dia
CC	1¾	44·45
DD	1·504 − 0·003	38·2 − 0·08
EE	1·625 − 0·003	41·27 − 0·08
FF	0·156 ± 0·002	3·96 ± 0·05

AEI X Band Magnetrons

BM1023
BM1024
BM1025



PERFORMANCE CHART—0·1 μs pulse length, 2000 p/s.

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AEI X Band Magnetron BM1031

This is a fixed frequency magnetron which has an indirectly heated cathode and a forced air cooled anode (see note 1).

DESIGN RATINGS

Minimum peak power output	27	kW
Frequency range	9420–9500	Mc/s
Peak anode voltage	11–14	kV
Peak anode current	10	A
Heater voltage (see note 2)	6·3	V
Heater current	0·8	A
Magnetic field	4850	G

MAXIMUM RATINGS

Maximum mean input power	110	W
Maximum pulse length	1	µs
Maximum duty cycle	0·001	
Maximum v.s.w.r.	1·5:1	
Maximum rate of rise of voltage	250	kV/µs
Maximum frequency pulling figure	15	Mc/s

TYPICAL OPERATING CONDITIONS

Field strength	4850 ± 50	4850 ± 50	G
Pulse length	1	0·25	µs
Pulse repetition frequency	1000	1500	p/s
Peak anode voltage	12	12	kV
Peak anode current	8	10	A
Peak power output	30	40	kW

MECHANICAL DATA

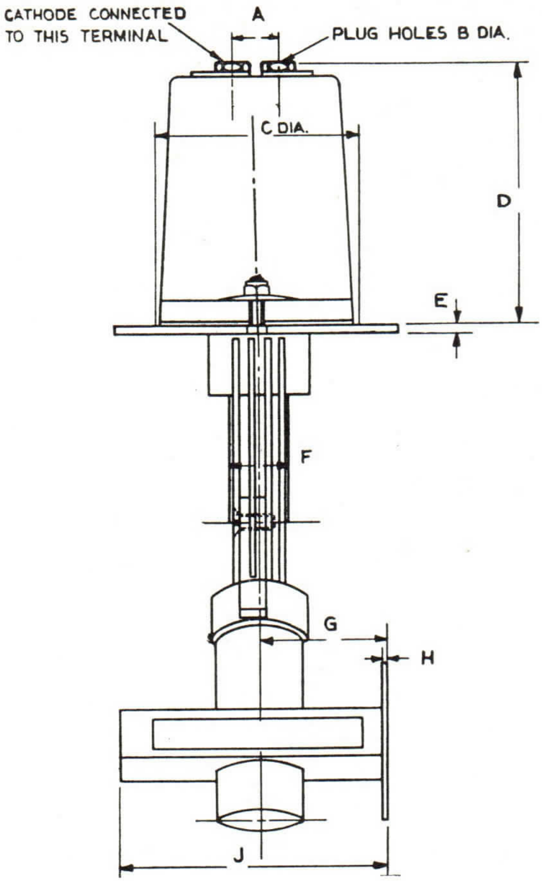
Mounting position	Any
Weight	1 lb 9 oz (0·71 kg)
Weight packed	5 lb (2·27 kg)
Output waveguide	No. 15

NOTES

1. Minimum air flow to be such that the anode temperature does not rise above 140°C.
2. The heater voltage must be applied for not less than three minutes before the application of H.T. voltage and during operation must be adjusted according to the following formula:—

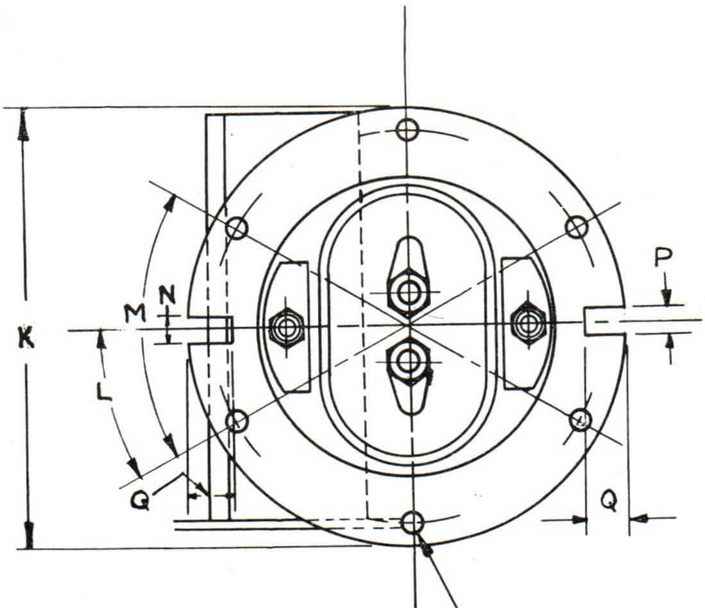
$$V_f = \sqrt{\frac{(1 - \text{Power (w) dissipated in anode})}{120}} \text{ volts}$$

X Band Magnetron



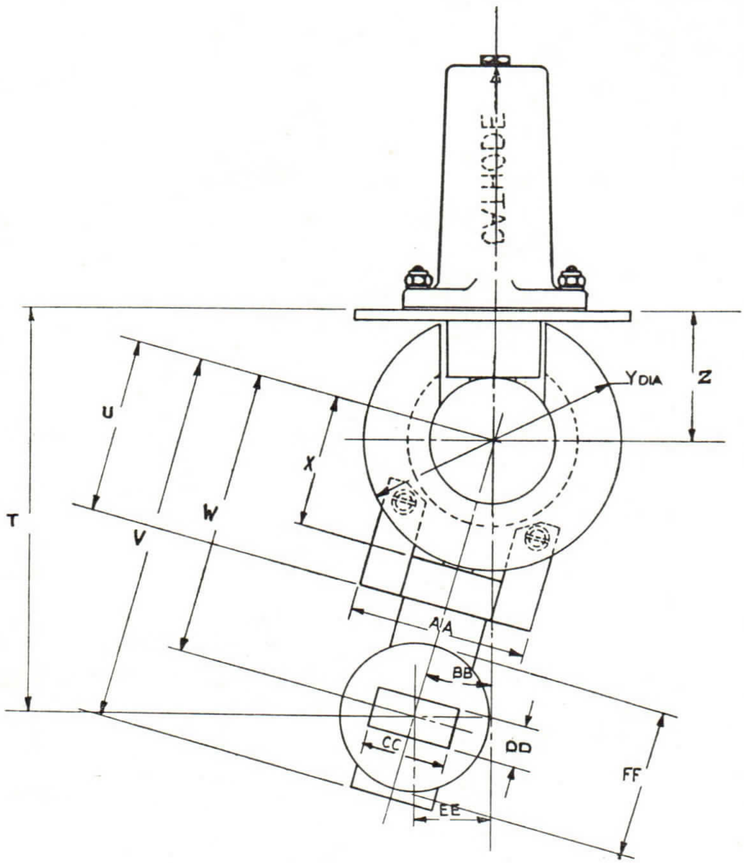
DIMENSIONS

	Inches	*Millimetres*		*Inches*	*Millimetres*
A	0·500 ± 0·010	12·7 ± 0·25	**F**	0·620 max	15·75 max
B	0·169 ± 0·002	4·29 ± 0·05	**G**	1·387 ± 0·020	35·28 ± 0·51
C	$2\frac{1}{4}$	57·15	**H**	0·064	1·63
D	3 ± $\frac{1}{16}$	76·2 ± 1·59	**J**	$3\frac{1}{16}$	77·79
E	0·125 ± 0·005	3·17 ± 0·13			



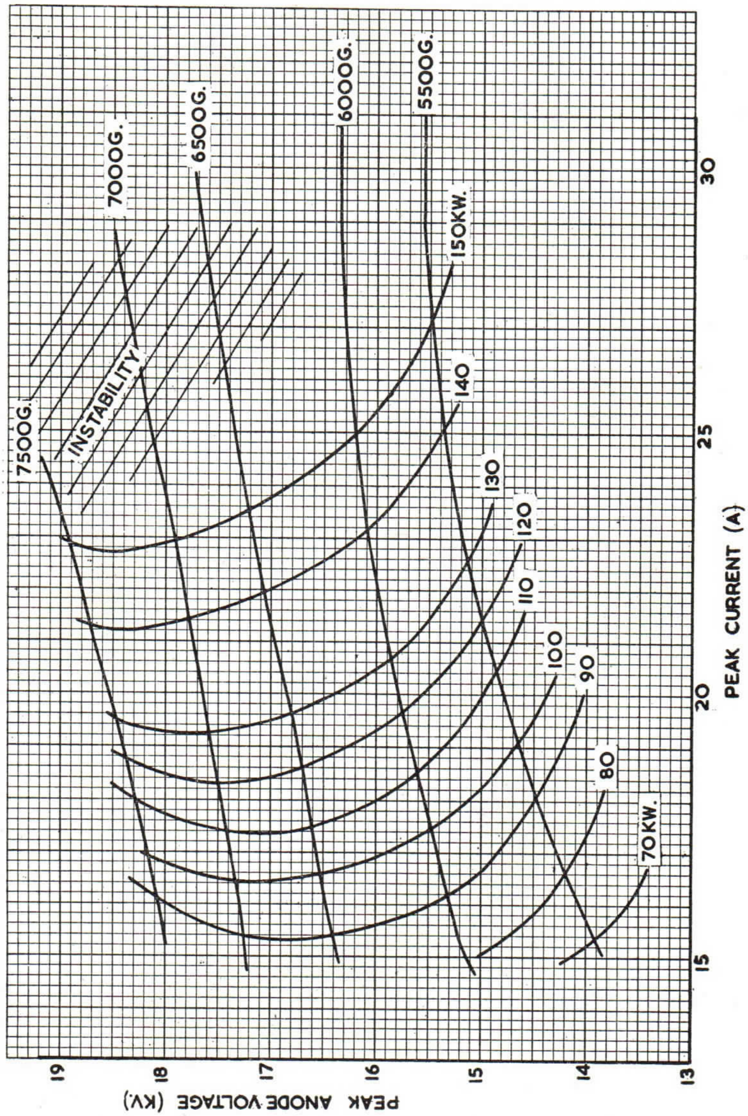
DIMENSIONS

	Inches	*Millimetres*
K	3·241 — 0·002	82·32 — 0·05
L	30° ± 0°15′	
M	60° ± 0°15′	
N	0·187 ± 0·002	4·75 ± 0·05
P	0·187 ± 0·002	4·75 ± 0·05
Q	$\frac{5}{16}$	7·94
R	0·201	5·11
S	2·875 ± 0·010	73·02 ± 0·25



DIMENSIONS

	Inches	*Millimetres*		*Inches*	*Millimetres*
T	4·800 ± 0·020	121·92 ± 0·51	**AA**	$2\frac{1}{8}$	53·97
U	$2\frac{1}{16}$	52·39	**BB**	15°	
V	$4\frac{7}{16}$	112·71	**CC**	1	25·4
W	3·355 ± 0·020	85·22 ± 0·51	**DD**	$\frac{1}{2}$	12·7
X	1·570 ± 0·020	39·88 ± 0·51	**EE**	0·870 ± 0·020	22·1 ± 0·51
Y	3·000 − 0·012	76·2 ± 0·30	**FF**	$1\frac{3}{4}$ dia	44·45 dia
Z	1·562 ± 0·020	39·67 ± 0·51			



PERFORMANCE CHART—0·1 μs pulse length, 2000 p/s.

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Issue 1
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AEI X Band Magnetron BM1040

This is a tunable magnetron which has an indirectly heated cathode and a forced air cooled anode (see note 1).

DESIGN RATINGS

Minimum peak power output	60	kW
Tuning range (see note 2)	9040—9120	Mc/s
Peak anode voltage	13—15	kV
Peak anode current	11	A
Heater voltage (see note 3)	6·3	V
Heater current	0·8	A
Magnetic field	6000	G

MAXIMUM RATINGS

Maximum mean input power	120	W
Maximum pulse length	1	µs
Maximum duty cycle	0·001	
Maximum v.s.w.r.	1·5:1	
Maximum rate of rise of voltage	250	kV/µs
Maximum frequency pulling figure	17	Mc/s

TYPICAL OPERATING CONDITIONS

Field strength	6000 ± 50	5500 ± 50	G
Pulse length	0·5	0·25	µs
Pulse repetition frequency	1440	4000	p/s
Peak anode voltage	15	14	kV
Peak anode current	11	11	A
Peak power output	65	50	kW

MECHANICAL DATA

Mounting position	Any
Weight	1 lb 7 oz (0·65 kg)
Weight packed	4 lb (1·81 kg)
Output waveguide	No. 16

NOTES

1. Minimum air flow to be such that the anode temperature does not rise above 140°C.
2. The tuning range specified is covered by approximately $1\frac{3}{4}$ turns of the tuner.
3. The heater voltage must be applied for not less than three minutes before the application of H.T. voltage and during operation must be adjusted according to the formula:—

$$V_f = \sqrt{\frac{(1 - \text{Power (w) dissipated in anode})}{120}} \text{ volts}$$

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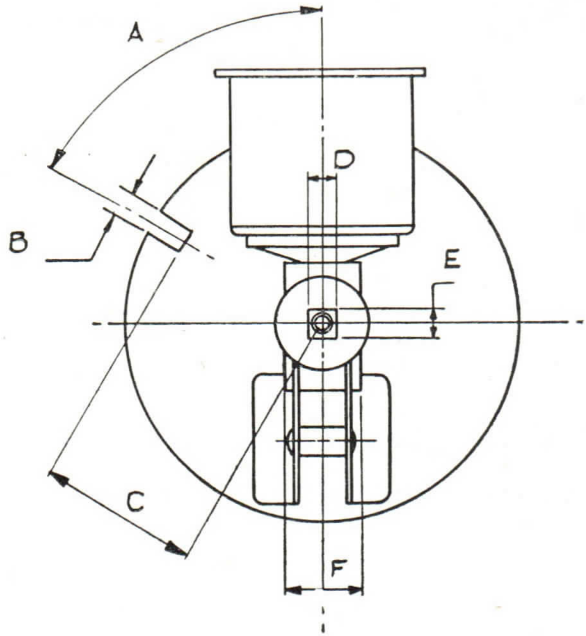
X Band Magnetron

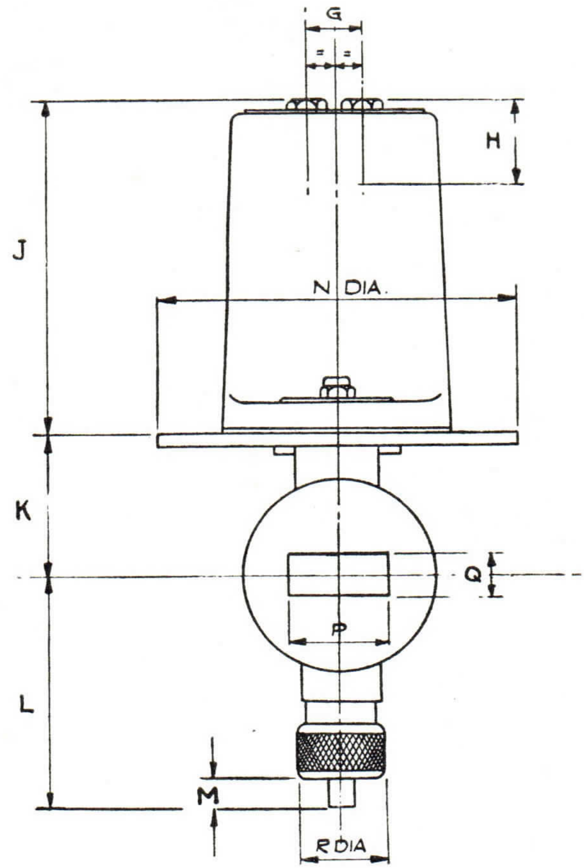


DIMENSIONS

	Inches	Millimetres
A	60° ± 0°30′	
B	0·187 ± 0·002	4·75 ± 0·05
C	1·312 ± 0·010	33·32 ± 0·25
D	0·250 ± 0·002	6·35 ± 0·05
E	0·250 ± 0·002	6·35 ± 0·05
F	0·620 ± 0·010	15·75 ± 0·25

X Band Magnetron

BM1040



DIMENSIONS

	Inches	Millimetres		Inches	Millimetres
G	0·500 ± 0·010	12·7 ± 0·25	**M**	$\frac{1}{4}$	6·35
H	$\frac{3}{4}$	19·05	**N**	3·241 — 0·002	82·32 — 0·05
J	3·000 + 0·062	76·2 + 1·57	**P**	0·900 ± 0·003	22·86 ± 0·08
K	1·250 — 0·031	31·75 — 0·79	**Q**	0·400 ± 0·003	10·16 ± 0·08
L	$2\frac{3}{32}$	53·18	**R**	$\frac{3}{4}$	19·05

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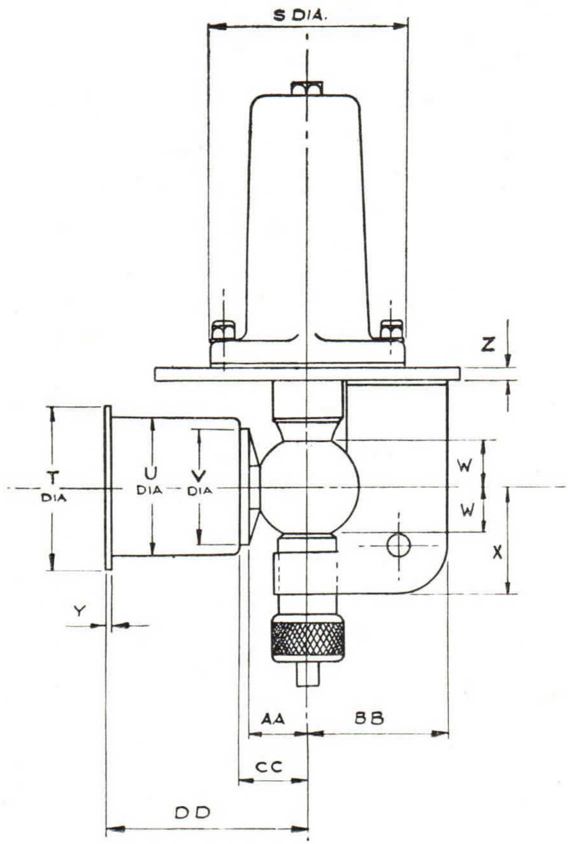
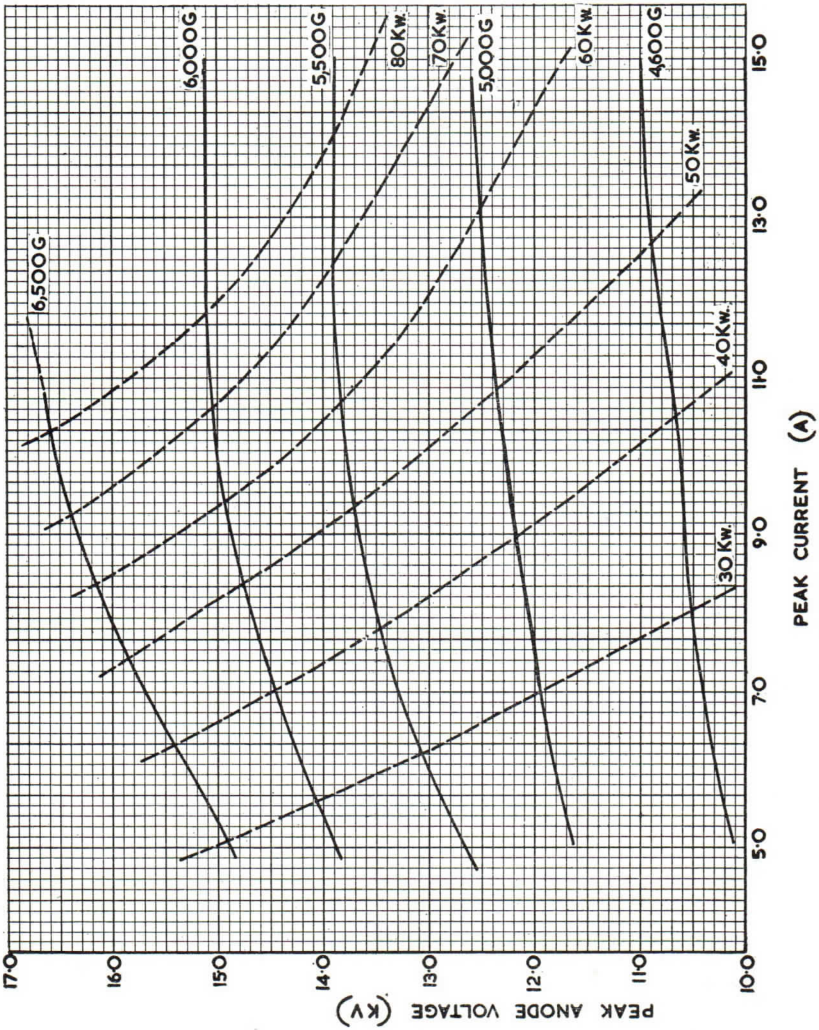
X Band Magnetron



DIMENSIONS

	Inches	Millimetres		Inches	Millimetres
S	$2\frac{1}{8}$ max	53·975 max	**Y**	0·062 ± 0·005	1·57 ± 0·13
T	$1\frac{3}{4}$	44·45	**Z**	0·125 ± 0·003	3·17 ± 0·08
U	$1\frac{1}{2}$	38·1	**AA**	0·620 ± 0·020	15·75 ± 0·51
V	$1\frac{1}{8}$	28·57	**BB**	$1\frac{1}{2}$	38·1
W	$\frac{1}{2}$	12·7	**CC**	0·71	1·80
X	$1\frac{1}{8}$	28·57	**DD**	2·062 ± 0·031	52·37 ± 0·79

PERFORMANCE CHART—0·5 μs pulse length, 1800 p/s.



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AEI X Band Magnetron BM1041

This is a tunable magnetron which has an indirectly heated cathode and a forced air cooled anode (see note 1).

DESIGN RATINGS

Minimum peak power output	23	kW
Tuning range (see note 2)	9040—9120	Mc/s
Peak anode voltage	10—14	kV
Peak anode current	9	A
Heater voltage (see note 3)	6·3	V
Heater current	0·8	A
Magnetic field	5000	G

MAXIMUM RATINGS

Maximum mean input power	100	W
Maximum pulse length	1	μs
Maximum duty cycle	0·001	
Maximum v.s.w.r.	1·5:1	
Maximum rate of rise of voltage	250	kV/μs
Maximum frequency pulling figure	17	Mc/s

TYPICAL OPERATING CONDITIONS

Field strength	5000 ± 50	5000 ± 50	G
Pulse length	0·5	0·25	μs
Pulse repetition frequency	1400	4000	p/s
Peak anode voltage	14	14	kV
Peak anode current	9	7	A
Peak power output	35	30	kW

MECHANICAL DATA

Mounting position	Any
Weight	1 lb 7 oz (0·65 kg)
Weight packed	4 lb (1·81 kg)
Output waveguide	No. 16

NOTES

1. Minimum air flow to be such that the anode temperature does not rise above 140°C.
2. The tuning range specified is covered by approximately $1\frac{3}{4}$ turns of the tuner.
3. The heater voltage must be applied for not less than three minutes before the application of H.T. voltage and during operation must be adjusted according to the formula:—

$$V_f = \sqrt{\frac{(1-\text{Power (w) dissipated in anode})}{120}}\ \text{volts}$$

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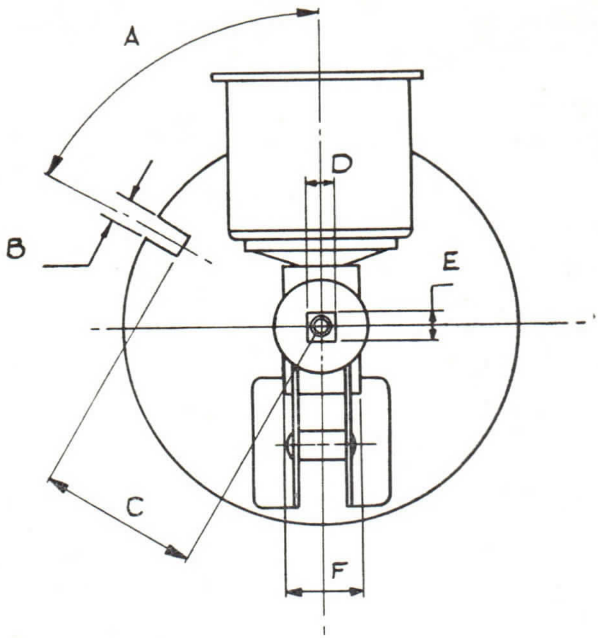
X Band Magnetron

AEI



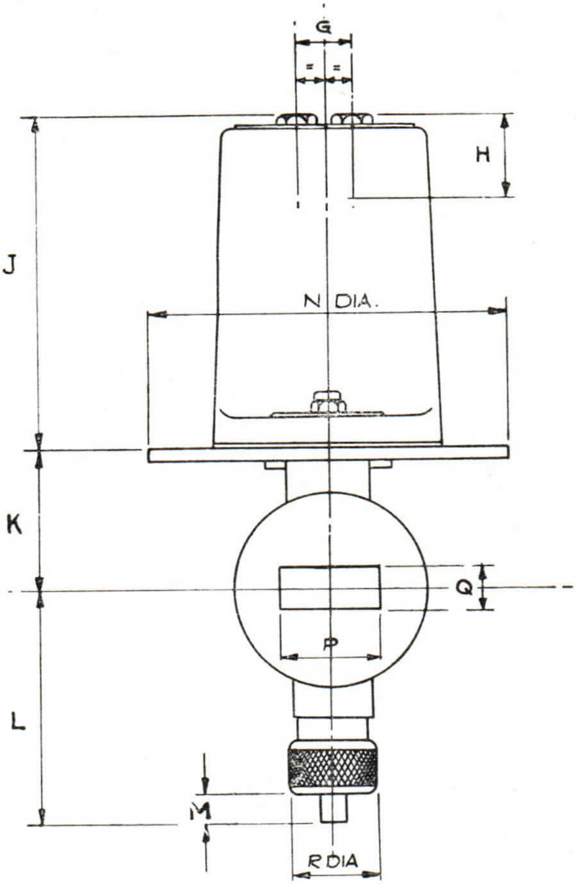
DIMENSIONS

	Inches	*Millimetres*
A	60° ± 0°30′	
B	0·187 ± 0·002	4·75 ± 0·05
C	1·312 ± 0·010	33·32 ± 0·25
D	0·250 ± 0·002	6·35 ± 0·05
E	0·250 ± 0·002	6·35 ± 0·05
F	0·620 ± 0·010	15·75 ± 0·25

AEI

X Band Magnetron

BM1041



DIMENSIONS

	Inches	Millimetres		Inches	Millimetres
G	0·500 ± 0·010	12·7 ± 0·25	M	$\frac{1}{4}$	6·35
H	$\frac{3}{4}$	19·05	N	3·241 − 0·002	82·32 − 0·05
J	3·000 + 0·062	76·2 + 1·57	P	0·900 ± 0·003	22·86 ± 0·08
K	1·250 − 0·031	31·75 − 0·79	Q	0·400 ± 0·003	10·16 ± 0·08
L	$2\frac{3}{32}$	53·18	R	$\frac{3}{4}$	19·05

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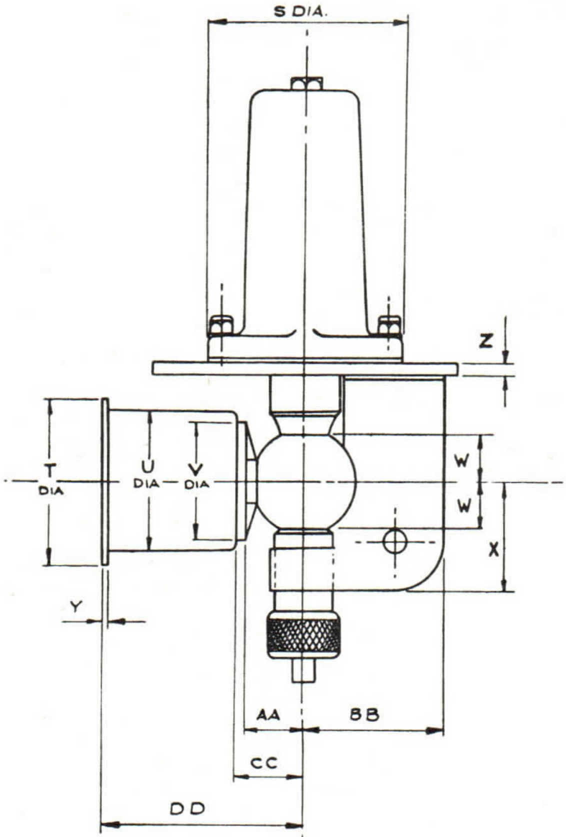
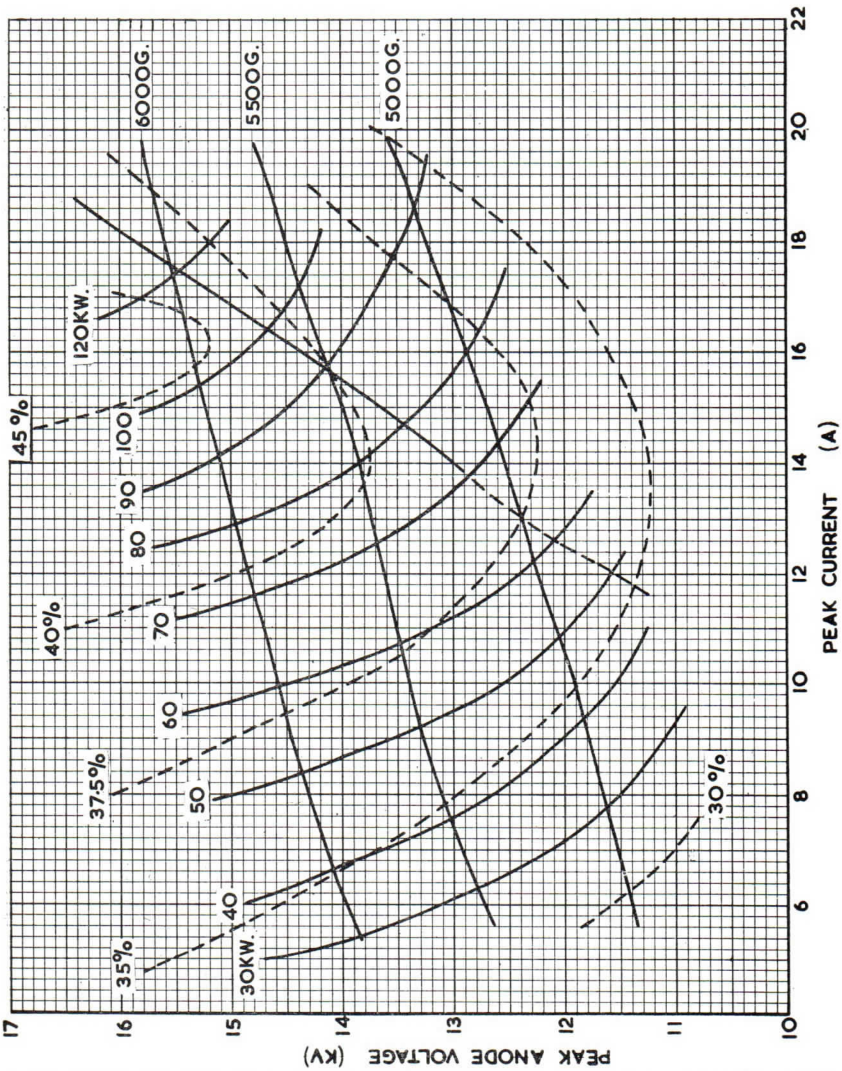


DIMENSIONS

	Inches	Millimetres		Inches	Millimetres
S	$2\frac{1}{8}$ max	53·975 max	Y	0·062 ± 0·005	1·57 ± 0·13
T	$1\frac{3}{4}$	44·45	Z	0·125 ± 0·003	3·17 ± 0·08
U	$1\frac{1}{2}$	38·1	AA	0·620 ± 0·020	15·75 ± 0·51
V	$1\frac{1}{8}$	28·57	BB	$1\frac{1}{2}$	38·1
W	$\frac{1}{2}$	12·7	CC	0·71	1·80
X	$1\frac{1}{8}$	28·57	DD	2·062 ± 0·031	52·37 ± 0·79

AEI **X Band Magnetron** **BM1041**

PERFORMANCE CHART—0·5 μs pulse length, 1,000 p/s.



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CW Magnetrons

Provisional Information

The BM20L CW Magnetron is intended for industrial microwave heating applications at frequencies near 900 Mc/s.

Two versions are available, one giving output into a 3 inch diameter coaxial line, the other into a No. 4 waveguide.

DESIGN RATINGS—D.C. operation

Frequency (U.S.A.)	915	Mc/s
(U.K.)	892	Mc/s
Power output	25	kW
Maximum v.s.w.r. all phases	3:1	
Nominal efficiency	80	%
Cathode heating time	10	s

MECHANICAL DATA

Minimum cooling water flow	2·2 gal/min (10 L/min)
Cooling air—output seals	20 ft^3/min (566 L/min)
Cooling air—filament seals	5 ft^3/min (142 L/min)
Weight	17 lb 4 oz (7·8 kg)

NOTES

1. Design details of a suitable electromagnet are available.
2. Design details of a suitable output launching section are available.

AEI CW Magnetron BM25L

1. DESCRIPTION

The BM25L magnetron has been developed primarily as a power source for r.f. heating applications at nominal frequencies of 892 Mc/s. and 915 Mc/s. A power output of 30kW. can be obtained into a matched load, at an efficiency of approximately 80%.

The magnetron has a directly heated tungsten spiral cathode, and the output is a probe which radiates into $9\frac{3}{4}$ inch by $4\frac{7}{8}$ inch aperture waveguide. The anode is water cooled, and the output window, cathode terminals and seals are forced air cooled.

The magnetic field is provided by an iron cased coil into which the valve fits, and which is integral with a waveguide launching section.

The magnetron may be run with fixed magnetic field, or with the electromagnet connected in series with the anode—a mode of operation which markedly reduces the variation in output power with supply voltage changes (see Section 4).

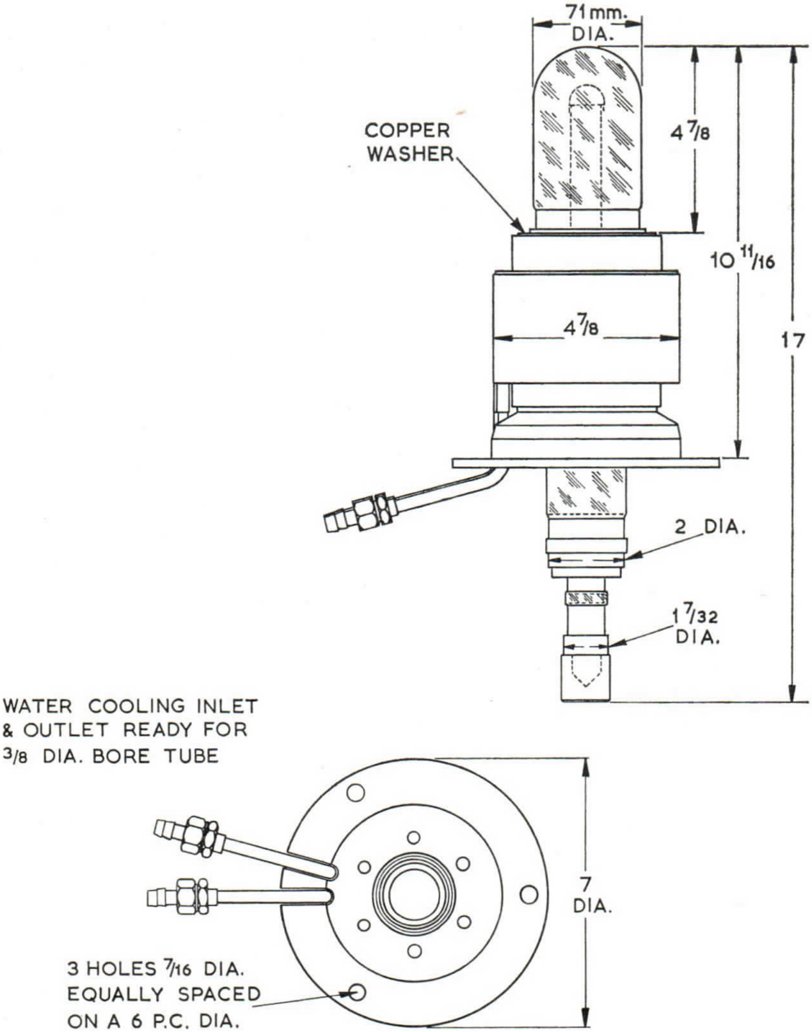
The magnetron is normally operated from a three-phase bridge rectified supply, with or without smoothing choke, whilst the cathode may be fed from a single-phase a.c. supply. The choice of supplies and degree of smoothing in any particular application is governed by the permissible power and frequency modulation of the r.f. output, these being determined mainly by the anode current ripple.

2. TECHNICAL INFORMATION

2.1.	H.T. Supply	'D.C.' from 6 (or higher) phase rectifier.
	Filament Supply	A.C. at mains frequency.
	Operation	Fixed or Series Field (see Sect. 4).
	Frequency	892±5 Mc/s. or 915±25 Mc/s.
	Anode Voltage	14 kV. maximum.
	Anode Current	4 Amp. maximum
	Frequency Pulling Figure (for 1·5 : V.S.W.R.)	2·25 Mc/s.

2.2. Filament

Filament Voltage	12 Volts rms.
Filament Current	115 Amp rms.
Filament Current, surge limit	250 Amp rms.
Cold Resistance	0·03 ohms approx.
Warm up time	10 seconds.



Dimensions in inches unless otherwise stated.
Fig. 1. Outline and dimensions, type BM25L magnetron.

2.3. Cooling

Anode Water, maximum outlet temperature	50°C.
Recommended Flow	10 litres/minute, minimum.
Electromagnet Water	1·0 litre/minute.
Output Window, air	20 cubic ft./minute at 2 inches water gauge.
Filament Terminals, maximum temperature	120°C.
Air Coolant	5 cubic ft./minute.

2.4. Mechanical

Mounting Position	Axis vertical, up or down.
Overall Dimensions	17 inches × 7 inches dia. excluding water pipes.
Weight	10 kilogrammes
Magnetron Outline	Fig. 1.
Magnetron, Electromagnet, and waveguide assembly	Fig. 2.

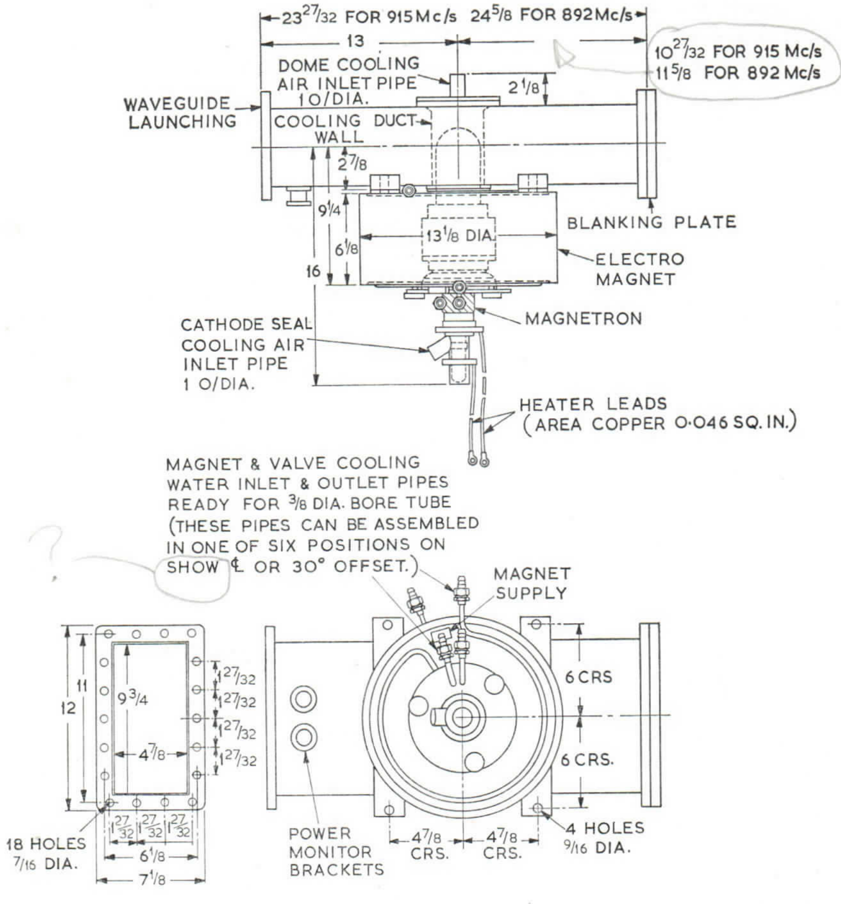
3. TYPICAL OPERATING CONDITIONS

3.1. 20kW. Output

	Magnitude	*See Note*
Magnetic Field	1350 Gauss	1, 2
Anode Voltage	11·5 kV.	1, 4
Anode Current	2·1 Amp	1, 3, 4
Filament Voltage	11 Volts	1, 3
Filament Current	106 Amp	1, 3
Voltage Standing Wave Ratio presented by the load	3 : 1	5, 8
Frequency Pushing	0·7 Mc/s. per Amp	6
Frequency Modulation	0·2 Mc/s.	7
Frequency Pulling Figure	2·25 Mc/s.	9

3.2. 25kW. Output

Magnetic Field	1450 Gauss	1, 2a
Anode Voltage	12·5 kV.	1, 4
Anode Current	2·4 Amp	1, 4
Filament Voltage	10·8 Volts	1, 3
Filament Current	103 Amp	1, 3
Voltage Standing Wave Ratio presented by the load	2·5 : 1	5
Frequency Pushing	–0·4 Mc/s./Amp	6
Frequency Modulation	0·2 Mc/s.	7
Frequency Pulling Figure	2·25 Mc/s.	9



Dimensions in inches unless otherwise stated.

Fig. 2. BM25L magnetron, waveguide and magnet outline.

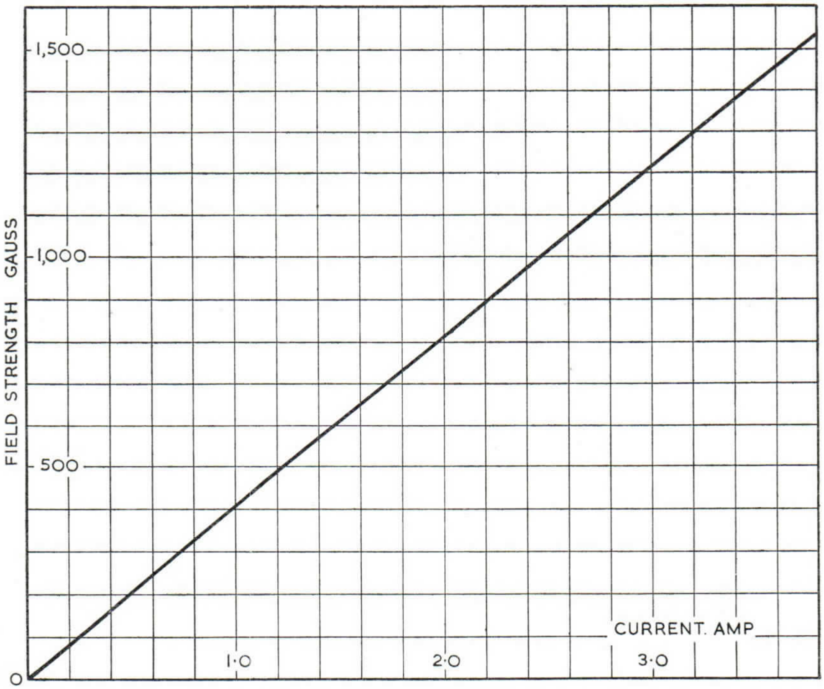


Fig. 3. Electromagnet characteristic with 2,450 turns of 15 S.W.G. wire.

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3.3. Notes

1. All coolants must be applied before switch on, see Section 2.3. For installation see Section 5.

2. This field corresponds to a magnet current of 3·3 Amp. See the characteristic of Fig. 3.

2a. This field corresponds to a magnet current of 3·6 Amp. See the characteristic of Fig. 3.

3. Before the H.T. is applied the initial values of filament voltage and current, $V_{fo} = 12$ Volts and $I_{fo} = 115$ Amp respectively, should be applied for 10 seconds.

   When the magnetron is oscillating V_f and I_f should be reduced to compensate the back bombardment heating. The values given apply for matched r.f. load.

   Maximum life will be obtained if the filament voltage is decreased until the filament resistance V_f/I_f is the same as that when the magnetron is not oscillating, that is V_{fo}/I_{fo}.

   For operating points shown in the performance chart of Fig. 4, or the Rieke diagram of Fig. 5, the values of V_f and I_f are given approximately by $V_f = kV_{fo}$, $I_f = kI_{fo}$, where

$$k = \sqrt{\left[1 - \frac{35\left(1 + \frac{P_D}{1000}\right)}{V_{fo} \cdot I_{fo}}\right]}$$

   and P_D = anode dissipation (Watts), taken to be $V_a I_a$ (1–3), where η = efficiency.

   When the r.f. load is reasonably constant V_f and I_f can be reduced a fixed amount using manual or switched control, but where the variation is considerable, more accurate compensation can be achieved by an automatic control.

4. The internal impedance of the H.T. supply should be such as to limit the peak anode current to 24 Amp in the event of the magnetron arcing. An automatic cut-out should be incorporated to switch the supply off in this case, and with the failure of any coolant.

5. This is a maximum value for any phase of voltage reflection coefficient.

6. The approximate steady state value including the contribution due to thermal effects.

7. Typical peak to peak value obtained using an H.T. supply with 6 phase rectifier and 5 Henry choke in series with the anode, giving an anode current ripple of 0·16 Amp peak to peak. Without the choke a ripple current of 0·56 Amp peak to peak, and peak to peak modulation of 0·7 Mc/s. is typical. The values apply with matched r.f. load, and a.c. filament current.

8. For operating points in the " sink " of the Rieke diagram the magnetron may stop oscillating, or oscillate in another mode if the V.S.W.R. exceeds this limit. In the event of oscillation in another mode the H.T. supply must be switched off for restart. Prolonged operation in this state may cause damage to the valve.

9. For a V.S.W.R. of 1·5 : 1. The Frequency Pulling Figure is fixed by the distance of the short circuit behind the magnetron probe, nominally equal to 26·75 cm. for 915 Mc/s. valves and 27·75 cm. for 892 Mc/s. valves. The optimum short circuit position is quoted for each valve on the test sheet.

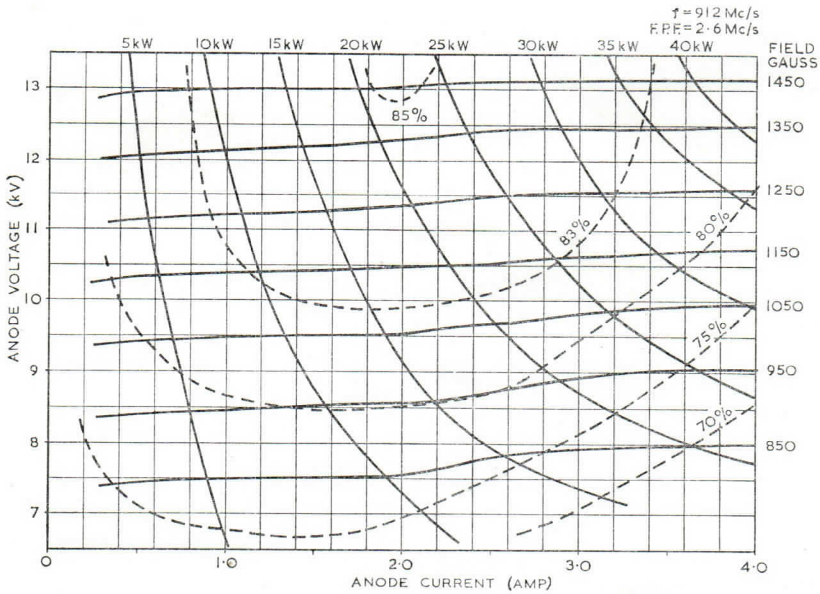

Fig. 4. Typical performance chart.

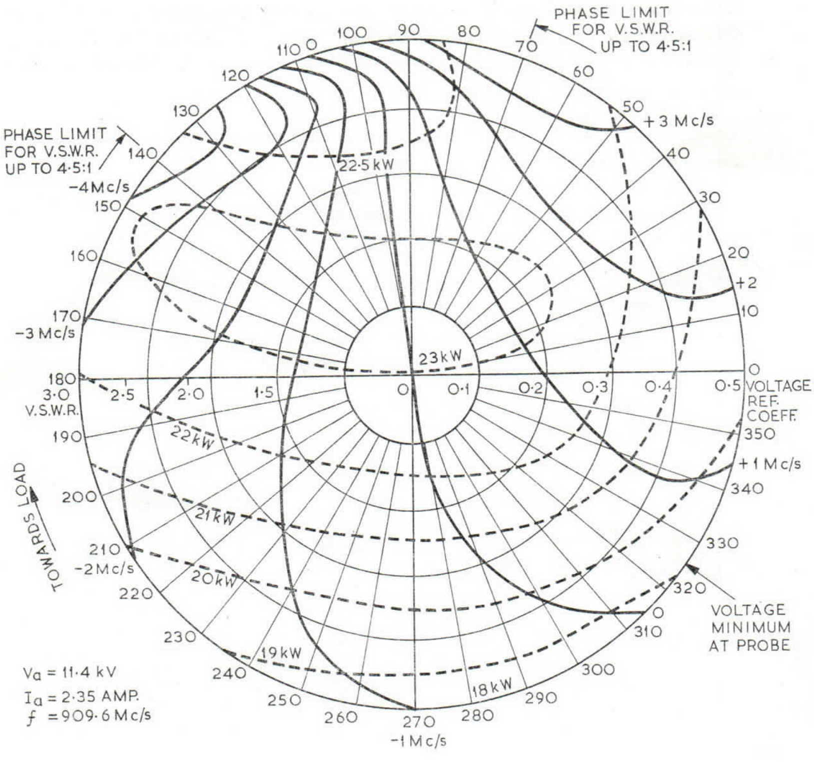

Fig. 5. Typical Rieke diagram with series field.

4. OPERATION WITH SERIES FIELD

With the coil of the electromagnet connected in series with the anode as shown in Fig. 6, the magnetron threshold voltage V_T (approx. equal to the anode voltage at zero anode current, see Fig. 4), becomes proportional to the anode current and curve of V_a against I_a for steady currents, and is obtained as given in Fig. 7. The slope of this characteristic, which depends upon the number of turns in the coil, is much greater than that with fixed field (compare with Fig. 4), and hence the power changes with supply voltage variations are correspondingly reduced. This is one advantage of the series field mode of operation.

Operating points to the left of the line can be reached by supplying a biasing current through the coil. Assuming an initial biasing current the behaviour is then as follows. As the anode voltage, and hence current, rises from zero the increasing volt drop across the magnet coil causes a decrease in the biasing current, and a V_aI_a characteristic of reduced slope* is obtained. Beyond the branch point shown in Fig. 7 the biasing current is zero and full series field behaviour is obtained. The characteristic is raised or lowered in accordance with the biasing current and threshold voltage V_T, and with a fixed supply voltage this enables the power output to be controlled in an economical way by varying the magnet current. Since the slope of the characteristic depends upon the magnet coil resistance there is a slight drift of the operating point as the coil warms up. This can be minimised by making R_b large compared with R_M, or by using a bias supply which behaves as a constant current source.

With series field anode voltage cannot be applied instantaneously without biasing field current, since a transient voltage approximately equal to the anode supply voltage is developed across the magnet coil, A method of starting is therefore to increase the biasing current to raise V_T above the no load voltage of the H.T. supply, switch on the H.T. voltage, and then reduce the biasing current until the required operating point is reached.

---

* In proportion to $\frac{Rb}{Rb+Rm}$, where R_b is the effective internal impedance of the biasing supply, and R_m the magnet resistance.

With series field the stability against load mismatch remains the same as that with fixed field, but the variation in anode impedance Va/Ia with phase of voltage reflection coefficient is reduced by a self-regulating action. This leads to a power variation (see Fig. 5 for example) which is mainly determined by efficiency changes.

Precautions should be taken to prevent excessive load reflection as stipulated in Sections 3.1 and 3.2., since operation in unwanted modes is always possible with full series field, following a cessation of oscillation in the proper mode.

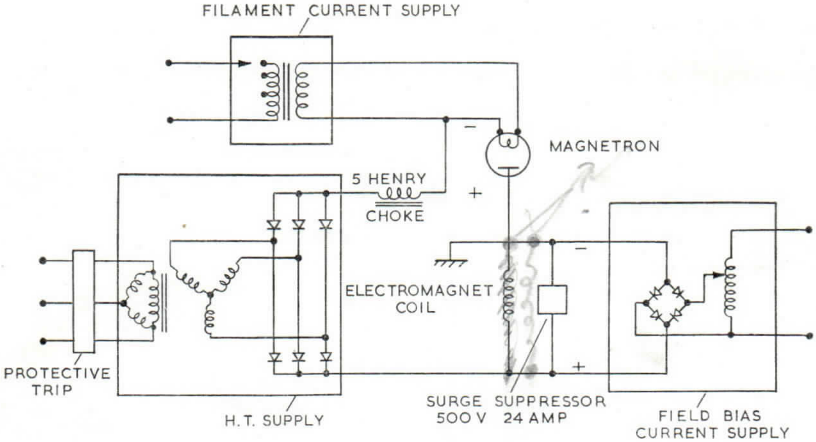

Fig. 6. Circuit for series field operation.

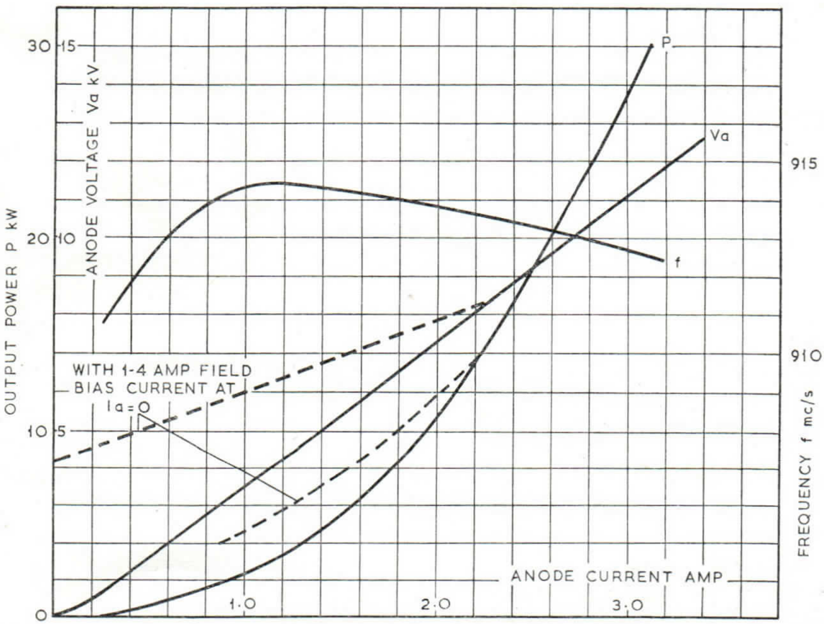

Fig. 7. Characteristics with series field (electromagnet 2,450 turns of 15 SWG wire).

5. INSTALLATION

The valve is constructed from metal and glass. Reasonable care should be taken to protect the valve from excessive shocks when handling and after installation. The mounting position is with axis vertical, either up or down.

R.F. connection between the magnetron and waveguide launching section is made by a copper washer retained on a spigot on the valve at the base of the dome window. The valve must be seated squarely in the electromagnet, and the retaining screws tightened up uniformly to ensure proper contact at the washer. A new washer should be used each time the magnetron is inserted.

The magnetron dome window is forced cooled by air ducted over the dome by a flanged insulating cylinder. To obtain proper cooling it is necessary to ensure a uniform gap between the cylinder and dome.

The cathode terminals must be securely clamped to make proper contact and avoid overheating. Cooling is by forced air through a duct attached to the small cathode terminal. The terminal should not exceed 120 °C.

AEI CW Magnetron BM1047

Provisional Information

The BM1047 is a 1 kW fixed frequency magnetron. It is intended primarily for microwave heating applications at 2450 Mc/s. The cathode is directly heated and the anode block water cooled. Output for radiation into the waveguide is provided by an aerial mounted within a glass dome.

DESIGN RATINGS—D.C. Operation	Nom	Min	Max	
Filament voltage	5·0			V
Filament current	16·0			A
Cathode heating time	8			s
Anode voltage	3·32		6	kV
Anode current	0·5		1	A
Power input			3	kW
Power output	1·0		1·5	kW
Frequency	2450	2410	2490	Mc/s
V.S.W.R. all phases			2·5:1	
V.S.W.R. restricted phase (mean)			4·0:1	
V.S.W.R. restricted phase (peak)			10·0:1	

DESIGN RATINGS—A.C. (50 c/s) Operation	Nom	Min	Max	
Filament voltage	5·0			V
Filament current	16·0			A
Cathode heating time	8			s
Peak anode voltage (conducting half cycle)	8·0		9·0	kV
True r.m.s. anode voltage	5·6			kV
Peak anode current	1·6			A
Mean anode current	300	290	325	mA
Power input (mean)			2·25	kW
Power output (mean)	1·0		1·25	kW
Conduction period	6·0			ms
Frequency	2450	2410	2490	Mc/s
V.S.W.R. all phases			2·5:1	
V.S.W.R. restricted phase (mean)			4·0:1	
V.S.W.R. restricted phase (peak)			10·0:1	

MECHANICAL DATA

Cooling water flow		0·04	L/s
Cooling water temperature		85	°C
Mounting position	Tube axis vertical		
Weight	1·25 lb (0·567 kg)		

Notes

1. Design details of a suitable electromagnet are available.
2. Design details of a suitable output launching section are available.

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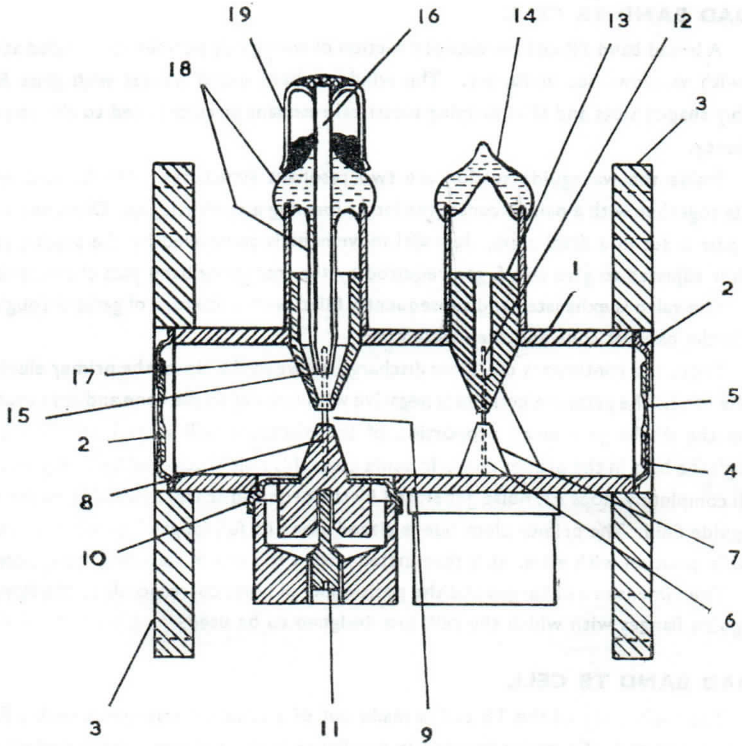
April 1963
4400-55/BM1047

TR & TB Cells

4400/56

AEI TR and TB Cells



Cross section of a TR Cell

1. Waveguide body
2. Windows
3. Flanges
4. Window frame
5. Window pane
6. Iris
7. Cone
8. Cone
9. R.F. gaps
10. Diaphragm
11. Tuning screw
12. Exhaust hole
13. Exhaust cone
14. Glass seal off
15. Primer electrode tip
16. Primer lead
17. Primer cone
18. Glass bead
19. Top caps

continued

BROAD BAND TR CELL

A broad band TR cell consists of a section of waveguide hermetically sealed at each end with windows set in flanges. The windows have metal frames with glass filling suitably shaped slots and thus forming electrical resonant circuits tuned to the required frequency.

Inside the waveguide section are two resonant structures, each formed by iris inserts together with a pair of cones, the latter forming a small r.f. gap. One cone out of each pair is set in a diaphragm. Its axial movement is controlled by the setting screw which is adjusted to give an r.f. gap required by the frequency band pass characteristics.

The valve is exhausted and subsequently filled with a mixture of gases through the hole in the exhaust cone and then sealed off.

There is a continuous d.c. glow discharge between the tip of the primer electrode and the cone. The primer electrode is negative with respect to the cone and consequently during the discharge a small proportion of the electrons will stray into the r.f. gap through the hole in the primer cone. In some cases this hole is covered by a very fine grid which completely stops r.f. noise generated by the primer discharge coupling to the main waveguide field. The primer electrode is glazed along its full length inside the valve and sealed in position with glass. It is terminated with a top cap of standard dimensions.

The dimensions of flanges and the positioning of holes corresponds to the standard waveguide flanges with which the cells are designed to be used.

BROAD BAND TB CELL

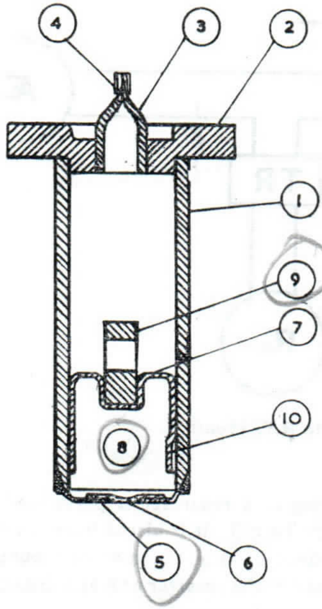
The main body of the TB cell is made out of a standard waveguide with a flange brazed at one end. Centrally situated in the flange is the exhaust tube sealed off by a cold weld process and secured with a soldered protective ring.

At the opposite end the waveguide is terminated by a window with a central slot filled with glass. The window forms a resonant structure which is tuned to a required frequency by a suitable choice of the window slot dimensions as well as the thickness of the glass.

Behind the window is an accurately positioned diaphragm forming a tunable resonance cavity. The valve is tuned to a required frequency by displacing the diaphragm with a tool engaged in the tuning bar through the exhaust tube prior to its sealing off.

continued

AEI TR and TB Cells



1. Waveguide body
2. Flange
3. Exhaust tip
4. Protective ring
5. Resonant window
6. Window pane
7. Diaphragm
8. Resonant cavity
9. Tuning bar

10. ?

Cross section of a TB Cell

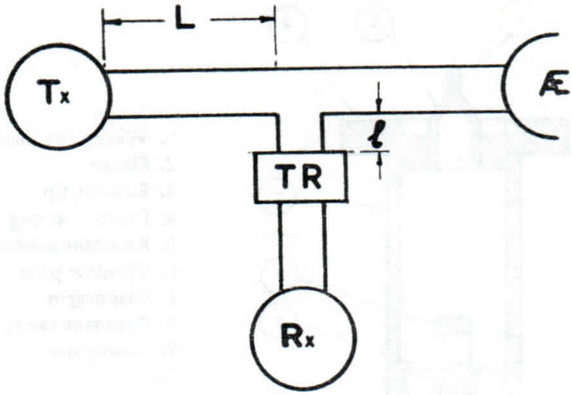
OPERATION OF TR AND TB CELLS

The heart of a microwave radar equipment is a duplexer. It makes possible the use of the same aerial for transmission and reception and thus considerably simplifies the radar equipment.

In its basic mode of operation it can be likened to a set of traffic lights at a T junction of roads. During transmission it directs the high power modulator pulse to the aerial, and prevents any of this energy from entering the sensitive receiving equipment and damaging delicate converter elements. At the completion of the transmission period the duplexer rearranges itself so that during the receiving phase the modulator is blocked from the aerial and the echo energy detected by the antenna can pass directly into the receiver.

Bearing in mind the order of magnitude of various parameters that describe the performance of a radar system, the analysis of the duplexing device is conveniently carried out at high and low power level.

continued



Simple R.F. Head

In its simplest form the duplexing in a radar set is performed by one valve referred to as Transmit Receive valve, or TR cell. It is placed between the magnetron and the aerial at a predetermined distance L. The cell may be mounted directly on the wall of the main waveguide or situated in the receiver arm at a distance 'l', equal to $\frac{n}{2}\lambda_g$, from it.

During the transmitting period when the magnetron power is building up to its maximum, the energy travelling towards the aerial divides itself at the TR junction according to the admittances presented by the aerial and receiver arms at the junction. The energy passing towards the crystal receiver has to pass through the TR cell and in the process of doing so induces voltage across each arm of the resonant circuits contained within the length of the cell.

When this voltage, which appears across the cones of the resonant structure, reaches a critical value, determined by the gas composition and geometry of the gap, breakdown occurs and a short-circuit is then established across the waveguide. The short produces low susceptance, and therefore high voltage, across the element $\lambda_g/4$ in front. With the help of this additional voltage a short-circuit is established across this element and finally at the back of the input window.

continued

Spike Energy

The energy which contrives to pass through the cell before an effective short-circuit is established is known as the spike leakage and generally expressed in ergs per pulse. The spike is very damaging to the crystal receiver and every effort is made to keep its value to a minimum. A very effective way to do this is to introduce a source of free electrons in the vicinity of the r.f. gap. Some stray electrons will then find their way into the gap and help to break it down more quickly when the r.f. power tries to pass through. Such a mechanism is provided by the primer d.c. glow discharge which is maintained in the vicinity of the second gap. A reduction of some sixty or more dB in spike energy is achieved in this way.

After the initial build-up of the pulse power, when a virtual short-circuit has been established across the receiver arm by the TR switch and the magnetron is generating its full power, a steady fired condition in the valve performance is obtained. A heavy plasma glow discharge behind the output window maintains almost a short circuit and carries the magnetron power to the aerial.

Flat Energy

After the passage of the spike energy, the gaps, deprived of most of the magnetron power, come back to their deionised low power state. Under this condition there is a small amount of magnetron power which reaches the crystal receiver; because of its constant magnitude it is called the flat leakage power generally expressed in mW per pulse. The mechanism which gives rise to this consists of two contributory parts. The first part represents the power which is coupled from the main waveguide and is propagated through the plasma discharge because of its finite impedance. The second part is the energy which is radiated towards the receiver by the plasma discharge itself.

The magnitude of the flat leakage power is influenced by the nature of the gases filling the valve and their respective pressures.

Arc Loss

During the transmission interval the discharge behind the input window carries the full waveguide current. The energy required to maintain the discharge is supplied by the magnetron and the loss sustained in the process is termed the arc loss, and generally expressed in dB. The power dissipated in the discharge is eventually lost as heat.

Recovery

At the completion of the transmitting pulse the valve returns to its low power "unfired" state in readiness to pass the reflected signal received by the aerial to the crystal detector. In the transition period the short circuit behind the input window gradually changes until matched conditions are attained. During this phase the effective

continued

attenuation of the valve changes from about 60 dB during the magnetron transmission to the insertion loss value when the discharge has completely ceased.

The rate at which this recovery is effected is determined among other factors by the maximum peak power and its duration as well as the nature of the gases or any other quenching agents used for this purpose in the valve.

The effect of the recovery attenuation is to reduce the magnitude of reflected power from near-by objects and its effect may be observed for some 5 to 30 microseconds after the main pulse. There are three different phenomena which together constitute the mechanism of recovery—diffusion, recombination and capture.

The electrons and ions in the discharge have high energies. As a result high velocities are attained by these bodies, particularly the electrons, whose masses are appreciably lower than those of the ions. The result of this motion is the tendency of the electrons to move out of the discharge. This drift is to some degree counteracted by the influence of the slower ions on the discharge which exert an opposing field on this outward movement. The net effect of this is to produce an ambipolar diffusion, whereby both the electrons and ions gradually drift out of the discharge region.

Recombination of atoms of broken molecules and free electrons is the least effective of the three mechanisms aiding recovery. It mostly takes place on the fringe of the discharge volume.

The electron capture is the most effective recovery process. A small amount of gas composed of heavy molecules of large cross-sectional area is introduced into the cell prior to its sealing off. In the discharge the velocities attained by these molecules are considerably smaller than those of electrons on account of their heavier weight. They, therefore, may be regarded as stationary with respect to the light fast-moving electrons. Because of their large cross-sectional area the probability of their being bombarded by the electrons is high. The result of such collisions is either slowing down of the electrons and altering their direction of motion or complete absorption of the impinging electron by the molecule. The result is an accelerated transition of the gas from the glow discharge to its steady state.

Reception

During the reception period the signal is picked up by the aerial and travels towards the Tx-Rx junction. There it splits and enters the Tx and Rx arms according to the admittances presented respectively by each arm. The cold admittance of the magnetron is high, and the distance is so arranged that this high admittance appears at the junction. The receiver and the TR cell present at this junction a matched admittance in series with that of the magnetron. Consequently nearly all of the signal is coupled from the aerial to the receiver.

continued

DEFINITIONS

Primer Ignition

The process of creating local ionisation by means of an applied primer power supply.

Firing

The ionisation of the cell which occurs due to the r.f. voltage.

Primer Current

The current which flows when a voltage is applied to the primer electrode for the purpose of increasing the electron density in the breakdown gap of the cell in order to facilitate the ionisation of the cell on the occurrence of high r.f. power.

Primer Interaction

The variations of the electrical parameters of the cell caused by primer current.

Excess Noise

Is that increase in noise power expressed in decibels which is indicated in the output of the intermediate frequency stage of a receiver due to Primer Ignition.

Total Insertion Loss

The loss of power expressed in decibels incurred in a transmission system due to the insertion of the cell between a matched generator and a matched load, with the cell operating under normal primer conditions.

Primer Insertion Loss

The loss of power expressed in decibels incurred in a transmission system due to the primer ignition of the cell situated between a matched generator and a matched load.

Centre Frequency

Defined as the geometric mean of the frequencies at which the measured v.s.w.r. values looking into the cell are equal and within a specified range.

Firing Power

The minimum applied r.f. power which causes the cell to fire, under specified operating conditions.

Firing Time

The time required for the cell to fire after the application of the high r.f. power.

Minimum Breakdown Power

The level of incident power upon the cell causing electrical breakdown at or near the cell in a transmission system when that power is raised gradually from a low level.

Power Rating

The maximum r.f. power which may be applied to the cell without reduction of the specified life period of the cell.

continued

Arc Loss

Defined as that attenuation change expressed in decibels obtained when the fired cell is replaced by a metallic short circuit.

Low Power Leakage

The maximum total leakage power through the cell which occurs as the incident power on the cell is gradually increased over a specified range extending from a point below to a point above that power level at which the cell fires.

Total Leakage Energy

Under specified primer conditions the total energy expressed as ergs per pulse which is transmitted through the cell when a high power r.f. pulse is applied.

Spike Leakage Energy

(Expressed as ergs per pulse.) The initial high intensity pulse of energy composed of continuous frequency sidebands extending to approximately $\pm$ 100 Mc/s from the carrier frequency which is transmitted through the cell prior to the firing of the cell when a high power r.f. pulse is applied.

Flat Leakage Power

(Expressed as peak milli-watts.) The power which is coupled through the cell during the period when the cell is fully fired.

Recovery Time

That period of time following the instant at which the r.f. ionising pulse ceases which is required before the attenuation caused by the cell to a low power signal falls to a level removed from that existing immediately before the occurrence of the r.f. ionising pulse by 6 dB or by a specified number of decibels.

Pulse Characteristics

(Magnetron current and attenuator primer current.)

Pulse Amplitude

The amplitude of a pulse waveform is the peak value of a curve drawn through the average of the deviations on the top of a pulse. Any spike on the leading edge of duration less than 10 per cent of the pulse length shall be ignored.

Pulse Current

The pulse current is the amplitude of the current pulse.

Pulse Length

(a). The pulse length is the time during which the current excluding the effects of capacitance current, exceeds 50 per cent of the pulse current.

(b). Alternatively, the pulse length may be defined and determined from the following expression:

$$\text{Pulse length} = \frac{I_m}{i_p \times f_p}$$

where I_m = Indicated mean current
i_p = Pulse current
f_p = Pulse repetition frequency.

continued

R.F. Pulse Length

The period of time for which the amplitude of the pulse waveform, as seen when using a suitable detector and C.R.O., exceeds 10 per cent of the indicated pulse amplitude.

Resonant Frequency

The resonant frequency of a TB cell is that frequency at which the cell in a series mount produces poorest SWR.

Loaded Q

The loaded Q is most conveniently defined in microwave applications as specifying the rate of change of susceptance with wave length according to the following expression.

$$B = -2\,(1 + G)\,Q_L \frac{\Delta\lambda}{\lambda_0}$$

where B = susceptance
G = conductance
λ = wavelength
λ_0 = resonance wavelength
Q_L = loaded Q

Tuning Susceptance

Tuning susceptance is the normalised susceptance of the valve measured at the resonance frequency.

Equivalent Conductance

The equivalent conductance is the normalised conductance of the valve measured at the resonance frequency.

S Band TR Cells

AEI # S Band TR Cells

NOTES

1. Primer Supplies

1.1. The primer supply voltage to be 1000V ± 50V d.c. having a peak to peak ripple voltage not exceeding 1% and negative with respect to the body of the cell.

1.2. The supply to be connected to the primer electrode through a resistance of 5·5 megohms.

1.3. A resistance of at least 0·5 megohm to be adjacent to the primer top cap.

1.4. The primer energising current is 90 to 150 μA.

1.5. The primer is energised in all tests carried out on the TR cells, except when the Primer Interaction is measured.

2. Voltage Standing Wave Ratio

2.1. The voltage standing wave ratio is measured, with an applied power of less than 10mW, at a number of frequencies equally spaced over the band.

2.2. The load is mounted directly behind the TR cell and its v.s.w.r. is better than 0·98.

3. Low Level Insertion Loss and Primer Insertion Interaction

3.1. The low level insertion loss is measured using a square law crystal and mounted behind a large padding attenuator. This combination gives matched impedance of v.s.w.r. > 0·91. It is immediately preceded by a section of copper waveguide equal in length to that of the TR cell. The change of crystal current when the dummy section is replaced by the TR cell under test is a measure of insertion loss.

3.2. When the supply to the primer is turned off, the change, if any, in the monitored crystal current is a measure of the primer insertion interaction. The interaction may be positive or negative.

3.3. The above tests are carried out at a power level of less than 10mW and at a frequency corresponding to the geometrical mean of the frequencies defining the ends of the band pass.

4. Peak Power Handling Capacity

4.1. The peak power quoted in the table is that found in general radar practice and at which the performance of the device had been evaluated.

4.2. When the cells are used at higher levels than specified, the useful life of the device may or may not be somewhat reduced.

5. High Power Leakage: Spike Energy

5.1. The spike leakage energy is measured at a frequency within the band pass of the valve and a power level of 1 MW. The pulse length is 2·5 μs and the p.r.f. is 750 c/s.

5.2. The principle of measurement is that known as "flat busting" technique. A small amount of magnetron power is diverted through directional couplers, attenuators and phase shifters, mixed with the TR cell leakage power and fed into a thermistor mount padded with a suitable attenuator. The minimum thermistor bridge power reading, obtained when the phase and magnitude of the injected power is suitably adjusted, is equal to the spike energy.

continued

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6. High Power Leakage: Flat Power

6.1. The flat leakage power is measured under conditions specified in 5.1 for spike leakage energy.

6.2. The thermistor mount and its padding attenuator are placed behind the cell under test. The total leakage ~~power~~ is measured and from it the spike energy is subtracted leaving the flat leakage power.

7. Low Power Leakage

7.1. This measurement is carried out under conditions specified in 5.1.

7.2. A portion of the magnetron output power is passed through a directive feed, variable attenuator, TR cell under test and monitored on a thermistor bridge. The level of this power is increased from a very small magnitude up to the value which causes the primer r.f. gap to ionise. This condition is noticed by a sudden drop in the power reaching the monitor. The value of the power at which the ionisation takes place is the maximum low power leakage.

8. Recovery Loss

8.1. The measurement is carried out under the conditions stipulated in 5.1.

8.2. Two pulses are fed through a variable attenuator and a directive feed into the main waveguide. They are directed towards the TR cell under test and the water load. The pulses of approximately 0·1 µs duration are timed so that the first pulse occurs half way between magnetron pulses, while the second one is generated after an adjustable interval following the magnetron pulse. The difference in dB's between the two pulses is the attenuation due to ionisation caused by the high power pulse.

9. Arc Loss

9.1. This measurement is carried out under test conditions specified in 5.1.

9.2. In the circuit used for the measurement of arc loss, the TR cell is mounted on the main waveguide and followed by a directive feed and a matched load. A fraction of the power passing the cell is measured by a thermistor bridge terminating one arm of the directive feed. The difference in dB in power levels when the TR cell is replaced by a short circuit plate is equal to the arc loss of the valve.

10. Short Circuit Position

10.1. This measurement is carried out under test conditions specified in 5.1.

10.2. Magnetron power is fed into arm 1 of a ring-circuit magic T. Arm 2, $\frac{1}{4}\lambda_g$ from arm 1, is terminated with a variable short circuit. Arms 3 and 4, $\frac{1}{2}\lambda_g$ and $\frac{3}{4}\lambda_g$ from Arm 1 respectively, carry a water load and the TR cell under test. The variable short circuit is adjusted for minimum reflection in the main guide and its position is noted. The TR cell is replaced by a flat short circuiting plate, similar in dimension to the input flange, and the position of the short circuit termination is re-adjusted for minimum reflection in the main waveguide. The difference between the two readings of the short circuit positions is equal to the distance of the TR cell short with respect to the plane of the flange.

AEI S Band TR Cell BS104

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2750—2860	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

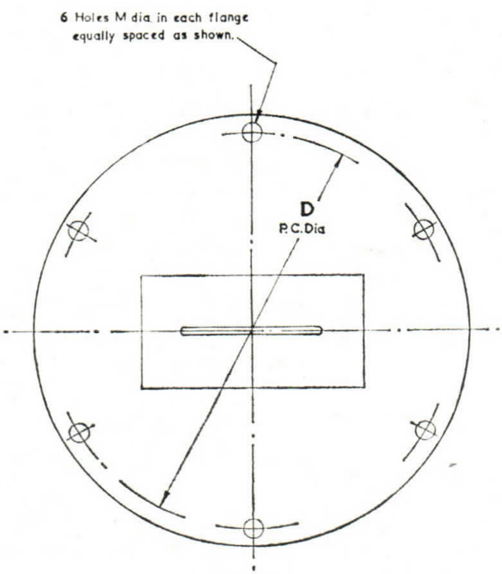
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

S BAND TR CELL. STYLE 'A'

DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

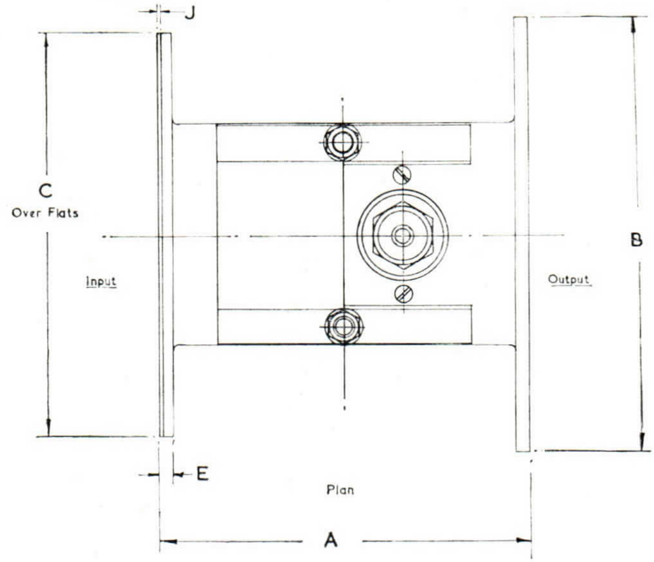
All dimensions in inches.
Millimetre dimensions derived.

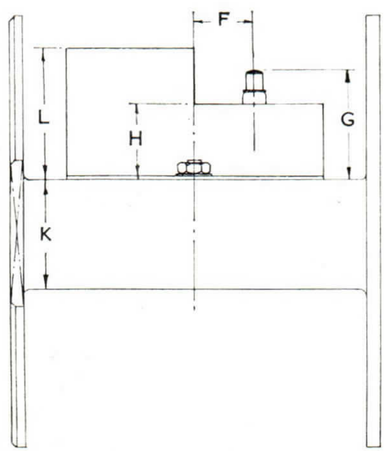


End View.

S Band TR Cell

BS104





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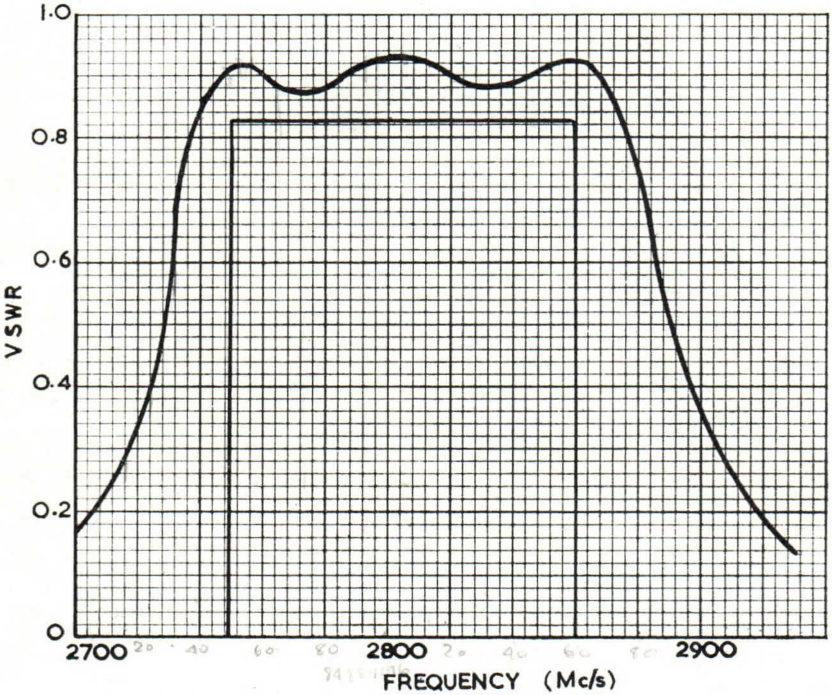
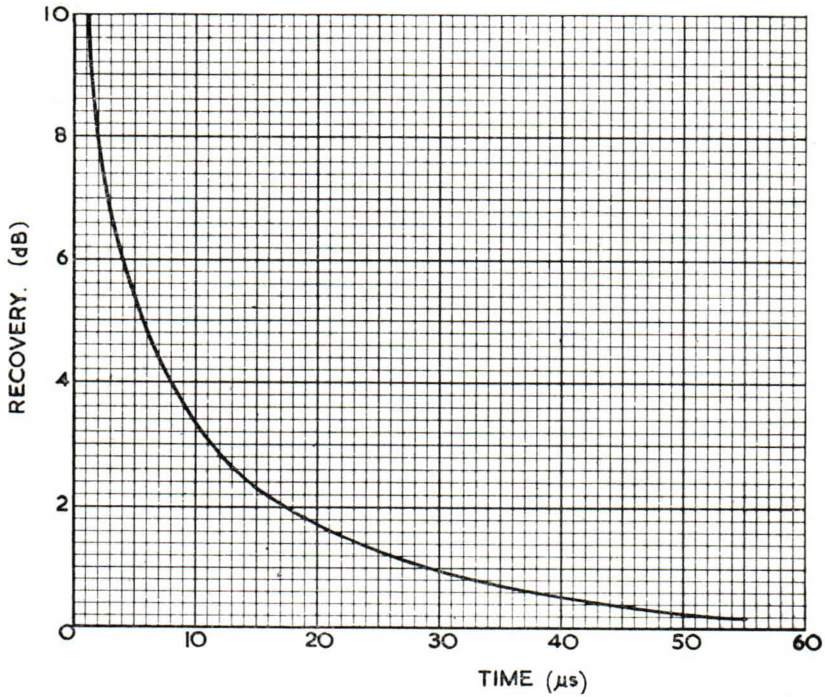
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



AEI S Band TR Cell BS198

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2700—2800	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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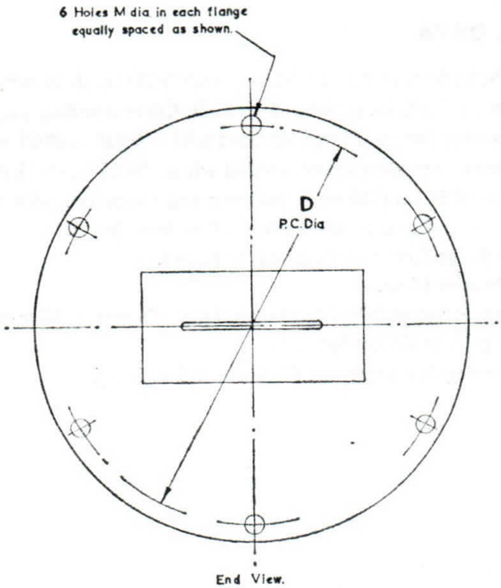
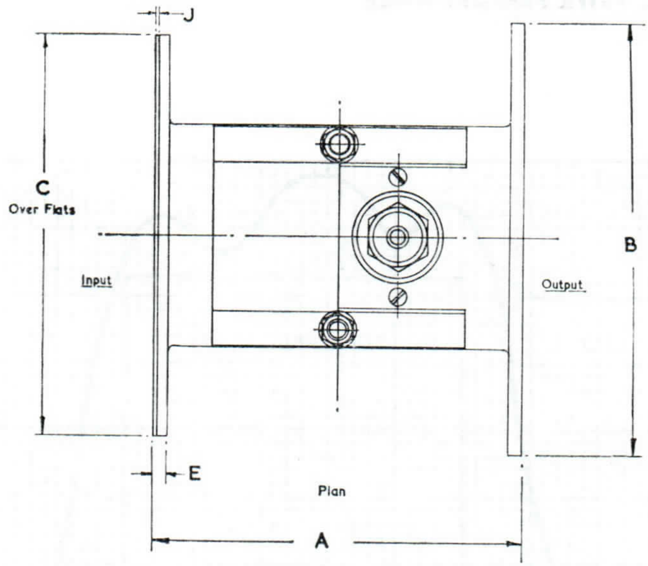
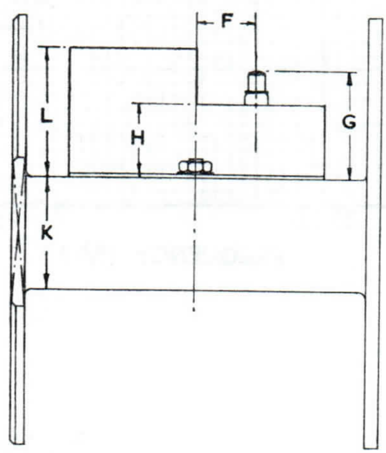
S BAND TR CELL. STYLE 'A'

DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

All dimensions in inches.
Millimetre dimensions derived.







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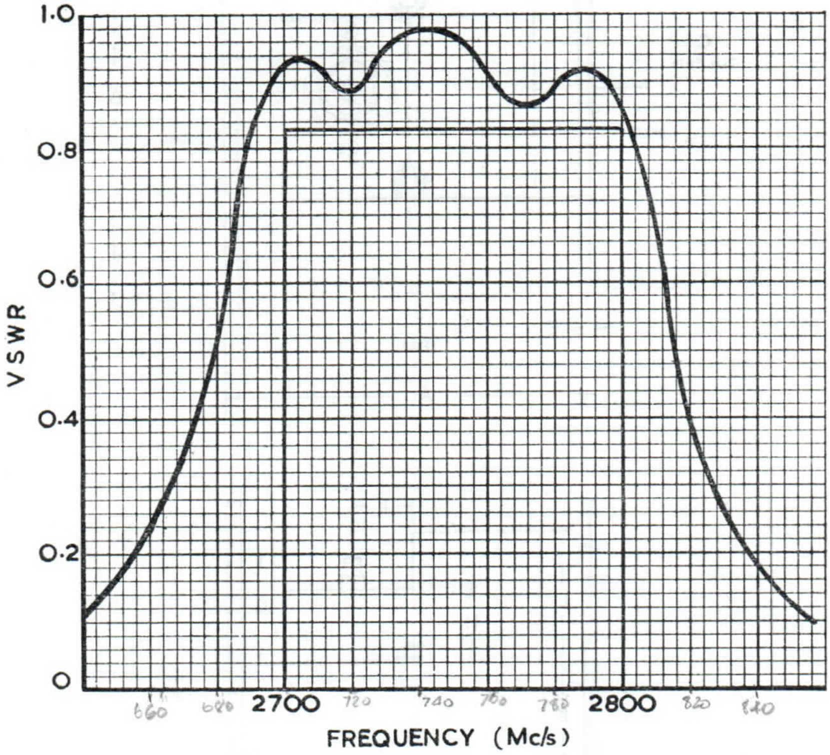
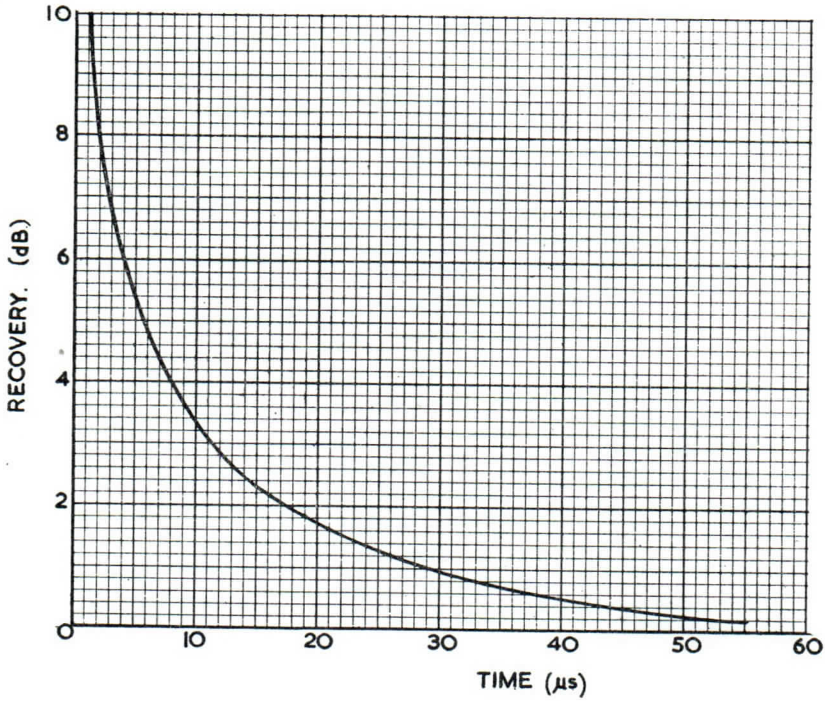
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



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AEI S Band TR Cell BS204

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	3000—3050	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

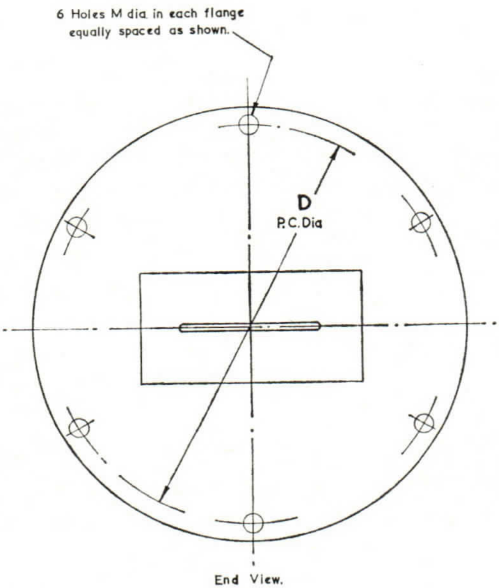
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

S BAND TR CELL. STYLE 'A'

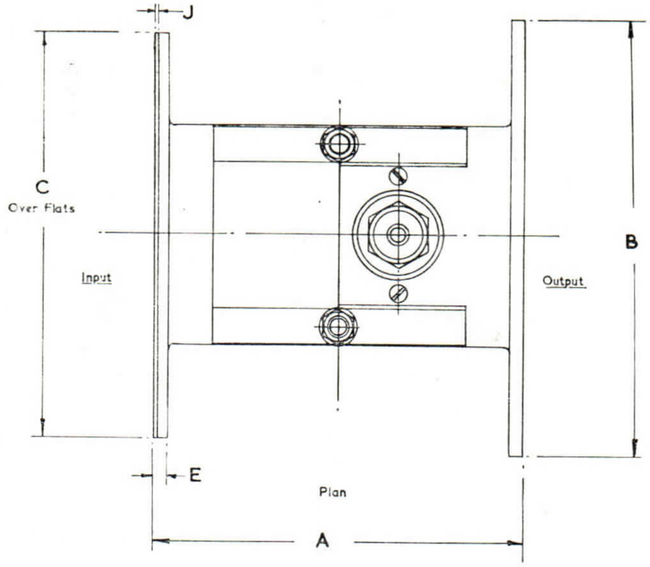
DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

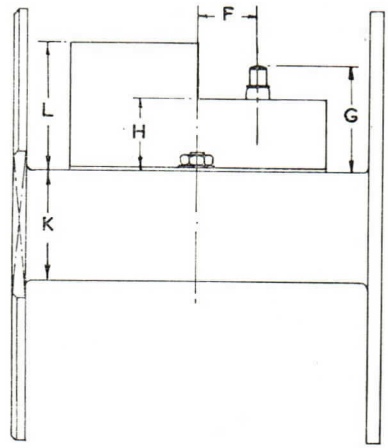
All dimensions in inches.
Millimetre dimensions derived.



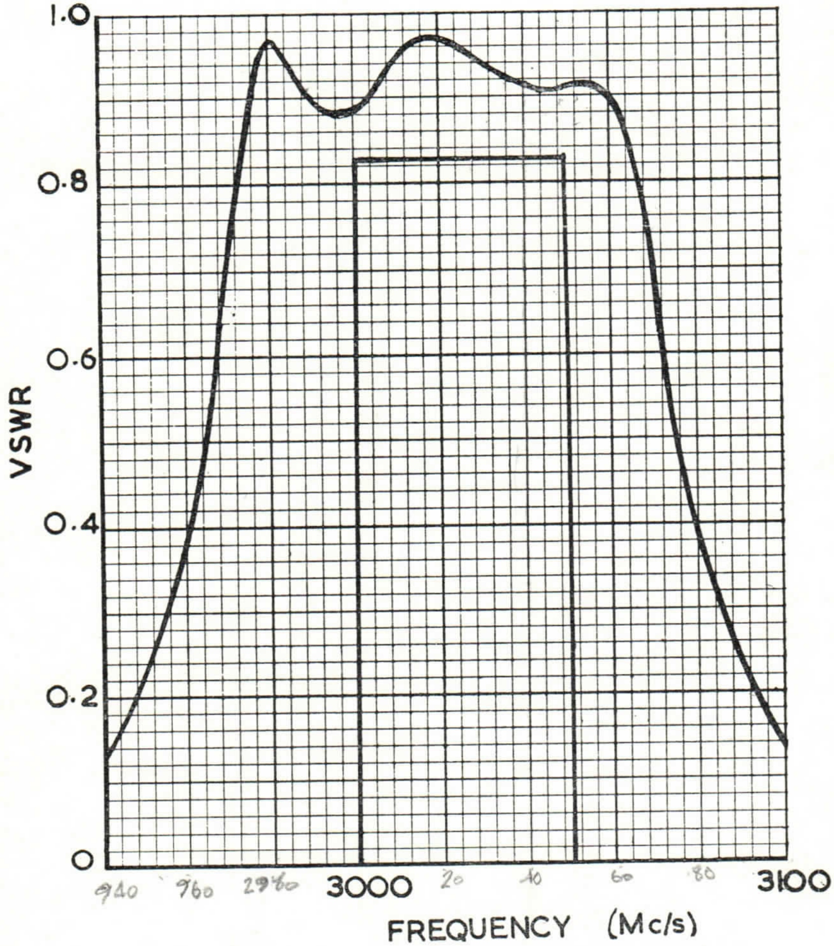
AEI S Band TR Cell

BS204

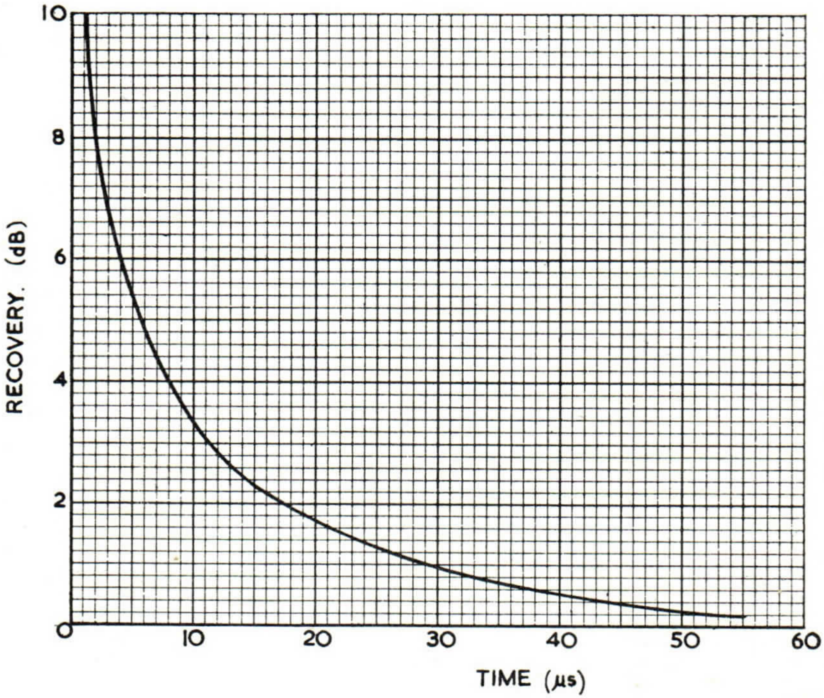




TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



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S Band TR Cell

BS272

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2940—3060	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

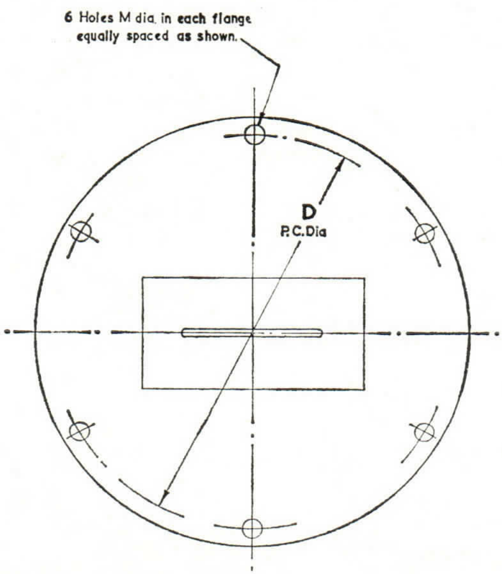
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

S BAND TR CELL. STYLE 'A'

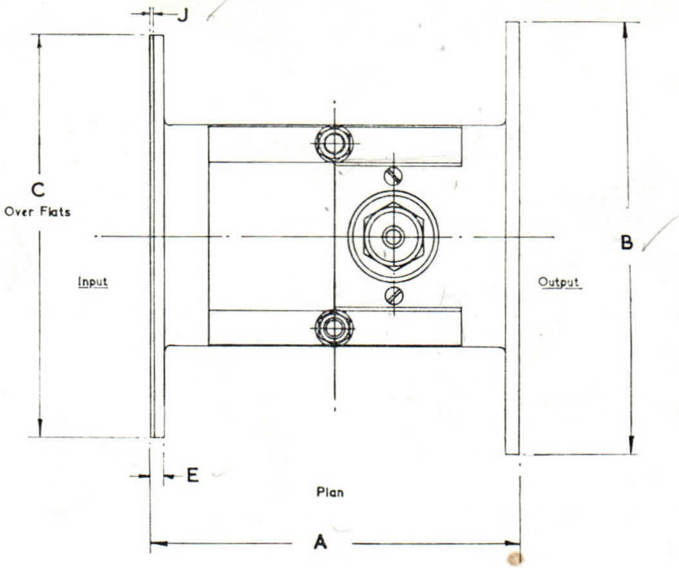
DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

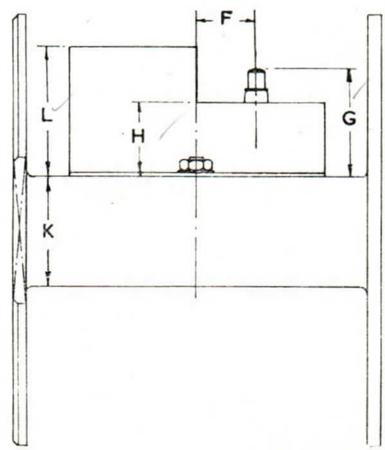
All dimensions in inches.
Millimetre dimensions derived.



End View.

AEI S Band TR Cell BS272





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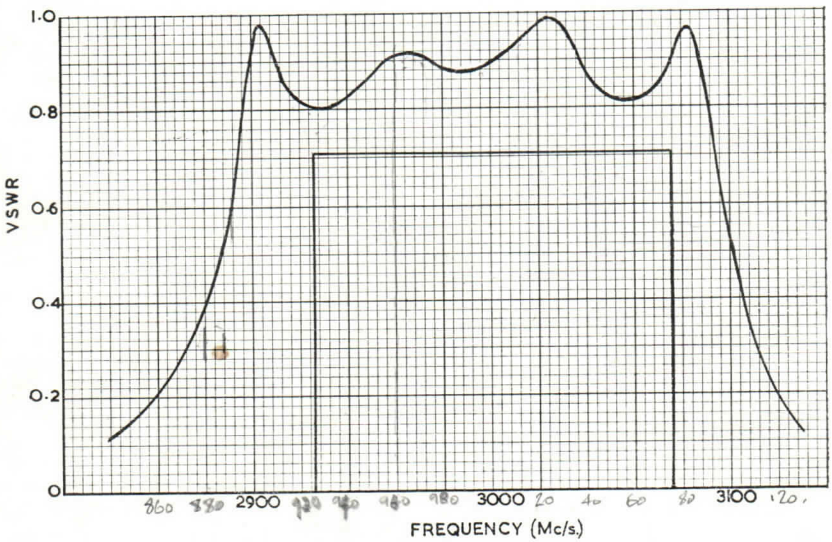
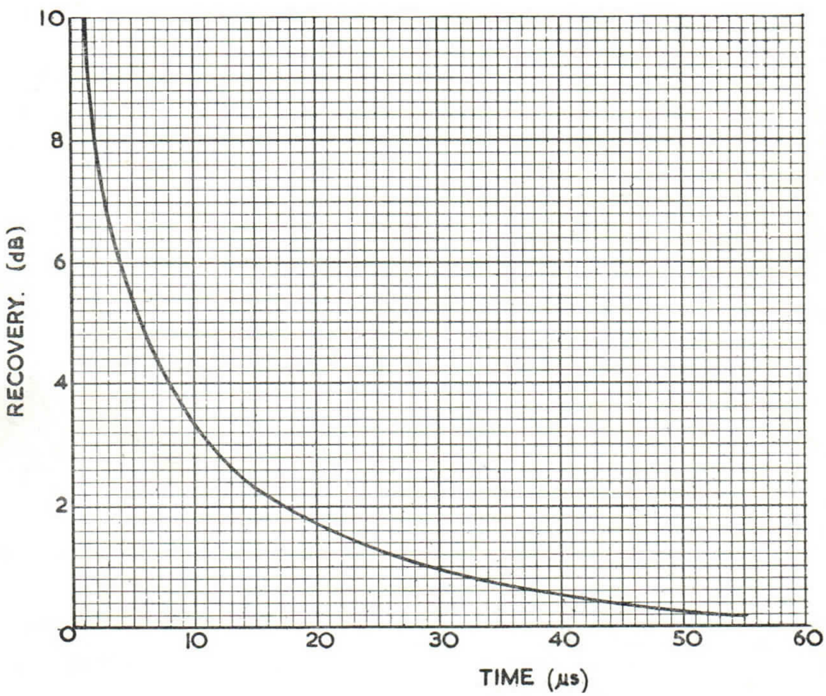
Issue 1
Feb 1962
4400-56/BS272

TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE

750 pps 2·5 µsec. 1·0 MW.



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AEI S Band TR Cell

BS280

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2900—3100	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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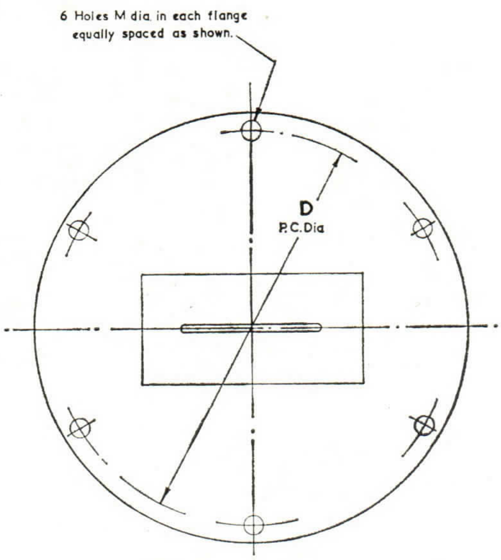
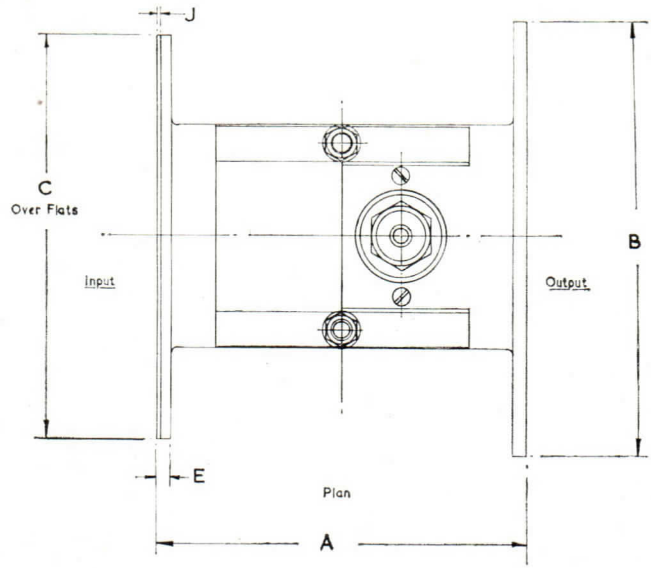
S BAND TR CELL. STYLE 'B'

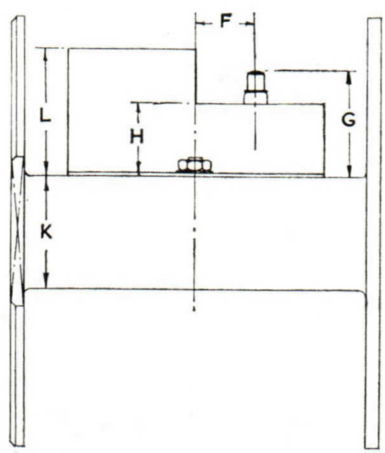
DIM	INCHES	MILLIMETRES
A	4·470 ± 0·005	113·6 ± 0·13
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·75 ± 0·062	19·06 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·0 ± 0·031	25·4 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

All dimensions in inches.
Millimetre dimensions derived.



End View.





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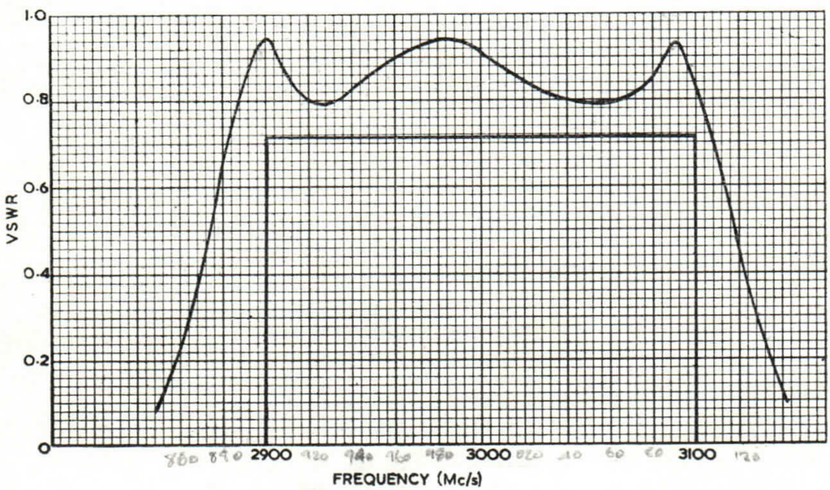
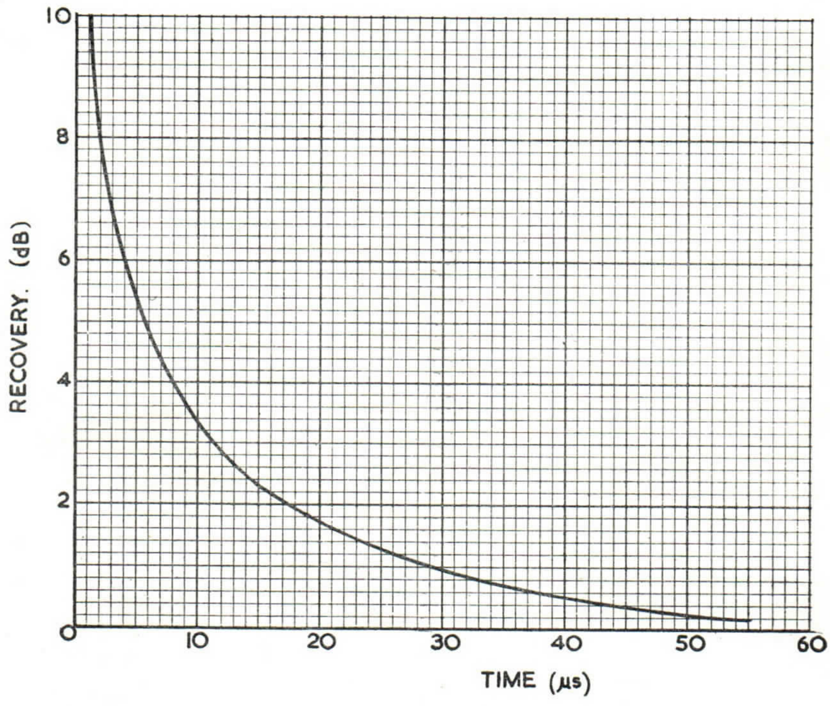
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



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S Band TR Cell

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2920—2980	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	µs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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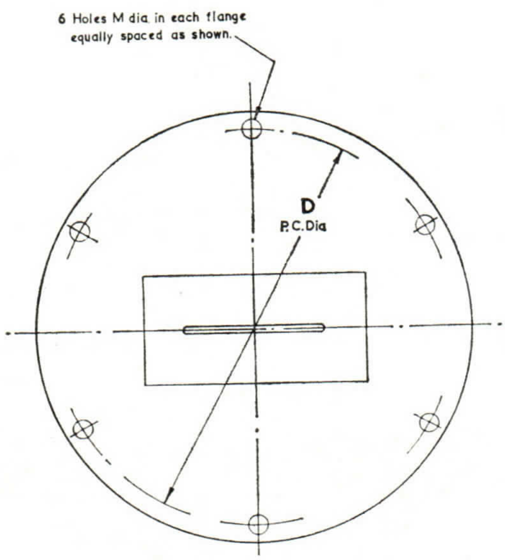
S BAND TR CELL. STYLE 'A'

DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

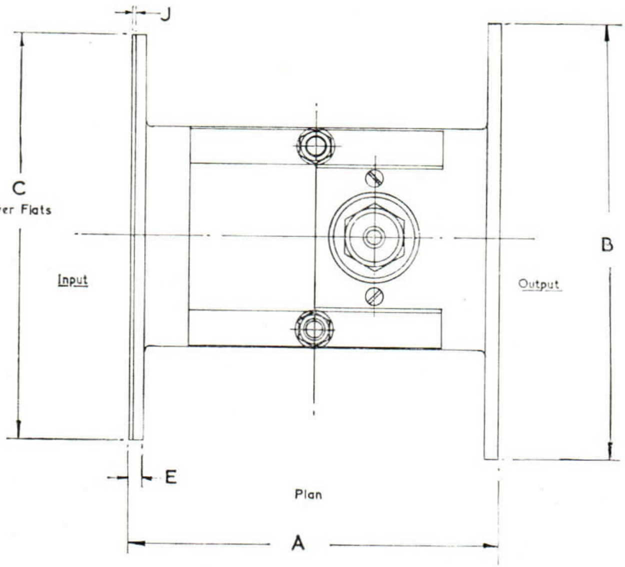
All dimensions in inches.
Millimetre dimensions derived.

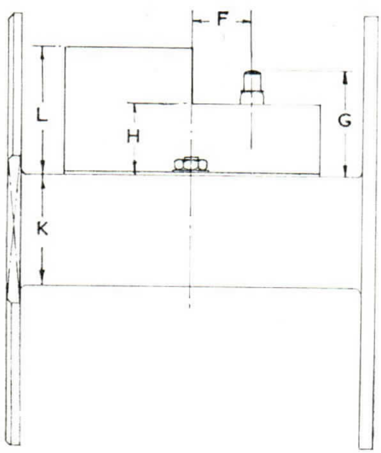


End View.

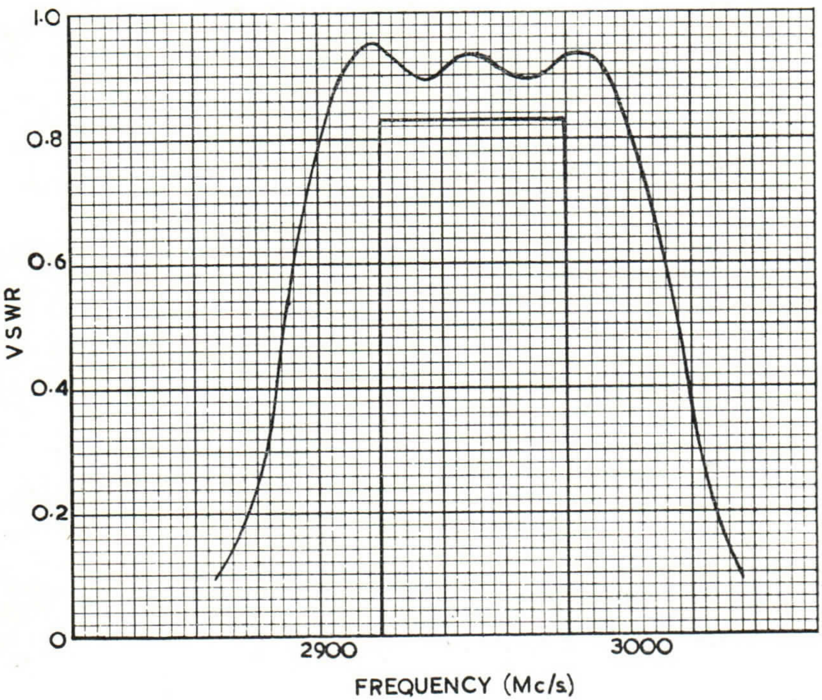
S Band TR Cell

BS282

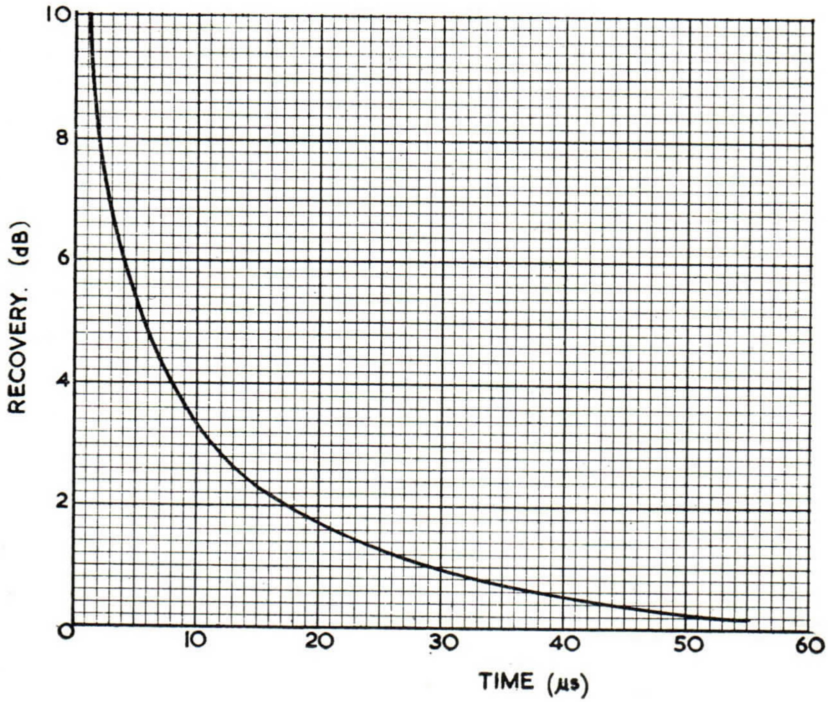




TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



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AEI S Band TR Cell BS286

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	3055—3105	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	µs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

Number of primer electrodes: One.

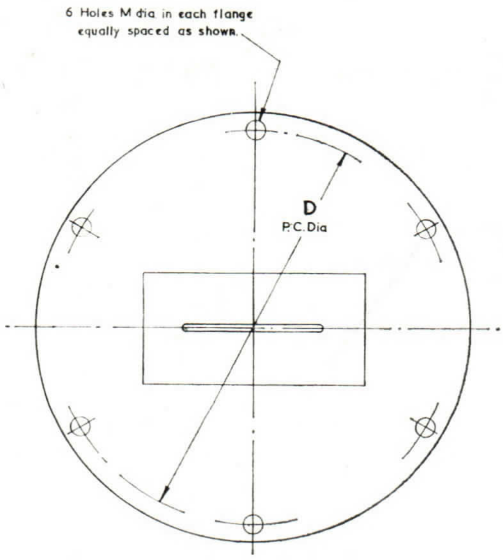
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

S BAND TR CELL. STYLE 'A'

DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

All dimensions in inches.

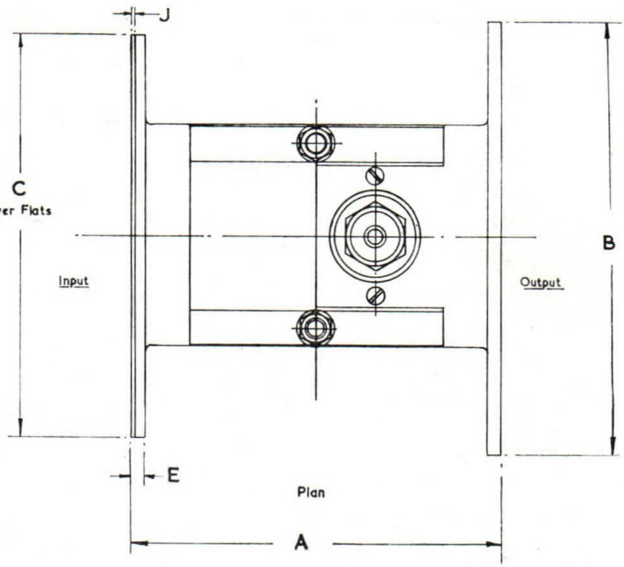
Millimetre dimensions derived.

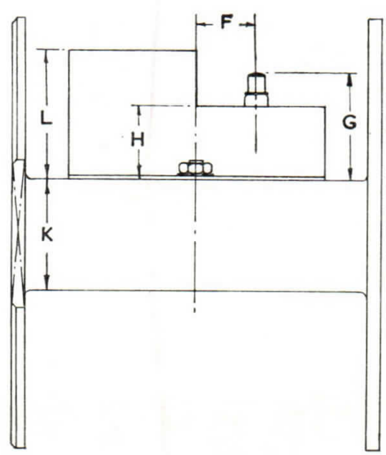


End View.

AEI S Band TR Cell

BS286





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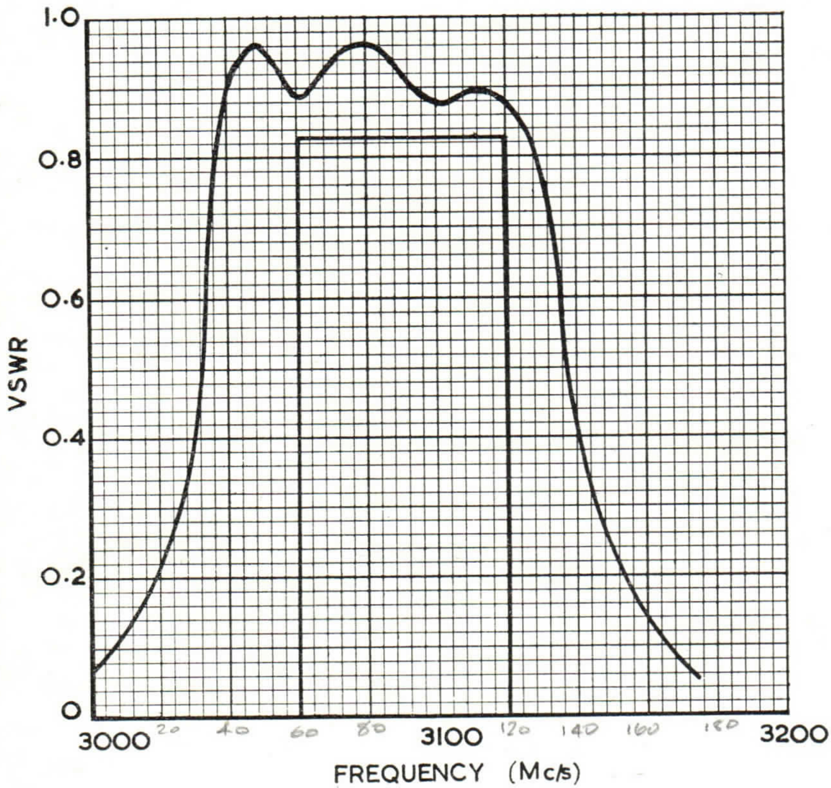
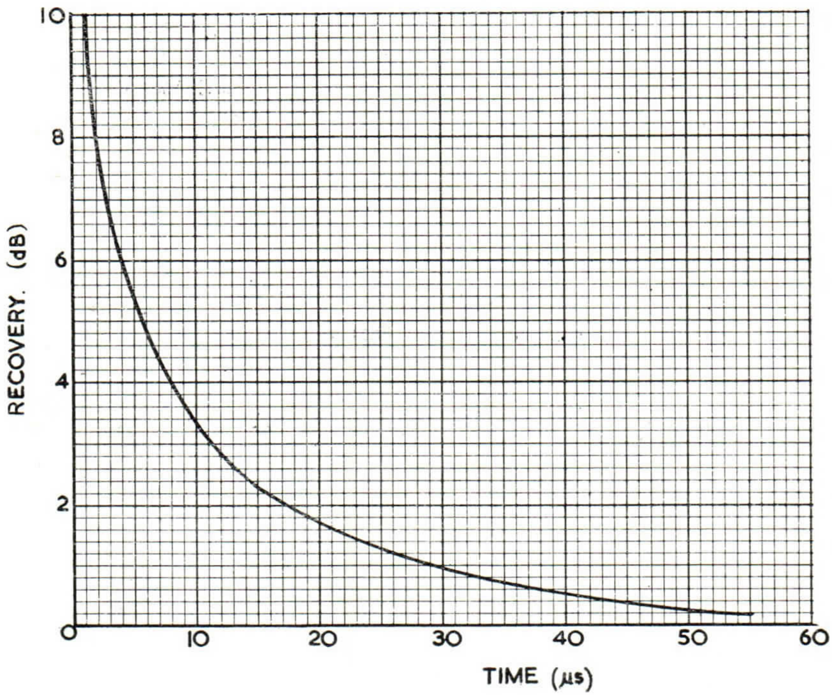
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



AEI S Band TR Cell

BS316

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	3000—3120	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

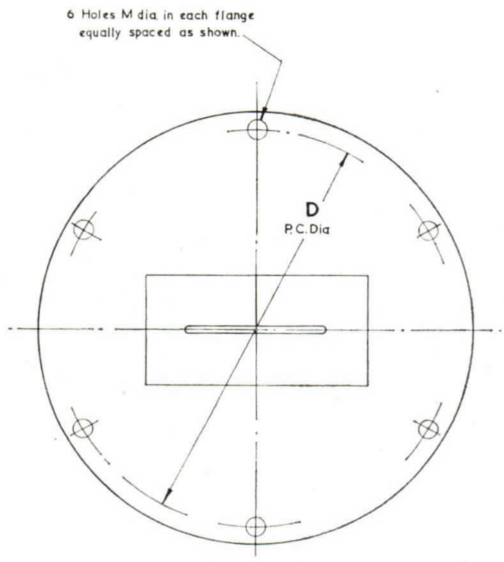
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

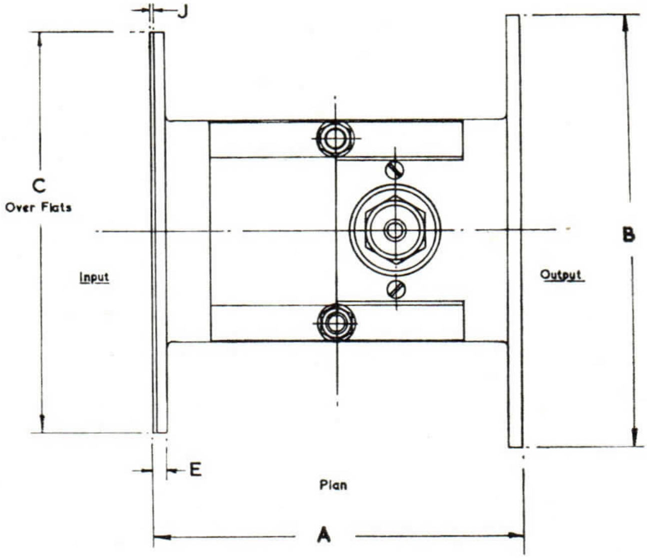
S BAND TR CELL. STYLE ~~'A'~~ B

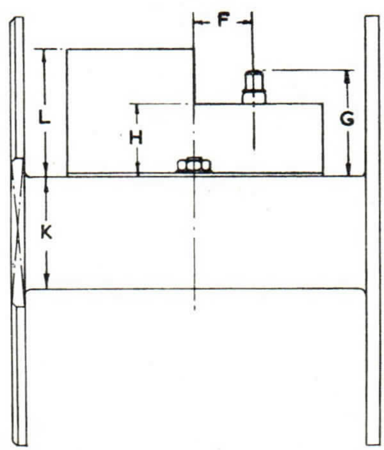
DIM	INCHES	MILLIMETRES
A	~~5·073 ± 0·01~~	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

All dimensions in inches.
Millimetre dimensions derived.



End View.





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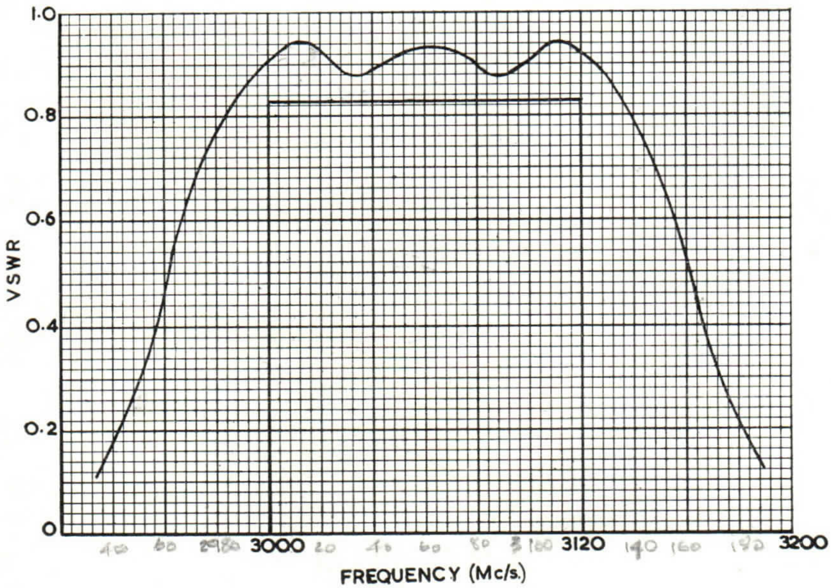
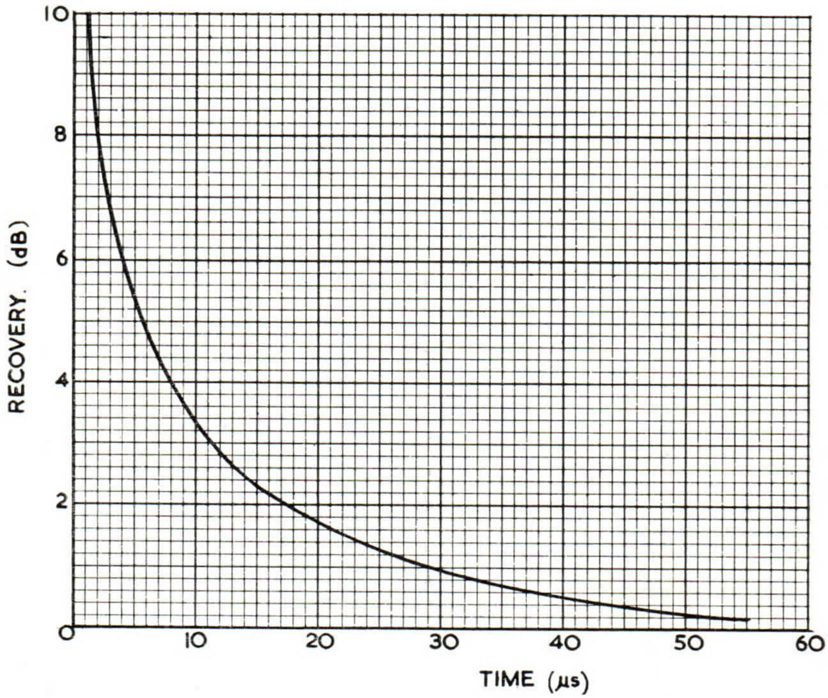
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



AEI S Band TR Cell BS318

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2750—2905	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	μs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

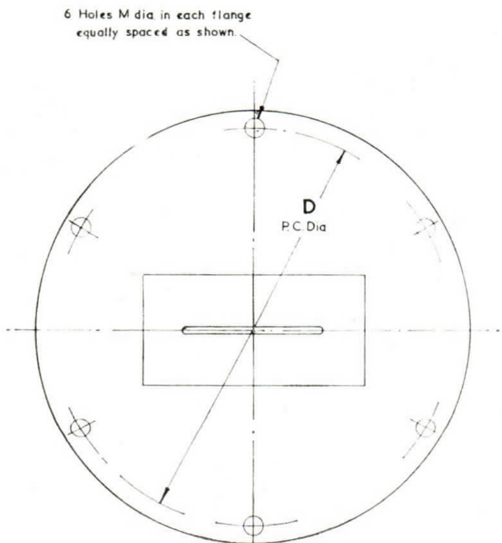
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

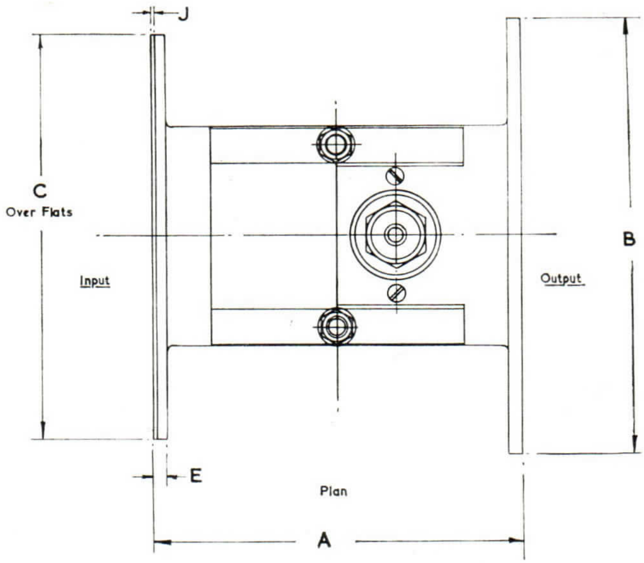
S BAND TR CELL. STYLE 'A'

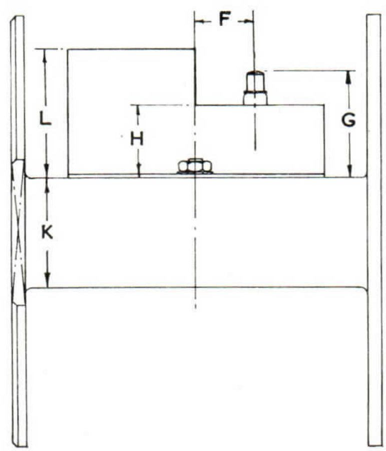
DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

All dimensions in inches.
Millimetre dimensions derived.

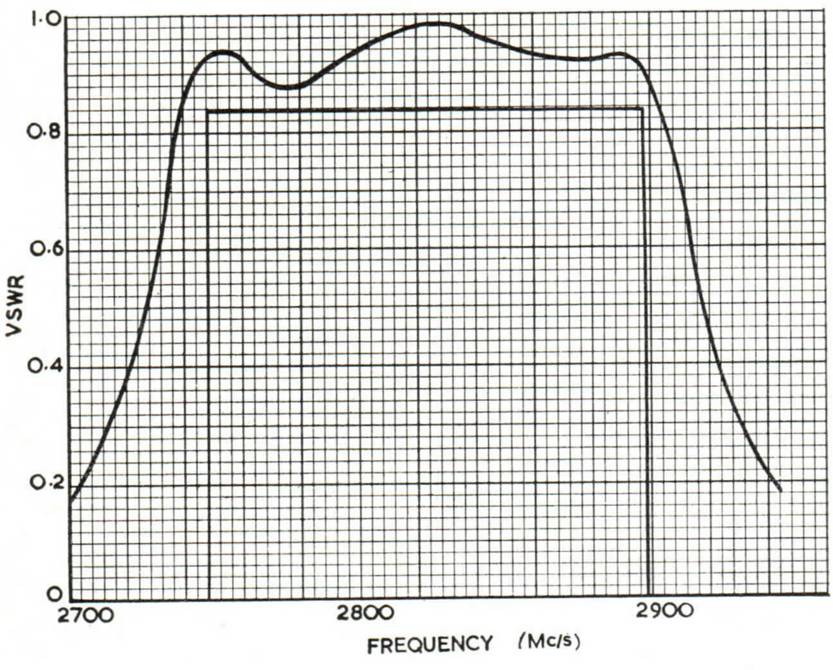


End View.

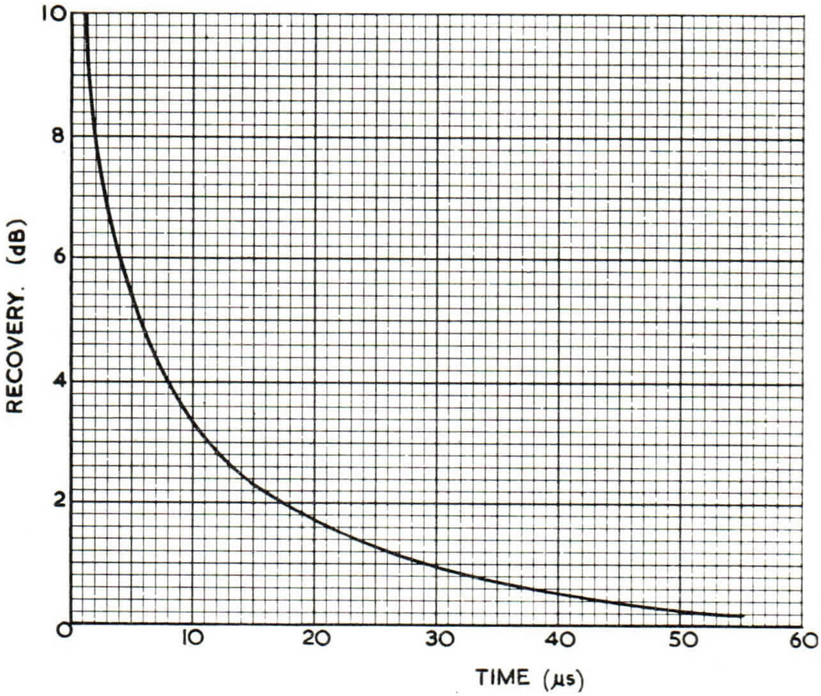

J
C
Over Flats
Input
Output
B
E
Plan
A


F
L
H
G
K

TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



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AEI S Band TR Cell BS324

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	2700—2900	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	1·0	dB
Peak power (see note 4)	1250	kW
Maximum leakage		
High power		
spike (see note 5)	0·25	erg
total (see note 6)	1·0	erg
Low power (see note 7)	500	mW
Maximum recovery at 6dB (see note 8)	15	µs
Maximum arc loss (see note 9)	0·8	dB
Position of short—nominal (see note 10)	0·062	in
	(1·6	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flange holes fit over six parallel pegs each 0·250 in. (6·35 mm) diameter equally spaced on a gauge on 5·375 in. (136·5 mm) P.C.D. Corresponding pegs of such a gauge where applied to either flange are in alignment within 0·020 in. (0·51 mm).

The two flange faces are flat and parallel within 0·005 in. (0·13 mm) over the area bounded by a circle of $5\frac{1}{8}$ in. (130 mm) diameter and concentric with the pitch circle.

Edges of input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG10 (3 in × $1\frac{1}{2}$ in) (76 mm × 38 mm).

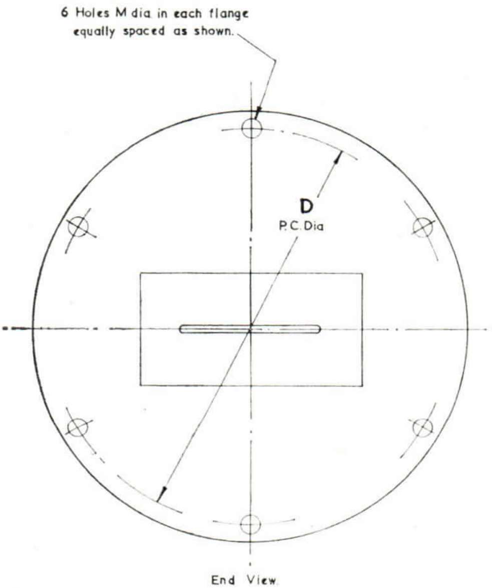
Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

S BAND TR CELL. STYLE 'A'

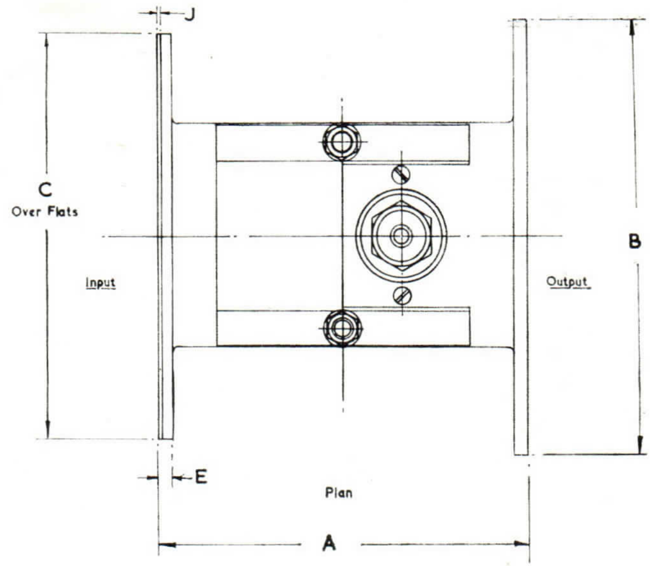
DIM	INCHES	MILLIMETRES
A	5·073 ± 0·01	128·8 ± 0·25
B	5·875 ± 0·031	149·2 ± 0·79
C	5·50 ± 0·031	139·7 ± 0·79
D	5·375 P.C.D.	136·5 P.C.D.
E	0·156 ± 0·031	3·96 ± 0·79
F	0·8125 ± 0·062	20·62 ± 1·59
G	1·625 MAX	41·25 MAX
H	1·125 MAX	28·55 MAX
J	0·0469 ± 0·0156	1·192 ± 0·4
K	1·50 ± 0·031	38·1 ± 0·79
L	1·875 MAX	47·6 MAX
M	0·260 ± 0·003	6·6 ± 0·08

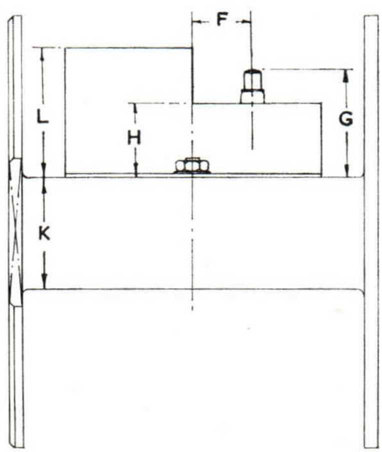
All dimensions in inches.
Millimetre dimensions derived.



S Band TR Cell

BS324





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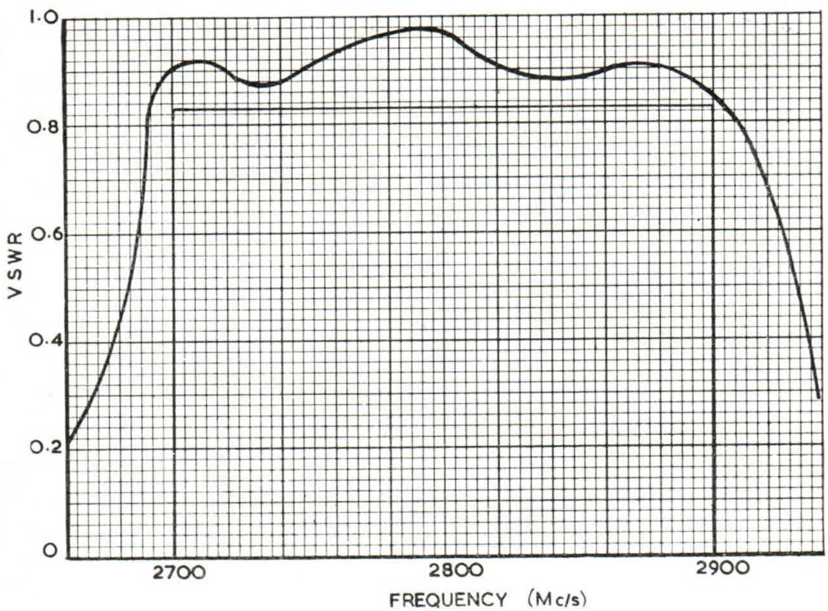
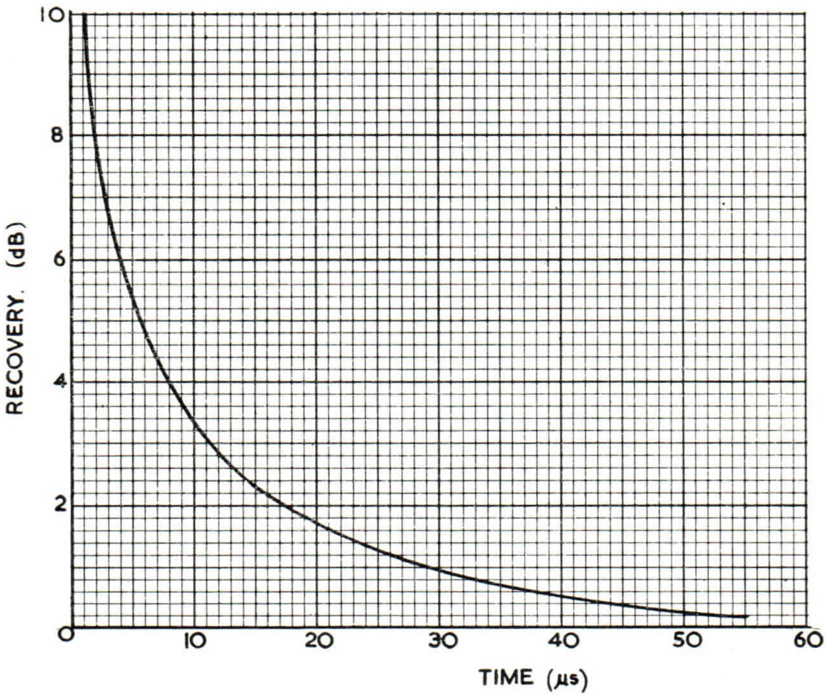
TYPICAL VSWR PERFORMANCE



TYPICAL RECOVERY PERFORMANCE



X Band TR Cells

AEI X Band TR Cells

NOTES

1. **Primer Supplies**

1.1. The primer supply voltage to be 1000V ± 50V d.c. having a peak to peak ripple voltage not exceeding 1% and negative with respect to the body of the cell.

1.2. The supply to be connected to the primer electrode through a resistance of 5·5 megohms.

1.3. A resistance of at least 0·5 megohm to be adjacent to the primer top cap.

1.4. The primer energising current is 90 to 150 μA.

1.5. The primer is energised in all tests carried out on the TR cells, except when the Primer Interaction is measured.

2. **Voltage Standing Wave Ratio**

2.1. The voltage standing wave ratio is measured, with an applied power of less than 10mW, at a number of frequencies equally spaced over the band.

2.2. The load is mounted directly behind the TR cell and its v.s.w.r. is better than 0·98.

3. **Low Level Insertion Loss and Primer Insertion Interaction**

3.1. The low level insertion loss is measured using a square law crystal and mounted behind a large padding attenuator. This combination gives matched impedance of v.s.w.r. $>$ 0·91. It is immediately preceded by a section of copper waveguide equal in length to that of the TR cell. The change of crystal current when the dummy section is replaced by the TR cell under test is a measure of insertion loss.

3.2. When the supply to the primer is turned off the change, if any, in the monitored crystal current is a measure of the primer insertion interaction. The interaction may be positive or negative.

3.3. The above tests are carried out at a power level of less than 10mW and at a frequency corresponding to the geometrical mean of the frequencies defining the ends of the band pass.

4. **Peak Power Handling Capacity**

4.1. The peak power quoted in the table is that found in general radar practice and at which the performance of the device had been evaluated.

4.2. When the cells are used at higher levels than specified, the useful life of the device may or may not be somewhat reduced.

5. **High Power Leakage: Spike and Flat**

5.1. The spike leakage energy is measured at a frequency within the band pass of the valve and at a power level of 40 kW 1000 p/s.

5.2. The measurement is carried out at two pulse lengths, 0·1 and 1 μs. All the power which breaks through at the shorter pulse is measured on a thermistor bridge and regarded as the spike leakage energy.

5.3. Similarly, the energy measured with the 1 μs pulse gives the total break through power, and the difference between the total and the spike leakage energies is equal to the flat break through power.

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6. **Low Power Leakage**

6.1. This measurement is carried out at 40 kW peak pulse power, 1 μs pulse length and 1000 p/s.

6.2. A portion of the magnetron output power is passed through a directive feed, variable attenuator, TR cell under test and monitored on a thermistor bridge. The level of this power is increased from a very small magnitude up to the value which causes the primer r.f. gap to ionise. This condition is noticed by a sudden drop in the power reaching the monitor. The value of the power at which the ionisation takes place is the maximum low power leakage.

7. **Recovery Loss**

7.1. The measurement is carried out under the conditions stipulated in 6.1.

7.2. Two pulses are fed through a variable attenuator and a directive feed into the main waveguide. They are directed towards the TR cell under test and a water load. The pulses of approximately 0·1 μs duration are timed so that the first pulse occurs half way between magnetron pulses, while the second one is generated after an adjustable interval following the magnetron pulse. The difference in dBs between the two pulses is the attenuation due to ionisation caused by the high power pulse.

8. **Arc Loss**

8.1. This measurement is carried out under test conditions specified in 7.1.

8.2. In the circuit used for the measurement of arc loss, the TR cell is mounted on the main waveguide and followed by a directive feed and a matched load. A fraction of the power passing the cell is measured by a thermistor bridge terminating one arm of the directive feed. The difference in dB in power levels when the TR cell is replaced by a short circuit plate is equal to the arc loss of the valve.

9. **Short Circuit Position**

9.1. This measurement is carried out under test conditions specified in 5.1.

9.2. Magnetron power is fed into arm 1 of a ring-circuit magic T. Arm 2, $\frac{1}{4}\lambda_g$ from arm 1, is terminated with a variable short circuit. Arm 3 and 4, $\frac{1}{2}\lambda_g$ and $\frac{3}{4}\lambda_g$ from Arm 1 respectively, carry a water load and the TR cell under test. The variable short circuit is adjusted for minimum reflection in the main guide and its position is noted. The TR cell is replaced by a flat short circuiting plate, similar in dimension to the input flange, and the position of the short circuit termination is re-adjusted for minimum reflection in the main waveguide. The difference between the two readings of the short circuit positions is equal to the distance of the TR cell short with respect to the plane of the flange.

AEI X Band TR Cell BS52

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	9320—9500	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·7	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·25	erg
total	0·7	erg
Low power (see note 6)	500	mW
Maximum recovery at 6dB (see note 7)	2	μs
Maximum arc loss (see note 8)	0·8	dB
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

Used in conjunction with WG16 (1 in × $\frac{1}{2}$ in) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

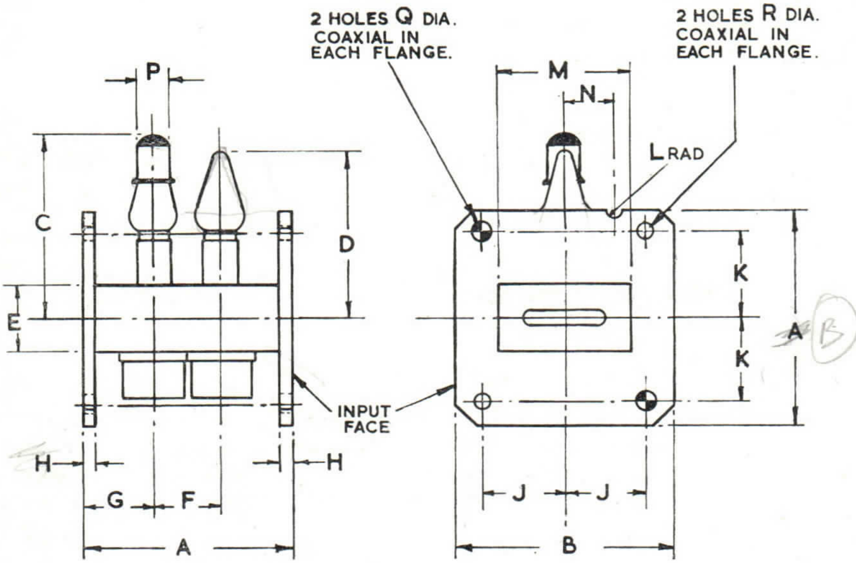
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

Weight (unpacked) 4 oz (110 gm).

X Band TR Cell

AEI

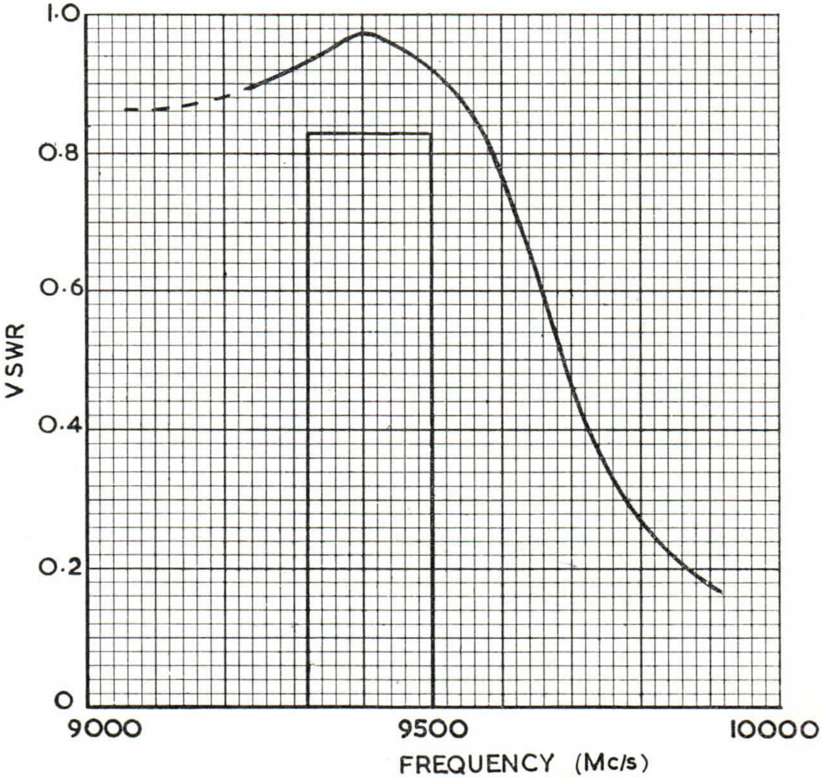
X BAND TR CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	1$\frac{5}{8}$	41·3
C	1$\frac{3}{8}$ MAX	34·9 MAX
D	1$\frac{1}{4}$ MAX	31·75 MAX
E	$\frac{1}{2}$	12·7
F	$\frac{1}{2}$	12·7
G	$\frac{17}{32}$	13·5
H	$\frac{3}{32}$ MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	$\frac{1}{4}$ DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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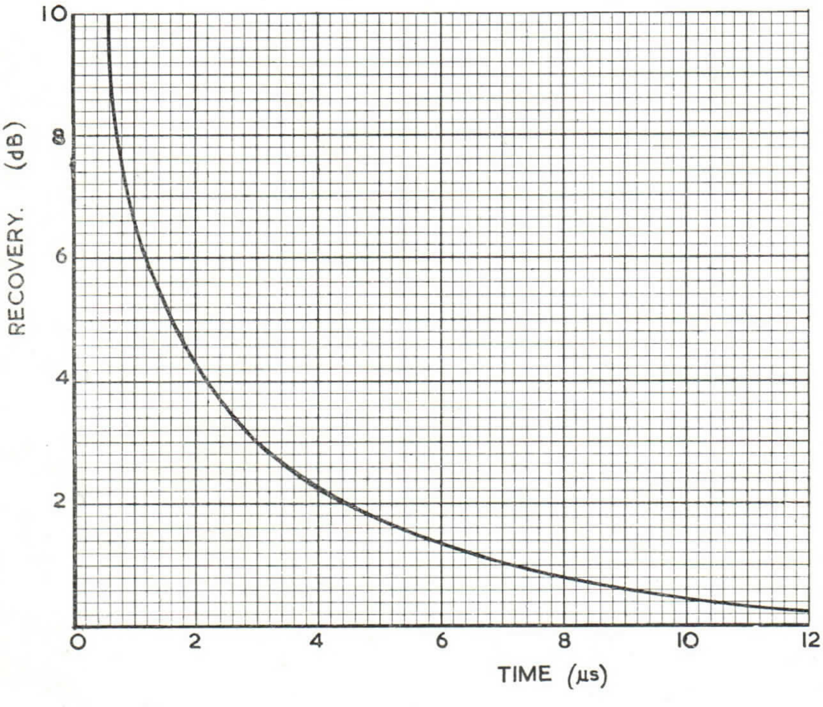
TYPICAL RECOVERY PERFORMANCE
at 40 kW peak power, 1 µs pulse length, 1000 p/s



AEI X Band TR Cell

BS120

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	8500—9050	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·8	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·20	erg
total	0·7	erg
Low power (see note 6)	400	mW
Maximum recovery at 6dB (see note 7)	4	µs
Maximum arc loss (see note 8)	0·8	dB
Position of short (see note 9)	0·021 ± 0·007	in
	(0·53 ± 0·18	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

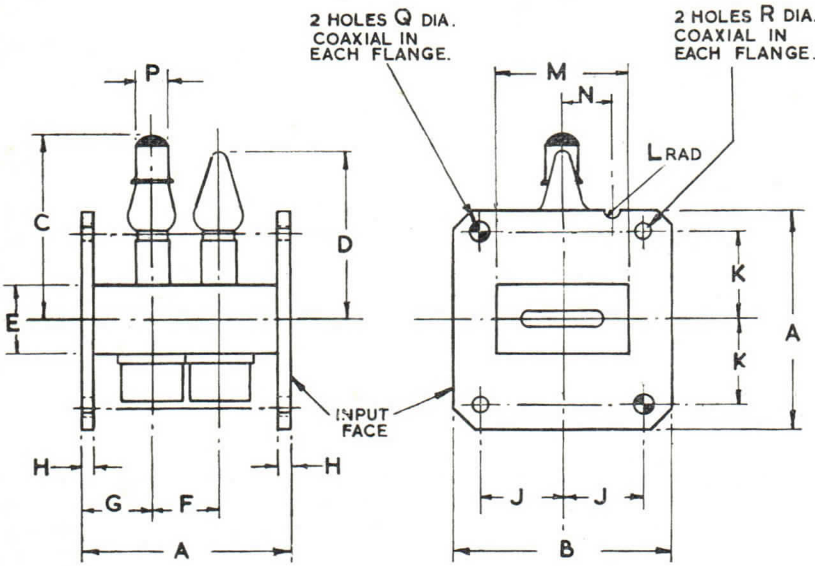
Used in conjunction with WG16, (1 in. × $\frac{1}{2}$ in.) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

Weight (unpacked) 4 oz (110 gm).

X BAND TR CELL. STYLE 'A'

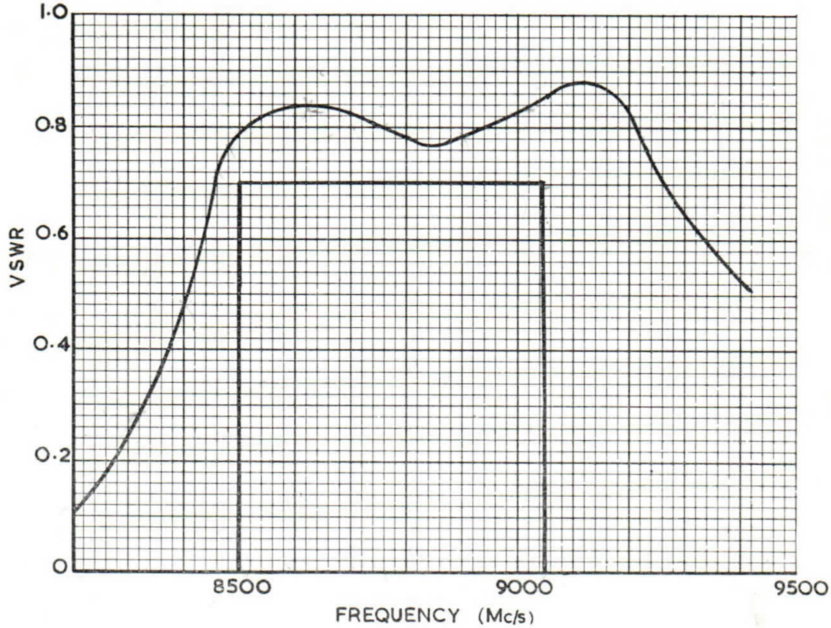


DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	$1\frac{5}{8}$	41·3
C	$1\frac{3}{8}$ MAX	34·9 MAX
D	$1\frac{1}{4}$ MAX	31·75 MAX
E	$\frac{1}{2}$	12·7
F	$\frac{1}{2}$	12·7
G	$\frac{17}{32}$	13·5
H	$\frac{3}{32}$ MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	$\frac{1}{4}$ DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.

Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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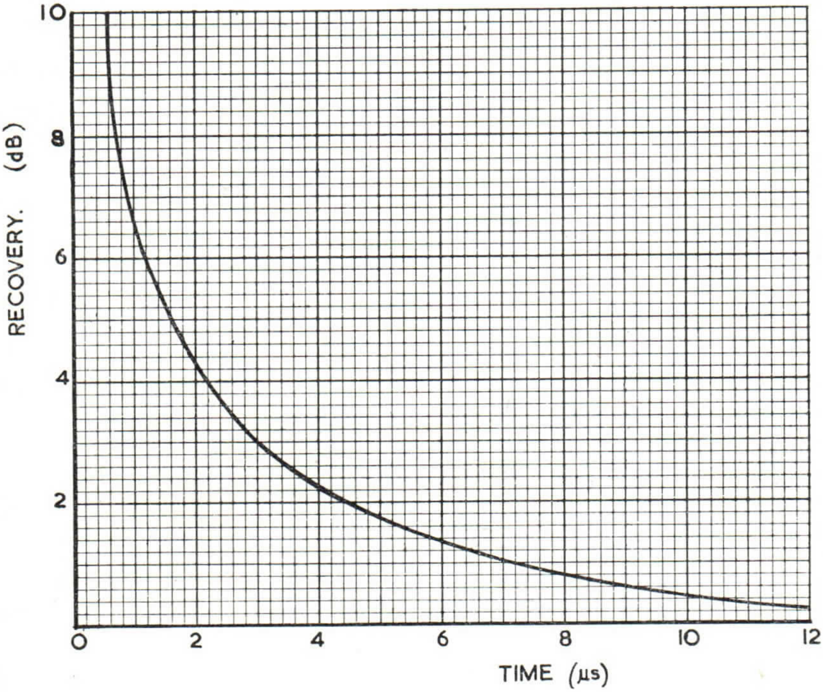
TYPICAL RECOVERY PERFORMANCE
at 40 kW peak power, 1 μs pulse length, 1000 p/s



AEI X Band TR Cell BS122

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	9050—9600	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·8	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·20	erg
total	0·7	erg
Low power (see note 6)	400	mW
Maximum recovery at 6dB (see note 7)	4	μs
Maximum arc loss (see note 8)	0·8	dB
Position of short (see note 9)	0·021 ± 0·007	in
	(0·53 ± 0·18	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on G1W6. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

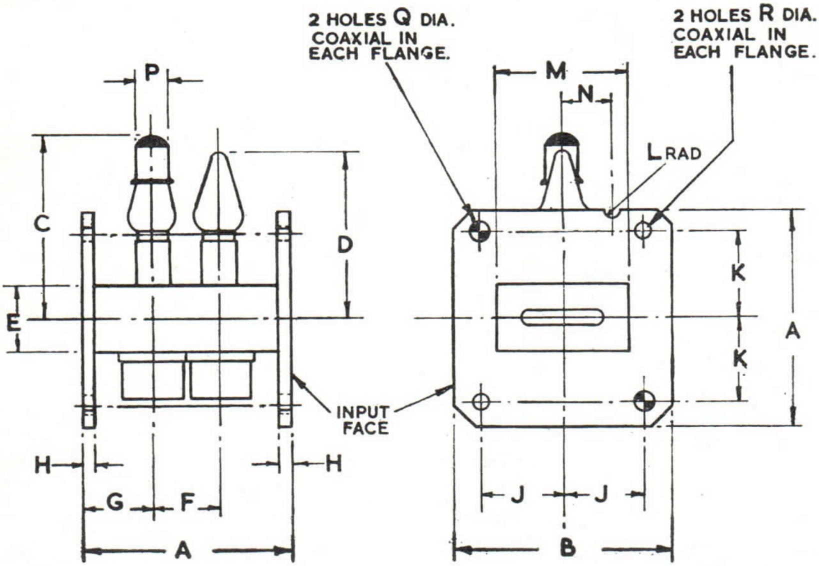
Used in conjunction with WG16 (1 in × ½ in) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

Weight (unpacked) 4 oz (110 gm).

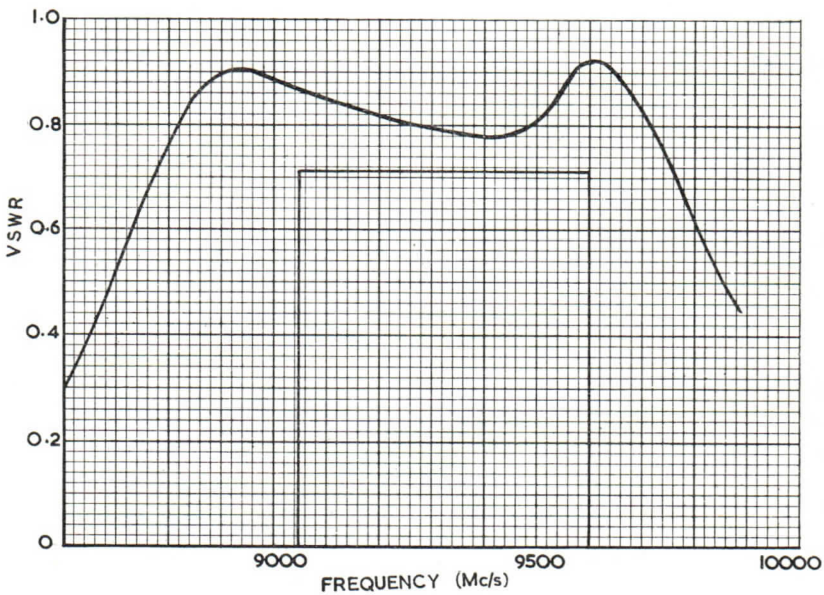
X BAND TR CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	$1\frac{5}{8}$	41·3
C	$1\frac{3}{8}$ MAX	34·9 MAX
D	$1\frac{1}{4}$ MAX	31·75 MAX
E	$\frac{1}{2}$	12·7
F	$\frac{1}{2}$	12·7
G	$\frac{17}{32}$	13·5
H	$\frac{3}{32}$ MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	$\frac{1}{4}$ DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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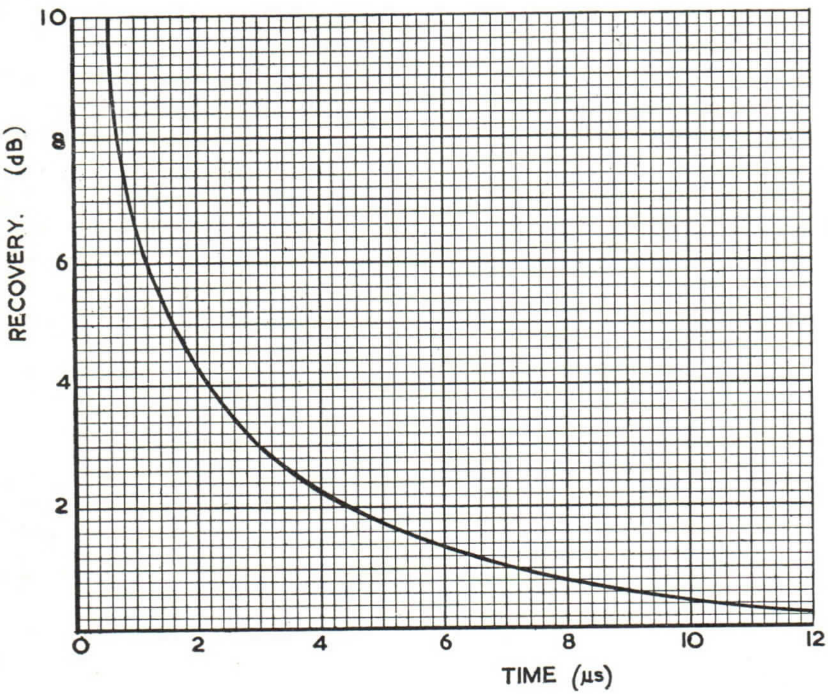
TYPICAL RECOVERY PERFORMANCE
at 40 kW peak power, 1 μs pulse length, 1000 p/s



AEI X Band TR Cell

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	9400—10000	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·8	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·20	erg
total	1·0	erg
Low power (see note 6)	250	mW
Maximum recovery at 6dB (see note 7)	4	µs
Maximum arc loss (see note 8)	0·8	dB
Position of short (see note 9)	0·021 ± 0·007	in
	(0·53 ± 0·18	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

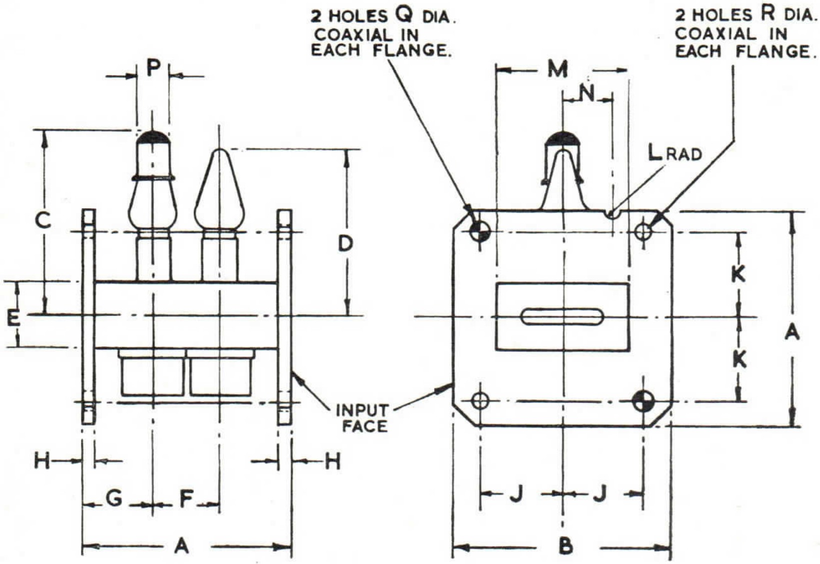
Used in conjunction with WG16 (1 in × ½ in) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

Weight (unpacked) 4 oz (110 gm).

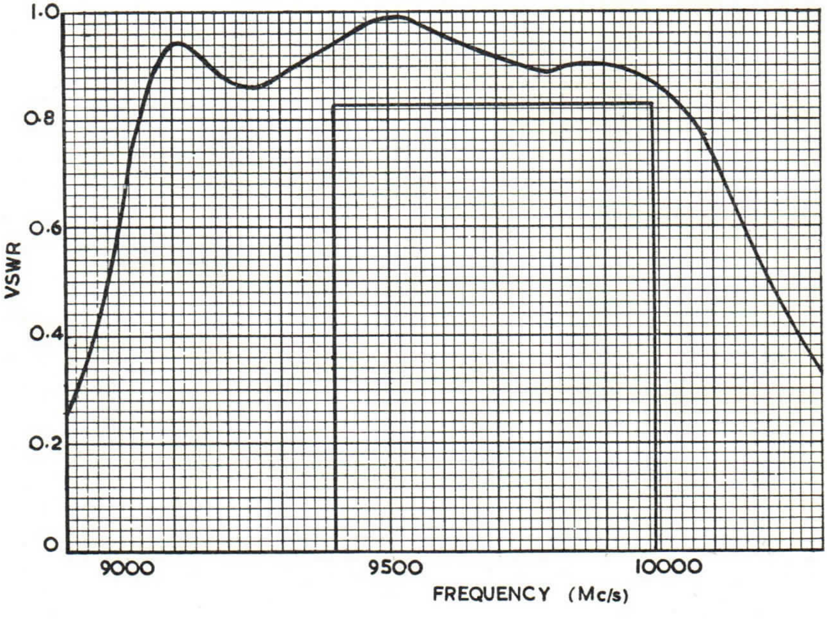
X BAND TR CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	1$\frac{5}{8}$	41·3
C	1$\frac{3}{8}$ MAX	34·9 MAX
D	1$\frac{1}{4}$ MAX	31·75 MAX
E	$\frac{1}{2}$	12·7
F	$\frac{1}{2}$	12·7
G	$\frac{17}{32}$	13·5
H	$\frac{3}{32}$ MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	$\frac{1}{4}$ DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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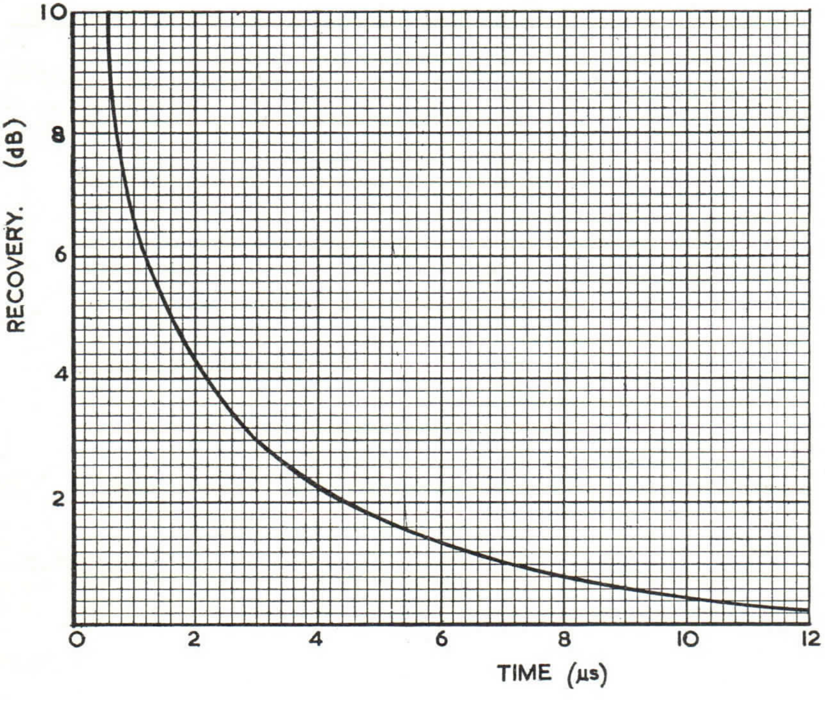
TYPICAL RECOVERY PERFORMANCE
at 40 kW peak power, 1 µs pulse length, 1000 p/s



AEI X Band TR Cell BS156

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	9000—9600	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·8	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·20	erg
total	1·0	erg
Low power (see note 6)	250	mW
Maximum recovery at 6dB (see note 7)	4	μs
Maximum arc loss (see note 8)	0·8	dB
Position of short (see note 9)	0·021 ± 0·007	in
	(0·53 ± 0·18	mm)
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

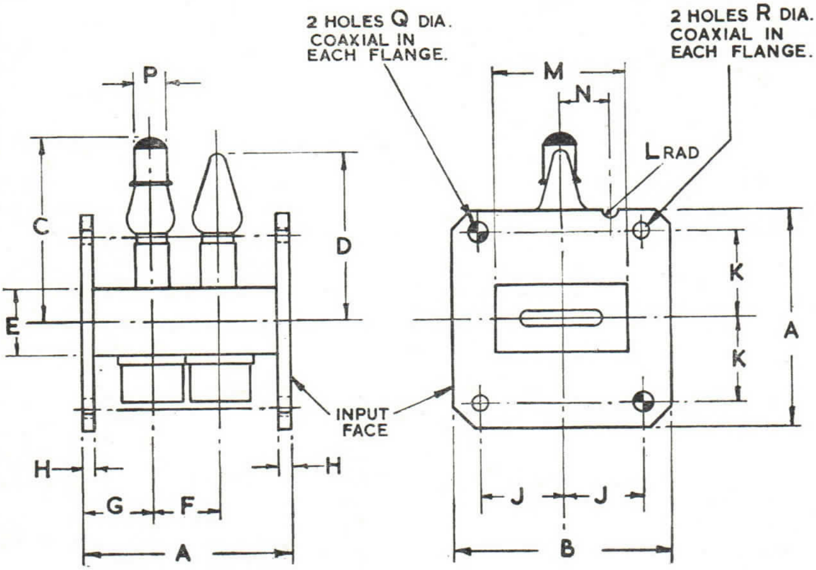
Used in conjunction with WG16 (1 in × ½ in) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

Weight (unpacked) 4 oz (110 gm).

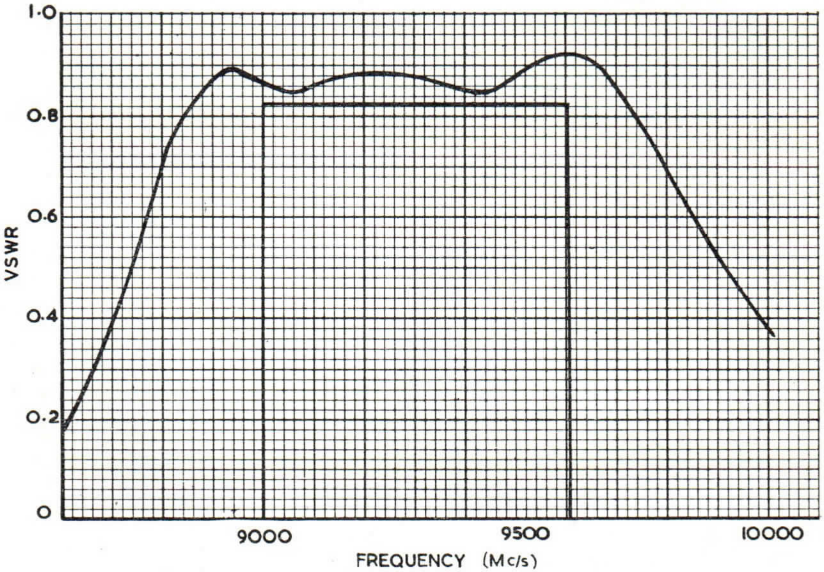
X BAND TR CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	$1\frac{5}{8}$	41·3
C	$1\frac{3}{8}$ MAX	34·9 MAX
D	$1\frac{1}{4}$ MAX	31·75 MAX
E	$\frac{1}{2}$	12·7
F	$\frac{1}{2}$	12·7
G	$\frac{17}{32}$	13·5
H	$\frac{3}{32}$ MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	$\frac{1}{4}$ DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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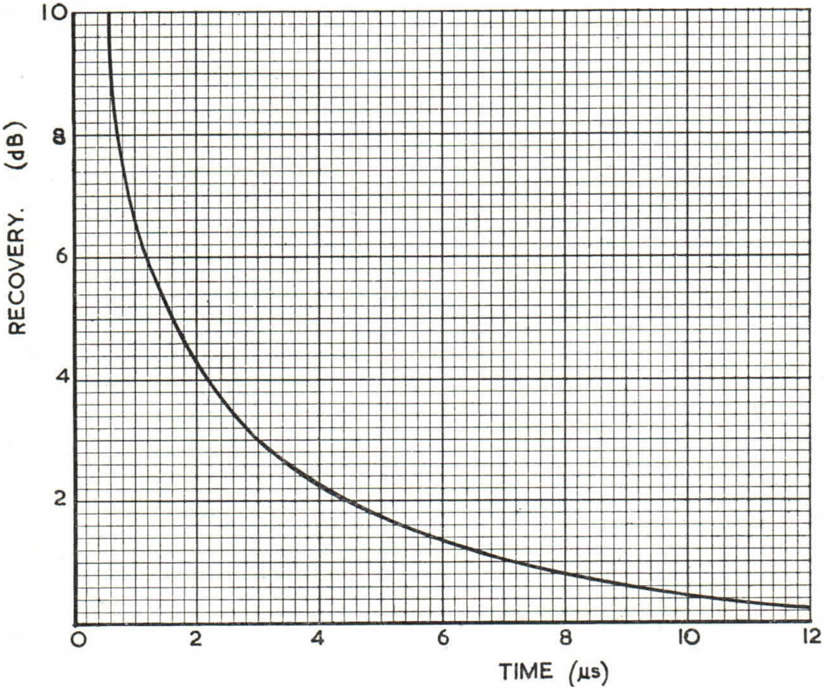
TYPICAL RECOVERY PERFORMANCE
at 40 kW peak power, 1 μs pulse length, 1000 p/s



AEI X Band TR Cell BS158

RATINGS—(See "Notes" at beginning of section)

Frequency range (see note 1)	8500—9100	Mc/s
Minimum v.s.w.r. (see note 2)	0·83	
Maximum loss (see note 3)	0·8	dB
Operating power (see note 4)	5—50	kW
Maximum leakage		
High power (see note 5)		
spike	0·20	erg
total	1·0	erg
Low power (see note 6)	250	mW
Maximum recovery at 6dB (see note 7)	4	μs
Maximum arc loss (see note 8)	0·8	dB
Position of short (see note 9)	0·021 ± 0·007	in
	(0·53 ± 0·18	mm)
Ambient (non-operating) temperature range	−40 to + 100	°C

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping. The notch at the top of the flange may be used to locate the input end against a peg, and in this way prevent an accidental insertion of the valve the wrong way round.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin or silver plated.

Mounting Position: Any.

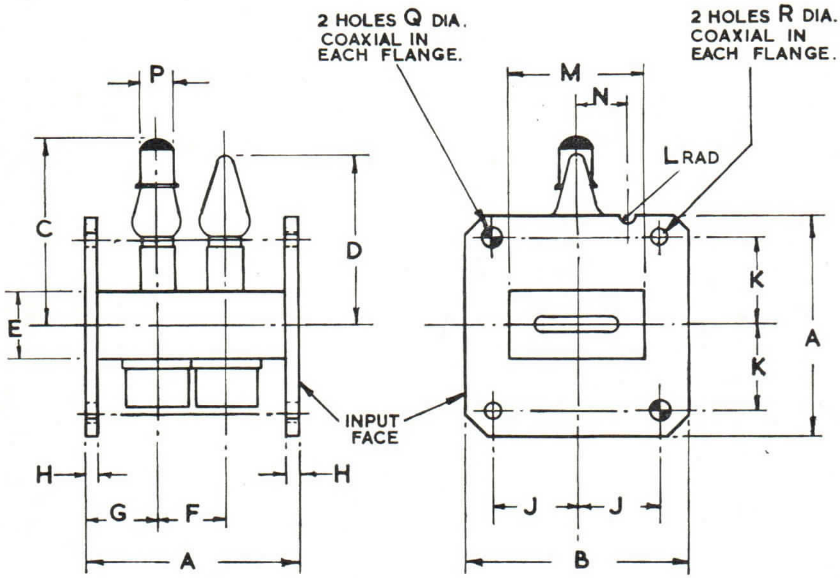
Used in conjunction with WG 16 (1 in × ½ in) (25·4 mm × 12·7 mm).

Number of primer electrodes: One.

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

Weight (unpacked) 4 oz (110 gm).

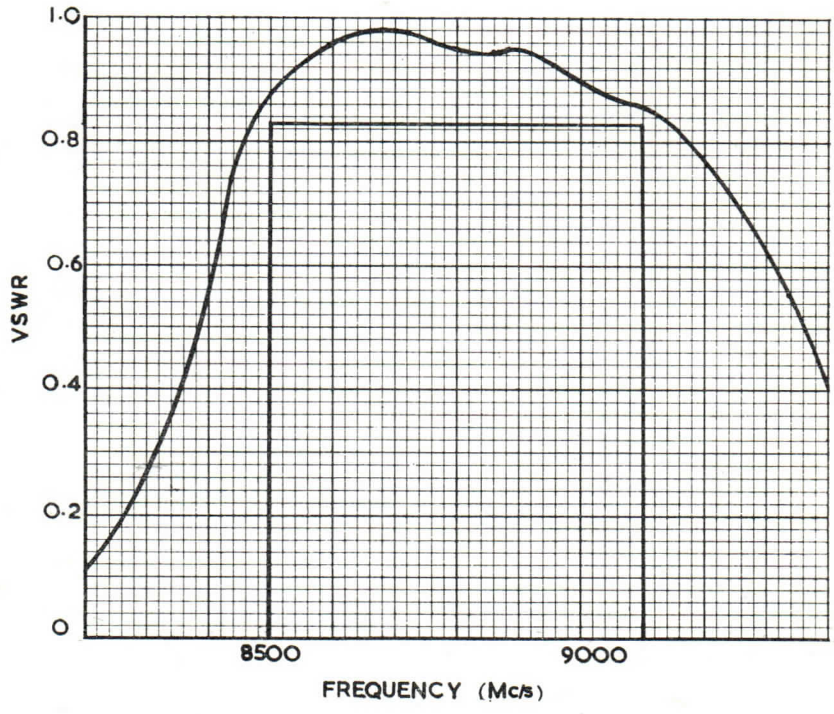
X BAND TR CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1·555 ± 0·002	39·50 ± 0·05
B	1 5/8	41·3
C	1 3/8 MAX	34·9 MAX
D	1 1/4 MAX	31·75 MAX
E	1/2	12·7
F	1/2	12·7
G	17/32	13·5
H	3/32 MIN	2·4 MIN
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 + 0·031	1·6 + 0·8
M	1·0	25·4
N	0·375 ± 0·005	9·5 ± 0·13
P	1/4 DIA	6·2/6·5 DIA
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL VSWR PERFORMANCE



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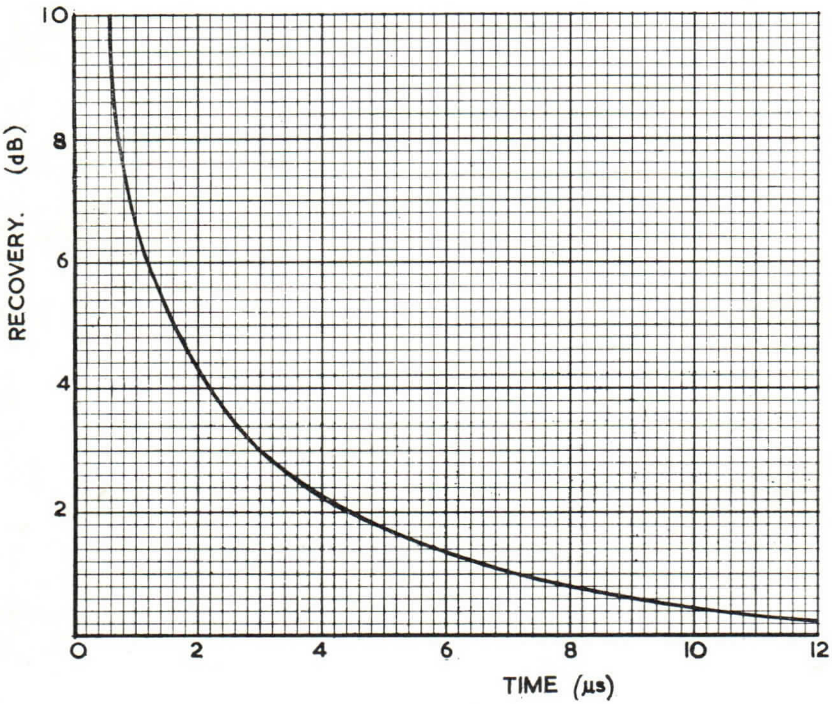
TYPICAL RECOVERY PERFORMANCE

at 40 kW peak power, 1 μs pulse length, 1000 p/s



AEI X Band TR Cell BS328

Provisional Information

This X Band TR cell incorporates a P-N junction diode which can be pre-pulsed so as to reflect the whole of the incident magnetron power.

SPECIFICATION—(See Preamble at beginning of "Microwave Switches" section)

Minimum v.s.w.r.	0·83	
Maximum insertion loss	1	dB
Operating power (at 0·001 duty cycle)	50	kW
Band width	600	Mc/s
*Attenuation range	1–25	dB
Maximum operating voltage	1·0	V
Maximum operating current	30	mA
Recovery time at 6dB	2	μs

* Corresponds to varying the applied current between 0 and 30mA.

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin plated.

Mounting position: Any.

Used in conjunction with WG16 (1 in x $\frac{1}{2}$ in) (25·4 mm x 12·7 mm).

Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

Weight (unpacked) 4 oz (110 gm).

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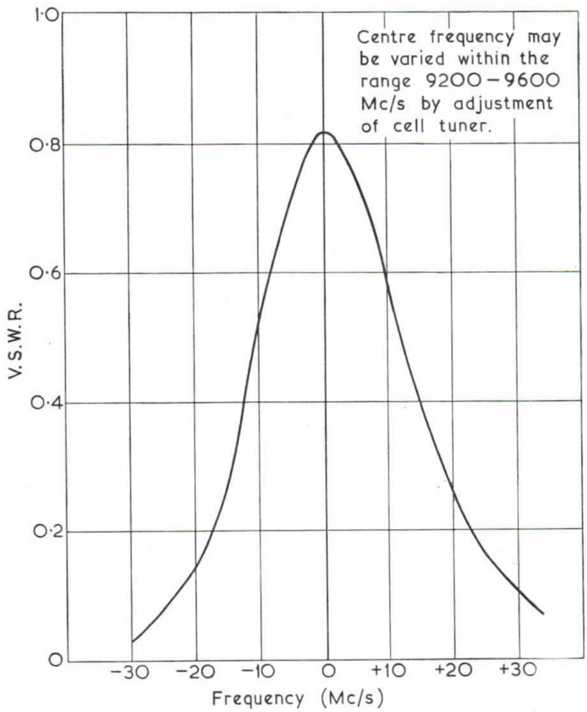

Fig. 1. Characteristics of the X-Band TR Cell, type BS332.

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X Band TB Cells

AEI X Band TB Cells

NOTES

1. Resonant Frequency

The resonant frequency is set as described in Note 3 below.

2. Loaded Q

The Q of the valve is determined by the Q of the resonant components used for making up of the valve. For this reason its value remains relatively constant and is determined from the susceptance measurements.

3. Tuning Susceptance

The susceptance is measured by comparing the phase of the reflection from the valve with the phase of the reflection from another similar valve which is known to be resonant at the test frequency. The difference between the phases of reflection, Δl is then used to determine the numerical value of the normalised susceptance, b, from:

$$b = (1 + 2g)\frac{2\pi\Delta l}{\lambda_g}$$

$$\text{or } b = \frac{2\pi}{\lambda_g}$$

or small values of 'l' and assuming that 2g is very small in comparison with 1.

4. Equivalent Conductance

The equivalent conductance is determined by measuring the v.s.w.r. of the tuned valve fixed in a series mount. At resonance, where the susceptance is negligible, the value of the conductance, g, is given by

$$g = r$$

where r is the v.s.w.r., and is numerically smaller than 1.

5. Operating Power

The minimum power is determined by the breakdown power capable of producing a short circuit behind the window. The maximum working power is mainly fixed by the operating life of the valve. If the valve is used at a power above that recommended in the specification, there may be a reduction in the total life.

6. Firing Time

The firing time is determined by the residual ionisation either left over from the previous discharge, released photoelectrically or generated by high energy cosmic particles. In order to be independent of the outside factors, a small amount of radioactive material is introduced into the valve to produce the necessary priming. In an unfired state the TB cell presents a considerable mismatch to the magnetron. The firing time is measured with the waveguide energised with 4 kW peak r.f. power, 1 μs pulse width and 1000 p/s. The test is performed at least 7 days after pumping and at least 24 hours after any previous discharge.

continued

7. Arc Loss

The arc loss represents the power necessary to establish and maintain the discharge behind the window. It is measured at 4 kW peak r.f. power, 1 μs pulse width and 1000 p/s.

8. Recovery Loss

The recovery loss is a measure of the speed with which the valve changes from the high to the low power mode of operation, and is expressed as an attenuation in dB presented by the valve at 2 μs after the trailing edge of the modulator pulse. The measurement is taken with the line energised with 12—15 kW peak r.f. power derived from a higher power source through an attenuator of not less than 6 dB, 1 μs pulse width and 1000 p/s.

9. Voltage Standing Wave Ratio

The v.s.w.r. is measured with the line energised at 40 kW peak r.f. power, 1 μs pulse width and 1000 p/s.

AEI X Band TB Cell

BS48

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9410	Mc/s
Maximum loaded Q (see note 2)	6·0	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·045	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

G
G
G
R
G
G
G
G
R

MECHANICAL DATA

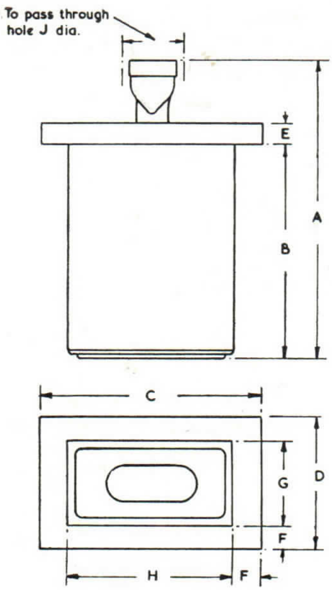
Finish: The flange faces are tin or silver plated.

Mounting Position: Any, in a mount as specified (see outline drawing).

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

G
G
R

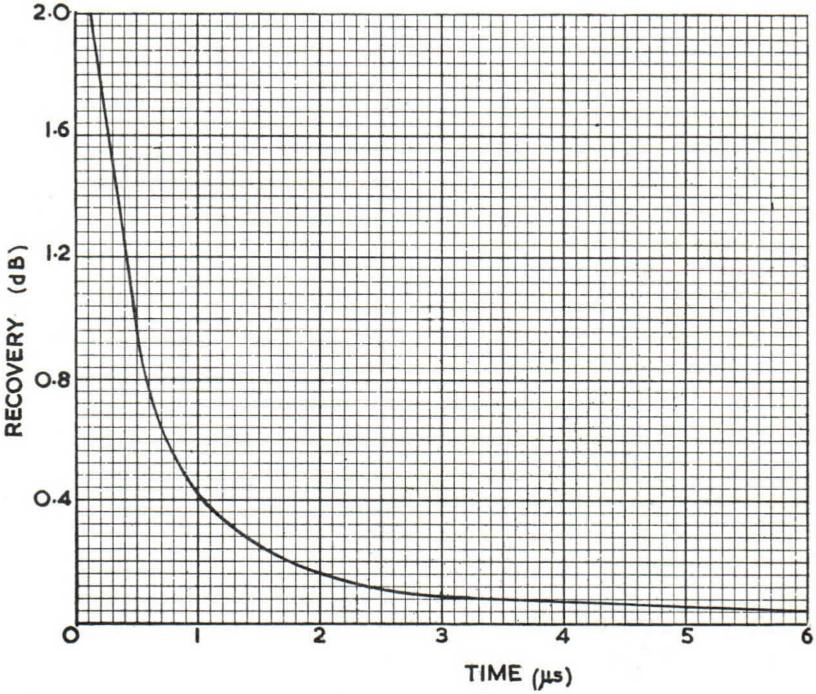
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	$1\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1µs



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AEI

X Band TB Cell

BS82

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9080	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·87	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

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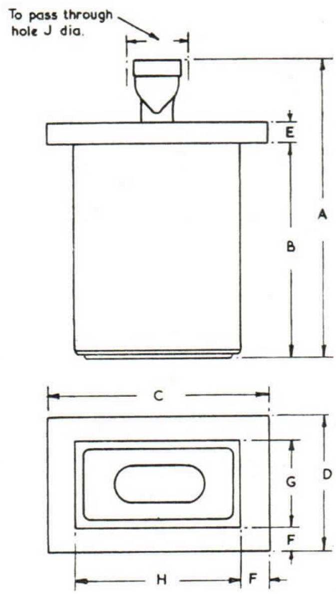
Issue 1
Feb 1962
4400-56/BS82

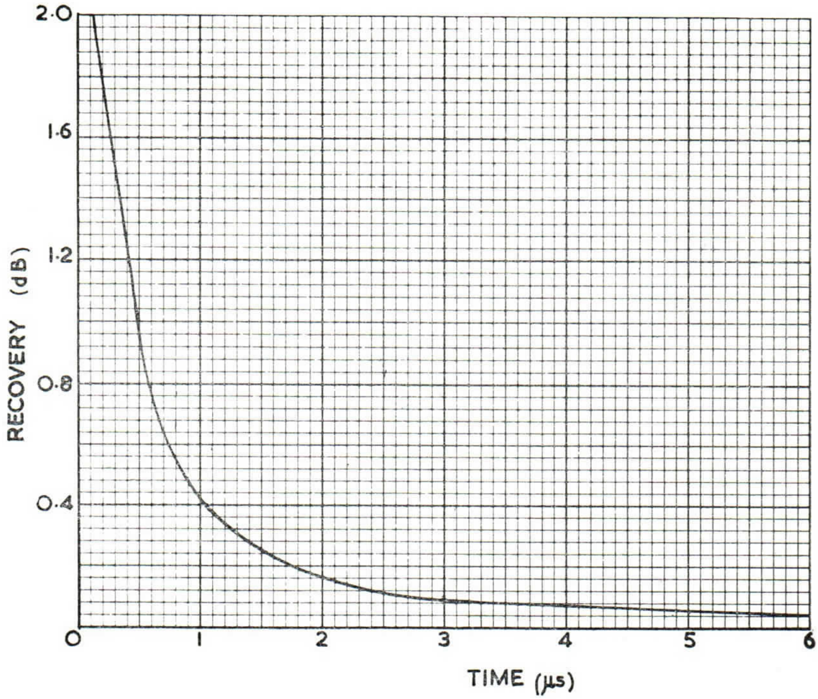
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	$1\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 − 0·006	33·10 − 0·15
D	0·803 − 0·006	20·40 − 0·15
E	0·133 − 0·016	3·40 − 0·41
F	0·142 MIN	3·6
G	0·510 − 0·020	12·90 − 0·51
H	1·010 − 0·020	25·60 − 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1μs



X Band TB Cell

BS84

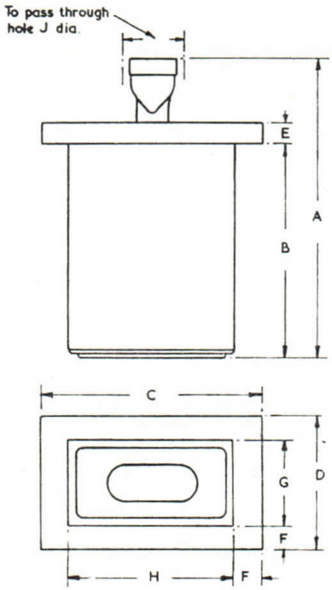
RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9240	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

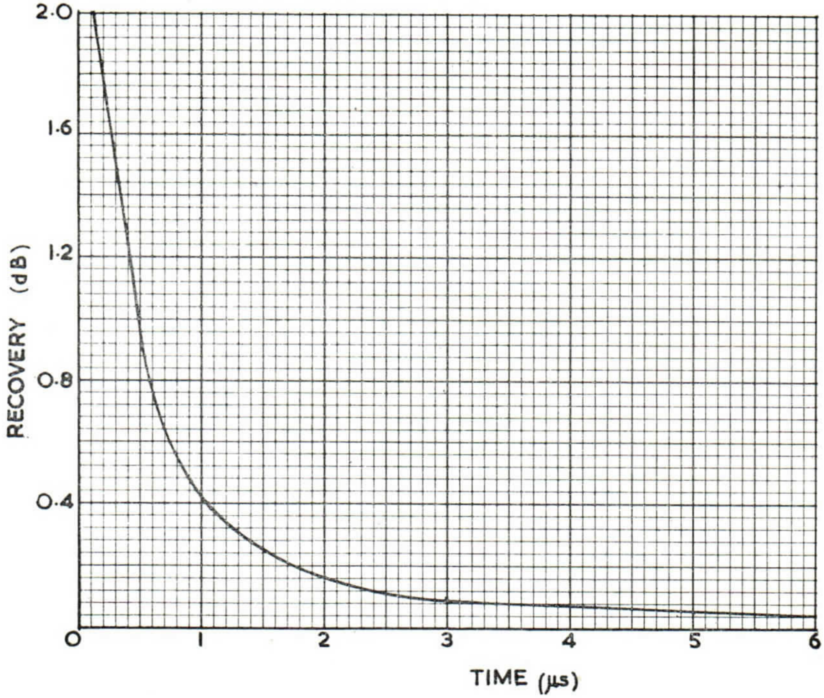
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	$1\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1μs



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AEI X Band TB Cell

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9375	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—200	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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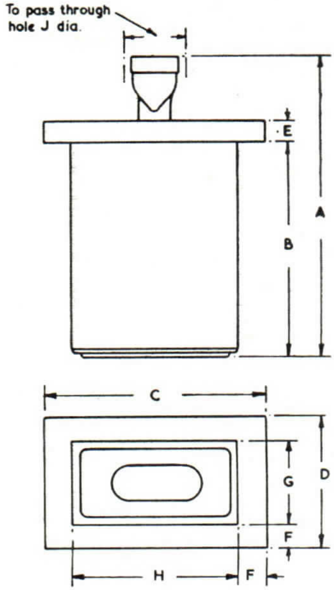
X Band TB Cell

AEI

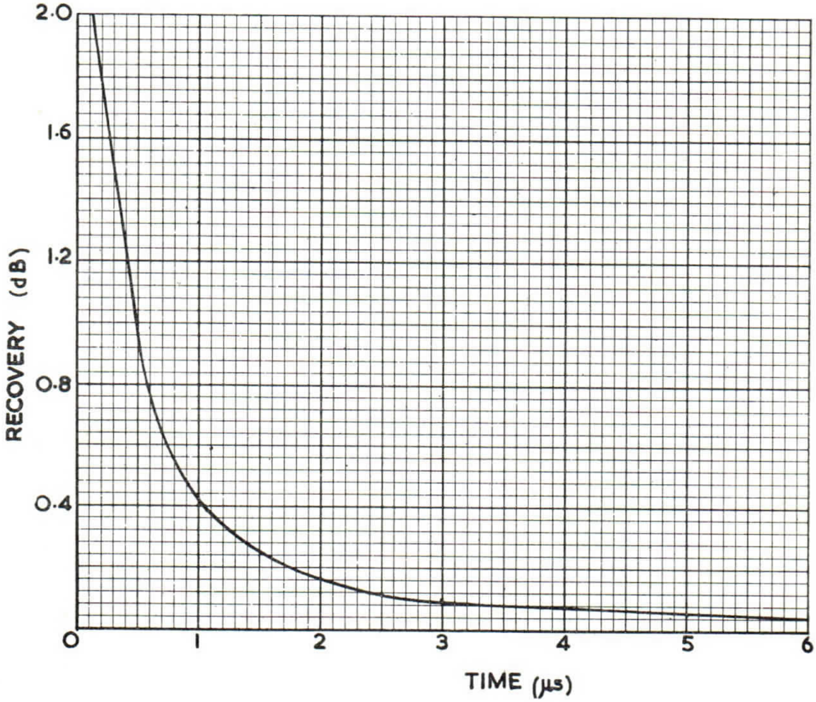
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1 13/16 MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	3/8	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1 µs



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AEI X Band TB Cell BS114

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9600	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·05	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

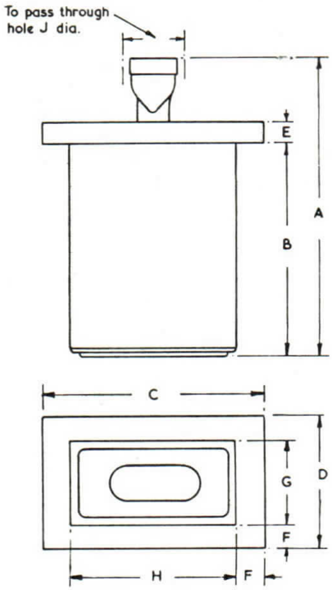
MECHANICAL DATA

Finish: The flange faces are tin or silver plated.

Mounting Position: Any, in a mount as specified (see outline drawing).

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

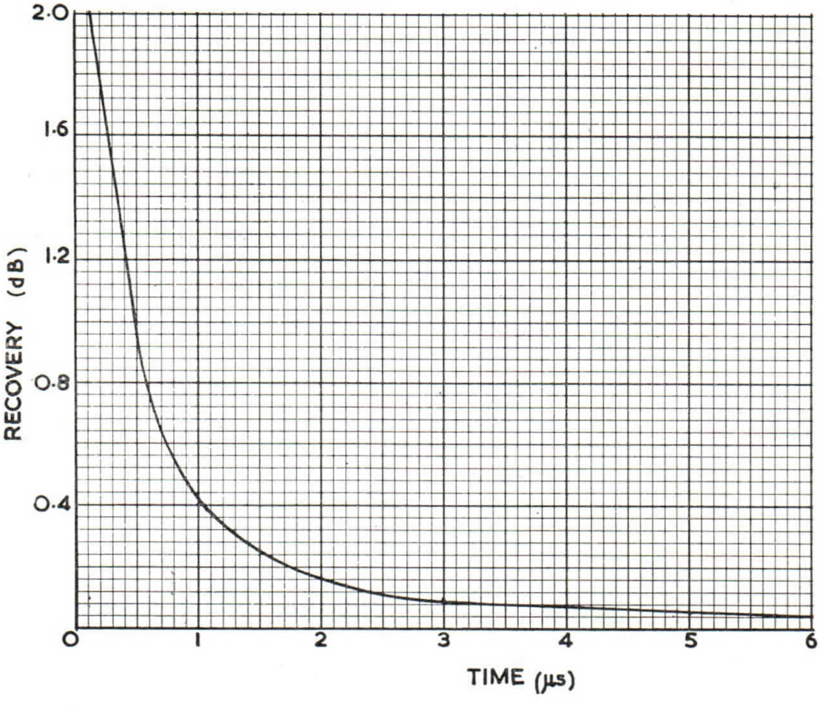
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1$\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1μs



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AEI X Band TB Cell

BS116

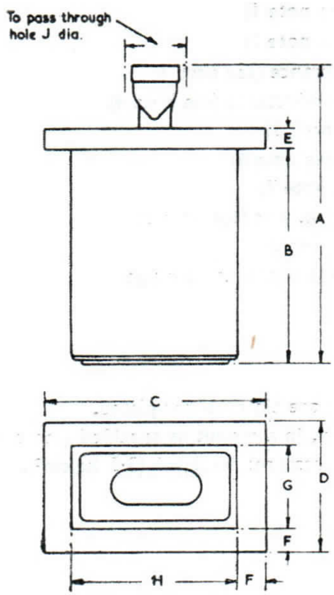
RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9325	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·90	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

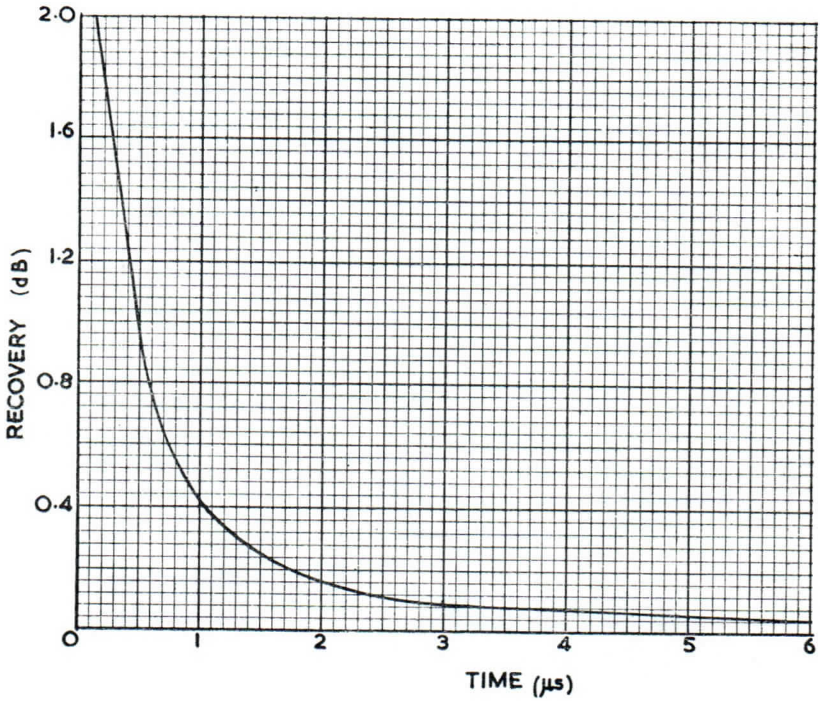
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	$1\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1μs



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AEI X Band TB Cell BS118

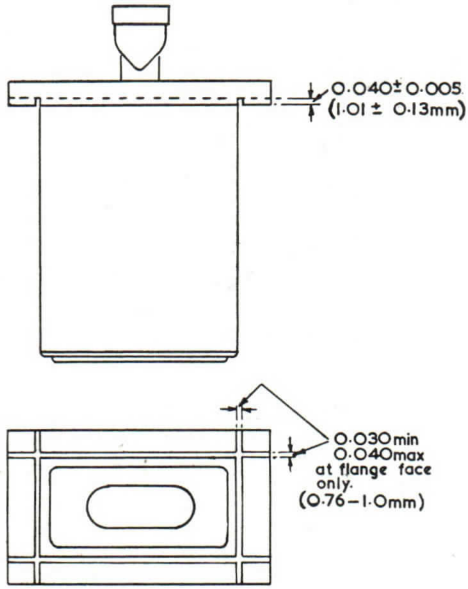
RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	8775	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Minimum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·90	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

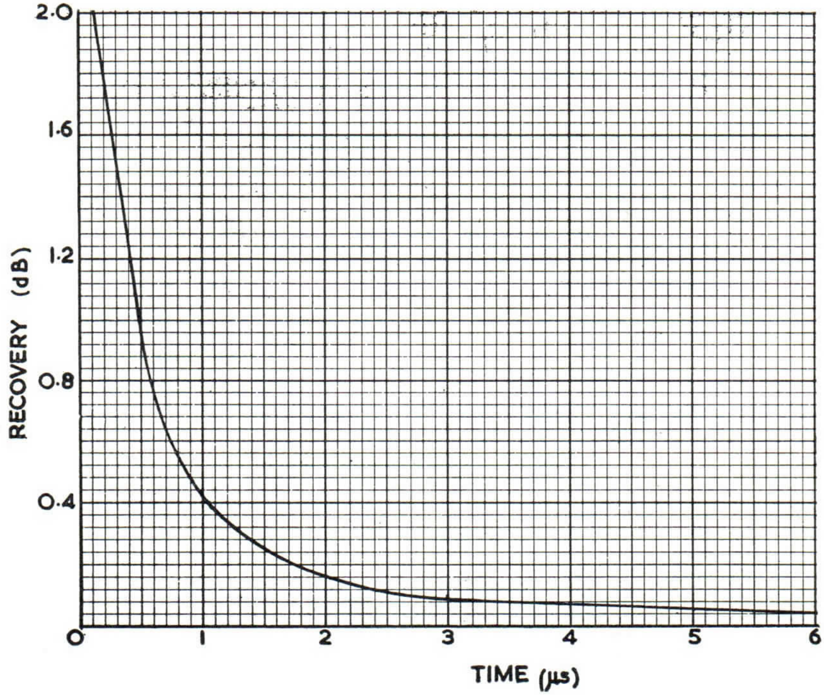
Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

X BAND TB CELL. STYLE 'B'



All other dimensions as X Band TB Cell style 'A'
All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1 µs



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AEI X Band TB Cell

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9850	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.

Mounting Position: Any, in a mount as specified (see outline drawing).

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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Issue 1
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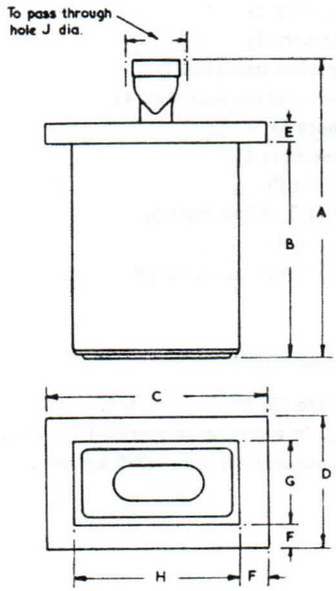
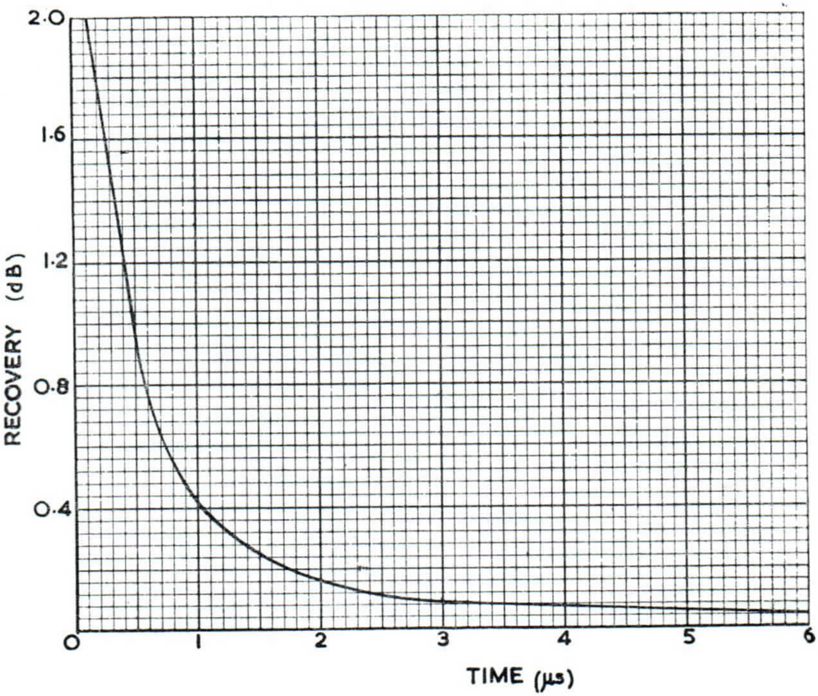
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	$1\frac{13}{16}$ MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 − 0·006	33·10 − 0·15
D	0·803 − 0·006	20·40 − 0·15
E	0·133 − 0·016	3·40 − 0·41
F	C·142 MIN	3·6
G	0·510 − 0·020	12·90 − 0·51
H	1·010 − 0·020	25·60 − 0·51
J	$\frac{3}{8}$	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1µs



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AEI X Band TB Cell BS248

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9025	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—50	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

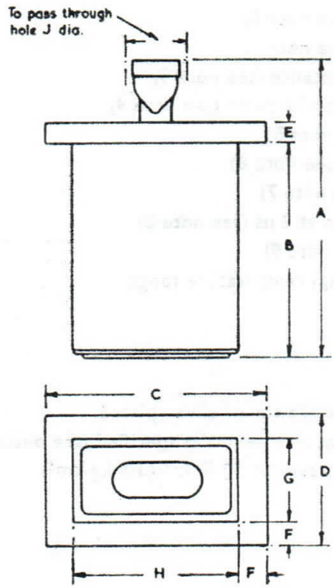
MECHANICAL DATA

Finish: The flange faces are tin or silver plated.

Mounting Position: Any, in a mount as specified (see outline drawing).

Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

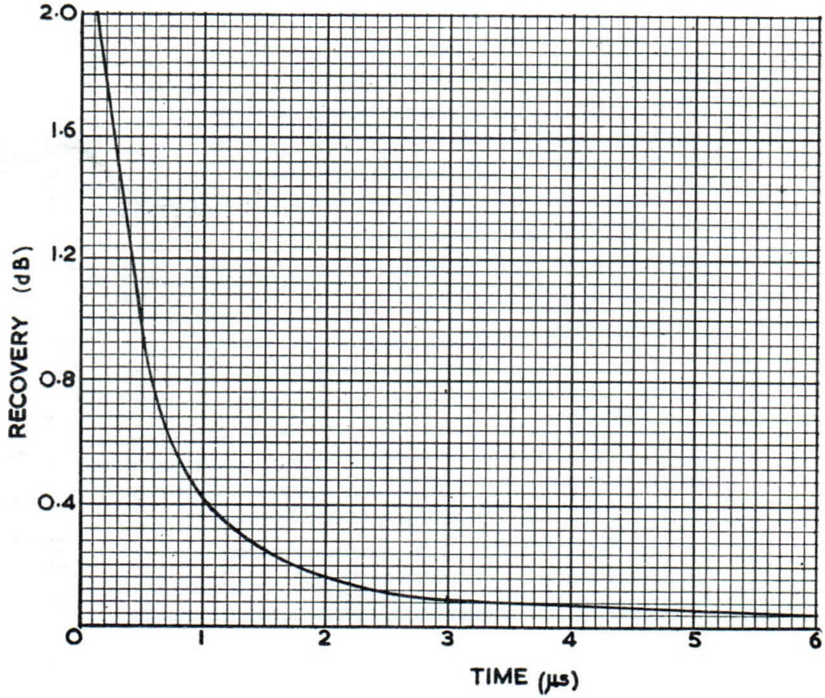
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1 13/16 MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	3/8	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1 µs



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AEI X Band TB Cell BS310

RATINGS—(See "Notes" at beginning of section)

Resonant frequency (see note 1)	9375	Mc/s
Maximum loaded Q (see note 2)	6·5	
Maximum tuning susceptance (see note 3)	±0·06	
Maximum equivalent conductance (see note 4)	0·1	
Operating power (see note 5)	5—200	kW
Maximum firing time (see note 6)	10	s
Maximum arc loss (see note 7)	0·8	dB
Maximum recovery loss at 2 μs (see note 8)	2	dB
Minimum v.s.w.r. (see note 9)	0·91	
Ambient (non-operating) temperature range	−40 to +100	°C

MECHANICAL DATA

Finish: The flange faces are tin or silver plated.
Mounting Position: Any, in a mount as specified (see outline drawing).
Maximum waveguide pressure: 50 lb/in² (3·5 kg/cm²).

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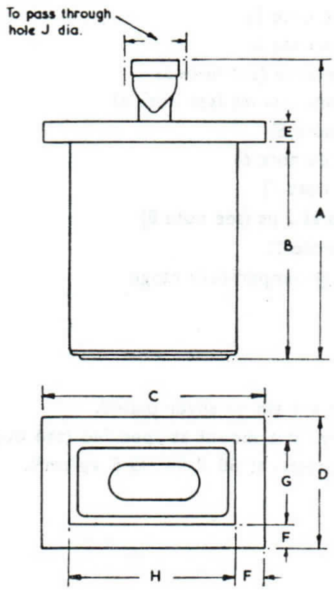
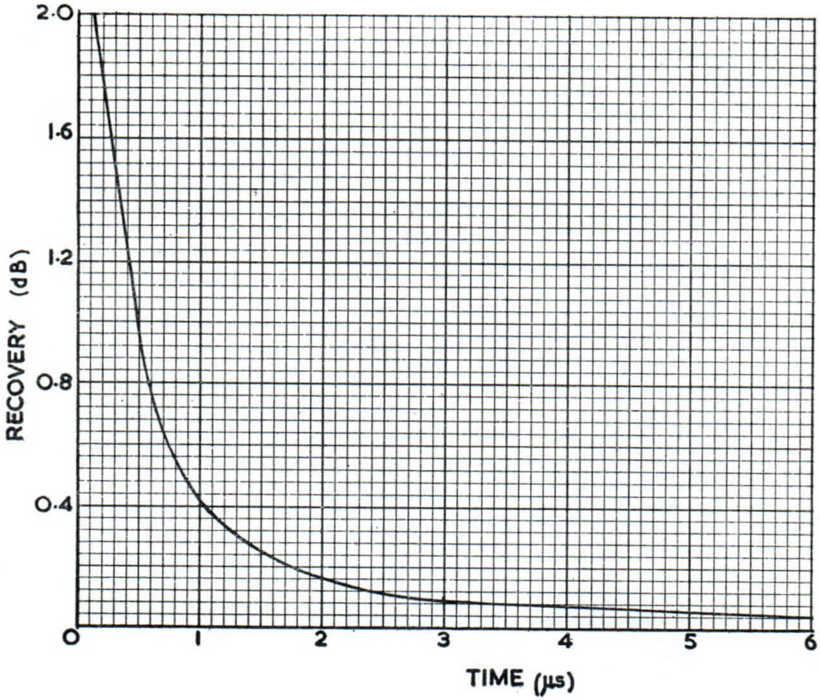
X BAND TB CELL. STYLE 'A'



DIM	INCHES	MILLIMETRES
A	1 13/16 MAX	46
B	1·299 ± 0·005	33·0 ± 0·13
C	1·303 — 0·006	33·10 — 0·15
D	0·803 — 0·006	20·40 — 0·15
E	0·133 — 0·016	3·40 — 0·41
F	0·142 MIN	3·6
G	0·510 — 0·020	12·90 — 0·51
H	1·010 — 0·020	25·60 — 0·51
J	3/8	9·5

All dimensions in inches.
Millimetre dimensions derived.

TYPICAL RECOVERY PERFORMANCE
at 50 kW, 1000 p/s, 1μs



Microwave Switches

4400/57

AEI Microwave Switches

PREAMBLE

The existing range of devices capable of switching microwave power on and off in waveguides are:—

(a) Mechanical devices which suffer from slow operating speed with an added disadvantage, in most cases, of excessive weight.

(b) Discharge tube devices whose main drawbacks are the inevitable generation of noise and relative slowness in establishing and falling away of the discharge. This is particularly evident in pulse applications.

(c) Ferrite devices which are relatively slow for pulse work, are bulky in size and require relatively high operating powers.

(d) Point-contact diodes whose limitation is that they can handle only small powers.

A semiconductor waveguide switch, a junction diode device, has been developed to overcome most of the disadvantages associated with the above mentioned components.

Its superiority is not only confined to light weight, small size and temperature insensitivity over a wide range, but its physical dimensions, attenuating property, broad band characteristics, power handling capacity and its fast operating speed make it an outstanding development.

Physically it resembles a point-contact diode of the shielded type similar to the CS9B microwave diode. The semiconductor wafer, with its high resistivity "intrinsic" region of silicon doped with phosphorous, is of the $p+ - p - n+$ structure. The $p+ - n$ junction is formed by alloying aluminium to silicon; the $n - n+$ junction is made using gold containing a small percentage of antimony.

Electrically it is a low capacitance, variable-resistance device whose equivalent circuit diagram is shown in Fig. 1A.

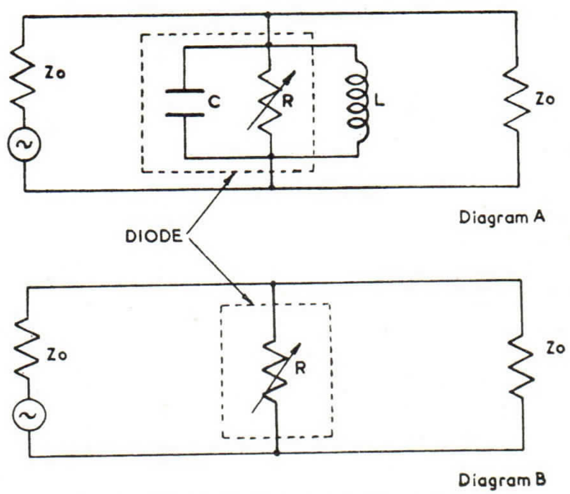


Fig. 1. Diode Switch, equivalent circuits.

The source and the load impedance are both equal to the characteristic impedance Z_o. C and R are the internal capacitance and resistance of the diode respectively. L is an added inductance to tune out this small shunt capacitance C. This leaves only the resistive component R as shown in Fig. 1B. The loss introduced by R into the system is given by:

$$\text{Loss (dB)} = 20 \log \left(1 + \frac{Z_o}{2R}\right)$$

The resistance of the diode is a function of the current passing through it. This biasing current is supplied from a d.c. source of approximately 1 volt. The resistance changes from a high value of the order of 2000 ohms at no applied bias, to a low value of the order of a few ohms when a current of approximately 20 mA d.c. is flowing through the diode. When these values are in turn inserted in the loss equation a switching ratio of about 60 is obtained. In practice this is equivalent to a change from about $\frac{1}{2}$ dB insertion loss to some 30 dB of attenuation due to reflection.

Devices incorporating the switching diodes are available for operation at any frequency in S-band to X-band and development is proceeding on devices for frequencies outside this range.

Construction

In the microwave switch the diode is mounted in a coaxial line and coupled to a section of rectangular waveguide terminated at each end with standard flanges.

OPERATION

General

A continuously variable mismatch is achieved by mechanical or electronic variation of the applied bias up to 1·0 volts d.c. It is therefore a very useful switching device having particular applications in multi-channel radar systems and c.w. equipments (for example, airborne radar) where costly and weighty ferrites may be replaced with advantage.

Since the diode operates on a variable-resistance principle the switch has a higher power-handling capacity than is possible with similar devices employing variable-capacitance diodes.

Speed of Operation

The speed of operation of the diode is of importance in some applications dealing with high frequency modulation or the generation of pulses of short duration. The rapidity with which the diode can be thrown into the attenuating state by applying steep rising current waveform, or the decay of attenuation when this current is removed instantaneously, is determined by the speed with which the holes can be established in or cleared from the semiconductor wafer. Unfortunately, it is the property of such materials that although the establishment of current can be carried out relatively fast, the low mobility of the holes results in delayed return to the non-conductive state.

Substantial improvements in this recovery are achieved by applying negative bias of some 40V to the diode at the end of the current pulse. Fig. 2 shows the recovery

continued on page 4

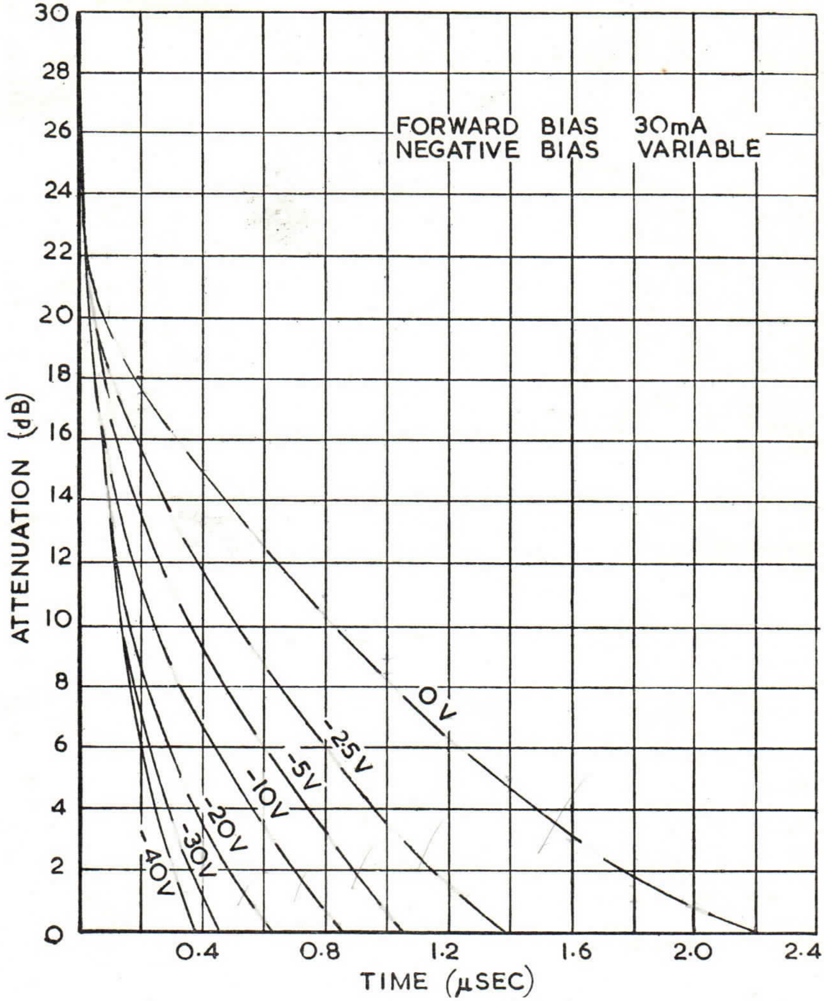


Fig. 2. "Switching off" Recovery (Minimum attenuation).

and how it is influenced by biasing the diode. Forward current bias of 30 mA is applied giving 30 db attenuation. At the end of the current pulse the applied voltage is swung negatively and the recovery measured from this instant at different bias levels. It will be observed that appreciable improvements are obtained by relatively small increase in biasing voltage at small biasing potentials. At —40V the diode recovers down to 6 dB in 0·2 μs which represents useful parameters for pulse modulation.

The forward bias has also pronounced effect on recovery. A corresponding set of curves on Fig. 3 shows the recovery of the diode when the forward bias is limited to 3 mA giving 18·5 dB attenuation. Complete recovery, compared with 6 dB previously, is now obtained at 0·2 μs with the same biasing voltage at —40V. Thus smaller forward current produces faster recovery.

The speed with which attenuation is established is shown on Fig. 4 and the influence of the magnitude of the forward current bias is represented by the set of curves. Large forward current produces faster switching.

It follows from the last two graphs that to get best square waveform modulation, the diode driving circuit should supply high accelerating field across the junction at the beginning of the pulse, settle down to about 3 mA at the end of it when fast rising negative voltage is applied. This voltage should then be reduced to zero before the diode is pulsed again in the forward direction.

As a Modulator

Another useful feature of this device is its ability to modulate c.w. microwave energy. This is easily achieved by applying a modulating signal of any waveform across the diode, which results in a modulation of corresponding wave shape in the c.w. signal fed into the waveguide.

A typical application, of considerable importance, is in the modulation of c.w. klystrons. This is normally performed by modulating the beam structure which results in the generation of appreciable amounts of noise deleterious to the operation of the equipment. If, however, a p—n junction switch is inserted into the waveguide output of the klystron and a signal of the required waveform applied to it, the modulated c.w. microwave energy is considerably less noisy and has the advantage of being easily variable.

As a Pulsed Attenuator

It has long been appreciated that effective improvements in the temporary or permanent deterioration of mixer crystals cannot be achieved without almost complete elimination of the leakage energy passing through their protective devices. Since the introduction of duplexers during the war some 20 years ago, there has been little progress in this respect in spite of considerable efforts devoted to it. With the advent of semiconductor devices, and junction diodes in particular, it has now been possible for the first time to lift this limitation.

In this application the TR cell is followed by the mount containing the switch at a suitable distance behind it. The operating conditions require the diode to be pre-pulsed with the biasing current. This may be done in many different ways using suitable waveforms. The common requirement however must be that the diode is in the reflecting state just prior to the magnetron pulse and during the whole or the greater part of it as shown in Fig. 5. If this condition is fulfilled the increasing magnetron power coupled to the receiver is attenuated by some 30 dB on reaching the diode.

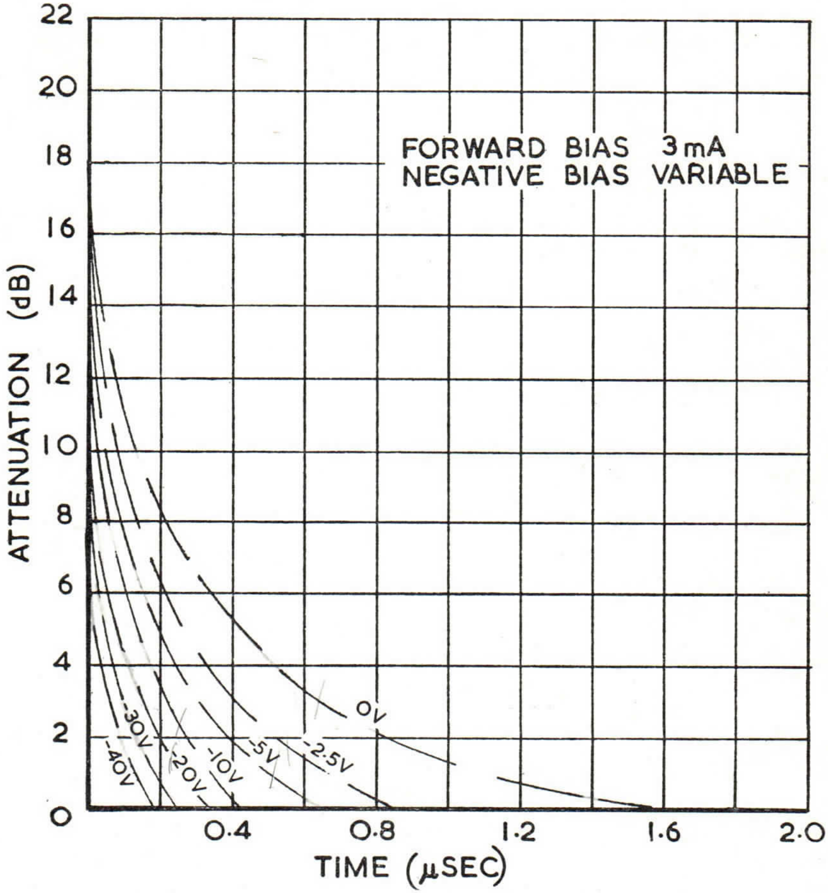


Fig. 3. "Switching off" Recovery (Minimum attenuation).

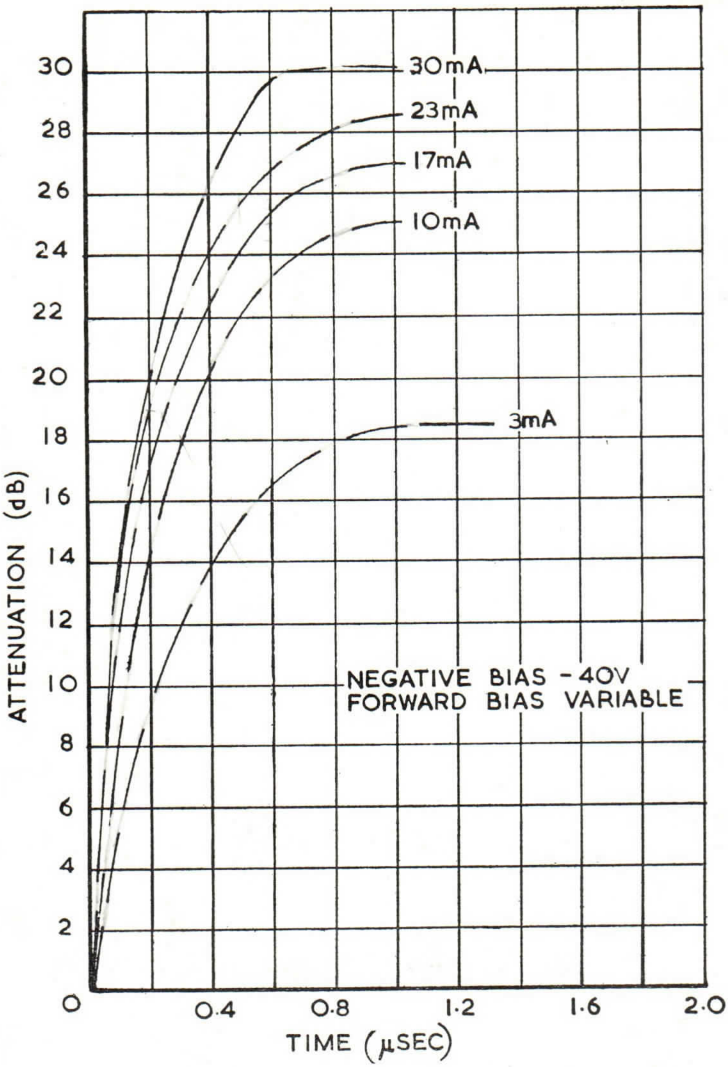


Fig. 4. "Switching on" Recovery (Maximum attenuation).

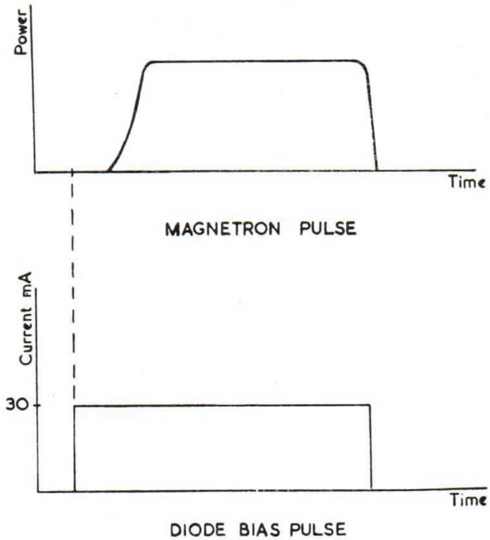

Power
Time
MAGNETRON PULSE
Current mA
30
Time
DIODE BIAS PULSE

Fig. 5.

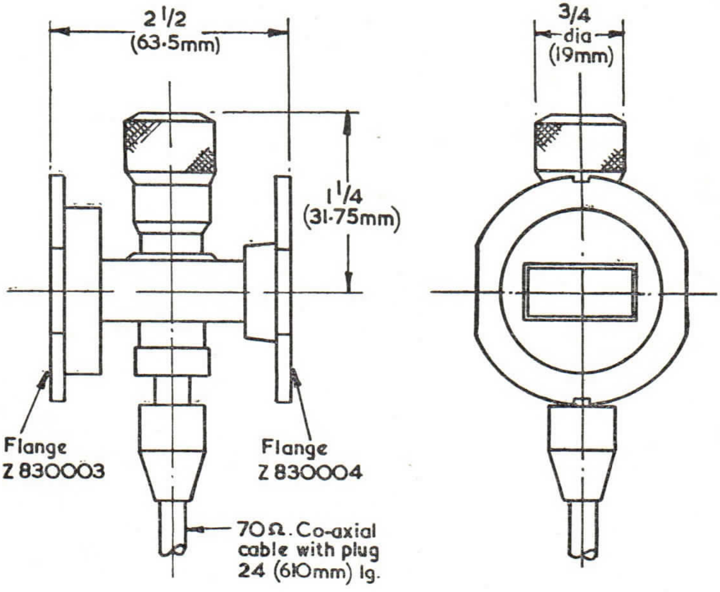
X Band Microwave Switch

BS336

SPECIFICATION

Maximum operating voltage	1·0	V
Maximum operating current	30	mA
Maximum insertion loss	1	dB
*Attenuation range	1 to 25	dB
Power handling capacity—		
Maximum peak pulsed line power	500	W
Maximum c.w. line power	10	W
Band width (fixed mount)	100	Mc/s
Minimum switching time	See figs. 2, 3 and 4 in Preamble	
Resonant frequency	Preset to requirement	

* Corresponds to varying the applied current between 0 and 30 mA.



All dimensions in inches.
Millimetre dimensions derived.

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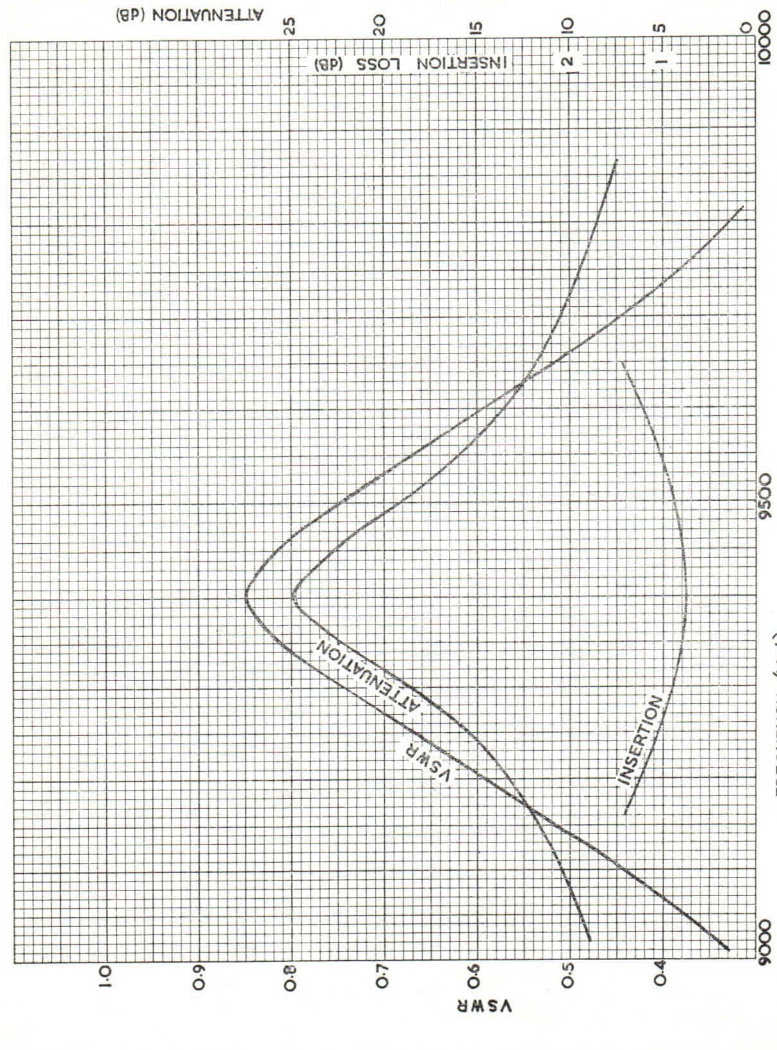
X Band Microwave Switch

AEI

TYPICAL PERFORMANCE CHARACTERISTICS



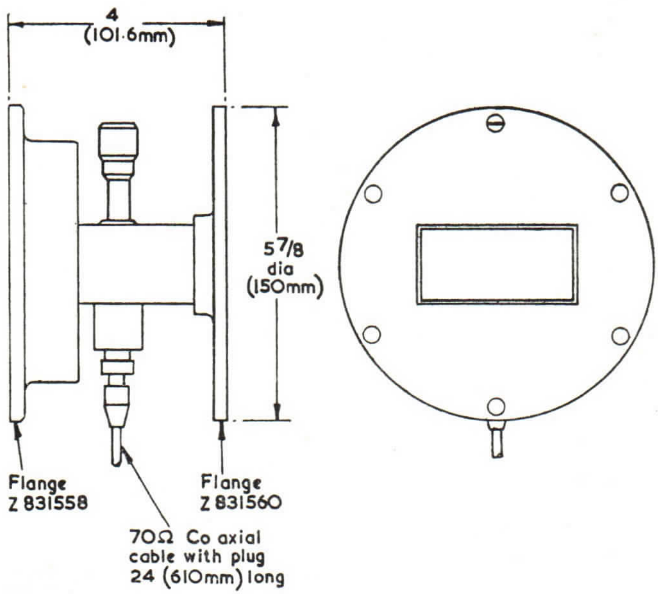
S Band Microwave Switch

BS338

SPECIFICATION

Maximum operating voltage	1·0	V
Maximum operating current	30	mA
Maximum insertion loss	0·5	dB
*Attenuation range	1 to 25	dB
Power handling capacity—		
Maximum peak pulsed line power	500	W
Maximum c.w. line power	10	W
Band width (fixed mount)	200	Mc/s
Minimum switching time	See figs. 2, 3 and 4 in Preamble	
Resonant frequency	Preset to requirement	

* Corresponds to varying the applied current between 0 and 30 mA.



All dimensions in inches.
Millimetre dimensions derived.

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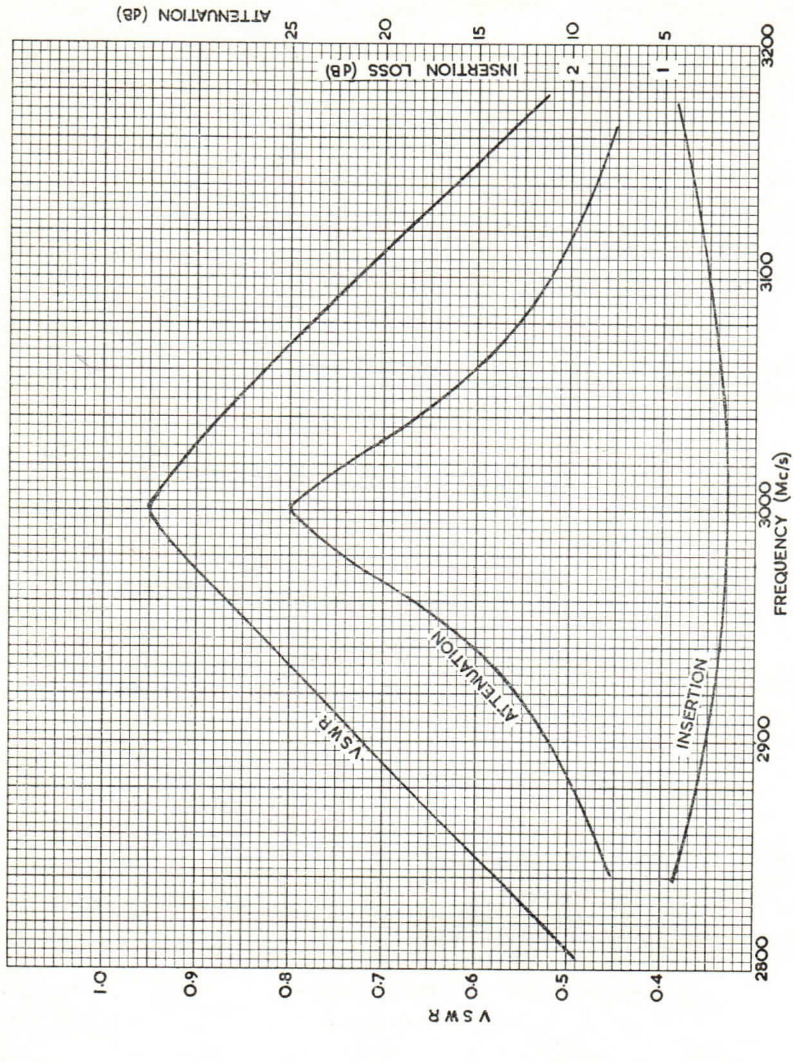
TYPICAL PERFORMANCE CHARACTERISTICS



AEI Broadband P-N Pulsed Attenuator

BS358

Provisional Information

This device when used in conjunction with a conventional TR cell is capable of attenuating magnetron power so as to render the spike leakage through the TR cell insignificant.

SPECIFICATION

Maximum operating voltage	1·0	V
Maximum operating current	30	mA
Maximum insertion loss	1	dB
Bandwidth	600	Mc/s
Minimum v.s.w.r.	0·71	
*Attenuation range	1—25	dB
Power handling capacity—		
Maximum peak pulsed line power	100	W
Mean pulsed line power	100	mW
Maximum c.w. line power	10	W
Minimum switching time	See figs. 2, 3 and 4 in Preamble	

* Corresponds to varying the applied current between 0 and 30 mA.

MECHANICAL DATA

The flanges are square and of standard dimensions as used on WG16. Two of the diametrically opposite holes are suitable for locating on dowel pegs, while the remaining two are used for clamping.

The two flanges are flat and parallel within 0·002 in (0·051 mm).

Edges of the input and output windows are free from burrs.

Finish: The flange faces are tin plated.

Mounting Position: Any.

Used in conjunction with WG16 (1 in × $\frac{1}{2}$ in) (25·4 mm × 12·7 mm).

Maximum waveguide pressure: 50 lb/in^2 (3·5 kg/cm^2).

Weight (unpacked) 4 oz (110 gm).

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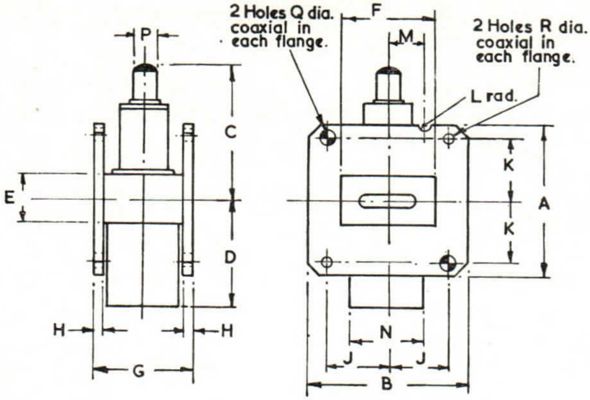
Broadband P-N Pulsed Attenuator

AEI



Dimension	Inches	Millimetres
A	1⅝	39·5 ± 0·05
B	1⅝	41·3
C	1⅜ max	34·9 max
D	1⅛	28·57
E	½	12·7
F	1·0	25·4
G	1·0 ± 0·010	25·4 ± 0·3
H	3/32 min	2·4 min
J	0·610 ± 0·002	15·50 ± 0·05
K	0·640 ± 0·002	16·30 ± 0·05
L	0·062 ± 0·031	1·6 ± 0·8
M	0·375 ± 0·005	9·5 ± 0·013
N	¾ dia	19·05 dia
P	¼ dia	6·2/6·5 dia
Q	0·1695 ± 0·004	4·30 ± 0·10
R	0·147	3·7

Spark Gaps

4400/58

4400/59

Miscellaneous

Nernst Filaments

NFT1
NFT2

The Nernst Filament is a useful source of infra-red radiation, capable of operating at very high temperature in air. As it has no glass or other envelope, there is no absorption of radiation.

The filament is in the form of a rod of sintered oxide powder to which two short platinum connecting leads are attached.

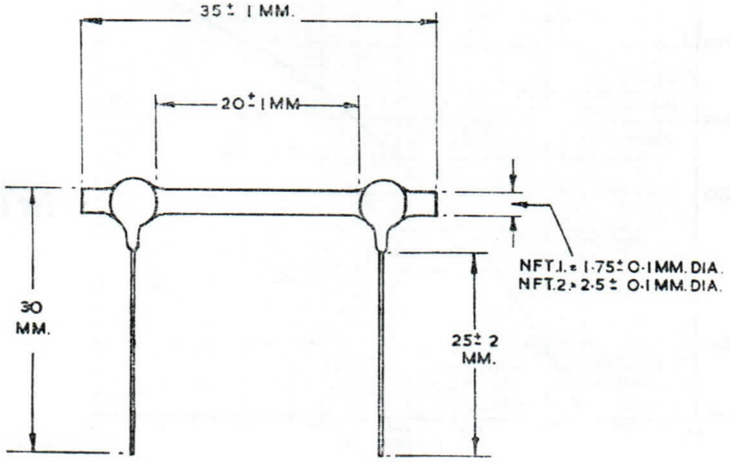
At normal room temperatures the filament is non-conducting. As the temperature is increased to a value of 880°C to 1000°C the filament becomes sufficiently conductive for current through it from a 200/250 volt supply to heat it still further.

A good life will be obtained when the filament is operated at temperatures up to 1750°C. Above this temperature evaporation of the platinum contact is accelerated and hence with increased temperatures the life is reduced rapidly. It is therefore recommended that the current should be kept to a minimum consistent with satisfactory operation.

The temperature quoted in the ratings has been determined by measurements with an optical pyrometer. It is, therefore, in effect the 'brightness temperature' (i.e. the temperature of a black body having equal brightness at about 0·7 microns wavelength).

RATINGS

	NFT1	NFT2	
Supply voltage (a.c.) with suitable series impedance	200/250	200/250	V
Voltage drop (r.m.s.)	90 to 110	100 to 140	V
Operating current (approx) to give a temperature of about 1700 to 1800°C	0·65	1·4	A
Temperature to give a minimum life of 100 hours	1750	1750	°C



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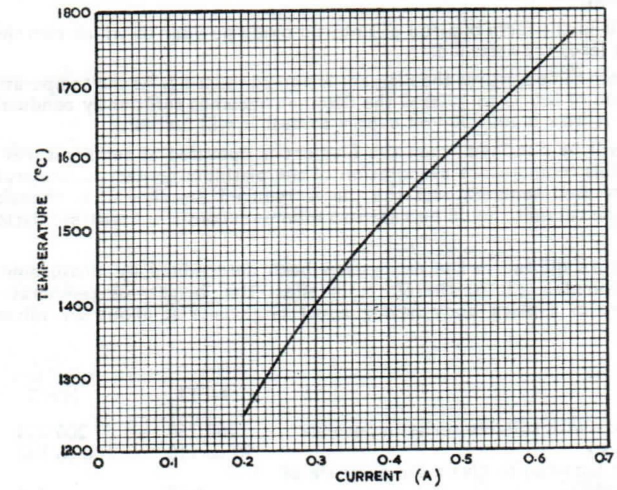
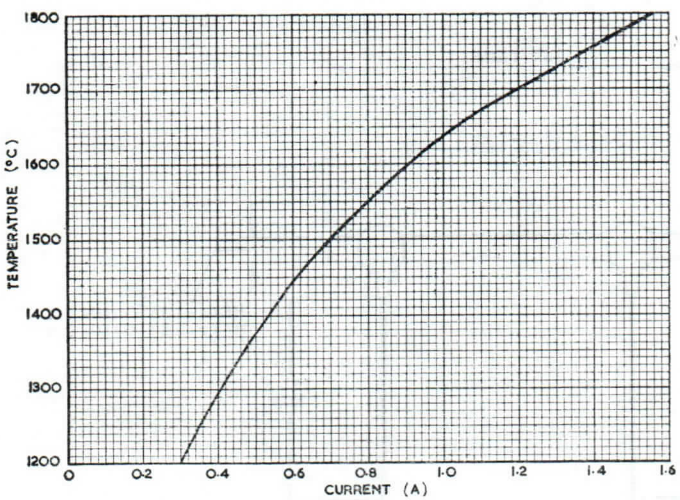
Nernst Filaments

AEI

TYPICAL OPERATING CHARACTERISTICS



NFT1



NFT2

AEI Windonuts

The Windonut (Patent 572020) provides in a very convenient form an inspection window for liquid-level indication and similar applications. It can be used satisfactorily on vacuum chambers or containers with appreciable internal pressure. Its production was made possible by the development of a special glass which could be hermetically sealed without gaskets or jointing-compound into its mild-steel frame, of which it became an integral part.

The Windonut must not be confused with devices of similar appearance in which a disc of glass is retained in position by mechanical means. By a unique process, the glass of the Windonut is *fused* into the surrounding metal, and, short of the grossest mis-handling, a Windonut *cannot* leak.

Hitherto, the conventional method of providing an oil-tight or gas-tight inspection window in a metal wall has been by means of a gasketed sight-glass. But a rise of temperature causes ordinary metals such as mild steel or cast-iron to expand over one-third more than plate or window glass, and more than three times as much as the borosilicate heat-resisting glasses. With the inevitable changes of working and ambient temperatures, it is obvious that if the joint is to continue gas- or oil-tight, the gaskets must be resilient and must remain so throughout their life.

In the Windonut, however, no gasket is used between glass and steel, and it is therefore unaffected by extremes of heat or cold ranging from −80°C to +200°C. Samples of the 1 in. B.S.P. size under test have satisfactorily withstood hydraulic pressures of more than two tons per square inch. The Windonut stands up well to rough treatment. A hard hammer-blow may chip the surface, but even then several successive blows are needed to force a hole.

A typical application is the use of a Windonut as an oil-gauge on a gearbox. In this instance the permissible change in oil-level is equal to the diameter of the glass, but larger ranges can be dealt with by the use of two Windonuts set at different levels.

In such applications, if the liquid is turbulent, as for instance the oil in a gearbox, it will readily be appreciated that some form of baffle is desirable if true indications of level are to be obtained.

CONSTRUCTION

The Windonut consists of a hollow hexagon-headed screw of copper-coated mild steel, into which a thick disc of special glass is pressure-cast while the metal is at red heat; the glass is thus united to the metal by fusion. The steel projects to form a protective ridge around the window.

continued

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Windonuts AEI

The glass is fire-polished on the outer face, which is of larger diameter than the inside face so as to increase the viewing angle. The inner surface is left slightly rough as pressed; this improves liquid-level indication.

The Windonut is designed to be screwed into a tapped hole and made oil- or gas-tight by conventional jointing methods. Alternatively, if the metal is too thin to be tapped, a back-nut can be used with a suitable gasket. British Standard Pipe sizes have been standardised for bore and thread, but Windonuts can be supplied with metric or other screw threads.

Certain important factors relative to the structure of solid glass have received careful consideration in the design of the Windonut. Glass can only fracture from a surface or boundary; it fails due to the tension component of stress at a surface; and it will not fail in pure compression. In practice, a tension of 0·7 tons per square inch may be assumed as a safe working value for sheet glass.

The glass of the Windonut possesses three surfaces, the inner and outer surfaces and the glass-to-metal junction. After the hot glass has been sealed into position, the metal shrinks more than the glass, and the glass at the junction is then in compression radially, tangentially, and parallel to the axis; the faces of the disc are in compression normal to the axis. These conditions prevail over the whole range of working temperatures. Thus in manufacture the glass is pre-compressed sufficiently to prevent any subsequent distortion of the hexagon by a spanner from setting up any harmful temporary or permanent stresses.

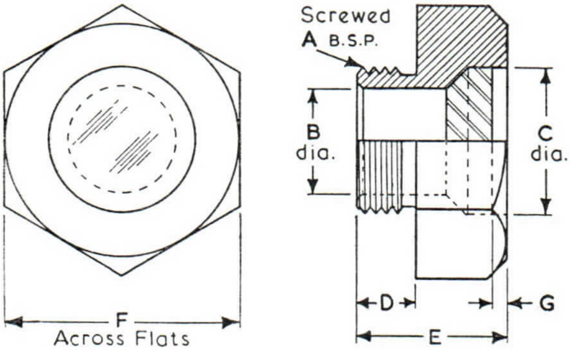
continued

AEI Windonuts

RANGE OF SIZES

The Windonut has been developed in six sizes, the "size" for convenience denoting the bore and the B.S.P. screw-thread. These sizes are $\frac{3}{8}''$, $\frac{3}{4}''$, $1''$, $1\frac{1}{4}''$, $1\frac{1}{2}''$ and $2\frac{1}{2}''$, and the principal dimensions of each are shown in the diagram and table below. Metric or other screw-threads can be supplied.

DIMENSIONAL OUTLINE AND HALF-SECTION



Dimension	S26		S27		S28		S29		S30		S31	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
A	3/8	—	3/4	—	1	—	1 1/4	—	1 1/2	—	2 1/2	—
B	3/8	9·5	3/4	19	1	25	1 1/4	32	1 1/2	38	2 1/2	64
C	9/16	14	1	25	1 1/4	32	1 1/2	38	1 3/4	44	2 3/4	70
D	3/8	9·5	3/8	10	1/2	13	1/2	13	1/2	13	1/2	13
E	3/4	19	7/8	22	1 1/4	32	1 1/4	32	1 1/4	32	1 3/8	35
F	0·820	21	1·48	38	1·86	47	2·05	52	2·41	61	3·89	99
G	1/8	3·2	1/8	3·2	1/8	3·2	1/8	3·2	1/8	3·2	1/8	3·2

All dimensions in inches.
Millimetre dimensions derived.

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AEI **Vacuum Switch** **BS378**

PROVISIONAL INFORMATION

This is a compact flame-proof device, capable of switching 600V at 300A at a rate of 600 times an hour. Operation is solenoid-controlled, and the switch may be normally closed, normally open, or 'fail-safe' depending on actuator designs. The electrodes are manufactured from a special alloy, which reduces contact wear and prevents high spots forming on the contact surfaces. This feature, coupled with accurate contact geometry, allows a minimum figure of one million operations to be expected. The switch will handle an overload of six times its normal rating in accordance with BS775.

RATINGS

Operating voltage (rms)	600	V
Operating current	300	A
Surge current	1800	A
Minimum number of operations	10^6	
Maximum switching rate	600 operations	/hr

AEI Argon-filled Noise Tube BS384

This glass encapsulated device has a directly heated cathode and provides a nominal noise power of 15·5 dB. It complies with British Services Specification CV1881.

RATINGS

Filament voltage	6·3	V
Filament current	0·4	A
*Striking voltage on d.c.	1000	V
Normal operating voltage (at $I_a = 180$ mA)	60	V
Maximum operating current	250	mA
**Nominal continuous operating current	180	mA
†Nominal noise power available (at $I_a = 180$ mA)	15·5	dB
Nominal noise power output change with current	−0·005	dB/mA
Nominal useful working frequency range	3000–12000	Mc/s
Nominal gas pressure	30	mm

CHARACTERISTICS

Maximum filament current (at $V_f = 6·3$ V)	0·45	A
Minimum filament current (at $V_f = 6·3$ V)	0·35	A
Minimum v.s.w.r. (at $V_f = 6·3$ V, f = 9375 ± 5 Mc/s)	0·95	
Maximum insertion loss (at $V_f = 0$, f = 9375 ± 5 Mc/s)	0·25	dB

MECHANICAL DATA

Mounting position—Any.

Maximum torque applied to each cap: 1·5 lbf in (0·173 kgf m).

* With earthed metal shield.

** The discharge current should be adjusted for optimum matching conditions but must not fall below 160 mA if instability is to be avoided.

† Relative to thermal noise at 17°C.

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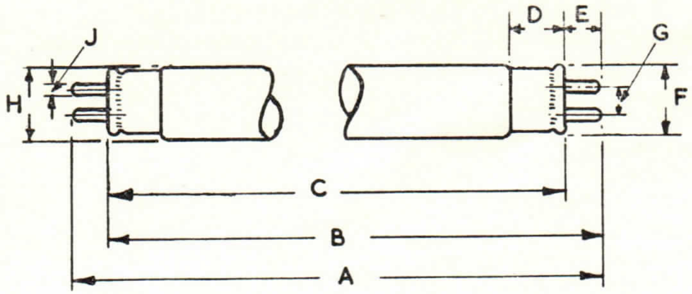
Argon-filled Noise Tube

AEI



Notes

1. The pins should enter a gauge consisting of two holes 0·110 in. diameter at 0·1875 in. centres.
2. Valve to pass through a tubular gauge of 0·610 in. internal diameter and length 8 in.

Dimension	Inches	Millimetres
A	$8\frac{29}{32}$ max	226·21 max
B	$8\frac{1}{2}$ ± $\frac{1}{8}$	215·900 ± 3·175
C	$8\frac{11}{32}$ max	211·94 max
D	0·405 ± 0·005	10·287 ± 0·127
E	0·276 ± 0·011	7·01 ± 0·28
F	$\frac{1}{2}$ dia	12·7 dia
G	$\frac{3}{16}$ centres	4·79 centres
H	0·55 ± 0·02	13·97 ± 0·51
J	0·0975 ± 0·0075	2·478 ± 0·192

All dimensions in inches.
Millimetre dimensions derived.

AEI Flame Detector 27F12

PROVISIONAL INFORMATION

The AEI flame detector is an electronic device which is sensitive to ultra violet radiation emitted by flames having a wavelength of 1650 to 2900 angstroms. Its associated electrical circuitry is tuned so that it will not respond to sunlight, infra red, cosmic rays, and incandescent and fluorescent light. The output from the device is sufficient to operate an electro-mechanical relay without further amplification.

The detector tube consists of a gas filled glass envelope containing two symmetrical electrodes, which are connected to an a.c. power supply of 700 volts with a load impedance of several thousand ohms. When operating on a.c. the polarity of the electrodes changes each half cycle ; alternatively rectified a.c. can be used, in which case the potential difference between anode and cathode drops to zero each half cycle, but the polarity does not change. A frequency of 50c/s is usually used but frequencies up to one hundred Kc/s can be used if required.

Electrons are released from the negative electrode whenever ultra violet radiation hits it. If this occurs near the peak of a cycle, the gas in the envelope ionises and a current flows. As the potential difference between the electrodes falls below the critical level, the discharge ceases. The current will not flow again until radiation strikes during a suitable part of the cycle. If the intensity of the radiation is high enough, and a sufficient number of half cycle discharges are activated, the average current flowing will be large enough to operate a relay or similar device.

PROVISIONAL SPECIFICATION

Maximum operating voltage rms	700V
Typical d.c. striking voltage	650V
Typical arc voltage drop	350V
Maximum average current	8mA
Peak current	30mA
Operating temperature range	–65 to +150°C
Wavelength of maximum response	2200 Angstroms

Response decreases rapidly below 1900A and above 2600A

Note

A resistor of 1·5kΩ minimum is required in series with one tube pin and immediately adjacent to the tube base.

Connections

Two opposite pins may be mounted in a slightly modified standard tube base. Tube guards, protective shields or retainers (exclusive of those in the socket) should not be less than $\frac{3}{8}''$ from the bulbs. The socket may be mounted on a metal panel.

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Sensitivity

1800 to 4000 counts per minute. Sensitivity is referred to a photo tube operated on 50 c/s and illuminated by a vertical commercial gas flame $1\frac{3}{4}''$ high spaced 12″ from the photo electrodes with the long axis of the bulb pointing horizontally towards the flame. This flame is approximated by that of a $\frac{3}{4}''$ diameter candle.

An electronic counter of suitable range is used to measure the number of conducting half cycles per minute.

Background count

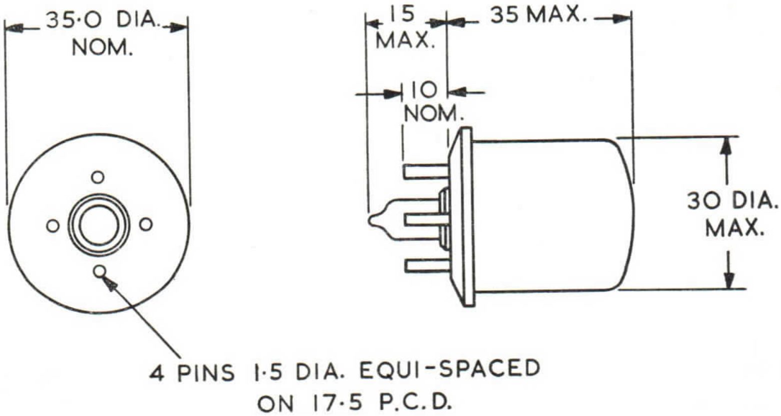
One count to five minutes approximately (Cosmic rays at sea level).

Direct sunlight

(Sea level) Ten counts per minute.

APPLICATION

The principal application of the AEI Flame Detector is as a safety device in stores, warehouses, etc., or wherever there is a fire danger. It is particularly suitable for applications where there is a danger of spontaneous combustion, as it will operate relays directly and hence the response time of extinguishing apparatus can be extremely rapid. For long life it is recommended that the resistance R be as high as possible so that the current through the flame detector during conduction is at a minimum for satisfactory operation. The relay must be of sufficient rating so that it will not be tripped by random half cycle discharges, in the Flame Detector, caused by cosmic rays and stray ultra-violet radiation.



Dimensions are in millimetres.

Fig. 1 Outline of type 27F12 Flame detector.

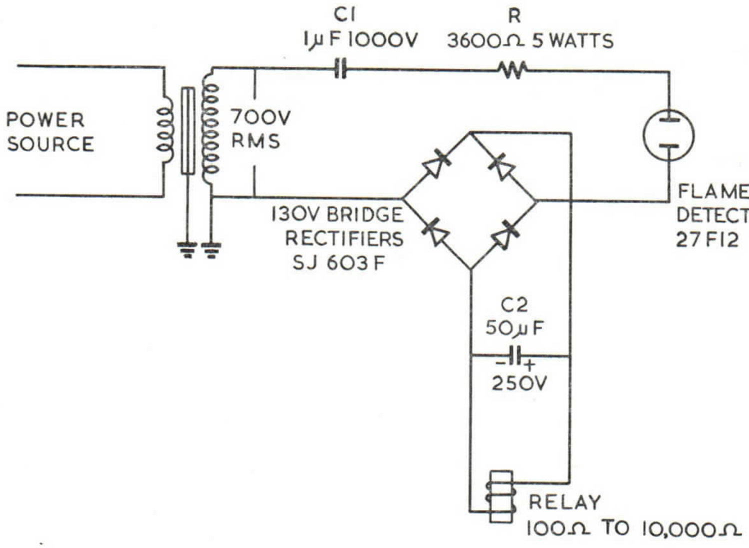


Fig. 2 Full wave a.c. circuit using short high current pulses.